A REVISED ESTIMATE OF CROP LOSS IN SUGARCANE CAUSED BY NEMATODES

VW SPAULL

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

Abstract

Previous estimates of crop loss from nematodes in the South African sugar industry were derived from data from conventional nematicide trials. These estimates were regarded as provisional as there could have been bias in the choice of sites. To avoid bias, a total of 48 crop loss trials were conducted over a period of three seasons in fields that were not known to have a problem from nematodes. An additional criterion for site selection was that the soil had a clay content of about 10%. The soil at most of the sites was of a Cartref or Kroonstad form. Each trial comprised replicated, paired plots treated with a split application of 11-15 kg aldicarb/ha and an untreated control. The results confirmed that, in loamy sand and sandy loam soils, unsuspected losses from nematodes are widespread. The magnitude of the responses to treatment varied from season to season, from about 11% in a very dry season to about 32% when rainfall was close to the long term mean. Average losses for the industry from nematode damage are now estimated at more than 700 000 tons cane per annum.

Introduction

Previous estimates of crop loss in sugarcane caused by plant parasitic nematodes in the South African sugar industry indicated that as much as 900 000 tons of cane are lost each year (Spaull *et al.*, 1990). The crop loss data were derived from conventional nematicide trials and were possibly liable to bias resulting from the selection of the sites. It was argued that, although any bias was probably small, the crop loss estimates should be regarded as the probable maxima until data from randomly selected sites were available. This paper reports crop loss data from sites which, although not selected at random, are considered to be reasonably representative of the soil types to which they belong.

It is well known that nematodes are a serious growth constraint in the Recent sands of the sugar industry (Donaldson, 1985), but their importance in the more widespread loamy sand and sandy loam soils derived from Table Mountain sandstone is uncertain. Therefore the current crop loss work was focused on these slightly better soils.

It was shown that treatment with a high rate of aldicarb (Temik 150G) increased yields by about 25% over that from treatment with the rates used commercially (Spaull *et al.*, 1990). A high rate of application was therefore used in all the crop loss trials reported here, although at some sites lower rates were also used.

It is known that in the absence of pests aldicarb may affect the growth of a number of plants (Barker and Powell, 1988; Barker *et al.*, 1988; Garabedian and van Gundy, 1982; Griffin, 1988; Womack and Schuster, 1986; Kluge, 1992). Whether the effect of the chemical is positive or negative may depend on a number of factors (Barker *et al.*, 1988). Initial work conducted in 1979 (*Spaull, unpublished data) indicated that aldicarb did not enhance the growth of sugarcane but, rather, that it was slightly phytotoxic when applied at high rates. However, in view of the work of Barker *et al.*, (1988) additional observations were made on the effect of aldicarb on sugarcane. These are reported here together with the original unpublished data.

Methods

Site selection

Over the three seasons from 1991 to 1994 a total of 48 crop loss trials were conducted in 24 fields. Most were located in the North Coast extension region of KwaZulu-Natal. Nine of the fields were used for all three seasons, six were used for two seasons and the remainder for one season. Fields were selected if they were rated by the grower as not having a problem from nematodes, if they had a clay content of about 10% or more and, with one exception (see below), were available as recently cut ratoons. Site selection also ensured that most of the sites were on TMS-derived Cartref form sands, loamy sands and sandy loams (Table 1).

Most of the remaining sites were on hydromorphic soils of the Kroonstad form where infield drainage was necessary. Except for one plant crop (Compl in the 1991-92 season) all the crops were ratoons. Most of the fields had been planted with varieties NCo376 or N12 (Table 1); a few fields had been planted with N14 or N16. Soil samples were collected from each site for textural analysis. All the sites were rainfed except the Nkwln site, which was irrigated. Rainfall data were obtained from nearby meteorological stations.

Trial procedure

Paired plots, each 4 rows × 10 m long and replicated 4 to 16 times, were marked out in each field (Table 1). Each pair of plots was widely spaced from neighbouring pairs to ensure a wide range in nematode population size. Each of the pairs comprised one plot treated with aldicarb at 16,8 g/10 m row (equivalent to 112 g Temik 150G/10 m row) and one untreated plot. Row space varied from 1,1 to 1,5 m so the rate of chemical applied ranged from 11,2 to 15,3 kg aldicarb/ha, with an average of 13 kg/ha (= 75-102 kg Temik/ha). Half of the chemical was applied by hand over the row, 2 to 13 weeks after harvest of the previous crop and the remainder 10 weeks later.

In 36 of the 48 trials the previous crop was harvested in winter and the following ratoon crop treated before or during spring. Where the previous crop was harvested in spring the following crop was treated within six weeks. It had been shown in an earlier study that such delays between harvest and treatment of the following crop did not affect the efficacy of treatment with a nematicide (Spaull and Donaldson, 1983). The single plant crop was treated within one week of planting and again 10 weeks later.

At a number of the sites additional plots were established adjacent to paired plots and treated with 4,2 g aldicarb/10 m row. The row space in these sites ranged from 1,1 to 1,4 m, so the rate ranged from 3,0-3,8 kg aldicarb/ha with an average of about 3,4 kg/ha.

* VW Spaull, Head Nematology Section, Pathology Dept, SASEX, Mt Edgecombe

Table 1

Summary of data for the trial sites

Soil group[n] and Site	Soil parent material and soil form*		Clay %	Cane variety	Number of plots treated with c 13 kg aldicarb per hectare per season		
					1991-92	1992-93	1993-94
TMS							
Comp3	TMS	Cf	10,0	NCo376	8	-	-
CSE1	TMS	Cf	11,0	NCo376	8	7	11
CSE2	TMS	Cf	9,9	N12	4	7	11
CSE3	TMS	Cf	7,9	N12	-	8	-
Darnl	TMS	Cf	10,0	Nco376	6	6	9
Elph1	TMS	Cf	9,6	N12	8	8	10
Elph2	TMS	Cf	11,3	N12	6	8	8
Elph3	TMS	Cf	8,0	N12	7	-	-
Elph4	TMS	Cf	8,2	N12	5	8	10
Gill	TMS	Cf	8,5	N14	-	8	-
Mlmth	TMS	Gs	18,8	N12	-	6	-
Saxe1	TMS	Cf	9,8	NCo376	6	8	9
Saxe2	TMS	Cf	19,7	N12	6	7	-
Saxe3	TMS	Cf	11,4	NCo376	6	9	9
Zink	TMS	Cf	11,8	NCo376	-	6	6
Hydro							
Comp1	RS	Kd	10,5	N16	6	8	-
Comp2	All	Kd	12,9	N14	5	8	8
Comp5	All	Kd	12,0	NCo376	-	6	6
Fraz1	RS	Kd	14,1	N16	-	12	-
Fraz2	RS	Kd	11,8	NCo376	-	5	-
LM2	Cll	Kd	8,0	NCo376	16	14	-
LM5	MES	Kd	18,8	NCo376	-	13	7
Mtunz	All	Ka	12,2	N14	-	5	-
Nkwln	Cll	nk	11,3	Nco376	-	7	-

[n] Soil group:
TMS = soil derived from Table Mountain Sandstone. Hydro = hydromorphic soil.

* Soil parent material and soil form:
All = alluvium; Cll = colluvium; MES = Middle Ecca sandstone; RS = Recent sand; TMS = Table Mountain sandstone; Cf = Cartref; Gs = Glenrosa; Kd = Kroonstad; Ka = Katspruit; nk = alluvial sands overlying Lower Ecca Shales.

Soil samples were taken from the plots shortly before the first nematicide treatment, to determine the nature and abundance of the nematode populations. Additional samples were taken 10 and 20 weeks later. Each sample comprised 18 × 24 mm diameter cores per plot, to a depth of 220 mm. The nematodes were extracted from the soil by a combined decanting-sieving-Baermann tray method (Brown and Boag, 1988).

The application of fertiliser and herbicide to the cane in the trial plots was done by the co-operator along with the rest of the field. Additional hand weeding was occasionally necessary.

The plots at most of the sites were harvested after 11 to 14 months of growth. Exceptions were the 1992-93 CSE3 site and the 1992-93 Comp2 and CSE2 sites, which were cut after 10 months, and the 1991-92 LM2 site and the 1992-93 Mlmth site, where the cane was 19 months old when harvested.

Shortly before the cane was harvested, a count was made of the number of stalks in the 8 m net rows, i.e. the centre two rows excluding 1 m from each of the ends, of the treated and control plots. The cane was then sample-harvested as follows: two lots of 30 adjacent stalks were cut from predetermined points in each of the two net rows. The leaves and tops were removed, and the mass of the 120 stalks from each plot was recorded. A representative 12-stalk subsample was collected for sucrose analysis. Mass of cane and sucrose/ha were derived from these measurements.

Influence of aldicarb on sugarcane

The effect of aldicarb on sugarcane in the absence of soil pests was measured in two pot trials, one on plant cane in 1979 and the other on a plant crop and the subsequent ratoon initiated in 1993.

In the first trial, pre-germinated single-budded setts of variety NCo376 were planted in methyl bromide sterilised river sand in 260 × 300 × 100 mm deep seed trays in a glasshouse. Corn-cob-based granules of Temik 150G were applied as a single application in a shallow furrow in the sand over the setts, at rates equivalent to 0,21, 0,42 and 0,84 g aldicarb/m (or 1,75, 3,5 and 7,0 kg aldicarb/ha, assuming a 1,2 m row space). There were four setts per tray and the treatments were replicated five times with two untreated controls. The plants were watered as required and fertilised with a hydroponic solution weekly. After 11 weeks the trial was terminated. The stalks and roots were weighed and the tips of the leaves indexed for the amount of scorching present on the leaf tip.

In the second pot trial, pre-germinated single-budded setts of variety N12 were planted in methyl bromide sterilised soil from the LM2 site in 400 × 220 × 210 mm deep asbestos pots outdoors. After three weeks, gypsum-based granules of Temik 150G were applied as a single application on the surface of the soil, at a rate equivalent to 0,36 g aldicarb/m (or 3 kg aldicarb/ha, assuming a 1,2 m row space) and as a split application equivalent to 1,68 g aldicarb/m, half at three weeks and half at 13 weeks after planting (= 14 kg aldicarb/ha). There were four setts per pot and the treatments were replicated 10 times, with two untreated controls. The plants were watered as required and fertilised with a hydroponic solution weekly. After 20 weeks the plant crop was harvested and the length and mass of the stalks recorded. Treatment of the following ratoon crop was as follows: five weeks after harvesting the plant crop, the 0,36 g aldicarb/m treatment was reapplied to the same pots and a 10 week split application of aldicarb at 1,68 g/m was made to one of the previously untreated controls. The pots previously treated at 1,68 g/m were left untreated, as were the remaining control pots. The plants were maintained as before. The cane was harvested after 30 weeks, growth and the length and mass of the stalks and the mass of the roots were recorded.

Results

During the first two seasons, rainfall was well below the long term mean. In the third season it was close to the mean (Table 2).

Nematode fauna

The nematode fauna in both the TMS-derived soils and the hydromorphic soils was dominated by *Pratylenchus zeae, Helicotylenchus dihystera, Xiphinema elongatum* and, to a lesser extent, *X. mampara*, and species of *Paratrichodorus, including P. lobatus, P. minor* and *P.cf porosus*. Other nematodes that were less abundant and that were less frequently found included species of *Criconemella, Hemicycliophora, Longidorus, Meloidogyne, Rotylenchus, Rotylenchulus, Scutellonema* and *Tylenchorhynchus*. Relatively large numbers of *Pratylenchus* and *Helicotylenchus* occurred in most of the sites; *Xiphinema* and *Paratrichodorus* were less numerous (Table 3). The numbers of nematodes present in the two soil groups at the start of each of the trials in the three seasons were remarkably consistent

Table 2

Mean annual rainfall (mm) for the Table Mountain sandstone (TMS) and hydromorphic (Hydro) sites and as percentage of long term mean (LTM)

Rainfall and soil group		1991-1992	1992-1993	1993-1994
Rainfall/site/annum	TMS	650 (11)*	639 (13)	976 (9)
	Hydro	807 (3)	587 (8)	1 015 (3)
	Mean	683	618	986
Annual rainfall (LTM)	TMS	1 026	1 026	1 033
	Hydro	1 034	1 067	1 034
	Mean	1 028	1 043	1 033
Rainfall/site % LTM	TMS	63,2	62,6	94,4
	Hydro	78,1	54,8	98,1
	Mean	66,4	59,6	95,3

* Number of sites in parenthesis.

Table 3

Initial population densities of the four common genera, Mean (± standard error) per 100 ml soil at the start of each trial in the Table Mountain sandstone (TMS) and Hydromorphic (Hydro) soil groups

	Soil	1991-1992	1992-1993	1993-1994
Pratylenchus	TMS	207 (±21,7)	159 (±19,4)	276 (±34,1)
	Hydro	231 (±114,5)	229 (±42,3)	749 (±52,7)
Helicotylenchus	TMS	260 (±35,7)	199 (±36,1)	187 (±23,5)
	Hydro	253 (±90,4)	198 (±34,1)	437 (±166,2)
Xiphinema	TMS	46 (±5,0)	51 (±5,4)	78 (±4,5)
	Hydro	103 (±27,5)	85 (±12,6)	70 (±10,0)
Paratrichodorus	TMS	64 (±10,0)	43 (±7,0)	41 (±5,1)
	Hydro	122 (±41,6)	91 (±17,0)	112 (±32,7)

Table 4

Mean per cent reduction in numbers of nematodes in all the sites following treatment with 11,2 to 15,3 kg aldicarb/ha

Nematode	Sampling occasion	Season			
		1991-92	1992-93	1993-94	Mean
Pratylenchus	10 wk	13,6	45,9	42,3	33,9
	20 wk	57,2	74,1	71,9	67,7
Helicotylenchus	10 wk	41,6	51,1	60,9	51,2
	20 wk	78,7	76,9	78,5	78,0
Xiphinema	10 wk	13,3	46,5	19,2	26,3
	20 wk	67,4	80,6	80,2	76,1
Paratrichodorus	10 wk	51,9	74,2	68,9	65,0
	20 wk	84,6	85,7	73,7	81,3

Table 5

Mean per cent reduction in numbers of nematodes following treatment with 3,0-3,8 kg aldicarb/ha (average c 3,4 kg) and 11,2-15,3 kg aldicarb/ha (average c 13,0 kg). Data for the 1992-93 season are from five TMS and five hydromorphic soil sites; data for the 1993-94 season are from one TMS and one hydromorphic soil site

Nematode genus	Sampling occasion	1992-1993		1993-1994	
		3,4 kg aldicarb	13,0 kg aldicarb	3,4 kg aldicarb	13,0 kg aldicarb
Pratylenchus	10 wk	35,0	60,5	36,3	45,3
	20 wk	31,1	79,3	30,1	77,2
Helicotylenchus	10 wk	35,7	38,4	25,5	16,9
	20 wk	27,1	76,8	−1,1	74,8
Xiphinema	10 wk	26,3	53,6	27,5	−16,7
	20 wk	45,6	82,8	47,0	74,0
Paratrichodorus	10 wk	64,8	81,5	22,3	57,2
	20 wk	49,5	84,0	−3,2	66,8

(Table 3). The only exception was *Pratylenchus* in the three hydromorphic soils in the 1993-94 season, where numbers were significantly greater than in the preceding two seasons and greater than in the TMS group of soils ($p<0,05$).

Treatment with 11-15 kg aldicarb/ha had a marked effect on the nematodes. Compared with the untreated controls numbers were reduced by between 13 and 74% 10 weeks after the first application, and by between 57 and 86% after 20 weeks, i.e. 10 weeks after the second application (Table 4). The effect of the treatment, when measured at 20 weeks, was similar each year. *Paratrichodorus* appeared to be more sensitive to treatment with aldicarb than the other nematodes. With two exceptions in the 1993-94 season, fewer nematodes were killed by the lower rate of application of aldicarb, especially when measured 20 weeks after treatment (Table 5).

Cane and sucrose yields

Yields of cane and sucrose in the untreated control plots and the response to treatment with 11-15 kg aldicarb/ha were generally lower on the TMS soils than on the hydromorphic soils, and were generally lower in the 1992-93 season than in the preceding and following season (Tables 6 and 7). The average response for all sites in the 1992-93 season was 11% (5 t cane/ha) compared with 22% (10 t cane/ha) in the first season and 32% (15 t cane/ha) in the third season. Similarly, responses to the lower rates of aldicarb were smaller in the 1992-93 season than in the other two seasons (Table 8). Excluding data for the 1992-93 season, the average response to treatment with the high rates of application of aldicarb was about two to three times larger than that obtained from the lower rates (compare data in Tables 6, 7 and 8).

Table 6

Yield of untreated sugarcane (t cane/ha) and response to treatment with 11,2 to 15,3 kg aldicarb/ha

Soil group[n] and Site	1991-1992		1992-1993		1993-1994	
	Control yield	Response	Control yield	Response	Control yield	Response
TMS						
Comp3	34,3	3,5				
CSE1	43,8	2,1	42,2	3,0	47,2	13,4**
CSE2	42,3	18,8	40,2	−1,2	35,4	17,1**
CSE3			31,8	4,7*		
Darnl	50,7	16,4**	19,6	6,4*	34,6	11,8**
Elph1	34,6	7,6*	33,2	5,6*	42,1	11,3*
Elph2	25,9	7,0*	23,0	−2,2	30,5	12,4**
Elph3	33,4	3,1				
Elph4	15,9	7,4	30,5	2,9	44,9	6,7
Gill			45,5	15,5*		
Mlmth			102,7	10,1		
Saxe1	69,7	5,4	24,6	2,6*	39,3	12,5*
Saxe2	56,7	3,6	27,0	1,3		
Saxe3	55,7	9,5	29,2	1,0	40,3	11,1**
Zink			34,1	1,6	37,3	12,8**
Mean	42,1	7,7 (18%)	37,2	3,9 (10%)	39,1	12,1 (31%)
Hydro						
Comp1	70,5	30,0*	51,1	5,0		
Comp2	56,9	18,3*	18,5	6,4	51,1	25,2**
Comp5			16,9	1,3	62,0	27,2**
Fraz1			78,5	1,0		
Fraz2			91,9	9,0		
LM2	40,8	7,0	28,7	10,6*		
LM5			49,7	7,5	78,5	15,1*
Mtunz			45,4	11,0		
Nkwln			72,6	3,6		
Mean	56,1	18,4 (33%)	50,4	6,2 (12%)	63,9	22,5 (35%)

[n] Soil group: see Table 1.
* Yield of treated cane significantly greater than the untreated control (p<0,05).
** Yield of treated cane significantly greater than the untreated control (p<0,01).

Table 7

Yield of untreated sugarcane (t ers/ha) and response to treatment with 11,2 to 15,3 kg aldicarb/ha

Soil group[n] and site	1991-1992		1992-1993		1993-1994	
	Control yield	Response	Control yield	Response	Control yield	Response
TMS						
Comp3	3,0	−0,2				
CSE1	4,5	−0,1	4,3	0,3	5,9	1,8**
CSE2	4,9	2,0	5,4	−0,3	4,6	2,1**
CSE3			4,0	0,4		
Darnl	5,7	1,4*	1,9	0,3	4,0	1,2**
Elph1	4,0	0,7	4,3	0,4	4,9	1,5*
Elph2	3,0	0,7	2,9	−0,6	3,9	1,6**
Elph3	4,1	0,2				
Elph4	1,8	0,7	3,9	−0,1	6,3	0,7
Gill			5,3	2,1*		
Mlmth			14,6	1,3		
Saxe1	7,4	0	2,8	0,1	5,2	1,3*
Saxe2	6,4	0,1	4,1	0,1		
Saxe3	6,9	1,4	3,9	0	5,2	1,3*
Zink			3,3	−0,2	4,8	1,4*
Mean	4,7	0,6 (13%)	4,7	0,3 (6%)	5,0	1,4 (28%)
Hydro						
Comp1	7,9	3,6	5,7	0		
Comp2	6,6	2,3	2,4	0,6	5,9	2,9**
Comp5			1,3	0	6,8	2,9**
Fraz1			8,9	−0,3		
Fraz2			11,5	0,9		
LM2	4,5	1,0	2,1	0,9		
LM5			6,6	1,0	10,7	1,7*
Mtunz			6,3	1,7		
Nkwln			9,2	0,4		
Mean	6,3	2,3 (37%)	6,0	0,6 (10%)	7,8	2,5 (32%)

[n] Soil group: see Table 1.
* Yield of treated cane significantly greater than the untreated control (p<0,05).
** Yield of treated cane significantly greater than the untreated control (p<0,01).

Of the nine sites on TMS soils that were used over all three seasons, four had been planted with variety NCo376 and four to N12. The average response to treatment with the high rates of aldicarb over the three seasons was 20% for NCo376 and 25% for N12.

Most of the data from the present study are summarised in Table 9, which also contains much of the original crop loss data from Table 1 of Spaull *et al.*, (1990). As in the aforementioned study, the response to treatment with nematicide is assumed to be equivalent to the loss in yield caused by nematodes. The current sites, labelled 'NEW', have been grouped according to the soil parent material and the four clay content categories used previously. The yield of cane from the untreated controls and the response to the high rates of aldicarb have been adjusted to tons cane/ha/annum. In the original study, the area of the various soil parent materials under cane was based on the proportions given in Anon (1984), on unpublished data of *Meyer and on an estimated total area under cane of some 392 000 ha. However, the average age of cane at harvest is greater than 12 months and the actual area of cane harvested each year, over the past few years, has been about 270 000 ha (Bond and Murdoch, 1994). Consequently the estimated area of each of the soil groups under sugarcane, given in the original table, has been altered to the estimated area of cane cut each year. The same adjustment has been made to the correction for the reduction in the loss in yield following the actual commercial use of nematicides (see Spaull *et al.*, 1990). The projected total loss of cane is derived from the product of the response to treatment with nematicide per hectare per annum and the estimated area of cane cut each year.

Since the new estimates for the loss in yield on TMS soils with 6-10 and 11-20% clay are very similar to the previous estimates derived from conventional nematicide trials, the projected total loss has been calculated from the mean of the old and new data.

From the revised data given in Table 9 it is estimated that the total loss in yield of sugarcane caused by nematodes in the South African sugar industry is more than 700 000 t/annum. This excludes data from alluvial and colluvial soils. As in the previous study (Spaull *et al.*, 1990), no attempt has been made to estimate the proportion of these soils within each of the four categories of soil texture due to the variable

* JH Meyer, Head Chemistry and Soils Dept, SASEX, Mt Edgecombe

Table 8

Response to treatment with aldicarb at 3,0 to 3,8 kg/ha

Seasons and sites	Tons cane/ha		Tons ers/ha	
	Control yield	Response to treatment	Control yield	Response to treatment
1991-92				
Comp3 (n=5)	30,1	1,7	3,0	−0,8
Darnl (n=6)	50,2	5,1	5,7	0,6
Compl (n=4)	65,5	12,7	7,9	1,3
Comp2 (n=4)	53,9	9,1	6,6	0,7
Mean	49,9	7,1 (14%)	5,8	0,5 (8%)
1992-93				
CSE3 (n=8)	31,8	1,5	4,0	0
Darnl (n=12)	20,4	1,5	2,0	0,1
Gill (n=8)	48,3	−1,2	5,7	0,1
Mlmth (n=6)	102,7	−4,7	14,6	−0,5
Zink (n=4)	35,3	−0,9	3,5	0
Compl (n=5)	51,8	−3,3	5,7	−0,6
Comp2 (n=6)	19,5	3,1	2,4	0,3
Comp5 (n=3)	15,6	0,5	1,0	0,1
Frazl (n=5)	76,8	−5,5	9,0	−1,2
LM5 (n=8)	49,5	−5,6	6,6	−1,1
Mean	45,2	−1,5 (−3%)	5,5	−0,3 (−5%)
1993-94				
CSE2 (n=8)	30,9	14,2*	4,0	1,9
Darnl (n=6)	35,3	2.3	4,1	0,3
Zink (n=3)	37,5	8,7	5,1	1,3
Comp2 (n=4)	43,5	15,2	5,3	1,6
Comp5 (n=3)	58,6	6,7	6,1	1,0
LM5 (n=6)	74,4	6,5	10,3	0.8
Mean	46,7	8,9 (19%)	5,8	1,1 (19%)

* Yield of treated cane significantly greater than the untreated control ($p<0,05$)

Table 9

Revised estimates of the loss in yield of sugarcane due to nematodes in South Africa (derived in part from Spaull *et al.*, 1990)

No. of trials	Soil group	Yield of untreated cane (t/ha/ann)	Est area of cane cut per annum (ha)	Loss in yield (t/ha/ann)	Projected total loss (tons cane /ann)
	2-5 % clay				
39	Recent sand	36,0	4 960	19,2 ± 1,7 (+24%)*	95 232 22 856
19	TMS Ordinary	43,3	6 750	9,7 ± 1,6	65 475
	Correction for cane treated with nematicide				−117 932
	Sub total				65 631
	6-10% clay				
44	Recent sand	62,7	9 300	12,8 ± 1,9 (+25%)*	119 040 29 760
19 19	TMS Ordinary TMS Ordinary NEW	56,6 36,7	26 860	8,7 ± 1,7 8,4 ± 1,3 mean=	229 653
	Correction for cane treated with nematicide				−29 975
	Sub total				348 478
	11-20% clay				
4	Recent Sand NEW	67,1	3 000	10,5 ± 5,9	31 500
5 14	TMS Ordinary TMS Ordinary NEW	52,2 38,8	26 860	6,1 ± 3,4 6,0 ± 1,4 mean=	162 503
2	Middle Ecca sandstone NEW	62,2	5 900	11,0 ± 4,1	64 900
	Sub total				258 903
	21-35% clay				
12	TMS Mistbelt	63,3	4 470	3,6 ± 1,1	16 092
1	Swaziland Basic Rock	190,6	1 650	23,5	38 775
	Sub total				54 867
	GRAND TOTAL				727 879

* Correction for increased response to above standard rate of nematicide on Recent sands. See text and Spaull *et al.*, (1990).

nature of the clay content in the profile of such soils. In the nine trials on alluvial and colluvial soils the untreated controls yielded an average of 42,0 t cane/ha/ann and the response to treatment was 12,5 t cane/ha/ann.

Effect of aldicarb

In the two pot trials none of the aldicarb treatments had a significant positive effect on the growth of sugarcane ($p<0.05$) although yields were slightly greater following treatment with the high rate in the second trial (Table 10). In the first trial root mass was depressed at the highest rate of application and scorching of the leaf tip was greater at the two higher rates ($p<0,05$).

Discussion and conclusions

The previous estimates of crop loss from nematodes in the South African sugar industry were based on data from nematicide trials (Spaull *et al.*, 1990). Although such data might be thought to be biased, it was argued that most of

Table 10

Effect of different rates of aldicarb on the growth of sugarcane in pots

Rate of chemical applied	Combined shoot length (mm)	Shoot dry mass/pot (g)	Root dry mass/pot (g)	Leaf scorch index!
Trial 1, Plant crop, Sept-Nov 1979				
Control (mean of two)	1 100	20,4	8,8	0,1
Aldicarb 0,21 g/m	1 120	20,8	7,4	0,2
Aldicarb 0,42 g/m	1 048	19,6	8,2	1,0*
Aldicarb 0,84 g/m	1 056	17,6	6,5*	1,6*
Trial 2, Plant crop, Dec 1993-Apr 1994				
Control (a)	4 919	436		
Control (b)	4 961	455		
Aldicarb 0,36 g/m	4 697	421		
Aldicarb 1,68 g/m	4 707	465		
Trial 2, Ratoon crop, Apr-Nov 1994				
Control(a)** — Control	3 233	289	102	
Control(b)** — Aldicarb 1,68 g/m	3 600	308	115	
Aldicarb 0,36 g/m** — Aldicarb 0,36 g/m	3 203	285	85	
Aldicarb 1,68 g/m** — Residual aldicarb	3 139	306	109	

! Index: 0 = no scorching to 3 = scorching of leaf extending back from the tip.
* Significantly different from untreated control ($p<0,05$).
** Treatment of preceding plant crop.

the trial sites were reasonably representative of the various soil textural categories within the different types of soil parent material. Extrapolating from the trial sites to the much greater area under commercial cane was therefore considered to be justified. This is supported by the new estimates, which are based on data from fields where nematodes were not known to be a problem. Although these fields were not selected at random, it seems unlikely that they were selected with a bias that would provide misleading crop loss data. The new crop loss/ha data for TMS-derived soils are remarkably similar to the original data, which were based on the response to 3 kg aldicarb/ha and not 13 kg as in the present study (Table 9). These observations are applicable also for data from the alluvial and colluvial soils. In three nematicide trials on alluvial soils, reported on in the previous study, the average response to treatment with 3 kg aldicarb/ha was 14,3 t cane/ha/annum. In the nine trials on alluvial and colluvial soils in the present study the average response to the high rates of aldicarb was 12,5 t cane/ha/annum. It may be assumed that, with more than 27 000 ha of alluvial soils harvested each year, the overall crop loss in such soils is considerable. Data are not available for any losses that may occur on the more than 70 000 ha of soils in the sugar industry derived from Granite and Dwyka tillite.

A feature not apparent in previous work with nematicides in sugarcane is the very marked season-to-season variation in the magnitude of the response to treatment. It appears that this was not due to differences in the size of the nematode populations, as these varied little from one season to the next (Table 3). Nor does it appear to be due to differences in the level of control of the nematodes, as the poor responses in the 1992-93 season were not associated with poor control (Table 4). However, it does seem to coincide with the amount of rainfall received by the crop, there being generally greater responses in the season when rainfall was close to the long term mean than when less rain was recorded (see Tables 2, 6 and 7). Furthermore, the large responses in the third season coincide with the good rainfall that was recorded within the first one or two months of growth of the new crop (Table 11). This contrasts with observations from a number of nematicide trials on lighter textured soils. In trials on poor Recent sands, the response to treatment was notably greater when rainfall was less than 200 mm during the first five months of growth (Donaldson, 1985). Also, in a plant crop and two ratoon crops on a Recent sand, the response to a nematicide was greater under rainfed conditions than where the cane was irrigated with 100% of its water requirement (Donaldson and Turner, 1988). The relationship between cane yield, rainfall and nematodes requires clarification.

Table 11

Mean rainfall (mm) per month before and after harvest of the preceding crop (averaged over all sites except the Nkwln site, which was irrigated)

Months before and after harvest	**1991-1992** (n = 14)	**1992-1993** (n = 18)	**1993-1994** (n = 12)
−2 months	109	19	16
−1 month	46	10	41
Crop harvested			
+1 month	45	12	85
+2 months	36	25	113
+3 months	49	37	146
+4 months	71	62	150
+5 months	92	85	119

Aldicarb can enhance the growth of a number of plants and for this reason Barker *et al.* (1988) voiced a word of caution concerning the use of this type of chemical when assessing the level of damage caused by nematodes. Data from the two pot trials show that aldicarb has no significant positive effect on the growth of sugarcane. However, a number of factors may influence the response of a plant to aldicarb, including temperature, dosage, soil moisture content, soil texture and crop cultivar (Barker *et al.*, 1988). The effect of all these factors was not investigated in the two pot trials, and enhanced growth from aldicarb may have contributed to the increased yields in the treated plots in the present study.

The new projected total loss in yield is somewhat smaller than the previous estimate in Spaull *et al.* (1990) because, in the calculation, it was necessary to substitute the total area under cane (incorrectly used in that publication) with the smaller area of cane cut each year. Nevertheless, the estimate of more than 700 000 tons of cane per annum represents a huge loss of income, amounting to more than R70 000 000 per year (assuming R100/t cane). The data show that only a proportion of the losses can be prevented using the lower rates of aldicarb (see Tables 6, 7 and 8). These rates are close to the registered rates of 2,25 to 3,0 kg/ha that may be used commercially. Alternatives to chemical control of nematodes in sugarcane are required.

Acknowledgements

Sincere thanks are due to colleagues from the Experiment Station who assisted with this project, and particularly to the several cane growers without whose co-operation this work would not have been possible.

REFERENCES

Anon (1984). Identification of the soils of the sugar industry. Bulletin No 19 (revised). *S Afr Sug Ass Exp Stn*, 112 pp.

Barker, KR and Powell, NT (1988). Influence of aldicarb on the growth and yield of tobacco. *J Nematol* 20: 432-438.

Barker, KR, Koenning, SR, Bostian, AL and Ayers, SR (1988). Growth and yield responses of soybean to aldicarb. *J Nematol* 20: 421-431.

Bond, RS and Murdoch, MG (1994). Summary of agricultural data for the South African sugar industry (1950-1994). *Proc S Afr Sug Technol Ass* 68: xv-xviii.

Brown, DJF and Boag, B (1988). An examination of methods used to extract virus-vector nematodes (Nematoda: Longidoridae and Trichodoridae) from soil samples. *Nematol medit* 16: 93-99.

Donaldson, RA (1985). The effects of soil pH, clay content, rainfall and age at harvest on the yield response of sugarcane to Temik. *Proc S Afr Sug Technol Ass* 59: 164-167.

Donaldson, RA and Turner PET (1988). A preliminary report of the effect of soil moisture level on responses to Temik and Curaterr. *Proc S Afr Sug Technol Ass* 62: 164-168.

Garabedian, S and van Gundy, SD (1982). Growth enhancement and inhibiting effect of insecticides/nematicides on the growth of plants in the absence of nematodes. *J Nematol* 14: 440-441 (Abstr).

Griffin, GD (1988). Comparative nematicidal control of *Heterodera schachtii* on sugar beet as affected by soil temperature and soil type. *Plant Dis* 72: 617-621.

Kluge, RL (1992). Effect of aldicarb on the growth of crofton weed, *Ageratina adenophera*. *Appl Plant Sci* 6: 48-49.

Spaull, VW and Donaldson, RA (1983). Relationship between time of nematicide application, numbers of nematodes and response to treatment in ratoon sugarcane. *Proc S Afr Sug Technol Ass* 57: 123-127.

Spaull, VW, Donaldson, RA and Meyer, JH (1990). Provisional estimate of crop loss in sugarcane caused by nematodes. *Proc S Afr Sug Technol Ass* 64: 124-127.

Womack, CL and Schuster, MF (1986). Testing the reported positive growth response for cotton, *Gossypium hirsutum, treated with aldicarb. J Econ Entomol* 79: 1118-1120.