EFFECTS OF NEMATICIDES AND METHODS OF APPLYING THEM ON FIELD GROWN SUGARCANE

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Abstract

The nematicides, aldicarb, 'D-D', EDB 2,25, DBCP 80 E.C. and a 10% granular formulation of DBCP were tested on sugarcane grown in a sandy soil which was known to be infested with nematodes. Plots treated with aldicarb gave the highest yields, and 'D-D' was more effective than EDB. Two DBCP formulations failed to cause significant growth responses.

Using tractor-mounted tine injector applicators, different methods of placement of the liquid formulations were compared. At the rates used in this experiment, no difference in effectiveness was found between injecting the nematicides 3 weeks before planting, a) along a line on which the planting furrows were later to be drawn, and b) into the base of drawn planting furrows. However, these treatments were found to be more effective than those in which the nematicides were injected overall into the soil with a multi-tined implement, the tines of which were 38 cm apart. DBCP 80 E.C. appeared to be equally effective when applied 3 weeks before planting and at the time of planting. EDB 2,25 applied by means of an injector gun did not improve the yield of cane. Nematodes found in this experiment were *Meloidogyne, Pratylenchus, Rotylenchulus Trichodorus, Criconemoides, Xiphinema* and Hoplolaims.

Introduction

Since 1956 nematodes have been recognized as serious pests of sugarcane cultivated on extensive areas of sandy soils in South Africa (Dick and Harris, in press). During this time much has been learnt about the nematode problem and the use of nematicides in sugarcane fields. Treatment with certain of the effective chemicals has also become economically more acceptable. In consequence it was decided to test these nematicides on a scale more closely resembling that which would be followed in commercial practice. The methods and results of one such experiment are described and discussed here.

Methods and Materials

The site chosen for the experiment was on a Clansthal sand at Tongaat on the Natal north coast. It had a history of poor cane growth. Samples of soil and crop roots showed infestations of the following genera of phytoparasitic nematodes: *Meloidogyne, Pratylenchus, Rotylenchulus, Trichodorus, Criconemoides, Xiphinema* and Hoplolaims (nematodes in the sub-family Hoplolaiminae).

The nematicides used were 1,3-dichloropropene and 1,2-dichloropropane ('D-D'); ethylene dibromide, (EDB 2,25 in hydrocarbon diluent); 1,2-dibromo-3-chloropropane, (DBCP); and a 10% granular formulation of 2-methyl-2-(methylthio) propionaldehyde O-(methylcarbamoyl)oxime, (aldicarb). A 4 x 4 lattice design with 14 treatments and two controls was used and replicated four times. Plots were twelve metres long and consisted of five rows spaced 1,4 metres apart. The first three treatments with the liquid formulations were applied 3 weeks before planting when the soil contained 7% moisture and the soil temperature at 23 cm depth was 21°C. The nematicides were injected into the soil by means of a pressure jet tine applicator with sealing roller, at a depth of 23 cm, and with a spacing of 38 cm between injection nozzles. The treatments were:

1. 'D-D' : 281 litres per hectare
2. EDB 2,25 : 101 kg active ingredient per hectare
3. DBCP 80 E.C. : 44 kg active ingredient per hectare.

The second three treatments with the liquid formulations were also applied 3 weeks before planting by means of a pressure-fed, tractor-mounted, single-tine applicator at a depth of 23 cm. The applications were made along the line where, 18 days later, the planting furrows were drawn. By driving a tractor wheel along the application line, the soil was sealed immediately after application of the nematicide. The treatments were:

4. 'D-D' : 225 litres per hectare (31,5cc/m)
5. EDB 2,25 : 76 kg a.i. per ha. (10,6g/m)
6. DBCP 80 E.C. : 29 kg a.i. per ha. (4,1g/m)

A further 3 treatments (7,8 and 9 respectively) with these three chemicals were applied at the same rates by means of the single-tine applicator in plots where the planting furrows were drawn 3 weeks before planting. The injections were made at a depth of 15 cm below the furrow base, and again the soil was sealed by driving a tractor wheel over the application line.

A tenth treatment using EDB was made by means of a hand injector-gun, at a depth of 23 cm below the soil surface (at the point of injection) and with injections spaced 30 cm apart. These were made along the centre of the ridge on either side of the furrow, halfway down the wall on each side of the furrow and into the base of the furrow. The treatment was:

10. EDB 2,25 : 101 kg a.i./ha

Four additional treatments were carried out at the time of planting when the soil temperature at 23 cm depth was 19,5°C and the moisture content at the same depth was 10,2%. DBCP 80 E.C. was applied in the furrow base as described for treatment No.9. A 10% granular formulation of DBCP was applied evenly by hand in a band

approximately 20 cm wide in the planting furrow. Granules of 10% aldicarb were applied at two rates by means of a hand-drawn applicator in the furrow in a band no more than 8 cm wide. The treatments were:

11. DBCP 80 E.C. : 29 kg a.i./ha (4,1 g a.i./m)
12. DBCP 10% granules : 7,9 kg a.i./ha (11,1 g 10% G/m)
13. Aldicarb 10% granules : 2,8 kg a.i./ha (3,9 g 10% G/m)
14. Aldicarb 10% granules : 5,6 kg a.i./ha (7,8 g 10% G/m)

Treatments 15 and 16 were the controls.

The plots for treatments 7, 8, 9 and 10 having been ridged out previously, the plots for the remaining treatments were ridged out 3 days before planting took place on 20th October, 1970. The plots were fertilized and planted with variety N55/805.

Soil and root samples for nematode analysis were taken regularly from one replication of the experiment. The soil samples consisted of 10 cores taken down to 23 cm from the centre three rows of each plot with a 2,75 cm soil sampling tube. Using a Baerman funnel, nematodes were extracted from 20 ml sub-samples of each composite soil sample, and all extracted nematodes were counted. Roots were sampled by removing them from soil which was sampled with a spade to a depth of 23 cm at 10 places. Samples were again taken along the centre three rows of each plot. A flask incubation method was used for extracting the nematodes from 3 g sub-samples.

Following an exceptionally wet growing season, the plant crop of the experiment was harvested 375 days after planting.

Crop Results

During the experiment it became obvious from observations of the experimental and surrounding sugarcane that a growth gradient existed along the length of the experiment. By rating the growth of the surrounding sugarcane and taking into account the trend across the experimental area, allowance for this gradient was made statistically. This had the effect of decreasing the high yield variability (cv 19,9%) to a more satisfactory level (cv 13,1%). Table 1 shows the final yield and ERS (estimated recoverable sugar) results.

Table 1 Final yield results and mean numbers of flowers per plot

Treatment No.	Chemical	Placement	Method	Rate	Tons Cane/ha	ERS%	Tons Cane response	No. of flowers
14	Aldicarb	Furrow	Granular	56 kg/ha	158	13,2	+ 66	50
13	Aldicarb	Furrow	Granular	28 kg/ha	140	13,7	+ 48	56
4	'D-D'	Pre-furrow	Single-tine	225 l/ha	122	13,3	+ 30	151
7	'D-D'	In-furrow	Single-tine	225 l/ha	122	13,8	+ 30	103
8	EDB	In-furrow	Single-tine	76 kg a.i./ha	110	13,2	+ 18	147
5	EDB	Pre-furrow	Single-tine	76 kg a.i./ha	105	12,9	+ 13	184
11	DBCP E.C.	In-furrow	Single-tine	29 kg a.i./ha	104	13,8	+ 12	156
1	'D-D'	Overall	Multi-tine	281 l/ha	102	13,4	+ 10	137
2	EDB	Overall	Multi-tine	101 kg a.i./ha	99	13,8	+ 7	102
9	DBCP E.C.	In-furrow	Single-tine	29 kg a.i./ha	99	13,9	+ 7	169
15, 16	Controls				92	13,8		152
6	DBCP E.C.	Pre-furrow	Single-tine	29 kg a.i./ha	88	14,4	— 4	186
3	DBCP E.C.	Overall	Multi-tine	44 kg a.i./ha	84	13,4	— 8	109
10	EDB		Inject. gun	101 kg a.i./ha	80	13,2	— 12	164
12	DBCP	In-furrow	Granular	7,9 kg a.i./ha	76	14,4	— 16	138

The response to aldicarb both at the high and low rates (66 and 48 tons cane/ha respectively) was greater than the response to any other treatment and the yields were significantly higher than the mean yield of the control plots ($P < 0,01$). The difference between the responses to the two rates of aldicarb approaches significance at the 5% level.

When the methods of applying nematicides by means of tractor-drawn implements were compared (see Table 2), the two single-tine methods of placement were found to be equally effective, but there were significant differences (at the 1% level for tons cane/ha and at the 5% level for tons ERS/ha) between yields obtained where multi-tine and single-tine applications were made, the latter being the more effective.

Table 2 Comparison of results for different methods of placement of nematicides

Application method	Tons cane per hectare	ERS%	Tons ERS per ha.
Multi-tine overall	95	13,5	12,8
Single-tine pre-furrow	105	13,5	14,1
Single-tine post-furrow	110	13,6	15,0

Table 3 Comparison of results for the three nematicides, 'D-D', EDB and DBCP 80 E.C.

Nematicide	Tons cane per hectare	ERS%	Tons ERS per hectare
'D-D'	115	13,5	15,6
EDB	105	13,3	13,9
DBCP	90	13,9	12,5

Table 4 Comparison of results for nematicides applied by the single tine method

	Tons cane per hectare	ERS%	Tons ERS per ha.
'D-D'	122	13,6	16,6
Response over control	30		
EDB	108	13,1	14,0
Response over control	16		

The mean yields for treatments with each of the three liquid formulations applied by tined implements are given in Table 3. The differences were significant at the 1% level, 'D-D' being more effective than EDB, which was in turn more effective than DBCP.

In Table 4 the mean yields from plots treated by the single tine method are compared with those from control plots. It can be seen that 'D-D' caused the greatest response (significant at the 1% level) and that the response to EDB was significant at the 5% level. The mean response to DBCP was 4 tons cane/ha which was not statistically significant.

No significant differences were found between the yields from plots treated with DBCP before and at planting. Treatments with EDB using the injector-gun and with DBCP granules gave yields which were lower than those of the control plots. No reasons for these effects can be offered at this stage. Where significant yield increases occurred these were found to be due to both increased stalk populations and increased stalk weights.

An interesting observation made during this experiment was that flowering was greatly suppressed in the aldicarb-treated plots, as shown in Table 1.

Nematode Results

Extracts obtained by means of the Baerman funnel from samples of soil taken over the entire experimental area two days before the first treatments were made, indicated that the following nematodes were present: *Meloidogyne, Pratylenchus, Trichodorus, Rotylenchulus, Xiphinema* and Hoplolaims (nematodes in the sub-family Hoplolaiminae). Later during the experiment, using a sugar flotation technique, *Criconemoides* was found in all soil samples taken from control and aldicarb treated plots (see Table 6) and it is therefore probable that this nematode was present in all plots.

Table 5

Nematodes extracted from 20 ml of soil using the Baerman funnel technique. Nos. of saprobes to closest multiple of 5.

			Aldicarb		'D-D'			EDB				DBCP				
Treatment	Control plots		High rate	Low rate	In furrow	Along furrow line	Overall multi-tine	In furrow	Along furrow line	Overall multi-tine	Inject. gun	At plant	In furrow	Along furrow line	Overall multi-tine	Granules
No.	15	16	14	13	7	4	1	8	5	2	10	11	9	6	3	12
Sampling time								*Pratylenchus*								
Preplant	2	2	2	2	0	0	0	0	0	0	1	1	0	0	0	8
48 wks post-plant	45	3	5	6	3	12	5	3	14	17	10	15	42	17	10	94
								Meloidogyne								
Preplant	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3
14 wks post-plant	0	0	0	0	1	0	0	3	0	5	16	0	2	0	0	0
48 wks post-plant	35	23	10	18	6	3	7	3	22	4	22	17	45	6	5	8
								Trichodorus								
Preplant	1	0	1	3	0	0	0	0	0	0	1	0	0	0	0	0
8 wks post-plant	3	1	0	1	0	5	0	1	3	46	20	14	1	3	3	0
48 wks post-plant	1	3	1	4	25	3	5	2	8	8	26	1	5	6	2	10
								Hoplolaims								
Preplant	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
48 wks post-plant	1	0	2	7	1	1	1	0	0	1	0	2	10	2	0	3
								Rotylenchulus								
Preplant	1	0	0	0	0	0	0	0	0	1	0	2	0	0	0	1
48 wks post-plant	3	0	1	1	0	1	0	0	0	0	0	8	39	0	2	11
								Saprozoic nematodes								
Preplant	5	25	25	10	0	0	0	5	0	10	55	35	10	5	10	60

Table 6 Nematodes extracted from 100 ml soil by sugar flotation 4½ months after planting

Nematode	Numbers of nematodes extracted							
	Control plots				Aldicarb(5.6 kg) plots			
Meloidogyne larvae	0	0	2	0	1	6	0	2
Pratylenchus	14	33	3	13	9	21	12	14
Trichodorus	15	6	7	2	3	7	42	5
Hoplolaims	65	15	22	22	11	29	103	146
Rotylenchulus	8	5	1	0	1	2	3	11
Xiphinema	3	0	1	25	0	8	6	18
Criconemoides	12	6	17	3	4	4	2	5

Table 5 shows nematode counts for each treatment from soil samples taken at different times during the experiment. The "pre-plant" samples were taken 11 days after the pre-plant treatments were made and samples from the plots to be treated with aldicarb, DBCP 80 E.C. and DBCP granules at the time of planting can therefore be considered as additional controls. The results indicate generally that a reduction in nematode populations was achieved by all treatments. EDB applied with the injector-gun appeared to be less effective than the other EDB treatments.

Table 5 shows that *Pratylenchus* had reappeared in soil from all plots 48 weeks after planting. Its presence in the soil was first noted in samples taken 14 weeks after planting but it is interesting to note that it occurred in root samples taken from all plots only 8 weeks after planting.

Initially both root and soil samples yielded exceptionally few *Meloidogyne* larvae, even in material taken from control plots. By the 14th week after planting, larvae were beginning to appear, but their occurrence did not seem to be related to treatment in a systematic way. After 48 weeks all plots were infested. Table 5 also shows that as the experiment progressed, populations of *Trichodorus* increased in the soil of plots treated with the 'fumigant nematicides'. This observation confirms the results of previous work (Dick and Harris[1]). When the final soil sampling was conducted, 48 weeks after planting, all plots were found to be infested with this nematode.

The Hoplolaims and *Rotylenchulus* were seldom found in large numbers in the soil during the experiment. Table 6 which shows results from the sugar flotation extraction, indicates that these nematodes may have been more evenly distributed than the results suggest and that the Hoplolaims may have been more numerous than was first thought.

Conclusions

The foregoing results indicate that with the rates and methods of application used under the conditions prevailing during this experiment, aldicarb was more effective than 'D-D' which in turn was superior to EDB. Although DBCP was ineffective in this instance, it has been effective in others (Dick and Harris[1]).

The superior performance of the single tine method of placement compared with the multi-tined method was probably due to the greater concentration of nematicide directly beneath the cane row. To obtain an equivalent or better effect with the multi-tined implement the application rate per hectare would presumably have to be increased appreciably.

From the analyses of both root and soil samples taken during the experiment no definite conclusions can be drawn regarding the sugarcane/nematicide/nematode relationships. This is probably because large areas could not be sampled intensively enough, and consequently no one species or genus or group of genera could be rated more important than another. It has been shown experimentally in pot trials however, that *Meloidogyne javanica* Chit. (Dick[2]), *Pratylenchus zeae* Graham, and *Trichodorus christiei* Allen, (Harris, in preparation) can cause severe damage to sugarcane.

REFERENCES

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