INSECTICIDE TESTING AGAINST *ELDANA SACCHARINA* WALKER

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Abstract

The results of work on insecticides for the control of *Eldana saccharina* Walker are presented and discussed. A measure of control has been achieved in young ratoons under moist conditions, in seedcane dipped in various liquids for 30 minutes and in tall cane.

Introduction

Eldana saccharina Walker was first recorded as a pest in the South African sugar industry in 1939 when a severe infestation occurred on the Umfolozi flats. This infestation did not spread to the rest of the industry and died out in the early 1950s. The borer reappeared at Hluhluwe in 1970 and has since occurred throughout much of the industry; the only areas which are not affected are the cooler, higher inland areas (Atkinson *et al*[5]).

Work on insecticides was started in the mid 1970s, and during the ensuing years extensive field trials were conducted. In both observation and replicated field trials a wide range of insecticides were tested. They were applied to the crop at all growth stages including the setts, and progress was reported regularly in the Annual Reports of the SA Sugar Association Experiment Station. In 1980 a new programme of work on insecticides was initiated; cognisance was taken of previous work and of the accumulated knowledge of the pest's behaviour and biology.

This new programme envisaged laboratory bioassay of a wide range of insecticides to determine their toxicity to eldana larvae. The most promising insecticides would then be tested in the field. This programme also included work on different methods of applying the insecticides. Implicit in the programme was the assumption that eldana is primarily a pest of older cane. Under normal conditions this is valid but, in times of drought, very young ratoons may be so severely affected that ratoon failure results. Because of the recent drought some work has also been done on eldana occurring in the stubble of recently cut cane and in seedcane.

Seedcane Treatment

Materials and methods

Cane stalks from fields infested with eldana larvae were tied into bundles of 25 stalks and trimmed to a length of 800 mm. Four bundles were immersed into 200ℓ drums of various concentrations of insecticides. Unless otherwise stated, the stalks were immersed for 30 minutes. The bundles were then laid out under cover for three days after which each stalk was cut open and the number of live and dead larvae recorded.

Many of the larvae leave the stalks during and after immersion and it is not possible to count them in each stalk before treatment so, as a control, some bundles were not immersed. The number of live larvae found in treated bundles was expressed as a percentage of the number of live larvae in the control bundles.

Results and discussion

The results of the first trials, in which a variety of insecticides were used, are shown in Table 1. While all the insecticides caused a reduction of more then 90% in the number of larvae, the effect of water or water and wetter was surprisingly high and appeared to be the cause of much of the mortality otherwise attributable to insecticide.

TABLE 1

***E. saccharina* control in seedcane immersed in insecticide**

Insecticide	Concentration (g ai/ℓ)	Larvae control (%)
Chlorpyrifos 48% ec	0,96	95,2
Cypermethrin 20% ec	0,50	96,9
Dimethoate 40% ec	1,00	90,5
Fenitrothion 60% ec	1,20	98,5
Gamma-BHC 20% ec	1,00	98,4
Isazophos 50% ec	1,00	100,0
Malathion 50% ec	2,50	98,4
Monocrotophos 40% ec	0,80	95,4
Parathion 50% ec	1,00	98,5
Permethrin 50% ec	0,50	100,0
Phoxim 50% ec	1,00	93,8
Wetter	0,75*	92,3
Water	—	84,7

Number of larvae in control: 65
* mℓ product/ℓ

In the next trial, five insecticides were selected on the basis of their relatively low mammalian toxicity. These were each tested at four different concentrations and the results are shown in Table 2. All the insecticides reduced the number of larvae at the concentrations used, dimethoate being the least effective. Malathion and phoxim showed signs of becoming less effective as the concentration dropped below 0,5 g ai/ℓ while cypermethrin and permethrin were still effective at the lowest rates tested.

TABLE 2

***E. saccharina* control in seedcane immersed in selected insecticides**

Insecticide	Concentration (g ai/ℓ)	Larvae control (%)
Cypermethrin 20% ec	0,4	97,2
	0,2	100,0
	0,1	97,2
	0,05	97,2
Dimethoate 40% ec	0,8	87,5
	0,4	91,7
	0,2	86,1
	0,1	88,9
Malathion 50% ec	1,0	98,6
	0,5	100,0
	0,25	93,1
	0,125	91,2
Permethrin 50% ec	0,5	95,8
	0,25	100,0
	0,125	98,6
	0,0625	98,6
Phoxim 50% ec	1,0	94,4
	0,5	95,8
	0,25	79,2
	0,125	79,2

Number of larvae in control: 72

The results of trials conducted on the effects of water and wetter are shown in Tables 3 and 4. These confirm the original findings that much of the larval mortality recorded in previous trials was due to the effect of water, and that this effect is enhanced by the addition of wetter.

TABLE 3

***E. saccharina* control in seedcane immersed in water**

Water temperature °C	Dipping period (mins)		
	10	20	30
50	98,4	96,8	100,0
40	60,3	79,4	95,2

Number of live larvae in control: 63

TABLE 4

***E. saccharina* control in seedcane immersed in wetter**

Wetter concentration (mℓ prod/ℓ)	Larvae control (%)
0,5	91,7
0,25	98,6
0,125	83,3

Number of live larvae in control: 72

Conclusions

Immersion of seedcane in insecticide solutions for 30 minutes reduces the number of larvae but water alone accounts for approximately 85% of the mortality. The addition of a wetter increases the mortality by about 7%, so the effect of the insecticides is relatively small. Larval mortality in cane immersed in water increases with time and with the temperature of the water.

Eldana in Young Ratoons

Introduction

The problem of eldana in the stubble of recently cut cane was apparent during the drought of 1980/81 and became increasingly serious during the drought of 1982/83. The problem is manifested by poor shoot germination and the death of many of the shoots that do appear. Poor shoot germination may be caused by a combination of drought and a trash blanket; but eldana larvae may affect already stressed cane to the point of causing ratoon failure.

In most cases the larvae causing the damage enter the stool before the previous crop is cut. Where this crop is trashed, eggs may be laid on the trash and the emerging larvae then enter the young shoots.

Materials and methods

In mid 1981 four replicated trials were conducted in recently cut cane. Trial 1 was laid down at a site from which all trash was cleared completely. In Trial 2, the trash was parted over the rows while Trials 3 and 4 were set up in fields where the previous crop had been burnt. All 14 of the insecticides used in the four trials were applied soon after the previous crop was cut. The insecticides were applied at a rate of 5 kg ai/ha to the row only. The rows were covered with a light layer of soil soon after the chemicals had been applied so that they were not degraded by light. In Trial 2, the rows were not covered. The trials were sampled again four to five weeks after treatment and Trials 2 and 3 were sampled four to five weeks after the first sampling. The sampling method involved removing five stools from each plot and counting the eldana larvae.

During the past three years, three trials were conducted in Swaziland and were aimed at controlling the beetle *Heteronychus licas* (Klug) which also kills the young shoots of germinating cane. In these trials the insecticides were applied at 2,5 kg ai/ha to the row only. Shortly after treatment, the rows were covered with a light layer of soil and irrigated. Approximately four weeks after treatment, the number of shoots killed by eldana and by *H. licas* were recorded.

Four observation trials were conducted in late 1983 to test two synthetic pyrethroid insecticides. Trial 1 was laid down in a field where the previous crop had been burnt and in the other three trials, the trash was cleared from the trial area. The insecticides were applied at a rate of 300 g ai/ha to the rows only. Approximately five weeks later, all trials were assessed by counting the dead shoots in two 30 m rows.

Results and discussion

The results of the 1981 trials are shown in Table 5 while Table 6 shows the results of the Swaziland trials (eldana only). The results of the four observation trials conducted in late 1983 are shown in Table 7.

TABLE 5

***E. saccharina* numbers in young ratoons as a percentage of untreated control (1981 trials)**

Insecticide	Trial 1	Trial 2		Trial 3		Trial 4
		1st sample	2nd sample	1st sample	2nd sample	
Aldicarb 15% g	147	96	73			73
Azinphos-ethyl 35% ec		93	59	159	155	
Carbofuran 10% g	158*	82	54			127
Chlormephos 10% g	147	82	59			
Chlorpyrifos 48% ec						82
Endosulfan 35% ec		52	46	209	155	119
Fenamiphos 10% g				84	55	
Gamma-BHC 20% ec	147	74	36*			127
Isofenphos 5% g				125	167	
Monocrotophos 40% ec		93	82	84	155	146
Oxamyl 24% ec	145	93	54			164*
Parathion 50% ec	150	82	59			
Phoxim 50% ec				92	178	
Terbufos 10% g	178*			117	145	164*
Control No./sample	1,20	0,90	0,73	0,40	0,30	0,37
CV%	33,9	51,0	77,4	53,1	55,1	43,6

* significantly different from control (P=0,05)

TABLE 6

Number of dead shoots caused by *E. saccharina* as percent of control (Swaziland trials)

Insecticide	Trial number		
	1	2	3
Carbofuran 10% g	64*	72*	37*
Chlormephos 10% g	115	115	
Chlorpyrifos 10% g		104	
Chlorpyrifos 48% ec			114
Carbosulfan 25% ec			112
Dieldrin 18,5% ec	78	59	102
Ethoprofos 10% g		116	
Fenamiphos 10% g	103		
Fenitrothion 60% ec			79
Fensulfothion 10% g		122	
Gamma-BHC 20% ec	107		
Isazophos 2,5% g		177	
Isofenphos 5% g	113	120	
Methomyl 90% wp			112
Phorate 10% g			102

* significantly different from control (P=0,05)

TABLE 7

Number of dead shoots per 30 m of row (1983 observation trials)

Trial number	Cypermethrin	Permethrin	Control
1	9,5	15,5	16,0
2	7,0	7,5	13,5
3	5,0	4,5	20,0
4	5,0	6,0	13,5
Mean	6,6	8,4	15,8
% of control	42	53	

Of the insecticides tested in two or more trials, none gave consistent control of eldana (Table 5); only chlorpyrifos and fenamiphos showed some promise and they were tested in one trial only. These chemicals were also tested in Swaziland (Table 6) where they did not perform well against eldana but they were applied at the lower rate of 2,5 kg ai/ha. The results in Table 6 show that carbofuran gave some control of eldana though this is not confirmed by the results in Table 5. It is likely that irrigation enhanced the activity of carbofuran.

In Table 7 it is shown that cypermethrin reduced the number of shoots killed by eldana to 42% and permethrin to 53% of the control. More than 200 mm of rain fell before the trials were assessed which would have enhanced the action of the insecticides and reduced the drought stress on the cane. Conditions were therefore good for cane growth and insecticide activity. In view of the poor results achieved in the 1981 trials (Table 5), it appears that the rain was largely responsible for the responses to the insecticides though these particular insecticides were not tested in 1981.

Conclusions

Of the insecticides which have been tested against eldana in young ratooning cane, only three have shown positive results in more than one trial. Carbofuran was effective only under moist conditions and had only limited action under dry conditions. The results obtained for cypermethrin and permethrin were positive in moist conditions but were not tested in dry conditions.

Bioassay

Introduction

A considerable number of insecticides were tested in the field in the late 1970s but results were markedly inconsistent. For this reason bioassay techniques were adopted, whereby the toxicity of insecticides to eldana larvae could be tested in the laboratory. Insecticides showing high toxicity were then tested in the field.

Materials and methods

Plastic pill-boxes 30 mm in diameter and 13 mm high were half filled with artificial diet medium (Atkinson[1]). After the medium had cooled and set, the surface was perforated because young larvae have difficulty in penetrating a smooth surface. These pill-boxes were placed on a moving belt which passed directly under a painter's spray gun from which insecticide was sprayed. A 6,25 mm diameter hole was drilled into each pill-box lid which was covered with 165 mesh stainless steel gauze. These lids also were placed on the moving belt and sprayed on the inner surface with insecticide.

About five hours after spraying, one newly emerged, first instar larva was placed in each pill-box and the lids were fitted. Two weeks later the pill-boxes were opened and the live and dead larvae counted.

In each test, either 50 larvae were exposed to each of 19 dilutions; or 100 larvae were exposed to each of 9 dilutions. Each insecticide was tested on at least two occasions, the results were pooled and subjected to probit analysis (Finney[7]). All work was carried out at a temperature of 26 ± 1°C.

Results and discussion

The concentrations of insecticide which are lethal to 10, 50 and 90% of the eldana larvae are shown in Table 8. The figures for slope indicate how close these lethal concentrations (LC) are to each other; the higher the slope, the steeper the graph. Thus at low doses monocrotophos kills some larvae but high concentrations are required to kill a large proportion of the larvae, which is shown by the LC_{90} figure. This information is apparent from the very low slope figure. On the other hand permethrin has a very high slope figure, indicating that relatively small increases in insecticide concentration will kill more larvae.

TABLE 8

Lethal concentrations of insecticides to *E. saccharina* larvae (ppm)

Insecticide	LC_{10}	LC_{50}	LC_{90}	Slope
Bromophos 20% ec	241,6	975,3	3 937,5	2,1145
Carbosulfan 48% ec	0,4	10,7	285,6	0,8979
Cypermethrin 20% ec	2,1	9,8	46,4	1,9071
Chlorpyrifos 48% ec	110,5	504,8	2 305,6	1,9428
Diazinon 27,5% ec	1 752,5	469 726,9	10^6	0,5278
Dichlorvos 100% ec	863,0	2 037,2	4 808,9	3,4358
Dimethoate 40% ec	40,9	952,1	22 174,3	0,9374
Endosulfan 35% ec	289,9	764,0	1 919,6	3,1225
Malathion 50% ec	1 059,3	36 920,6	10^6	0,8310
Monocrotophos 40% ec	0,2	85,9	31 747,0	0,4991
Permethrin 50% ec	9,0	21,3	50,0	3,4497
Phoxim 50% ec	77,0	1 194,2	18 514,0	1,0766
Quinalphos 25% ec	16,5	217,7	2 865,5	1,1450

Endosulfan has a fairly steep slope, is widely used in agriculture and has good persistence in the field. It is however fairly toxic to mammals, considerably more so than some other potentially suitable insecticides such as cypermethrin and permethrin. Similarly, dichlorvos and bromophos have reasonably steep slopes and high LC figures. Neither of these insecticides has good residual activity in the field and they are therefore unlikely to be suitable for commercial use.

Cypermethrin and permethrin both have reasonably steep slopes, (particularly permethrin) and low LC figures. They are relatively non-toxic to mammals and have reasonable persistence in the field.

Conclusions

Cypermethrin and permethrin appeared to be the most toxic insecticides to eldana but had low mammalian toxicity and reasonable persistence.

Eldana in Tall Cane

Introduction

It has been shown that eldana moths tend to lay their eggs on dead leaves (Atkinson[2]) and, as the cane crop ages, the number of larvae tends to increase (Carnegie[6]). Leslie[8] has shown that the newly emerged larvae bore into the stalks over a 10 day period following eclosion. Field observation has shown that the moths are active at night and are found in the canopy of the host plant (Atkinson[3]). During the day the moths are found among the dead plant material of the host plant.

Atkinson[4] found that moths are not susceptible to insecticide deposits so treating the canopy with insecticide is unlikely to be effective in reducing eldana numbers. During the late 1970s, insecticide was applied aerially to the canopy of sugarcane but this failed to reduce the number of eldana larvae. Insecticide deposits on the canopy of the host plant are highly susceptible to degradation by light, therefore their period of residual activity is short.

Larvae in the sugarcane stalk are an attractive target in that infested fields could be treated on a curative basis, although some damage would already have occurred. This would require a systemic insecticide which would be taken up by the plant and carried to the larvae. Such insecticides are not normally effective in controlling lepidopterous larvae because insufficient insecticide is ingested (Ware[9]). Furthermore, few systemic insecticides are translocated down the stem from the leaves where they are absorbed.

The young larvae on the trash are an easy target since they are small and would be killed by a low dose of insecticide. The eggs and moths also are found on the trash so might be affected by insecticide deposits.

For these reasons, the insecticides selected and tested were aimed primarily at the young larvae before they entered the sugarcane stalks, and with the knowledge that there might be some effect on the eggs and moths as well.

Materials and methods

Five trials were laid down during 1982 and 1983 to test the efficacy of cypermethrin and permethrin in controlling eldana larvae in tall cane. All trials were of a 6 × 6 latin square design with five treatments and a control (see Tables 9 and 10). Each plot consisted of 7 rows, each 15 m long.

TABLE 9

Mean results of trials 1, 2 and 3

Treatment	Larvae/100 stalks			% stalks damaged		
	Weeks after treatment			Weeks after treatment		
	0	6	12	0	6	12
Untreated control	5,9	10,3	21,7	36,7	49,4	66,6
Pretrashed	6,9	4,7(46)	12,0(55)	37,2	44,3(90)	60,0(90)
Pretrashed + cypermethrin	6,4	3,3(32)	6,7(31)	36,9	42,9(87)	51,8(78)
Pretrashed + permethrin	6,4	3,3(32)	7,7(35)	37,1	43,7(88)	52,9(79)
Cypermethrin	7,4	8,0(78)	14,3(66)	35,4	42,8(87)	55,9(84)
Permethrin	8,1	7,0(68)	18,7(86)	37,6	45,3(92)	60,5(91)

Figures in brackets refer to percent of control

TABLE 10

Number of larvae per 100 stalks (trials 4 & 5)

Treatment	Trial 4			Trial 5		
	Weeks after treatment			Weeks after treatment		
	0	6	12	0	6	12
Untreated control	72,3	36,0	19,0	167,7	119,3	91,5
Pretrashed	58,7	14,0(39)	7,5(39)	172,0	70,3(59)	36,8(40)
Pretrashed + cypermethrin	61,2	15,0(42)	6,7(35)	155,5	64,3(54)	49,8(54)
Pretrashed + permethrin	62,0	11,2(31)	5,7(30)	166,7	63,3(53)	42,8(47)
Cypermethrin	67,9	26,8(74)	15,3(81)	156,0	87,2(73)	72,7(79)
Permethrin	73,3	39,7(110)	18,3(96)	164,5	100,8(84)	77,7(85)

Figures in brackets refer to percent of control

A knapsack sprayer with a vertical lance and two outward facing floodjet nozzles (TK2,5) was used to direct the insecticide onto the cane stalks below the leaf canopy at a rate of 150 g ai in 300ℓ of water per hectare.

Prior to treatment and at two intervals of six weeks thereafter, the larval populations were assessed by counting the damaged stalks and the larvae in 20 stalks taken from each of the central five rows in each plot.

Results

At the start of Trials 1, 2 and 3 there were less than 15 larvae per 100 stalks and the results for all three trials were very similar. For this reason and for the sake of clarity, the results have been meaned and appear in Table 9.

Trials 4 and 5 were conducted in mid and late 1983 during the height of the drought. Both trials had very high larval populations at the time of treatment and more than 95% of the stalks were damaged. The results of these two trials in terms of larval numbers only, are shown separately in Table 10.

Discussion

Since the object of controlling eldana in sugarcane is to reduce losses in yield, the ultimate test for the efficacy of any treatment is whether it increases the yield compared with the yield of untreated areas. Yield was not determined in any of these five trials since intensive sampling of trials tends to affect yield results. Data of the number of larvae show whether the treatments affect the insect while data on damaged stalks indicate the possible effects on yield.

In most cases, the number of larvae was lower in pretrashed cane which had been sprayed with insecticide than in cane which had been pretrashed only. This was less marked in Trials 4 and 5 (Table 10) where larval numbers declined naturally. In all trials, the application of insecticide to non-trashed cane had less effect on larval numbers than pretrashing alone. Where cypermethrin was applied to non-trashed cane, there were fewer damaged stalks, than in the cane which was pretrashed (see Table 9). It is possible that if samples had been taken more than 12 weeks after treatment, there would have been an even lower proportion of damaged stalks in the treated plots compared with the untreated plots.

It is thus apparent that all treatments are likely to result in higher yields than those obtained from untreated cane, and that this effect will probably be greatest if the insecticide is applied to pretrashed cane.

Conclusions

Pretrashing resulted in reduced numbers of larvae and less damage to stalks compared with the untreated cane. This was achieved by the application of the insecticides cypermethrin and permethrin.

Insecticide applied to non-trashed cane also had the effect of reducing larval numbers and the proportion of stalks damaged compared with the untreated cane though the reduction was less marked than in pretrashed cane.

General Conclusions

Although considerably more work needs to be done, some progress has been made towards the control of eldana by means of insecticides. Dipping seedcane into insecticides, wetter and water can reduce eldana numbers by 85 to 100%. Dipping the setts for 30 minutes would be inconvenient under field conditions, but the practice would normally be followed only when planting nurseries.

Treating young ratoons for eldana is possible provided conditions are moist because insecticides are not effective in dry conditions. It has yet to be established whether or not treatment with an insecticide would be warranted in a good season.

Bioassay work has shown that some insecticides are considerably more effective than others in killing eldana and this has led to a more critical approach in selecting insecticides for field trials.

Previous work has shown that pretrashing can reduce eldana numbers in the field. Current work has shown that insecticide applications to pretrashed and non-trashed cane can reduce eldana numbers by 75% and the number of damaged stalks by 22%. Further work on the frequency and rates of application and on the effects on yield is necessary.

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