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CONTRACT REPORT

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Screening of insecticides for the control of Lettuce Root Aphid on Lettuce - 1988

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AUTHENTICATION

I declare that this work was done under my supervision according to the procedures described herein and that this report represents a true and accurate record of the results obtained.

.....
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SCREENING OF INSECTICIDES FOR THE CONTROL OF LETTUCE ROOT APHID ON LETTUCE - 1988

Summary

The efficacy of a range of insecticides against lettuce root aphid (Pemphigus bursarius) was tested in two direct drilled crops and one transplanted (cell raised) crop of lettuce.

Although moderate infestations developed at one of the direct drilled sites and also in the transplanted crop, lettuce root aphid did not affect either the size or quality of produce at any of them.

Only at one of the drilled sites did treatments significantly reduce the numbers of aphids present when the crops were harvested. Effective treatments included carbofuran (1.5 kg a.i./ha), disulfoton (1.4 kg a.i./ha), fonofos 10 G (1.4 kg a.i./ha), fonofos MS (1.38 kg a.i./ha), gamma-HCH (1.12 kg a.i./ha), phorate (2.0 kg a.i./ha) and pirimicarb (0.25 kg a.i./ha). Neither a pre-drilling application of diazinon nor two foliar sprays of diazinon reduced aphid numbers.

The results are discussed in the light of this year's and also last year's experimental work.

Proposals for future work are outlined.

INTRODUCTION

Lettuce root aphid (Pemphigus bursarius) is a widespread and important pest of lettuce. Existing pesticides do not prevent damage effectively when aphid numbers are high and the plants are suffering from water stress.

The main objective of this work was to assess the effectiveness of a range of insecticides against lettuce root aphid on cell raised and direct drilled crops on mineral and organic soils.

The work started in 1987 as a two/three year project. This report summarises the results obtained in 1988.

MATERIALS AND METHODS

Site details

Three trials were carried out on commercial holdings by ADAS entomologists based at Cambridge (direct drilled crop on organic soil near Barway, Cambridgeshire), Leeds (direct drilled crop on mineral soil near Everingham, N Humberside) and Wye (cell raised plants on mineral soil near Eastry, Kent).

At all three trials the iceberg lettuce cultivar Saladin was used. This cultivar is known to be very susceptible to attacks of lettuce root aphid.

Trials at Barway and Everingham were drilled on 17 and 24 June respectively. Plants were subsequently thinned to 30 cm spacing. At Eastry, the cells (approximate volume of a cell is 20 cm^3) were seeded on 13 May and planted out in the field on 10 and 13 June at 43 cm spacing.

Design

All three trials were of a randomised block design, replicated three (Everingham and Eastry sites) or four times (Barway site). Plots were four rows wide by 8 to 10 metres long.

Treatments

See the Results section for treatment details.

Assessments

1. Phytotoxicity

The plants were checked for phytotoxic symptoms during the lifetime of the crop.

2. Aphid numbers

The numbers of lettuce root aphid were assessed twice at each trial, on the following dates:

Barway:	15 August and 5 September
Everingham:	24 August and 22-26 September
Eastry:	26 July and 11-15 August

The second assessments were made when the crops were harvested. Ten plants per plot were assessed on the first assessment and 25 plants per plot on the second assessment. Plants were selected at regular intervals from the middle two rows of each plot.

Roots were examined for root aphids and each plant was assigned a score based on the system below:

Numbers of aphids per root system	Score
0	0
1 - 4	1
5 - 11	2
12 - 33	3
34 - 100	4
101 - 300	5
301 - 900	6
901+	7

Following the assessment of aphid numbers, a grade score for each plot was calculated by multiplying the number of plants in each category by the appropriate score, totalling up the scores and dividing by the number of plants examined. The resulting score thus had a possible range from 0 (no aphids at all) to 7 (every plant with over 900 aphids). The scores were statistically analysed by analysis of variance (ANOVA).

3. Weight and marketability of produce

At harvest, plants which had been assessed for aphids were cut and individually weighed and graded. The criteria used in the grading is outlined in the 'EC Common Quality Standards for Lettuces'.

RESULTS

Phytotoxicity

No signs of phytotoxicity were observed in any of the trials.

Aphid numbers

Aphid numbers at the Barway site remained extremely low throughout the season, never exceeding a mean aphid score of 0.2 in the untreated plots so little meaningful information was obtained from this site. Tables 1 and 2 summarise the aphid counts at Everingham and Eastry where infestations were higher.

At Everingham all the treatments except diazinon significantly reduced aphid numbers until harvest. In contrast at Eastry, none of the treatments significantly reduced aphid numbers at harvest although the tefluthrin, the liquid formulation of fonofos and demeton-S-methyl with fenvalerate significantly reduced aphid numbers on the first assessment.

Weight and marketability of produce

At none of the sites did any of the treatments significantly increase weight or improve the marketability of the produce. Table 3 summarises the data obtained from the untreated plots at each site. The figures show the large variation in size and quality that occurred between the sites. The full data obtained from the harvest assessments is summarised in Appendices A and B.

Table 1 Insecticides applied to direct drilled crops of lettuce at Barway and Everingham and numbers of lettuce root aphids present on roots during the season and at harvest at the Everingham site

Treatment (Product)	Rate a.i.	Rate Product	Aphid Score Mid-season	Aphid Score Harvest
Single sprays applied pre-drilling kg or l/ha in 300 l water/ha				
Diazinon (Basudin 40 WP)	1.0 kg	2.5 kg	2.1	3.7
Fonofos (Dyfonate MS)	1.38 kg	2.5 l	1.0***	2.6**
Gamma HCH (Gammacol)	1.12 kg	1.4 l	1.2	2.7**
Granules applied pre-drilling as 6 inch wide bands g/100 m length of drill row				
Carbofuran (Yaltox)	2.29 g	45.72 g	0.2***	0.9***
Disulfoton (Disyston FE-10)	2.13 g	21.34 g	0.2***	0.8***
Fonofos (Dyfonate 10 G)	2.13 g	21.34 g	0.0***	1.2***
Phorate (Campbells Phorate)	3.05 g	30.48 g	0.5***	1.8***
Two mid-season foliar sprays				
Diazinon; kg/ha in 1500 l water/ha (Basudin 40 WP)	0.30 kg	0.75 kg	2.0	3.9
Pirimicarb; kg/ha in 1000 l water/ha (Pirimor)	0.25 kg	0.50 kg	1.7**	1.7**
Untreated	-	-	2.4	4.4
SED			0.2	0.5
CV (%)			26	25

** and *** indicate treatment is significantly different from the untreated at the 1% and 0.1% levels respectively.

Footnotes

1. At the Everingham site all pre-drilling treatments were incorporated into the soil to a depth of 75 mm before drilling. At Barway site the pre-drilling treatments were not incorporated although the drill coulter itself incorporated the granules shallowly.
2. All granular treatments were applied before drilling as 15 cm wide bands using a Horstine Farmery microband applicator.
3. Foliar sprays were applied on 12 July and 1 August at Barway site and 4 and 16 August at Everingham site.
4. Pre-drilling spray of gamma-HCH was applied in 200 l water/ha at the Everingham site.

Table 2 Insecticides applied to cell raised crop at Eastry and numbers of lettuce root aphids present on roots during the season and at harvest

Treatment (Product)	Rate a.i.	Rate Product	Mid-season	Harvest
Module incorporation treatments g/m³ of compost				
Diazinon; in 100 l water/m³ compost (Basudin 40 WP)	14.8 g	37 g	3.8	3.3
Fonofos (Dyfonate 10 G)	78 g	780 g	3.3	3.6
Module incorporation plus drench to established seedlings before planting				
Fonofos; (Dyfonate MS) incorporated in 40 l water/m³ compost	43.3 g	100 ml	2.2*	4.4
; drenched in 1.56 l water/1000 seedlings	0.17g	0.39ml		
Module incorporation combined with a pre-planting field treatment				
Diazinon; (Basudin 40 WP) incorporated in 100 l water/m³ compost	14.8 g	37 g	3.9	4.7
; pre-planting spray in 300 l water/ha	1 kg	2.5 kg		
Drench to established seedlings before planting combined with a pre-planting field treatment				
Tefluthrin; drenched in 1.56 l water/1000 seedlings	0.16g	3.13ml	2.5*	2.6
; pre-planting granule application	0.1 kg	20 kg		
Pre-planting field treatment				
Diazinon; (Basudin 40 WP) kg in 300 l water/ha	1 kg	2.5 kg	2.7	3.8
Two mid-season foliar sprays				
Diazinon; (Basudin 40 WP) kg in 1500 l water/ha	0.3 kg	0.75 kg	3.3	2.9
Pirimicarb; (Pirimor) kg/ha in 1000 l water/ha	0.25 kg	0.5 kg	3.0	2.8
Demeton-S-methyl (Metasystox 55) plus Fenvalerate (Sumicidin); ml or l in 1000 l water/ha	1.22 kg	2.1 l	1.5*	2.2
	25 g	250 ml		
Untreated			3.7	3.1
SED			0.5	0.5
CF (%)			22	17

* treatment significantly different from the untreated at the 5% level

Footnotes

1. Individual cell size is approximately 20 cm³; 160 cells to a tray.
2. Module incorporation treatments were made just prior to seeding.
3. Seedling drench treatments were applied just prior to planting out.
4. All pre-planting field treatments were incorporated into the soil to a depth of 75 mm.
5. Foliar sprays were applied on 23 June and 8 July.

Table 3 Weight and marketability at harvest

Site	Mean weight of crisphead (g)	Mean % in each class		
		Class I	Class II	Unmarketable
Barway	611	82	13	5
Eastry	853	35	41	24
Everingham	426	75	1	24

DISCUSSION

Lettuce root aphid did not affect the size or the quality of the lettuce at any of the sites. Although moderate infestations of root aphid occurred at Everingham and Eastry the crops seemed able to tolerate the attacks during the cool, wet summer. Under drier conditions, the effect of the aphids would have been more damaging and the insecticides would have been tested more rigorously.

Direct drilled crops: at the Everingham site several treatments significantly reduced aphid numbers. Surprisingly, and in contrast to the results in 1987, the diazinon treatments that are recommended commercially and were included in the trials as 'standards' gave the poorest control. Mid-season foliar sprays of pirimicarb proved to be as effective in reducing root aphid numbers as pre-drilling granular treatments and would also control any leaf feeding aphids that may be present. Essential to using foliar sprays effectively would be the need to monitor aphid migration from their overwintering sites (poplar) into the lettuce crops so that treatments could be timed accurately. Ministry funded work has already begun on studying aphid migration into crops and would complement experimental work investigating the importance of the timing of spray applications.

On the basis of the 1987 and 1988 work a number of treatments showed potential in controlling lettuce root aphid and these are summarised in Table 4 overleaf.

Table 4 Direct drilled lettuce trial sites (1987-1988) where treatments significantly reduced lettuce root aphid numbers when assessed at harvest

Treatments	1987 Leeds	1987 Cambridge	1988 Everingham
Granules applied pre-drilling			
Carbofuran	N/A	N/A	*
Disulfoton	N/A	N/A	*
Fonofos	**	-	*
Phorate	**	-	*
Tefluthrin	*	-	N/A
Sprays applied pre-drilling			
Diazinon	**	-	-
Fonofos (FS formulation)	**	-	N/A
Fonofos (MS formulation)	*	-	*
Gamma HCH	*	-	*
Foliar sprays during the season			
Pirimicarb	N/A	N/A	*

Footnote

N/A means that insecticide was not tested at that site.

* means that treatment significantly reduced root aphid numbers when assessed at harvest at either one (*) or two sites (**).

- means that treatment did not significantly reduce aphid numbers when assessed at harvest.

However as the past two seasons' trials have not had serious root aphid damage it remains to be seen how effective the treatments are under greater pest pressure; both diazinon and phorate which appear in the above list often perform badly in such circumstances.

With the exceptions of demeton-S-methyl, diazinon, phorate and pirimicarb none of the treatments are approved for use on lettuce. The granular insecticides all have a six week harvest interval on other crops and therefore essential to any further development work would be a study on chemical residues in the produce. Foliar sprays of pirimicarb have a short harvest interval of 3 days (on outdoor lettuce) and have the advantage that the chemical is already approved for use on lettuce. Two insecticides, fonofos (FS) and tefluthrin, neither of which are available commercially, have also shown promise.

Module crop: demeton-S-methyl mixed with fenvalerate, fonofos (FS) and tefluthrin reduced root aphid numbers at the first assessment, but by harvest none of the treatments were better than the untreated plots. In fact, a couple of treatments had significantly more aphids than the untreated, a result which cannot be explained.

In both the 1987 and 1988 cell raised crop trials at Eastry, lettuce root aphid control has not been successful. A number of methods of applic;ation have been tested including incorporation of the chemical into the module compost, seedling drenches prior to planting out, pre-planting field treatments and mid-season foliar sprays. Module incorporated treatments have the advantage of being relatively cheap and they also provide a way of treating a large number of plants in a comparatively short period of time. Their disadvantage however is that no protection is given to the roots which grow outside the module. Similarly, treatments in field soil will not protect the roots within the module. The combination of a module incorporated treatment with a field treatment was tested using diazinon but was not successful. Incorporating the fungus Verticillium lecanii (a biocontrol agent used for aphid and whitefly control in glasshouses) in the module compost could be effective as it might possibly spread out of the module and control aphids feeding on roots in the soil. At present, well timed foliar sprays of conventional insecticides may be more suitable for cell raised crops.

CONCLUSIONS

1. In spite of a moderate attack of lettuce root aphid at two sites the numbers of the pest were not large enough to affect the crop.

2. In one of the drilled crop sites a number of insecticides significantly reduced root aphid numbers. Both pre-drilling soil treatments and mid-season foliar sprays proved to be effective.

3. None of the treatments tested on the cell raised crop reduced the number of aphids present when the crop was harvested.

PROPOSALS FOR FUTURE WORK

Two years work has now been completed in screening insecticides for lettuce root aphid control. Because 1987 and 1988 were not years when lettuce root aphid caused serious damage the trials did not test the insecticides as rigorously as they would have done in a year like 1986. A number of the insecticides reduced the numbers of aphids on occasions but the results were not always consistent. Clearly, more work needs to be done. The following options for future work are therefore suggested.

1 Testing mid-season foliar sprays

Preliminary results with pirimicarb foliar sprays have been encouraging. Further work is needed looking at the importance of timing and number of sprays needed in order to obtain successful control. Other insecticides could also be screened for efficacy as foliar applied treatments.

2 Pre-drilling treatments

Manufacturers of the insecticides which have been found to be effective should be contacted by ADAS. If the companies are interested in the possibility of their products being used on lettuce, further work can be carried out and this can be part funded by the companies themselves. Each chemical needs to be tested for efficacy against lettuce root aphid at various application rates. Residue analysis should also be done on the harvested produce. The aim would be to find a cost-effective rate of application of chemical which gave acceptably low residues in the produce at harvest.

3 Investigating non-chemical control methods

Controlling lettuce root aphid by means other than the use of chemicals has been little investigated, but may offer a long term solution to the problem especially if such methods were integrated with the use of a chemical. The following areas are suggested for further investigation.

(a) Importance of water: in a wet season, serious lettuce root aphid damage seldom occurs. However, the importance of water whether as rainfall or from irrigation equipment and its effect on root aphids has not been quantified.

(b) Lettuce root aphid behaviour: more information is needed about the factors which attract lettuce root aphid to a crop and whether any can be exploited for monitoring or controlling the insect. There is a possibility of producing an annual 'risk forecast' based on the numbers of aphids caught in suction traps. This work should be jointly carried out by ADAS and the IHR.

(c) Use of the fungus Verticillium lecanii as a module incorporation treatmen deserves further investigation, initially in the laboratory and if promising results are obtained, in the field as well.

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STORAGE OF DATA

The raw data for each trial will be stored by the department responsible for that trial for a period of 5 years.

Appendix (A) Weight and marketability of produce at harvest at Barway (B) and Everingham (E) sites

Treatment	Mean weight of crisphead (g)		Mean % in each class: Class I		Class II		Unmarketable	
	B	E	B	E	B	E	B	E
Single sprays applied pre-drilling								
Diazinon	596	527	80	79	15	1	5	20
Fonofos	572	557	74	80	17	8	9	12
Gamma -HCH	569	553	72	7	20	7	8	16
Granules applied pre-drilling								
Carbofuran	614	621	78	83	13	4	9	13
Disulfoton	571	572	82	73	8	3	10	24
Fonofos	558	553	75	76	17	5	8	19
Phorate	557	588	70	87	23	1	7	12
Two mid-season foliar sprays								
Diazinon	611	515	71	73	16	11	13	16
Pirimicarb	589	561	69	84	20	3	11	13
Untreated	611	426	82	75	13	11	5	24

Appendix B Weight and marketability of produce at harvest at Eastry site

Treatment	Mean weight of crisphead (g)	Mean % in each class		
		Class I	Class II	Unmarketable
Module incorporation treatments				
Diazinon	913	52	29	19
Fonofos	653	21	39	40
Module incorporation plus drench to established seedlings before planting				
Fonofos	647	32	43	25
Module incorporation combined with a pre-planting field treatment				
Diazinon	790	51	36	13
Drench to established seedlings before planting combined with a pre-planting field treatment				
Tefluthrin	690	43	35	23
Two mid-season foliar sprays				
Diazinon	893	56	28	16
Pirimicarb	573	29	28	43
Demeton-S-methyl plus fenvalerate	833	52	31	17
Untreated	853	35	41	24
Pre-planting field treatment				
Diazinon	703	49	28	23