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Period of investigation: May-September 1989
Date of issue of report: August 1990
No of pages in report: 20

CONTRACT REPORT

No C/87/0512
FV/16/87

Control of Lettuce Root Aphid

Undertaken for the Horticultural Development Council

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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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SUMMARY

Nine replicated field trials were done over a 3 year period at 3 sites in Kent, Humberside and Cambridgeshire in drilled and transplanted crops of lettuce (cv Saladin) to assess the efficacy of a range of insecticide treatments for control of lettuce root aphid (Pemphigus bursarius) in comparison with currently approved products.

No treatment gave consistently good control of lettuce root aphid in including those products which are currently approved for control of this pest. Damage due to lettuce root aphid was only recorded at one site (Barway, 1989) throughout the period of study and it seems likely that frequent rain or irrigation limits damage from this pest.

At one site (Everingham, 1988) two foliar sprays of pirimicarb reduced numbers of aphids more than any other treatment. Accurate timing of foliar sprays is critical and methods of forecasting aphid migration into lettuce crops from poplar trees are discussed.

INTRODUCTION

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

This report summarises the results of the final year of a three year project investigating the effectiveness of a range of insecticides against lettuce root aphid on block raised and direct drilled crops. Previous results are reviewed and proposals for future work are discussed.

MATERIALS AND METHODS

Site Details

Three trials were carried out on commercial holdings by ADAS Entomologists based at Cambridge (direct drilled crop on peaty loam soil near Barway, Cambridgeshire), Leeds (direct drilled crop on sandy loam near Everingham, N Humberside) and Wye (block raised plants on a silty loam near Canterbury, Kent).

At all three trial sites 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 24 May and 4 July respectively. Plants were subsequently thinned to 30 cm spacing. At Canterbury, the blocks (4 cm3 volume) were planted out in the field on 13 June at 29 cm spacing.

Design

All three trials were of a randomised block design, replicated three (Canterbury and Everingham sites) or four times (Barway site). Plots were four rows wide by 7.5 to 10 metres long.

Insecticides

Table 1. Insecticides, active ingredients (a.i.) and dose rates

Insecticide	ai	Amount ai in product	Dose rate product/ha
Basudin 40 WP	diazinon	400 g/kg	2.5 kg at drilling/ transplanting 750 g as a foliar spray
Campbell's Phorate	phorate	100 g/kg	20 kg
Pirimor	pirimicarb	500 g/kg	500 g
Metasystox 55	demeton-s-methyl	580 g/l	420 ml
Water	-	-	1000 l

Treatments

Table 2. Treatments at drilling and foliar sprays programmes timed to coincide with crop emergence or the presence of the first lettuce root aphid (LRA) in the crop.

	Treatment	Timing
1.	Diazinon	Applied to soil and incorporate before drilling
2.	Phorate*	Applied at drilling in 15 cm bands, incorporated by action of the drill
3.	Diazinon	Foliar spray when first LRA seen and repeated 14 days later
4.	Pirimicarb	Foliar spray at crop emergence and repeated every 7 days until end of LRA migration
5.	Pirimicarb	Foliar spray when first LRA seen and repeated 7 to 14 days later
6.	Pirimicarb	Foliar spray when first LRA seen and repeated 7 days later
7.	Pirimicarb	Foliar spray when first LRA seen
8.	Demeton-s-methyl	Foliar spray when first LRA seen and repeated 14 days later
9.	Water	Foliar spray at crop emergence and repeated every 7 days until end of LRA migration
10.	Untreated	

* Drilled crops only

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:	27 July and 9 August
Canterbury:	14 July and 31 July
Everingham:	7 September and 29 September

The second assessments were made at harvest. 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 scored using the system below;

Number of root 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 numbers 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).

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 are outlined in the 'EC Common Quality Standards for Lettuces'.

4. Aphid Trapping

Two water traps were used at each site. Each trap consisted of a plastic photographic developing dish (measuring 45 x 55 x 8 cm) painted bright yellow on the inside and black on the outside. A yellow curciform arrangement of perspex sheets was placed inside the trays in order to increase trapping efficiency.

Statistical Analysis

Aphid scores and yield data were subjected to an analysis of variance. Where appropriate mean separation was by Duncan's Multiple Range Test.

RESULTS

Phytotoxicity

No signs of phytotoxicity were observed at any of the three trials.

Aphid Numbers

At the Canterbury site, all the treatments significantly reduced aphid numbers at the first assessment but not at harvest two weeks later. At Barway, where aphid numbers were larger, there were no significant differences between any treatments. Lowest numbers of aphids were recorded at Everingham and there were no significant differences between any of the treatments on either assessment date. Tables 1, 2 and 3 summarise the results.

Weight and Marketability of Produce

At the Canterbury site the produce was over one kg weight and showed no sign of root aphid damage. None of the treatments significantly improved either weight or quality. Similarly at Everingham none of the treatments had any significant effect on the weight or quality of the produce. In contrast at Barway, aphid damage throughout all the plots at harvest time was extensive. It was not possible to grade produce as the majority of plants were unmarketable. None of the treatments improved yield or quality.

Aphid Trapping

At the Canterbury site, traps were not checked regularly but on occasions in order to gauge the start and end of root aphid migration. It was estimated that root aphid migration began week beginning 12 June and finished week ending 30 June.

Detail records were kept at Barway and the results are presented in Figure 1. Traps were set out in the field on the 12 June and the first root aphids were caught on 13 June. Numbers increased rapidly to a peak on 17 June before declining. The migration was effectively over by 30 June.

Table 3. Results for Canterbury Site

Insecticide (product)		Aphid Score 14/7	Aphid Score 31/7	Produce Weight (g)	Produce Grade Class I	Produce Grade Class II	Produce Grade Unmarketable
1.	Basudin 40 WP Diazinon	1.1**	3.8	1089	37	44	19
2.	Basudin 40 WP Diazinon	0.5***	4.1	1139	48	42	10
3.	Basudin 40 WP Foliar spray x 2	1.4*	2.6	1073	44	39	17
4.	Pirimor Foliar spray x 4	0.8**	4.2	1033	32	56	12
5.	Pirimor Foliar spray x 3	1.0**	2.7	1139	41	41	18
6.	Pirimor Foliar spray x 2	1.4*	2.0	1114	49	36	15
7.	Pirimor Foliar spray x 1	0.8**	3.2	1076	31	49	20
8.	Metasystox 55 Foliar spray x 2	1.0**	2.4	1037	33	55	12
9.	Water Foliar spray x 4	2.0	2.6	1036	27	55	18
10.	Untreated	2.4	2.1	1057	32	47	21
	SED	0.4	0.8	69	13	13	6
	CV(%)	42	33	8	42	34	45

Footnotes to the above table

Sprays applied using a CP3 knapsack sprayer (Flat fan 80° nozzles) at 3 bar pressure. Diazinon sprays applied in 300 litres of water/ha, all other treatments applied at 1000 litres of water/ha.

Results marked *, ** or *** are significantly different from the untreated plots at the $p < 0.05$, $p < 0.01$ and $p < 0.001$ levels respectively.

Table 4. Results for Barway Site

Treatment (product)		Root aphid score 27/7	9/8	Mean weight of Produce (g)
1.	Campbells Phorate at drilling	3.5	5.7	334
2.	Basudin 40 WP at drilling	4.0	5.7	254
3.	Basudin 40 WP Foliar spray x 2	4.4	5.8	248
4.	Pirimor Foliar spray x 5	3.6	5.7	349
5.	Pirimor Foliar spray x 3	3.5	5.6	304
6.	Pirimor Foliar spray x 2	4.2	5.7	203
7.	Pirimor Foliar spray x 1	4.0	5.7	248
8.	Metasystox 55 Foliar spray x 2	3.3	5.7	282
9.	Water Foliar spray x 5	3.8	5.5	284
10.	Untreated	3.4	5.6	345
	SED	0.4	0.2	77
	CV%	15	5	38

Footnotes to the above table

Sprays applied using an MDM carbon dioxide powered precision knapsack sprayer (flat fan 100° nozzles) at 2 bar pressure. Diazinon predrilling sprays applied in 300 litres of water/ha. All foliar insecticides sprays were applied in 1000 litres of water/ha except demeton-S-methyl which was applied in 300 litres of water/ha.

Table 5. Results for Everingham Site

Insecticide (product)		Aphid Score 7/9	Aphid Score 29/9	Produce Weight (g)	Produce Grade Class I	Produce Grade Class II	Produce Grade Unmarketable
1.	Basudin 40 WP at drilling	0.2	0.9	1030	39	25	36
2.	Campbell's Phorate at drilling	0.1	0.2	943	37	16	47
3.	Basudin 40 WP Foliar spray x 2	1.0	0.8	1030	35	20	45
4.	Pirimor Foliar spray x 4	0.5	0.7	1024	19	27	54
5.	Pirimor Foliar spray x 3	0.3	0.5	1033	22	22	56
6.	Pirimor Foliar spray x 2	0.7	0.8	825	32	27	41
7.	Pirimor Foliar spray x 1	0.4	0.9	914	27	17	56
8.	Metasystox 55 Foliar spray x 2	0.3	0.8	987	40	23	37
9.	Water Foliar spray x 4	0.6	0.8	994	23	21	56
10.	Untreated	0.8	1.2	882	39	20	41
	SED	0.4	0.5	131	10	6	10
	CV%	92	85	17	39	33	26

Footnotes to the above table

Sprays were applied using an Oxford Precision Sprayer (00 Specification nozzles) at 3 bar pressure. All sprays applied in 1000 litres water/ha.

Aphid catches at Everingham are shown in Figure 2. Although traps were not emptied daily it is likely that peak migration occurred between 10-17 July. The period of aphid migration was also longer at Everingham than at either of the other sites.

DISCUSSION

At the Canterbury site all the treatments significantly reduced aphid numbers up to two weeks before harvest. However, because the crop had been frequently irrigated the plants were never under stress and the produce harvested showed no symptoms of root aphid attack. Also by harvest time aphid numbers in all the treated plots were similar to the untreated.

At Barway where the largest aphid migration was recorded none of the treatments effectively controlled the pest. The first foliar spray at Barway was applied two days after the first winged root aphids had been found in the traps. It is possible but unlikely therefore, that this two day delay may have enabled root aphids to become established on the crop and so more difficult to control.

Drilling and emergence of the crop at Everingham was delayed and the first foliar sprays were not applied until the lettuce root aphid migration was virtually complete. Not surprisingly these treatments had little effect on aphid numbers. Delayed drilling and emergence would also account for the low numbers of aphids recorded on the roots at this site in comparison with previous trials. Although treatments at drilling were applied only 1-2 weeks before the peak of lettuce root aphid migration the level of infestation in plots treated with phorate and diazinon was not significantly lower than in the control suggesting that neither of these approved products gives good control of this pest.

In the three year study investigating possible new chemical control measures against lettuce root aphid no treatment has been found to give consistently good control. Only in 1989 (Barway) was the aphid pressure high enough to see visual symptoms in the plants and in this situation none of the treatments were effective. In view of their persistence and therefore potential residue problems at harvest granular insecticides are unlikely to be developed by chemical manufacturers. An insecticide with a novel mode of action that moves from the leaves to the roots may give good control of lettuce root aphid but at present no such product is commercially available. Foliar sprays, provided that lettuce is not cropped after lettuce, therefore provide the most logical alternative. Results have been inconsistent but more work is needed to see whether modifying the timing and frequency of foliar spray treatments will improve control. First, trapping alate aphids in traps in the field is unlikely to be totally successful because there may well be a critical time delay between detection of the aphids and spraying. Therefore, beginning treatments as soon as alate aphids are found in poplar galls is likely to be more successful and should be investigated. In the experiments carried out, foliar sprays were applied either at weekly intervals or less frequently. Sprays applied during the aphid migration period with a 2 to 3 day spray interval should also be investigated. Also the use of synthetic pyrethriods which deter incoming winged aphids could be explored.

Water both limits root aphid damage and reduces the rate at which the aphids breed. Regular irrigation of the crop during the main aphid migration period may help to reduce damage and should be given a high priority for further work. Environmentally, this would be more acceptable than chemical control and similar to the way in which cutworms can be controlled by applying water at critical times. This approach would also help to reduce insecticide costs.

Figure 1. Catches of lettuce root aphid in water traps at Barway, June 1989

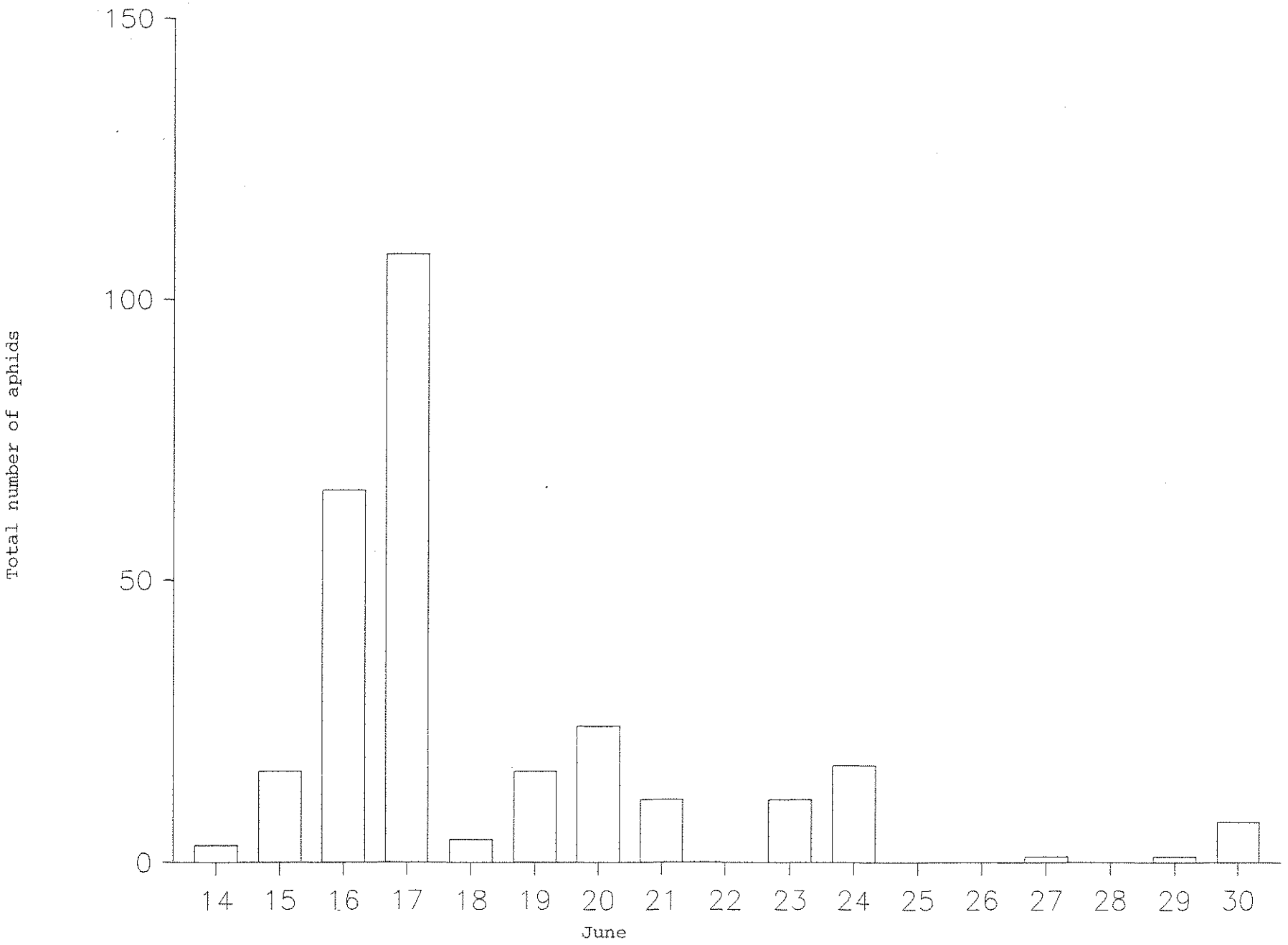
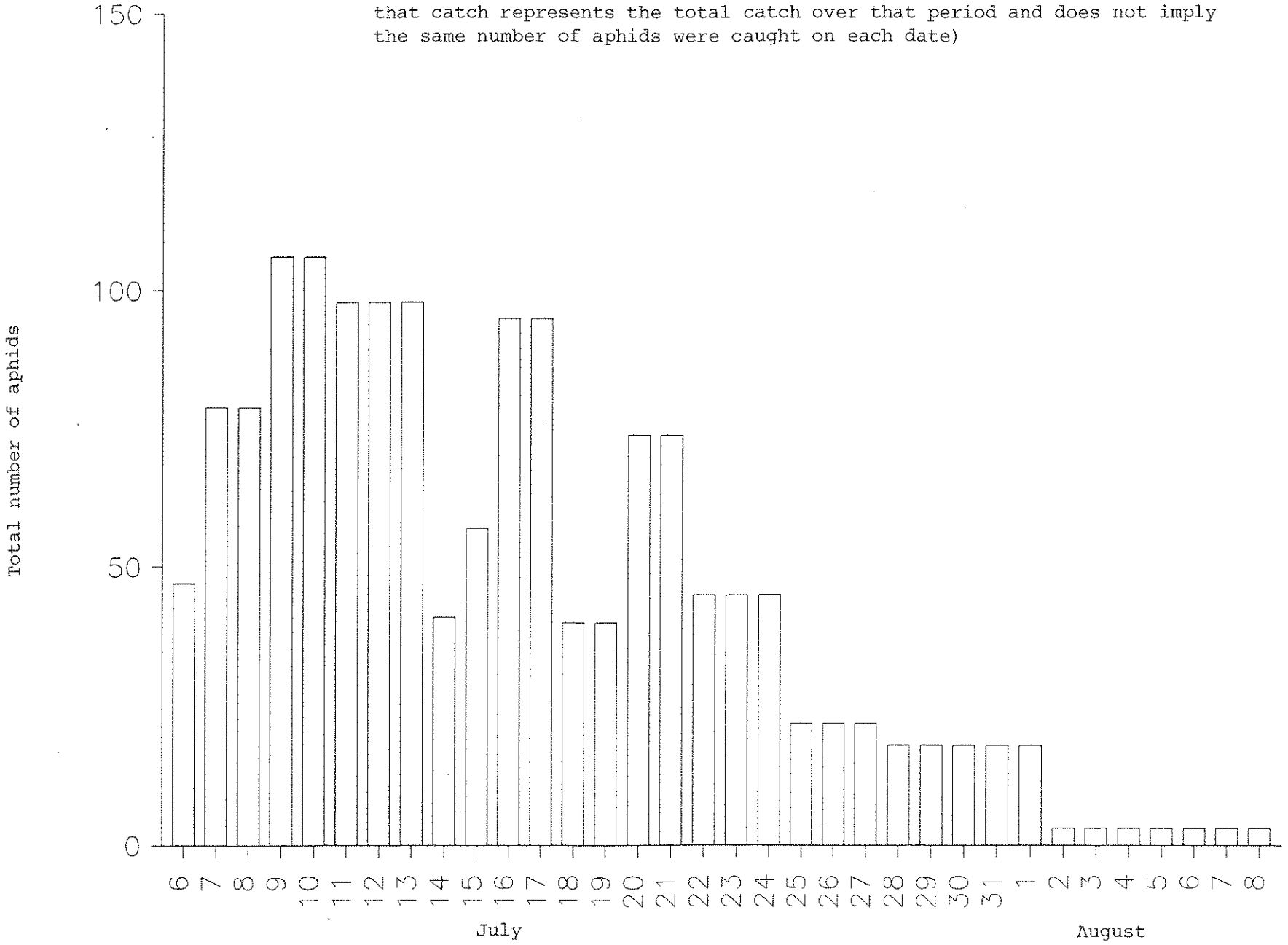


Figure 2. Catches of lettuce root aphid in water traps at Everingham, July-August 1989 (where a series of consecutive dates show the same number of aphids caught that catch represents the total catch over that period and does not imply the same number of aphids were caught on each date)



Conclusions 1989

i. No treatment gave good control of lettuce root aphid.

ii. At Barway where aphid numbers were high enough to cause physical symptoms of pest attack the crop was unmarketable.

iii. At Canterbury all treatments significantly reduced numbers of lettuce root aphid at the first but not second assessment. No physical symptoms of pest damage were evident in control plots probably due to the frequent irrigation of the crop.

iv. At Everingham delayed drilling and crop emergence meant that the first foliar sprays were not applied until lettuce root aphid migration was virtually complete. The treatments therefore were not rigorously tested against this pest.

Conclusions 1987-89

i. Over three years no treatment has consistently given good control of lettuce root aphid in drilled or transplanted crops, including those products which are currently approved for the control of this pest.

ii. At only one site (Barway, 1989) were there physical symptoms of damage due to lettuce root aphid. It seems likely that frequent rainfall or irrigation limits the damage due to this pest.

iii. At one site in 1988 (Everingham) two foliar sprays of pirimicarb reduced numbers of aphids more than all other treatments. Accurate timing foliar sprays is critical. A slight delay between recording the first aphid in the crop at Barway in 1989 and applying the first foliar spray probably allowed the pest to establish.

Recommendations

i. Work on foliar sprays should continue. The use of water traps should be compared with other means of triggering the first foliar spray eg the appearance of the first winged aphids in poplar galls.

ii. Other insecticides especially the synthetic pyrethriod, and any novel products which are capable of moving from the foliage to the roots, should be compared with pirimicarb and demeton-s-methyl as foliar sprays.

iii. The importance of water as irrigation or rainfall in limiting lettuce root aphid attacks should be quantified.

iv. The practicality of crop covers eg floating mulches should be studied as a means of providing a physical barrier to migrant aphids during the relatively short migration period.

v. Work on the development of lettuce varieties resistant to lettuce root aphid attack should continue. The ability of currently available resistant varieties eg Beatrice, Wallop and Debbie to withstand attack from this pest should be investigated.

Acknowledgements

We thank Messrs Thornton, G S Shropshire & Sons and I Stickles and D W F Prior of Kent Salads Ltd for providing the trial sites and their co-operation. We also thank all ADAS participants and the several students who assisted in the work.

Storage of Data

All the raw data will be retained by ADAS. ADAS will consult the HDC before disposing of the data.