Project Title:	**Pear: Evaluation of insecticides for the control of pear sucker eggs and nymphs 2005**
HDC Project Number:	TF 162
EMR Project No.	GEP05/001
Project Leader:	Jerry Cross
Report:	Final report 2005 (issued 24 August 2005)
Previous reports:	None
Key Workers:	Jerry Cross Stella Cubison Adrian Harris Esther Debon Verdu
Location of Project:	East Malling Research Kent ME19 6BJ Tel: 01732 843833 Fax: 01732 849067
Project consultant:	Neil Obbard
Date Project commenced:	1 April 2005
Expected completion date:	31 March 2006

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Principal Scientists:

J V Cross MA, MBPR (Hort.), FRES (Entomologist) (project leader, author of report)
S Cubison MSc (Organic fruit specialist)
A Harris (Entomologist)

Statistical advisor

G Arnold BA, MSc, CStat (Biometrician)

Authentication

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

.....J V Cross
Signature

Date .....

East Malling Research is an Officially Recognised Efficacy Testing Organisation
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Grower summary

TF162

Pear: Evaluation of insecticides for the control of pear sucker eggs and nymphs 2005

Final report 2005

Headline

- Karamate is an effective control and although slow acting, Envidor is an effective new treatment for pear sucker control.

Background and deliverables

Pear sucker is the most damaging pest of pears and is difficult to control being resistant to many broad-spectrum insecticides. This experiment was conducted to determine the efficacy of a wide range of foliar spray treatments on nymphs and the viability of eggs.

Summary of the project and main conclusions

A replicated orchard experiment was done in June 2005 to evaluate the efficacy of foliar sprays of Hallmark (300 ml/ha), Insegar (600 g/ha), sulphur (3.0 litres of 800 g/l SC/ha), Envidor (600 ml/ha), Dimilin Flo (300 ml/ha), Karamate (5.6 kg/ha), Masai (500 g/ha), Tracer (250 ml/ha), Elvaron Multi (2.25 kg/ha), Masai (500 g/ha), Epsom salts (7.5 kg/ha) for control of pear sucker eggs and nymphs. Water only and untreated control treatments (the latter double replicated) were included. Sprays were applied at a volume of 500 l/ha on 2 June and again on 17 June 2005. Pear sucker egg and nymph populations were determined 4, 11 and 19 days after the first treatment, this latter assessment also being 4 days after the second spray.

None of the treatments affected egg numbers which were high (~50/leaf throughout the experiment). There were no significant treatment differences at the assessment 4 days after treatment, weather conditions having been cool (max temperature < 20 ºC) since spraying. At 11 days after the first spray treatment, the most effective treatments were Insegar, Karamate, Hallmark and Sulphur which reduced total numbers of nymphs by 81%, 75%, 73% and 72% respectively, though none of these was significantly better than the water or Mitac treatments. Insegar, Mitac, Dimilin, Sulphur, Hallmark, Elvaron Multi and Envidor all reduced the numbers of first stage nymphs by 94%, 91%,

81%, 77%, 74%, 64% and 64% respectively. At 19 days after the first spray and 4 days after the second, Karamate, Envidor and Mitac were the only treatments which had reduced total nymph numbers significantly, by 74%, 68% and 60% respectively. Envidor significantly reduced the numbers of second stage (N2) nymphs by 61% but there were no statistically significant differences for the other treatments. No phytotoxicity was observed.

This work indicates that Envidor is an effective new treatment for pear sucker (though slow acting). It also demonstrated the effectiveness of Karamate. Results with Insegar were contradictory. It gave very good control at an assessment 11 days after treatment but reductions 19 days after treatment were disappointing and not statistically significant. Several of the other treatments showed moderate activity in the short term and some of these (e.g. sulphur) may be more effective if applied over the longer term in a programme of multiple sprays where they may make the foliage less susceptible to pear sucker attack.

Further work is necessary to validate these results. The trial site chosen was very heavily infested with pear sucker, so the trails had to be abandoned and oversprayed with amitraz (Mitac) after 19 days to avoid catastrophic crop loss. In any future trials it might be preferable to use a less heavily infested crop, but this would lead to a requirement to increase sample size and would increase the amount of work involved.

Financial benefits

Pear sucker is the most important pest of pears and the UK industry typically spends £100-200 per ha per annum (total >£200k per annum) controlling it. When the pest is not controlled effectively it can lead to very severe crop loss and death of trees. The loss of Mitac means that the UK industry no-longer has an effective treatment for curative control. The cost of this research is a very small fraction of any benefit that is likely to arise from more effective control methods that may be identified.

Action points for growers

- Envidor and Karamate were shown to be effective treatments for insecticidal control of pear sucker in this experiment and these materials should be used as part of an integrated management programme for control of pear sucker.

Science Section

Pear: Evaluation of insecticides for the control of pear sucker eggs and nymphs 2005

Summary

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but this would lead to a requirement to increase sample size and would increase the amount of work involved.

Introduction

The 'soft pesticides hard trees' strategy of controlling pear sucker (*Cacopsylla pyricola* is the species in the UK) was outlined by Burts in the early 1980s (Burts, 1983, 1984). Soft pesticides are those which control pear sucker without harming the pest's key natural enemies, especially the predatory flower bugs *Anthocoris nemoralis* and *A. nemorum*. Hard trees have less lush foliage which is less favourable to pear sucker. The strategy has been used by most UK pear growers since the mid 1970s when pear sucker developed resistance to a wide range of broad spectrum insecticides including organophosphates, carbamates and pyrethroids.

For selective insecticides, amitraz (Mitac) and diflubenzuron (Dimilin) were used initially supplemented with fenoxycarb (Insegar) when it became available. Amitaz (Mitac) is effective against young nymphs and is quick acting, especially in hot weather, and has been relied on as a fire brigade treatment for many years. Unfortunately, amitraz (Mitac) was not supported in the European pesticides harmonisation process and approval in the UK ceased on 12 August 2005, depriving growers of there only quick acting pear sucker insecticide. Diflubenzuron (Dimilin) acts on eggs and young stages (Frankenhuyzen and Meinsma, 1978) and is more effective when sprayed in admixture with oil (Szeoke, 1995). However, pear sucker is considered to be widely resistant to diflubenzuron though it is probable that no resistance tests have been done. Fenoxycarb (Insegar) when applied before oviposition or to newly laid-eggs has an ovicidal effect or delays hatching. When young nymphs are treated, they die in the 5th instar stage. It also causes anomalous adult moulting and nymphal-adult intermediates, thus acting as a juvenile hormone analogue (Larguier & Rivenez, 1990) and is also known to have effects on the fecundity and survival of winter adults (Horton & Lewis, 1996).

Early work in Canada and the USA (McMullen & Jong, 1970; Bode, 1978; Burts, 1983, 1984) showed that foliage sprays of mancozeb at high doses (up to 11 kg a.i. ha^{-1} per spray) showed promise as a selective insecticide in management of pear sucker (*Cacopsylla pyricola*) suppressing populations of eggs and nymphs considerably. The effect on eggs was subsequently confirmed in the UK funded by the APRC by Cross (1994, 1995) has shown that Karamate is effective for suppressing pear sucker. Tolylfluanid (Elvaron Multi) gave promising results against pear sucker (*Cacopsylla pyri*) laboratory tests and before flowering in the field against young nymphs but were ineffective after flowering in Belgium in the late 1990s (Champagne & Bylemans, 1999). There is little in the published literature about the effects of sulphur or magnesium sulphate (Epsom salts) on pear sucker. However, promoted by FAST, spray programmes initially of sulphur and more recently of magnesium sulphate have been found to generally reduce pear sucker outbreaks in commercial orchards in the UK. It is probable that the effect is

due to hardening the foliage though insecticidal effects of these materials on pear sucker do not appear to have been investigated.

The objective of the experiment reported here was to determine the efficacy of a wide range of chemicals on pear sucker eggs and nymphs.

Methods and materials

Site

The experiment was conducted in a commercial Conference pear orchard at Furminger Farm, Gallants Lane, East Farleigh, Nr. Maidstone, Kent ME15 0LG by kind permission of Mr Don Fermor. The orchard ('Big Field') was planted in 1985 using Quince C rootstocks in 1985. The row spacing was 4.4 m and trees were spaced 2.8 m apart in the rows.

Treatments

Treatments were two sprays of different pesticide products (Table 1), applied on 2 June 2005 and 17 June 2005.

Table 1. Treatments

Treatment	Active substance and formulation	Product	Product Dose /ha
A	lambda-cyhalothrin 100 g/l CS	Hallmark	300 ml
B	fenoxycarb 25% w/w WG	Insegar	600 g
C	sulphur 800 g/l SC	Sulphur SC	3.0 l
D	spirodiclofen 240 SC	Envidor	0.6 l
E	diflubenzuron 480 g/l SC	Dimilin Flo	300 ml
F	mancozeb 75% w/w WG	Karamate Dry Flo	5.6 kg
G	tebufenpyrad 20% w/w WB	Masai	500 g
H	spinosad 480 g/l SC	Tracer	250 ml
I	tolylfluanid 50.5% w/w WG	Elvaron Multi	2.25 kg
J	amitraz 200 g/l EC	Mitac	3.5 l
K	magnesium sulphate	Epsom salts	7.5 kg
L	water	-	-
M	untreated†	-	-

† Double replicated

They were applied when there are numerous eggs present on the leaves that were expected to hatch.

Experimental approval

The test products were fully approved for use on pear, except Envidor and Tracer. Use of Envidor and Tracer was under a non crop destruct experimental approvals held by Bayer UK and Dow AgroSciences. No crop destruction was required as all the products had full or non-crop destruct experimental approval

Spray application

Sprays were applied at a volume of 500 l/ha with a motorised air-assisted knapsack sprayer.

Table 2. Accuracy of spray applications

Treatment	Product	2 June	17 June
A	Hallmark	95	93
B	Insegar	88	93
C	Sulphur SC	91	93
D	Envidor	100	93
E	Dimilin Flo	107	88
F	Karamate Dry Flo	97	91
G	Masai	107	94
H	Tracer	96	93
I	Elvaron Multi	94	88
J	Mitac	97	91
K	Epsom salts	91	81*
L	Water	100	91

* blocked nozzle

Experimental design and layout

A randomised complete block experimental design with 5 replicate plots of each treatment was used. Plots consisted of single pear trees in a row with one guard tree in between treated trees and at either end. Guard rows between adjacent rows of plots were included to minimise interplot contamination by spray drift (see plan below).

Meteorological records

Wet and dry bulb temperature, wind speed and direction will be recorded before and after spraying. Full records for the trial duration are available from HRI-EM met station.

Table 3. Meteorological measurements at time of spraying

	2 June	17 June
Air temperature (°C)	15.5-18	20.5-24
RH (%)	82-90	86-87
Windspeed (Kph)	2-7	0-2

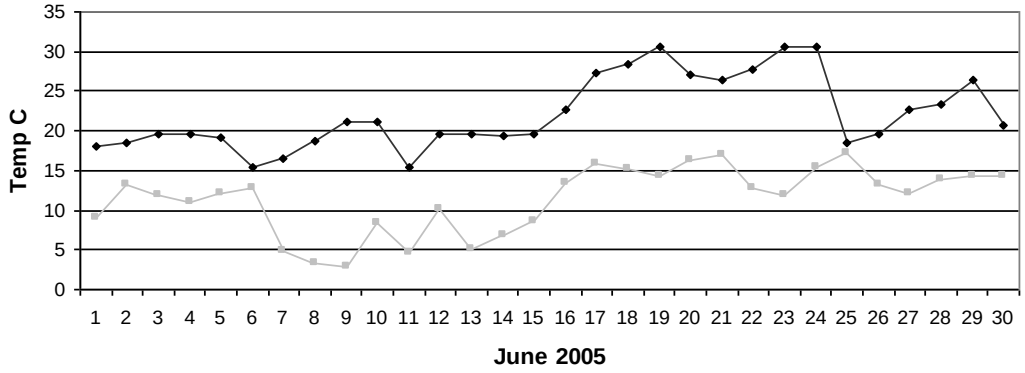

Figure 1. Daily maximum and minimum air temperatures at EMR in June 2005.

Assessments

On 31 May 2005, two days before the first spray application, five preliminary overall samples of 25 leaves and one sample of 25 fruiting clusters were taken from the whole experimental area. The first of the five leaf samples consisted of 25 of the first expanded (> 2cm diameter) leaves in the shoots (leaf 1). The second sample was of 25 of the second age leaves down the shoots (leaf 2), the third of third age leaves down the shoot (leaf 3), the fourth of the fourth age leaf down the shoot (leaf 4) and the fifth of fifth age leaves down the shoot (leaf 5). Additionally, a sample of 25 fruiting clusters was taken. Each leaf or cluster in each sample was taken from a different tree selected at random from the whole experimental plot. Several leaves of each age were left tagged in the orchard so that the age class could be traced during the progress of the experiment. Samples were stored in polythene bags in a laboratory fridge at approximately 4 °C until counting. The pear sucker eggs (newly laid, semi-mature and mature eggs were counted separately) and nymphs of each of the five nymphal stages (N1…N5) were counted on each leaf under a binocular microscope, and on three leaves and two fruitlets from each cluster. Numbers of anthocorid eggs were counted on each leaf sample above taken for pear sucker and the degree of stickiness due to honeydew contamination scored for each treatment on the scale of none, slight, moderate or severe.

The assessments of the pre-spraying samples indicated that populations of eggs and nymphs were greatest on leaf 1 (Table 4). Note that the cluster counts included 3 leaves and 2 fruitlets per truss. It was decided that it was

most efficient to assess pear sucker populations on the leaf 1 age stratum. The sample of 25 leaf 1 leaves contained 852 eggs and 38 nymphs indicating that a sample size of 10 leaves, containing 340 eggs (and 15 nymphs already hatched) was likely to be very adequate.

Table 4. Total numbers of pear sucker eggs, nymphs and adults on the samples of 25 leaves or 25 clusters taken on 31 may 2005 from the whole trail area 2 days before spraying

Leaf	Eggs			Nymphs					Adults
age	New	Semi	Mature	N1	N2	N3	N4	N5	
Leaf 1	329	440	83	18	5	10	5	0	15
Leaf 2	127	450	204	2	3	5	0	1	2
Leaf 3	132	356	224	2	3	1	0	0	1
Leaf 4	83	273	443	7	2	11	0	0	0
Leaf 5	61	160	199	7	11	12	0	0	1
Truss	46	1307	454	10	38	18	0	1	2

A sample of 10 leaves was therefore taken at random from each plot on 6 June 2005, 4 days after the first spray, on 13 June 2005, 11 days after the first spray, and on 21 June 2005, 19 days after the first spray and 4 days after the second. This sample size was chosen as it gave data suitable for statistical analysis each assessment taking 12 man days in the laboratory. The leaves selected were those from the stratum which had been the first expanded at the tine of spraying, as indicated by the tagging. Pear sucker and anthocorid egg numbers were determined as described above.

In the protocol, it had been intended to determine pear sucker adult numbers by beat sampling or by shoot inspection but this intention was abandoned because preliminary inspection indicated that adult numbers were very high and did not vary between plots, even those treated with Hallmark or Mitac. The plots were too small to determine differences for a highly dispersive pest like pear sucker.

Determination of the phytotoxic effects of the treatments was not a central aim of this work. However, plots were inspected for any visual signs of phytotoxicity from the treatments on each sampling occasion. As no symptoms were observed, no special phytotoxicity assessment was done.

Shortly after the third post spraying assessment, the trial had to be abandoned and oversprayed with amitraz (Mitac) because the pear sucker was causing significant damage and catastrophic crop loss and tree damage had to be avoided.

Statistical analysis

Data were collated, plot totals for each life stage calculated and statistically analysed by ANOVA. Analysis was done after square root and $\log_{10}(n+1)$

transformation to stabilise variances. The analyses of the square root transformed data were generally satisfactory though the $\log_{10}(n+1)$ transformed results are also presented for completeness. Treatment differences were determined by least significant difference testing (p=0.05), mainly making comparisons with the untreated control.

Results

First assessment 4 days after the first spray

Populations of eggs were high (grand mean 571 eggs per 10 leaves), 25% were newly laid, 56% semi-mature and 19% mature. Nymphs (grand mean 45.3 per 10 leaves) comprised 7.4% of the population (excluding adults), 17% being N1, 33 % N2, 36% N3, 14% N4 and 0.6% N5 (Tables 5, 6 and 7, Figure 2). However, the analyses of variances revealed no significant treatment effects or differences on either egg or nymph numbers. Numbers of anthocorid eggs and nymphs were too small and erratic to warrant statistical analysis or draw conclusions from the data. Temperatures over the period between spraying and this first assessment were cool with the maximum daily temperature not exceeding 20 ºC (Figure 1). There was no significant rainfall.

Second assessment 11 days after the first spray

Populations of eggs (grand mean 670 per 10 leaves) had risen by 42% by the second assessment 11 days after the first treatment application. The percentages of eggs that were newly laid or semi-mature eggs had decline to 15% and 45% respectively, but the percentage of eggs that were mature had increased to 40%. This is as expected as the stratum of leaves sampled had matured and pear sucker eggs are preferentially laid on the younger leaves. Nymph numbers increased by 36%, 24% being N1, 42% N2, 24% N3, 8% N4 and 1.6% N5.Temperatures were over the period between spraying and this second assessment were cool with the maximum daily temperature not exceeding 21 ºC (Figure 1). There was no significant rainfall.

There were no statistically significant treatment effects or differences in egg numbers. However, all the treatments except Tracer significantly ($P \leq 0.05$) reduced numbers of pear sucker nymphs compared to the untreated control (Tables 8, 9 and 10; Figure 2). Even the water treatment reduced total nymph numbers by 60% and the standard Mitac treatment by 69%. The best treatments were Insegar, Karamate, Hallmark and Sulphur which reduced number of nymphs by 81%, 75%, 73% and 72% though none of these was significantly better than the water or Mitac treatments. Insegar, Mitac, Dimilin, sulphur, Hallmark, Elvaron Multi and Envidor all reduced the numbers of first stage nymphs (N1) by 94%, 91%, 81%, 77%, 74%, 64% and 64% respectively. Numbers of anthocorid eggs and nymphs were too small and erratic to warrant statistical analysis or draw conclusions from the data.

Third assessment 19 days after the first spray application and 4 days after the second

Populations of eggs (grand mean 463 per 10 leaves) had declined by 31% by the third assessment 19 days after the first treatment application and 4 days after the second. The percentages of eggs that were newly laid remained at 15%, semi-mature eggs had declined to 33% but the percentage of eggs that were mature had increased to 52%. This is as expected as the stratum of leaves sampled had matured and pear sucker eggs are preferentially laid on the younger leaves. Temperatures were over the period between the second and third assessments were much warmer with the maximum daily temperature exceeding 25 ºC on 4 days and 30 ºC on one day (Figure 1). There was no significant rainfall. The high temperatures caused significant egg hatch and total nymph numbers increased by 20% since the previous assessment, 27% being N1, 33% N2, 25% N3, 11% N4, 4% N5.

Analyses of variances revealed no significant treatment effects or differences in egg numbers. Total nymph numbers were significantly reduced by the Karamate, Envidor and Mitac treatments by 74%, 68% and 60% respectively but none of the other treatments significantly reduced total nymph numbers (Tables 11, 12 and 13, Figure 2). However, there were highly significant treatment effects on second stage nymph (N2) and total nymph numbers. Karamate, Envidor and Mitac were the only treatments which reduced total nymph numbers significantly, by 74%, 68% and 60% respectively, compared to the untreated control. Envidor significantly reduced the numbers of second stage (N2) nymphs by 61% but there were no other statistically significant effects of treatments on any of the other individual life stages. Numbers of anthocorid eggs and nymphs were too small and erratic to warrant statistical analysis or draw conclusions from the data.

Phytotoxicity

No phytotoxic symptoms were observed on any of the plots at any of the sampling dates and therefore no special assessment of phytotoxicity was done.

Conclusions

- None of the treatments affected egg numbers which were high.
- At 11 days after the first spray treatment, the most effective treatments were Insegar, Karamate, Hallmark and sulphur which reduced number of nymphs of all stages by 81%, 75%, 73% and 72% respectively, though none of these was significantly better than the water or Mitac treatments. Insegar, Mitac, Dimilin, sulphur, Hallmark, Elvaron Multi and Envidor all reduced the numbers of first stage nymphs by 94%, 91%, 81%, 77%, 74%, 64% and 64% respectively.
- At 19 days after the first spray and 4 days after the second, Karamate, Envidor and Mitac were the only treatments which reduced total nymph numbers significantly, by 74%, 68% and 60% respectively. Envidor significantly reduced the numbers of second stage (N2) nymphs by 61%.

- Results with Insegar were contradictory. It gave very good control at the assessment 11 days after treatment, but reductions 19 days after treatment were not statistically significant.
- No phytotoxicity was observed.
- This work indicates that Envidor is an effective new treatment for pear sucker (though slow acting). It also demonstrated the effectiveness of Karamate though the 19 days results with Insegar were disappointing. Several of the other treatments showed moderate activity in the short term and some of these (e.g. sulphur) may be more effective if applied over the longer term in a programme of multiple sprays where they may suppress pear sucker populations and make the foliage less susceptible to pear sucker attack.
- Further work is necessary to validate these results. The trial site chosen was very heavily infested with pear sucker, so the trails had to be abandoned and oversprayed with amitraz (Mitac) after 19 days to avoid catastrophic crop loss. In any future trials it might be preferable to use a less heavily infested crop, but this would lead to a requirement to increase sample size and would increase the amount of work involved.

Acknowledgements

This work was funded by the HDC Tree Fruit Panel. We are most grateful to Don Fermor for provision of the trial site and to Yajia Liu, Esther Debon Verdu, Antonia Zurbuchen and Asya Ter-Hovannesyan who assisted with the sampling and counts.

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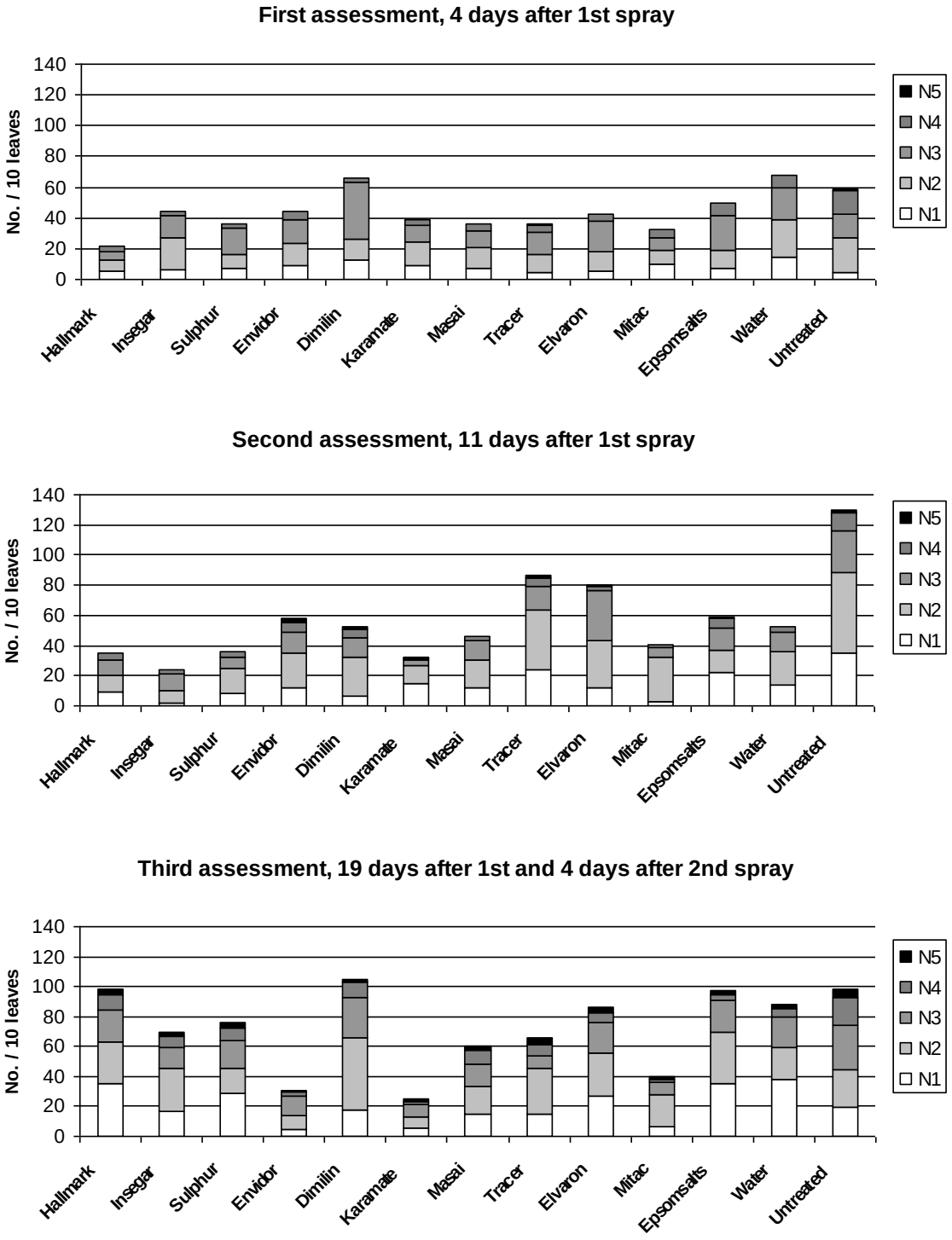

Figure 2. Mean numbers of pear sucker nymphs per 10 leaves 4, 11 and 19 days after application of the first sprays on 2 June 2005. Note the third assessment was 4 days after the second spray applications.

Table 5. Mean numbers of pear sucker per 10 leaves recorded at the first assessment 4 days after the first treatment application

Treatment	Eggs				Nymphs					
	New	Semi-	Mature	Total	N1	N2	N3	N4	N5	Total
Hallmark	55.8	107.8	111.6	275.2	5.2	7.6	5.0	3.6	0.4	21.8
Insegar	201.0	244.8	118.2	564.0	6.6	20.8	14.2	2.6	0.0	44.2
Sulphur	258.0	328.4	83.2	669.6	6.8	9.8	16.8	2.4	0.4	36.2
Envidor	226.4	318.8	96.8	642.0	9.0	14.4	15.6	5.2	0.2	44.4
Dimilin	181.4	418.4	148.6	748.4	12.8	13.0	37.6	2.6	0.0	66.0
Karamate	70.8	345.8	62.4	479.0	9.2	15.4	10.2	4.4	0.0	39.2
Masai	170.8	262.2	73.4	506.4	6.8	14.0	10.8	4.4	0.2	36.2
Tracer	108.6	271.8	74.8	455.2	4.4	11.8	14.2	4.4	1.0	35.8
Elvaron	181.0	260.6	146.6	588.2	5.2	13.2	19.2	5.0	0.0	42.6
Mitac	86.4	437.6	118.6	642.6	10.2	9.2	7.8	5.6	0.0	32.8
Epsom salts	145.4	417.2	99.6	662.2	7.6	11.6	22.4	8.0	0.2	49.8
Water	95.4	370.6	136.2	602.2	14.6	24.6	20.2	8.6	0.0	68.0
Untreated	98.6	363.5	115.9	578.0	4.9	22.1	15.7	15.0	0.8	58.5

Table 6. Mean square root numbers of pear sucker per 10 leaves recorded at the first assessment 4 days after the first treatment application

Treatment	Eggs				Nymphs					
	New	Semi-	Mature	Total	N1	N2	N3	N4	N5	Total
Hallmark	6.14	10.05	9.63	16.16	1.97	2.42	1.89	1.41	0.40	4.48
Insegar	13.45	15.18	10.66	23.47	1.62	3.85	3.17	1.24	0.00	6.22
Sulphur	14.23	16.93	8.71	24.82	2.13	2.71	2.94	1.30	0.40	5.66
Envidor	13.35	17.38	9.71	24.69	2.43	3.69	3.45	2.01	0.20	6.57
Dimilin	12.94	19.71	11.59	26.77	2.80	3.06	4.98	1.06	0.00	7.56
Karamate	8.02	18.05	7.83	21.56	2.24	3.86	2.76	1.67	0.00	6.14
Masai	11.62	15.30	8.29	21.59	1.93	3.51	3.09	1.71	0.20	5.70
Tracer	10.38	16.24	8.46	21.22	1.67	2.99	3.44	1.84	0.63	5.73
Elvaron	11.69	15.73	11.61	23.37	2.17	3.59	3.59	1.87	0.00	6.22
Mitac	8.91	19.44	10.44	24.47	2.84	2.54	1.77	1.30	0.00	5.22
Epsom salts	11.13	19.95	9.89	25.48	2.34	3.36	3.92	2.57	0.20	6.66
Water	9.50	17.89	11.59	23.75	3.25	4.94	4.29	2.49	0.00	8.12
Untreated	9.42	18.40	10.50	23.65	1.88	4.52	3.67	3.48	0.54	7.31
Fprob	0.140	0.101	0.444	0.336	0.801	0.193	0.254	0.143	0.202	0.281
SED (53 df)†	2.387	2.517	1.590	3.012	0.752	0.823	0.955	0.806	0.2567	1.131
SED (53 df)‡	2.756	2.907	1.837	3.478	0.869	0.950	1.103	0.931	0.2964	1.306

† Comparisons with untreated ‡ Other comparisons

Table 7. Mean Log10(n+1) transformed numbers of pear sucker per 10 leaves recorded at the first assessment 4 days after the first treatment application

Treatment	Eggs				Nymphs					
	New	Semi-	Mature	Total	N1	N2	N3	N4	N5	Total
Hallmark	1.366	1.980	1.870	2.393	0.665	0.768	0.632	0.473	0.120	1.294
Insegar	2.215	2.343	2.042	2.731	0.497	1.086	0.942	0.429	0.000	1.549
Sulphur	2.118	2.391	1.846	2.749	0.648	0.860	0.797	0.432	0.120	1.468
Envidor	2.132	2.454	1.966	2.761	0.750	1.142	1.019	0.684	0.060	1.635
Dimilin	2.185	2.552	2.072	2.836	0.823	0.921	1.209	0.336	0.000	1.697
Karamate	1.774	2.489	1.786	2.656	0.654	1.187	0.848	0.542	0.000	1.570
Masai	1.971	2.325	1.816	2.635	0.615	1.085	0.972	0.562	0.060	1.485
Tracer	2.033	2.410	1.840	2.650	0.537	0.923	1.046	0.632	0.216	1.489
Elvaron	1.890	2.365	2.096	2.693	0.731	1.133	0.989	0.621	0.000	1.559
Mitac	1.867	2.517	1.992	2.748	0.902	0.796	0.524	0.382	0.000	1.368
Epsom salts	2.029	2.574	1.987	2.803	0.756	1.080	1.067	0.828	0.060	1.603
Water	1.931	2.438	2.126	2.726	0.957	1.402	1.254	0.796	0.000	1.813
Untreated	1.888	2.490	2.021	2.731	0.627	1.295	1.106	1.052	0.178	1.700
Fprob	0.222	0.035	0.537	0.251	0.860	0.118	0.291	0.140		0.234
SED (53 df)†	0.2342	0.1296	0.1481	0.1180	0.2207	0.1951	0.2371	0.2369		0.1556
SED (53 df)‡	0.2704	0.1497	0.1710	0.1363	0.2549	0.2253	0.2738	0.2375		0.1796

† Comparisons with untreated ‡ Other comparisons

Table 8. Mean numbers of pear sucker per 10 leaves recorded at the second assessment 10 days after the first treatment application

Treatment	Eggs				Nymphs					
	New	Semi-	Mature	Total	N1	N2	N3	N4	N5	Total
Hallmark	121.6	206.6	155.6	483.8	9.2	11.0	9.8	4.8	0.4	35.2
Insegar	77.2	226.2	225.2	528.6	2.2	7.6	11.2	2.8	0.2	24.0
Sulphur	94.2	337.8	264.0	696.0	8.2	16.6	7.8	3.0	0.4	36.0
Envidor	92.0	269.4	254.6	616.0	12.4	22.8	13.8	6.2	2.8	58.0
Dimilin	112.4	380.6	262.4	755.4	6.8	25.2	13.4	5.4	1.4	52.2
Karamate	56.4	184.8	194.0	435.2	14.4	12.6	3.4	0.8	0.6	31.8
Masai	77.0	227.0	228.4	532.4	11.8	18.6	12.6	2.6	0.6	46.2
Tracer	111.0	221.8	252.6	585.4	23.6	39.8	16.0	5.4	2.2	87.0
Elvaron	105.4	370.4	298.0	773.8	12.4	31.0	33.0	2.6	1.0	80.0
Mitac	91.4	341.6	354.2	787.2	3.0	29.2	6.6	1.4	0.2	40.4
Epsom salts	109.0	356.2	296.2	761.4	21.8	14.6	14.8	6.8	1.4	59.4
Water	80.6	255.6	351.6	687.8	13.6	22.6	12.6	3.4	0.2	52.4
Untreated	144.0	408.4	318.5	870.9	34.9	53.4	27.8	12.0	1.6	129.7

Table 9. Mean square root numbers of pear sucker per 10 leaves recorded at the second assessment 10 days after the first treatment application

Treatment	Eggs				Nymphs					
	New	Semi-	Mature	Total	N1	N2	N3	N4	N5	Total
Hallmark	10.05	14.08	11.75	21.78	2.53	3.13	3.11	1.68	0.28	5.83
Insegar	7.82	14.79	14.37	22.75	1.31	2.57	2.75	1.18	0.20	4.44
Sulphur	8.65	17.30	15.12	24.79	2.67	3.69	2.57	1.31	0.28	5.61
Envidor	8.76	15.43	14.08	23.05	2.81	4.41	3.41	1.99	1.25	7.04
Dimilin	9.46	18.29	15.39	26.36	2.14	4.61	3.41	2.19	0.88	6.74
Karamate	6.30	12.80	12.70	19.45	3.53	3.37	1.60	0.55	0.48	5.42
Masai	8.26	13.98	14.14	21.72	3.14	3.62	3.11	1.39	0.60	6.34
Tracer	9.50	14.59	14.90	23.20	4.15	6.21	3.95	2.03	1.13	9.23
Elvaron	8.89	18.88	16.13	26.94	2.76	5.31	4.91	0.95	0.63	8.64
Mitac	8.97	18.00	18.46	27.65	1.12	4.74	2.12	0.69	0.20	5.93
Epsom salts	9.39	18.16	16.28	26.70	3.97	3.77	3.43	2.16	0.75	7.10
Water	8.11	15.51	17.66	25.30	2.94	4.04	3.19	1.29	0.20	6.77
Untreated	11.07	19.92	17.45	29.27	4.77	6.73	5.00	2.97	0.94	11.01
Fprob	0.861	0.204	0.650	0.454	0.018	0.042	0.030	0.094		<0.001
SED (53 df)†	2.131	2.562	2.782	3.789	0.939	1.189	0.903	0.740		1.341
SED (53 df)‡	2.461	2.959	3.212	4.375	1.084	1.373	1.042	0.855		1.548

† Comparisons with untreated ‡ Other comparisons

Table 10. Mean $log_{10}(n+1)$ transformed numbers of pear sucker per 10 leaves recorded at the second assessment 10 days after the first treatment application

Treatment	Eggs				Nymphs					
	New	Semi-	Mature	Total	N1	N2	N3	N4	N5	Total
Hallmark	1.888	2.277	2.084	2.669	0.789	0.998	1.025	0.564	0.095	1.530
Insegar	1.584	2.327	2.272	2.707	0.451	0.845	0.830	0.389	0.060	1.253
Sulphur	1.732	2.394	2.274	2.703	0.867	1.084	0.834	0.451	0.095	1.452
Envidor	1.732	2.301	2.159	2.626	0.832	1.220	1.039	0.636	0.426	1.592
Dimilin	1.780	2.448	2.325	2.795	0.687	1.281	1.049	0.735	0.295	1.607
Karamate	1.462	2.141	2.111	2.503	1.071	1.054	0.547	0.181	0.156	1.448
Masai	1.789	2.220	2.239	2.618	0.977	0.990	0.953	0.476	0.181	1.540
Tracer	1.879	2.312	2.283	2.697	1.130	1.584	1.211	0.687	0.391	1.927
Elvaron	1.746	2.538	2.354	2.831	0.805	1.423	1.272	0.311	0.216	1.842
Mitac	1.831	2.487	2.518	2.872	0.350	1.234	0.679	0.229	0.060	1.495
Epsom salts	1.843	2.484	2.377	2.823	1.083	1.172	1.024	0.698	0.260	1.642
Water	1.715	2.352	2.439	2.774	0.858	1.087	0.981	0.423	0.060	1.604
Untreated	1.986	2.588	2.466	2.926	1.149	1.565	1.370	0.899	0.316	2.048
Fprob	0.921	0.258	0.513	0.408	0.016	0.161	0.017	0.117		0.006
SED (53 df)†	0.2626	0.1547	0.1773	0.1528	0.2074	0.2474	0.2020	0.2297		0.1829
SED (53 df)‡	0.3032	0.1786	0.2047	0.1746	0.2395	0.2856	0.2333	0.2652		0.2112

† Comparisons with untreated ‡ Other comparisons

Table 11. Mean numbers of pear sucker per 10 leaves recorded at the third assessment 7 days after the second treatment application

Treatment	Eggs				Nymphs					
	New	Semi-	Mature	Total	N1	N2	N3	N4	N5	Total
Hallmark	33.4	88.6	166.2	288.2	35.4	27.8	21.6	9.8	3.4	98.0
Insegar	76.8	145.8	500.2	722.8	17.0	28.0	14.0	8.0	2.6	69.6
Sulphur	46.6	90.2	218.6	355.4	28.6	16.8	18.8	8.0	4.0	76.2
Envidor	84.2	164.2	217.0	465.4	4.6	9.6	13.0	2.2	1.6	31.0
Dimilin	56.0	202.2	321.4	579.6	18.0	48.2	26.2	10.2	2.4	105.0
Karamate	38.2	104.2	126.0	268.4	5.2	8.0	8.2	2.0	2.0	25.4
Masai	63.6	72.4	154.6	290.6	14.8	19.0	14.6	9.0	2.6	60.0
Tracer	65.6	148.2	174.6	388.4	14.6	31.0	8.0	7.4	4.8	65.8
Elvaron	125.6	263.0	315.4	704.0	26.6	29.0	20.6	6.0	4.4	86.6
Mitac	59.8	274.0	316.4	650.2	6.8	21.0	8.8	1.8	1.4	39.8
Epsom salts	110.2	191.0	292.8	594.0	35.4	34.0	21.0	4.0	2.6	97.0
Water	20.6	52.0	141.6	214.2	37.8	21.8	20.0	5.4	2.8	87.8
Untreated	108.4	162.8	209.0	480.2	19.3	24.8	29.9	18.6	5.7	98.3

Table 12. Mean square root numbers of pear sucker per 10 leaves recorded at the third assessment 7 days after the second treatment application

Treatment	Eggs				Nymphs					
	New	Semi-	Mature	Total	N1	N2	N3	N4	N5	Total
Hallmark	4.32	8.55	11.90	15.93	4.55	4.56	4.01	2.40	1.42	8.73
Insegar	6.94	10.14	20.31	24.40	3.56	4.52	3.48	2.34	1.34	7.68
Sulphur	4.81	8.34	14.15	17.63	4.44	3.68	3.56	2.14	1.31	8.07
Envidor	7.91	11.90	14.38	20.63	1.82	2.42	3.39	1.45	0.79	5.19
Dimilin	5.91	13.88	16.83	23.32	2.94	6.55	4.81	2.90	1.34	10.04
Karamate	5.09	8.88	10.94	15.47	1.87	2.24	2.30	1.08	1.04	4.28
Masai	7.36	8.28	11.84	16.57	2.87	4.13	3.44	2.63	1.50	7.43
Tracer	6.77	11.20	12.88	18.90	2.85	4.26	2.17	2.16	1.53	7.09
Elvaron	9.78	15.74	17.12	25.74	4.12	5.12	4.37	2.11	1.78	9.01
Mitac	7.04	15.88	17.57	25.38	2.47	4.17	2.63	1.00	0.88	6.01
Epsom salts	6.35	11.94	15.96	21.61	4.34	5.63	4.35	1.81	1.37	9.25
Water	4.26	6.73	11.28	14.06	4.88	4.53	4.08	2.14	1.37	8.63
Untreated	8.68	10.99	13.23	19.72	3.43	4.59	4.17	3.09	1.90	9.19
Fprob	0.671	0.091	0.166	0.210	0.526	0.009	0.463	0.289	0.901	0.009
SED (53 df)†	2.472	2.708	2.923	4.125	1.299	0.879	1.025	0.763	0.598	1.337
SED (53 df)‡	2.854	3.127	3.375	4.763	1.500	1.015	1.184	0.881	0.690	1.544

† Comparisons with untreated ‡ Other comparisons

Table 13. Mean log10(n+1) transformed numbers of pear sucker per 10 leaves recorded at the third assessment 7 days after the second treatment application

Treatment	Eggs				Nymphs					
	New	Semi-	Mature	Total	N1	N2	N3	N4	N5	Total
Hallmark	1.081	1.723	2.064	2.325	1.075	1.197	1.109	0.733	0.489	1.682
Insegar	1.462	1.848	2.496	2.665	1.031	1.194	1.070	0.747	0.445	1.704
Sulphur	1.080	1.749	2.263	2.442	1.139	1.071	0.990	0.648	0.407	1.739
Envidor	1.605	2.078	2.294	2.584	0.610	0.740	1.055	0.486	0.276	1.385
Dimilin	1.308	2.268	2.401	2.708	0.775	1.595	1.325	0.909	0.455	1.991
Karamate	1.236	1.773	2.060	2.333	0.612	0.702	0.724	0.372	0.350	1.151
Masai	1.653	1.817	2.110	2.417	0.807	1.219	1.042	0.829	0.492	1.717
Tracer	1.438	1.977	2.201	2.512	0.801	1.058	0.683	0.676	0.491	1.547
Elvaron	1.794	2.367	2.433	2.791	1.063	1.388	1.271	0.703	0.598	1.885
Mitac	1.594	2.364	2.480	2.806	0.821	1.196	0.833	0.340	0.295	1.536
Epsom salts	1.130	2.035	2.344	2.574	1.002	1.479	1.253	0.597	0.464	1.873
Water	1.224	1.604	2.067	2.268	1.169	1.310	1.184	0.711	0.451	1.804
Untreated	1.668	1.823	2.162	2.472	0.954	1.281	1.033	0.836	0.610	1.862
Fprob	0.397	0.169	0.234	0.192	0.748	0.002	0.355	0.289	0.918	0.004
SED (53 df)†	0.3011	0.2571	0.1745	0.1827	0.2760	0.1773	0.2300	0.1985	0.1935	0.1705
SED (53 df)‡	0.3477	0.2969	0.2015	0.2110	0.3187	0.2048	0.2656	0.2292	0.2234	0.1969

† Comparisons with untreated ‡ Other comparisons