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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.

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Signature

Date ....

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Grower summary

Headline

- Dynamec or the coded products A8612 AB (in admixture with an adjuvant) and A9584 C were the most effective treatments for pear sucker control.

Background and deliverables

Pear sucker is a devastating pest of pears which is currently out of control and causing serious widespread damage in many commercial pear orchards in the UK. It is difficult to control chemically being resistant to many broad-spectrum insecticides. Anthocorid predatory bugs are key natural enemies of pear sucker but they often colonise orchards too late in spring and in insufficient numbers to prevent serious attacks. Growers are diligent in avoiding use of pesticides that are harmful to them. Current methods of management of pear sucker in UK orchards are not sustainable.

Alternative effective insecticidal treatments are needed for pear sucker control in the UK. This experiment was conducted to determine the efficacy of a wide range of foliar spray treatments to provide growers with information on practical treatments for the pest.

Summary of the project and main conclusions

A small plot replicated field experiment was done in May and June 2007 to evaluate the efficacy of a wide range of insecticides for control of pear sucker nymphs. Treatments tested either comprised 2 sprays (spray volume 500 l/ha, CAF factor 1.0) of various products, applied at the onset of a mass hatch of eggs on 23 May and 14 days later on 6 June, or a programme of 6 sprays at approximately weekly intervals on the 9, 17, 23, 31 May, 6, 13 June, as listed below:

Product	**No. of sprays**
Insegar	2
Envidor	2
Karamate Dry Flo	2
Tracer	2
Dynamec	2
A8612 AB + Li 700	2
A8612 AB + Break-Thru S240	2
A8612 AB + LI 700, then A9584 C	2
A9584 C	2
Sulphur SC	6
$MgSO_4$	6
Activator 90	6
$MgSO_4$ + Sulphur SC + Activator 90†	6
Untreated (double replicated)	0

The products A8612 AB and A9584 C were included as treatments, funded by the parent company. Note that A8612 AB was tested in admixture with the adjuvants LI 700 or Break-Thru S240. Another treatment comprised a first spray of A8612 AB + LI 700 followed by a second spray of A9584 C. Karamate Dry Flow was included at the reduced rate of 2 kg product/ha as it is likely that the recommended dose for use of this product will be reduced from the current dose of 4.5 kg/ha to the lower dose in the near future. The treatments that comprised 6 sprays were of sulphur (3 l of 800 g/l SC product /ha), magnesium sulphate (7.5 kg/ha) or the non-ionic wetter Activator 90 (500 ml/ha), or a three way mix of these products.

A randomised complete block experimental design with five replicate guarded single tree plots per treatment was used. The efficacy of the treatments was assessed by counting the numbers of young (N1-N3) and old (N4-N5) pear sucker nymphs and eggs on leaf samples taken from each plot on 1, 13 and 28 June 2007. These samples were 8, 21 and 34 days respectively after the first of the sprays (for the two spray treatments) was applied and 5 days before and 7 and 22 days respectively after the second of the sprays (for the two spray treatments) were applied. The severity of contamination of leaves and fruits by honeydew and sooty mould was scored.

At the first assessment on 1 June:

- Dynamec and treatments with A8612 AB in admixture with an adjuvant significantly reduced numbers of pear sucker nymphs (on average by 64%)
- No benefits of the addition of adjuvant to A8612 AB could be determined
- A9584 C reduced nymph numbers by 88% and was significantly ($P \leq 0.05$) better than the Dynamec and A8612 AB treatments on average
- Karamate and Tracer also reduced total nymph numbers significantly, but only by <54%
- None of the other treatments significantly reduced nymph numbers and none significantly affected egg numbers

Heavy rainfall that occurred subsequently on 27 and 28 May and at intervals throughout June caused pear sucker nymph numbers to collapse and there were no significant differences at subsequent assessments.

At the assessment on 13 June 2007, there were significant differences in the severity of honeydew contamination of leaves ($P = 0.002$) and in the severity of foliage blackening by sooty mould ($P < 0.001$):

- The treatments with Dynamec, A8612 AB with adjuvants and especially the A9584 C had markedly less contamination by honeydew or sooty mould than the untreated control or any of the other treatments

At the assessment on 28 June, many of the spray treatments showed a significant reduction in the severity of blackening by sooty mould of the developing fruits, especially round the calyces:

- The treatments with Dynamec or A8612 AB showed the lowest amounts of blackening

In summary, Dynamec, A8612 AB in admixture with an adjuvant and the A9584 C were the most effective treatments and the only ones to give a commercially acceptable degree of control.

The programme of 6 sprays of sulphur + magnesium sulphate + wetter, or of each of these materials individually, gave poor results failing to both reduce egg numbers and control the first hatch of nymphs. These treatments did give a marginal reduction in fruit blackening, but the degree of control achieved was not commercially acceptable.

The treatments with 2 sprays of Envidor, Karamate, Tracer and Insegar also gave poor results. Envidor is known to be slow acting and there was some evidence that it may have yielded better results had it been applied earlier, or at later assessments, had nymph numbers not been reduced due to rain.

No phytotoxic affects of the treatments were observed.

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 the result can be very severe crop losses and tree death. The loss of Mitac means that the UK industry no-longer has an effective treatment for curative control. More effective control will have a considerable financial impact and could influence the viability of UK pear production.

Action points for growers

- Dynamec (abamectin) is an effective product for pear sucker control. An application for approval for use on pears in the UK has been submitted by the manufacturer. The approval process is ongoing.
- Programmes of multiple sprays of sulphur + magnesium sulphate + wetter, or of 2 sprays of Envidor, Karamate, Tracer and Insegar are of limited efficacy and can not be relied on to give commercially acceptable control of severe infestations, though Envidor may give better results if applied earlier or in the longer term.

Science Section

Evaluation of insecticides for the control of pear sucker, 2007

Introduction

Pear sucker (*Cacopsylla pyricola* Förster) is a devastating pest of pears which is currently out of control and causing serious widespread damage in many commercial pear orchards in the UK (note *C. pyri* is the dominant species in other European countries). Nymphs suck sap from leaves and fruits excreting honeydew which turns black with sooty mould. This contaminates the foliage and fruits, ruining the crop. Attacks weaken the trees which suffer from severe depletion in fruit buds the year following attack or may even be killed. The pest transmits pear decline, a debilitating phytoplasma disease of young trees. The pest seriously threatens the future of pear production in the UK which otherwise has opportunity to expand substantially.

Pear sucker is favoured by hot, dry conditions and is particularly devastating when there are prolonged periods of dry weather. Climate change is seriously exacerbating the problem which threatens the future of pear growing in the UK and threatens any expansion of the area of production of this crop in the UK, which otherwise is favoured by warmer conditions.

Approximately 173,000 tonnes of pears are consumed per annum in Britain but the area of UK pear industry is small (1,536 ha with 23,800 tonnes marketed in 2005). The UK industry cannot meet the market demand, which is increasing due to the desire by supermarkets to source pears locally. Yields from UK orchards are low compared to Dutch and Belgium competitors where the bulk of UK marketed pears are sourced. Grade out is particularly poor with typically only 40-50% in class I. There is no market for class II. Low average yields are due to a significant proportion of older, less intensive orchards. Poor grade outs are caused by russetting, resulting from unfavourable weather during early fruit development and pear sucker attacks, and misshapes. The UK industry would like to substantially increase production, but pear sucker is one of the limiting factors which undermine confidence to invest in new intensive orchards. Several pear growers have recently invested in substantial new intensive pear plantings which have high output potential but investment in further expansion has been halted by the pear sucker problem.

Pear sucker has developed multi-resistance to a wide range of insecticides and there are currently no pesticide treatments available to UK growers that are adequately effective. The recent loss of amitraz (Mitac) due to the EU pesticides review has deprived the UK industry of its only effective treatment. In attempts to control the pest, growers make multiple applications of a wide range of different chemicals. One currently favoured approach is to make a weekly full programme of high volume sprays of sulphur + magnesium sulphate + wetters in admixture at high doses. This programme may be supplemented with sprays of insect growth regulators and the fungicide mancozeb. UK pear growers typically spend >£200 per ha per season in prophylactic treatments against pear sucker and this amount can rise substantially if weather conditions favour the pest.

Anthocorid predatory bugs are key natural enemies of pear sucker but they often colonise orchards too late in spring and in insufficient numbers to prevent serious attacks. Growers are diligent in avoiding use of pesticides that are harmful to anthocorids but otherwise have no clear management practices for fostering them. Current methods of management of pear sucker in UK orchards are not sustainable.

Alternative effective insecticidal treatments are needed for pear sucker control in the UK. The experiment reported here was done to evaluate the efficacy of a wide range of treatments for control of pear sucker nymphs, including Dynamec, A8612 AB and A9584 C. The A8612 AB was evaluated in admixture with adjuvants on the request of the parent company which funded the work with their coded products. Treatments with the existing approved products Insegar, Envidor, Karamate Dry Flow (at the reduced rate of 2 kg product/ha) and Tracer were included for comparison. The remaining treatments comprised 6 sprays of sulphur, magnesium sulphate or the non-ionic wetter Activator 90, and a three way mix of these products. Many UK growers currently apply a full programme of weekly sprays of this mix at weekly intervals starting from petal fall. These products were included alone or in admixture to determine the efficacy of the grower programme and to quantify what contribution each of the components makes to efficacy.

Methods and materials

A replicated experiment was done in a 15-year-old conference pear orchard at Dux Farm, Dux Lane, Cooling (by kind permission of David Long, Marsh Gate Farm, Cooling) in May and June 2007 to evaluate the efficacy of foliar sprays of a range of materials for control of pear sucker, *Cacopsylla pyricola*. The orchard was chosen because it was exceptionally heavily infested with pear sucker. It was situated at NGR TQ 778 747. The planting was in single rows and the spacing was 14’ x 6’ (= 4.27 x 1.83 m), giving a tree density of 1280 trees/ha. Trees were on average 1.8 m tall, of typical conical bush form, 1.5 m wide at the base with lowest branches at ~ 0.5 m and had an estimated PACE Crop Adjustment Factor of 1 at the time of application of the sprays

Treatments

Fourteen treatments were included, as shown in Table 1 overleaf. Dynamec, A8612 AB and A9584 C were included as treatments, the work with the latter coded products being funded by the parent company. Note that A8612 AB was tested in admixture with the adjuvants LI 700 or Break-Thru S240. Another treatment comprised a first spray of A8612 AB + LI 700 followed by a second spray of A9584 C. Karamate Dry Flow was included at the reduced rate of 2 kg product/ha as it is likely that the recommended dose for use of this product will be reduced from the current dose of 4.5 kg/ha to this dose in the near future. Two spray treatments with Insegar, Envidor, Karamate Dry Flow (at the reduced rate of 2 kg product/ha) and Tracer were included for comparison. The remaining treatments comprised 6 sprays of sulphur, magnesium sulphate or the non-ionic wetter Activator 90, and a three way mix of these products, and an untreated control (replicated twice in each block). Many UK growers currently apply a full programme of sprays of this mix at weekly intervals starting from petal fall and these treatments were included to evaluate the efficacy of the mix and try to determine what contribution each of the components makes to efficacy. The formulation details of the products and their doses of application are given in Table 2.

For the treatments which received two spray applications, the first spray was applied on 23 May 2007 with a second application 14 days later on 6 June 2007. The first sprays on 23 May were carefully timed to coincide with the onset of a mass hatch of pear sucker eggs. For the treatments that received 6 sprays, applications were made at approximately weekly intervals starting at the end of petal fall. The applications were made on 9, 17, 23, 31 May, 6, 13 June 2007. Note that the 3rd and 5th spray in this series coincided with the two successive sprays for the other treatments.

Spray application

Sprays were applied at a volume of 500 l/ha with a Birchmier motorised air-assisted knapsack sprayer fitted with a red Micron spray restrictor. The average height and width of the tree canopy recorded at time of the first spray application for the 2 spray treatments (23 May 2007) were 1.9 m and 1.4 m respectively. The Crop Adjustment Factor (CAF) of the trees was 1.0. Pre-treatment calibration showed that the sprayer delivered spray at a flow rate of 426 ml/minute so each tree was sprayed for a duration of 56 seconds (28 seconds each side) to deliver a required spray volume of 390 ml to each tree. Measurement of the volumes of spray solution remaining in the tank after spraying showed that applied spray volumes for each treatment were generally within less than 10% of the required volume. Exceptions were treatment 10 on 9 May which received 87% of the target volume and treatment 11 on 13 June which received 113 % of the target volume.

Met conditions at the time of spraying

Wet and dry bulb temperature, wind speed and direction were recorded before and after spraying. All sprays were applied in dry conditions. Temperature and relative humidity estimated from the air temperature and depression of the wet bulb temperature are given in Table 3.

Table 3. Air temperature and humidity conditions at the time of spray application

Date (2007)	At beginning of spray applications		At end of spray applications	
	Air temp (˚C)	RH%	Air temp (˚C)	RH%
9 May	13.0	90	15.0	75
17 May	17.0	80	17.5	75
23 May	17.5	72	24.0	57
31 May	17.0	64	16.0	79
6 June	12.5	89	14.5	74
13 June	22.0	61	24.0	53

Experimental design and layout

A randomised complete block experimental design with 5 replicate plots of each treatment was used, with the untreated control being replicated twice in each block. Each plot consisted of 1 dwarf pear tree plus one dwarf guard tree at either side in a row. Plots in each block were arranged end to end in one row. Guard rows between adjacent rows of plots were included to minimise interplot contamination by spray drift.

Maintenance sprays

The whole orchard was oversprayed with Indar (fenbuconazole 50 g/l EW, 1.4 l/ha) + Novogib (gibberellins, 10 g/l) on 13 April 2007 and with chlorpyrifos (480 g/l EC, 1.5 l/ha) on 28 April 2007 by the grower using his normal axial fan airblast sprayer (250 l/ha). These sprays were well before the experiment commenced. No spray treatments were applied to the trial area for the duration of the experiment.

Meteorological records

Full records for the trial duration were taken from the EMR met station, which is approximately 30 km south of the trial site. The records (Figure 1) showed that, although a few days of dry weather occurred after the first spray application for the two spray treatments on 23 May, very heavy rainfall (total of 35 mm) occurred on 27 and 28 May. The air temperature during this period was also much lower than average. Rainfall causes high mortality of pear sucker nymphs, especially neonates. The heavy rainfall coincided with the main hatching period of neonates and caused a strong decline in nymph numbers which would have increased markedly had the weather remained dry. Rainfall also occurred on many days in the second half of June causing pear sucker populations to fall to very low levels by the end of the trial.

Assessments

Pear sucker: Three overall samples of 50 young expanded shoot leaves and 50 older expanded leaves from the fruitlet clusters were taken from untreated guard trees on 9, 16 and 25 May. The numbers of eggs, young (N1-N3) nymphs and more mature (N4-N5) nymphs present on each leaf were counted and the mean numbers per leaf calculated for each sampling date.

Assessments of pear sucker nymph and egg numbers on each plot were made on 1 June, 13 June and 28 June 2007. The first assessment was 8 days after the date of the first spray for the two spray treatments. Three sprays had been applied for the 6 spray treatments. The second assessment was 7 days after the second spray of the 2 spray treatments. Three sprays had been applied for the 6 spray treatments at that time. The third, final assessment was 22 days after the second spray for the two spray treatments and 15 days after the last of the 6 spray treatments.

For the first assessment, separate samples of 10 young expanded leaves from the shoots and 10 old expanded leaves from the clusters were taken per plot. For the second assessment, one sample of 25 young expanded leaves was taken from the shoots per plot. The older leaves were not sampled because numbers of pear sucker present on them were very small.

In each sample, the total number of young nymphs (N1-N3) and the total number of older (N4-N5) nymphs were counted. The numbers of eggs present were counted on 2 leaves per sample for the first assessment and on all leaves in the subsequent samples.

No assessments of numbers of adults were made because this was not considered to be worthwhile as the plots were small and surrounded on all sides by untreated trees that provided a source of adults which are highly dispersive.

Natural enemies: Numbers of anthocorid eggs present in the above leaf samples were counted. At the second assessment on 13 June, each plot was beat-sampled over a beating tray and a full record of numbers of predatory insect in each sample taken.

Crop damage and phytotoxicity: On each leaf of the leaf sample taken on 13 June, an assessment of the degree of contamination by honey dew and sooty mould was made. The following severity categories were used 0=none, 1=slight, 2=moderate, 3=severe.

The orchard was suffering from a low level of iron deficiency, the expression of which varied from tree to tree. Thus there was an underlying variation in the yellowing colour of the foliage. Some trees also showed a degree of brown spotting of the foliage. This was present on unsprayed guard trees and did not appear to be related to treatment. However, in order to ascertain whether the variation in the yellowness of the foliage or the occurrence of the brown spotting was treatment related, each plot was carefully examined on 13 June 2007 and the degree of yellowing of the foliage, the tree vigour, the degree of honeydew and sooty mould contamination of the foliage and the degree of brown spotting of the foliage was scored into the following severity categories: 0=none, 1=slight, 2=moderate, 3=severe.

As the pear sucker attack caused honeydew and sooty mould contamination of the pear fruits, at the final assessment on 28 June, each of approximately 20 fruits per plot were scored for the severity of damage using the same severity categories.

Plots were also inspected for any obvious visual signs of phytotoxicity from the treatments on each sampling occasion.

Statistical analysis

ANOVA of counts of pear sucker eggs and nymphs was done after appropriate log_{10}(count+1) transformation to stabilise variances.

Crop destruction

The test products were approved for use on pear except Dynamec, A8612 AB and A9584 C. Use of these products was made under the conditions of automatic experimental permits.

Results

Pear sucker

Very high populations of pear sucker eggs and nymphs were present on the untreated guard trees in May (Table 4). No anthocorid eggs were recorded in any of the samples.

Table 4. Mean numbers of pear sucker eggs and nymphs per leaf in overall samples taken from untreated guard trees.

Date	Young leaves in shoots			Older cluster leaves		
	Eggs	N1-N3	N4-N5	Eggs	N1-N3	N4-N5
9 May	44.4	0.3	0.02	12.2	0.2	0.0
16 May	61.8	1.2	0.1	12.3	0.3	0.0
25 May	18.5	3.8	0.0	39.6	18.3	0.2

At the first assessment of egg and nymph numbers every treated plot on 1 June, analysis of variance of the log_{10}(count+1) data showed highly significant ($P < 0001$) treatment affects on numbers of nymphs (Table 5). Dynamec and the treatments which included A8612 AB in admixture with an adjuvant significantly reduced numbers of pear sucker nymphs (on average by 64%). A9584 C had reduced nymph numbers by 88% and was significantly better ($P \leq 0.05$) better than the Dynamec or A8612 AB treatments on average. Karamate and Tracer also reduced total nymph numbers significantly, but only by <54%. None of the other treatments significantly reduced nymph numbers and none of the treatments significantly affected egg numbers. There were no statistically significant differences ($P = 0.428$) in the numbers of eggs (Table 6).

At the second assessment on 13 June numbers of nymphs present per leaf had declined sharply on all plots irrespective of treatment (Table 7). On the untreated controls, the total numbers of nymphs had declined from 13.5 per leaf at the fist assessment on 13 June to 3.3 per leaf. There were no statistically significant differences between treatments in the numbers of nymphs, though Envidor had the lowest numbers. The Dynamec, A8612 AB and A9584 treatments tended to have more eggs on the leaves than the untreated, and this was statistically significant in the case of the Dynamec and the A9584 C treatment (Table 8).

By the third assessment on 28 June 2007, pear sucker egg and nymph numbers had declined to very low levels and there were no statistically significant treatment differences (Tables 9 & 10).

Honeydew and sooty mould contamination

At the assessment on 13 June 2007, the analyses of variance showed that there were significant differences in the mean score of the severity of honeydew contamination of leaves ($P = 0.002$) and in the mean score of foliage blackening by sooty mould ($P < 0.001$) (Table 11). The treatments with A8612 AB with adjuvants (treatments 6-8) and especially the A9584 C (treatment 9) had markedly less contamination by honeydew than the untreated control or any of the other treatment. Note that Dynamec did not significantly reduce stickiness. However, the Dynamec and the treatments with A8612 AB and especially the A9584 C significantly reduced the severity of sooty mould.

At the assessment on 28 June 2007, many of the spray treatments had significantly reduced the mean score of the severity of blackening by sooty mould round the calyces of the fruit (Table 12). The treatments with Dynamec or A8612 AB had the lowest mean values but the values were not significantly less than the other spray treatments that had reduced the mean score for this variate.

Phytotoxicity

The assessments of the degree of foliar yellowing and severity spotting and the analyses of variance of the means scores for these variates showed no statistically significant treatment affects, confirming that these symptoms were not caused by differing degrees of pear sucker attack. It is suspected that the variation in foliar colour was caused by iron and other nutrient deficiencies and not by any of the spray treatments.

Predatory insects

Counts of anthocorid eggs on the leaf samples were mostly zero at the first assessment on 1 June 2007. Numbers had risen to ~ 0.5 per leaf by 13 June but the data was too erratic for statistical analysis and there were no obvious treatment affects. Numbers of predatory insects present in the beat samples were also small and erratic with anthocorid adults and nymphs being most abundant (Table 13).

Conclusions

- Very high populations of pear sucker eggs (reaching an average of > 60 /young leaf) were present at the outset and these were starting to hatch when the first of the sprays for the two spray treatments was applied on 23 May. However, a period of heavy rainfall that occurred on 27-28 May caused numbers of pear sucker nymphs to decline strongly. The heavy rain coincided with the main hatch period of neonates, which are particularly susceptible to rainfall which causes a high mortality. Further rain in June caused pear sucker numbers to decline to very low levels in the latter stages of the trial
- However, strong treatment affects were apparent at the first assessment on 1 June 2007. At this assessment, Dynamec and all treatments which included A8612 AB in admixture with an adjuvant, significantly reduced numbers of pear sucker nymphs (on average by 64%)
- A9584 C had reduced nymph numbers by 88% and was significantly better than the Dynamec or A8612 AB treatments on average
- Karamate and Tracer also reduced total nymph numbers significantly, but only by <54%. None of the other treatments significantly reduced nymph numbers and none of the treatments significantly affected egg numbers
- There were no statistically significant differences in the numbers of eggs at the first assessment. Dynamec, A8612 AB and A9584 C treatments tended to have more eggs on the leaves than the untreated, and this was statistically significant in the case of the A8612 AB alone treatment and the A9584 C treatment. The increase was probably because good control of pear sucker nymphs had occurred on these trees

so they had lush green foliage that was suitable for oviposition

- At assessment on 13 June 2007, there were significant differences in the mean score of the severity of honeydew contamination of leaves ($P = 0.002$) and in the mean score of foliage blackening by sooty mould ($P < 0.001$). The treatments with Dynamec or A8612 AB with adjuvants and especially the A9584 C had markedly less contamination by honeydew or sooty mould than the untreated control or any of the other treatment
- At assessment on 28 June 2007, many of the spray treatments had significantly reduced the mean score of the severity of blackening by sooty mould round the calyces of the fruit (Table 12). The treatments with Dynamec or A8612 AB with adjuvants had the lowest mean values but the values were not significantly less than the other spray treatments that had reduced the mean score for this variate
- The programmes of 6 sprays of sulphur + magnesium sulphate + wetter, or of each of these materials individually, gave poor results failing to reduce egg numbers or to control the first hatch of nymphs. The treatments did give a marginal reduction in fruit blackening, but the degree of control achieved was not commercially acceptable
- The treatments with 2 sprays of Envidor, Karamate, Tracer and Insegar also gave poor results. Envidor is known to be slow acting and there was some evidence that it may have given better results had it been applied earlier or at later assessments had nymph numbers not been reduced due to rain
- No phytotoxicity was observed
- Numbers of predatory insects present were small and erratic with anthocorid adults and nymphs being most abundant

Acknowledgements

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Table 1. Pear sucker trial treatments*

Trt	Product	Product Dose /ha	No. of sprays	Dates of application
1	Insegar	600 g	2	23 May, 6 June
2	Envidor	600 ml	2	23 May, 6 June
3	Karamate Dry Flo	2.0 kg	2	23 May, 6 June
4	Tracer	250 ml	2	23 May, 6 June
5	Dynamec	750 ml	2	23 May, 6 June
6	A8612 AB + Li 700	confidential	2	23 May, 6 June
7	A8612 AB + Break-Thru S240	confidential	2	23 May, 6 June
8	A8612 AB + LI 700, then A9584 C	confidential	2	23 May, 6 June
9	A9584 C	confidential	2	23 May, 6 June
10	Sulphur SC	3.0 l	6	9, 17, 23, 31 May, 6, 13 June
11	$MgSO_4$	7.5 kg	6	9, 17, 23, 31 May, 6, 13 June
12	Activator 90†	500 ml	6	9, 17, 23, 31 May, 6, 13 June
13	$MgSO_4$ + Sulphur SC + Activator 90†	7.5 kg + 3.0 l + 500 ml	6	9, 17, 23, 31 May, 6, 13 June
14	Untreated‡	-	0	-

† Maximum concentration Activator 90 = 0.1%
‡ Double replicated
* Spray volume 500 l/ha.

Table 2. Products and their formulation details

Product	Parent Company	Active substance. & formulation	Product dose rate/ha	Approval status on pear#
Insegar WP	Syngenta	fenoxycarb 25% w/w WG	600g	Approved
Envidor	Bayer	spirodiclofen 240 g/l SC	600 ml	Company
Karamate Dry Flo	Landseer	mancozeb 75% w/w WG	2 kg	Approved
Tracer	Landseer	spinosad 480 g/l SC	250 ml	Approved
Dynamec	Syngenta	abamectin 18 g/l	750 ml	Experimental
A8612 AB	Syngenta	confidential	confidential	Experimental
A9584 C	Syngenta	confidential	confidential	Experimental
Sulphur SC	Headland	sulphur 800 g/l SC	3 litres	Approved
$MgSO_4$	-	epsom salts	7.5 kg	n/a
Activator 90	De Sangosse	alkylphenyl hydroxypolyoxyethylene 750 g/l + natural fatty acids 150 g/l	0.1 % conc	Approved
LI 700	De Sangosse	lecithin 350 g/l + propionic acid 35% w/w + alcohol ethoxylate 9.39% w/w	0.5 % conc	Approved
Break-Thru 240 S	PP Products	polyalkylene oxide modified heptamethyl trisiloxane	300 ml	Approved

Company = consumer assessed experimental approval held by parent company; Experimental permit = requiring crop destruction

Table 5. Mean numbers of nymphs recorded per leaf on 1 June 2007

Product	No. sprays	Young (N1-3) nymphs		Old (N4-5) nymphs		Total nymphs	
		Count	Log_{10} (count+1)	Count	Log_{10} (count+1)	Count	Log_{10} (count+1)
1. Insegar	2	7.97	0.700	0.42	0.090	8.39	0.714
2. Envidor	2	11.74	0.731	0.52	0.116	12.26	0.746
3. Karamate	2	7.24	0.619	0.30	0.080	7.54	0.641*
4. Tracer	2	5.89	0.627	0.26	0.069	6.15	0.646*
5. Dynamec	2	5.56	0.413*	0.12	0.033*	5.68	0.421*
6. A8612 AB +Li700	2	4.19	0.439*	0.08	0.021*	4.27	0.442*
7. A8612 AB +BreakThru	2	5.15	0.520*	0.08	0.023*	5.23	0.529*
8. A8612 AB +Li, then A9584 C	2	4.09	0.461*	0.07	0.020*	4.16	0.466*
9. A9584 C	2	1.58	0.212*	0.10	0.029*	1.68	0.233*
10. Sulphur	6	9.37	0.743	0.61	0.130	9.98	0.762
11. $MgSO_4$	6	8.39	0.614	0.97	0.160	9.36	0.647*
12. Activator	6	8.58	0.767	0.51	0.116	9.09	0.792
13. $MgSO_4$+Sulphur+Activator	6	9.62	0.722	0.87	0.162	10.49	0.748
14. Untreated (double replicated)	0	12.83	0.804	0.71	0.140	13.54	0.821
Fprob			<0.001		0.004		<0.001
s.e.d. (57 df)‡			0.0990		0.0408		0.1006
s.e.d. (57 df)†			0.1144		0.0472		0.1162
l.s.d. (P = 0.05)‡			0.198		0.082		0.165
l.s.d. (P = 0.05)†			0.229		0.094		0.233

* significantly less than control ($P \leq 0.05$)
‡ comparisons with untreated control
† other comparisons

Table 6. Mean numbers of eggs recorded per leaf on 1 June 2007

Product	No. sprays	Eggs Count	Eggs Log_{10} (count+1)
1. Insegar	2	26.0	0.892
2. Envidor	2	17.2	0.762
3. Karamate	2	22.8	0.875
4. Tracer	2	13.6	0.943
5. Dynamec	2	31.6	1.023
6. A8612 AB +Li700	2	26.1	0.927
7. A8612 AB +BreakThru	2	16.0	0.734
8. A8612 AB +Li, then A9584 C	2	26.4	0.982
9. A9584 C	2	21.7	0.738
10. Sulphur	6	61.0	1.156
11. $MgSO_4$	6	21.2	0.764
12. Activator	6	24.9	0.923
13. $MgSO_4$+Sulphur+Activator	6	67.1	1.296
14. Untreated (double replicated)	0	33.1	1.140
	Fprob		0.428

Table 7. Mean numbers of nymphs recorded per leaf on 13 June 2007

Product	No. sprays	Young (N1-3) nymphs		Old (N4-5) nymphs		Total nymphs	
		Count	Log_{10} (count+1)	Count	Log_{10} (count+1)	Count	Log_{10} (count+1)
1. Insegar	2	1.4	0.251	0.34	0.0774	1.7	0.303
2. Envidor	2	0.8	0.150	0.09	0.0235	0.9	0.162
3. Karamate	2	3.1	0.401	0.15	0.0403	3.3	0.419
4. Tracer	2	4.6	0.541	0.56	0.1256	5.2	0.588
5. Dynamec	2	3.7	0.434	0.18	0.0403	3.9	0.446
6. A8612 AB +Li700	2	2.7	0.352	0.10	0.0245	2.8	0.364
7. A8612 AB +BreakThru	2	1.6	0.272	0.11	0.0256	1.7	0.284
8. A8612 AB +Li, then A9584 C	2	3.4	0.391	0.16	0.0389	3.6	0.404
9. A9584 C	2	1.9	0.260	0.13	0.0358	2.0	0.278
10. Sulphur	6	2.2	0.391	0.15	0.0431	2.3	0.409
11. $MgSO_4$	6	2.1	0.356	0.14	0.0389	2.3	0.375
12. Activator	6	1.9	0.291	0.06	0.0183	2.0	0.296
13. $MgSO_4$+Sulphur+Activator	6	2.1	0.282	0.13	0.0301	2.2	0.299
14. Untreated (double replicated)	0	3.0	0.428	0.29	0.0619	3.3	0.453
	Fprob		0.088		0.123		0.091

Table 8. Mean numbers of eggs recorded per leaf on 13 June 2007

Product	No. sprays	Eggs	
		Count	Log_{10} (count+1)
1. Insegar	2	4.0	0.392
2. Envidor	2	1.6	0.219
3. Karamate	2	5.7	0.425
4. Tracer	2	5.7	0.505
5. Dynamec	2	16.3	0.750*
6. A8612 AB +Li700	2	10.7	0.588
7. A8612 AB +BreakThru	2	3.6	0.339
8. A8612 AB +Li, then A9584 C	2	11.4	0.595
9. A9584 C	2	13.9	0.729*
10. Sulphur	6	4.7	0.425
11. $MgSO_4$	6	4.1	0.403
12. Activator	6	2.2	0.286
13. $MgSO_4$+Sulphur+Activator	6	4.0	0.402
14. Untreated (double replicated)	0	4.9	0.426
Fprob			0.025
s.e.d. (57 df)‡			0.1293
s.e.d. (57 df)†			0.1493
l.s.d. (P = 0.05)‡			0.259
l.s.d. (P = 0.05)†			0.299

* significantly greater than control ($P \leq 0.05$)
‡ comparisons with untreated control
† other comparisons

Table 9. Mean numbers of nymphs recorded per leaf on 28 June 2007

Product	No. sprays	Young (N1-3) nymphs		Old (N4-5) nymphs		Total nymphs	
		Count	Log_{10} (count+1)	Count	Log_{10} (count+1)	Count	Log_{10} (count+1)
1. Insegar	2	0.008	0.0024	0.008	0.0024	0.016	0.0038
2. Envidor	2	0.048	0.0135	0.000	0.0000	0.048	0.0135
3. Karamate	2	0.000	0.0000	0.008	0.0024	0.008	0.0024
4. Tracer	2	0.064	0.0173	0.056	0.0159	0.120	0.0311
5. Dynamec	2	0.040	0.0100	0.016	0.0048	0.056	0.0135
6. A8612 AB +Li700	2	0.048	0.0125	0.008	0.0024	0.056	0.0149
7. A8612 AB +BreakThru	2	0.048	0.0120	0.016	0.0038	0.064	0.0159
8. A8612 AB +Li, then A9584 C	2	0.016	0.0048	0.000	0.0000	0.016	0.0048
9. A9584 C	2	0.056	0.0144	0.000	0.0000	0.056	0.0145
10. Sulphur	6	0.040	0.0110	0.000	0.0000	0.040	0.0110
11. $MgSO_4$	6	0.024	0.0073	0.008	0.0024	0.032	0.0097
12. Activator	6	0.016	0.0048	0.032	0.0096	0.048	0.0135
13. $MgSO_4$+Sulphur+Activator	6	0.048	0.0125	0.000	0.0000	0.048	0.0125
14. Untreated (double replicated)	0	0.020	0.0060	0.008	0.0024	0.028	0.0084
	Fprob		0.431		0.489		0.395

Table 10. Mean numbers of eggs recorded per leaf on 28 June 2007

Product	No. sprays	Eggs Count	Eggs Log_{10} (count+1)
1. Insegar	2	0.032	0.0072
2. Envidor	2	0.248	0.0401
3. Karamate	2	0.016	0.0038
4. Tracer	2	0.136	0.0295
5. Dynamec	2	0.040	0.0100
6. A8612 AB +Li700	2	0.488	0.0703
7. A8612 AB +BreakThru	2	0.144	0.0298
8. A8612 AB +Li, then A9584 C	2	0.048	0.0104
9. A9584 C	2	0.496	0.0522
10. Sulphur	6	0.456	0.0557
11. $MgSO_4$	6	0.145	0.0348
12. Activator	6	1.056	0.1240
13. $MgSO_4$+Sulphur+Activator	6	0.216	0.0375
14. Untreated (double replicated)	0	0.236	0.0318
	Fprob		0.364

Table 11. Mean honeydew stickiness and sooty mould score (0=none, 1=slight, 2=moderate, 3=severe) on 13 June 2007

Product	No. sprays	Honeydew stickiness score score	Sooty mould score score
1. Insegar	2	1.03	2.2
2. Envidor	2	0.82	1.4
3. Karamate	2	1.04	2.0
4. Tracer	2	1.70	1.8
5. Dynamec	2	0.86	1.0*
6. A8612 AB +Li700	2	0.46*	0.6*
7. A8612 AB +BreakThru	2	0.62*	1.2*
8. A8612 AB +Li, then A9584 C	2	0.30*	0.8*
9. A9584 C	2	0.48*	0.2*
10. Sulphur	6	0.81	1.4
11. $MgSO_4$	6	0.83	1.4
12. Activator	6	0.90	1.4
13. $MgSO_4$+Sulphur+Activator	6	0.93	1.6
14. Untreated (double replicated)	0	1.30	2.3
	Fprob	0.002	< 0.001
	s.e.d. (57 df)‡	0.26	0.42
	s.e.d. (57 df)†	0.31	0.48
	l.s.d. (P = 0.05)‡	0.53	0.84
	l.s.d. (P = 0.05)†	0.61	0.97

* significantly less than control ($P \leq 0.05$)
‡ comparisons with untreated control
† other comparisons

Table 12. Mean score of sooty mould blackening to calyces of fruit on

28 June 2007

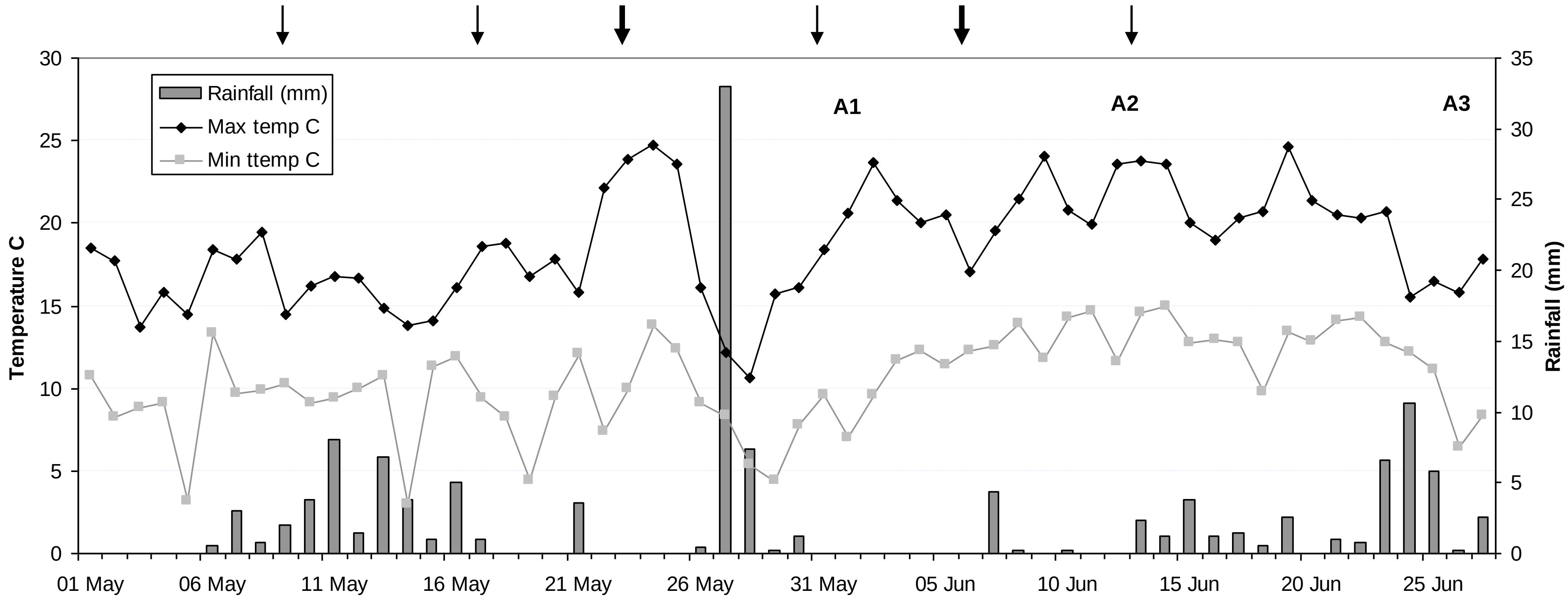
Product	No. sprays	Calyx blackening severity score
1. Insegar	2	0.51*
2. Envidor	2	0.83
3. Karamate	2	0.55*
4. Tracer	2	1.33
5. Dynamec	2	0.05*
6. A8612 AB +Li700	2	0.32*
7. A8612 AB +BreakThru	2	0.16*
8. A8612 AB +Li, then A9584 C	2	0.22*
9. A9584 C	2	0.47*
10. Sulphur	6	0.51*
11. $MgSO_4$	6	0.75*
12. Activator	6	0.75*
13. $MgSO_4$+Sulphur+Activator	6	0.48*
14. Untreated (double replicated)	0	1.16
	Fprob	< 0.001
	s.e.d. (57 df)‡	0.20
	s.e.d. (57 df)†	0.23
	l.s.d. (P = 0.05)‡	0.39
	l.s.d. (P = 0.05)†	0.45

* significantly greater than control (P ≤ 0.05)
‡ comparisons with untreated control
† other comparisons

Table 13. Mean numbers of anthocorid eggs per leaf and mean numbers of predators collected by beat sampling on 13 June

2007

Product	No. sprays	Leaves	Mean number from 3 beats per plot						
		Anthocorid ggs/leaf	Anthocorids	ladybirds	syrphid	spiders	earwigs	lacewings	Soldier beetles
1. Insegar	2	0.26	0.8	0.0	0.0	0.2	0.0	0.0	0.4
2. Envidor	2	0.09	0.4	0.2	0.2	0.6	0.0	0.0	0.2
3. Karamate	2	0.48	0.6	0.8	0.0	0.4	0.0	0.0	0.0
4. Tracer	2	1.20	1.6	1.4	0.0	1.0	0.2	0.0	0.0
5. Dynamec	2	0.50	0.2	0.2	0.0	0.8	0.0	0.0	0.2
6. A8612 AB +Li700	2	0.64	0.0	0.2	0.2	0.4	0.0	0.0	0.0
7. A8612 AB +BreakThru	2	0.16	0.4	0	0.0	1.0	0.0	0.0	0.2
8. A8612 AB +Li, then A9584 C	2	0.58	0.2	0.2	0.0	0.6	0.0	0.2	0.0
9. A9584 C	2	0.32	0.6	0,0	0.0	0.6	0.0	0.0	0.2
10. Sulphur	6	0.49	0.8	1.0	0.0	1.2	0.2	0.2	0.0
11. $MgSO_4$	6	0.48	0.0	1.2	0.0	0.8	0.0	0.0	0.0
12. Activator	6	0.41	0.2	0.4	0.0	1.2	0.0	0.2	0.0
13. $MgSO_4$+Sulphur+Activator	6	0.67	0.6	0.4	0.2	0.8	0.0	0.0	0.0
14. Untreated (double replicated)	0	0.51	0.4	0.5	0.2	0.7	0.0	0.0	0.0



↓ Application dates of sprays for treatments that received 6 sprays

⬇ Application dates of sprays for treatments that received 2 sprays and for those that received 6 sprays

A1, A2, A3 Assessments on 1, 13 and 28 June 2007

Figure 1. Daily maximum and minimum air temperature (˚C) and daily rainfall amount at East Malling Research in 2007.