Project title:	Further development of earwig-safe spray programmes for apple and pear orchards
Project number:	TF 220
Project leader:	Dr Michelle Fountain, East Malling Research, New Road, East Malling, Kent, ME19 6BJ Tel: 01732 843833; Fax: 01732 849067
Report:	Year 3 final report, 2016
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Key staff:	Adrian Harris, Maddie Cannon, Alvaro Delgado Dr Philip Brain (Biometrician)
Location of project:	NIAB EMR, New Road, East Malling, Kent, ME19 6BJ
Industry Representative:	Dr Oliver Doubleday DPhil FRAgS, G H Dean & Co Ltd, Hempstead Farm, Tonge, Sittingbourne, Kent, ME9 9BJ. Tel: 01795 423981, email: oliver@ghdean.co.uk
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Date project completed (or expected completion date):	31 March 2017

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The results and conclusions in this report are based on an investigation conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.

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AUTHENTICATION

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

Dr Michelle Fountain

Deputy Head of Pest and Pathogen Ecology

NIAB EMR, New Road, East Malling, Kent, ME19 6BJ

Signature .... Date 31 March 2017

Report authorised by:

Professor Jerry Cross

Science Group Leader

NIAB EMR, New Road, East Malling, Kent, ME19 6BJ

Signature .... Date 31 March 2017

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GROWER SUMMARY

Headline

- The effects on earwigs of commonly used pest control products in orchards are revealed.

Background and expected deliverables

Earwigs are important generalist predators in both apple and pear orchards. They play a key part in regulating populations of several highly damaging pests including woolly aphid and other aphid pests, mussel scale, codling moth and pear sucker. Recent laboratory tests and field experiments by NIAB EMR and experiments by other European scientists have indicated that several commonly used insecticides including thiacloprid (Calypso), indoxacarb (Steward), chlorpyrifos and spinosad (Tracer) have harmful effects on earwigs and could be responsible for low populations in some orchards. However, growers need to be able to use products containing acetamaprid (Gazelle), thiacloprid (Calypso), abamectin (Agrimec) and spirodiclofen (Envidor) for control of aphids, mussel scale, weevils, capsids, pear sucker and sawfly.

This project builds on research carried out by EMR in AHDB Project TF 196, which showed that earwigs can be disrupted by routine crop protection programmes. It tested how to integrate key crop protection products into pest management programmes without causing harm to earwig populations in orchards. It also investigated the sub-lethal effects (growth and reproduction) that these products have on nymph and adult earwigs in highly replicated laboratory trials.

Summary of the project and main conclusions

In the first year of the project (2014) nymph and adult earwigs exposed to acetamaprid (Gazelle), thiacloprid (Calypso), abamectin (Agrimec) or spirodiclofen (Envidor) and compared to a water only control in laboratory tests, demonstrated that earwig nymphs avoid feeding on bean leaves sprayed with Calypso, but Envidor appeared to stimulate adult earwig feeding. Calypso also slowed the growth of earwig nymphs and male adults. The tests suggested that in the short term Gazelle, Envidor and Agrimec appeared to be safe to earwig nymphs and adults.

Adult earwigs exposed to one of 4 orchard insecticides in the laboratory in 2014 were maintained as paired males and females, kept in cool conditions over the winter and then

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allowed to reproduce in the spring of 2015. Fecundity measurements were taken to determine long-term effects of exposure to acetamaprid (Gazelle), thiacloprid (Calypso), abamectin (Agrimec) or spirodiclofen (Envidor) in comparison to a water only control. There was significant female earwig mortality with previous exposure to Agrimec and Envidor residues compared to the water only control. In addition, Envidor significantly delayed egg laying by a month compared to the control. It was noted, in the previous year, that Envidor stimulated feeding of residue contaminated bean leaves. The combined effects of autumn and spring earwig mortality and delayed egg laying meant there were a third more eggs laid in the water only control, overall, compared to the Envidor, Calypso and Agrimec treatments.

In 2015, a replicated field trial was done to assess the impacts of Calypso and Gazelle at recommended field rates on earwig numbers in a Gala apple orchard. The plots were blocks of 24 trees sprayed with an air assisted knapsack sprayer either pre-blossom or mid-season with one or two applications of Calypso or Gazelle compared to unsprayed blocks of trees. No significant effects of either Calypso or Gazelle were found on earwig populations with either one or two spray applications in the spring or mid-season. In previous field tests (Project TF 196) foliar applications of Calypso reduced the numbers of earwigs. Differences may have been due to canopy density and hence spray coverage or earwig population levels.

In 2016, a replicated field trial was done to assess the impacts of Calypso, Envidor or Agrimec at recommended field rates on earwig numbers in a Conference pear orchard. The plots were blocks of 60-360 trees. Blocks were sprayed with the grower’s own commercial equipment at pre-blossom (21 March), early summer (08 June), mid-summer (21 July) or post-harvest (18 October) and compared to an untreated control. No significant effects of Calypso were found on earwig populations with either the pre-blossom or post-harvest sprays. An early summer (08 June) foliar application of Envidor or Agrimec reduced the numbers of earwig nymphs significantly. However, by mid-summer (21 July), when the earwigs were fully mature, Envidor and Agrimec had no discernible effect on the numbers of adult earwigs in pear trees.

The results of these experiments suggest that an occasional application of Gazelle or Calypso targeted to control pests which reach threshold are unlikely to have long term effects on earwig populations if earwig populations are already high in the orchard. It should be noted that Agrimec is no longer approved for use on pear. Early summer

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applications of Envidor in pear orchards should be avoided where possible as young earwigs appear to decline in trees treated at this time.

Building up earwig populations in orchards by selective use of crop protection products will firstly increase natural control of many major orchards pests, but secondly allow occasional sprays of more earwig harmful products when they are needed to control early spring or sporadic pests.

Financial benefits

- This research has provided the industry with independently obtained information on the relative safety of critical orchard insecticides on earwigs; important natural enemies of several damaging pests.
- Growers and agronomists will be able to judge when best to use which products for essential control of aphids, weevils, capsids, pear sucker and sawfly.
- There will be fewer problems with many important orchard pests if earwig populations are allowed to thrive.

Action points for growers

- Growers should make considered choices of pest control products based on the knowledge of important predators in the orchard at the time of spraying.
- Growers can consult agronomists to determine which products are safe to apply at key times of the earwig lifecycle and check correct application rates.
- Gazelle could be an alternative to Calypso for sawfly, muscle scale or weevil control, but further work is needed on Gazelle efficacy for this purpose.
- Growers should avoid early summer applications of Envidor where possible, when earwig nymphs seem to be susceptible to these products.
- At the time of writing, the approval for Agrimec for use on pear was nearing expiry.

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SCIENCE SECTION

Introduction

Earwigs (Dermaptera) are important predators of many pests (Fig. 1a) of orchards including scale insects (Karsemeijer 1973; McLeod & Chant 1952), psyllids (Sauphanor *et al*., 1994), woolly apple aphid (Phillips, 1981; Ravensburg, 1981; Noppert *et al*,. 1987; Mueller *et al*., 1988; Solomon *et al*., 1999; Nicholas *et al*., 2005) and codling moth (Glen, 1977). Reports that earwigs are declining in some orchards (Gobin *et al*., 2008) has raised concern for this effective, natural, biocontrol agent. The earwig most commonly encountered in UK orchards is *Forficula auricularia* (Fitzgerald and Solomon, 1996; Solomon *et al*., 1999). A female *F. auricularia* lays 50 to 90 eggs in the spring (Fig. 1b). She attends the first stage nymphs and then dies before mid-summer. Third instar nymphs move into the tree canopy (Phillips, 1981) from May onwards and, after the fourth instar, emerge as adults (July-August) (Gobin *et al*., 2008). Earwigs are nocturnal and their numbers are often underestimated in orchards.

(a)  (b) 

Figure 1. (a) Female earwig feeding on rosy apple aphid (b) and with offspring

Insecticides applied between March and October could have effects on earwig populations and effects on earwig behaviour may have consequences on populations the following year. Earwigs are exposed to spray residues whilst moving around and feeding at night in the tree canopy and on the ground (Ffrench-Constant and Vickerman, 1985). The data available for sensitivity of earwigs to many modern insecticides is building; however, growers need to apply potentially earwig harmful insecticides at certain times of the year to protect against pests such as aphids, weevils, capsids, pear sucker and sawfly. These include the neonicotinoids, acetamiprid (Gazelle) and thiacloprid (Calypso), and two products used to help manage pear sucker in the summer, abamectin (Agrimec) and spirodiclofen (Envidor).

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The vulnerability of the different earwig life stages to these products requires investigation in well replicated trials.

Laboratory experiments have screened adult earwigs at experimental doses of a few pesticides (Peusens & Gobin, 2008) and EMR/AHDB project TF 196 has screened the most commonly used UK insecticides in laboratory trials, but more research is needed on the timing of applications in real orchards and any sub lethal effects of the few pesticides available for aphid, weevil, capsid, pear sucker and sawfly control.

AHDB project TF 196 began testing spray programmes on two farms, but no consideration was made to sprays of thiacloprid and abamectin. It is also not known whether acetamaprid (more water soluble than thiacloprid) would have less detrimental effects on earwigs. Evidence from studies of predatory mites suggests that these latter products differ in toxicity (Beers and Himmel 2002; Bostian *et al*. 2009).

Project aim:

To determine whether (if and when?) acetamiprid (Gazelle), thiaclorpid (Calypso), abamectin (Agrimec - no current approval) and spirodiclofen (Envidor) can be used in earwig safe spray programmes on apple and pear.

Year 3 objective:

Evaluate the effects on earwig populations of early season (pre-petal fall) versus mid-season (fruit development) foliar applications of spirodiclofen (Envidor) or abamectin (Agrimec - no current approval) or thiacloprid (Calypso) in pear orchards (year 3).

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Materials and Methods

Site: 'Stoney Rock' conference pear orchard (4.5 ha, row spacing 4 m, tree spacing 2 m) planted in the 1950s was used by kind permission of David Long, Childs Farm, Rochester.

Treatments: Either Calypso, Agrimec, and/or Envidor were applied by farm spray operator and growers own machinery under supervision of NIAB EMR staff at the recommended field concentration (Table 1). Treatments were applied on 21 March, 08 June, 21 July and 18 October (Table 2).

Table 1. Products applied to the Conference pear orchard in 2016

Product	**a.i.**	**Field rate/ha**	**No. of Applic.**	**Harvest interval**
Calypso	thiacloprid	0.375 l	2	14 d
Envidor	spirodiclofen	0.6 l	1	14 d
Agrimec	abamectin	0.75 l	2	14 d

Table 2. Treatments applied to the Conference pear orchard in 2016

Treatment	**21 Mar**	**08 Jun**	**21 July**	**18 Oct**
1				
2	Calypso	Envidor		Calypso
3		Agrimec	Agrimec	
4			Envidor	

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Experimental design and statistical analyses: Each plot was 3 rows wide with a guard row between plots. Because of the shape of the orchard, 8 of the 16 plots were 120 m and 8 were 40 m long. Plots were deployed as randomised blocks and there were 4 replicates of each treatment (Fig. 2).

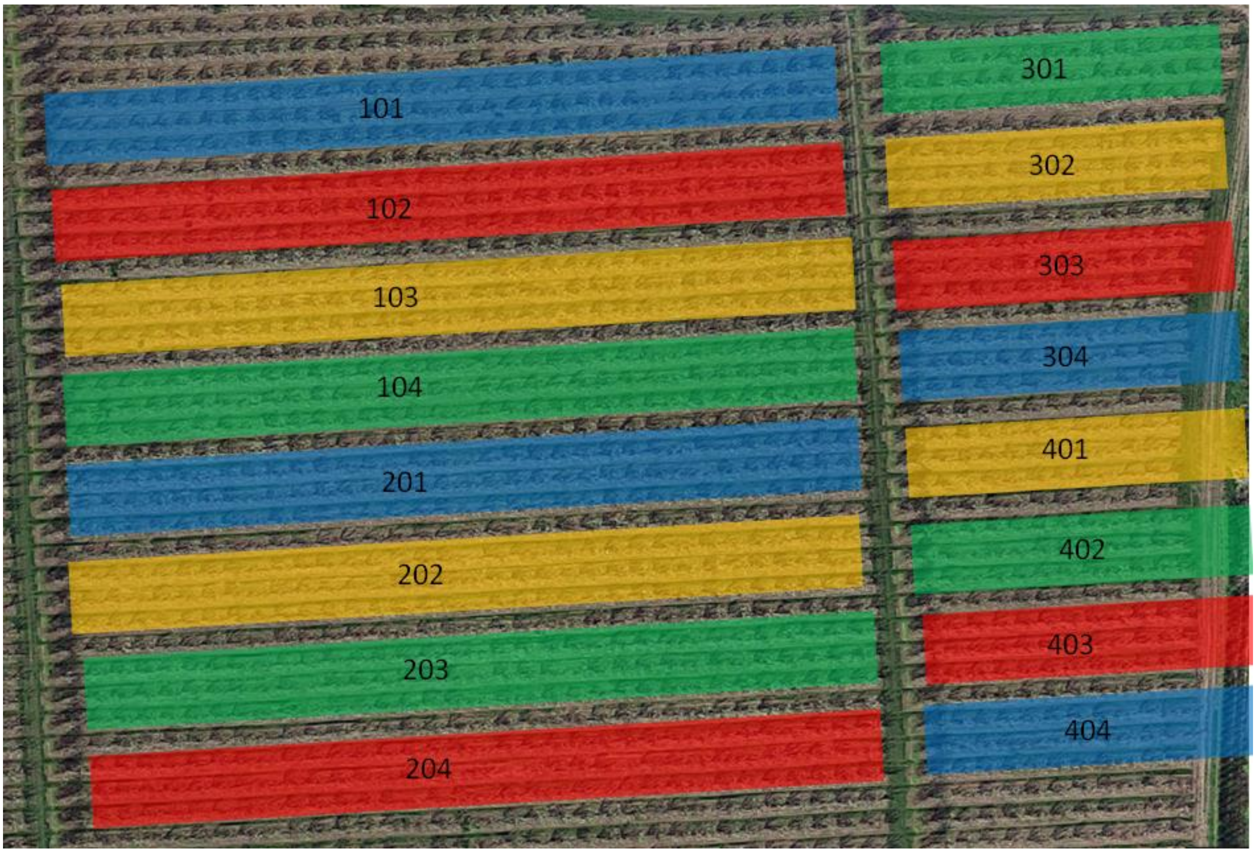

Figure 2. Plan of the plots in the foliar spray field trial (green = untreated control (treatment 1), red = 2 x Calypso and 1 x Envidor (treatment 2), blue = 2 x Agrimec (treatment 3), yellow = 1 x Envidor (treatment 4) (see Table 2)

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Sprays were applied to the orchard with a Kirkland triprop (NSTS Pass certificate No 159547) pulled by a New Holland T4 75N tractor. The accuracy of each application was calculated from the amount of spray left in the spray tank and the amount of spray which should be used if an application of 100% accuracy was achieved. Spray accuracy was between 96% and 101% (Table 3).

Table 3. Accuracy of each spray application

Date	**Treatment**	**% accuracy**
21 Mar	Calypso	101
08 Jun	Envidor	98
	Agrimec	96
21 July	Agrimec	99
	Envidor	98
18 Oct	Calypso	101

Meteorological records: Dry and wet bulb temperature, wind speed and direction were recorded before and after each spray occasion (Table 4). Relative humidity (% RH) was estimated from the dry and wet bulb temperature readings. Records of daily maximum and minimum air temperature and relative humidity were recorded by two Lascar EL-USB-2 data loggers (Appendix 1).

Assessments: Assessments were conducted before and after each application on 16, 23 Mar, 07, 14 Jun, 19, 26 Jul and 17, 26 Oct. At each assessment 30 trees from each plot were tap sampled after sunset and the numbers of natural enemies and pests recorded.

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Table 4. Weather conditions at the time of spray application

Date	Time	Air temperature			Wind speed	
		ºC dry	ºC wet	% RH	Km/h	direction
21 Mar	20:30	7.5	4	73	1.5	NW
	21:00	7	4	76	2	NW
08 Jun	12:47	25	20	86	0.9	W
	13:55	27	22	78	2	W
21 Jul	12:45	24	21	86	2.5	SW
	13:34	25	23	90	2.5	SW
18 Oct	08:43	12.5	10	88	4.2	S
	09:06	12.5	10	88	4.2	S

Statistical analyses: The design of the experiment was unbalanced in that treatment plots were only assessed if they were treated (Table 2), hence repeated measures ANOVA could not be used. Square root transformations of all insect counts were analysed using Restricted Maximum Likelihood (REML). The square root transform was used to stabilise the variance.

The population change is the difference in the numbers of invertebrates from before to after a spray application. Typically for the controls the populations increased (positive integer) and for the sprayed the populations decreased (negative integer) or were unchanged (zero). To assess the effect of the sprays on the populations, the differences between the population increases for control and the population changes for sprayed, were compared using t-tests. A significance implied that the population change for the spray was significantly less than that for control.

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Results

25 groups or development stages of invertebrates were recorded. The natural enemies were;

- Earwigs male, female and nymphs
- Ladybird adults and larvae
- Lacewing adults and nymphs
- Hoverfly adults and larvae
- Anthocorids
- Centipedes
- Harvestmen (Opiliones)
- Spiders

The pest species recorded were;

- Pear bud weevil
- Pear sucker adults

Several species/families were present and recorded but their numbers were so low that statistical analysis was not possible. These were;

- Heterotoma (predatory bug)
- Nabid (predatory bug)
- Solider beetle,
- Miridae nymphs,
- Wasps,
- Capsids,
- Click beetles,
- Rove beetles,
- Solitary bees,
- Assassin bug

The matrix (Table 5) shows how the abundance of arthropods changed over time in the untreated controls.

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Table 5. Presence or absence of each species/life stage recorded at each sampling date. Each value is the mean total number from 30 trees/plot in the untreated control. ● = present but the numbers are so low that they cannot be analysed

		Date							
	Arthropod	**16 Mar**	**23 Mar**	**07 Jun**	**14 Jun**	**19 Jul**	**26 Jul**	**17 Oct**	**26 Oct**
Predators	Earwig male	.	1.0	●				8.8	14.3
	Earwig female				●	1.5	●		
	Earwig nymphs			1.3	4.8				
	Ladybird adult	●	1.0			●	●	●	
	Ladybird larvae							●	●
	Hoverfly adult			●	●	●		●	
	Hoverfly larvae								●
	Lacewing adult					1.8	1.5		●
	Lacewing larvae								●
	Anthocorid	●	●			●		●	1.8
	Heterotoma					●	●		
	Centipede	●		1.8	4.3		●	●	●
	Harvestmen			●	1.3	1.0	1.8	14.0	12.8
	Spider	11.8	25.5	13.8	19.3	42.5	32.3	1.5	14.0
Pests									
	Pear bud weevil	9.5	2.3	2.0	●				
	Adult pear sucker		4.3	2.3	●	21.3	15.0		1.8
Incidental	Miridae					●		●	
	Assassin bug							●	
	Nabid								●
	Rove beetle		●	●		●			
	Click beetle						●		
	Soldier beetle							●	●
	Solitary bee					●			
	Wasp					●			

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Numbers of earwig nymphs were reduced significantly in the pear plots treated with Envidor (spirodiclofen) applied on 08 June in comparison to the untreated control plots. Whilst numbers of earwig nymphs did increase in the Agrimec (abamectin) treated plots over time, the rate of increase was significantly lower than the numbers in the untreated control (Fig. 2). Once the earwigs reached adulthood no significant differences were apparent (Table 6).

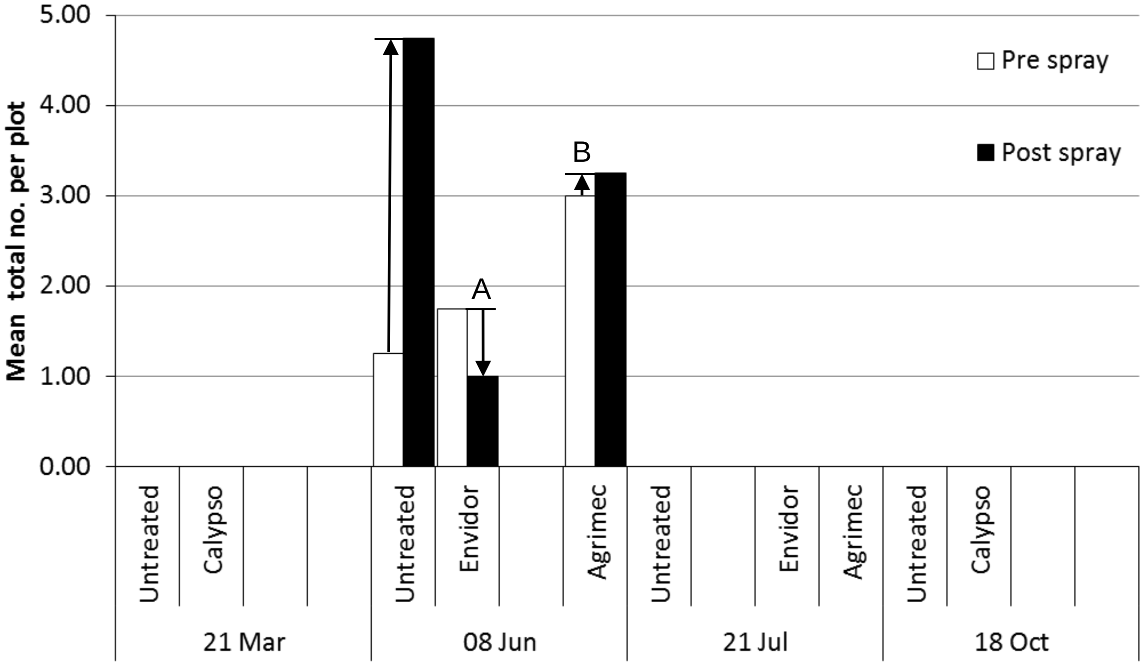

Figure 3. Mean number of earwig nymphs per plot, pre and post spraying for all application dates. Capital letters denote significant differences in population change when compared to the untreated control, different letters denote differences between treatments. Arrows indicate the size and direction of population changes

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In the untreated control the numbers of pear bud weevil increased from 16 March to 23 of March, whilst in plots treated with Calypso (thiacloprid) the numbers of pear bud weevil decreased (Fig. 4).

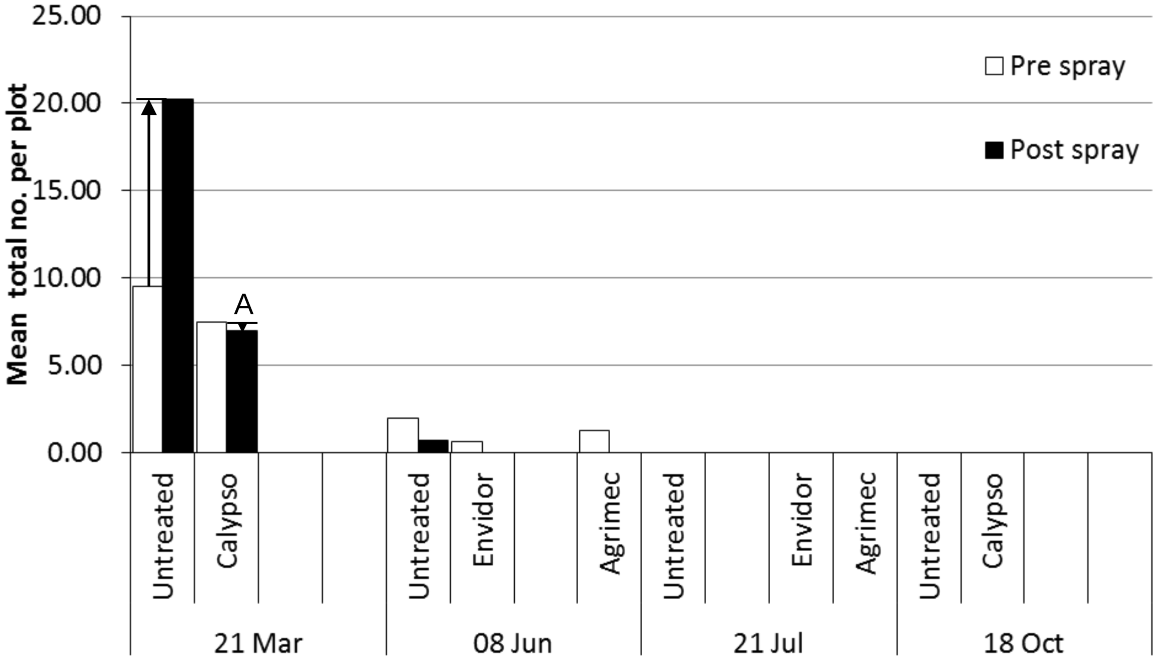

Figure 4. Mean numbers of pear bud weevil per plot, pre and post spraying for all application dates. Capital letters denote significant differences in population change when compared to the untreated control. Arrows indicate the size and direction of population changes

REML analysis was conducted on all of the species and life stages recorded for all the assessment dates. None of the sprays of Envidor (spirodiclofen), Agrimec (abamectin) or Calypso (thiacloprid) had any measurable adverse effects on numbers of natural enemies, pests or other, incidental, species that were present in numbers high enough to be analysed (Appendix 2).

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Table 6. REML analysis of the square route transformed total numbers of invertebrates per 30 trees per plot, pre spray and post spray application, positive numbers denote an increase in population between assessments, negative numbers denote a decrease in population between assessments, * denotes significant differences pre and post spray. ** denotes significantly different to the untreated control

Treatment	Application Date	Pear Bud weevil Pre spray	Post spray	Difference	Earwig nymphs Pre spray	Post spray	Difference
1	21 Mar	3.077	4.433	1.357*	0.000	0.000	0.000
2	21 Mar	2.737	2.635	-0.102**	0.000	0.000	0.000
3	21 Mar						
4	21 Mar						
1	08 Jun	1.183	0.604	-0.579	0.787	2.052	1.265*
2	08 Jun	0.395	0.000	-0.395	1.287	0.854	-0.433**
3	08 Jun						
4	08 Jun	0.787	0.000	-0.787	1.492	1.766	0.274**
1	21 Jul	0.000	0.000	0.000	0.000	0.000	0.000
2	21 Jul						
3	21 Jul	0.000	0.000	0.000	0.000	0.000	0.000
4	21 Jul	0.000	0.000	0.000	0.000	0.000	0.000
1	18 Oct	0.000	0.000	0.000	0.000	0.000	0.000
2	18 Oct	0.000	0.000	0.000	0.000	0.000	0.000
3	18 Oct						
4	18 Oct						
SED		0.298			0.286		
d.f.	57						
LSD		0.598			0.572		

Significant difference of the differences

Comparison	Date		Difference	Sig		Difference	Sig
1 vs 2	21 Mar		-1.459	0.001			
1 vs 2	08 Jun					1.698	>0.001
1 vs 4	08 Jun					-0.991	0.017

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Discussion and Conclusions

In previous laboratory tests earwig nymphs exposed to residues of Calypso on bean leaves took longer to reach adulthood (>42 days) compared to the control (water only) earwigs (35 days). In field tests on cv. Gala and cv. Conference there were no significant effects on earwigs of either Calypso or Gazelle (Gala only) with either one or two spray applications in the spring or mid-season. In previous work (HDC TF 196) foliar applications of Calypso reduced the numbers of earwigs in apple trees. Differences may be due to canopy density and hence spray coverage or earwig population levels in the orchards, i.e. the effects observed may depend on the density of earwigs in the trees. It can be concluded that Calypso has minor sub lethal effects on earwig nymphs, but if only applied occasionally and not multiple times a season will not significantly reduce populations of earwigs over a longer period if already established in orchards.

In the laboratory Agrimec appeared to be relatively safe to earwig nymphs and adults. However in field conditions earwig nymph numbers decreased over time in pear sprayed with Agrimec in comparison to the untreated control. The mechanism for this reduction is uncertain, but repellence or a reduction in food availability in the trees cannot be ruled out.

In the year 1 laboratory studies adult earwigs maintained throughout the winter for reproduction assessments after exposure to Envidor showed increased feeding on the treated leaf material and egg laying was delayed by approximately 33 days compared with earwigs which had not been exposed to Envidor. It is possible that the increased ingestion of the insecticide resulted in a higher uptake which had long term effects on reproduction. In pear trees sprayed with Envidor on 08 June 2016 (year 3) there were significantly fewer earwig nymphs in the trees compared to untreated trees. It is uncertain whether this is a direct toxicity effect or repellence. Envidor is a moulting agonist and seems to impede development and onset of egg laying in earwigs.

In field conditions neither Envidor or Agrimec appeared to have detrimental effects on the numbers of adult earwig adults in fruit trees.

Encouragingly single applications of Calypso early or late in the growing season and the single applications of Envidor or two applications of Agrimec mid-season had no measurable effect on the populations of other natural enemies present (where numbers were high enough to analyse e.g. spiders, harvestmen, adult ladybirds or adult lacewings).

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Calypso timed to spring emergence of pear bud weevil (21 March in 2016) reduced numbers in pear trees (see also 2017 AHDB Tree Fruit Report TF223).

The results of these experiments suggest that an occasional application of Gazelle or Calypso to control early season pests are unlikely to have long term effects on earwig populations if the latter are already in good numbers in the orchard and the application is made in response to pest thresholds as part of Integrated Pest Management. Applications of Envidor correctly timed, avoiding peak earwig nymph activity in tree fruit and applied only when necessary are likely to have minimal effects, but repeated prolonged use should be avoided. It should be noted that Envidor can only be applied once per year in pear orchards, and that the approval for Agrimec for pear was withdrawn on 31 January 2016 (Appendix 3).

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Knowledge and Technology Transfer

9 April 2014 Michelle Fountain and Jerry Cross - Conservation of the common earwig, *Forficula auricularia*, in orchards. University of Reading Seminar

24 April 2014 Michelle Fountain and Adrian Harris - Further development of earwig-safe spray programmes for apple and pear orchards, HDC Tree Fruit day

8 May 2014 Michelle Fountain - Pests, Predators and Pollinators, Warwick

25 September 2014 Michelle Fountain - Pests, Predators and Pollinators, Ornamental Nursery Group, EMR

20 November 2014 Michelle Fountain, Adrian Harris - Conservation of the common earwig, *Forficula auricularia*, in orchards. AAB conference

5 February 2015 Michelle Fountain, Northern Ireland Apple Growers Association – Pollination, Pest Control and Blastobasis in Orchards

11 February 2015 Michelle Fountain, Cider Growers Association – Pollination and Pest Control in Orchards

17 January 2017 Maddie Cannon, Northern Ireland Apple Growers Association - Earwig safe spray programmes

28 February 2017 Adrian Harris, EMR Association/AHDB Horticulture Tree Fruit Day. Technical Up-Date on Tree Fruit Research. ‘Earwig safe spray programmes’

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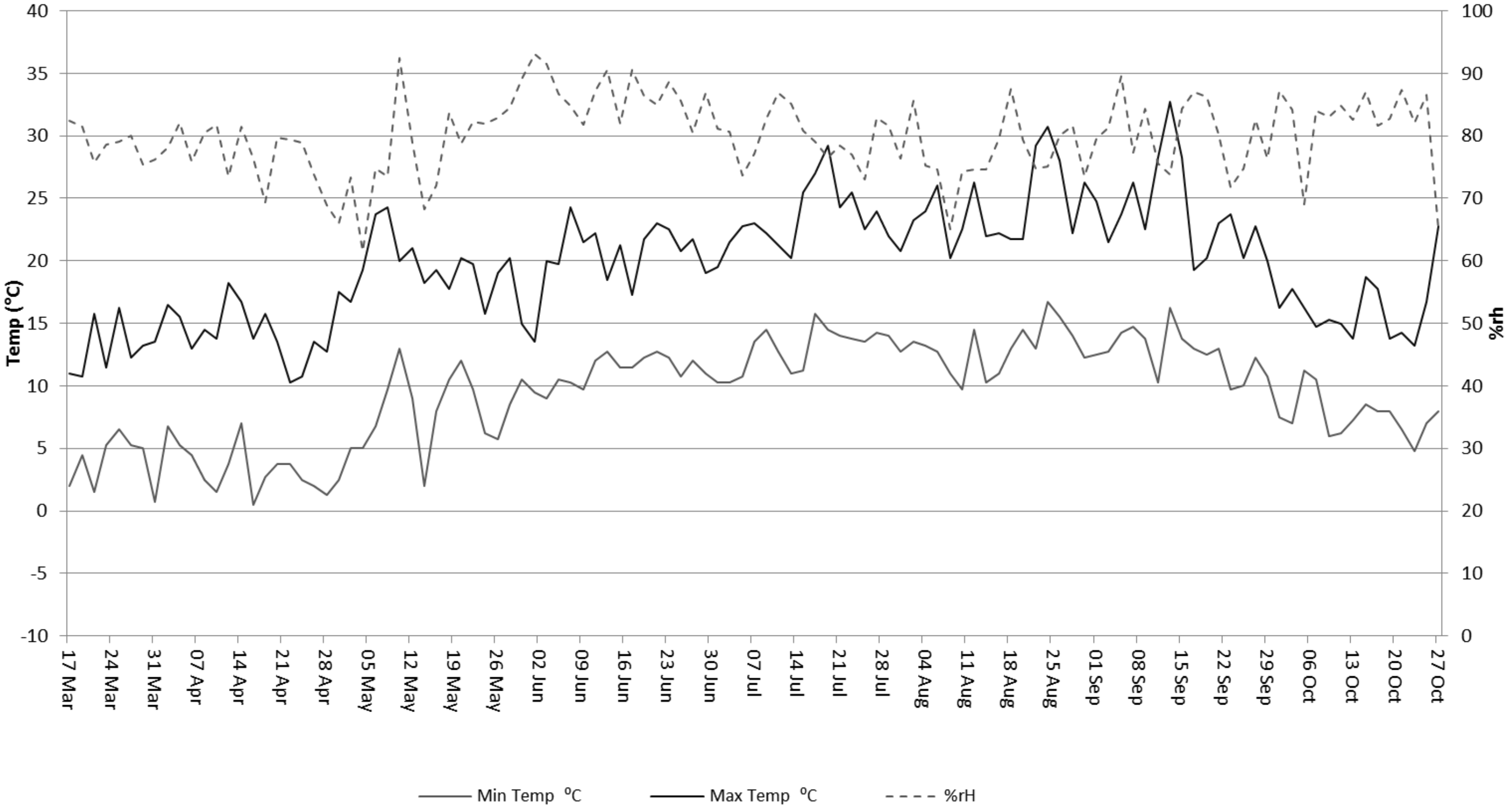
Appendix 1. Weather records for Childs farm for the duration of the experiment



Appendix 2. REML analysis of the square route transformed total numbers of an individual per plot, pre spray and post spray and difference

		Pear Bud weevil			**Spider**			**Earwigs total**		
Treatment	**Date**	**Pre spray**	**Post spray**	**Difference**	**Pre spray**	**Post spray**	**Difference**	**Pre spray**	**Post spray**	**Difference**
1	21 Mar	3.077	4.433	1.357	3.384	4.984	1.600	0.250	0.683	0.433
2	21 Mar	2.737	2.635	-0.102	3.371	4.656	1.284	1.104	0.604	-0.500
3	21 Mar									
4	21 Mar									
1	08 Jun	1.183	0.604	-0.579	3.705	4.266	0.561	0.854	2.140	1.287
2	08 Jun	0.395	0.000	-0.395	3.452	3.602	0.150	1.287	1.061	-0.226
3	08 Jun									
4	08 Jun	0.787	0.000	-0.787	3.708	3.818	0.110	1.492	1.819	0.327
1	21 Jul	0.000	0.000	0.000	0.809	3.644	2.835	1.984	3.493	1.508
2	21 Jul									
3	21 Jul	0.000	0.000	0.000	1.207	2.833	1.626	1.779	3.284	1.504
4	21 Jul	0.000	0.000	0.000	0.250	3.246	2.996	0.707	3.552	2.845
1	18 Oct	0.000	0.000	0.000	6.462	5.662	-0.800	0.809	0.500	-0.309
2	18 Oct	0.000	0.000	0.000	5.802	6.036	0.234	0.933	0.750	-0.183
3	18 Oct									
4	18 Oct									
SED		0.298			0.595			0.778		
d.f.	57									
LSD		0.598			1.192			1.559		

Appendix 2 continued. REML analysis of the square route transformed total numbers of an individual per plot, pre spray and post spray and difference

		Earwig male			Earwig female			Earwigs nymph		
Treatment	**Date**	**Pre spray**	**Post spray**	**Difference**	**Pre spray**	**Post spray**	**Difference**	**Pre spray**	**Post spray**	**Difference**
1	21 Mar	0.250	0.683	0.433	0.000	0.000	0.000	0.000	0.000	0.000
2	21 Mar	1.104	0.604	-0.500	0.000	0.000	0.000	0.000	0.000	0.000
3	21 Mar									
4	21 Mar									
1	08 Jun	0.250	0.000	-0.250	0.000	0.354	0.354	0.787	2.052	1.265
2	08 Jun	0.000	0.000	0.000	0.000	0.500	0.500	1.287	0.854	-0.433
3	08 Jun									
4	08 Jun	0.000	0.000	0.000	0.000	0.250	0.250	1.492	1.766	0.274
1	21 Jul	1.984	3.493	1.508	0.000	0.000	0.000	0.000	0.000	0.000
2	21 Jul									
3	21 Jul	1.779	3.284	1.504	0.000	0.000	0.000	0.000	0.000	0.000
4	21 Jul	0.707	3.552	2.845	0.000	0.000	0.000	0.000	0.000	0.000
1	18 Oct	0.000	0.000	0.000	0.809	0.500	-0.309	0.000	0.000	0.000
2	18 Oct	0.866	0.250	-0.616	0.250	0.500	0.250	0.000	0.000	0.000
3	18 Oct									
4	18 Oct									
SED		0.682			0.285			0.286		
d.f.	57									
LSD		1.366			0.570			0.572		

Appendix 2 continued. REML analysis of the square route transformed total numbers of an individual per plot, pre spray and post spray and difference

		Anthocorid			Ladybird adult			Ladybird larvae		
Treatment	**Date**	**Pre spray**	**Post spray**	**Difference**	**Pre spray**	**Post spray**	**Difference**	**Pre spray**	**Post spray**	**Difference**
1	21 Mar	0.250	0.500	0.250	0.250	0.854	0.604	0.000	0.000	0.000
2	21 Mar	0.250	0.500	0.250	0.683	0.500	-0.183	0.000	0.000	0.000
3	21 Mar									
4	21 Mar									
1	08 Jun	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	08 Jun	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	08 Jun									
4	08 Jun	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	21 Jul	0.250	1.140	0.890	0.250	0.000	-0.250	0.250	0.500	0.250
2	21 Jul									
3	21 Jul	0.250	0.957	0.707	0.250	0.000	-0.250	0.854	0.354	-0.500
4	21 Jul	0.000	0.787	0.787	0.250	0.250	0.000	0.000	0.000	0.000
1	18 Oct	0.354	0.000	-0.354	0.500	0.250	-0.250	0.000	0.000	0.000
2	18 Oct	0.854	0.500	-0.354	0.604	0.250	-0.354	0.000	0.000	0.000
3	18 Oct									
4	18 Oct									
SED		0.353			0.299			0.188		
d.f.	57									
LSD		0.706			0.598			0.376		

Appendix 2 continued. REML analysis of the square route transformed total numbers of an individual per plot, pre spray and post spray and difference

		Pear sucker adult			Lacewing adult			Lacewing larvae		
Treatment	**Date**	**Pre spray**	**Post spray**	**Difference**	**Pre spray**	**Post spray**	**Difference**	**Pre spray**	**Post spray**	**Difference**
1	21 Mar	0.000	1.766	1.766	0.000	0.000	0.000	0.000	0.000	0.000
2	21 Mar	1.207	1.309	0.102	0.000	0.000	0.000	0.000	0.000	0.000
3	21 Mar									
4	21 Mar									
1	08 Jun	1.045	0.250	-0.795	0.000	0.000	0.000	0.000	0.000	0.000
2	08 Jun	1.334	0.250	-1.084	0.000	0.000	0.000	0.000	0.000	0.000
3	08 Jun									
4	08 Jun	1.216	0.750	-0.466	0.000	0.000	0.000	0.000	0.000	0.000
1	21 Jul	0.000	0.913	0.913	0.000	0.250	0.250	0.000	0.250	0.250
2	21 Jul									
3	21 Jul	0.500	1.319	0.819	0.000	0.250	0.250	0.000	0.000	0.000
4	21 Jul	0.000	0.000	0.000	0.250	0.250	0.000	0.000	0.354	0.354
1	18 Oct	4.529	3.568	-0.961	1.311	1.037	-0.274	0.000	0.000	0.000
2	18 Oct	5.153	4.141	-1.012	1.537	0.250	-1.287	0.250	0.000	-0.250
3	18 Oct									
4	18 Oct									
SED		0.681			0.228			0.157		
d.f.	57									
LSD		1.363			0.456			0.314		

Appendix 2 continued. REML analysis of the square route transformed total numbers of an individual per plot, pre spray and post spray and difference

		Harvestmen			Hoverfly adult			Hoverfly Larvae		
Treatment	Date	Pre spray	Post spray	Difference	Pre spray	Post spray	Difference	Pre spray	Post spray	Difference
1	21 Mar	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	21 Mar	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	21 Mar									
4	21 Mar									
1	08 Jun	0.250	0.559	0.309	0.250	0.250	0.000	0.000	0.000	0.000
2	08 Jun	0.000	0.604	0.604	0.000	0.250	0.250	0.000	0.000	0.000
3	08 Jun									
4	08 Jun	0.500	0.854	0.354	0.000	0.354	0.354	0.000	0.000	0.000
1	21 Jul	3.578	3.469	-0.109	0.250	0.000	-0.250	0.000	0.250	0.250
2	21 Jul									
3	21 Jul	2.779	2.845	0.066	0.250	0.250	0.000	0.250	0.604	0.354
4	21 Jul	2.989	2.903	-0.086	0.000	0.354	0.354	0.500	0.000	-0.500
1	18 Oct	0.707	1.116	0.409	0.250	0.000	-0.250	0.000	0.000	0.000
2	18 Oct	0.604	1.390	0.787	0.000	0.000	0.000	0.000	0.000	0.000
3	18 Oct									
4	18 Oct									
SED		0.503			0.251			0.181		
d.f.	57									
LSD		1.007			0.503			0.362		

Appendix 2 continued. REML analysis of the square route transformed total numbers of an individual per plot, pre spray and post spray and difference

		Centipede			Heterotoma			Soldier Beetle		
Treatment	**Date**	**Pre spray**	**Post spray**	**Difference**	**Pre spray**	**Post spray**	**Difference**	**Pre spray**	**Post spray**	**Difference**
1	21 Mar	0.750	0.000	-0.750	0.000	0.000	0.000	0.000	0.000	0.000
2	21 Mar	0.250	0.000	-0.250	0.000	0.000	0.000	0.000	0.000	0.000
3	21 Mar									
4	21 Mar									
1	08 Jun	1.104	1.975	0.871	0.000	0.000	0.000	0.000	0.000	0.000
2	08 Jun	1.707	1.545	-0.162	0.000	0.000	0.000	0.000	0.000	0.000
3	08 Jun									
4	08 Jun	1.299	2.405	1.106	0.000	0.000	0.000	0.354	0.000	-0.354
1	21 Jul	0.250	0.250	0.000	0.604	0.750	0.146	0.000	0.000	0.000
2	21 Jul									
3	21 Jul	0.433	0.250	-0.183	0.809	1.183	0.374	0.433	0.000	-0.433
4	21 Jul	0.433	0.250	-0.183	0.913	0.933	0.020	0.500	0.000	-0.500
1	18 Oct	0.000	0.250	0.250	0.000	0.000	0.000	0.250	0.000	-0.250
2	18 Oct	0.250	0.000	-0.250	0.000	0.000	0.000	0.250	0.000	-0.250
3	18 Oct									
4	18 Oct									
SED		0.436			0.335			0.227		
d.f.	57									
LSD		0.873			0.672			0.455		

Appendix 3. WITHDRAWAL OF PLANT PROTECTION PRODUCT(S)

IN THE UNITED KINGDOM

PLANT PROTECTION PRODUCTS REGULATION (EC) No 1107/2009

Withdrawal Notice

Date of issue: 27 January 2016

This authorisation ends:

(a) 31 January 2016 for sale and distribution by the authorisation holder

(b) 31 July 2016 for sale and distribution by persons other than the authorisation holder

(b) 31 July 2017 for the disposal, storage and use of existing stocks by any persons

The expiry dates of the authorisations for the plant protection products listed in the Withdrawal Table have been amended to the above dates.

ALL OTHER CONDITIONS OF AUTHORISATION REMAIN UNCHANGED

Withdrawal Table

Product Name	**MAPP Number**	**Authorisation Holder**	**Withdrawal Number**
Abam	M15535	CMI Limited	0162 of 2016
Agrimec	M14491	Syngenta Crop Protection UK Limited	0163 of 2016
Hi-Mectin	M15420	Hockley International Limited	0164 of 2016

Signed by: Wayne McLeod
Signing time:Wednesday, January 27 2016, 12:35:2 GMT
Location: CRD York
Reason to sign: For the Health and Safety Executive

HSE Digital Signature

This Amendment is signed by the Health and Safety Executive ('HSE') for and on behalf of the Secretary of State, the Welsh Ministers, the Scottish Ministers and the Department of Agriculture and Rural Development in Northern Ireland.

EXPLANATORY NOTES

1. This Notice has been issued following Commission Directive 2008/107/EC to include abamectin in the list of approved active substances included in Regulation (EU) No 540/2011. Following this decision, all plant protection products containing this active must be evaluated in accordance with the Uniform Principles on the basis of dossiers satisfying the requirements of Annexes II and III.

2. The above notice gives a phased withdrawal to authorisations for products containing only this active which have not been evaluated to the Uniform Principles. This enables any stock which has already been manufactured, packaged and labelled in accordance with those Authorisations to be used up.

3. This withdrawal allows sale and distribution of existing stocks by the Authorisation Holder until 31 January 2016. Sale and distribution of existing stocks by any other person may continue until 31 July 2016. Disposal, storage and use of existing stocks may continue until 31 July 2017.

4. Expiry dates are subject to further decisions which may be made by Ministers.

5. This Notice will be published on the website of the Chemicals Regulation Directorate of the HSE.