Report

Project Title: Dealing with Aphids and Potato Psyllid in Australian Potato Crops.

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Summary

Aphids have long been considered pests of potato crops, mainly because they can vector diseases of potatoes such as leaf-roll virus (PLRV), or more recently, Potato Virus Y (PVY).

Potato psyllid (also known as tomato-potato psyllid, *Bactericera cockerelli*) is an extremely severe pest of potatoes and other solanaceous crops such as tomatoes, capsicums and tamarillos in the USA and New Zealand. The potato psyllid is the vector of a bacteria *Candidatus* Liberibacter solanacearum (Lso) which in processing potatoes causes "zebra chip". It can cause yield reductions of 50 – 80% and in the case of seed and processing potatoes can cause crops to be totally rejected.

Potato psyllid is not yet present in Australia, but it is very possible that the pest could enter the country from New Zealand as have other pests such as lettuce aphid.

In New Zealand the manner of dealing with potato psyllid was to apply many insecticides, at least weekly and initially up to 19 insecticides per crop. To avoid Australian growers being required to follow the same approach, another project (PT09004) has been conducted in New Zealand to develop control methods that are compatible with an IPM strategy in Australia. That project has been completed with success, and is reported separately. However, an important part of the strategy is that insect predators are required as biological control agents of the potato psyllid. These predators are the same as those now considered important in controlling aphids within an IPM strategy.

This project has demonstrated that the key beneficial (predatory) insects that would be required to help control potato psyllid are present in potato crops across south-eastern Australia. These include brown lacewings (*Micromus tasmaniae*), hoverflies (Syrphidae), damsel bugs (*Nabis kinbergii*) and several species of ladybird beetles (Coccinellidae).

For growers to be able to utilize these biological control agents then it is essential that they are not killed by applications of insecticides targeting either aphids, other pests or psyllids. Chemical control options within the strategy rely on minimal pesticide use and the use of selective or low-residual products where available.

Cultural control methods may include strip plantings of grasses to encourage populations of beneficial species. There is a suggestion from this preliminary work that there could be a benefit but the optimum timing of such plantings and the composition of plant species is not yet known and would require more work.

Introduction

Potato psyllid (*Bactericera cockerelli*) is an extremely serious pest of solanaceous crops in USA and also in New Zealand. The psyllid vectors a serious disease of potatoes, known as "yellows", that is caused by a bacterium, *Candidatus* Liberibacter solanacearum (Lso). Significant losses (up to 50%) have been reported from potato crops in the USA and up to 80% in glasshouse tomatoes in New Zealand. In processing potatoes the problem it causes is called “Zebra chip” because of change in sugars stored in the tubers. The insect and the disease poses a massive threat to the Australian potato industry.

Potato psyllid was discovered in New Zealand in a glasshouse near Auckland in 2006 and is now established throughout the country but has not yet been detected in Australia. History suggests that this pest will soon be a problem for Australian farmers and so we should be prepared for it. At the July 2012 Psyllid Conference in Auckland, New Zealand, a researcher from the USA commented that it was certain that potato psyllid would arrive in Australia, and it was just a matter of when.

In New Zealand the occurrence of potato psyllid destroyed IPM in many crops where minimal insecticide use had been practiced. This includes glasshouse crops where highly developed IPM strategies had been implemented for many years. The approach to dealing with this pest in NZ potato crops has so far been by the regular use of a range of insecticides, including many broad-spectrum insecticides. Weekly applications of such insecticides have been common, with up to 19 insecticides being used on a single crop.

In Australia by contrast there has been a world-leading adoption of IPM and consequent minimal use of insecticides (Horne and Page 2008). The arrival of potato psyllid threatens that status. If broad-spectrum insecticides are used against potato psyllid then it will destroy the IPM control of other pests such as aphids, thrips and potato moth which can currently be dealt with using IPM strategies.

The potato psyllid has natural enemies such as lacewings and damsel bugs overseas but they are different species to those in Australia. This project aimed to confirm that the key beneficial species necessary to prey on potato psyllid are already present in potato crops in south-eastern Australia.

A proposal to study means of controlling potato psyllid that would suit Australian production methods was made to APRP2 in late 2008. The field work for this project (PT09004) has just been completed within APRP2 (April 2012) and is described in a separate report to HAL. In that project it was confirmed that brown lacewings, hoverflies, damsel bugs and a species of ladybirds all accepted psyllids as prey, even in the presence of alternative prey such as aphids. All these predators also feed on aphids and so the use of them is important for the control of both pests. This means that the generalist predators that are present in Australian potato crops are going to be extremely important in controlling potato psyllid if it arrives and are currently available to help control aphids.. Field trials in Canterbury, NZ, confirmed that the draft IPM strategy could be used to control all pests, including potato psyllid.

However, to utilize these beneficials, growers and field officers involved in the industry need to recognise that these species are (i) present in their locality and (ii) that care needs to be taken not to kill them with insecticides targeting other pests. The use of broad-spectrum insecticides targeting minor pests such as grasshoppers, or major pests such as aphids or potato moth, needs to be avoided in order to maintain the biological control agents of psyllids in the crops.

Aphids vectoring virus diseases are currently a serious problem for seed growers in Australia, while potato psyllid is still just a potential threat. There is evidence from Australia and overseas that strip plantings of grasses or hedgerows can increase populations of beneficial species and this project also aimed to look at whether planting grassy strips could have a positive impact on populations of predatory insects.

Materials and Methods

Sites used in this project

Sites were selected in the following regions:
Gippsland, - Thorpdale (3 sites)

Gippsland – Toongabbie (1 site)

Gippsland – Kooweerup swamp (1 site)

Ballarat – (6 sites)

Tasmania – North Coast, (19 sites)

It was originally intended to sample all through the growing season, from about October, but the late start to contracting this project meant that sampling commenced in December 2011.

Sampling Procedure

Potato crops in Victoria were sampled every 2 weeks until crop senescence or sprayed off, using both suction sampling and direct searching.

1. Direct Search

   Each crop was sampled at 2 points: 1- on the very edge of the crop, and 2 – 20m into the crop.

   At each point, 20 true leaves were inspected for the presence of beneficial species (eggs, nymphs and adults).

   Also counted were winged and wingless aphids, and any other pests.

2. Suction Sample

   At each site, on each sampling trip, a 20m long section of row (40 sweeps) was sampled using a vacuum (blower-vac). The insects and mites collected were tipped into a white tray and all key predator, parasitic and pest species counted.

3. Sticky Trap

   At each site a sticky trap was placed in a bamboo stake on the edge of the crop and replaced each fortnight. This was the main method of sampling insects in Tasmania, where each trap was collected, covered in either GladWrap or Cellophane (preferred) and sent to IPM Technologies.

Grassy strips?

Victorian farmers collaborating in this project were also prepared to plant a cereal (grass) strip next to the potato crop to see if this would assist in elevating populations of the key predatory species. This is similar to work carried in New Zealand as part of Project PT09004. Therefore, both the potato crop and the grassy strip were suction sampled at each visit.

Figure 1: The type of grassy strip referred to, in Thorpdale (left) and in Canterbury (right).

Grassy Strips to encourage predators Victoria and NZ

Results

The most important result of the project is that it shows that all of the key predatory species that are needed for the control of potato psyllid and aphids are present in potato crops in all locations sampled (Table 1).

Table 1: The presence of Key beneficial species at the sites sampled.
● = Present

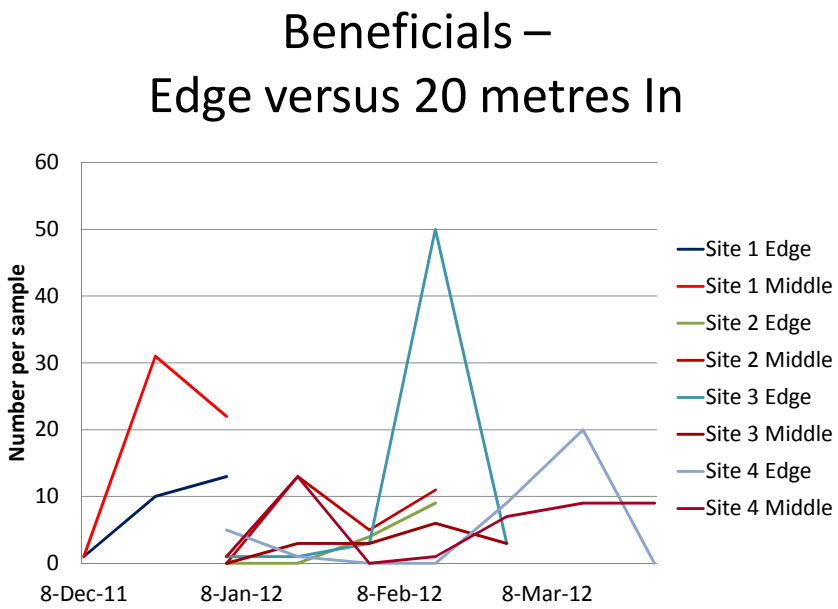
Presence of Key Beneficials

Site	Lacewings	Ladybirds	Hoverflies	Damsel bugs
Thorpdale	●	●	●	●
Gippsland (lowland)	●	●	●	●
Kooweerup	●	●	●	●
Ballarat	●	●	●	●
Tasmania (N)	●	●	●	●

Hoverfly and lacewing eggs were particularly abundant in most crops, and our work in New Zealand suggests that these species are the most important in that country. Damsel bugs were not found to be present in significant numbers in New Zealand potatoes, but in Australia they are far more abundant and important, particularly in late summer and Autumn.

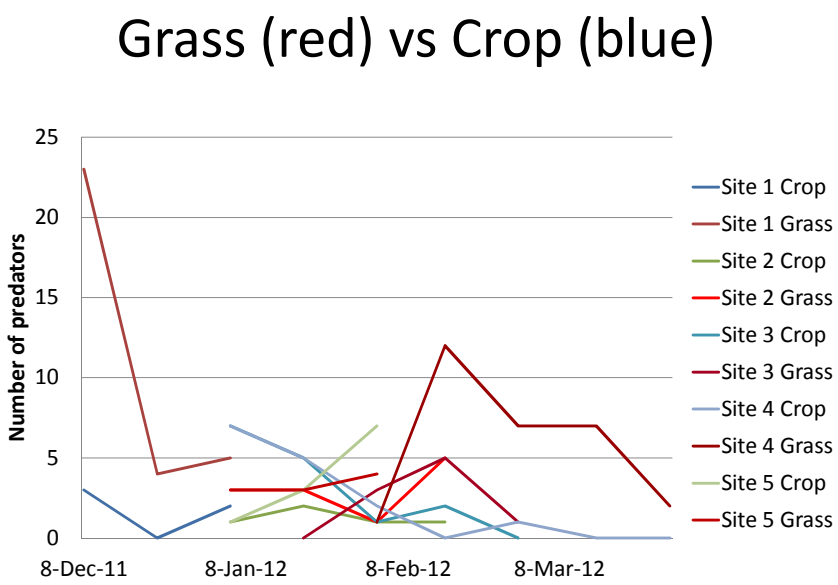
There did not appear to by any particular edge effect in numbers of these beneficial species (Figure 2), but there did seem to be higher numbers of predators in the grassy strip than in the crop at many sites (Figure 3).

Figure 2: Counts of beneficial species on the edge of the potato crop and 20 metres into the potato crop, Gippsland Sites.



Grassy strip?

Figure 3: Numbers of predators in the grassy strip and in the potato crop in Gippsland.

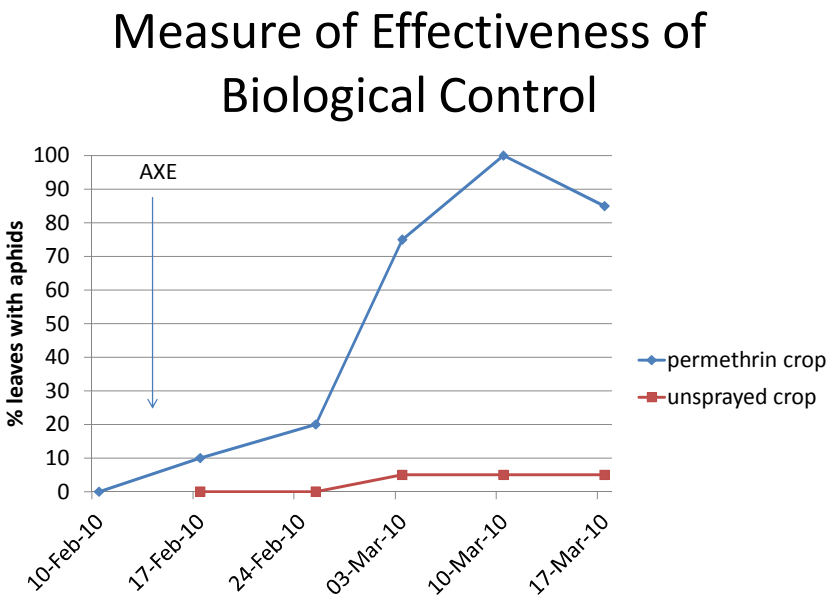


There were not always higher numbers of beneficial species in the grassy strip, but there were on many occasions at many sites. The age of the grass may be the biggest factor affecting the numbers of predators found.

The full set of sampling results are presented in Appendices 1, 2 and 3. The results from Tasmania are all based on sticky traps and so there are no counts of lacewing eggs or hoverfly eggs. We do not have insecticide data for these sites, but at a couple of sites there were no beneficials recorded at all, but at these same sites aphid numbers were very high. This is exactly what we would predict to happen if broad-spectrum insecticides were applied.

An example of how important invertebrate predators can be in controlling aphids is given by Page and Horne (2012) and is shown in Figure 4. Half a potato paddock on the Kooweerup swamp was sprayed with a synthetic pyrethroid (Permethrin or "Axe") and the other half was not. The percentage of leaves with aphids present went from zero to 100% in 4 weeks only in the half of the crop that received the synthetic pyrethroid.

Figure 4: Aphid numbers following an application of a synthetic pyrethroid.



Discussion and Conclusions

Predatory species, and in particular brown lacewings, hoverflies and damsel bugs are found in all districts, and are likely to be the most important element in controlling potato psyllid if it arrives in Australia. They currently are important in the control of aphids, along with parasitic wasps.

A Draft IPM strategy has been developed to include the pest potato psyllid. This was done as part of project PT09004. If it is to be implemented in Australia then all in the industry need to be aware of the key beneficial species that are present and the impact of losing these predators due to insecticide sprays that may be targeting any pest species. The IPM Strategy can be summarised as in table 2.

Table 2: Draft IPM Strategy developed in project PT09004.

Draft IPM Strategy

Pest	Beneficial 1	Cultural 2	Chemical (3)
Potato Psyllid	**Damsel Bugs** **Brown Lacewings** **Ladybirds** **Hoverflies**	**Border strip plantings?**	**Border Sprays** **Seed Dressing** ***Chess*** ***Movento*** ***Success***
PTM	*Orgilus lepidus* *Apanteles* *Copidosoma* Nabid bugs	Overhead Irrigation Soil management	Nil (Spray after Senescence)
Aphids (Virus)	*Aphidius* Ladybirds Brown lacewings	Certified seed Weed management *Isolation of Seed crops*	Nil (Seed dressing)
Thrips (TSWV)	Predatory thrips Predatory mites	Control volunteers Variety/ Location Weed control	Nil (Seed dressing) (Spinosad)
Caterpillars	Nabid bugs Pentatomid bugs Parasitic wasps	-	BT or GemStar*

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It is essential that the entire set of control measures are used and that there is not a reliance on the chemical options alone. To utilize these beneficials, growers and field officers involved in the industry need to recognise that these species are (i) present in their locality and (ii) that care needs to be taken not to kill them with insecticides targeting other pests. The use of broad-spectrum insecticides targeting minor pests such as grasshoppers, or even potato moth, needs to be avoided in order to maintain the biological control agents of psyllids in the crops.

The use of grassy strips has previously been shown to assist with the establishment of beneficial species that help to control pest species (Holland *et al*. 2012). A project funded by HAL (VG05088) and also conducted by us, investigated the use of grassy strips in leafy vegetable crops. The results from this preliminary work in potatoes suggests that it could be a useful method in assisting to control pests such as potato psyllid and aphids, but it requires a more detailed assessment.

Communications/ Extension

Results of this project have been communicated to the potato industry via field walks in Thorpdale and Tasmania (Devonport area), and in a talk presented to the 2012 Potato Conference in Ballarat (July, 2012).

Recommendations:

- Workshops and further training on IPM would be beneficial to many in the potato industry so that inappropriate use of insecticides is avoided.
- A poster, similar to the "Pest and Beneficial Poster" produced for the Victorian strawberry industry as part of Project BS08011 could be a very useful means of raising awareness of the range of beneficial species that are present in Australian potato crops.

Acknowledgements

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for organising, taking and sending the sticky trap samples. We thank Nigel Crump (VicSpa), Seed Potatoes Victoria and the Potato Processing Association of Australia for their financial support and co-operation in this work.

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Page, J. and Horne, P.A. (2012). *Controlling invertebrate pests in agriculture.* CSIRO Publishing. 116 pp.

Appendix 1: Gippsland District Results

Site: Confidor +Movento – EDGE direct search Des Jennings – "Childers"												
	Things that eat aphids and psyllids					**pests**						
	BLW		hoverflies			aphids		loopers		heliothis		
Date	egg	larvae	egg	larvae	other	winged	wingless	egg	caterpillar	egg	caterpillar	other
8/12/11	1				1 mummy		0			1	1	
22/12/11	1	-	8	-	1 GLW larva, 2 spiders		3	1	1	-	-	-
5/1/12	3	-	10	-	2 juv. Haplothrips			1	-	-	1	

Site: Confidor +Movento – MIDDLE direct search Des Jennings – "Childers"												
	Things that eat aphids and psyllids					**pests**						
	BLW		hoverflies			aphids		loopers		heliothis		
Date	egg	larvae	egg	larvae	other	winged	wingless	egg	caterpillar	egg	caterpillar	other
8/12/11	1						0					
22/12/11	1	-	30	-	-	-	-	-	1	-	-	-
5/1/12	1	-	21	-	1 juv haplothrips	-	-	-	-	-	4	-

Site: Confidor – EDGE direct search Des Jennings – "Childers"												
	Things that eat aphids and psyllids					**Pests**						
	BLW		hoverflies			aphids		loopers		heliothis		
Date	egg	larvae	egg	larvae	other	winged	wingless	egg	caterpillar	egg	caterpillar	Other
8/12/11	2						1					
22/12/11	5	-	17	-	-		3	1	1	-	-	-
5/1/12	1	-	5	-	1 adult haplothrips, trichogramma	1	-	4	1	1	1	1 juv bug

Site: Confidor – MIDDLE direct search Des Jennings – "Childers"												
	Things that eat aphids and psyllids					**Pests**						
	BLW		hoverflies			aphids		loopers		heliothis		
Date	egg	larvae	egg	larvae	other	winged	wingless	egg	caterpillar	egg	caterpillar	Other
8/12/11	1		1				2					
22/12/11	2	-	34	1	-		1	2	-	-	1	-
5/1/12	-	-	15	-		-	-	1	-	-	3	

Site: Confidor +Movento – Suction sample Des Jennings – "Childers"												
	Things that eat aphids and psyllids							Pests				
	BLW		hoverflies		nabids		other	aphids		loopers	heliothis	
Date	adults	larvae	adults	larvae	adults	nymphs		winged	wingless	caterpillars	caterpillars	other
8/12/11	2				0		1 ladybird, 2 Aphidius					
22/12/11	0	0			0		2 Aphidius				2	
5/1/12	2						4 Aphidius			2	2	3 LBAM

Site: Confidor – Suction sample Des Jennings – "Childers"												
	Things that eat aphids and psyllids							Pests				
	BLW		hoverflies		nabids		other	aphids		loopers	heliothis	
Date	adults	larvae	adults	larvae	adults	nymphs		winged	wingless	caterpillars	caterpillars	other
8/12/11	3				0		2 Aphidius					
22/12/11	0				0		1 Aphidius			2	3	
5/1/12	3				2		5 wasps			2	4	

Site: grassy strip 1 – Suction sample Des Jennings – "Childers"												
	Things that eat aphids and psyllids							Pests				
	BLW		hoverflies		nabids		other	aphids		loopers	heliothis	
Date	adults	larvae	adults	larvae	adults	nymphs		winged	wingless	caterpillars	caterpillars	other
8/12/11	20				3		5 Aphidius					

22/12/11	3				1		1 Aphidius					1 armyworm
5/1/12	1				2		5 wasps, 1 mite					

Site: grassy strip 2 – Suction sample Des Jennings – "Childers"												
	Things that eat aphids and psyllids							Pests				
	BLW		hoverflies		nabids		other	aphids		loopers	heliothis	
Date	adults	larvae	adults	larvae	adults	nymphs		winged	wingless	caterpillars	caterpillars	Other
8/12/11	15				1		2 Aphidius					
22/12/11	1				0		2 Aphidius					
5/1/12	2				3		8 wasps					3 armyworm, many leafhoppers

Site: sticky trap – Des Jennings "Childers"								
	Things that eat aphids and psyllids				Pests			
Date	BLW	hoverflies	nabids	other	aphids	bugs	thrips	Other
22/12/11								
5/1/12	1			1 aphidius	1			

Site: Confidor – EDGE direct search Des Jennings – "Shed"												
	Things that eat aphids and psyllids					**Pests**						
	BLW		hoverflies			aphids		loopers		heliothis		
Date	egg	larvae	egg	larvae	other	winged	wingless	egg	caterpillar	egg	caterpillar	Other
5/1/12	-	-	-	-	trichogramma	-	-	-	-	-	-	Many cutworm eggs
19/1/12	-	-	-	-	1 aphidius	-	-	-	1	2	-	
2/2/12	1		3		Trichogramma							
15/2/12	1		8		1 haplothrips							

Site: Confidor – MIDDLE direct search Des Jennings – "Shed"												
	Things that eat aphids and psyllids					**Pests**						
	BLW		hoverflies			aphids		loopers		heliothis		
Date	egg	larvae	egg	larvae	Other	winged	wingless	egg	caterpillar	egg	caterpillar	Other
5/1/12	-	-	-	-	Trichogramma	-	-	-	-	-	-	Many cutworm eggs
19/1/12			13		1 aphidius					2		
2/2/12	1		4					1				
15/2/12	4		6		5 juv. haplo, 1 Bdellid, 1 Nabid							

Site: Confidor – Suction sample Des Jennings – "Shed"												
	Things that eat aphids and psyllids							Pests				
	BLW		hoverflies		nabids		other	aphids		loopers	heliothis	
Date	adults	larvae	adults	larvae	adults	nymphs		winged	wingless	caterpillars	caterpillars	other
22/12/11												
5/1/12	1						2 wasps			1		
19/1/12	2						1 spider			1	1	5 crop mirids, many leafhoppers
2/2/12					1		1 wasp			2	7	1 adult + 2 juv. Crop Mirids
15/2/12					1		12 Haplothrips 5 spiders			3		20+ Crop Mirid nymphs

Site: grassy strip - Suction sample Des Jennings – "Shed"												
	Things that eat aphids and psyllids							Pests				
	BLW		hoverflies		nabids		other	aphids		loopers	heliothis	
Date	adults	larvae	adults	larvae	adults	nymphs		winged	wingless	caterpillars	caterpillars	Other
22/12/11	0				0		0					
5/1/12	2				1		4 wasps					Many leafhoppers
19/1/12	3						2 wasps, 1 armyworm					Many leafhoppers
2/2/12					1		2 wasps					Many leafhoppers, 10 green "false" nabiids
15/2/12	1				3		1 ladybird, 2 wasps, 1 predatory mite					Many leafhoppers and green "false" nabiids, 2 crop mirids, 1 armyworm

Site: No Confidor – EDGE direct search Gary Willis												
	Things that eat aphids and psyllids					**pests**						
	BLW		hoverflies			Aphids		loopers		heliothis		
Date	egg	larvae	egg	larvae	other	winged	Wingless	egg	caterpillar	egg	caterpillar	other
5/1/12	1							2				
19/1/12	1				1 spotted thrips			1				
2/2/12	1		2							2		
15/2/12			50		1 adult haplothrips		2			1		
29/2/12			3		2 red (pred) bugs, 1 juv. +2 adult haplothrips							

Site: No Confidor – MIDDLE direct search Gary Willis												
	Things that eat aphids and psyllids					**pests**						
	BLW		hoverflies			Aphids		loopers		heliothis		
Date	egg	larvae	egg	larvae	other	winged	Wingless	egg	caterpillar	egg	caterpillar	other
5/1/12					trichogramma							Many cutworm eggs
19/1/12			2		1 nabid				1			
2/2/12			3									Low level thrips
15/2/12			6		1 haplothrips, 1 red (pred) bug							
29/2/12			2		4 juv + 3 adult haplo, 1 nabid				1		3	

Site: No Confidor – Suction sample Gary Willis												
	Things that eat aphids and psyllids							Pests				
	BLW		hoverflies		nabids		other	Aphids		loopers	heliothis	
Date	adults	larvae	adults	larvae	adults	nymphs		Winged	Wingless	caterpillars	caterpillars	other
5/1/12	4				1		2 LB, 4 wasps, 2 spiders					
19/1/12	2				2		1 LB, 1 spider			1		Many leafhoppers
2/2/12					1		2 wasps			1		3 crop mirids, 1 Gr. mirid
15/2/12	1						1 LB, 1 wasp, 5 Haplothrips			2	3	2 adult + 2 juv crop mirids
29/2/12										1	1	10 crop mirids
15/3/12							2 wasps					20+ crop mirids

Site: Grassy Strip – Suction sample Gary Willis												
	Things that eat aphids and psyllids							Pests				
	BLW		hoverflies		nabids		other	Aphids		loopers	heliothis	
Date	adults	larvae	adults	larvae	adults	nymphs		Winged	wingless	caterpillars	caterpillars	other
5/1/12							Too small to sample					
19/1/12							1 spider, many LH, 1 armyworm					
2/2/12					1		2 LB, 2 wasps				1	Many LH
15/2/12					1	4	2 wasps					Many L/H
29/2/12					1		2 wasps					3 false nabiids
15/3/12							2 wasps					2 false nabiids

Site: sticky trap – Gary Willis								
	Things that eat aphids and psyllids				Pests			
Date	BLW	hoverflies	nabids	other	aphids	bugs	thrips	other
5/1/12	1				6			2 native psyllids
19/1								
2/2								
15/2	1			1LB	0			Many thrips

Site: Confidor – EDGE direct search Don DiSisto												
	Things that eat aphids and psyllids					**pests**						
	BLW		hoverflies			Aphids		loopers		heliothis		
Date	egg	larvae	egg	larvae	other	winged	Wingless	egg	caterpillar	egg	caterpillar	other
5/1/12					5 ladybirds					2		
19/1/12					1 ladybird							
2/2/12					1 pred mite			1				Many juv. thrips
15/2/12					1 haplothrips							
29/2/12	8		1									
15/3/12	2	1	17			6			1			
29/3/12						1						

Site: Confidor – MIDDLE direct search Don DiSisto												
	Things that eat aphids and psyllids					**pests**						
	BLW		hoverflies			Aphids		loopers		heliothis		
Date	egg	larvae	egg	larvae	other	winged	Wingless	egg	caterpillar	egg	caterpillar	other
5/1/12					1 ladybird					1		
19/1/12			13		1 aphidius			1				
2/2/12												Juvenile thrips
15/2/12					1 stethorus						2	
29/2/12			7		1 macrolophus							
15/3/12	1		41		Shield bug eggs		2				1	
29/3/12	1		8		1 wasp	4	1				1	

Site: Confidor – Suction sample Don DiSisto												
	Things that eat aphids and psyllids							Pests				
	BLW		hoverflies		nabids		other	aphids		loopers	heliothis	
Date	adults	larvae	adults	larvae	adults	nymphs		winged	wingless	caterpillars	caterpillars	other
5/1/12	4				1		2 LB, 4 wasps, 2 spiders					
19/1/12							5 LB, 1 wasp, 1 spider					2 leafhoppers
2/2/12					2		1 wasp				1	1 crop mirid
15/2/12							2 wasps, 1 Apple Dimpling bug				4	1 crop mirid
29/2	1						3 Plague Soldier Beetle				1	
15/3/12										1		
29/3/12							1 wasp				1	1 crop mirid

Site: Grassy Strip – Suction sample Don DiSisto												
	Things that eat aphids and psyllids							Pests				
	BLW		hoverflies		nabids		other	aphids		loopers	heliothis	
Date	adults	larvae	adults	larvae	adults	nymphs		winged	wingless	caterpillars	caterpillars	other
5/1/12							Too small to sample					
19/1/12							1 wasp					
2/2/12							1 LB, 2 wasps	1				
15/2/12					1		11 LB (Harmonia, 1 Diomus, 1 mordellid	0		0	0	
29/2/12							7 ladybirds					
15/3/12					5		2 L/B, 2 wasps					
29/3/12					1		1 LB					

Site: EDGE direct search Wayne Tymensen												
	Things that eat aphids and psyllids					**Pests**						
	BLW		hoverflies			Aphids		loopers		heliothis		
Date	egg	larvae	egg	larvae	other	winged	wingless	Egg	caterpillar	egg	caterpillar	other
28/12/11	0				1 spider			2				
5/1/12					2 spotted thrips, trichogramma					1		Many cutworm eggs
19/1/12	1				Trichogramma, 1 spotted thrips,1 nabid			1				
2/2/12					2 GLW eggs, 2 Apple dimpling nymphs							
15/2/12	Flooded – no sample											
29/2/12			2				1					
15/3/12					Crop Finished							

Site: MIDDLE direct search Wayne Tymensen												
	Things that eat aphids and psyllids					**Pests**						
	BLW		hoverflies			Aphids		loopers		heliothis		
Date	egg	larvae	egg	larvae	other	winged	wingless	egg	caterpillar	egg	caterpillar	other
28/12/11	0				1 spider			2				
5/1/12					1 spotted thrips			1				
19/1/12					1 spotted thrips							
2/2/12			2		2 apple dimpling nymphs							
15/2/12	Flooded – no sample											
29/2/12			40		1 red (pred) bug							
15/3/12	Crop finished											

Site: Suction sample Wayne Tymensen												
	Things that eat aphids and psyllids							Pests				
	BLW		hoverflies		nabids		other	aphids		loopers	heliothis	
Date	adults	larvae	adults	larvae	adults	nymphs		winged	wingless	caterpillars	caterpillars	other
5/1/12							1 LB, 2 wasps, 1 pred thrip					1 Green Mirid
19/1/12	1				2		2 wasps			2	3	1 Gr. Mirid, 4 crop mirids
2/2/12	1				5		1 LB, 2 wasps			2		1 adult + 3 juv mirids
15/2/12	Flooded. No sample											
29/2/12						2	2 wasps, I pred thrips					

Site: Grassy Strip – Suction sample Wayne Tymensen												
	Things that eat aphids and psyllids							Pests				
	BLW		hoverflies		nabids		other	aphids		loopers	heliothis	
Date	adults	larvae	adults	larvae	adults	nymphs		winged	wingless	caterpillars	caterpillars	other
5/1/12	1				2		4 wasps, 2 pred mites					1 armyworm, many leafhoppers
19/1/12	1				2							Many LH
2/2/12					4		4 wasps, pred mites and thrips					Many LH
15/2/12												
29/2/12					4							2 false nabiids, 1 crop mirid

Site: sticky trap – Wayne Tymensen								
	Things that eat aphids and psyllids				Pests			
Date	BLW	hoverflies	nabids	other	aphids	bugs	thrips	other
5/1/12				1 LB, 1 wasp				
19/1/121	1			1 LB, 1 wasp	2			
2/2/12	1			1 LB				
15/2/12	Flooded – No sample.							

Appendix 2: Ballarat District Results

Site: Confidor – EDGE direct search Ken Labbett														
	Things that eat aphids and psyllids							**pests**						
	BLW		hoverflies		ladybirds		other	aphids		loopers		heliothis		
Date	egg	larvae	egg	larvae	egg	larvae		winged	wingless	egg	caterpillar	egg	caterpillar	other
14/12/11														
27/12/11												1		
11/1/12			1									1		
25/1/12														
8/02/12														
22/2/12							2 spids							

Site: Confidor – MIDDLE direct search Ken Labbett														
	Things that eat aphids and psyllids							**pests**						
	BLW		hoverflies		ladybirds		other	aphids		loopers		heliothis		
Date	egg	larvae	egg	larvae	egg	larvae		winged	wingless	egg	caterpillar	egg	caterpillar	other
14/12/11														
27/12/11														
11/1/12			1				1 spid							
25/1/12														
8/02/12							1 spid				1			
22/2/12														

Site: Confidor + Spray – EDGE direct search Ken Labbett														
	Things that eat aphids and psyllids							**Pests**						
	BLW		hoverflies		ladybirds		other	aphids		loopers		heliothis		
Date	egg	larvae	egg	larvae	egg	larvae		winged	wingless	egg	caterpillar	egg	caterpillar	Other
14/12/11														
27/12/11														
11/1/12														
25/1/12											1			
8/02/12	2						1 spid							
22/2/12														

Site: Confidor + spray – MIDDLE direct search Ken Labbett														
	Things that eat aphids and psyllids							**Pests**						
	BLW		hoverflies		ladybirds		other	aphids		loopers		heliothis		
Date	egg	larvae	egg	larvae	egg	larvae		winged	wingless	egg	caterpillar	egg	caterpillar	Other
14/12/11														
27/12/11							1x spid					1		
11/1/12							1 spid					2		
25/1/12														
8/02/12	1						1 spid 1 wasp							
22/2/12														

Site: Confidor – Suction sample Ken Labbett													
	Things that eat aphids and psyllids								Pests				
	BLW		hoverflies		nabids		ladybirds	other	aphids		loopers	heliothis	
Date	adults	larvae	adults	larvae	adults	nymphs			winged	wingless	caterpillars	caterpillars	other
14/12/11					1	1		7 spid					
27/12/11								2 spid					thrips
11/1/12								3 wasps					
25/1/12	3							Wasp spid					
8/02/12	4				3			8 spid			1		
22/2/12	1					1		2 wasp					

Site: Confidor + spray – Suction sample Ken Labbett													
	Things that eat aphids and psyllids								Pests				
	BLW		hoverflies		nabids		ladybirds	other	aphids		loopers	heliothis	
Date	adults	larvae	adults	larvae	adults	nymphs			winged	wingless	caterpillars	caterpillars	other
14/12/11													
27/12/11							2	10 spids					
11/1/12	1												1 pot moth L
25/1/12	4							6 spids, wasps			1		
8/02/12					1								
22/2/12								1 spid					

Site: Cereal edge – Suction sample Ken Labbett													
	Things that eat aphids and psyllids								Pests				
	BLW		hoverflies		nabids		ladybirds	other	aphids		loopers	heliothis	
Date	adults	larvae	adults	larvae	adults	nymphs			winged	wingless	caterpillars	caterpillars	other

14/12/11								1 spid		1			
27/12/11	2						1(a)	5 spids, 3 wasp		1		1	
11/1/12					1		2(a)	1 spid					
25/1/12	1							Spid wasps		3			
8/02/12													
22/2/12					1								

Site: Confidor – sticky trap Ken Labbett									
	Things that eat aphids and psyllids					Pests			
Date	BLW	hoverflies	nabids	ladybirds	other	aphids	bugs	thrips	other
27/12/11								yes	
11/1/12									
25/1/12						12		yes	
8/02/12	1					7			
22/2/12						3			

Site: Confidor +spray – sticky trap Ken Labbett									
	Things that eat aphids and psyllids					Pests			
Date	BLW	hoverflies	nabids	ladybirds	other	aphids	bugs	thrips	other
11/1/12						1			
25/1/12	1			1		14			
8/02/12			1	1		12			
22/2/12	3			1		20			

Site: EDGE direct search Rod Fraser															
	Things that eat aphids and psyllids							**pests**							
	BLW		hoverflies		ladybirds		other	aphids		loopers		heliothis			
Date	egg	larvae	egg	larvae	egg	larvae		winged	wingless	egg	caterpillar	egg	caterpillar	other	
12/12/11												1			
27/12/11			1									1		Pot moth(L) x1	
11/1/12					1 (a)		1 spid								
25/1/12							1 spid	1							
8/02/12															
22/2/12					1 (a)		1 spid								

Site: MIDDLE direct search Rod Fraser															
	Things that eat aphids and psyllids							**pests**							
	BLW		hoverflies		ladybirds		other	aphids		loopers		heliothis			
Date	egg	larvae	egg	larvae	egg	larvae		winged	wingless	egg	caterpillar	egg	caterpillar	other	
12/12/11							LB (a), GLW eggs x 2								
27/12/11			2												
11/1/12							1 spid								
25/1/12			1											Juv mirid	
8/02/12															
22/2/12															

Site: Suction sample Rod Fraser													
	Things that eat aphids and psyllids								Pests				
	BLW		hoverflies		nabids		ladybirds	other	aphids		loopers	heliothis	
Date	adults	larvae	adults	larvae	adults	nymphs			winged	wingless	caterpillars	caterpillars	other
12/12/11	9						5	6 spids					
27/12/11	4						2	5 wasp					
11/1/12							1	1 spid 1 R & B beetle					
25/1/12	5						1	5 spids					Juv mirid
8/02/12	1				1		1	6 spid 1 r&b					
22/2/12	2				1		2	8 spid 2 wasp					

Site: Grassy edge – Suction sample Rod Fraser													
	Things that eat aphids and psyllids								Pests				
	BLW		hoverflies		nabids		ladybirds	other	aphids		loopers	heliothis	
Date	adults	larvae	adults	larvae	adults	nymphs			winged	wingless	caterpillars	caterpillars	other
12/12/11	12	1					2	5 spids					
27/12/11					1			4 spid, 3 wasp					
11/1/12	1				1			12 spids					
25/1/12	1				3			1 R & B					
8/02/12					1			Spid wasp					
22/2/12					1	1							

Site: – sticky trap Rod Fraser									
	Things that eat aphids and psyllids					Pests			
Date	BLW	hoverflies	nabids	ladybirds	other	aphids	bugs	thrips	other
27/12/11	1					2		yes	
11/1/12	2			1					
25/1/12	3			1		24		yes	
8/02/12	4			3					
22/2/12				3					

Site: EDGE direct search Powells														
	Things that eat aphids and psyllids							**pests**						
	BLW		hoverflies		ladybirds		other	aphids		loopers		heliothis		
Date	egg	larvae	egg	larvae	egg	larvae		winged	wingless	egg	caterpillar	egg	caterpillar	other
25/1/12											1			
8/02/12														
22/2/12														
6/3			10											

Site: MIDDLE direct search Powells														
	Things that eat aphids and psyllids							**pests**						
	BLW		hoverflies		ladybirds		other	aphids		loopers		heliothis		
Date	egg	larvae	egg	larvae	egg	larvae		winged	wingless	egg	caterpillar	egg	caterpillar	other
25/1/12														
8/02/12														
22/2/12							2 spid							
6/3			4						1					

Site: Suction sample Powells													
	Things that eat aphids and psyllids								Pests				
	BLW		hoverflies		nabids		ladybirds	other	aphids		loopers	heliothis	
Date	adults	larvae	adults	larvae	adults	nymphs			winged	wingless	caterpillars	caterpillars	other
25/1/12	3				2			spids			1		
8/02/12	1							2 spid wasp			1		
22/2/12								2 spid wasp			6		
6/3								3 spid			1	2	

Site: Grassy edge – Suction sample Powells													
	Things that eat aphids and psyllids								Pests				
	BLW		hoverflies		nabids		ladybirds	other	aphids		loopers	heliothis	
Date	adults	larvae	adults	larvae	adults	nymphs			winged	wingless	caterpillars	caterpillars	other
25/1/12	1				11		2	Spid wasp					
8/02/12	3						2	2 spid					
22/2/12								2 spid					
6/3								3 spid					

Site: – sticky trap Powells									
	Things that eat aphids and psyllids					Pests			
Date	BLW	hoverflies	nabids	ladybirds	other	aphids	bugs	thrips	other
25/1/12	6		1	2		2		yes	
8/02/12	4								
22/2/12	3								
6/3						1			

Site: EDGE direct search Triggs														
	Things that eat aphids and psyllids							**pests**						
	BLW		hoverflies		ladybirds		other	aphids		loopers		heliothis		
Date	egg	larvae	egg	larvae	egg	larvae		winged	wingless	egg	caterpillar	egg	caterpillar	other
25/1/12														
8/02/12														
22/2/12			1											
6/3			4											

Site: MIDDLE direct search Triggs														
	Things that eat aphids and psyllids							**pests**						
	BLW		hoverflies		ladybirds		other	aphids		loopers		heliothis		
Date	egg	larvae	egg	larvae	egg	larvae		winged	wingless	egg	caterpillar	egg	caterpillar	other
25/1/12														
8/02/12							1 spid							
22/2/12									1	1				
6/3			8										1	

Site: Suction sample Triggs													
	Things that eat aphids and psyllids								Pests				
	BLW		hoverflies		nabids		ladybirds	other	aphids		loopers	heliothis	
Date	adults	larvae	adults	larvae	adults	nymphs			winged	wingless	caterpillars	caterpillars	other
25/1/12					2			spids		1			
8/02/12	1				3			7 spid wasp					
22/2/12	1				3			3 spid wasp			4		
6/3	1				1			4 spid			4	1	

Site: Grassy edge – Suction sample Triggs													
	Things that eat aphids and psyllids								Pests				
	BLW		hoverflies		nabids		ladybirds	other	aphids		loopers	heliothis	
Date	adults	larvae	adults	larvae	adults	nymphs			winged	wingless	caterpillars	caterpillars	other
25/1/12					1								
8/02/12					3	2		Spid wasp					
22/2/12					1			Spid					
6/3					1	1		Spid 1x R&B beetle					

Site: – sticky trap Triggs								
	Things that eat aphids and psyllids					Pests		
Date	BLW	hoverflies	nabids	ladybirds	other	aphids	bugs	thrips	other
25/1/12	13			3		2			
8/02/12	17								
22/2/12	3					3			
6/3	1					2			

Site: EDGE direct search Cricks														
	Things that eat aphids and psyllids							**pests**						
	BLW		hoverflies		ladybirds		other	aphids		loopers		heliothis		
Date	egg	larvae	egg	larvae	egg	larvae		winged	wingless	egg	caterpillar	egg	caterpillar	other
25/1/12							2 spids							

8/02/12							1 wasp							
22/2/12														
6/3			4											

Site: MIDDLE direct search Cricks														
	Things that eat aphids and psyllids							**pests**						
	BLW		hoverflies		ladybirds		other	aphids		loopers		heliothis		
Date	egg	larvae	egg	larvae	egg	larvae		winged	wingless	egg	caterpillar	egg	caterpillar	other
25/1/12														1 mirid
8/02/12														
22/2/12							spid				3			Many mirid J
6/3														

Site: Suction sample Cricks													
	Things that eat aphids and psyllids								Pests				
	BLW		hoverflies		nabids		ladybirds	other	aphids		loopers	heliothis	
Date	adults	larvae	adults	larvae	adults	nymphs			winged	wingless	caterpillars	caterpillars	other
25/1/12					2			spid			2		3 juv mirid
8/02/12	1				1			spid			2		
22/2/12							1 (a)	Spid R&B			5		

								beetle					
6/3							3 (a)	6 spid			2		

Site: Grassy edge – Suction sample Cricks													
	Things that eat aphids and psyllids								Pests				
	BLW		hoverflies		nabids		ladybirds	other	aphids		loopers	heliothis	
Date	adults	larvae	adults	larvae	adults	nymphs			winged	wingless	caterpillars	caterpillars	other
25/1/12					1			Spid wasp					
8/02/12					13								
22/2/12							1 (a)	5 spid					
6/3								1 wasp					

Site: – sticky trap Cricks									
	Things that eat aphids and psyllids					Pests			
Date	BLW	hoverflies	nabids	ladybirds	other	aphids	bugs	thrips	other
25/1/12				1					
8/02/12	1			1					
22/2/12	2			2		2			
6/3	1								

Appendix 3: Tasmanian sites results

Site: sticky trap – Red Hills Clarke								
	Things that eat aphids and psyllids				Pests			
Date	BLW	hoverflies	nabids	Other	aphids	bugs	thrips	other
24/1/12				Wasps	45			
31/1/12					7			
7/2/12					5			
14/2/12				1 wasp	1			
22/2/12	-	-	-	-	-	-	-	-
29/2/12				3 wasps	1			
6/3/12	-	-	-	-	-	-	-	-
13/3/12					1			

Site: sticky trap – Riana trial								
	Things that eat aphids and psyllids				Pests			
Date	BLW	hoverflies	nabids	Other	aphids	bugs	thrips	other
24/1/12	2				540			
31/1/12	4				6			
7/2/12	1				10			
14/2/12	13				9			
22/2/12			1		6			
29/2/12	5				4			
6/3/12	-	-	-	-	-	-	-	-
13/3/12	-	-	-	-	-	-	-	-

Site: sticky trap – Forthside								
	Things that eat aphids and psyllids				Pests			
Date	BLW	hoverflies	nabids	Other	aphids	bugs	thrips	other
24/1/12	4			1 ladybird, 4 wasps	3			
31/1/12	5			2				
7/2/12	5			2 wasps				
14/2/12	5	1			1			
22/2/12	3			2 wasps	2			
29/2/12				9 orgilus				

6/3/12	-	-	-	-	-	-	-	
13/3/12	-	-	-	-	-	--	-	-

Site: sticky trap – Maclaren								
	Things that eat aphids and psyllids				Pests			
Date	BLW	hoverflies	nabids	Other	aphids	bugs	thrips	Other
24/1/12	2			9 wasps	5			
31/1/12	-	-	-	-	-	-	-	-
7/2/12	-	-	-	-	-	-	-	-
14/2/12	3			10 wasps				
29/2/12	1			1 ladybird				
6/3/12	-	-	-	-	-	-	-	-

Site: sticky trap – Sisters Ck Elphinstone								
	Things that eat aphids and psyllids				Pests			
Date	BLW	hoverflies	nabids	Other	aphids	bugs	thrips	other
22/12/11				2 wasps	1			
31/1/12					4			
7/2/12				2 wasps	2			
14/2/12				2 wasps	2			
29/2/12					20			
13/3/12					3			

Site: sticky trap – Anderson Ag								
	Things that eat aphids and psyllids				Pests			
Date	BLW	hoverflies	nabids	Other	aphids	bugs	thrips	other
22/12/11	1			3 wasps, many anystis	25			
31/1/12				2 wasps	7			

7/2/12				1 anystis				
14/2/12	1			1 wasp				
22/2/12				1 wasp				
29/2/12				1 wasp				

Site: sticky trap – Anderson Ag p17								
	Things that eat aphids and psyllids				Pests			
Date	BLW	hoverflies	nabids	Other	aphids	bugs	thrips	other
22/12/11				6 wasps	1			
31/1/12	-	-	-	-	-	-	-	-
7/2/12				1 ladybird	1			
14/2/12	1			1 ladybird, 4 wasps				
22/2/12				2 wasps				
29/2/12	1			4 ladybirds				
6/3/12				1 wasp				
13/3/12	1				2			

Site: sticky trap – Rockliff								
	Things that eat aphids and psyllids				Pests			
Date	BLW	hoverflies	nabids	Other	aphids	bugs	thrips	other
22/1/12					3			
31/1/12	-	-	-	-	-	-	-	-
7/2/12	-	-	-	-	-	-	-	-
14/2/12					3			
22/2/12	6			2 wasps				
29/2/12	-	-	-	-	-			
6/3/12	-	-	-	-	-	-	-	-

Site: sticky trap – Sassafras Caltex								
	Things that eat aphids and psyllids				Pests			
Date	BLW	hoverflies	nabids	Other	aphids	bugs	thrips	other
22/1/12					210			
31/1/12					20			
7/2/12					9			
14/2/12					7			
22/2/12					4			
29/2/12					2			
6/3/12	-	-	-	-	-	-	-	-
13/3/12					1			

Site: sticky trap – BRA Braddons lookout								
	Things that eat aphids and psyllids				Pests			
Date	BLW	hoverflies	nabids	Other	aphids	bugs	thrips	other
22/1/12	1							
31/1/12	1				1			
7/2/12	1							
14/2/12				5 wasps				
22/2/12				1 ladybird	1			
29/2/12				1 ladybird, 1 wasp				
13/3/12				2 wasps	2			

Site: sticky trap – Coote , Toddy's Plain								
	Things that eat aphids and psyllids				Pests			
Date	BLW	hoverflies	nabids	Other	aphids	bugs	thrips	other
31/1/12	-	-	-	-	-	-	-	-
7/2/12	1							
14/2/12				3 wasps				
29/2/12	2							

Site: sticky trap – Johnson								
	Things that eat aphids and psyllids				Pests			
Date	BLW	hoverflies	nabids	Other	aphids	bugs	thrips	other
31/1/12					3			
7/2/12	1							
14/2/12				1 wasp	2			
22/2/12	1							
29/2/12-		-	-	-	-	-	-	-
6/3/12	-	-	-	-	-	-	-	-
13/3/12					1			

Site: sticky trap – Rhebenvale								
	Things that eat aphids and psyllids				Pests			
Date	BLW	hoverflies	nabids	Other	aphids	bugs	thrips	other
31/1/12	1				7			
7/2/12					1			
14/2/12	2			1 ladybird, I wasp	1			
22/2/12				1 wasp	2			
29/2/12				1 ladybird	1			
13/2/12	-	-	-	-	-	-	-	-

Site: sticky trap – Chaplin								
	Things that eat aphids and psyllids				Pests			
Date	BLW	hoverflies	nabids	Other	aphids	bugs	thrips	other
31/1/12	-	-	-	-	-	-	-	-
7/2/12	-	-	-	-	-	-	--	-
14/2/12				1 Ladybird, 1 wasp	1			
22/2/12	3							
29/2/12	2				6			

Site: sticky trap – Addison								
	Things that eat aphids and psyllids				Pests			
Date	BLW	hoverflies	nabids	Other	aphids	bugs	thrips	other
31/1/12	1							
7/2/12	4				1			
14/2/12				2 wasps	2			
22/2/12	1							
29/2/12	-	-	-	-	-	-	-	-
13/3/12	-	-	-	-	-	-	--	-

Site: sticky trap – Craigie								
	Things that eat aphids and psyllids				Pests			
Date	BLW	hoverflies	nabids	Other	aphids	bugs	thrips	other
31/1/12					3			
7/2/12				1 wasp				
14/2/12	2			1 ladybird	2			
22/2/12				1 ladybird				
29/2/12	2			2 wasps				
6/3/12					1			
13/3/12					2			

Site: sticky trap – Harvester Gate								
	Things that eat aphids and psyllids				Pests			
Date	BLW	hoverflies	nabids	Other	aphids	bugs	thrips	other
31/1/12	1				60			
7/2/12	-	-	-	-	-	-	-	-
14/2/12				3 wasps	3			
22/2/12				1 wasp				
29/2/12				1 wasp	6			

Site: sticky trap – Harvester Office								
	Things that eat aphids and psyllids				Pests			
Date	BLW	hoverflies	nabids	Other	aphids	bugs	thrips	other
31/1/12	1			7 wasps	24			
7/2/12					2			
14/2/12	2			1 wasp				
22/2/12	1			2 wasps				
29/2/12	1			3 wasps	6			
6/3/12	1				2			

Site: sticky trap – 212 potatoes								
	Things that eat aphids and psyllids				Pests			
Date	BLW	hoverflies	nabids	Other	aphids	bugs	thrips	other
31/1/12					4			