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Improved Export Market Access for Australian Wildflowers through Integrated Pest Management

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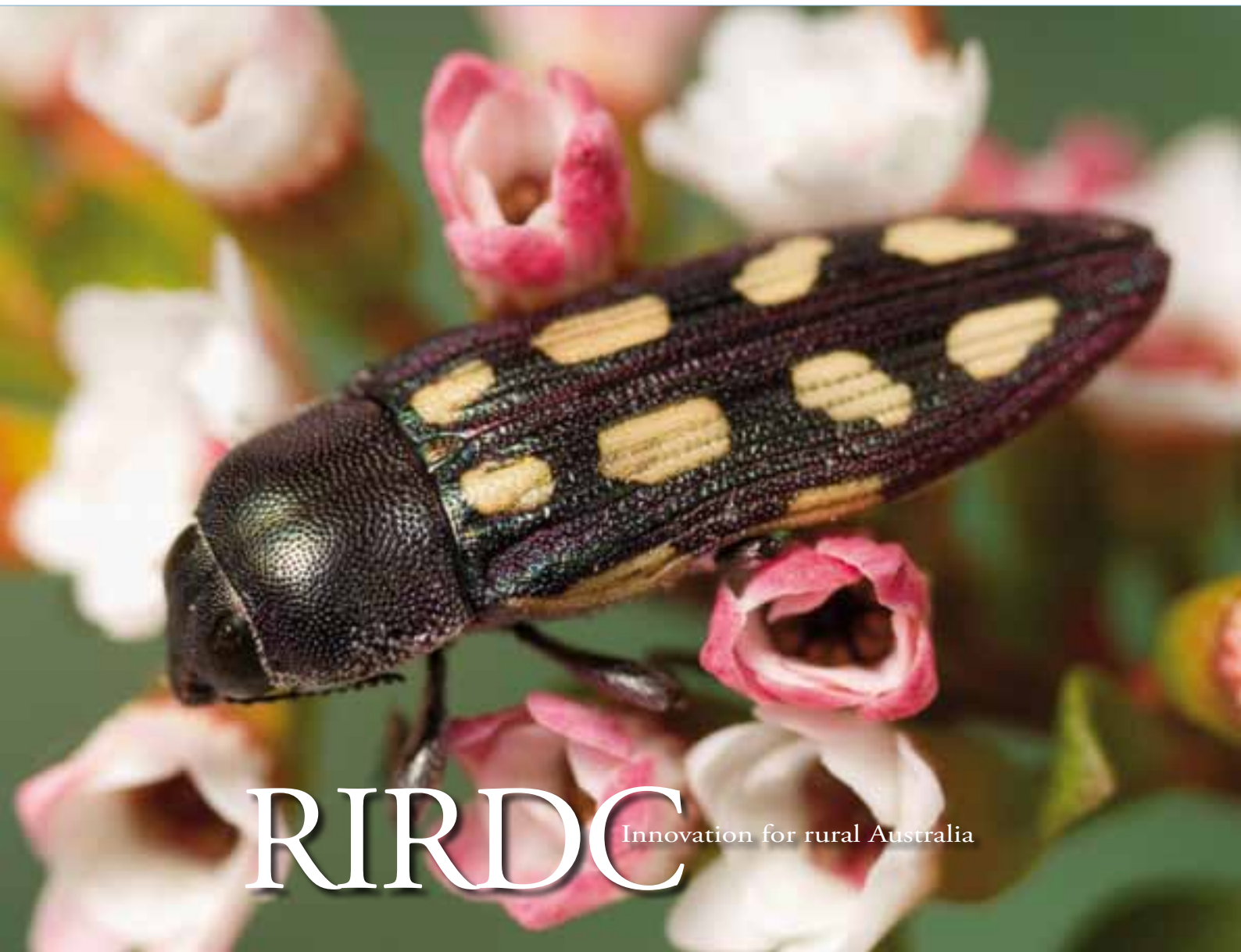

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Improved Export Market Access for Australian Wildflowers through Integrated Pest Management

by Audrey Gerber

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Foreword

There is currently much concern in the industry regarding flower shipment rejections by the USA due to insect contaminations, with particular reference to thryptomene and waxflower from Australia. A workshop was held to determine strategies to reduce United States Department of Agriculture (USDA) interceptions of flowers exported from Australia, predominantly for thryptomene and waxflower. Through the development and implementation of an Integrated Pest Management program, the number of insect interceptions and corresponding shipment rejections is expected to decrease. Increased confidence of USDA in the quality of Australian flowers will reduce the rigorous scrutiny to which they are subjected, and export market access to USA of these and other Australian flowers will improve.

This project was funded from RIRDC core funds provided by the Australian Government, and from industry funds, provided by Wafex, Austwinds International, Big Spring Mount, Mt Talbot Wildflowers and Winfield Rosemount.

This report, an addition to RIRDC's diverse range of over 1900 research publications, forms part of our Wildflowers & Native Plants R&D program, which aims to provide profitable and sustainable production and management systems.

Most of RIRDC's publications are available for viewing, downloading or purchasing online at www.rirdc.gov.au. Purchases can also be made by phoning 1300 634 313.

Peter O'Brien
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About the Author

Dr Audrey Gerber was an Industry Development Officer for Primary Industries Research Victoria for a number of years working with new industries (including cut flowers) to identify barriers to industry growth and help find ways to overcome them. Dr Gerber currently operates through a family company as a consultant to the Wildflower industry, offering solutions in all aspects of specialised horticulture, including development of farm management plans for improved production, facilitating and delivering training programmes, conducting and providing research advice, and critically appraising and editing popular and scientific publications.

Acknowledgments

Technical assistance and monitoring liaison with growers was provided by Denis Crawford of Graphic Science (http://www.graphicscience.com.au/).

Dr Paul Horne and Jessie Page of IPM Technologies Pty Ltd, Hurstbridge, provided valuable assistance in project development, including the initial workshop, and advice on insect identification and control (www.ipmtechnologies.com.au/).

Industry funding was provided by:

- Export companies: Wafex and Austwinds International.
- Flower producers: Big Spring Mount, Mt Talbot Wildflowers, and Winfield Rosemount.

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Executive Summary

What the report is about

This action oriented research was instigated in conjunction with growers on-farm in order to develop best-practice Integrated Pest Management, and as a consequence of that, reduce insect interceptions and associated market access issues with key export markets.

Who is the report targeted at?

The results of this report will be important for growers and exporters of Australian grown wildflowers and also for importers of Australian grown wildflower products who are concerned about insect pest incursions.

Background

The majority of Australian grown wildflowers are exported. All countries have controls, regulations and inspections of fresh plant materials transported into their territory. The United States Department of Agriculture inspects flowers exported from Australia into USA, and any shipments found to contain insects are intercepted and then fumigated and/or destroyed. Two large Australian export companies, Wafex and Austwinds International worked together to collect data on the number of interceptions occurring in 2006 and 2007. The financial losses were considered unacceptable and meetings were held with growers to decide on appropriate action.

IPM Technologies Pty Ltd assisted in holding a workshop to discuss current insect management strategies of thryptomene and waxflower growers in the Grampians region of Victoria, Australia. Possibilities for improvement in field management of insects were indentified and this project was initiated.

Aims/Objectives

The aim of this research was to reduce insect interceptions and shipment rejections through the development and implementation of an IPM programme for Australian grown wildflowers. The project was established to increase the confidence of the United States Department of Agriculture, in particular, with respect to the quality of Australian grown flowers.

Whilst this initial project was implemented with waxflower and thryptomene growers in a particular region, this project aims to provide an example of how a similar approach could be applied to other wildflower crops and for other regions in Australia

Methods used

A preliminary IPM strategy for thryptomene and waxflower was developed in conjunction with participating growers. Key elements of the strategy development included:

- Monitoring
- Insect identification
- Development of a monitoring calendar
- Control measures
- Market feedback

Results/Key findings

This project conducted the preparatory work for developing an Integrated Pest Management (IPM) Programme for thryptomene and waxflower. The programme developed protocols for regular crop monitoring, and highlighted critical pests and critical times for action. Recommendations have been made for cultural and biological control of known insect pests. A second follow up season of monitoring is required for the development of a full IPM programme.

Implications for relevant stakeholders

The potential exists to extend this project to other regions to contribute further to a decrease in intercepted shipments from Australia. Ideally, this project serves as a pilot to encourage growers of waxflower and thryptomene around Australia to adopt regular monitoring and move towards developing an IPM programme. The monitoring templates developed are easily adaptable to other regions, and the monitoring calendar gives an indication of key insects for which to monitor, and critical times for when to expect activity. The implementation of this IPM Programme would enable any grower of these products in Australia to better manage insect populations in the crop. The 2008/09 season showed a significant decrease in both the number of interceptions and the concurrent financial loss incurred by both exporters and growers. The resulting reduction in likelihood of insect contamination in export shipments will improve confidence in product from Australia and greatly assist access of Australian flowers into export markets.

1. Introduction

Australian flowers exported to USA are subjected to intense scrutiny by the United States Department of Agriculture (USDA), and shipments are too often rejected when insects are found within the flowers. When flower shipments are rejected due to insect interceptions both the grower and the exporter incur financial losses. Key export companies kept records for interceptions through the 2006 and 2007 seasons. Financial losses were significant, running into tens of thousands of dollars, and growers and exporters decided to address this issue.

Active management of insects in the field will enable cleaner product to be exported. Fewer shipment rejections will send a clear message to the USDA that Australian growers have taken active steps to comply with their stringent requirements, and Australian flowers will be subjected to less intensive scrutiny.

Management of insect populations in the field through the development and implementation of an Integrated Pest Management (IPM) Programme is expected to contribute to a reduction or an eradication of insects in harvested flowers. In part, this is due to improved insecticide use which maintains populations of potential pest species at acceptably low levels. In addition, an IPM programme has proven environmental benefits in reducing the use of agrochemicals, due to a focus on cultural and biological control methods. The growers involved in this programme currently use broad spectrum insecticides and fungicides in a regular spray programme. While these agrochemicals are acceptable for use in agriculture, there are better choices for more targeted control. An active monitoring programme will further add to reducing chemical use by enabling growers to spray only when essential to maintain crop quality.

2. Objectives

This project will develop tools to assist in future establishment of an Integrated Pest Management (IPM) Programme for thryptomene and waxflower. The programme will include protocols for regular crop monitoring, and will highlight critical pests and critical times for action. Recommendations will be made for cultural and biological control of known insect pests. The implementation of these tools in an IPM Programme will enable any grower of these products in Australia to better manage insect populations in the crop. The resulting reduction in likelihood of insect contamination in export shipments will greatly assist access of Australian flowers into export markets.

3. Methodology

Monitoring field crops for insects

Development and successful implementation of an IPM programme relies on information arising from regular monitoring. This project used a three stage process to establish an efficient monitoring routine:

Stage 1:

A workshop was held with growers to gather information on the insects that had been noticed in plantations over the last few seasons. This information was largely anecdotal and few detailed identifications had been made. Growers provided their observations on when the insects that they had observed were likely to cause problems. Six growers of thryptomene and waxflower in the Grampians area attended this workshop. Three growers continued with the monitoring programme.

Information was also recorded on control methods used by growers for particular insect pests.

A grower "Monitoring Kit" was prepared and provided to each grower. The kit contained:

- A field guide for identification of insect pests (Pests, diseases, disorders and beneficials in ornamentals: field identification guide, 2004, Steiner, M and Goodwin, S. Published by NSW Agriculture, ISBN 0 7347 1854 9).
- A reference book for identification of beneficial insects (The Good Bug Book. 2nd Edition, Published 2002 by Integrated Pest Management Pty Ltd, ISBN 0 9580589 0 3).
- A 10X magnification hand lens
- A starter pack of Yellow Sticky traps for field trapping of flying insects
- Delta traps for Light Brown Apple Moth, with a 3 pack starter kit of pheromone
- Film canisters for collection of insects for identification
- Brown paper bags for collection and posting of plant material
- Contact details for monitoring assistance, identification assistance and control recommendations, and general assistance.

Stage 2:

The information from the workshop (Stage 1) was used to develop a broad monitoring sheet for growers to use in weekly monitoring. The sheet listed some insects that were expected, based on information provided by the growers and allowed space for growers to record names and details of insects observed. Denis Crawford of Graphic Science assisted growers with monitoring, with monthly visits through the peak season.

Stage 3

Through discussion with growers during monthly monitoring visits, Denis Crawford tailored a monitoring sheet that was easier to use and specific for the crop and the region. Monitoring was recommended to occur weekly, and fifteen plants selected at random in a specific block were monitored each time.

Insect identification

In addition to the two reference books provided to growers, identification assistance was provided through regular visits by Denis Crawford of Graphic Science, and access via email or telephone to Paul Horne and Jessica Page of IPM Technologies Pty Ltd. As new insects were encountered and identified, photographs were placed on a dedicated webpage, linked by password, through the Graphic

Science website. Where necessary, samples were reared to adult stage by Denis Crawford of Graphic Science and sent to CSIRO in Canberra for identification.

Developing a monitoring calendar

One grower, showing particular interest in the programme, was selected to undertake intensive monitoring. This grower recorded information on which insects were seen in the crop and what numbers or relative intensity of insect populations were observed.

Results from this intensive monitoring were used to develop a calendar to assist with monitoring in future seasons. This information was related to the both the season and plant growth stage to identify critical times to monitor for specific insects. The same level of intensive monitoring will be required on other farms through the region to verify the applicability of this information to the entire region.

Developing an Integrated Pest Management Programme

The final stage in developing an IPM programme is to identify and record appropriate response strategies. The appropriate response depends on the potential economic loss that may be occurred due to the pest population. When the potential economic loss to the crop exceeds the cost of implementing control measures the ‘Economic or Action Threshold’ has been reached. Monitoring through successive seasons is essential in developing this ‘Action Threshold’.

Assessing the effect of a change in insect management strategy on marketing success

Two exporting companies who handle the major portion of the thryptomene crop from this region provided information on volume and value of shipments made during the 2008/09 season. The number and value of rejections due to pest interceptions was compared with data collected in the 2007/08 season. The data set from one season was insufficient for statistical analysis.

4. Results

The current insect management strategy employed by thryptomene and waxflower growers in the Grampians region includes both field or pre-harvest activities, and packing shed or post-harvest techniques.

Discussions with the growers involved in this project revealed that there was little that could be changed to improve the current post-harvest strategy. Techniques used are those recommended in standard industry references (Faragher, 2004). IPM Technologies P/L suggested two factors that may be included in the current strategy. On arrival in the packing shed, the flowers could be placed in a dark chamber with a bright light. Highly mobile insects would be attracted away from flowers in the packing shed towards the light. The insects move toward the light where they are either extracted by a fan, and/or zapped. One grower installed a bright light together with an insect zapper in a section of the packing shed and reported success using this method. However, this result was not quantified. The other factor that may be improved on is an adjustment of flow of flowers through the packing shed to prevent reinfestation of flowers after treatment. Flowers arriving from the field may have insects present. If these flowers receive any treatment to remove insects (dipping or light treatment) subsequent packing shed flow must physically separate these from untreated flowers to ensure that the treated flowers are not likely to be contaminated by insects as they arrive in the packing shed on flowers directly from the field. It is unclear how great the risk of reinfestation is during transport.

Three key factors in the field management of insects were noted for review by IPM Technologies P/L, namely,

- regular monitoring and identification of insects
- choice of agrochemical
- choice of control method.

Regular monitoring and identification of insects

In past seasons, insect control sprays that were used, were applied as a matter of routine. Through regular monitoring, the decision to take action can be made based on the positive identification of the insect observed and rational assessment of the level of pest activity. In this way, sprays are only applied when necessary. This has obvious environmental and economic benefits.

Through discussions during regular visits to the growers, monitoring tools were developed to assist growers in decision making for pre-harvest pest management. Appendix A lists insects noticed in the field during monitoring in the 2008/09 season. Initially, a draft monitoring sheet was used (Appendix B). After discussion with growers, a second monitoring sheet was produced (Appendix C). Continuing monitoring for a second season would be required for the growers to appreciate the value of regular monitoring, and feel comfortable with adapting their farm management programmes based on information from this tailored monitoring sheet.

To assist with identification of insects seen during monitoring, Denis Crawford of Graphic Science created a website with photographs of insects commonly seen in the field. The website was accessible only to growers through a link with the Graphic Science website (http://www.graphicscience.com.au/). Although this is a valuable resource, its use to these growers may have been limited due to inefficient internet access.

Positive identification is critical to selecting the right action. A common insect causing damage to the crop, and of great concern to growers and exporters, is a leaf- rolling caterpillar. Material was sent to CSIRO in Canberra for positive identification. The caterpillar in the leaf-rolling stage was sent in a live state for hatching under controlled conditions. The mature stage (moth) is essential for

identification. CSIRO confirmed that this leafroller was not Light Brown Apple Moth (LBAM) as had been assumed, but was *Holocola* sp. (Tortricidae) (see figures 1 and 2). This has two important implications. Firstly, it assists exporters in dealing with AQIS and USDA who are greatly concerned about LBAM entering USA. In March 2009, LBAM was intercepted in a shipment of flowers from New Zealand to USA, and all imports from New Zealand were banned until USDA was content with new control measures. Secondly, an alternative monitoring method must be developed to monitor incidence of this leafroller. The Delta traps provided in this project are specific to LBAM. Yellow sticky traps have limited efficacy in the field due to wind-blown sand and other debris which collects on the traps. Light traps may be effective in capturing moths to assess the population size and growth, and these should be trialled in future seasons.

Figure 1: Shoot tip damage caused by the larva of *Holocola* sp. (Lepidoptera: Tortricidae)

Figure 2: Adult stage (moth) of *Holocola* sp. (Lepidoptera: Tortricidae)

Regular monitoring provides the grower with information on relative insect activity allowing an informed decision to be made on when action is to be taken. When action is taken, and which action is most appropriate is defined by the 'Action or Economic Threshold,' that is specific for a pest/crop combination. Low numbers of certain insects can be tolerated, particularly if monitoring shows an increase in numbers of beneficials. Monitoring for successive seasons is required to define this threshold for the major pests. Developing an 'Action Threshold' for response was beyond the scope of this project.

However, intensive monitoring on one site enabled the development of a preliminary Monitoring Calendar (Appendix D). This is a tool that alerts the grower which insects to monitor for at specific times. The timing is linked both to season and to growth phase of the crop. Through regular monitoring on a number of sites with reference to this monitoring calendar, a general monitoring calendar could be developed for thryptomene or waxflower for any region.

Choice of agrochemical

Many effective agrochemicals are broad spectrum insecticides and kill all insects, including pests and beneficials. Populations of beneficials are slower to recover, during which time pest populations increase unchecked. The use of broad spectrum pesticides, or certain fungicides may induce disastrous outbreaks of pests. Specific examples are aphids, thrips and certain mites, including rust mite and two-spotted mite. There are many selective agrochemicals available for use in an Integrated Pest Management programme which assist the development of healthy crop ecosystems containing stable populations of important beneficial insects. Advice on choice of agrochemical was available during the project from IPM Technologies Pty Ltd, but some growers chose not to seek that advice.

Leaf-roller caterpillars reduce the saleability of thryptomene due to feeding on leaves causing unsightly damage, and rolling themselves up in a leaf tube from where they are practically impossible to dislodge. Product offered for sale with leaf rollers present amongst the leaves will be rejected. The ideal control measure for leaf roller is to eradicate or reduce field populations, as current post harvest techniques are largely ineffective. Two peaks in the leaf-roller population are commonly observed in thryptomene crops in the Grampians region. One peak occurs early in the season (December) and the other, larger peak, later in the season (February), arising from eggs laid by adults emerging from the first cycle. In past seasons, regular sprays with broad spectrum insecticides has been the method employed.

The 2008/09 season was unusual as there was only one peak in the leafroller population – during December. The grower chose to spray with chlorpyrifos, but attempted to only apply it to the outer layer of the plant where the leafrollers were located. Two weeks later, many leafrolls were opened and their contents examined. No leafroller larvae had survived to pupation and some of the leafrolls had been occupied by spiders. Although the grower maintained that the monitoring program had not assisted in his decision to spray (as he was always alert to the presence of leafrollers) it gave him an insight into the insect life on his plants. He was especially pleased to learn about the wide range of beneficials in his crop.

Choice of control method

An added value of monitoring and identification of insects in a field crop is in developing an awareness that not all insects are pests. Many insects found in a healthy plant ecosystem do not directly damage the crop. Two groups of beneficials are found.

Examples of beneficial insects found during monitoring during this project are shown in Figures 3, 4 and 5.

Resident: these are always present in healthy plant ecosystems, and include spiders, beetles and mites.

Seasonal: these are present only during the growing season, and include parasites, lacewings and assassin bugs.

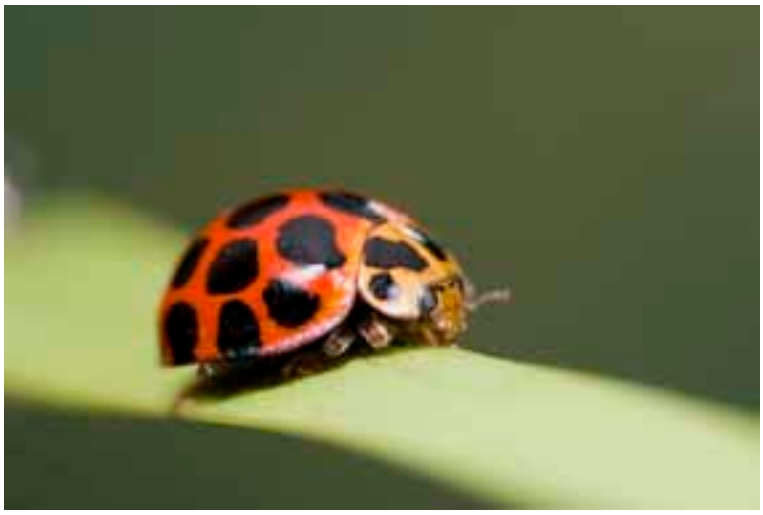

Figure 3: The common spotted ladybird beetle (*Harmonia conformis*)

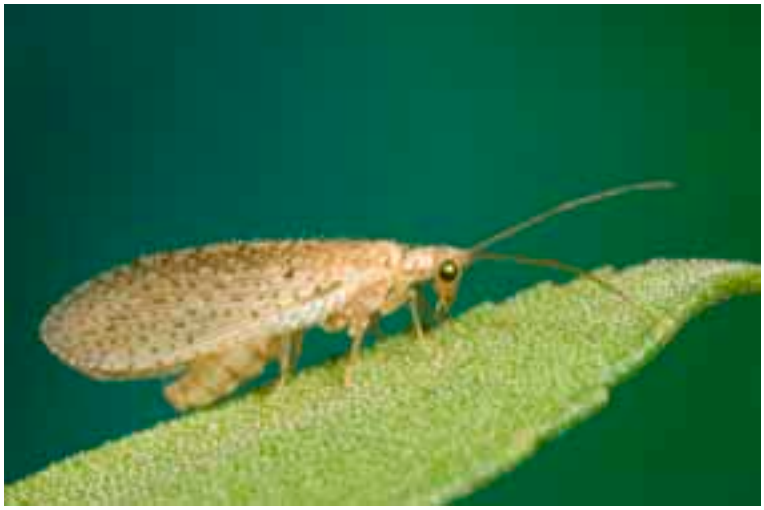

Figure 4: Lacewing adult *Micromus* sp. (Neuroptera: Hemerobilidae)

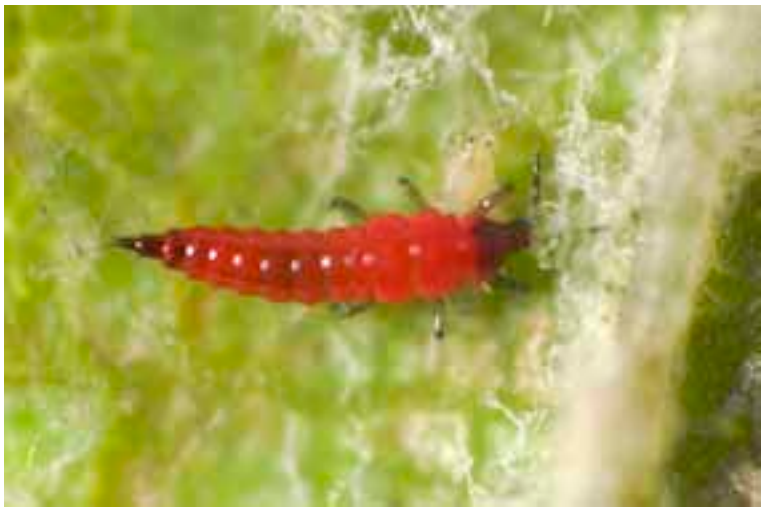

Figure 5: Predatory thrips (*Haplothrips* sp.)

The monitoring sheet (Appendix C) lists the beneficial insects monitored for in this project. Although spiders (Family Araneae) are not themselves insects, they are beneficial in reducing insect numbers by predation and their presence in the crop was also noted.

An IPM programme aims at keeping pest insect numbers low, while allowing populations of beneficials to thrive. To achieve this three levels of control are available:

- Biological
- Cultural
- Chemical

Appendix E lists options for biological and cultural control of some key insect pests. The pests listed in Appendix E are those named by growers in the first workshop in April 2008. Subsequent monitoring has shown that some of these pests did not occur in 2008/09 season, and others were identified through this project to be different pests from those expected, eg the leaf roller that was initially thought to be LBAM was identified as *Holocola* sp. (Tortricidae).

There are a number of chemical control measures used in agriculture. An IPM programme requires the use of targeted chemicals with low impact on beneficial insects. The regulations for use of agrochemicals vary between states, and growers are encouraged to seek advice from appropriate sources in selecting chemical control measures.

Assessing the effect of a change in insect management strategy on marketing success

Flowers arriving in USA are subject to scrutiny by USDA to prevent spread of exotic pests and diseases into USA. If insects are found, the shipment is generally rejected, often requiring costly fumigation. The direct costs of these interceptions by USDA and the loss of income due to the rejected shipment are shared by agreement between exporter and grower.

Table 1 outlines the interceptions for the past 2 seasons in comparison with the 2008/09 season during which this project ran. The number of shipment rejections increased from 14.44% in 2006/07 to 18.67% in 2007/08. In 2008/09 the number of boxes rejected decreased to 9.0% of the total number of boxes shipped. There are insufficient data to run statistical analyses, however a 50% decrease in the number of boxes rejected has significant financial impact for both growers and exporters.

Table 1: Interceptions of flowers exported from Australia to USA through two exporters participating in this project

	2006/07 season	2007/08 season	2008/09 season
Number of thryptomene shipments intercepted	9	8	7
% of boxes of thryptomene shipped that were rejected	14.55%	18.67%	9.0%
% of total interceptions[1]	36%	56%	-[2]

[1]This is the number of boxes of thryptomene from the Grampians area that were rejected, expressed as a percentage of the total number boxes intercepted for waxflower and thryptomene from any region that were exported by the two exporters participating in this project.

[2]This figure was not available for 2008/09.

In past seasons, rejections of thryptomene grown in the Grampians region formed a large portion of the total rejections of thryptomene and waxflower exported through these two exporters (Table 1). The potential therefore exists to extend this project to other regions to contribute further to a decrease in intercepted shipments from Australia. Ideally, this project serves as a pilot to encourage growers of waxflower and thryptomene around Australia to adopt regular monitoring and move towards developing an IPM programme. The monitoring templates developed are easily adaptable to other regions, and the monitoring calendar gives an indication of key insects for which to monitor, and critical times for when to expect activity.

Not only do rejected shipments have associated additional costs, both exporter and grower incur loss of income. Table 2 shows the financial significance of rejected shipments.

Despite a reduction in shipment rejections (Table 1) in the 2008/09 season compared with the past 2 seasons, a financial loss was still incurred by both growers and exporters (Table 2). Further attention to this problem is required until growers and exporters agree that the financial loss incurred by rejected shipments is low enough to be an acceptable business risk.

Table 2: Thryptomene interceptions exported to USA in 2008/09 through two exporters

	Exporter 1	Exporter 2
% of harvest rejected	9%	4%
% of income lost [3]	14.5%	10.9%
Total direct costs of rejected shipments	AU$15,000	
Total loss of income	AU$80,000	

[3]Including cost of fumigation of rejected shipments

5. Implications

This project was intended as a pilot project to encourage thryptomene and waxflower growers in the Grampians region to adopt regular monitoring for insects with a view to establishing and implementing an IPM programme in the future. A continuation of the project over successive seasons would hopefully prove the economic benefits of adopting these activities and principles.

The difference in the list of insects identified in the workshop at the start of the project, compared with the insects monitored for after discussions with growers (Appendix C), indicates that monitoring is a valuable tool to correctly assess presence and numbers of insects. An example in this project is the assumption that the leafroller caterpillar causing concern was Light Brown Apple Moth (LBAM). Delta traps with LBAM pheromone failed to detect the presence of LBAM moths, despite evidence of leaf rolling caterpillars in the field. Samples sent to CSIRO in Canberra confirmed that the leaf rolling caterpillar occurring in thryptomene plants in the Grampians region was not LBAM. Monitoring and control techniques need to be adapted accordingly. Monitoring has particular relevance in recognising the presence and value of beneficial insects and other invertebrates. With involvement of technical expertise, it is possible to develop a draft Monitoring calendar over a single season. This tool will greatly assist growers with correct identification of insects, and provides them with timely reminders of when to expect outbreaks of key pests. This should minimise the need for routine sprays of broad spectrum agrochemicals, and offers the grower the option of selecting targeted control measures compatible with an IPM programme.

6. Appendices

Appendix A: List of insects and other arthropods observed by growers during monitoring in 2008/09 season

Aphid (Hemiptera: Aphididae)

Ant (Hymenoptera: Formicidae)

Assassin bug (Hemiptera: Reduviidae)

Bigeyed bug *Geocoris* sp. (Hemiptera: Lygaeidae)

Borer (Lepidoptera: Cosmopterigidae)

Coreid bug (Hemiptera: Coreidae)

Case moth (Lepidoptera: Psychidae)

Clerid beetle (Coleoptera: Cleridae)

Flower grub – beetle larva (Coleoptera)

Flower wasp (Hymenoptera: Tiphiidae)

Froghopper (Hemiptera: Cercopidae)

Gall wasp (Hymenoptera)

Hover fly (Diptera: Syrphidae)

Lacewing (Neuroptera: Hemerobiidae)

Ladybird (Coleoptera: Coccinellidae)

Leafroller *Holocola* sp. (Lepidoptera: Tortricidae)

Looper (Lepidoptera: Geometridae)

Jewel beetle (Coleoptera: Buprestidae)

Mantis (Mantodea)

Mirid bug (Hemiptera: Miridae)

Parasitic wasp (Hymenoptera)

Predatory thrips *Haplothrips* sp. (Thysanoptera: Phlaeothripidae)

Planthopper *Syphanta* sp. (Hemiptera: Flatidae)

Rutherglen bug *Nysius vinitor* (Hemiptera: Lygaeidae)

Scale (Hemiptera: Coccidae)

Shield bug *Oechalia schellembergii* (Hemiptera: Pentatomidae)

Snout mite (Acarina: Bdellidae)

Spider (Araneae)

Springtail (Collembola)

Thrips (Thysanoptera)

Weevil (Coleoptera: Curculionidae)

Appendix B: Monitoring sheet developed at start of project

WEEK 1

Block _____ **Date** _____

Number of plants monitored	Number of plants with insects	Caterpillars	Aphids	Scale	Thrips	Weevils	Borers	Other
	Low							
	Med							
	High							
	Comments							

Number of insects	LBAM trap	Sticky trap	Lacewings	Ladybirds	Damsel bugs	Wasp Parasitoids	Other
Low							
Med							
High							
Comments							

General observations _____

Appendix C: Monitoring sheet developed after discussions with growers

BLOCK_____ DATE_____

PESTS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Thrips															
Aphids															
Loopers															
Leaf rollers															
Mirid bugs															
Coreid bugs															
Clerid beetles															
Flower grubs															
Scale															
Weevils															
Borers															
PEST COMMENTS:															

GOOD BUGS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ladybird beetles															
Ladybird larvae															
Lacewing adults															
Lacewing larvae															
Assassin bugs															
Shield bugs															
Big-eyed bugs															
Mantids															
Wasp parasite															
Predatory thrips															
Snout mites															
Damsel bugs															
GOOD BUG COMMENTS:															

LBAM TRAP:

STICKY TRAP:

OTHER COMMENTS:

Appendix D: Monitoring Calendar

Month	Date	PESTS													BENEFICIALS									
		Aphids	Borers	Coreid bugs	Flower grubs	Frog hoppers	Leafrollers	Loopers	Mirid bugs	Rutherglen bugs	Scale	Springtails	Thrips	Weevils	Assassin bugs	Bdellid mites	Big-eyed bugs	Lacewings	Ladybirds	Mantids	Predatory thrips	Shield bugs	Spiders	Wasp Parasites
July	22/07/2008		med			low		low			low	low	low			low			low					low
	29/07/2008		med					low			low		low						low					
August	5/08/2008		med					low			med		low			low							low	
	12/08/2008		med		low			low			med		low			med								
	19/08/2008		high						med				med			med		low	low		low			
	26/08/2008		high										med			low								
September	2/09/2008	low						low	med				med			low			low		low			
	9/09/2008	low							med				med			low								
	16/09/2008	low											med											
	24/09/2008	low											low			med			med		low		high	med
	30/09/2008												low			med			med		low		high	med
October	7/10/2008			low	low	low		low	low				low			low	low	low	low		low	low	high	low
	14/10/2008														low	med		med	med		med			
	21/10/2008																						high	
	28/10/2008																						med	
November	4/11/2008							med	med							med		med					high	
	12/11/2008			low					low							low		med	med				med	
	18/11/2008																	med	med					
	26/11/2008	low						high					low	low				med	high	med			high	
December	3/12/2008							high										high	high				high	
	9/12/2008							high											high				high	
	16/12/2008							low																
	20/12/2008						med																	
	30/12/2009						med																	
January	6/01/2009						med *																	
	13/01/2009																							
	20/01/2009							low		high			low										high	
	28/01/2009							low												low			high	
February	4/02/2009							low		low										low	low		med	
	10/02/2009							low	low	low													high	
	17/02/2009							low	low							low							low	
	25/02/2009							low	low							low			low				low	
March	4/03/2009																						low	
	15/03/2009																							
	19/03/2009																			low	low		low	

* Sprayed with chlorpyrifos 9/1/09

Appendix E: Biological and cultural control options for thryptomene and waxflower in the Grampians Region. This appendix was prepared following the first workshop in April 2008

Insect	Beneficial insect for control	Cultural control	Monitoring
Leafroller, loopers. (Order Lepidoptera)	Parasitic wasps (Trichogramma is an example) Damsel bugs	Capeweed is an alternative food source. Controlling capeweed is effective in reducing numbers of LBAM. The Vineyard industry uses a product called "Blockout" as a cover crop to limit capeweed growth [1]	Visual inspection of plants weekly. Delta traps with Isomate pheromone strips attract LBAM only, and are an effective method to monitor for LBAM presence and numbers [2]. Light traps may be useful to monitor for other moths
Black scale (Order Homoptera) This is the same pest found in Olives. **Aphids** (Order Hemiptera)	Ladybirds Lacewings Parasitic wasps Metaphycus is a parasitic wasp currently being developed for the Olive industry [3]		Visual inspection of plants weekly. Black scale lies flat along branches and the monitor must look inside the plant canopy. Aphids generally feed on young soft tissue; stem tips and flower buds are targets for inspection.
Flies (Order Diptera) Contaminant, possibly beneficials, eg Hoverfly which eat ahpids	Praying mantis (Order Mantodea)		
Gall wasps (Order Hymenoptera)	Beneficial wasps	Remove infected stems and branches and burn or destroy.	Visual inspections weekly. Galls occur on stems inside the canopy, requiring careful looking to find.
Thrips (Order Thysanoptera)	Predatory thrips, Predatory mites	Allow contact of shoots between plants. Predatory mites move from plant to plant along shoots which are touching.	Visual inspections weekly. Yellow or blue sticky traps work well if protected from wind and dust. Thrips are very small and a hand lens is useful for inspecting sticky traps. Tapping flower heads shakes thrips out, which otherwise may been missed.
Weevils ,Borers, cockchafers (Order Coleoptera)	Parasitic wasps	Grass and weed management can be effective by attracting the insect away from the crop, eg cockchafer selectively eat sorrel.	Visual inspections weekly. Monitor for signs of bark damage on the stem just below the soil surface.
Rutherglen bug (Order Hemiptera) Contaminant, no evidence of plant damage.	Numbers overwhelm any beneficials that may be present.		Rutherglen bug move in on hot north winds. Monitoring weather conditions in early to mid-summer will indicate when flights are expected.

[1]**Blockout"** is available from Valley Seeds. Viticulture/ horticulture: blends have been specifically formulated for use in specialist situations such as vineyards and orchards. Cover crops provide an additional element to the management regime, designed to maximize the performance of crops and minimize the impact of competition.
Valley Seeds Australia Pty Ltd, 295 Maroondah Link Highway, Alexandra, VIC 3714
Ph: +61(0)3 5797 6203 Freecall Australia only: 1800 226 905 Fax: +61(0)3 5797 6307 Email: info@valleyseeds.com

[2]**Isomate LBAM Plus** is available from Biological Services, PO Box 501, Loxton SA 5333, Australia. Phone: (08) 8584 6977 Fax: (08) 8584 5057.

[3]**Metaphycus wasps** for the control of black scale are under development by Biological Services. Small quantities should be available soon.
It is envisaged that they will be released as adults despatched as parasitised pupae inside the soft scales bodies. Releases will be innoculative; release of wasps where soft scales are known to exist and try to control or reduce ant populations in the release vicinity beforehand.
Biological Services, P.O. Box 501,Loxton SA 5333. Phone: (08) 8584 6977 Fax: (08) 8584 5057
e-mail: info@biologicalservices.com.au web page: www.biologicalservices.com.au

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Improved Export Market Access for Australian Wildflowers through Integrated Pest Management

RIRDC Publication No. 09/150

By Audrey Gerber

The majority of Australian grown wildflowers are exported. All countries have controls, regulations and inspections of fresh plant materials transported into their territory. The United States Department of Agriculture inspects flowers exported from Australia into USA , and any shipments found to contain insects are intercepted and then fumigated and/or destroyed.

This research was instigated in conjunction with growers on-farm in order to develop best-practice Integrated Pest Management, and as a consequence of that, reduce insect interceptions and associated market access issues with key export markets.

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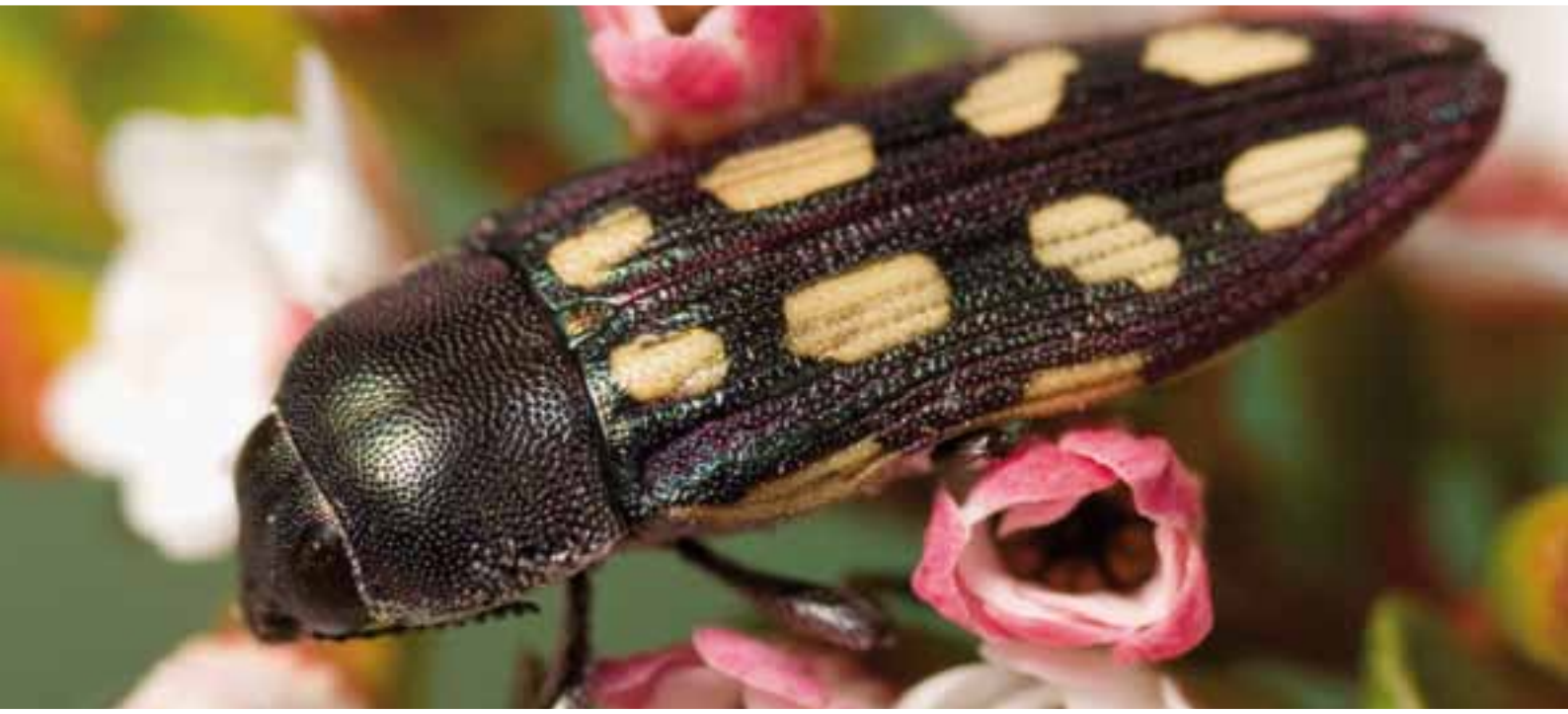

Cover photo: Jewel beetle (Coleoptera: Buprestidae) on flowers of *Thryptomene calycina.*

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