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Facilitating IPM adoption in vegetable crops through regional extension programs

Tony Burfield
SA Research &
Development Institute

Project Number: VG02040

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Facilitating IPM Adoption in Vegetable Crops Through Regional Extension Programs

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VG 02040

Tony Burfield

South Australian Research and Development Institute

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ABBREVIATIONS

IPM: Integrated Pest Management
PAL: Participatory Action Learning
SARDI: South Australian Research and Development Institute
PIRSA: Primary Industries and Resources South Australia
VHC: Virginia Horticulture Centre
GMP: Greenhouse Modernisation Project
TAFE: Technical and Further Education
WFTSC: Western Flower Thrips Steering Committee
WFT: Western Flower Thrips
TSWV: Tomato Spotted Wilt Virus
TSM: Two Spotted Mite
BC: Biological Control
QA: Quality Assurance
IDO: Industry Development Officer

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- WFT steering committee (WFTSC) members for advice and support with industry strategies
- The nine local growers making their farms and personal expertise available for IPM farm trials (?) list
- Local businesses assisting with information dissemination and grower recruitment:
  DiManno Seeds and Chemicals
  P and P Agricultural Supplies
  Elders Limited
  Stoeff Greenhouse supplies
  Virginia Irrigation
- Local businesses and government agencies assisting with extension planning and review
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MEDIA SUMMARY

Australian vegetable growers are hard pressed to attain cost-effective control of key pests, especially Western Flower Thrips (WFT) and whitefly (Greenhouse and Silverleaf).

The successful WFT Management extension pilot (2000-2002) at Virginia demonstrated the value of taking Integrated Pest Management (IPM) expertise to growers through local extension programs. This positive outcome led to further funding of IPM extension work in the same vegetable crops in 2002-2005. The new project set out to develop management tools and strategies and demonstrate their use for the full range of key pests, especially in greenhouse crops, and to promote IPM adoption at an industry/regional level. This was done by developing tools and information through on-farm trials; extending the new information to the wider industry; and forming partnerships that could support IPM adoption at a regional level.

An independent evaluation and feedback from growers and industry services shows that the project had a very positive impact. The farm trials proved very successful at improving pest management outcomes and promoting investment in new farm technology with major reductions in chemical usage in most cases. Wider extension of the new resources is reaching many more growers. At the regional level good work has been done on a weed control strategy and promoting improved farm hygiene. The project has also collaborated with the Revegetation by Design research project that aims to reduce pest levels by planting selected native vegetation species that also support beneficial insects. Key industry services have used IPM tools and information from the project and are keen to continue supporting the adoption process.

To promote widespread commercially sustained IPM adoption by the greenhouse industry and technical consultants there should be a series of advanced IPM trials, linked to training for growers and consultants, in commercial hi-tech greenhouses. This should be done in conjunction with an expanded range of biological agents and protocols and permits for compatible soft chemistry. Particular attention should be paid to greenhouse designs that can achieve maximum pest exclusion while maintaining good climate control. Similar trials should be conducted in field crops to clarify the potential role and conservation of wild beneficial insect populations. Further co-ordinated support should also be given to help industry services to routinely promote relevant IPM information in their service delivery roles.

TECHNICAL SUMMARY

Australian vegetable growers are frequently hard pressed to achieve cost-effective control of key pests, especially Western Flower Thrips (WFT) and whitefly (Greenhouse and Silverleaf). Resistance management is an ongoing battle with these and other pests with the constant threat of expanded resistance to chemical groups and incursions of new pests. The challenge of controlling Western Flower Thrips has been a catalyst for IPM research and extension leading to a significant shift in attitudes and practices amongst many growers. However the widespread adoption of sustainable IPM systems requires farm strategies that can integrate the management of all key pests and diseases. The success of the WFT Management extension pilot (2000-2002) at Virginia demonstrated the value of taking Integrated Pest Management (IPM) expertise to growers through local extension programs. This positive outcome led to further funding in 2003-2005 to develop and test management tools and strategies for the overall suite of key pests, especially in greenhouse cropping systems, and to promote IPM adoption through regional strategies.

The project focused on 'IPM Adoption' as a graduated shift away from insecticide reliance by showing how to maximise the use of non-chemical pest control options. This process began with the WFT extension program in 2000-02 by improving existing insecticide based practices through introducing crop scouting, improving spray coverage and other spray technology factors and paying close attention to thorough crop hygiene. These basic changes made it more feasible to implement further non-chemical strategies including trials of beneficial insects as a major element of the pest control program.

A new series of farm trials on 9 farms targeted the key pests within improved chemical programs, and trials of more advanced technologies involving beneficial insects and improved greenhouse design. Target pests were WFT, Greenhouse whitefly, mites (two spotted mite and broad mite), fungus gnats and aphids. The trials were used to develop tools and information to help with pest management needs assessment, program planning and implementation. Consideration was also given to the impact of chemicals used for disease control and how greenhouse design to exclude pests could aggravate disease management by restricting ventilation. The resources and case histories generated were then published in industry publications and at meetings and used in brief IPM workshops.

Adoption of IPM technologies and practices was also promoted at an industry/regional level through working partnerships with commercial operators, local government and state government agencies. Their support was obtained for overall program design and evaluation, developing a regional weed control program and enabling broader IPM information output.

An independent evaluation showed that the project had a very positive impact. The farm trials proved very successful at improving pest management outcomes and promoting investment in new farm technology with major reductions in chemical usage in most cases. Wider extension of the new resources is having a significant impact on the practices of many more growers.

Combining scouting for the complete pest range with life cycle information and thrips ID enabled targeted spray decisions that gave improved control of WFT, greenhouse whitefly and other pests with decreased chemical usage. Western Flower Thrips control in cucumbers was sometimes difficult. Trials using beneficial insects (encarsia for whitefly and montdorensis for WFT) were not clearly effective and require further work, preferably in more modern greenhouse systems. However the improvements to greenhouse design, crop scouting and restrained chemical use motivated by using beneficial insects have helped to reduce pest pressure and chemical use significantly and growers remain very motivated about this technology.

At the regional level good work has been done on a weed control strategy. The project has also collaborated with the Revegetation by Design research project that aims to reduce pest levels by planting selected native vegetation species that also support beneficial insects. Key industry services have used IPM tools and information from the project and are keen to continue supporting the adoption process.

To promote widespread commercially sustained IPM adoption by the greenhouse industry and technical consultants there should be a series of advanced IPM trials in modern greenhouses. This should be done in conjunction with an expanded range of biological agents and protocols and permits for compatible soft chemistry. Particular attention should be paid to greenhouse designs that can achieve maximum pest exclusion while

maintaining good climate control. The conduct and outcomes of these trials should be linked to training for growers and consultants.

Similar trials should be conducted in field crops to clarify the potential role and conservation of wild beneficial insect populations.

Further co-ordinated support is recommended for a further two to three years so that industry service groups reach a level where they can routinely promote relevant IPM practices and information in their service delivery roles.

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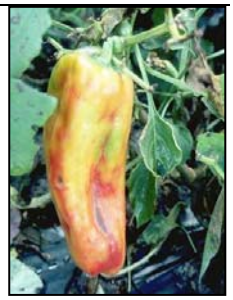
1. PROJECT BACKGROUND



1.1 The need for IPM

Western Flower Thrips (WFT) inflicts serious direct (feeding) damage to a wide range of vegetable crops. It is also an important vector of tomato spotted wilt virus (TSWV) and has a history of developing resistance to insecticides, especially when their application is not well managed. The arrival of this difficult pest in Australia in 1993 highlighted the need to change pest management practices on vegetable farms across the country. As a result WFT has become a catalyst for extension of Integrated Pest Management (IPM) across Australia because of its ongoing major economic impact.

In 1993 The Horticulture Research and Development Corporation (now Horticulture Australia Limited or HAL) began funding research and extension to support a national approach to the problem of WFT Management. A National WFT Management extension package was developed and in November 2000 a pilot program (VG00085) was implemented to trial this package in the Virginia area in South Australia. This project ran through to June 2002 and was very successful at assisting Vietnamese and other greenhouse growers to begin improving key aspects of their pest program including resistance management, spray coverage, farm hygiene and review of greenhouse design and operation.

The success of this project led to a further three year's funding for the current project to do the following:

- Expand IPM resources and strategies by building on the WFT pilot project (VG 00085), i.e. develop extension information, resources and strategies for management of other key pests in vegetable crops (capsicum, cucumber, lettuce and bunch lines)
- Develop regional strategies to support IPM adoption through strengthening the capacity of the region's key stakeholders to support IPM adoption

1.2 Defining the term IPM

Pest control practices in the vegetable industry have been dominated by the routine use of broad-spectrum insecticides to control pests. Often, especially amongst migrant grower groups, there is a poor understanding of effective and efficient chemical use and little adoption of non-chemical pest control strategies. There is a high risk of insecticide failure in this approach to pest control, usually due to insecticide resistance, or possibly other errors in spray technology. The term 'Integrated Pest Management' (IPM) is applied to pest management programs that greatly reduce the use of insecticides by maximising the use of non-chemical pest control strategies including crop scouting, farm hygiene, crop planning, greenhouse design, beneficial insects and 'soft' chemicals to keep pests at acceptable levels. In this project the term 'IPM Adoption' has been used more loosely to describe a program of progressive change away from almost total reliance on the use of insecticides. This began with efforts to improve existing insecticide practices by introducing crop scouting and improving spray coverage and other spray technology factors. There were tangible benefits arising from these changes making it possible to progressively implement non-chemical strategies beginning with the less technically and financially demanding changes. In some farming systems it then became possible to progress to using beneficial insects as a major element of the pest control program.

1.3 Industry characteristics presenting a challenge to IPM adoption

This project has been run in an area where the industry is characterised by the following features:

- There are significant learning barriers with some growers because of low formal education levels and language differences.
- The presence of ethnic sub-groups and individualistic approaches to business operations works against co-operation between growers.
- There is an historical culture of almost total reliance on conventional chemical based practices.
- There is limited use of consultants by growers for advice on crop protection and business and market planning.
- Growers focus on maximising production output rather than market strategy which results in them being price takers rather than price setters.
- National oversupply of a few key commodities on which the industry is based leading to opportunistic competition between states
- Fragmentation of external and internal strategies and resources for industry development
- Persistence of informal negative beliefs held inside and outside the industry re the value/prospects of aspiring for significant change in industry practices and structure
- Difficulties in accessing capital to modernise farm technology and business strategies

2. TECHNOLOGY TRANSFER STRATEGY

2.1 Strategy outline

The pilot program (VG 00085) established the value of Participatory Action Learning (PAL) as a very effective communication process that could be used to develop, test and apply tools and messages to support IPM adoption. PAL enables closer and more open-ended interaction between all participants leading to more relevant content, more effective demonstration of adoption outcomes and more robust partnership building. The key to this approach is involving the target group members in an ongoing two-way learning exchange rather than top down delivery of content developed prior to, or largely without, their input. This results in a reduced level of structured control over activities and timelines while increasing the ownership and value of learning outcomes for all participants, including the extension team and their wider support network.

PAL was used to engage stakeholders as two complementary groups that together could support the range of extension needs. These groups and their involvement are described below.

Group 1 - Growers as targets for IPM adoption:
Intensive involvement with a limited number of growers was the basis to developing/improving extension tools and messages through trialing new pest management practices on-farm followed by wider extension activities based on trial outcomes. The majority of these were Vietnamese greenhouse producers who were a high priority target group with significant skill needs and language barriers. Most field growers are third generation migrants with more developed farming and business management skills. Their main participation was in supporting the regional 'Clean-up' initiatives along with the non-grower stakeholders in Group 2.

Group 2 - Regional stakeholders for building whole of industry co-operation on key priorities:
Apart from the grower steering committee, the target participants were non-growers, i.e. industry service providers as follows:

- retailers of consumable farming products and materials
- specialist service providers: horticulture consultants, Q.A. compliance services, biological pest control products
- training providers: Chemcert and Q.A. accreditation , Virginia Horticulture Centre, Torrens Valley TAFE, Roseworthy TAFE
- local and State government program areas (City of Playford, Barossa Catchment Water Board)
- PIRSA Animal and Plant Control team

These businesses and agencies were approached to assist with identifying weaknesses and gaps in farm practices and regional issues and co-operated on driving adoption outcomes via their operational roles and expertise. This included, providing information, resources and technical support for demonstrations and trials of pest management practices, supporting extension output to industry and strategic planning for regional land use changes (weed control).

A highly individualized approach to most stakeholders was necessary because of the widely differing nature of their core business and initial lack of any working relationship to each other. Apart from the pre-existing Industry Steering Committee contact with these stakeholders was established or extended through selective targeting (retailers and some industry services). Others emerged in various ways as we progressed in identifying and responding to industry issues like chemical residue problems, permit approvals or promoting the use of non-chemical management strategies.

Key elements of the partnership building strategy were as follows:

- Recruiting stakeholder interest via direct approaches to relevant contacts and following up requests for information arising from project publications and word of mouth contacts
- Engaging in further discussions with new contacts to identify IPM needs/opportunities that they are aware of/engaged with already
- Using this 'recruitment' process to gather their support for assisting in communication of IPM information to target audiences
- Introducing expert scientific and technical input to relevant meetings

As key relationships were established they were maintained and developed further by:

- Offering support to develop strategies that enhance their operational capacity related to IPM needs
- Keeping the information loop alive through visits, phone calls, printed updates and meetings focusing on progress with farm trials and industry adoption
- Cultivating the scope and depth of partnerships and resources to address IPM needs

2.2 Aims

The project aimed to:

1. Work closely with industry to expand IPM resources and strategies beyond WFT to multiple pest issues (2.4)
2. Test these IPM resources and strategies through wider industry extension (2.5)
3. Develop regional strategies and partnerships to support IPM adoption (2.6)

2.3 Evaluation

Three separate evaluations were conducted; one against each of the project's three aims. An independent evaluation was also commissioned and a summary of that report is presented in Section 4.1.

2.4 Working closely with industry to expand IPM resources and strategies

Targeting Western Flower Thrips as a major economic pest in the previous pilot program had established a strong foundation for engaging the industry on pest management issues. Growers now wanted us to address their need to integrate management of this pest with other key pests and bring the wider industry, including non-growers, together to improve regional outcomes. This required further attention to crop scouting, insect identification, chemical use skills and options, greenhouse design and the potential role of beneficial insects.

This developed through a process of detailing their specific needs and then trialling and demonstrating relevant pest management methods and results. Some wider extension was then conducted with support form the Virginia Horticulture Centre, (VHC), especially through IPM modules in Freshcare workshops and Greenhouse Modernisation Project (GMP) information sessions. The other major focus of attention was developing communication and co-operation pathways with technical experts and various strategic partners for driving sustainable change in a whole of industry sense. Grower and non-grower input was drawn into a range of overlapping activities to identify needs and develop resources and strategies to enhance IPM adoption.

2.4.1 Development of IPM resources and strategies from farm trials

We obtained support for pest management trials from 10 greenhouse growers (mostly Vietnamese) who were willing to participate in IPM property assessments, workshops and various farm trials matching their needs and greenhouse systems. They were mostly producers of levied crops, i.e. capsicums and cucumbers. Most of these growers were engaged in one or all of the following core activities:

- Recruitment into consultation on multiple pest issues (many from the previous program VG 00085)
- Selection and engagement of farms for ongoing supported pest management trials to develop and test strategies to inform wider extension activities
- Participation in intensive greenhouse skills program via Virginia Horticulture to support farm trials and deliver training and trial outcomes to a wider grower group
- Participation in the 2003 Greenhouse Hydroponic Conference in Melbourne
- Formation of a grower group looking at incorporating IPM into overall farm modernisation and business needs as part of a wider VHC program

Changes in Pest Management technology were approached on two levels, i.e.:

- Consolidation/refinement of spray programs and basic non-chemical practices (esp. farm hygiene) involving all 9 growers. This extension activity focused on expanding management skills and knowledge that these growers had already begun to put into practice in the first project. The required information and demonstration activities at this level were seen to be easier to deliver and adoption of these practices less constrained by time and cost issues because the changes are more easily described and cheaper and easier to implement.

- More advanced pest management strategies involving trials of improved greenhouses (5 growers), with 2 of these trialing beneficial insects. Adoption of these practices has been restrained by perceived time and cost issues, a low level of uptake of commercial consultant services and limited access to capital to modernise farm technology. These areas required a higher level of expert support to design, implement, evaluate and communicate demonstrations of effective practice.

IPM tools and information developed through farm trials was then more widely extended through:

- presenting IPM modules within Freshcare training programs
- output of articles in industry publications (Grower, Good Fruit and Vegetables), occasional newsletters and mail-outs *(see ATTACHMENT 1 for list of published extension and a couple of examples)*
- trouble shooting of broad mite issues with Cambodian growers
- a stand alone greenhouse spray demonstration
- various grower seminars and meetings
- information output via a widely used Q.A. service provider who also referred several growers to us with MRL issues

The table below summarises the main activities undertaken to identify IPM needs and develop resources to support extension, in relation to the two stakeholder groups. These activities were developed in response to input at consultation meetings by (mostly) Vietnamese growers on their pest management issues and their desire for 'hands-on' demonstration in their technology systems.

ACTIVITIES CONDUCTED	GROWER ROLE	NON-GROWER SUPPORT
Survey of key pests via consultation meetings and 1:1 interviews	Providing information on significant pests in their crops (WFT, Greenhouse whitefly, two spotted mites, fungus gnats, aphids, various chewing grubs)	Clarification/confirmation of specific pests where grower interpretations unclear
Consultation on chemical needs and issues: • Assessing and addressing factors that may compromise chemical efficacy apart from resistance • Collation of information re chemical needs and permits gaps • Advocating for chemical use exemptions under new SA legislation	Nominating desired chemicals, and providing information on their effectiveness	Detailed technical information including, permit status, chemical efficacy factors and resistance risks

Greenhouse trials to monitor performance of specific practices for controlling multiple pests	1) Participating in crop trials to gauge effectiveness of scouting based decision making, specific chemicals and chemical application practices, 2) Participating in crop trials to compare effectiveness of pest control in 3 different types of greenhouses 3) Participating in crop trials to gauge effectiveness of greenhouse conditions and biological control	1) & 2) Monitoring of pest levels and control outcomes from spray applications Insect and disease diagnostics (paid) 3) Advice re variations in greenhouse design and biological control trials and supply of organisms
Spray coverage assessment for capsicum growers who thought they had resistance problems with WFT, incl. Spinosad.	Supply of test crop, equipment and venue	Conducting spray coverage trials
Resistance testing for lettuce and capsicum growers with suspected WFT resistance problems including Spinosad.	Supply of samples from capsicums, lettuce and egg plant crops	Technical support for collection and transport of samples Resistance assays
Development and translation of resources for intensive trials and support	Prioritising of resources for translation (Vietnamese)	Assistance with creation of resources and translation (paid)
Gathering height and number data on flying pests in late spring (thrips and whitefly)	Providing sites for data collection outside of greenhouses	Designing and installing data collection method and diagnosing sticky trap results

2.4.2 Evaluation of impact of new farm IPM resources and strategies

A survey of greenhouse growers involved in farm trials and those receiving intensive support was conducted to determine impact of the trials and associated technical support on pest management practices and outcomes.

The survey was used to provide information about adoption levels and grower perceptions in 4 key management areas as well as some overall comment on the benefits of IPM adoption. This has enabled a review of what was achieved by the program through identifying changes in grower perceptions, behaviours and future intentions.

The survey was conducted using face-to-face interviews on four key IPM management topics. A total of 9 growers were asked 5 questions about 17 IPM sub-topics that were grouped in four management categories as follows:

1. Ways of reducing pest and disease pressure on crops (4 sub-topics)
2. Use of crop monitoring information to make crop treatment decisions (4 sub-topics)
3. Improving Effectiveness of Chemical Applications (5 sub-topics)
4. Using Biological Control Agents (4 sub-topics)

The following questions were asked about each of the 17 IPM sub-topics:

Q 1.: Have you taken a fresh look at these I.P.M. practices since 2000 ? _____YES/NO
Q 2.: What changes (if any) have you made in this area ? _____COMMENT
Q 3.: If so what main source(s) of information did you use ? _____COMMENT
Q 4.: Have any changes made been helpful ? _____YES/NO
Q 5.: Do you want to make further changes in these areas ? _____YES/NO

A further overall series of questions (Q6a-d) sought more detail about the benefits of any changes in pest management. The questions used where as follows:

a) Have you been able to improve control of WFT and TSWV in your crops ? YES / NO
b) Have you been able to improve control of other pests like whitefly ? YES / NO
c) Have these changes resulted in a clear economic benefit to your bottom line YES / NO
d) Have you been able to reduce your use of insecticides without suffering an increase in crop damage from pests YES / NO

The survey results of the management area 1., "The ways of reducing pest and disease pressure on crops", are shown in the table below.

	Adoption rating of responses								
	Q1.1 Practice reviewed			Q1.4 Value of any changes			Q1.5 Seeking further improvement		
IPM Sub topics	***Yes***	***No***	***Null***	***Yes***	***No***	***Null***	***Yes***	***No***	***Null***
• Controlling broadleaf weeds	8		1	6		3	5	1	3
• Improving crop hygiene practices (seedlings, old crops & sick plants)	9			6	2	1	7		2
• Improving greenhouse design/operation to exclude pests	8	1		7		2	5		4
• Crop planning to avoid damage/infestation of young plants	6	3		2		7	4	1	4
TOTALS	**31**	**4**	**1**	**21**	**2**	**13**	**21**	**2**	**13**

The overall YES scores were high for all four sub-topics. Lower YES scores were generally related to higher NULL scores. The NULL responses were significant for questions 1.4 and 1.5. The value of making changes (Question 1.4.) in this area of IPM can be hard to measure leaving some growers cautious about claiming a clear benefit and thus giving a higher NULL score. The NULL responses in question 1.5 were mostly due to growers feeling that they have gone as far as they can at their current investment level.

The qualitative responses to Questions 2 give a more detailed understanding of the changes that have, or have not occurred. This input is summarised below:

- All of these farms now maintain a high standard of weed control and much improved crop hygiene practices for seedlings, TSWV infected plants and old crops. Most growers now provide increased protection for young plants, especially at times of higher risk for attack by WFT. They are cleaning up old crops and weeds well in advance of planting and monitoring young plants closely. Generally 2-3 sprays of a broad-spectrum insecticide are used to 'clean up' seedling plantings, followed by close monitoring. About half are confident enough to with hold any treatment until needed. The increase in IPM awareness and pest management standards has made growers keen to have a closer working relationship with nurseries to ensure they are consistently adopting seedling care practices to reduce pest and virus threats and limit resistance risks. Some growers say they are raising their cucumbers from seed so that they can be certain of the entire history of their plants. Capsicum growers hold similar concerns.

- Major changes to crop planning were considered impractical by most growers who felt that the market was the biggest determinant of planting time hence few attempted changes during the time frame of the

project. Increasing fallow intercrop spaces and time periods is still not seen as economical and changing to new crops not affected by TSWV is seen as too much of a gamble. Almost half indicated they might consider making changes in the future if the economics could be more clearly substantiated.

- All of these farms have looked at their greenhouse design and operation, making changes to their structures and fine-tuning ventilation practices on 'high risk' days to limit thrips invasion. Six growers have made major improvements in terms of height, fine mesh, and other features. Three growers have installed double entry doors and the rest say they intend to. The re-investment process is still incomplete, especially for heating, automated climate control and hydro systems.

The survey results of the management area 2., "Use of crop monitoring information", are shown in the table below.

	Adoption rating of responses								
	Q2.1 Practice reviewed			Q2.4 Value of any changes			Q2.5 Seeking further improvement		
IPM Sub topics	***Yes***	***No***	***Null***	***Yes***	***No***	***Null***	***Yes***	***No***	***Null***
• Seeking more info. on insects & scouting	9			8		1	7		2
• Implementing crop scouting program	9			8		1	4		5
• Keeping monitoring records	7	2		3		6	1	4	4
• Basing crop treatment decisions on scouting info.	8		1	8		1	6		3
TOTALS	**33**	**2**	**1**	**27**	**0**	**9**	**18**	**4**	**14**

Most growers have made changes and identified benefits from those changes in this management area. The lower YES and higher NULL scores in Q1.5 are largely due to grower satisfaction with their newly improved scouting and crop treatment practices – i.e. no need for further changes unless they want to use biological control agents. All growers thoroughly reconsidered their management practices in these areas, but most did not establish a pest monitoring record system. All gave a high score to basing their treatment decisions on their 'before and after' scouting results and displayed a good knowledge of scouting practices.

Comments and discussion around Question 2 revealed the following information:

- Workload is a big factor limiting record keeping for small owner operators. They have however become very good at monitoring day to day pest levels and assessing treatment outcomes now that they understand what they are looking for in pest activity and how to respond to changes and assess outcomes. More growers are 'spot treating' as a result of better scouting information and all are making more precise assessments of their chemical strategy. Spray use has reduced by at least 50% and in some cases by 75%.

Note: All of these growers have Quality Assurance or are undertaking training and need to maintain a spray diary. They will be encouraged to incorporate some basic pest data with each treatment entry, i.e. target pest and results achieved. The lack of crop health related record keeping presents an issue for any growers wanting to use biological control agents. This is likely to become another catalyst for change in the future as many are keen to implement this technology.

The survey results of the management area 3., "Improving Effectiveness of Chemical Applications", are shown in the table below.

IPM Sub topics	Adoption rating of responses								
	Q3.1 Practice reviewed			Q3.4 Value of any changes			Q3.5 Seeking further improvement		
	Yes	***No***	***Null***	***Yes***	***No***	***Null***	***Yes***	***No***	***Null***
• Practicing resistance management by chemical rotation	8		1	9			3	1	5
• Checking results/efficacy of chemical applications	9			9			2	1	6
• Ensuring good spray coverage	9			8	1		4	1	4
• Knowledge of the differing properties of chemicals to ensure efficacy	9			7	1	1	6		3
• Checking and maintaining quality of tank mixes	5	1	3	4	2	3	3	1	5
TOTALS	**40**	**1**	**4**	**37**	**4**	**4**	**18**	**4**	**23**

Tank mixing practice was the only low scoring sub-topic in this area. This is because most growers in this survey found no need for change when they evaluated their water quality and tank mixing practices.

All growers have upgraded their resistance management and identified this as important. Similar results were obtained for ensuring good spray coverage and improving knowledge of product characteristics affecting insecticide efficacy.

Comments in response to Question 2:

- Growers believe that the large reductions have been achieved in reliance of insecticides are due to both improved crop scouting and to improvements in technical aspects of chemical use.
- Leading growers are increasingly preferring a limited range of 'soft' pest treatments. When discussing this with them a strong demand was identified for detailed trials of products such as Success, Applaud, Confidor, Eco-oil and Insecticidal soaps in a range of different spray application technologies (misters, foggers, booms, hand sprayers and fan assisted technology such as that designed for vine crops). This would yield an evaluation of the efficacy of these chemicals and application technologies in terms of coverage differences and residue and pest control outcomes. If transferred to registrations and permits such information would have very high uptake with many growers and is likely to enable them to safely reduce their chemical use further, reduce the risk of resistance to these new chemicals and enhance prospects for biological control (BC).

The survey results of the management area 4., "Using Biological Control Agents", are shown in the table below.

IPM Sub topics	Adoption rating of responses								
	Q4.1 Practice reviewed			Q4.4 Value of any changes			Q4.5 Seeking further improvement		
	Yes	***No***	***Null***	***Yes***	***No***	***Null***	***Yes***	***No***	***Null***
• Investigation of the pros and cons of using beneficial insects	9			2	1	6	5		4
• Knowledge of the suitability of farm conditions to sustain beneficial insects	7	2		3		6	3		6
• Knowledge of specific beneficials to control key pests	6	3		2		7	2		7
• Accessing technical support for using biological control agents	5	2	2	3		6	3		6
TOTALS	**27**	**7**	**2**	**10**	**1**	**25**	**13**	**0**	**23**

YES scores decreased as growers moved from taking a general look at using to BC to evaluating specific information about implementing BC suited to their needs and farm infrastructure.

These lower scores reflect two issues:
1) there is not yet a proven BC agent for WFT in greenhouses under NAP conditions (summer heat & winter cold)
2) most growers do not yet have adequate climate control systems for summer heat and winter cold to maintain stable populations of pests and predators.

All growers have looked more closely at using biological control agents, with five undergoing formal and informal trials with a range of beneficial organisms (montdorensis mites for WFT, aquatic nematodes for fungus gnats, hypoaspis mites for WFT and fungus gnats, encarsia for whitefly, persimilis mites for spider mites, diadegma wasps for diamond backed moth).

Our farm trial results indicate that it may be possible to combine soft chemical control of WFT early in crop life with BC strategies for pests other than WFT in greenhouses that have good pest exclusion. Two growers who have Azrom greenhouses that assist with WFT exclusion are persisting with biological control (BC) as supplements to a soft chemical program.

Question 3 – management areas 1-4:

Apart from SARDI input growers from the trial farms were using a range other information sources. The information sources nominated by growers are listed below in order depending on the number of growers identifying that particular source:

- Their own experience and experimentation – 8 growers
- Consultants (Domenic Cavallaro, Greg Perendergast, James Altmann) - 7 growers
- Books, publications and product information – 6 growers
- PIRSA rural extension staff – 3 growers
- Wider Grower community – 3 growers
- Retailers – 2 growers
- Greenhouse supplier – 2 growers
- Staff – 2 growers

The first three points show that these growers were self-motivated, accessing (free) consultant information (which was made available to them through the farm trials and the greenhouse skills adoption training program), and absorbing a range of other published information.

Benefits of making changes:

The results of an overall question (Q 6 a-d) are shown in the table below.

QUESTION:	YES	NO	N/A
Have you been able to improve control of WFT & TSWV in your crops	8		1
Have you been able to improve control of other pests like whitefly	8	1	
Have these changes resulted in a clear economic benefit to your bottom line ?	7	2	
Have you been able to reduce your use of insecticides without increased crop damage	9		

These results identify an overall major benefit from the implementation of improved pest management practices that were made available through the Multiple Pest IPM extension program. Ongoing adoption and continuous improvement of IPM systems will require further support, especially for the optimal use of soft chemicals and implementation of BC agents. Greenhouse growers will also need assistance to prioritise IPM focused greenhouse improvements and to develop business plans to help them access the capital required to upgrade their greenhouses.

2.5 Conduct wider extension of farm IPM resources and strategies

2.5.1 Extension activities

IPM extension activities were undertaken as a response to industry input through greenhouse grower consultation meetings, 1:1 discussions with growers in farm trials and industry service providers. This input resulted in the following extension activities:

- An advanced greenhouse skills training program was delivered through the VHC as a 'Greenhouse Skills Adoption' package accessed by 12 Vietnamese growers, many of whom participated in the farm trials.
- Additional pest management posters to do with spray application and resistance management, crop scouting, greenhouse design and area hygiene were displayed at chemical resellers
- IPM information packs and talks were organised as part of two GMP open days.
- Various articles covering issues, activities and progress in industry publications (The Grower, Good Fruit and Vegetables, a Vietnamese reseller newsletter and the VHC newsletters)
- Six Cambodian capsicum growers were assisted with a short term crisis with a new pest problem (broad mite) in spring 2003 which was dealt with on-farm and successful results reported in the VHC newsletter.
- Freshcare workshops were put in place to meet new Q.A. compliance standards set by Woolworths and provided an ideal opportunity to summarise key IPM information and results that had been demonstrated at Virginia. Over 70 growers passed through these workshops where key information on chemical and non-chemical strategies for WFT and greenhouse whitefly was presented.
- Industry representation formed the basis of a successful initiative to obtain conditional exemptions from new state government chemical use legislation based on a chemical needs review, Q.A. compliance and MRL testing protocols.

These activities formed the background for evaluating the industry's response to IPM extension.

2.5.2 Evaluation of wider extension using new farm IPM resources and strategies

A survey of greenhouse (and some field) growers was conducted to determine the impact of broader extension efforts on the industry. The surveys gathered responses from growers not involved in intensive trials to assess the impact of extension activities on their awareness, practices and perceived benefits. They were also asked about barriers preventing change and further assistance required to manage their pests.

Information was received from 20 growers; ten responses came from face to face or phone contact with Vietnamese growers who had attended the WFT workshops in the previous project (VG00085) and ten responses came from a mail-out to 200 European growers.

Six main survey questions were put to the growers:

1. Are you aware of the Western Flower Thrips management / Integrated Pest Management extension program conducted by SARDI and the Virginia Horticulture Centre since November 2000 ? (YES/NO)
2. If YES how has this happened ? (check box list)
3. Since November 2000 have you been able to improve WFT/other pest control; reduce insecticide use; improve economic performance (4 YES/NO questions)
4. If YES to any of question 3) what changes to your pest management program were important ? (check box list)
5. If NO to all of question 3 why not ? (4 YES/NO questions)
6. Please make any comments you wish about further action needed to assist growers with their pest management.

The impact of specific resources and strategies is not rigorously separated out in the evaluation process. Rather the overall impact of the program was explored with room for respondents to make comment on specific positive and negative features.

The results of the survey were as follows:

1. Have you become aware of the WFT/pest management extension program ?	EURO MAIL	VIET PHONE	TOTAL
Total against maximum possible score	9/10	10/10	19/20

The awareness of the extension program was high for European and Vietnamese growers.

2. If YES how:	EURO MAIL	VIET PHONE	TOTAL
WFT posters	2	10	12
Attending WFT workshop	4	10	14
Pest management meetings	5	10	15
Info at GMP	2	9	11
VHC newsletters/mailouts	7	4	11
Articles in hort publications	5	5	10
Local newspapers	0	5	5
Word of mouth – growers	5	10	15
Word of mouth – VHC staff	2	9	11
Word of mouth – Cem. stores/other retailers	1	8	9
Word of mouth –consultants/industry services	3	0	3
Other	1	1	2
Totals against maximum possible score	37/120	81/120	118/240

The substantial scores for indirect information uptake for VHC newsletters, horticulture articles in both groups and the Greenhouse Modernisation Project for Vietnamese growers indicate that these avenues are capable of having a significant extension impact.

It is difficult to link this information uptake directly to the changes in pest management below, as changes in management practice have been based on information uptake from a range of sources over time. However it is clear in answers to question 2. and 4. that the Vietnamese growers who had all attended training workshops have accessed information at more points and made more changes than the European growers of which only 4 had attended workshops. This may also reflect a greater need for learning and change amongst the Vietnamese growers.

The use of consultants has traditionally been restricted to European field growers, but the Vietnamese growers receiving intensive extension support are keen to arrange affordable technical services.

3. Since Nov 2000 were you…	EURO MAIL	VIET PHONE	TOTAL
Able to improve control of WFT & TSWV	8	9	17
Able to improve control of other pests like whitefly	8	9	17
Able to reduce insecticides w/out an increase in pest damage	8	9	17
Able to see clear economic benefit due to changes	9	9	18
Totals against maximum possible score	31/40	36/40	69/80

The responses for achieving positive change are very strong for both groups. It is likely that the Vietnamese growers would not have been able to match results achieved by English speaking growers without the extension program. Most European growers have a long history of horticultural practice and are not disadvantaged by language/cultural barriers.

4. If YES what changes were important ?	EURO MAIL	VIET PHONE	TOTAL
Improving weed control	*9*	10	19
Improving GH design to exclude flying pests	1	10	11
Learning to identify pests more accurately	5	9	14
Setting up weekly scouting program	6	6	12
Crop decisions based on scouting information	5	6	11
Keeping records to asses effectiveness o f control methods	3	8	11
Rotating chemical groups	9	9	18
Ensuring good spray coverage	5	10	15
Care of tank mixes	4	5	9
Compiling chemical information details	4	2	6
Investigating pros and cons of using beneficials	4	0	4
Other	1	0	1
Totals against maximum possible score	56/120	75/120	131/240

Vietnamese growers made more changes that they considered important than the European growers but there is no real baseline in this information to the pre-existing standards of practice amongst the European growers. General experience with field growers over 4 years indicates strongly that they are beginning from a much higher technical base. The two biggest pest management issues they perceive are control of broadleaf weeds and pesticide resistance. This is reflected in the high scoring by European growers for changes to these management practices.

Question 5 was not relevant as no growers responded to this question.

6. Additional comments made about assistance with pest management	EURO MAIL	VIET PHONE	TOTAL
Totals against maximum possible score	6/10	5/10	11/20

About half of each group had additional comments to make. These fell into two main groups:

1) Field growers emphasised the need to further improve weed control
2) Vietnamese greenhouse growers emphasised the need for further pest management/crop health training with on-farm follow-up

2.6 Develop regional strategies and partnerships to support IPM adoption

2.6.1 Regional IPM adoption building activities

Two main goals were pursued to develop regional capacity for IPM adoption; firstly by lifting whole of industry co-operation and secondly by improving regional hygiene. This was achieved by building co-operation with industry stakeholders on all aspects of IPM, developing a strategic plan to control weeds and old crops and promoting these initiatives through industry publications (e.g. Good Fruit and Vegetables, The Grower, National WFT Newsletter).

The activities conducted and the role played by grower and non-grower stakeholders is summarised in the table below.

ACTIVITIES CONDUCTED	GROWER ROLE	NON-GROWER SUPPORT
Promoting grower co-operation on crop protection technologies and strategies	Vietnamese grower group attended national greenhouse study tour and greenhouse hydro conference Vietnamese greenhouse grower group formed to identify needs and agree on initiatives re crop health and related technical needs Lettuce grower group formed to address lettuce aphid issues Field and greenhouse grower put to regional clean-up campaignin	Support to identify needs and deliver required information/action Encouraging grower co-operation on crop health and business management Co-ordination of study tour and conference attendance
Responding to regional/newly emerging issues: • Apparent WFT resistance to Spinosad and TSM to Vertimec • Lettuce aphid threat • Regional clean-up campaign	Providing input on issues and needs Working together at meetings to identify needs and agree on strategies	Monitoring issues and developing technical analysis of problems/threats and designing responses Support to identify needs and deliver required information/action
Strategic planning and action at regional level – clean-up campaign 	Development of a strategic plan to Clean-Up the region for the Western Flower Thrips Steering Committee	Strategic planning and inclusion of key stakeholders Updating information re regional – clean-up and pests and beneficials on vegetation Promotional output (caps, brochures, signs, venues and input to articles)

2.6.2 Evaluation of regional strategies to support IPM adoption

A survey of the industry sector providing support or services to growers (including local businesses, local government, private consultants, educational services, etc) was conducted to evaluate their understanding and practical support for IPM.

From 22 survey outputs by e-mail and face:face, 16 were completed with the following respondents:

1. Retailers of horticultural products – 3 chemical resellers and 3 seed merchants
2. Commercial industry service providers – a horticultural consultant, vegetation consultant, Q.A./residue tester service and Chemcert provider
3. Local and state government stakeholders – 1 involved in land management services through local government and 2 from PIRSA who provide 'biosecurity' expertise and strategic planning support
4. Providers of free/subsidised training and education – a private provider and representatives of 2 TAFE colleges

The program's impact on pest management practices was indicated through their stated degree of awareness and engagement in the extension program and their answers to a range of questions about the programs impact in terms of:

1. Awareness and degree of stakeholder engagement
2. How it has affected their core business
3. Perceived positive changes and gaps in key IPM technical areas
4. Feedback on perception of the suitability of extension materials and activities
5. Their perception of the IPM program's influence on industry practices and the need for further extension

A summary of the results from these surveys is presented below.

Summation of results of non-grower surveys

Survey results showed that the extension strategy has been very well received. We found very strong IPM-related awareness and engagement amongst stakeholders resulting in clear feedback about priorities, progress and further action. The release of the extension resource kit along with this survey has identified very strong interest in participating in a more advanced co-operative approach.

Effective partnerships were formed that have contributed to positive action in the following areas:

1. Regional clean-up and bio-security awareness raising. As a result there will be a major public launch of the Clean-Up campaign in August-September 2005 via the VHC.
2. Development of training, support, information and tools to address key technical needs including crop monitoring and sustainable chemical use
3. Grower co-operation through the WFTSC and the Virginia Fresh group
4. Upgrading of overall industry momentum toward more sustainable pest control practices including greenhouse modernisation and strengthened understanding and interest in the use of beneficial insects, closer co-operation between diverse businesses and services on chemical issues, permits and information, promotion of regional hygiene and of other non-chemical components of sustainable pest management practices.
5. Additional research in the form of the SARDI "Revegetation by Design" program

Survey respondents consistently emphasised the following things:

1. The strong foundation of basic trust, relevant resources and working partnerships established by the WFT extension program with growers and other stakeholders
2. A strong awareness of the impact of WFT on the industry and the support from the extension program for their active engagement with the associated pest management issues via their core business
3. Recognition that the program is very successful in developing an area-wide strategy for weed management (Mill Road demonstration, roadside mapping and the pending area wide promotional campaign)
4. Recognition that many individual growers have benefited from making major changes to their practices as a result of their farm-based involvement in extension, but for most although the 'talk' is often there the 'walk' is not
5. The imperative of not letting up on the long term task of securing sustained change in the industry at large, particularly in regard to farm hygiene and sustainable chemical use
6. Resellers focused on the importance of finding a way to increase their level of direct contact with individual growers to build trust and achieve a more effective transfer of advice and information
7. For all players there is a strong interest in working much more closely with the extension program and possibly with each other to promote and reinforce the core messages

3. INDEPENDENT EVALUATION OF THE PROJECT (VG 02040)

An independent evaluation of the whole project was contracted as per milestone 12. Three evaluation consultants were contacted and provided with a project background and milestone reports and asked to provide quote for the evaluation. Dr Jeff Coutts (Coutts J&R, PO. Box 2681, Toowoomba, QLD, 4350, (07) 4638 9119) was selected to conduct the evaluation. The full report (hard copies) are to be forwarded to HAL with this final report. The summary section of this evaluation is reproduced below.

3.1 Summary of independent evaluation conducted by Coutts J&R

The purpose of this report is to provide an external evaluation into the effectiveness and impact of the Vegetable IPM Project. As well as drawing from reports and evaluations, an independent survey of growers and industry service personnel was undertaken.

Overall
This evaluation has demonstrated that a critical mass of growers in the Virginia area have made significant inroads into using integrated pest management approaches to more effectively manage their farms. It has also shown that these growers consider these changes to have resulted in improved pest control, reduced chemical usage, increased productivity and increased profits.

Despite the progress and impact, there are still further gains needed to maintain the momentum. This includes further trials and demonstrations with those insects (perceived to be) difficult to manage with IPM approaches, further development and confidence building with biological control and continued education about cleaning up weeds. There is also further research, development and learning needed for the field crop situations.

The lessons learnt from this project have significant implications for other growers in the region as well in other regions across Australia. It is noted that resource materials have been made available to other states – which is commendable – but the process of working with the growers has also much to offer new and existing projects tackling IPM in horticultural crops generally.

There is good evidence that the project has been instrumental in strengthening the broader industry network in being able to better promote, provide advice and manage IPM within the vegetable industry in Virginia.

There were some areas that the industry service personnel indicated that they needed more knowledge about – or training in. These included the use of biological control, insect identification and crop scouting. There is scope to follow up on this need through the Virginia Horticultural Centre.

Context
The industry is facing increasing challenges with chemical resistance of insect pests and few effective chemicals being available for control – providing an impetus for growers to consider IPM as part of their management strategy. There are, however, a number of factors working against change including industry fragmentation across ethnic and industry sub-groups, learning barriers and historical dependence on chemicals and marketing issues.

Activities
All activities foreshadowed in the project proposal were undertaken in practice. These included workshops, on-farm trials, on-farm follow-up, and strong interaction with industry service personnel. Regular newsletters, fact sheets, posters and promotional campaigns provided a good range of extension materials and relevant information. Almost all grower and industry survey respondents had interacted with the project through multiple avenues.

People Involvement
The project has been successful in engaging growers and industry personnel in learning about and developing successful IPM strategies. There was a high level of awareness and interaction with the project by both grower and industry service personnel who responded to the survey. It is not clear how widespread the awareness/involvement is beyond this group – although the need to determine this is not great given that the project overtly dealt intensively with a smaller group during this phase. The promotional campaigns undertaken

and the use of posters and extension material in re-sellers shops should have ensured that the wider group of growers in the region were exposed to project outputs.

Reactions
There was a very positive reaction to the project and IPM by most grower and industry survey respondents and previous feedback from stakeholders. There was concern by some that the government wasn't doing enough in supporting areas (regulations, imports) to help vegetable producers.

Knowledge Attitude Skills & Aspirations
There was a good understanding of the broad elements of IPM as described by the project documents amongst grower and industry respondents. Industry service personnel showed a moderate to high level of understanding of the key elements of IPM management with further learning needed in the areas of biological control, pest identification and greenhouse design.

Practice Change
Grower respondents showed a high level of practice change with respect to the techniques being promoted in the IPM project. Examples provided in newsletters and fact sheets demonstrated specific examples of practice change and IPM management practice. There are areas such as the use of biological control and choosing crop varieties that have scope for further training for growers. This level of IPM management use was supported in previous surveys. It is not clear how widespread such practices are beyond the respondent group. Stakeholders have taken steps to increase their level of working with growers on these issues.

Broader Impact
There is good evidence that the IPM project has resulted in significant benefits for those involved and the broader industry/community in the Virginia region. Grower survey respondents reported decreased use of chemicals, reduced insect damage, increased productivity and cost savings. Such benefits were also reported from a 2004 survey of greenhouse growers. Half of the industry survey respondents also considered that there was a significant impact in the use and benefits of IPM – which reflected an earlier survey of stakeholders – although it was noted there are many growers that yet need to 'walk the talk'. There is also some evidence of increased community networks and industry capacity in working on IPM usage.

Role of IPM Project in bringing about change
Almost all survey respondents attributed the increase in the awareness and practice of IPM on farms in Virginia to the IPM project at some level – with training in chemical usage, insect identification and chemical resistance playing an important part. The Virginia Horticulture Centre, mass media and consultants were seen as the main sources of other information on IPM.

Barriers and further needs
Although there have been strong inroads into IPM management amongst vegetable growers, further work is needed to continue the momentum. This includes on-going work to develop effective approaches and/or confidence in using IPM against some of the persistent insect pests, encouraging further cross-industry cooperation – for example in cleaning up programs - and extending the extension effort into the larger grower population. Further developing consultant expertise is also seen as important.

Comparison against similar projects
This assessment shows that the project has a very strong theoretical base and appropriate practical approach to participatively tackling an issue such as IPM. It rated very highly on the scale of best practice in implementing a 'technology development extension project'. It has also demonstrated that it has been true to its espoused extension approach. There is some scope to look at related policy and marketing incentives to complement the technical excellence.

4. PROVIDING SUPPORT FOR NEW INTERSTATE IPM PROJECTS (extension to VG 02040)

In November 2003 a national meeting of the National WFT Management Program representatives (research and extension), state vegetable IDO'S and HAL representatives decided to open a tendering process to fund additional vegetable IPM projects based on the Virginia extension model. The agreed role of the South Australian extension project was to facilitate the establishment of these new projects by providing 1) Transfer of extension resources and expertise developed at Virginia, 2) Co-ordination of general communication between projects on IPM issues and extension 3) Facilitating co-operation at the national level between projects and the national IPM 'audience'.

The SA role did not become a reality until July 2004 when a formal agreement was entered into between HAL and SARDI as an extension of VG 02040. Below is a summary of the commitments made and outputs achieved:

Commitment: Maintain an information exchange with NSW researchers (Stephen Goodwin and Marilyn Steiner) and the Virginia GMP re their research on predatory mites to control WFT and IPM technology in general

Action: Two visits to the Gosford research facility occurred during the life of the project and ongoing correspondence concerning trials of beneficial insects and compatibility of 'soft' chemicals has supported several trials of beneficial insects in Virginia greenhouses. Although the Virginia trials were inconclusive re WFT control using *montdorensis* mites grower support for using beneficial insects was strengthened and success was achieved with several other pests (fungus gnats, whitefly, two spotted mites, DBM and green peach aphid) in some instances. A number of growers are now modernising their greenhouse systems to make them more conducive to biological control and more consistent quality of produce. The development of national communications has enabled us to gather a number of relevant farm histories of successful control of WFT and whitefly with natural enemies (including *montdorensis* and *cucumeris* mites) in Australia. Further farm trials are being planned at Virginia with support from Biological Services and local hort. consultant Domenic Cavallaro.

Commitment: Co-ordinate communication and resource sharing between 3 state IPM projects

Action:
The co-ordination role has not had much time to develop its capacity as it has only been in effect since July 2004 when the agreement was completed. The Queensland project commenced around this time, but the NSW IPM project was not operational until late 2005.

New project extension workers were contacted as soon as they were formed and provided with background on the program history and current status at Virginia. A visit to Queensland was organised in November 2004 to visit farms and meet with researchers and extension workers. This tour covered the Gatton and Bundaberg farming regions and is reported extensively in the first national 'newsletter' in Good Fruit and Vegetables in January and March 2005. A further visit to NSW was not a major priority until the project gathered momentum, as we were already familiar with the regions farms and research precinct and would meet with their extension team in May 2005.

A package of IPM extension resources and farm tools from the Virginia extension program was compiled and sent to the NSW and Qld projects AS a folder and CD. *(An outline of the resource package contents can be found in ATTACHMENT 2)*

Two national meetings were co-ordinated as follows:

- A national meeting of state IPM projects on May 10th in Brisbane to build working links, share project delivery information and review national priorities.
- A national IPM strategic planning meeting with HAL and AUSVEG on July 7th

Commitment: Develop a national vegetable IPM web page to host information generated by the projects for access by growers and consultants

Action:
A web page covering SARDI project information and providing links to relevant IPM pages in NSW and Queensland DPI's, as well as other key information points (APVMA etc.) is being developed by SARDI and ARRIS and will be launched early in September. *The site address is www.arris.com.au/vegipm*

Commitment: Produce and distribute two national newsletters in three states (S.A., Qld and NSW)

Action:
The first newsletter featured our visit to Queensland farms and research facilities in two major instalments and was published in Good Fruit and Vegetables to access a wide readership until information and communication strategies were agreed between the three states. The second newsletter is a compilation of farm IPM case histories as decided at a National IPM projects meeting in Brisbane and is being distributed through the IPM project networks

5. RECOMMENDATIONS

The project has successfully demonstrated to growers and industry services the value of moving toward IPM, particularly in greenhouses, and has helped to address some important gaps in technical information. There has been a strong uptake of new practices by trial growers on trial farms in the 4 key management areas addressed and a significant uptake by the wider industry of basic elements of these practices. There has been throughout the project a strong and increasing involvement from wide range of service providers, including substantial regional efforts to clean-up roadside weeds and farm weeds and old crops. The project has assisted the emergence and implementation of the Revegetation by Design research project that aims to reduce pest levels by planting selected native vegetation species that also support beneficial insects. Key industry services have used IPM tools and information from the project and are keen to continue supporting the adoption process.

The effectiveness of the Participatory Action Learning approach taken in this project to working with growers and non-grower stakeholders is demonstrated by its achievements. The momentum that was established with growers in the previous project has been extended and now includes a range of important businesses and agencies committed to IPM adoption. It is essential that this engagement is consolidated to become a self-sustaining change in the region where IPM is a mainstream item of service provision including effective technical services, product support, education and training and communication of up-to-date IPM developments re new pest issues and R and D.

It is recommended that a further 2-3 years of funding for an IPM Adoption Coordinator be provided to assist these services and partnerships to develop the following capacities in IPM service provision:

- Competently servicing IPM needs and gaps identified by growers in chemical and non-chemical pest management strategies
- Routinely accessing and extending IPM tools and information from local and national sources (*)
- Thoroughly trialling full-blown IPM and developing relevant support services, training and cost benefit assessments in newly constructed modern greenhouse systems at Virginia
- Evaluating and developing applications for current field research into the relationships between vegetation, pests and beneficial insects in field crops
- Ongoing delivery of IPM workshops and training

(*) The recommended project work would also assist development of the relevant IPM resources and tools at the national level.

This work would be designed to promote demand and capacity for commercial IPM service delivery. This is the key to sustainable change and is supported by the interest of service providers in playing a more mature role in promoting IPM adoption. There also needs to be a targeted effort to support nurseries and their customers to integrate their business needs around IPM compatible practices.

6. ATTACHMENTS

1. List of extension outputs with examples
2. Outline of contents of IPM resource package

ATTACHMENT 1

1. List of extension outputs with examples

Sept 2003
- "The Grower" (Veg Link segment) article; SA Greenhouse Grower delegation to hydroponic conference

Dec 2003
- "The Grower" and Good Fruit and Vegetables (Veg Link segment) article; "Come together – right now over weeds

Jan 2004
- HAL Veg notes sheet series; "Western Flower Thrips" – project outline for industry
- Good Fruit and Veg article; "Getting into the Marketplace"

Feb 2004
- "The Grower" (Veg Link segment) article "Safely growing cucumbers with less insecticide"

April 2004
- Good Fruit and Veg article; "Permits and pests

May 2004
- IPM extension Presentation to Buslink National conference

May 2004
- Messenger Newspapers article; Strategic Plan completed for Regional Weed Control

June 2004
- IPM Presentation to Nursery Industry National Conference
- Production of Nursery fact sheet series on IPM x 4 – convertible to vegetable crops
- FarmBis Case study feature article "Vietnamese Vegetable Growers in Virginia South Australia"

July 2004
- Concept design of IPM Web Page for Virginia Horticulture Centre

August 2004
- Joint presentation with Sonya Broughton (WA Agriculture) on WFT issues in Australian Vegetables at The International Congress of Entomology in Brisbane (August 2004)

September 2004
- Production of brochure for campaign to "Clean up The Adelaide Plains"

October 2004
- Conversion of Nursery IPM fact sheets to vegetable crops

November 2004
- Presentation at GMP open day on partnerships for regional weed management
    - Production of IPM Newsletter for Virginia
    - Queensland IPM tour talks on 'The SA experience with Managing WFT' to:

1. *Vietnamese grower group meeting – Gatton*
2. *Meeting of Hort consultants, researchers, Qld extension staff and growers at Gatton University*
3. *Meeting of Hort consultants, researchers and growers at Bundaberg offices of Queensland DPI*

December 2004
- SA Grower – Veglink: Weeds Strategy Cleans Up

Jan 2005

- Good Fruit and Vegetables: Report on November Queensland Tour – part 1.

March 2005

- Good Fruit and Vegetables: Report on November Queensland Tour – part 2.
- IPM resources package released to local stakeholders and NSW and Qld IPM projects

April 2005

- SA Grower – VHC segment: Weed Problems Slashed
- Good Fruit and Vegetables – Vegetable Platter: Clean-up of Adelaide Plains Begins

May 2004

- *National IPM projects meeting*

June 2005

- Stock Journal (Open Gate) – Clean-up

July 2005

- Vegetables Australia Vol 1.1 "Small pest ignites IPM interest Australia Wide"
- Good Fruit and Vegetables Vol 16 No. 2 "Researchers meet growers at the national vegetable expo"
- National IPM newsletter
- Web page
- *National IPM Strategic Planning Meeting*

Other (June 2004 – March 2005) ?
Presentation of 8 'Freshcare' Q.A. program workshops on IPM from July 2004 to December 2004

EXAMPLES ATTATCHED:

1. Article
2. Newsletter

Cleaning Up the Adelaide Plains!

Photo: Rural Press

Vegetable growers in the Northern Adelaide Plains are uniting with Council and PIRSA in a major clean-up of weeds to defeat the Western Flower thrips that attack and inflict serious damage on crops such as capsicums, lettuces, tomatoes and potatoes.

"People are catching on to the vision that together we can change at a regional level and make substantial progress in our fight against these damaging vegetable pests," says SARDI Integrated Pest Management (IPM) Extension Officer, Tony Burfield.

"Growers and researchers are increasingly concerned that our narrow dependence on chemicals actually promotes pest problems, and this must change if our industry is to survive," says Mr Burfield.

"For example, using broad spectrum herbicides during spring to get rid of the thrips and other pests living in the weeds which grow around vegetable crops only promotes the growth of broad leaf weeds during winter. This of course leads to increased pest problems the following spring."

Every spring on the Northern Adelaide Plains weeds, which harbour pests such as thrips, mites, whitefly and heliothis, sprout in plague proportions.

A promotional campaign will begin this winter to drive a clean-up campaign over the entire vegetable farming region at Virginia. There are approximately 1100 farms on 50 square kilometres, many of whom have been doing the right thing for some time, but their hard work needs to be supported 100% to really improve the pest problem. Growers and other landholders will be asked to undertake regular moving to reduce broadleaf weeds and promote grasses as they harbor far fewer pests. In time a SARDI research program (Revegetation By Design) may also lead to replacement of some weed areas on roadsides and farms with selected native vegetation. This would have multiple biodiversity, environmental and commercial benefits if the right plants can be identified and established in a cost effective program. Early results are encouraging.

The weed removal campaign grew out of SARDI's IPM program that was developed as a National Western Flower Thrips pilot extension program in 2000 following a particularly bad season in Virginia in 1999.

The program is funded by the Horticulture Research and Development Corporation (HAL) and supported by the Virginia Horticulture Centre, a local grower committee and SARDI entomologists.

A series of workshops and demonstrations has brought together the region's growers, many of whom are migrants from Vietnam who do not have a farming background and need training as well as facing language significant barriers. The program has helped improve grower practices including resistance management, spray coverage, farm hygiene practices, greenhouse design and operation and using crop scouting as a basis to decision making.

Programs in NSW and Queensland have now also been established with HAL funding based on the SA model. The SA extension team has been assigned to help coordinate and support these new projects.

"By getting together in workshops and at demonstrations, growers are clearer about about what they are up against, and managing insect and other vegetable pests with greater confidence," said Mr Burfield.

South Australian grower, Emmanuel Cafcakis, who produces greenhouse capsicums, cucumbers and tomatoes, says he has gained much from working with the SARDI IPM programs.

"The most important thing was in learning more about the breeding cycle of the thrips, how to monitor their numbers effectively and when to spray," said Mr Cafcakis.

"Although we plant varieties partially resistant to the thrips, understanding the cycle and how to rotate chemical applications has saved us a lot of money."

Growers are also changing other farming practices that encourage pest problems such as poor spray coverage, crops sown too close together, not removing old crops soon enough and leaving rubbish and old crop remnants around on the farm. As these changes become standard practice throughout the region there will be major benefits with reduced pests and greater sense of regional pride.

Details: Tony Burfield (08) 8303 9580

Newsletter Issue no 3. - October 2004

INTEGRATED PEST MANAGEMENT

in

Vegetable Crops on the Adelaide Plains

Feature Article

"CLEANING UP THE ADELAIDE PLAINS"

Prepared by IPM Extension team members:
Tony Burfield, Gabriella Caon

Program sponsored and supported by:
Horticulture Australia, SARDI, PIRSA, Virginia Horticulture Centre

Contact Tony Burfield at the Virginia Horticulture Centre on 8282 9200 or mob: 0401 120 857

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1. The big weed clean up. Where are we at now?

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- c) Renewal of permits for WFT
- d) Any hope for new chemicals! ?

3. Non-chemical responses to pest Management
- a) Stimulating plant immunity to disease
- b) Parasitic nematodes that attack insects
- c) Plant extracts to control insect damage

4. Some highlights from the International Congress of Entomologists (Brisbane August 2004)

5. Pest Management training at the Virginia Horticulture Centre

6. Other Pest Management Information and Resources available

7. Invitation for Industry Feedback

1) The big weed clean up. Where are we up to now?

Because of major pest control issues and the unsightliness of weeds The Western Flower Thrips Steering Committee has developed a Strategic Plan for cleaning up the Weeds on the Adelaide Plains. Now it needs to be put into action!

Now to implement the Strategic Clean-Up Plan !

A recent survey of a range of producer and industry groups showed very strong industry support for the plan. Some of the stakeholders who back this effort are:

- Western Flower Thrips Steering Committee (12 local growers)
- Virginia Horticulture Centre
- Adelaide Plains Wine Producers
- NAPWCB (Northern Adelaide Plains Water Board)
- Marilyn Baker, Mayor of The City of Playford
- Various grower groups & associations including almond & olive producers, large individual producers & representatives of the Vietnamese Farmers Association
- Animal and Plant Control consultants from PIRSA Rural Solutions

This important industry plan needs to be turned into reality by getting the necessary co-operation from all local landholders and local and state government. The Virginia Horticulture Centre, City of Playford and PIRSA Rural Solutions consultants are keen to work with the Western Flower Thrips Steering Committee and local industry to achieve this outcome.

The next step being proposed is to convert the existing support into two formal working agreements:

1. an industry code of practice on weed control and related land management responsibilities
2. a Memorandum of Understanding between The local Industry (via the VHC) and the City of Playford (followed by other relevant councils) to get on with the job.

Another meeting will be held shortly after the Greenhouse Modernisation Project Open Day on the 15th of October. You will soon see information raising the profile on this issue around the area, including a brochure about weed management.

If you are interested in providing your support now or just finding out more contact the Virginia Horticulture Centre on 8282 9200 or Tony Burfield on 0401 120 857.

2) Chemical Responses to Pest Management

a) Changes to pesticide compliance legislation for S.A. growers

Possible impact of changes

As of August the 29th, 2004 new state regulations for pesticide use came into force.

Basically if a pesticide does not have a registration or permit for a particular crop and any level of residue is detected the grower will have committed a violation. Chemical use is not restricted to a specific pest or disease on the crop but to a registration or label and associated MRL (Minimum Residue Limit) for use on that crop. With many more growers now being audited under Q.A. programs the auditors will be obliged to identify and report such occurrences as offences under the act.

Most vegetable growers have been very concerned about their ability to legally control their pest and disease problems under this legislation.

Possible exemptions

In response these concerns the Virginia Horticulture Centre (VHC) formed a task group to negotiate with the state government for an exemption option with an alternative set of compliance conditions. An agreement was reached which allows growers to make their case for specific exemptions provided they can meet the compliance conditions. If there is an established MRL for use of a specific chemical on one crop (e.g. tomatoes), application may be made to use it on another crop (e.g. cucumbers).

The VHC will be releasing further advice and information on these changes, including the opportunity for growers to apply for exemptions.

Recommended action

1. Get advice about the requirements of the new legislation from your retailer or the State Government offices
2. List which chemicals are important to you for controlling pests and diseases and managing resistance by rotating chemical groups
3. Check which ones do not have a registration or permit for your crops
4. Check if any of these chemicals have registrations or permits on any 'similar' crops that may justify applying for an exemption to continue using them

b)Web sites to check for permit and registration information

http://www.apvma.gov.au/

Australian Pesticides and Veterinary Medicines Authority
This site will allow you to search
The DATABASE of registered products (Pubcris) and
The DATABASE of permits already issued

http://www.pestgenie.com.au/

PestGenie is a database specializing in information about plant protection
You can search a Crop Protection database for product, Active, Pest, Crop or use situation

c) Renewal of permits for Western Flower Thrips

Off Label permits for WFT ran out at the end of September, but the following extensions have been advised:

PER4402 - abamectin / tomato, ornamentals, strawberries/ WFT
Valid 1/6/04 to 31/3/05
Valid in all states except Vic where it is not required.

PER4406 - pyrazophos / cucumber / WFT
Valid 1/6/04 to 31/3/05
Valid in all states except Vic where it is not required.

PER4407 - methomyl / lettuce, capsicum, tomato, ornamentals, strawberries/ WFT
Valid 1/6/04 to 31/3/05
Valid in all states except Vic where it is not required.

PER4409 - methidathion / capsicum, tomato, ornamentals / WFT
Valid 1/6/04 to 31/3/05
Valid in all states except Vic where it is not required.

PER4411 - maldison / cucumber, lettuce, tomato, ornamentals, strawberries/ WFT
Valid 1/6/04 to 31/3/05
Valid cucumber, lettuce - in all states except Vic where it is not required

Full details of the permits are available on the APVMA website,
http://www.apvma.gov.au/permits/permits.shtml

d) New chemicals for WFT – the search goes on!

The NSW research project that has conducted resistance testing for WFT and provided advice for Off Label Permit applications is now funded to search for new insecticides to combat WFT. The researcher is negotiating direct with chemical companies to conduct efficacy trials on new chemistry and will recommend any promising new products for permit applications.

This work is a response to the withdrawal of an increasing number of insecticides like Nitofol (in greenhouses) and Endosulfan due to resistance and safety issues. There will soon be an enormous reliance on one or two chemicals like Spinosad (Success) that is likely to lead to even more serious resistance problems.

We must always remember that there are no guarantees of new products coming along any time soon. It remains vital to protect against resistance to the small range of available chemicals we still have and to continue decreasing our dependence on chemical control methods. There is some information in the next section on potential new non-chemical strategies.

3) Non-Chemical Responses to Pest Management

a) Novel options to look out for

Increasing Plant Immunity to Disease

Tomato Spotted Wilt Virus is a plant disease. Plants have immune systems to help them fight diseases that can be stimulated to increase resistance to attack. A well known company is conducting trials to assess the value of salicylic acid in protecting a range of vegetables against infection from various diseases. They claim promising results with some vegetables and diseases. More information can be expected in the forseable future on the availability of registered products of this type.

Parasitic nematodes

We have a limited biological control arsenal at our disposal at the moment in Australia. Many of these are very sensitive to any pesticide use. It was reported at the recent International Congress of Entomology in Brisbane that the use of parasitic nematodes that attach insects on plants is slowly growing in popularity overseas.

Control by using nematodes has been reported for the larvae of vine weevil, strawberry root weevil and many borers. Turf pests and some surface dwelling caterpillars have also been controlled by nematodes. The nematodes are applied to crops as a foliar spray under high humidity and cool to moderate temperatures. They require 2-3 hours to enter and parasitise the insects causing them to die within a couple of days.

Overseas work has shown that WFT can also be controlled by nematodes. There is interest in doing research with this biological control agent under Australian conditions.

Plant extracts

Reports at the recent International Congress of Entomology in Brisbane on the use of new plant extracts for pest control were very impressive. Several overseas research teams are assessing a wide range of plant extracts to help in the fight against insect pests. Plant extracts can work in many different ways:

- As insecticides that kill outright
- As repellents and anti-feedants to discourage attack or as attractants to draw insects away from crops
- As insect growth regulators that interfere with the insects life cycle

4) Highlights from the International Congress of Entomology

In August Tony Burfield attended the International Congress of Entomologists in Brisbane where Integrated Pest Management and WFT were well covered. Here are a few more things that may be of interest to those battling with their pests !

New information and IPM partners

Parisitic nematodes to control WFT ?

Two overseas researchers have begun sharing information with the local IPM team at SARDI concerning the use of parasitic nematodes to control thrips. Small scale trials are likely during the next year to see if our local nematode strains can be a cost effective control agent for WFT and other pests.

Researching pest entry into greenhouses
An Israeli researcher reported on a thorough study into how pests enter greenhouse roof vents. His study showed how prevailing wind currents cause pests to enter at the downwind end of greenhouses, so a westerly wind would cause problems at the eastern end ! His team intends to continue work on design solutions to this problem and is keen to share information, and possibly conduct joint studies, with SARDI and the Greenhouse Modernisation Project.

Thrips and Tomato Spotted Wilt Virus (TSWV)
WFT breed more rapidly on TSWV infected plants
Female WFT are strongly attracted to plants infected with Tomato Spotted Wilt Virus (TSWV). WFT eggs laid on TSWV infected plants produce more young because more of them hatch and they develop more rapidly than on uninfected plants ! It only takes a thrips larvae about 15 minutes of feeding on an infected plant to pick up the TSWV virus. If it flies to another plant as an adult it is likely to spread the infection.

Once a virus vector, not always a virus vector (and vice versa)
One researcher reported that Onion Thrips (thrips tabaci) are no longer a significant vector for TSWV in many Northern Hemisphere growing regions ! This is not as ridiculous as it may seem because the connection between an insect species and a virus can vary between locations and change over a period of time. This may be one reason why the significance of aphids as virus carriers (e.g. in lettuce for the disease necrotic yellows), can change significantly over the years.

5) IPM Training at the Virginia Horticulture Centre (8282 9200)

There is a range of pest management training options available through the Virginia Horticulture Centre to help with pest management:

1. IPM for greenhouse growers focuses on WFT control and covers other key pests
2. The Greenhouse Skills Adoption program includes Pest Management in an overall greenhouse management skills package
3. Spray application for field growers focuses on spray application and coverage

**** Programs with interpreters can be arranged if there is sufficient demand***

6) Other Pest Management Information and Resources:

- **Pest Management Information Pack** available from your IPM extension officer (Tony Burfield: 0401 120 857)

- **The Good Bug Book** contains information about all the biological pest control organisms that can be bought 'off the shelf' in Australia and New Zealand from members of Australasian Biological Control (ABC). This second edition (110 pages) contains descriptions of twelve new organisms that were not included in the first edition.

  Topics covered include:
  - descriptions of each beneficial organism and its lifecycle (illustrated with colour photographs)
  - pests controlled

- suitable crops and environments
- how to handle and manage the parasites and predators before release, at release, and after release
- cultural practices that promote establishment of beneficial organisms
- compatibility of beneficial organisms with various pesticides.

A general section on integrated pest management (IPM) rounds out the book.
The Good Bug Book is a valuable resource for crop growers, agricultural and horticultural advisers and consultants, students and teachers of agriculture and horticulture, and anyone else interested in integrated pest management.

www.goodbugs.org.au/
(or Tony Burfield: 0401 120 857)

➢ **NSW Agriculture publications on IPM** (books and Guides)
These are listed in the Publications Catalogue, and can be purchased through the Bookshop — orders may be placed by telephone, fax or mail order. An order form is provided on the website www.agric.nsw.gov.au/reader/bookshop to facilitate mail or fax ordering, or you can email them at bookshop@agric.nsw.gov.au.

1. **INTEGRATED PEST MANAGEMENT IN LETTUCE: Information Set — Made up of an Information Guide and Field Guide —** it provides essential knowledge about IPM as well as invaluable reference material for the IPM practitioner. It explains: what IPM is, tools for an IPM program, how to monitor lettuce crops, treatment thresholds and how they vary, what 'beneficials' are and how to employ them, how pesticide resistance develops and how to combat it, principles of spray application — and much more. The guides, designed as companion works, are sold as a set B432 for $71.25, or sold separately:
2. **INTEGRATED PEST MANAGEMENT IN LETTUCE: Information Guide B282 $50.00**
3. **INTEGRATED PEST MANAGEMENT IN LETTUCE: PESTS, DISEASES, DISORDERS AND BENEFICIALS IN LETTUCES: Field Identification Guide B430 $33.75**
4. **INTEGRATED PEST MANAGEMENT IN VEGETABLES: Pests, Diseases, Disorders and Beneficials in Vegetables Set.** The set comprises both the Information Guide and Field Guide. The guides, designed as companion works, are sold as a package, or separately. From NSW Agriculture. B281 $110.00
5. **INTEGRATED PEST MANAGEMENT IN VEGETABLES: Information Guide 2nd ed. B279 $93.50**
6. **INTEGRATED PEST MANAGEMENT IN VEGETABLES: PESTS, DISEASES, DISORDERS AND BENEFICIALS IN VEGETABLES: Field Identification Guide 2nd ed. B280 $27.50**

7) INVITATION FOR INDUSTRY FEEDBACK

*If you have got something to say now don't wait'. Give us a call at the Virginia Horticulture Centre on **08 8282 9200***

ATTACHMENT 2

Outline of Contents of Resource package (200 pages total)

Contents summary

A package of IPM extension resources developed from farm trials and extension workshops was prepared and distributed locally and interstate covering the following topics:

1). Pest and disease facts - Key pests and Tomato Spotted Wilt Virus

2). Economic significance of key pests - describing damage levels and costs

3). IPM needs assessment and planning

4). Monitoring and decision making

5). Improving Insecticide Efficacy

6) Non Chemical Strategies

7) Program Information

Each section contains material organised under four headings that approximate the forums in which they might be used:

1. Farm tools/handouts and fact sheets
2. Workshop sessions/farm visits
3. Posters for public display
4. Other (regional activities etc.)

The package is not exhaustive and is designed for updating and expansion within these IPM topics