5.1 Best practice production models (lettuce, brassicas)

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Victorian Department of Primary Industries (VICDPI)

Project Number: VG07110
VG07110

This report is published by Horticulture Australia Ltd to pass on information concerning horticultural research and development undertaken for the vegetables industry.

The research contained in this report was funded by Horticulture Australia Ltd with the financial support of the vegetables industry.

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ISBN 0 7341 2544 5

Published and distributed by:
Horticulture Australia Ltd
Level 7
179 Elizabeth Street
Sydney NSW 2000
Telephone: (02) 8295 2300
Fax: (02) 8295 2399

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Final Report

Horticulture Australia Project Number VG07110 (2010)

Best Practice Production Models (lettuce, brassica)

Rob Dimsey, David Carey & Sally-Ann Henderson

Department of Primary Industries, Victoria
HAL Project VG07110
Final Report – Best practice production models (lettuce, brassicas)
November 2010

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Purpose: This final report fulfils the requirements of Milestone number 190 for the Horticulture Australia Limited (HAL) project VG07110. This final report details the work carried out to fulfil the requirements of the project and produce Best practice production models for integrated pest management (IPM) in Lettuce and Brassicas.

Funding: This project has been funded by HAL using the vegetable industry levy and matched funds from the Federal Government. Financial support for the project was provided by the Department of Primary Industries Victoria, Department of Employment, Economic Development and Innovation Queensland.

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1. Media Summary
A large amount of research and development work for a range of key insect pests and diseases has been carried out in lettuce and brassica crops over the last 10 years. Many of the control strategies developed for these are consistent with Integrated Pest Management (IPM). However, control strategies have tended to be developed in isolation for each specific insect pest and disease.

IPM has been identified as a high priority in the vegetable industry for research, development and extension. General adoption of IPM has been relatively low and there is a recognised need to increase adoption of IPM practices within the vegetable industry. Barriers to adoption of IPM have not been comprehensively studied but there is likely to be a range of issues. IPM is complex and made up of a number of interrelated activities and implementation is not necessarily straightforward. In addition there will be a range of other factors that may affect the ability of the grower to adopt an IPM program.

Effective IPM uses a combination of chemical, cultural (which includes farm management practices) and biological methods to keep weeds, insect pest numbers, disease pressure and other crop production problems low enough to prevent significant economic losses.

A large amount of material has been developed to support IPM such as; Field Guides, Brassica Integrated Crop Management (ICM) toolkit, brochures, booklets and a range fact sheets. Some of these are generic while others are targeted at specific insect pest and disease issues.

The project aim was to provide information in a user friendly format relevant to a range of levels of understanding of IPM which will enhance the resources currently available, facilitate better adoption and is designed with growers in mind.

The first stage of the project was to develop suitable formats which were tested with industry. A key issue that needed to be considered was the use of chemicals and their IPM fit. This is highly valued by industry but publications containing chemical information quickly date. Following field testing and industry feedback the project decided on three final products:

1. An overview poster which provides an outline of IPM and the generic practices that are required to implement an IPM program.

2. Posters for lettuce and brassica listing registered chemicals and their IPM “fit”, including impacts on beneficial species and the environment.

3. Two booklets in the form of “Ute” guides, which provide more detailed information on IPM practices for key pests to facilitate understanding and uptake of IPM, “Lettuce Best Practice – Integrated Pest Management” and “Brassica Best Practice – Integrated Pest Management”.

1
2. Introduction

Integrated pest management (IPM) has been identified as a high priority in the vegetable industry for research, development and extension. There is a recognised need to increase adoption of IPM practices within the vegetable industry. A significant amount of research and development has been carried out over the last 10 years but general adoption of IPM has been relatively low.

In brassicas and lettuce projects have tended to focus on single disciplines and specific issues such as pests or diseases for example; white blister, clubroot and diamond back moth on brassicas and *Helicoverpa*, lettuce aphid and sclerotinia control in lettuce. McDougall (2007) points out that in the past most researchers begin IPM studies by concentrating on one pest in the system. There has been a range of publications produced to support the implementation of IPM and report on research outcomes. These include: field guides, newsletters, fact sheets, electronic toolkits and websites (Appendix 1). Industry needs analyses have shown that industry prefers to access information in a range of formats.

There is a recognised need to increase adoption by industry of IPM practices but the on-going nature of research and the complexity of IPM, which requires the application of a range of inter-related activities can result in a lack of awareness and application of research and development results. Pesticides and cultural control methods used in the control of some pests and diseases may negatively impact on IPM strategies for other pests and diseases. Adoption and implementation of IPM is complex and many factors impinge on the ability/need of the grower to change practice, including conflict with “on-farm” practices, the perceived needs and associated benefits of change, and in some cases processing sector supply agreement requirements.

The objective of this project was to build on the existing material produced to support IPM such as field guides, Brassica ICM toolkit and Fact sheets and to add value by combining information on pest and disease management in a “whole of crop” context for each crop. The project aims to combine the existing detailed discipline information for IPM of insect pests, diseases, weeds and nematodes into a holistic package for both lettuce and brassica crops, and is designed with the grower in mind.
3. Background
The adoption of some components of IPM by the vegetable industry has progressed in recent years due to a number of factors such as; the increased availability of new selective soft option products for Lepidopterous pests, the ability to rotate them to reduce resistance pressure and greater awareness of crop scouting and monitoring techniques (Carey 2008).

However, a scoping study to identify why there had been poor adoption and implementation of IPM, identified that not only was there low adoption, but that even the growers who profess to use IPM are in many cases relying totally on pesticide applications (Page and Horne, 2007). The survey results indicated that there is confusion about what constitutes IPM and that growers have not had guidance on the integration of the range of pest control options. Each of the individual strategies that make up IPM such as the use of IPM products, monitoring and scouting, resistance management, cultural and biological control methods, on their own do not constitute IPM but need to be applied in combination. The application of IPM principals is not simple, there are a diverse range of components which are all interlinked and require continual refinement to maximise effectiveness. A “whole of crop” approach and ultimately a whole of farm (and district) approach is required to effectively implement IPM.

In addition to traditional research and development projects Horticulture Australia Limited (HAL) has funded a project, Benchmarking vegetable integrated pest management against other agricultural industries (VG05043) as well as a project on IPM Gap Analysis for pathology (VG06092). The aim of these projects was to provide recommendations for research, development and extension in vegetables, identify some of the gaps in IPM knowledge and provide recommendations on priorities for the 2007/08 industry call. There has also been a suite of projects funded in the 2006/07 call on IPM including: Impacts of pesticides on key beneficials, IPM gap analysis for Asian vegetables and IPM advisory, mentoring and training for vegetable growers.

This project was part of a special call for projects under the Vegetable IPM Diseases program which comprises a suite of projects under 6 Programs which include:

- Program 1  Pesticide Strategies
- Program 2  Soilborne Disease
- Program 3  Foliar Disease
- Program 4  Viral Disease
- Program 5  Communication and Extension
- Program 6  Innovative Science

This project fell under Program 5 and although part of the Vegetable IPM diseases program is relevant to all pests including insect pests, diseases, weeds and nematodes.

The description of the call for this project was;

To utilise national IPM experts (pathology, entomology, nematology, weed sciences) to develop whole farm holistic packages which identify and deliver to industry the best practice strategies for successful implementation of IPM on farm. This project will review the knowledge gained in past research projects to develop the best management brochures for the national vegetable industry.
The challenge in delivering this project, which aims to produce a “whole of crop” approach to IPM for lettuce and brassica, is that there is a range of levels of understanding of IPM and varying levels of adoption. No “one” format for information will suit everyone. A key difficulty is the production of information in a form that can be easily understood, is relevant and useful in a situation where there is a wide variation in knowledge and understanding, ranging from those that have limited knowledge to those that have some expertise. There is a significant range of publications addressing pest control and IPM that are currently available including: pest and disease handbooks, as well as field guides and decision support CDs, which have been distributed to industry. The aim of what is produced in this project has been to build on what has already been done and integrate the information into a summary reference guide.

The main objective of the project was to present IPM information for growers in an integrated form that summarises current knowledge for the key pest issues. The original format of a brochure was seen as a good option as it could provide an easy to read summary, bringing all the research together into one integrated whole farm system approach that would provide growers with a guide to implementing IPM into every stage and aspect of production.

A major challenge for the project was to identify the format and level of detail/content for the outputs produced. As can be seen from the attached resource list (Appendix 1), which does not include research papers or final reports there is large amount of relevant information that is available for pest and disease management for both lettuce and brassica crops. To combine this information in one document would create a book which would simply duplicate what had already been done, would not add value to the information and would not facilitate ease of use. IPM is not just about using soft/targeted chemicals or scouting, but combining all the individual activities that when blended together combine to produce a true IPM outcome. The project aim was to provide information in a user friendly format relevant to a range of levels of understanding of IPM, which will enhance the resources currently available, facilitate better adoption and is designed with growers in mind.

A key roadblock in the beginning of the project was to envisage what form the final product might take. The project evolved through industry interaction to determine the most appropriate style of presentation of the key information. A range of issues needed to be considered particularly in relation to chemical use, which can become quickly dated, combined with the need to maintain relevance and easy reference.

The HAL projects Pesticide Effects on Beneficial Insects and Mites in Vegetables (VG06087), which was undertaken by Paul Horne and a project on Development of effective pesticide strategies compatible with IPM management used on farm (VG07109), by Peter Dal Santo have added significant information on pesticide use, IPM fit and impacts on beneficials. These have been a key resource for this project.
4. Methodology
While the original project brief was couched along the lines of developing a brochure for best management practices for IPM it was clear that the first phase of the project needed to be one of scoping what the final outputs might look like, their format as well as determining the level of detail and content.

The team developed a set of guidelines for the outputs/outcomes of the project, which would determine the content and the type of products to be developed. It should also be noted that unless otherwise specified the term pests refers to insect pests, disease, nematodes and weeds.

The guidelines identified that the outputs produced should:
- Build on what has previously been produced and add value.
- Not duplicate existing information or documents.
- Be “user friendly” and relevant to industry needs with enough information to be relevant but not so much that confusion is created and accessibility is reduced for the average user.
- Be applicable to a range of knowledge levels and understanding of IPM.
- Provide guidelines for the application of IPM in a whole of crop context.
- Not date too quickly.
- Provide directions for more detailed information.
- Be a suite of products to suite different information needs.

There were a number of phases to the project that needed to be completed in a stepwise process to determine the final concept for the outputs and appropriate formats for the information.

Project Phases
1. Identify lead experts
The first component was to identify and gain the cooperation from key experts in a range of states to provide content from their own expertise and that of their peers for the key insect pests and diseases for the crops.

2. Expert forum
Once the experts were identified a forum in the form of a workshop was held to discuss the potential outputs, format, content, design, information to collect and develop a suitable template to populate. This was a brainstorming session held in Melbourne 18th of March 2008.

3. Data template developed and populated
As would be expected from such a meeting a wide range of views and concepts were put forward. This allowed the project team to develop a template which was then circulated for the experts to fill in details for IPM management for the key pests in relation to their specific areas of expertise.

4. Data collation and concept development
Once the data from the experts was returned in the template the information was collated which then allowed some initial presentation concepts to be developed for the format of the products.
These test products were populated with some examples of the IPM strategy and controls (for diseases and insect pests). These were then tested with industry to gain feedback and direction about preferences for the type of product and content.

5. **Refine product concepts and populate**
   Following feedback, the product concepts were refined and then developed in detail with controls for each specific pest. Following this expert feedback on the products and concepts was sought.

6. **Graphic design**
   A graphic designer was consulted and formats developed for the products that could be tested with industry.

7. **Draft final concepts tested with Industry**
   Following the expert feedback on format and content and the initial format development, full drafts were tested with industry. The evaluation and feedback from these sessions allowed further modification and refinement.

8. **Final expert check and formatting**
   The completed drafts were submitted to the experts for a final content check and feedback prior to final formatting.

9. **Final products produced**
   The initial concept for products that was tested with industry included a 6-8 page brochure for each crop, posters detailing IPM practices for each crop and posters listing registered chemicals and their impact on beneficials and the environment. The industry stakeholders consulted included growers, consultants and chemical resellers. They were asked to consider what they liked and disliked about the various products and to consider what sort of information would help them make IPM a more integral part of their production system. There was also discussion on what the products were that they were currently using to get information and why they were using those products. Feedback on the concepts was obtained from regions across Victoria, NSW and Queensland.

   Although the information preferences varied, there were some noticeable trends. Posters were popular because they allowed information to be gleaned at a glance. A poster could be put up in a central spot to be accessed by everyone. This information format was useful for training all workers including those that are more transient.

   The initial discussions indicated that chemicals and their use should be a key component of whatever was produced however a key issue with chemicals is that any publication containing chemical recommendations quickly becomes dated. For that reason it was decided that information for chemical registrations and their IPM fit should be in a stand alone format.

   The initial concept also included presenting the more detailed information for IPM control of specific pests either at specific crop growth stages or in a more generic management format.
Following initial feedback it quickly became obvious that no one suite of products or individual product would suit every individual. There was a diverse range of preferences in how information should be best presented and varying indications of how it might be used. The one constant was the positive response to chemical information and a preference for the use of posters.

It also became clear that a brochure would not be a suitable format and would not adequately provide the level of detail and presentation needed.

5. Results
It was not clear until late in the project, after a number of products and formats had been developed and tested, what final format that the products should take. Following the industry feedback the final concept for the products was changed to the production of three products for each crop.

These were:
1. An Overview Poster summarising the key generic issues and the application of an IPM system. This was developed as the basic introduction to IPM and applies to both lettuce and brassica crops.

2. A chemical poster which would show the impact any registered chemical had on beneficials and an IPM system as a whole. The information in this poster included chemical groups, Cornell University product toxicity ratings, Australian research findings (Horne et al. 2009) and was colour coded into red, yellow and green for easy identification of the chemicals’ suitability in an IPM system. (See Appendix 2)

3. A “Ute guide” style booklet in A5 size format that would hold the summary information included on the poster, as well as additional more detailed information in a quick reference format to provide IPM recommendations on a “whole of crop” approach to IPM.

The ‘Ute Guide’ style booklets were a product that was robust enough to be carried around the farm in a “ute” and with enough detail to be useful without bogging the reader down in too much text. The intention was that this would support the various field guides for pests and beneficials that have been produced in the past.

The following picture of a page demonstrates the key aspects of the tables within the guide. It shows the potential IPM fit for the management strategies and critical comments that need to be considered, as well as outlining the beneficials and options for control including biological and management.
**Aphids**

Range of species: Cabbage aphid *Brevicoryne brassicae*, Green Peach aphid *Myzus persicae*, Turnip aphid *Lipaphis erysimi*

<table>
<thead>
<tr>
<th>Infestation Risk Factors</th>
<th>Cultural Practices</th>
<th>Chemical Control</th>
<th>Conflicts / Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increases the risk</td>
<td>Reduces the risk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A nearby crop or a weedy area could be a source of insect pests.</td>
<td>Cool/cold weather.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild weather — spring and autumn plantings.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brussels sprouts: aphids in crevices can make them unmarketable even if no damage is done.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Monitoring Control Thresholds**

3-4 aphids on most seedlings checked.

When scouting check for aphid "mummies" to indicate parasitoid activity.

Monitor using yellow sticky traps to check aphid levels.

**Beneficial Insects**

- Parasitoids: Aphid wasps
- Predators: Spiders, Predatory bugs, Ladybird beetles, Lacewings, Hoverflies
- Consider providing habitat for beneficial insects.

**Other**

Plant with spacing that allows maximum spray coverage.

Subsequent plantings should be upwind in a different area of the farm.

Select a production period that will minimise pest pressure.

Aphids can be a source of virus spread within the crop. (Refer to virus table).

Identify the pest accurately.

Cabbage aphid colonies may be confined to single plants and commercial cut out may not be greatly affected.

Aphids are generally not a problem during cooler weather and once the crop is established.

**Pest Lifecycle**

**Chemical Group**

- Range of IPM suitable and soft option aphid-specific chemicals available with good IPM rating.

**IPM Chemical Issues**

- Year-round production increases the risk of insecticide resistance.
- Use targeted chemicals if possible when control is required.
- Monitor closely some soft option products take a few days before you see a visual effect.

- Effective control can be achieved by beneficiais.
- Need to monitor beneficial activity and aphid pressure to determine the need for chemical control.

- Allow for a lag to allow beneficial build up for control.
- Remove virus affected plants and weeds.

Some systemic chemicals not suited to IPM.
6. Evaluation and Outcomes

The products produced by this project are seen as part of an overall technology transfer approach to contribute to the adoption of IPM for the vegetable industry. In some crops conventional methods continue to work well and the reality is that a key driver for adoption of new methods occurs when there are control failures for specific pests or diseases. There are a range of drivers for, and barriers to adopting a fully integrated IPM system. Not all the barriers to adoption have been identified, IPM is complex and there are a range of factors that affect adoption by growers.

The products generated by this project will not directly facilitate adoption of IPM or best production practices but will help to provide information, education and the resources that will assist in the understanding and adoption of integrated pest management in a whole of farm (or crop) context.

The final products developed by this project were very much part of an evolutionary process. A large amount of work was put into developing the appropriate products that were identified to be of most use to the industry and included extensive industry feedback and refinement.

The final product development process has been discussed in methodology however it is worth looking at the feedback from various growers, resellers and the contributing experts to gain an overview of the industry comments.

The initial workshop with the discipline experts identified a range of potential formats for the products; posters, brochures and booklets etc and potentially what the content should look like. Templates for each key pest were developed and filled in by the contributing experts, it was then possible to see what a final product may look like and the various limitations and advantages of these of formats from a growers perspective.

The initial formats included a 6-8 page brochure, a poster for chemicals and their IPM fit, a poster with detailed information based on pest or growth stage and a booklet with a CD-rom and additional supporting information. These options were all tested with a range of industry representatives including growers, resellers and agronomists in a range of production areas in Queensland and Victoria. Initial feedback and comments were sought on preferred formats and presentation as well as the content detail and form.

First Consultation
General comments from the first consultation include;

Chemical Charts
- “Chem chart good – I’ll stick that on the spray shed wall but please laminate it. Could colour code green for low impact products.”
- “Put a $ cost next to chemical.”
- “Don’t mention varieties or trade names as it dates too quickly.”
- “Better to have posters than brochure.”
"I really like the chemical poster – when making decision it is a quick reference."
"Do not want rates or withholdings on table too complicated and they are on label."

Booklet, brochure and other posters

- "Would use brochure as a training guide for staff as well as the handbook."
- "Generally not relevant brochure too general and wouldn’t use handbook or CD-rom we are on top of things and if a problem will ring up, but like chemical poster."
- "Would use brochure for training staff and handbook handy for new staff and prefer not-table form. I might use a CD-rom."
- "Like brochure and booklet would be handy - would use CD-rom."
- "Growers struggle with monitoring and frequency – should be in booklet."
- "Table is preferred – easier to read."
- "Booklet if it is too texty is too hard to read."
- "Booklet has more detail – but I need access to quick information."
- "Prefer paper to CD-rom – too slow and can get lost."
- "Can quickly flick through a book – computer doesn’t display information on one page and slower to read through."
- "Table pamphlet preferred as A5 format and on tough paper so it lasts."
- "Rarely - never look at HAL or Ausveg website."

These are a consistent representative example of the comments provided. Resellers generally liked the concept and liked posters that could be given out and growers also preferred the poster option. The concept of a brochure was not liked for there would not be enough detail to be useful and the likelihood would be that it would just be filed as another piece of “paper.”

As seen from the range of comments it is clear that no one format was universally liked apart from the chemical posters. Information on IPM needs to be presented in a range of forms to meet the requirements of industry and cater to the way people prefer to access information.

As a result of the industry feedback, the project team decided to delete the concept of the overview brochure and replace it with a poster to provide an introduction to Integrated Pest Management. The general consensus was that the table form of the guide for both crops was the preferred format although some preferred a text format. The use of posters to provide the key pest information was not practical - there is just too much information to present in an easily readable form – although some consideration was given to summary posters as the project proceeded.

The use of a CD-rom received mixed feedback and the project team decided to concentrate on the posters and “ute guide”. While a CD-rom may be used by some, it was anticipated that much of the information will be available on the internet and that some of this will be updated while the CD-rom will not. It is also viewed as desirable that there should be a central site where growers can access all the information and tools produced as a result of projects and a CD-rom would be superfluous.
Second Consultation
The project team met with a graphic designer as the next step to refine the formats of the posters and booklet or “ute guide”. Complete drafts of the booklet for both brassica and lettuce in table form were developed, an overview poster and the chemical posters were then refined in response industry (grower and reseller) feedback.

A more extensive consultation was carried out in this phase with the project team consulting with industry in Victoria, NSW and Queensland. The Victorian vegetable Industry Development Officers (IDO) were also provided with copies of the proposed material and consulted with growers and resellers extensively.

Much of the feedback in this consultation phase was more around refining the content and presentation rather than the format, but some general comments are provided below:

Overview Poster
- “Need to know when to monitor and the specifics of when to do it and when to scout e.g. twice weekly summer.”
- “Overview poster better than brochure – people will put on wall.”
- “Need to take into account range of variables particularly in summer when there are a high number of crops in the ground – need to get around to spray them all when needed – needs to fit and coincide with irrigation/ wind and weather/ pickers and field workers.”
- “More information on principals and thresholds – but then saw thresholds in ute guide and ok.”

Ute Guide
- “Highlight clubroot first 3 weeks after transplanting is critical.”
- “Like to open pages with an image on them eg pest with scale size.”
- “Most like having something in their hand.”
- “Re-seller, ute guide concept good.”
- “Will be good for helping out in the shop with discussions about chemicals.”
- “Don’t need two Cornell columns.”
- “Funding essential to update and maintain chemical posters. Need commitment to do it. Promotional posters could be sent out each with updates. By HAL Ausveg.”

A summary poster condensing the contents of the ute guide was also shown to growers, comments were mainly negative however there were some positive responses:
- “Too hard to follow.”
- “Don’t know??”
- “Grower wouldn’t use it wouldn’t last a week before being thrown out.”
- “If reduce information on the poster what’s the point?”
- “Don’t waste money doing summary posters.”
- “Too much information probably – a picture of disease would be good.”
- “Wouldn’t go into chemical shed to make a decision to spray or not.”
- “Decisions would be based on ute guide.”
• “Likes overview brassica poster for all laid out and easy to see – would certainly hang in the shed.”

As discussed the poster and “ute guide” will not in themselves result in adoption but will contribute to the facilitation of adoption by filling in some of the missing requirements that are needed for practice change. The following diagram shows where the outputs and activities fit within Bennett’s Hierarchy and demonstrate how they will contribute to the desired outcome which is increased adoption of IPM.

<table>
<thead>
<tr>
<th>Bennett’s Hierarchy Level</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inputs and Resources</td>
<td>Staff time, industry support, project budget etc.</td>
</tr>
<tr>
<td>Extension Activities</td>
<td>Feedback and test formats for products that will provide suitable information for a whole of crop approach to IPM</td>
</tr>
<tr>
<td>People Involved Participation</td>
<td>Growers and Resellers, Consultants and Scientists</td>
</tr>
<tr>
<td>Reaction of people involved</td>
<td>Like chemical use posters and will use them, Mixed reaction to various components but general industry support.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Change in</th>
<th>Production of Chemical posters, “Ute Guide”, Overview poster, Increased knowledge and resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge,</td>
<td>Better understanding of the components of IPM</td>
</tr>
<tr>
<td>Attitudes,</td>
<td>Additional tools that can facilitate the implementation of IPM</td>
</tr>
<tr>
<td>Skills,</td>
<td>Growers want better user focused information resources</td>
</tr>
<tr>
<td>Aspirations</td>
<td>Improved IPM decision making for pest control</td>
</tr>
<tr>
<td>Practice Change</td>
<td>Improving Social Economic and Environmental Conditions</td>
</tr>
</tbody>
</table>

The aim of the posters and “ute guides” is to make the information on IPM application easily accessible by removing the barrier of information being hard to come by or not presented in an integrated format. The chemical posters provide information that has not been readily available to chemical users in the past. It is likely that the chemical posters will be the resource developed that will be most quickly adopted/utilised and by the widest range of users.

Adoption of the information provided in the “ute guide” is likely to be driven by an individuals set of circumstances including farm context, business priorities, pest issues and whether or not there are production failures due to pests. Industry focused effective resources such as the outputs from this project will underpin this knowledge and provide the material to support changes to aspirations that will ultimately drive change.
It is anticipated that the users of the guide are likely to range from growers who already use IPM and just want to refine their system, through to farm workers who have little understanding of IPM but want to use the most appropriate chemical.

The aim will be to distribute the publications to all levy-paying lettuce and brassica growers across Australia.
7. Discussion

As discussed in the methodology there were a range of parameters that the delivery of the project had to meet. Ideally the outputs of the project would suit the requirements of all those in the industry from growers with little or no knowledge of IPM to those with considerable experience. The project outputs should provide value to experienced practitioners, resellers and farm workers with a range of experience and knowledge and result in increased adoption of IPM on a whole or crop basis. The path to achieving this aim was a key roadblock in the beginning of the project.

Consequently the delivery of the project involved some evolution to determine what the final products might look like and slowed the projects progress somewhat as the project team tried to design the most appropriate and useful outputs. The ultimate aim of increasing adoption of IPM on a “whole” of crop basis was outside the scope of this project but will be assisted by the projects deliverables.

The initial concept of a brochure that pulls together IPM for brassica and lettuce crops in whole of crop approach sounds simple but the reality is somewhat different. There is a wide range of pest and control issues that need to be considered and a simple brochure is not practical. The implementation of IPM is complex and consequently needs be clarified and made simpler however if it is “dumbed down”, then to a large section of the target audience it will not be useful.

A large amount of research and development has been carried out over the last 10 years. Consequently a large number of diverse publications have been produced in a range of formats over this long period of time. These resources can be hard to track down, however it was not seen as the aim of this project to replicate these but to add value to what already exists.

The initial evaluation sessions reinforced the concept that industry responds to information in a range of formats. The one constant is that chemical information is valued and is information that industry finds immediately relevant and useable.

The clear conflict with the provision of chemical information is that it dates quickly and if embedded in publications quickly dates the whole publication. Consequently in deciding the appropriate formats for the products to be produced it was seen as crucial to separate out the chemical information from the other information products. The poster format for the chemical information can be readily updated and can be kept current if placed on a web site if provided resources are available to maintain it.

Production of an overview poster was the best way of introducing the generic concept of IPM. A poster has potential to be a multiple use tool for both resellers and growers whereas a brochure may be quickly consigned to the shelf or the bin.

Provision of detailed pest information in a format that is readily accessible, can be easily carried around and presents the critical IPM management information for key pests was seen as the other key output. If more detail on each pest is required there are a range of resources such as information sheets, books, field guides and brochures available in hard copy or through the internet.
In putting together the “ute guide” it is apparent that for some pests there is still much that is not known and that issues associated with many pests such as virus management are quite complex. Applying IPM on a whole of crop basis is not simple and requires the assessment of a range of parameters such as; crop management, chemical effectiveness, impact of chemical on beneficials, weed control; cost implications; and timing just to name a few.

These issues demonstrate the complexity of implementing IPM and the range of levels of understanding and adoption. Information to industry and growers on new chemistry when it first becomes available may be incomplete for in some cases new chemistry may be found to not be as IPM friendly as first thought, and may end up in conflict with some other potential control methods.

Complexity and confusion are demonstrated in the way the term IPM is sometimes used for reference to insect pests, or all pests and diseases, by the experts. It is therefore not surprising that this leads to an additional layer of confusion.

In assessing the resources available and where to find them, it quickly became apparent that while significant resources and information have been produced over the years many of these are not readily accessible, nor do current electronic copies exist, but hard copy still exists for many publications. It is essential that existing resources are collated and placed on a single website that can be readily accessed by industry and researchers.

The list of resources identified is attached as Appendix 1 and has been placed in the “Ute Guides” for reference. Materials such as chemical information should be developed in a format that can be placed on the web, readily updated and available for download so that growers and businesses can access the latest relevant IPM chemical information easily. The posters for this project: “A guide to potential impacts on beneficials” have been produced with this in mind.

One grower observed that it was essential to update and maintain chemical posters and that there needs to be a commitment by industry to do this. His thought was that promotional posters could be sent out annually each year with updates funded by HAL or Ausveg and some costs could be covered by contributions from chemical resellers and chemical companies.

In considering the issue of increased adoption of IPM, this project will contribute by the provision of additional resources that approach IPM from a “whole of crop” perspective. However it is essential to increase the understanding of what drives the adoption of IPM and the impact of its complexity. Drivers such as control failure for a given pest or disease are understood as are the drivers for change when markets or processors demand a practice to meet their supply requirements.

IPM is a range of innovations that come together to form an integrated management system. This comprises individual innovations such as scouting, biological control, modelling techniques and chemical control but the reasons for adoption of each individual innovation are not necessarily going to be the same. Rarely will a grower adopt all the innovations at once, hence the range of levels and understanding of what constitutes IPM. In the Scoping Study on IPM by Page and Horne (2007) 49% of
respondents judged that they currently implemented IPM, but in reality only 28% were implementing all components, with a large number practicing individual IPM activities.

It cannot be simply assumed that there is lack of adoption because industry does not have enough information or it is in the wrong format. It is essential that there is better understanding of the drivers for, or barriers to, adoption of IPM to enable a more targeted approach to uptake of IPM.

Issues, Gaps and Conflicts Identified
The combining of all the information into one strategy helped to highlight areas that need further information, research, or development in future projects.

- A clear gap in the knowledge is comprehensive information of the impact of registered chemicals and while it is not feasible to test registered chemicals on all beneficials there will be a range of key beneficial species that are critical to the application of IPM.
- It is also desirable to evaluate the applications methods for chemical controls, which may have a registration for both foliar application or as a soil drench. There may well be different affects on beneficials due to the differences in application methods.
- A potential issue with new products are industry claims, where the benefits and fit may not be in line with the realities of the new product’s fit in an IPM system. This has the potential to increase the confusion for growers and industry.
- There remains an ongoing issue with limited availability of suitable chemistry for thrips control combined with potential for resistance development particularly in relation to Western flower thrips.
- Similarly for whitefly control there are limited options and there is a need to further develop the range of products available.
- The use of soil drenches for Currant lettuce aphid remains a conflict particularly if nurseries treat all seedlings irrespective of varietal resistance or whether there is a likelihood of pest pressure.
- In developing irrigation guidelines for disease control for key diseases researchers must consider the time of season, plant growth stage and agronomic issues in conjunction with the likelihood of disease pressure.
- With respect to Lettuce big vein virus there is a need to consider if there are suitable IPM options for control or the potential development of resistant varieties. Currently there are few options for control or prevention if conditions are suitable and the disease is present.
- In understanding and implementing IPM over a whole farm it is likely that there will be different information needs for the grower and or farm manager, and the workers in the paddock. This is an area, which needs further exploration.
Due to the complex nature of IPM the barriers to adoption are still not clearly understood. This limits the opportunities and understanding how best to facilitate practice change.

8. Recommendations

The project has made a significant number of learnings along the way and these will be valuable for any future work.

1. It is essential that existing resources are collated by a body such as Ausveg or Horticulture Australia Limited and placed on a central website or central data store that can be readily accessed by industry and researchers as a database of key management information that can be downloaded as needed.

2. It is essential that a better understanding of the drivers for and barriers to adoption is understood given that IPM is a complex process that involves the application of a combination of a range of individual components that must be integrated over a range of crops and seasons.

3. An overall IPM rating assessment for chemicals should be developed given that there is likely to be a variance of the impact of different chemicals on the range of beneficial species. This increases the potential for confusion and conflict so the provision of a generic rating assessment for individual chemicals with a warning of adverse effects on specific beneficial species may be preferable.

4. Resources should be allocated to update the project’s chemical posters regularly (at least annually) to account for new products that have been developed and others that have been deregistered. If resources are made available having the poster information on the website will allow it to be updated in real time and maintain its relevance.

5. The grower and farm manager are likely to have very different information needs to the workers out in the paddock. It would be relevant to assess the information needs for the various sectors in the industry and develop suitable formats, which may assist the specific requirements within the industry.

6. Given the limited options for IPM suitable control methods for thrips and other sucking pests and their importance as vectors of viral diseases there should be an ongoing research and development program for IPM control of thrips and other sucking pests.

7. There needs to be improved threshold levels identified for a range of pests and diseases, which would assist in better targeted pesticide application and improved use of IPM.
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Acknowledgements

Acknowledgements to Technical Editors

The project team would like to acknowledge the following for their technical contribution without which the guide could not have been produced.

Department of Primary Industries, Victoria

Dr Elizabeth Minchinton, Senior Plant Pathologist

Dr Oscar Villalta, Senior Plant Pathologist

Dr Ian Porter, Principal Research Scientist, Plant Pathology

Dr Caroline Donald, Senior Plant Pathologist

Dr Brendan Rodoni, Senior Plant Virologist

South Australian Research & Development Institute

Dr Barbara Hall, Senior Research Scientist
Tasmanian Institute of Agricultural Research, (TIAR, UTAS)
Dr Frank Hay, Senior Plant Pathologist

Agri-Science Queensland
as a service of the Department of Employment, Economic Development and Innovation.
Denis Persley, Principal Plant Pathologist
John Duff, Senior Plant Protectionist
Dr Lara Senior, Entomologist

Primary Industries, Industry & Investment NSW.
Dr Sandra McDougall, Industry Leader (Field Vegetables)
Len Teserioro, Senior Plant Pathologist

CSIRO Ecosystem Sciences, Brisbane, Queensland
Dr Cate Paull, Post Doctoral Fellow

Acknowledgements for photos:
The project team would also like to acknowledge the Technical Experts contribution of photos and the use of photos from Field Guide to Pests, Diseases and Disorders of Vegetable Brassicas.
APPENDIX 1

Brassica Resource List

Disease


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Managing Western Flower Thrips & Tomato spotted wilt virus in Vegetables (2003), Department of Primary Industries Vic (CD – unavailable)
Notes can be downloaded from Horticulture Industry Network website <hin.com.au/> and enter “WFT” into search.

National Diamondback Moth Project, South Australian Research and Development Institute (SARDI) Website with links, newsletters etc
Available from SARDI website <www.sardi.sa.gov.au/pestsdiseases/horticulture/horticultural_pests/diamondback_moth>


The reality of resistance, DVD, South Australian Research and Development Institute (SARDI)
DVD outlining the importance of good production practices and how they act to slow the development pesticide resistance in diamondback moth
For information or copies of the DVD contact Tony Burfield, SARDI website <www.sardi.sa.gov.au/>

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Virus


General
Agrilink information products.
Many of the original Agrilink titles have now sold out. Contact the Queensland Government Bookshop <www.bookshop.qld.gov.au> for availability or the brassica product can be downloaded from Queensland, DEEDI Primary Industries website <http://www.dpi.qld.gov.au/26_14826.htm>

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Virus


General
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Appendix 2

Posters

Best practice IPM - Overview

What is IPM (Integrated pest management)?

This is an approach to improve management and profitability using regular crop monitoring to determine if, when and what treatments are needed for effective control of pests. Effective IPM employs a combination of chemical, cultural and biological strategies to keep weeds, insect pests, disease pressure and other crop production problems low enough to minimize economic crop loss.

IPM decision making tactics:

Good forward planning, careful design of the production system and management can reduce the dependence on and improve the use of chemicals for pest control.

- Plants stressed through irrigation or nutrition are more prone to disease and pest problems than healthy plants.
- Good management practices include crop rotation, identification of your best production window, efficient irrigation and drainage systems.
- In an understanding of available weed, disease and pest control products including their IPM fit is essential.

Scouting/Monitoring crops for pest, disease, weed, beneficial activity and general crop health is essential.

Scouting (Inspecting crops in the field) and monitoring provides a good picture of pest, disease, weed and beneficial insect activity in your crop. Effective monitoring includes:

- Count numbers of pests and beneficials as well as the incidence of disease and level of weeds in the crop and surrounding headlands.
- Record this information, the actions you take and results for future reference.

Crop scouting

A picture of the pest and disease levels in each crop can be provided by:

- Scouting each area or block regularly.
- Cover a good cross section of the block as pests and diseases can occur in patches or hot spots.
- The number of plants to inspect will depend on the crop stage and the total area of crop.

Crop monitoring

Monitoring uses traps to assess the level and presence of key pests and beneficials around a crop.

- This will help to determine how often to scout the crops.
- Traps may indicate the likelihood of damage but is not a substitute for scouting the crop.

Traps available for monitoring pests include pheromone traps (hormone traps which attract males or specific pests); yellow sticky traps and light traps.

- If high pest pressure is indicated then crop scouting should be more frequent.
- Monitor weeds for they can host pest and diseases but may also provide habitat for beneficials.

(For more detailed information on scouting, scouting patterns and monitoring see the site guide or there are a range of crop IPM guides available.)

Standard IPM practices that apply to most pests and diseases

There are a range of standard practices that apply to most pests, diseases, viruses, weeds and nematodes.

Farm hygiene

Good farm hygiene is the most overlooked method of IPM. It reduces the risk of bringing new weeds, diseases and pests onto the farm, and reduces the spread of existing problems.

- Restricted access and movement onto the farm, or farm area by suppliers, contractors and visitors who do not comply with your hygiene practices.
- Avoid moving soil around the farm or dirty equipment, vehicles or worker’s boots.
- Work from young to old plantings when scouting and litter now cultivating and do known problem areas last.

Good farm hygiene includes these management practices:

- Production breaks: to avoid carrying over a week, pest or disease problems from one season to the next.
- Good land preparation: to assist with plant establishment, weed control and reduces the risk of waterlogging and pest issues from damping-off and other soil borne diseases.
- Selecting the right crop variety and site: to maximize your choice of success. Keep records to build a picture of weed, disease and pest risk on different parts of the farm.

(For specific IPM guides, see associated charts and for more detail on specific control measures for pests and diseases see the site guide.)

Crop management

Green manure/compost

- Improve soil health, water and nutrient holding capacity
- Provides a break from control problem weeds and reduces pest disease pressure.

Peat harvest

- Reduce soil quality and nutrients, plants developing if removed after harvest.

Production

- Use IPM practices
- Use only clean transport
- Monitor crops.

Crop rotation

- Break the cycle of diseases, pests and weeds.

Nursery hygiene

- Maintains good soil quality
- Use sterile practices
- Isolate nursery from crops and keep free of weeds and host plants of pests/diseases.

Definitively useful information about the use of IPM or a useful guide for people who are starting to work in this area.

IPM: Integrated pest management.

References:

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Brassica crop protection products
A guide to potential impacts on beneficials

Relative potential impact of Australian brassica industry crop protection products on beneficials and the environment

This quick reference guide is designed to assist you to choose effective brassica protection products which minimise impact on beneficial insects in your crop and on the overall environment. Always refer to the current product label and product registration documents before product application.

Note that when you apply and how you use a product may alter its potential impact. A preplant product application may not impact as much as applications later in the crop.

![](image)

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<td>Fungicide</td>
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<td>0</td>
</tr>
<tr>
<td>Bixol (Propizamide)</td>
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<td>Herbicide</td>
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<td>0</td>
</tr>
<tr>
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<td>Herbicide</td>
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</tr>
<tr>
<td>Bifuralin (Alachlor)</td>
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<td>Herbicide</td>
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<td>Biv国 (Metribuzin)</td>
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</tr>
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<td>Fungicide</td>
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<td>Herbicide</td>
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Lettuce crop protection products
A guide to potential impacts on beneficials

Relative potential impact of Australian lettuce industry crop protection products on the environment

This quick reference guide is designed to assist you to choose effective crop protection products which minimise impact on beneficial insects in your crop and on the overall environment.

Always refer to the current product label and product registration documents before product application.

Note that when you apply and how you use a product may alter its potential impact. A peatmeal product application may not impact as much as applications later in the crop.

**Lettuce** - Australian Registered actives and current permits as at December 2010

<table>
<thead>
<tr>
<th>Active Ingredient</th>
<th>Example Common Trade Name</th>
<th>Chemical Name</th>
<th>Rate</th>
<th>Low Impact</th>
<th>Moderate Impact</th>
<th>High Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>chlorosulfuron</td>
<td>herbicide</td>
<td>1H-1,1-dichloro-2-(N-phthalimido)1,1-dimethylethyl urea</td>
<td>1L</td>
<td>10 L</td>
<td>20 L</td>
<td>50 L</td>
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<tr>
<td>clodinafop-propargyl</td>
<td>herbicide</td>
<td>1H-1-[2-(2-carbethoxyvinyl)phenyl]-1,1-dimethylurea</td>
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<tr>
<td>diquat</td>
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<td>10 L</td>
<td>20 L</td>
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<tr>
<td>fensulfothion</td>
<td>herbicide</td>
<td>1H-1,1-Dimethyl-2-[[(4-nitrophenyl)acetyl]amino]cyclopropane-1-carboxylic acid</td>
<td>1L</td>
<td>10 L</td>
<td>20 L</td>
<td>50 L</td>
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<tr>
<td>metribuzin</td>
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<td>10 L</td>
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<td>mecoprop</td>
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<tr>
<td>sethoxydim</td>
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<td>1H-1,1-Dimethyl-5-[[3-(2,4-dichlorophenoxy)propyl]carbamoyl]cyclohexyl methyl sulphonate</td>
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<td>terbinafine</td>
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<td>1H-1,1-Dimethyl-5-[[3-(2,4-dichlorophenoxy)propyl]carbamoyl]cyclohexyl methyl sulphonate</td>
<td>1L</td>
<td>10 L</td>
<td>20 L</td>
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**Bactericides**

<table>
<thead>
<tr>
<th>Active Ingredient</th>
<th>Example Common Trade Name</th>
<th>Chemical Name</th>
<th>Rate</th>
<th>Low Impact</th>
<th>Moderate Impact</th>
<th>High Impact</th>
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<tbody>
<tr>
<td>chlorothalonil</td>
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<td>1H-1,1-Dimethyl-5-[[3-(2,4-dichlorophenoxy)propyl]carbamoyl]cyclohexyl methyl sulphonate</td>
<td>1L</td>
<td>10 L</td>
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<tr>
<td>mancozeb</td>
<td>fungicide</td>
<td>1H-1,1-Dimethyl-5-[[3-(2,4-dichlorophenoxy)propyl]carbamoyl]cyclohexyl methyl sulphonate</td>
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<td>50 L</td>
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<tr>
<td>zineb</td>
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<td>1H-1,1-Dimethyl-5-[[3-(2,4-dichlorophenoxy)propyl]carbamoyl]cyclohexyl methyl sulphonate</td>
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<td>10 L</td>
<td>20 L</td>
<td>50 L</td>
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**Contact Insecticides & Acaricides**

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<tr>
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<tr>
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<td>50 L</td>
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<tr>
<td>permethrin</td>
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<td>1L</td>
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**Environmental Note:**

- The potential impact of these treatments on beneficial insects is determined using the Environmental Impact Score (EIS). This score is calculated using a formula that takes into account the environmental impact of the active ingredient, the rate of application, and the frequency of application. A higher EIS indicates a higher potential impact on beneficial insects.