5.1 Best practice production models (lettuce, brassicas)

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Final Report

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Best Practice Production Models (lettuce, brassica)

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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.

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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”.

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 20007/08 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*

Effective IPM Fit √ √ √ √ √

Critical Comments: Some chemicals not suited to IPM need to be chosen carefully. There are good targeted IPM options available. It is important to consider the aphid species present and whether control is needed.

Infestation Risk Factors		Cultural Practices			Chemical Control			Conflicts / Issues
Increases the risk	**Reduces the risk**	**Monitoring Control Thresholds**	**Beneficial Insects**	**Other**	**Pest Lifecycle**	**Chemical Group**	**IPM Chemical Issues**	
A nearby crop or a weedy area could be a source of insect pests. Mild weather – spring and autumn plantings. Brussel Sprouts- aphids in crevices can make them unmarketable even if no damage is done.	Cool /cold weather.	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.	**Parasitoid** · Aphid wasps **Predators** · Spiders · Predatory bugs · Ladybird beetles · Lacewings · Hoverflies Consider providing habitat for beneficial insects.	Plant with spacing that allows maximum spray coverage. Subsequent plantings should be up-wind in a different area of the farm. Select a production period that will minimise pest pressure. Aphids are generally not a problem during cooler weather and once the crop is established.	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.	Range of IPM suitable and soft option aphid-specific chemicals available with good IPM Rating.	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. Evaluate other pests and beneficials present when deciding on control methods.	Effective control can be achieved by beneficials. 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.

Sample page from the Brassica Best Practice guide

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.

<u>First Consultation</u>
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 (IDOs) 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.

Bennett's Hierarchy Level	*Comments*
Inputs and Resources	Staff time, , industry support, project budget etc.
Extension Activities	Feedback and test formats for products that will provide suitable information for a whole of crop approach to IPM
People Involved Participation	Growers and Resellers Consultants and Scientists
Reaction of people involved	Like chemical use posters and will use them Mixed reaction to various components but general industry support.
Change in	
Knowledge,	Production of Chemical posters, "Ute Guide", Overview poster. Increased knowledge and resources
Attitudes,	Better understanding of the components of IPM
Skills,	Additional tools that can facilitate the implementation of IPM
Aspirations	Growers want better user focused information resources
Practice Change	Improved IPM decision making for pest control
	Improving Social Economic and Environmental Conditions

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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APPENDIX 1

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Disease

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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 minimise economic crop loss.

IPM decision making tactics:

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

- Plants stressed through poor 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 windows, efficient irrigation and drainage systems
- 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.

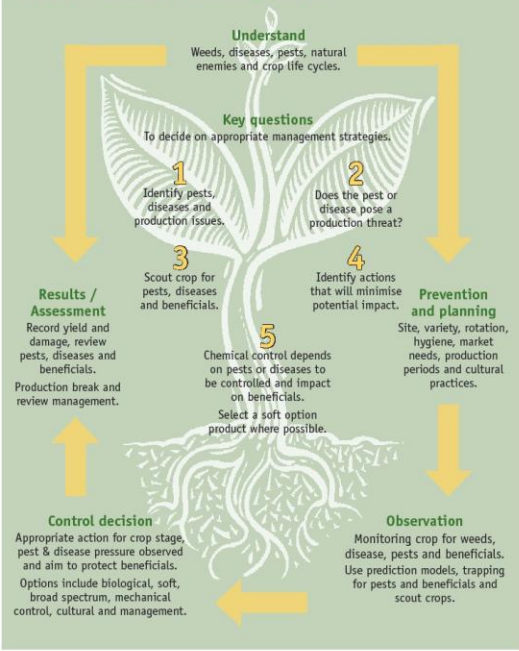
Crop monitoring

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 crop.
- Activity 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 of specific pests) yellow sticky traps and light traps.
- If a 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 ute guide or there are a range of crop IPM guides available.)

The IPM decision making process



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 often 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.

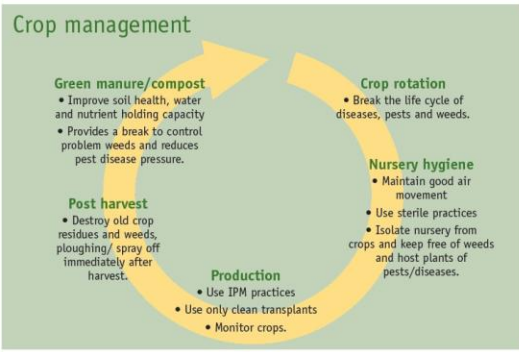
- Restrict access and movement onto the farm, or farm areas by suppliers, contractors and visitors who do not comply with your hygiene practices.
- Avoid moving soil around the farm on dirty equipment, vehicles or worker's boots.
- Work from young to old plantings when scouting and inter row cultivating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

Good farm hygiene includes these management practices:

- **Production break.** To avoid carrying over a weed, 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 water logging and plant losses from damping-off and other soil borne diseases
- **Selecting the right crop variety and site.** To maximise your chance of success. Keep records to build a picture of weed, disease and pest risks on different parts of the farm.

(Note: For pesticide IPM ratings see associated charts and for more detail on specific control measures for pests and diseases see the ute guides.)

Crop management



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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 crop protection products which mininise 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

Colour Key: Low Impact | Moderate Impact | High Impact

Brassica - Australian Registered actives and current permits as at December 2010

	Active Ingredient	Example Common Trade Name	Chemical Group	Use	Impact on Beneficial Insects and Fungi Data from USA Cornell University Rating *	Total Environmental Impact Data from USA Cornell University Rating *	Impact on Beneficial Insects and Mites Australian data HAL report rating	Impact on Beneficials Colour Key Some known impacts
Insecticide	abamectin	Vertimec	6A	sucking pests	28	35	High	
Insecticide	acephate(970g/kg)	Orthene XTRA	1B	chewing pests	22	25		
Insecticide	alpha-cypermethrin	Dominex Duo	3A	chewing pests	23	27		Broad spectrum
Insecticide	beta-cyfluthrin	Bulldock	3A	chewing pests	47	32		Broad spectrum
Insecticide	bifenthrin	Talstar	3A	chewing / sucking pests	47	44		Broad spectrum
Insecticide	botanical oil - emulsifiable		wetter	insecticide			Derived Impact	
Insecticide	Btaz	Xentari WG	11C	soft option insecticide	16	13	Low	
Insecticide	Btk	Delfin WG	11C	soft option insecticide	16	13	Low	
Insecticide	bupirofezin	Applaud	17A	Insecticide	28	29		
Insecticide	chlorantraniliprole	Coragen	28	chewing pests	9	18	Low	
Insecticide	chlorantraniliprole + thiomethoxam#	Durivo	28 + 4A	chewing and sucking insects	For impact see ratings for the component products			
Insecticide	chlorfenapyr	Secure	13A	chewing / sucking pests	36	46		Broad spectrum
Insecticide	chlorpyrifos	Lorsban	1B	chewing / sucking pests	25	27	Harmful	Broad spectrum
Insecticide	cypermethrin	Scud Elite	3A	chewing pests	28	36		Broad spectrum
Insecticide	deltamethrin	Decis	3A	chewing pests	22	28		
Insecticide	diazinon	Diazinon	1B	chewing pests	47	44		Broad spectrum
Insecticide	dimethoate	Rogor	1B	sucking pests	47	33		Broad spectrum
Insecticide	emamectin as benzoate	Proclaim	6A	soft option insecticide	8	26	Low / Moderate	
Insecticide	fenitrothion	Sumithion	1B	insecticide			Group 1B Derived Impact	Broad spectrum
Insecticide	fipronil	Regent	2C	chewing pests	68	91		
Insecticide	flubendiamide	Belt	28	soft option insecticide	9	19	Low / Low	
Insecticide	gamma-cyhalothrin	Trojan	3A	insecticide	47	44		Broad spectrum
Insecticide	Helicoverpa NPV	Gemstar / Vivus Gold	virus	soft option insecticide			Derived Impact	
Insecticide	imidacloprid#	Confidor / Senator / Nuprid	4A	insecticide	39	37	Moderate / High	Trichogramma, bugs, beetles
Insecticide	indoxacarb	Avatar	22A	soft option insecticide	18	31	Low / Moderate	Predatory beetles
Insecticide	lambda-cyhalothrin	Karate	3A	insecticide	46	44		Broad spectrum
Insecticide	maldison	Maldison	1B	insecticide	25	23		Parasitic wasps,beetles,bugs,lacewings
Insecticide	methamidophos	Monitor	1B	insecticide	25	37		Parasitic wasps,beetles,bugs,lacewings
Insecticide	methomyl	Lannate	1A	insecticide	25	22		Parasitic wasps, predatory beetles bugs, lacewings and spiders
Insecticide	mevinphos	Phosdrin	1B	insecticide	36	15		
Insecticide	parathion-methyl	Methyl Parathion	1B	insecticide	47	26		
Insecticide	permethrin	Ambush	3A	insecticide	25	29		Very toxic to all parasitic wasps, predatory beetles bugs, lacewings and spiders
Insecticide	phorate	Thimet	1B	insecticide	35	48		
Insecticide	pirimicarb	Pirimor	1A	soft option aphid pests	15	16	Low	Egg parasitic wasp (Trichogramma) hoverfly
Insecticide	prothiofos	Tokuthion	1B	insecticide			Group 1B Derived Impact	Broad spectrum
Insecticide	pymetrozine	Chess	9A	soft option aphid pests	11	20	Low	Parasitoids & Ladybirds
Insecticide	pyrethrins	pyrethrin insecticide	3A	insecticide	25	37		Toxic to beneficials on contact short term but not persistent.
Insecticide	pyriproxyfen	Admiral	7C	insecticide	5	15		Parasitoids
Insecticide	spinosad	Success	5A	soft option insecticide	12	14	Low / Moderate	Egg parasitic wasps
Insecticide	spirotetromat	Movento	23	soft option sucking pests	47	35	Safe to common vegetable predators	Low on common predators
Insecticide	sulphur	elemental sulphur	M2	fungicide / insecticide	87	45	Low / Low	Trichogramma
Insecticide	tau-fluvalinate	Mavrik Aquaflow	3A	insecticide	25	46		
Insecticide	thiomethoxam		4A	insecticide	Not registered as a stand alone product for brassica or lettuce			
Insecticide	thiodicarb	Larvin	1A	insecticide	25	23		
Insecticide	vegetable oil	Protec oil		insecticide			Derived Impact	
Insecticide	zeta-cypermethrin	Fury	3A	insecticide	23	27		
Herbicide	chlorthal-dimethyl	Dacthal	D	herbicide			Group D Derived Impact	
Herbicide	clethodim	Select	A	herbicide	15	17	Low / Moderate	
Herbicide	clopyralid as tipa	Lontrel / cauliflower	I	herbicide	19	18		
Herbicide	fluazifop-P as butyl	Fusilade	A	herbicide	21	29		
Herbicide	metolachlor	Bouncer	K	herbicide	15	22		
Herbicide	oxyfluorfen	Goal	G	herbicide	36	34		
Herbicide	pendimethalin	Stomp / Rifle	D	herbicide	30	30		
Herbicide	propachlor	Ramrod	K	herbicide		moderate	Group K Derived Impact	
Herbicide	quizalofop-P-ethyl	Tiger	A	herbicide	16	22		
Herbicide	S-metolachlor	Dual Gold	K	herbicide	15	22		
Herbicide	sethoxydim	Poast	A	herbicide	24	21		
Herbicide	trifluralin	Trifluralin	D	herbicide	5	19		
Fungicide	azoxystrobin	Amistar	11	fungicide eradicant	33	27	Low / Low	
Fungicide	boscalid	Filan	7	fungicide eradicant	15	26	Low / Low	
Fungicide	chlorothalonil	Bravo	M5	fungicide protectant	39	37		Broad spectrum
Fungicide	Cu as cuprous oxide	Norshield	M1	fungicide protectant			Low / Low	
Fungicide	Cu as hydroxide	Kocide	M1	fungicide protectant	15	38		
Fungicide	Cu as oxychloride	Copper oxychloride	M1	fungicide protectant			Group M1 Derived Impact	
Fungicide	Cu as sulfate (tribasic)	Tri-base blue	M1	fungicide protectant	77	62		
Fungicide	dimethomorph+mancozeb	Acrobat	40	fungicide eradicant	24	24		Broad spectrum
Fungicide	fluazinam	Shirlan	29	fungicide protectant	15	23		
Fungicide	iprodione	Rovral	2	fungicide protectant	20	24		
Fungicide	mancozeb	Mancozeb	M3	fungicide protectant	24	26	Low / Low	Predatory mites
Fungicide	mancozeb + metalaxyl	Ridomil Gold	4	fungicide eradicant	39	30		
Fungicide	metiram	Polyram	M3	fungicide eradicant	46	40	Low / Moderate	
Fungicide	penconazole	Topas	3	fungicide eradicant			Group 3 Derived Impact	
Fungicide	phosphorous acid	Agriphos	33	fungicide eradicant	5	7		
Fungicide	potassium bicarbonate	Armicarb, Kaligreen	28	fungicide protectant	5	8		
Fungicide	prochloraz as MnCl2 complex	Octave	3	fungicide eradicant	15	22		
Fungicide	procymidone	Procymidone	2	fungicide			Group 2 Derived Impact	
Fungicide	propiconazole	Propiconazole	3	fungicide eradicant	27	32		
Fungicide	pyraclostrobin	Cabrio	11	fungicide	25	27		
Fungicide	sulphur	elemental sulphur	M2	fungicide / insecticide	87	45	Low / Low	Trichogramma
Fungicide	tebuconazole	Folicur	3	fungicide eradicant	25	40		
Fungicide	thiram	Thiram	M3	fungicide protectant	15	29		
Fungicide	triadimenol	Bayfidan	3	fungicide			Group F Derived Impact	
Fungicide	zineb	Zineb	M3	fungicide	77	38		
	metaldehyde+methiocarb	Metaldehyde	molluscicide	Snails & Slugs	55	33		Pellet form reduces impact

Note that these ratings are for foliar application not as seedling drench

* The higher the figure the higher the impact

Derived Impact This indicates the assumed impact based on the chemical or product group.

The benefits and impacts of a product within an IPM program must be considered in your individual crop situation and growing environment.

Explanatory Notes

What do the rating figures mean?
These are not to indicate the scale and level of impact but provide a comparison (relative measure) between the different chemicals or product group.

Note: some ratings of moderate impact chemicals may appear high but this will be due to the range of beneficials and fungi affected.

Impact on Beneficial Insects and Fungi
(Cornell University data) is based on test results exposing seven beneficial insects and three beneficial fungi test species to the above products (details appear in the reference listed below).

Impact on Beneficial Insects
Australian Data is based on test results exposing a range of beneficial insects and mites to a range of products (details appear in the reference).

Total Environmental Impact
(Cornell University data) This score represents the overall effect of each pesticide on: the applicator, picker, consumer, groundwater, aquatic life, bird, bee, beneficial insect and fungi.

These figures are shown to provide guidance as to the environmental impact of these chemicals.

The Environmental Impact Quotient (EIQ)
The formula for determining the EIQ value of individual pesticides is listed below and is the average of farm worker, consumer, and ecological components (see reference 1).

EIQ=(C[(DT*5)+(DT*P)]+[(C*((S+P)/2)*SY)+(L)]+[(F*R)+(D*((S+P)/2)*3)+(Z*P*3)+(B*P*5)])/3

DT = dermal toxicity,
C = chronic toxicity,
SY = systemicity, F = fish toxicity
L = leaching potential
R = surface loss potential
D = bird toxicity
S = soil half-life
Z = bee toxicity
B = beneficial arthropod toxicity
P = plant surface half-life

Environmental impact is determined by the underlying impact of the product adjusted according to product formulation and the application rate.

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Lettuce crop protection products
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Colour Key: Low Impact | Moderate Impact | High Impact

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	Active Ingredient	Example Common Trade Name	Chemical Group	Use	Impact on Beneficial Insects and Fungi Data from USA Cornell University Rating *	Total Environmental Impact Data from USA Cornell University Rating *	Impact on Beneficial Insects and Mites Australian data HAL report rating	Impact on Beneficials Colour Key Some known impacts
Insecticide	abamectin	Vertimec	6A	sucking pests	29	35	High	
Insecticide	alpha-cypermethrin	Dominex Duo	3A	insecticide	23	27		
Insecticide	Bacillus thuringiensis (kustaki)	Xentari, Dipel	11C	soft option insecticide	16	13	Low	
Insecticide	bifenthrin	Talstar	3A	chewing / sucking pests	48	44		Very toxic to all parasitic wasps,predatory beetles ,bugs,lacewings and spiders
Insecticide	botanical oil - emulsifiable			insecticide			Derived Impact	
Insecticide	chlorantraniliprole	Coragen	28	chewing pests	10	18	Low	
Insecticide	chlorantraniliprole + thiomethoxam#	Durivo	28 + 4A	chewing and sucking insects	For impact see ratings for the component products			
Insecticide	chlorpyrifos	Lorsban	1B	chewing / sucking pests	25	27	Harmful	
Insecticide	diazinon	Diazinon	1B	chewing pests	47	44		Very toxic to all parasitic wasps,predatory beetles ,bugs,lacewings and spiders
Insecticide	dimethoate	Rogor	1B	sucking pests	47	33		Very toxic to all parasitic wasps,predatory beetles ,bugs,lacewings and spiders
Insecticide	emamectin as benzoate	Proclaim	6A	soft option insecticide	8	26	Low / Moderate	Predatory bugs
Insecticide	fatty acids - K salt	Natrasoap		insecticide			Derived Impact	
Insecticide	fenitrothion	Sumithion	1B	insecticide			Group 1B Derived Impact	
Insecticide	flubendiamide	Belt	28	soft option insecticide	10	19	Low / Low	
Insecticide	Helicoverpa NPV	Gemstar / Vivus Gold		soft option insecticide			Derived Impact	
Insecticide	imidacloprid#	Confidor/ Senator/ Nuprid	4A	insecticide	39	37	Moderate / High	Trichogramma, bugs,beetles
Insecticide	indoxacarb	Avatar	22A	soft option insecticide	18	31	Low / Moderate	Predatory beetles
Insecticide	maldison	Maldison	1B	insecticide				Parasitic wasps,beetles,bugs,lacewings
Insecticide	methamidophos	Monitor	1B	insecticide	25	37		Very toxic to all parasitic wasps,predatory beetles ,bugs,lacewings and spiders
Insecticide	methomyl	Lannate	1A	insecticide	25	22		Very toxic to all parasitic wasps,predatory beetles ,bugs,lacewings and spiders
Insecticide	permethrin	Ambush	3A	insecticide	25	39		Very toxic to all parasitic wasps,predatory beetles ,bugs,lacewings and spiders
Insecticide	petroleum oil			insecticide			Derived Impact	
Insecticide	pirimicarb	Pirimor	1A	aphid pests	15	16	Low	Egg parasitic wasp (Trichogramma)
Insecticide	pymetrozine	Chess	9A	aphid pests	11	20	Low	Parasitoids & ladybird beetles
Insecticide	pyrethrins	pyrethrin insecticide	3A	insecticide	25	37		Very toxic to all parasitic wasps,predatory beetles ,bugs,lacewings and spiders
Insecticide	spinosad	Success	5A	soft option insecticide	12	14	Low / Moderate	Egg parasitic wasps
Insecticide	spirotetromat	Movento	23	soft option sucking pests	47	35	Safe to common vegetable predators	
Insecticide	sulphur	elemental sulphur	M2	fungicide / insecticide			Low / Low	Trichogramma
Insecticide	thiomethoxam		4A	insecticide	Not registered as a stand alone product for brassica or lettuce			
Insecticide	trichlorfon	Dipetrex	1B	insecticide	20	15		
Insecticide	vegetable oil	Protec oil		insecticide			Derived Impact	
Herbicide	chlorthal-dimethyl	Dacthal	D	herbicide			Group D Derived Impact	
Herbicide	clethodim	Select	A	herbicide	15	17	Low / Moderate	
Herbicide	fluazifop-P as butyl	Fusilade	A	herbicide	21	29		
Herbicide	pendimethalin	Stomp / Rifle	D	herbicide	30	30		
Herbicide	phenmedipham	Betanal	C	herbicide	17	16		
Herbicide	propachlor	Ramrod	K	herbicide			Group K Derived Impact	
Herbicide	propyzamide	Kerb	D	herbicide	18	19		
Herbicide	sethoxydim	Poast	A	herbicide	24	21		
Fungicide	azoxystrobin	Amistar	11	fungicide	33	27	Low / Low	
Fungicide	boscalid	Filan	7	fungicide erradicant	16	26	Low / Low	
Fungicide	Cu as ammonium acetate	Liquicop	M1	fungicide protectant			Derived Impact	
Fungicide	Cu as cuprous oxide	Norshield	M1	fungicide protectant			Low / Low	
Fungicide	Cu as hydroxide	Kocide	M1	fungicide protectant	16	39		
Fungicide	Cu as oxychloride	Copper oxychloride	M1	fungicide protectant			Group M1 Derived Impact	
Fungicide	Cu as sulfate (tribasic)	Tri-base blue	M1	fungicide protectant	77	62		
Fungicide	cyprodinil + fludioxonil combines 2 actives	Switch	9	fungicide erradicant	20	27		
Fungicide	cyprodinil + fludioxonil combines 2 actives	(second active)	12	fungicide erradicant	19	26		
Fungicide	dimethomorph + mancozeb	Acrobat	40	fungicide erradicant	24	24		
Fungicide	iprodione	Rovral	2	fungicide protectant	20	24		
Fungicide	mancozeb	Mancozeb	M3	fungicide protectant	24	26	Low / Low	Predatory mites
Fungicide	mancozeb + metalaxyl	Ridomil Gold	4	fungicide erradicant	39	44		
Fungicide	metiram	Polyram	M3	fungicide erradicant	46	40	Low / Moderate	
Fungicide	phosphorous acid	Agriphos	33	fungicide erradicant	5	7		
Fungicide	potassium bicarbonate	Armicarb, Kaligreen	28	fungicide protectant	5	8		
Fungicide	prochloraz as MnCl2 complex	Octave	3	fungicide erradicant	15	22		
Fungicide	propineb	Antracol	M3	fungicide protectant	8	17		
Fungicide	propineb + oxadixyl	Rebound	4	fungicide erradicant			Low / Low	
Fungicide	sulphur	elemental sulphur	M2	fungicide / insecticide			Low / Low	Trichogramma
Fungicide	tebuconazole	Folicur	3	fungicide erradicant	25	40		
Fungicide	thiram	Thiram	M3	fungicide protectant	15	30		

Note that these ratings are for foliar application not as seedling drench

*** The higher the figure the higher the impact**

Derived Impact
This indicates the assumed impact based on the chemical or product group.

The benefits and impacts of a product within an IPM program must be considered in your individual crop situation and growing environment.

Explanatory Notes

What do the rating figures mean?
These are not to indicate the scale and level of impact but provide a comparison (relative measure) between the different chemicals or product group.

Note: some ratings of moderate impact chemicals may appear high but this will be due to the range of beneficials and fungi affected.

Impact on Beneficial Insects and Fungi
(Cornell University data) is based on test results exposing seven beneficial insects and three beneficial fungi test species to the above products (details appear in the reference listed below).

Impact on Beneficial Insects
Australian Data is based on test results exposing a range of beneficial insects and mites to a range of products (details appear in the reference).

Total Environmental Impact
(Cornell University data) This score represents the overall effect of each pesticide on; the applicator, picker, consumer, groundwater, aquatic life, bird, bee, beneficial insect and fungi.

These figures are shown to provide guidance as to the environmental impact of these chemicals.

The Environmental Impact Quotient (EIQ)
The formula for determining the EIQ value of individual pesticides is listed below and is the average of farm worker, consumer, and ecological components (see reference 1).

EIQ=[[(DT*5)+(DT*P)]+[(C*(S+P)/2)*SY)+(L)]+[(F*R)+(D*((S+P)/2)*3)+(Z*P*3)+(B*P*5)]]/3

DT = dermal toxicity,
C = chronic toxicity,
SY = systemicity, F = fish toxicity
L = leaching potential
R = surface loss potential
D = bird toxicity
S = soil half-life
Z = bee toxicity
B = beneficial arthropod toxicity
P = plant surface half-life

Environmental inpact is determined by the underlying impact of the product adjusted according to product formulation and the application rate.

References

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