Demonstrating integrated pest management of IPM in brassica crops

Dr Paul Horne
IPM Technologies Pty Ltd

Project Number: VG05007

VG05007

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 vegetable industry.

ISBN 0 7341 2022 2

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

Know-how for Horticulture™

Final Report

Project Number: VG05007

Project Title: Demonstrations of IPM in Brassicas

Authors: Paul Horne and Jessica Page

IPM Technologies Pty Ltd

HAL Project VG05007

Project Leader: Dr Paul Horne

IPM Technologies Pty Ltd

PO Box 560, Hurstbridge, Victoria, 3099.

Ph: 03 9710 1554

Fax: 03 9710 1354

Email: ipmtechnologies@bigpond.com

Other personnel:

Jessica Page

IPM Technologies Pty Ltd

This report describes the work done to demonstrate an IPM approach to the control of pests in brassica vegetable crops at locations around Australia. It trialed a particular approach to increase adoption of IPM that involved giving small groups of growers direct access to IPM experts. It details how and where demonstrations were conducted, how different methods were required on different farms, and the development of a new strategy to minimize pesticide use even amongst growers already using IPM.

This study was facilitated by HAL in partnership with AusVeg and was funded by the vegetable levy. The Australian Government provides matched funding for all HAL's R&D activities.

May 2009.

Table of Contents

Contents

Media Summary

1. This project was mainly concerned with the extension of existing knowledge on integrated pest management (IPM). It aimed to increase adoption of IPM by providing small groups of growers access to IPM specialists and detailed advice on how to implement IPM on their farms. It did not aim to conduct entomological trials at each site, other than to test whether or not an IPM approach would work.
2. Most importantly it showed that the method used, of IPM experts working directly with small groups of growers and agronomists, was highly successful in achieving adoption of IPM.
3. The approach taken at each site was determined by the needs of the growers involved, and information had to be site-specific. Although a general strategy was used, it needed to be adapted to suit different conditions. For example, Brussels sprouts growers in Tasmania face different issues than growers of brassicas in Werribee or South Australia.
4. For growers to make the change from conventional insecticide-based control measures to IPM, there needed to be help with decision-making given by IPM experts. It was necessary to give growers clear and easy to understand information. That is, the change to IPM became as easy as conventional spraying because we could show them how to make decisions based on more than just pest numbers. The questions to ask were:1. Is any insecticide needed? 2. If so, which is the most appropriate? Often the decision not to use any insecticide was the most difficult.
5. Most information requested during this project related to pesticide effects on beneficial species and how to decide which pesticide to use in different situations. The project allowed farmers to get more information on how to make some selective insecticides to work better and also provided the support needed for the decision not to spray any insecticide.
6. For brassica IPM, there are many useful chemicals but it also makes the options more difficult. A perception by some growers is that simply rotating their use of chemicals is IPM. Simply having a range of chemicals that give effective control of pests means that the incentive to adopt IPM (which is more difficult at first and seen as risky) is not always great. Through this project we were able to address these issues and demonstrate how IPM could work easily.
7. To help address the problem of simply using “soft” insecticides we worked with some IPM growers and resellers to develop a simpler strategy that used a combination of BT, Coragen and releases of biological control agents.

Technical Summary

This project was mainly concerned with the extension of existing knowledge on integrated pest management (IPM). It aimed to increase adoption of IPM by providing small groups of growers access to IPM specialists and detailed advice on how to implement IPM on their farms. It did not aim to conduct entomological trials at each site, other than to test whether or not an IPM approach would work. At each location collaborating farmers agreed to follow an IPM approach as outlined in an initial workshop, and following the suggestions of IPM advisors when decisions needed to be made.

Most importantly this project has showed that the method used, of IPM experts working directly with small groups of growers and agronomists, was highly successful in achieving adoption of IPM. This occurred even in the absence of a crisis in pest management, as there are currently a range of insecticides that are effective on the key pest, diamondback moth.

The approach taken at each site was determined by the needs of the growers involved, and information had to be site-specific. Although a general strategy was used, it needed to be adapted to suit different conditions. For example, Brussels sprouts growers in Tasmania face different issues than growers of brassicas in Werribee or South Australia. Some growers exporting to Europe, for example, are not able to use products that are registered for use in Australia. During this project we worked with both large-scale producers and small sized farms.

For growers to make the change from conventional insecticide-based control measures to IPM, there needed to be help with decision-making given by IPM experts. It was necessary to give growers clear and easy to understand information. That is, the change to IPM became as easy as conventional spraying because we could show them how to make decisions based on more than just pest numbers. The questions to ask were:1. Is any insecticide needed? 2. If so, which is the most appropriate? Often the decision not to use any insecticide was the most difficult, especially where a routine insecticide programme had been used in the past.

Most information requested during this project related to pesticide effects on beneficial species and how to decide which pesticide to use in different situations. The project allowed farmers to get more information on how to make some selective insecticides to work better and also provided the support needed for the decision not to spray any insecticide.

For brassica IPM, there are many useful chemicals but it also makes the options more difficult, as there is a greater choice and more combinations of what effects insecticides have on beneficial species. There was a perception by some growers that simply rotating their use of chemicals is IPM, even when the products are highly disruptive to beneficial species. There was definitely some confusion between IRM (Insecticide Resistance Management) and IPM.

Simply having a range of chemicals that give effective control of pests means that the incentive to adopt IPM (which is more difficult at first and seen as risky) is not always great. Through this project we were able to address these issues and demonstrate how IPM could work easily.

In the final stages of this project we attempted to develop a slightly different strategy because of difficulties experienced by growers in using BT based products (especially time of day to spray to avoid UV degradation and wash-off effects when irrigating). It meant that it was easier to opt for a relatively selective chemical such as Success or Coragen, and these products would be overused.

To help address the problem of simply using “soft” insecticides we worked with some IPM growers and resellers to develop a strategy that used biological control as the basis for control. In particular it involved the release of approximately 700 *Diadegma semiclausum* wasps as pupae, in the early stages of the crops. Initial results are good and further trials are planned.

Introduction

This project was initiated following our involvement in a previous project relating to control of diamondback moth run by SARDI (National Diamondback Moth Project). In that previous project and also in this current project we found that brassica growers would adopt an IPM strategy if they were shown how to do so, in detail, on their own farm. The entire basis of this project was that we could help growers who were interested in IPM to actually implement real IPM on their own farms. The experts in IPM needed to be present on-farm and show in minute detail exactly how to implement an IPM strategy. This project provided the means to do exactly that with collaborating brassica growers and agronomists.

Over the course of this project we have demonstrated how IPM works to a range of interested brassica growers and agronomists across Australia and have succeeded in reducing the amount of insecticides sprayed for the control of DBM.

Definition of IPM

The term "IPM" is well known these days and the letters stand for **I**ntegrated **P**est **M**anagement. IPM involves 3 control components and they must be integrated so that they are compatible (ie working together, not against each other). For example, insecticides targeting aphids could kill biological control agents needed for caterpillar control.

The three components of any IPM strategy are:

1. Biological control

2. Cultural control

3. Chemical control

It is an approach to pest management that can be applied to any crop from glasshouse flowers to broad-acre cropping.

The "I" part of IPM has often been forgotten. It is essential in any IPM programme in any crop that control measures are integrated so that they work together in a compatible way. It is also essential that biological control agents are integral in any IPM strategy.

Dealing with all pests:

There are at least 21 definitions of integrated pest management (or IPM) (Food and Agriculture Organisation 2000, Bajwa and Kogan 1996) but the term is taken here to mean using biological, cultural and chemical control methods in a compatible way to manage pest problems (Alston and Reading 1998, Horne and Page 2008). In practice, an IPM approach needs to deal with all pests, not just one or two. That means that brassica growers need to use a strategy that deals with more than just diamondback moth (*Plutella xylostella*).

There are definitions of IPM that include diseases and weeds and vertebrates as pests as well as invertebrate pests. Such an holistic approach is obviously desirable, but, at present, there is an entomological bias with IPM reflecting the greater amount of research into control of invertebrates using IPM. In this project we demonstrated to brassica growers how to control the invertebrate pests in their crops, and this included taking into consideration the pesticides used for disease control but it did not cover approaches to deal with diseases.

The project commenced without depending upon further research results but instead relied upon using existing knowledge on both pests and beneficial species. We utilized existing knowledge on the pests, beneficial species, pesticides and cultural controls. We began by helping brassica growers to implement an IPM strategy that involved using monitoring for both pests and beneficial species, and using highly selective insecticides if there were too many pests or too few beneficials.

This project aimed to immediately provide information on IPM to brassica growers in major production districts but we also believed that this project would work only with growers who were genuinely interested in adopting IPM. It was never intended to push an IPM approach on growers who were not interested in such an approach, and in fact only ever worked with growers who were interested in working with us. Working with small groups rather than having large field days was also seen by us as being important in achieving adoption.

During this project IPM experts Dr Paul Horne and Jessica Page visited brassica crops with collaborating farmers and agronomists and showed them beneficial species, suggested cultural options and helped make decisions about which (if any) insecticide should be applied. The collaborating farmers and agronomists were provided with information on the best ways to select and use pesticides (timing, rates, adjuvants, weather conditions).

In the last few years there have been a range of new insecticides available for the effective control of the major brassica pests, Plutella and aphids. That has meant that it has been more difficult to get growers to change from a conventional insecticide-based strategy to an IPM strategy. It also meant that it was easier for growers already using IPM to opt for a spray that was not necessarily the best option in terms of the IPM strategy. (ie spray a chemical that could be used at any time of day or in some weather conditions even if it disrupted beneficial species). That is, there is no current crisis in pest control in brassicas as growers can rotate through a range of fairly effective insecticides using an IRM approach. However, the industry risks losing some highly selective insecticides if they are not used within an IPM strategy.

Originally our aim was to demonstrate IPM in-field in a range of locations to growers who were using older broad-spectrum insecticides. We began the demonstrations with a short workshop to explain the principles of IPM. This approach worked but there were also many growers who were only using the newer, more selective insecticides, but not IPM. To help this latter group, we were able to provide information and advice that was specific to their farms and this included insect ID and information on pesticide effects on beneficial species.

This project aimed to increase adoption of IPM where growers were interested and not to simply raise awareness of IPM. Previous projects funded by HAL and the brassica industry had already conducted such awareness raising activities. For example the National Diamondback Moth Project lead by SARDI and the production of a CD called the *Brassica ICM CD* have provided resources and awareness of IPM but this project was conducted to help growers to actually use IPM.

Methods:

Interested growers and agronomists were contacted about possible demonstrations or training in IPM using a range of existing contacts, IDO's, brassica committee members, industry meeting and state DPI's.

Our methods needed to be able to deal with both smaller farms where the owner was usually responsible for the spraying and larger corporate farms where the decisions on pest management may have been delegated. The method we used was to work directly with small groups of growers and deal with specific issues that they had with pest control. This method has worked successfully for us in previous projects and is documented in the scientific and extension literature (Horne, Page and Nicholson 2008).

The main brassica production districts are listed below, using the broccoli production (tonnes, 2006/2007) (Australian Bureau of Statistics) as an indicator of the relative amounts produced in each.

Werribee South (VIC)	23,900 t
East Gippsland (VIC)	9,700 t
Manjimup (WA)	11,300 t
Perth (WA)	6,300 t
Granite Belt (QLD)	12,300 t
Lockyer Valley (QLD)	6,800 t
Cooma-Monaro (NSW)	2,500 t
Tasmania	7,000 t

Demonstrations and training were conducted in most of the major production areas. Localities that were visited in this project to conduct such activities included:

- Werribee South (VIC)

- Lindenow (VIC)
- Cranbourne (VIC)
- Devonport (TAS)
- Cressy (TAS)
- Launceston (TAS)
- Adelaide Hills (SA)
- Mt Gambier (SA)
- Manjimup (WA)
- Granite Belt (QLD)
- Sydney Basin (NSW)

Some locations were re-visited when there were new opportunities to conduct demonstrations or training (eg. Werribee South) and there were also several sites visited within the localities listed.

We were able to use some of the good tools that the brassica industry has developed, such as the field guide to pests and beneficial invertebrates. However, we found that to make the most of these, there needed to be direct contact with IPM specialists to condense a range of information into a simple decision. Although photos of beneficial insects were available, it usually needed direct sighting of specimens or live insects in the field before growers would recognize the insects.

In all cases the demonstrations and training began with a workshop to explain how IPM had to deal with all pests, the beneficial species to look for, cultural control options and how to select an appropriate insecticide if required. The best way to monitor crops and what to look for was also covered in these workshops. Depending on the group involved the workshop would take between 1 and 6 hours.

In the workshops we developed an IPM strategy that covered the range of pests that growers were concerned about, and used cultural control measures that the farmers though could be practical. The type of strategy developed was like the one outlined in Table 1, but varied between districts and farms.

Table 1: An example of an IPM strategy dealing with a range of invertebrate pests in brassicas. This type of matrix was developed to suit different situations with varying pest species or pest pressures.

Pest	Beneficial	Cultural	Chemical	Monitoring
Plutella xylostella (DBM)	Parasitoid wasps (*Diadegma, Cotesia*) Damsel Bugs (*Nabis*)	Remove flowering brassicas Sequential planting	BT sprays (eg, Dipel, Delfin, XenTari etc (Success*, Coragen**, Avatar*, Proclaim*)	Direct search Check for all life stages
Cabbage white butterfly (*Pieris rapae*)	Parasitoid Wasps Damsel bugs	"	"	Direct search Check for all life stages
Centre Grub	Damsel bugs	"	"	"
Cabbage Aphids	*Aphidius* wasps Hoverflies Brown lacewings (*Micromus*)	Weed control	Pirimor*, Chess*	Direct search Check for all life stages
Slugs	Carabid beetles	Tillage	MultiGuard, Slug-Out, Metarex	Shelter traps

- *Each of these chemicals was harmful to at least one species of beneficial, and so the decision on what to use was made based on the beneficials present or which were considered of greater importance at the time.
- **Coragen only became available in the last few months of this project.

The approach to demonstrations of IPM depended largely on the existing level of knowledge about IPM by the group involved. Initially it was planned to make 3 visits in the paddock to cover the life on one crop and then growers would see how decisions were made and see a successfully grown brassica crop. This approach was successfully used at many sites.

On some larger farms, already part-way towards IPM, we ran workshops and in-field training, especially in insect ID and selection of support pesticides. Others were happy with us giving further back-up and assistance in decision-making without regular visits (eg King Island). In those cases growers were provided with standard monitoring record sheets which were faxed to us to help decide what decision to make.

Working with agronomists and agronomy companies allowed the information that we provided to reach a larger group of farmers. Given that many of the growers questions related to pesticide effects on beneficial species then it was good to provide this information to the agronomists who advise farmers on pesticide selection. There are large difference between districts in terms of access to and use of independent agronomists . For example there is little use of independent agronomists in Werribee South but a high level of agronomist input in Tasmania. Similarly there was a large difference between farmers awareness of IPM , and so the demonstrations and training could not be rigid. The strategy outlined in Table 1 was the starting point and needed to be tailored to each individual situation.

The most successful demonstrations were where growers contacted us (which showed that they were already interested).

The availability of new insecticides and the prospect of still more in the near future lead us to work with existing IPM growers, resellers and chemical companies to develop a strategy that we hoped would be an IPM alternative to simply rotating through the use of the new insecticides. This was often attributed to difficulties in applying BT sprays (time of day, wash-off issues). BT sprays are rapidly degraded by UV and so need to be applied late in the day to avoid high UV and this is often inconvenient to growers. Therefore we have tried two different methods of improving and retaining IPM adoption.

A. Making BT's easier to use.
B. Augmentative releases of a parasitoid wasp that attacks Plutella.

A. To address the problems associated with BT's we wanted to see if they could be applied in the day with the use of a UV protectant.

Laboratory bioassays with an adjuvant (Nufilm P) confirmed that this adjuvant did protect the BT used from UV degradation. However, that was with a standard dose of UV and we needed to know if it worked in the field. We conducted trials in commercial crops where growers applied BT's as usual, but with or without the UV protectant, early in the day.

B. Attempt to provide a standard approach where Plutella is certain to be present. *Diadegma semiclausum* is known to occur in brassica production areas within Australia and is usually one of the most important parasitoids as measured by the level of parasitism.

The strategy is outlined as follows:

1. Seedlings transplanted (Week 1).
2. Release approximately 250 *Diadegma semiclausum* pupae per week for 3 weeks (weeks 2, 3 and 4).
3. The farmer agrees not to spray any insecticides for these first 4 weeks.
4. Week 5 or 6: Spray with Coragen.
5. Week 6 or 7: Spray with BT.

6. Week 10: Harvest commences
7. Summary – 2 insecticides for Plutella. An additional BT may be required for Cabbage white butterfly (*Pieris rapae*).

Diadegma semiclausum releases with Coragen and BT will work best where there are sequential plantings in the same paddock. There need only to be releases as described in the first planting. The advantage of this strategy is that the grower does not need to monitor as closely as would otherwise be required and there will still only be two insecticides used. This means that Coragen is only used once per crop. We have arranged for an Honours student from La Trobe University to study this approach in more detail with some assistance and supervision from IPM Technologies P/L in 2009 - 2010.

Coragen was chosen because it is the newest chemical on the market for Plutella and from our testing, it is the softest on beneficials after BT's. Therefore it is highly rated for IPM and we do want to lose it because of resistance. Sales of Coragen indicate that it may be overused in some places.

Results:

This project has resulted in the increased adoption of IPM in all localities visited. Many brassica growers also grow other vegetable crops and this project has lead to many choosing to apply IPM to other vegetable lines on their farms. On some of the larger farms this has meant a significant increase in IPM adoption in vegetables. For example, Mark Kable, Agricultural Director for Harvest Moon in Tasmania has said following his experience with IPM in brassicas "Work to date with Broccoli and Onions has worked very well, ….and I am all for IPM for Potatoes/Lettuce/Beans and other crops for that matter".

Adoption of IPM as a result of this project:

We estimate that **100%** of participants in this project have changed pest management practices as a result of what was discussed as part of this project. The major changes have been to pesticide use to minimize effects on beneficial species.

The changes have also been to a greater reliance on beneficial species.

We have listed a range of sites in our reports. We now list them as sites that have implemented IPM or made significant changes in pest management methods as a result of this project. The area of crop involved is not necessarily relevant, but some of these growers are key producers of particular lines (eg export Brussels sprouts). In other cases the area of crop grown is significant within a local area (eg Bon Accord Produce). Table 2 lists the changes that we observed in a range of sites.

Jerome Thomson of Werribee South Farm supplies confirms that there has been a major move away from broad-spectrum insecticides such as chlorpyrifos, lannate and alpha-cypermethrin in the last few years. He also notes an increase in the use of BT-based products when growers adopt IPM.

Table 2: Changed practices observed during this project with collaborating farmers.

Location/ Farmer	Crop	Changed practice(s)		
Werribee South, (Vic) John Nedinas	Cabbage, cauliflowers	IPM Monitoring	Use of BTs Strategic use of selective insecticides	No broad-spectrum insecticides used
Werribee South, (Vic) Kon Temuskos	Cauliflowers, broccoli	IPM Monitoring	Use of BTs Strategic use of selective insecticides	No broad-spectrum insecticides used
Werribee South, (Vic) Anthony Agosta	Cauliflowers, broccoli	Already using IPM Will use *Diadegma* wasps when available		
Little River, (Vic) Little River Hydroponics	Asian Vegetables	Mass trapping with pheromones	Use of BTs	No broad-spectrum insecticides used
Lindenow, (Vic) Bon Accord Produce	Cabbage	IPM monitoring	Use of BTs Strategic use of selective insecticides	Eliminate use of broad-spectrum insecticides (especially Lannate)
Cranbourne, (Vic)	Rocket, Tatsoi, Mazuna	IPM monitoring	Use of BTs Strategic use of selective insecticides	Move to eliminate use of broad-spectrum insecticides (especially Lannate)
Devonport, Cressy (Tas) Harvest Moon	Broccoli	IPM monitoring	Use of BTs Strategic use of selective insecticides	No broad-spectrum insecticides used
Launceston, (Tas) Stephen Welsh	Wasabe	Mass trapping with pheromones	Use of BTs No broad-spectrum insecticides used	Use of *Diadegma*
Devonport, (Tas) Lauren Damen	Brussells Sprouts	IPM monitoring	Use of BTs Strategic use of selective insecticides	Most crops grown without broad-spectrum insecticides
Adelaide Hills, (SA) John Cranwell	Brussells Sprouts	IPM monitoring	Strategic use of selective insecticides	Understanding of how insecticides applied for one pest can interfere with control of other pests
Sydney Basin (NSW) Eddie Galea	Broccoli	IPM monitoring	Use of BTs Strategic use of selective insecticides	No broad-spectrum insecticides used

Manjimup, (WA) Brad Ipsen	Broccoli	IPM monitoring	Use of BTs Strategic use of selective insecticides	No broad-spectrum insecticides used
Granite Belt (QLD) Harslett Farm	Chinese Cabbage	Better IPM monitoring	Better use of BTs Strategic use of selective insecticides	No broad-spectrum insecticides used

The feedback from those participating in the project has been positive. There has been particular comment on how useful it was to have the information provided on the effects of pesticides on beneficial species. This was so even from those who had thought they were using IPM before being involved with this project. There is obviously great value in having local information on pesticides (Project VG06087).

In addition to explaining the effects of pesticides on beneficial species, information was also presented on how to obtain improved results with insecticides including BT products, Success, Chess, Pirimor and GemStar. These are selective products that may be used in an IPM strategy but can fail under certain weather conditions. Because of these constraints, some have a poor reputation amongst growers and so it was necessary to demonstrate that these products can work well when used correctly.

Nufilm trial: The results were generally positive, but not all gave clear results. We concluded that it gave some measure of protection, but under conditions of high UV levels for many hours, then the protection may only last for part of the day. However, it does mean that spraying a BT could be done at least a few hours earlier than we would otherwise recommend.

Diadegma releases and minimal insecticide use: This approach is one that could be translated easily to other locations where there is no IPM adviser. Trials testing this approach have so far been conducted on three farms and an assessment at harvest in each case indicated that it was effective, with no more *Plutella* contamination than in other crops receiving more insecticide applications.

Discussion and Conclusion.

Adoption of IPM for many growers involves changing from a conventional spray-based programme to something different and unfamiliar. Unless there is a failure with that conventional approach then there may be little incentive to make that change (Horne, Page and Nicholson 2008, Page and Horne 2007). However, there are well-founded methods that can be used to help growers adopt IPM in the absence of a crisis and these involve specialist IPM advisors working with small groups of farmers (Herbert 1995, Olsen, Zalom and Adkisson 2003). This project was successful in using such an approach to help growers adopt IPM in all locations that we undertook demonstrations and training.

There were several issues that it was necessary to address in this project. The first was that there were several insecticides available for control of the main pest of brassicas, diamondback moth, that were effective. The situation at present is that there are new products on the market for control of caterpillar pests and so dealing with diamondback moth with a pesticide-based strategy is likely to work.

To help prolong the effective life of these products a significant amount of effort has been spent in promoting an insecticide resistant management strategy (IRM) for diamondback moth. Growers and their advisors have been provided with a CD on crop management (ICM for Brassica Crops) which includes the IRM strategy. This strategy suggests when to use particular products and to rotate through different chemical groups. However, each of the pesticides that have been available until very recently have killed at least one or more species of beneficial insects (ref. Project VG06087). Therefore, rotating through these different products means that progressively more beneficial species are killed. So while it is a very valid control strategy IRM is very different to IPM, but we encountered many farmers and agronomists during this project who believed they were using IPM if they were rotating their use of the newer insecticides. The acronyms IPM, IRM and ICM are so similar that this alone does not help with IPM adoption.

The second point related to this is that the IRM strategy is for caterpillar pests. Control of aphids is disrupted by many of the pesticides nominated as they kill the major parasitoid wasps and other predators that attack cabbage aphid. There have not been the same number of effective aphicides available as there have been caterpillar sprays, and so control of aphids was often nominated as a serious concern.

Effectively dealing with all pests of concern was the aim of this project and so a significant amount of effort was spent explaining the different effects of pesticides on the different species of beneficial insects. Having highly detailed local information on the effects of pesticides on native Australian species via project VG06087 meant that we did not have to rely on information from overseas or from tests that did not include sub-lethal assessments (such as effects on egg production).

It has been said that "IPM cannot be packaged like seeds" (FAO 2000) and it needs to suit the individuals involved (Horne, Page and Nicholson 2008). In this project ,site-specific advice was given directly to farmers and agronomists based on the general strategy outlined in Table 1. This accounts for the high level of adoption achieved with participants. This project did not try to raise awareness of IPM by providing a single standardized set of notes to all brassica growers as that has been done by others, but instead dealt specifically with helping those interested in IPM to be able to implement such an approach.

Growers involved in this project generally changed their pesticide use as a result of this project. For some the changes were substantial while for others it was more like fine tuning.

It has been noted before that even after IPM has been adopted there is still a requirement for collaboration between entomologists, farmers and agronomists to avoid IPM being seen as simply an alternative insecticide programme and the availability of insecticides leads to a loss of adoption (Horne, Page and Nicholson 2008, Sivapragasam 2001). A recent paper describes "backsliding in IPM practice" by brassica growers in SE Queensland due to the availability of new insecticides and the lack of on-going contact with skilled extension officers (Zalucki, Adamson and Furlong 2009).

It was noted in the course of many discussions with brassica growers that the requirement to spray BT-based insecticides late in the day to avoid UV degradation made the use of these products less attractive than other products that could be sprayed in the morning. The BT-based sprays were harmless to beneficial species and so were the first choice for most situations when an insecticide was required. Now that Coragen is available, it is possible that it may be overused (and resistance develop) simply because of the easier application. The possibility of developing a strategy such as using UV protectants for BT products and release of *Diadegma semiclausum* wasps is one means of addressing overuse of such useful products. Commercial trials conducted during this project indicate that it would be accepted if it could be proven in a variety of situations.

Further to this current project, two students at LaTrobe University will undertake projects this year to investigate in greater detail (1) The degree of protection provided by different UV screening adjuvants and (2) the effectiveness of *Diadegma semiclausum* releases as described in the Methods section of this report.

Acknowledgements

This project was only possible with the help of the collaborating brassica growers who were prepared to try something different. We thank those who helped to co-ordinate growers and grower groups for demonstrations and training. In particular we thank Shane Trainer (DPI WA), Rachel Lancaster (DPI WA), Peter Aird (ServeAg, TAS), Lionel Hill (DPI TAS), Greg Baker (SARDI), and Alison Anderson (IDO, NSW) for assistance in contacting interested growers. We also thank John Cranwell (SA), Brad Ipsen (WA), Mark Kable (TAS), Eddie Galea (NSW) and Geoff McSpedden (NSW) for their support of this project. We gratefully acknowledge the support and interest of Jerome Thompson (Werribee South Farm Supplies) and Doug Paton (Sumitomo Chemicals) with the trials looking at UV protectants.

References

Alston, D.G. and Reading, M.E. (1998) Factors influencing adoption and educational outreach of Integrated Pest Management. *Journal of Extension* **36** (3). Available online at http://www.joe.org/joe/1998june/a3.html

Bajwa, W.I. and Kogan, M. (1996) A compendium of IPM definitions. Oregon State University, Corvallis, Oregon. Available online at http://ipmnet.org/IPMdefinitions/

Food and Agriculture Organisation (2000). An evaluation of the impact of integrated pest management research at international agricultural research centres. A report from the Technical Advisory Committee's Standing Panel on Impact Assessment. TAC Secretariat, Food and Agriculture Organisation of the United Nations.

Herbert, D. A. Jr. (1995). Integrated Pest Management Systems: Back to Basics to overcome Adoption Obstacles. *Journal of Agricultural Entomology*. **12**, 203 – 210.

Horne, P.A. and Page, J. (2008). *IPM for crops and pastures.* 119 pp. CSIRO Landlinks Press, Australia.

Horne, P.A. , Page, J., and Nicholson, C. (2008). When will IPM strategies be adopted? An example of development and implementation of IPM strategies in cropping systems. *Australian Journal of Experimental Agriculture* **48**:1601 – 1607

Olsen, L., Zalom, F. and Adkisson, P. (2003). Integrated Pest Management in the USA. pp249 – 271 in *Integrated Pest Management in the Global Arena*. 512pp. Maredia, K.M., Dakouo, D. and Mota-Sanchez, D. (eds). (CABI Publishing, UK.)

Page, J. and Horne, P.A. (2007). Final Report to Horticulture Australia Limited. Project VG06086: Scoping Study on IPM Potential and Requirements. Available online at http://www.horticulture.com.au

Sivapragasam (2001). Brassica IPM adoption: progress and constraints in south-east Asia. Available online at http://www.regional.org.au/au/esa/2001/03/0301siva.htm

Zalucki, M. P., Adamson, D. and Furlong, M.J. (2009). The future of IPM: whither or wither? *Australian Journal of Entomology* **48**: 85 – 96.