Horticulture Innovation Australia

Final Report

Updating & Republishing Valuable Vegetable Industry Resources

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Contents

Summary

The purpose of this project was to review the many books, field guides, management tools, fact sheets, posters, e-tools and other resources that are outputs from vegetable industry related projects. A selection of these was then to be prioritised for updating and republication. This would ensure that valuable information is not lost but refreshed and made readily available to vegetable growers.

Part of this process aimed to explore new methods of communication. Information is increasingly online, rapidly changing and available anytime, anywhere. It was thought that some resources could be reformatted to make them available electronically, easily searchable by smartphone or tablet, and with links to other materials as needed.

Nearly 300 resources were collated and reviewed. It was surprising to find that some only a few years old were already difficult to locate. Changes within the state departments of agriculture / primary industries mean there are few central repositories for either publications or the materials used to generate them. Where staff have left or changed roles materials have already been lost.

A steering committee was formed with grower representatives as well as HIA, AUSVEG, the (former) vegetable industry advisory committee (IAC) and the project team. The collated materials were reviewed and it was agreed that pest, disease and disorder identification guides were both highly valued by growers and suitable for republication.

However, it was also felt that printed guides have a limited future. A pest and disease identification 'app' could act as a central repository for a large range of materials, be readily updated, widely distributed at little cost and potentially offer a range of interactive features. This could be a better long term solution.

To satisfy both demands, the project outputs therefore include a pest, disease and disorder identification app and five field guides. While some materials are based on previous publications others are entirely new. Many of the photographs are also new, taken specifically for the guides, while written text has been kept to a minimum.

The field guides describe pests, diseases and disorders of;

- Brassica vegetables (based on a Vic DPI publication 'A Field guide to pests, diseases and disorders of vegetable brassicas' by C. Donald *et al.*)
- Babyleaf vegetables (entirely new publication)
- Sweetpotato (based on QDAF Agrilink problem solver)
- Sweet corn (based on QDAF Agrilink problem solver)
- Carrots, celery and parsley (new publication)

The app contains a total of 250 individual insect, disease and disorder records, illustrated with over 880 photographs. It is searchable by pest type, crop type or both, or by keyword. Photographs have been selected to shown different insect lifestages and/or severity of symptoms. These can be viewed full screen, with captions, or with some short text describing the pest, its damage or cause.

At the time of this report over 800 copies of each of the Brassica and Babyleaf field guides have been distributed. They have proven extremely popular with many positive comments received. All

five field guides and the app will be further promoted and distributed at the 2015 Ausveg convention.

Keywords

Pest, disease, disorder, ute guide, field guide, book, app, resource, identification, vegetable, update, extension, online, photo

Introduction

Over many years the Australian vegetable industry, together with government departments, private companies and Horticulture Australia (now Horticulture Innovation Australia), has developed a wide range of resources, tools and guidance materials for growers covering topics such as soil management and postharvest handling.

However, many of these valuable resources are no longer useable. They may be out of print, contain outdated information or need to be published in a more accessible format. It is important that such resources are not lost, thereby wasting or even requiring a repeat of previous research.

The aim of this project was to collate, review and then republish outputs from previous vegetable industry projects. With industry consultation, these were prioritised in terms of immediate value to industry members and the costs / benefits of each publication.

In some cases, the results are entirely new, having been collated from various sources in order to meet a new and emerging need, such as for information on babyleaf crops. Other outputs present old information in a new, electronic format, consistent with the advent of new technologies and the need to regularly update and continually improve availability of information to an increasingly connected grower base.

Methodology

Project steering committee

A steering committee was formed to oversee the project and decide which resources should be prioritised for republication. Members of the committee changed during the project but included representatives from HIA (Kathryn Young, Alison Anderson, Will Gordon, Byron DeKock), AUSVEG (Andrew White, Tim Shue, Scott Kwasny), the vegetable IAC (John Said) and grower representatives (Scott Samwell, Stuart Grigg, Adam Schreurs). Meetings were held at the AUSVEG office in Melbourne and via teleconferences.

The tasks of the committee were to:

- Review and comment on previously published resources and discuss what types of resources are most useful for growers—books, fact sheets, posters etc.
- Investigate the cost and technical issues involved in creating an app to consolidate vegetable information and make it available and readily updateable.
- Suggest and prioritise topics for publication / re-publication and discuss what features would make these most useful.

Collating, reviewing and evaluating existing resources

Resources relevant to the vegetable industry were collated as both hard copies, where these could be sourced, and as electronic versions. The list of resources—nearly 300 in all—is included as Appendix 1 of this report.

Even resources that were not very old proved surprisingly difficult to locate. This is largely due to the major changes in the agricultural state agencies, the traditional repositories of much of this information. Most have now closed their bookshops so publications and guides often sit in boxes in researchers' offices. Such resources can be lost as researchers either leave or are transferred into other research areas.

The state agencies also used to print and update fact sheets. However, this now seldom happens, so outdated fact sheets have been physically and electronically deleted. Both Vic DPI and QDAF are moving to web based information only, so pdfs are no longer available.

The NSW DPI previously attempted to collate all vegetable industry resources by referencing them on the "Vegetable resource database", hosted at http://vegdb.arris.com.au. Unfortunately, many links to the original documents are now broken due to website changes or removal of older materials. A considerable amount of information was sourced through the Horticulture Industry Network (www.hin.com.au). A search for "vegetables" brought up over 1,500 hits on this website, and included events, news releases and service providers as well as resources. Other sources of information included the state based vegetable associations, particularly the Victorian Growers Association, and the AUSVEG website.

The resources that appeared to be most useful were those which:

- **Identified** something, such as a pest, disease or disorder.
- Provided instructions on how to **do** something, eg calculate irrigation requirements, spray application, monitor soil health, combine crop management strategies for best effect etc.
- were **portable**, easily taken into the field where needed eg a ute guide or electronic app.
- Were **long-lasting**, so unlikely to quickly become outdated.

Pest and disease field guides

In conjunction with the steering committee, it was determined that pest and disease identification guides were the most immediately useful items for growers. Other suggestions were soil management and improvement information and plant nutrition guides. The format for pest and disease information was discussed. While many growers value a physical publication, in the longer term this information could be provided using an app. This format is readily updateable and expandable, fully portable and even potentially interactive. It would also effectively provide a more permanent database of information.

Initial publications were developed and distributed. The priorities were then reviewed and a number of new items added. It was therefore decided to publish:

1. A pest and disease identification app for iphone, Android and tablet (*discussed in following section*)
2. Pests, diseases and disorders of brassicas (based on Vic DPI Field guide to pests, diseases and disorders of vegetable brassicas by C. Donald *et al.*)
3. Pests, diseases and disorders of babyleaf vegetables (completely new publication)
4. Pests, diseases and disorders of sweetpotato (based on QDAF Agrilink sweetpotato information kit and problem solver)
5. Pests, diseases and disorders of sweet corn (based on QDAF AgriLink sweet corn information kit and problem solver)
6. Pests, diseases and disorders of *Apiaceae* vegetables (completely new publication but combining information from 'A guide to common diseases and disorders of parsley' by VicDPI, various carrot related FactSheets by DAFWA and a carrot diseases poster by Serve-Ag Tasmania)

Key factors to be incorporated into the ute guides were:

- A6 size, spiral bound, portrait orientation
- Water resistant matte finish paper
- Pictures of a range of stages (disease symptoms or pest lifestage) where possible
- Limited text with basic information on insect life cycle, seasonality etc. No information on

chemical control as this rapidly becomes outdated and is affected by market requirements. Management information only in general terms such as field hygiene and vector transmission.

- Focus on obtaining good quality pictures and ensuring these are as large and clear as possible

At the beginning of the project it was expected that materials to aid re-publication of an old resource could be obtained from the original publisher. As such resources had been produced using HIA funding, there was a strong case for these to be supplied by the relevant agency to aid updating and re-publication.

In fact, most such materials simply no longer existed. Of the state agencies, only NSW DPI maintains a central photo library. In other states, all text and photographs used in publications remained in the possession of the author/s. If these authors no longer worked at the agency or had been transferred into another area of research, the materials were essentially lost. It is perhaps surprising that neither the original organisations nor the funding bodies involved have retained physical or electronic files relating to previous publications.

Without the generous assistance of NSW DPI as well as a number of key individuals within both QDAF and NSW DPI, few of the original materials could have been recovered.

Another issue was that earlier publications were illustrated using slides. Scanned slides do not have the same clarity as modern digital photographs. The blue background once considered standard practice for photographing specimens is distracting and now looks old-fashioned. This meant the photographs previously used were not always ideal for a new publication, so new photographs were needed.

Photographs (particularly of pests) were taken on targeted farm visits and sourced from within the project team's own collections. Other pictures were obtained by personal requests to researchers, interested amateur photographers and agriculture related government organisations. Some were also found on open access internet sources (such as Bugwood.org and Wikicommons).

Lists and descriptions of pests, diseases and disorders were compiled from the library of previous publications as well as using the project team's own knowledge. All articles were checked with relevant researchers and agronomists for accuracy and completeness. Publications were thoroughly edited before design and layout by a professional graphic designer.

Pest and disease application ('app')

The app was developed by "BreakThrough Apps". This company came highly recommended, having previously developed apps for the vegetable industry and other clients.

The app is essentially a searchable database. Users are able to search by crop (Pictorial list of 30 different crops provided) then by pest / problem (insect, disease or disorder). Or, this can be done in the reverse order. Users can also select All crops or All pests. They can also search using keywords. This finds entries which have the specific word in the title or included as a keyword for the record. For example, searching for "spot" brings up entries including "Septoria leaf spot" as well as herbicide

damage and red legged earth mite, both of which cause spots on the leaves.

Each entry is initially seen as a thumbnail picture, which has been selected to show the most likely symptom / insect lifestage that would be seen on the crop (Figure 1).

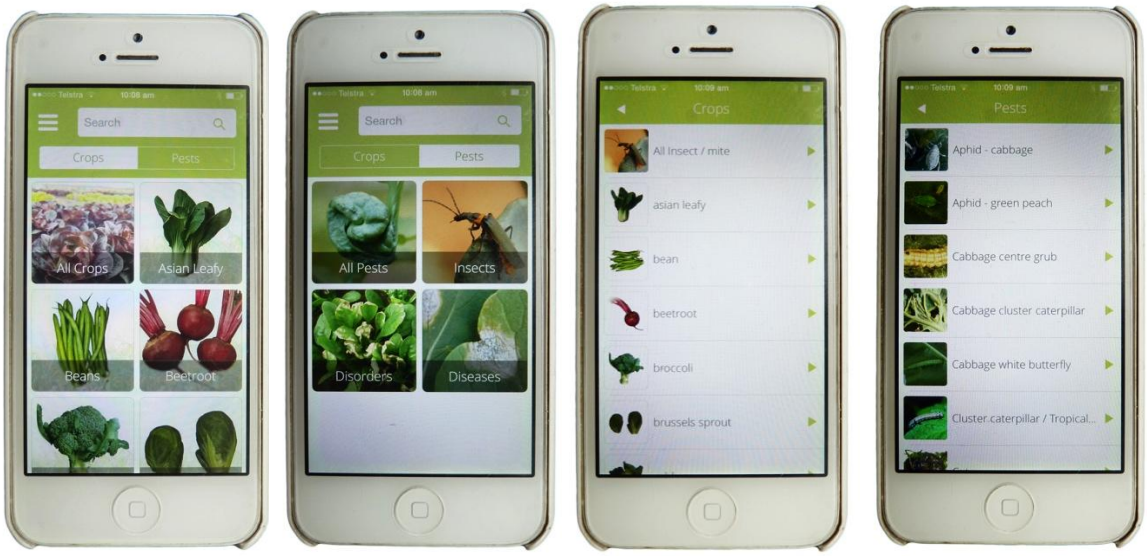

Figure 1 Opening search screens of app. In this case the user has searched by pest, then insect, then broccoli

On opening the entry, the viewer is presented with one or more photos. Tapping an information icon (i) shows a caption for the photograph. Tapping the name of the disease / insect reveals its Latin name. A series of dots on the picture indicates the number of photographs available (up to nine for each entry). These have been chosen to show different lifestages of the insect, different severities of disease, closeups and wider crop shots, all of which may aid proper diagnosis. Tapping the photo allows it (and the other photos for the entry) to be rotated and viewed full screen with caption in place. Simply swiping across the screen easily and quickly scrolls through the photo collection.

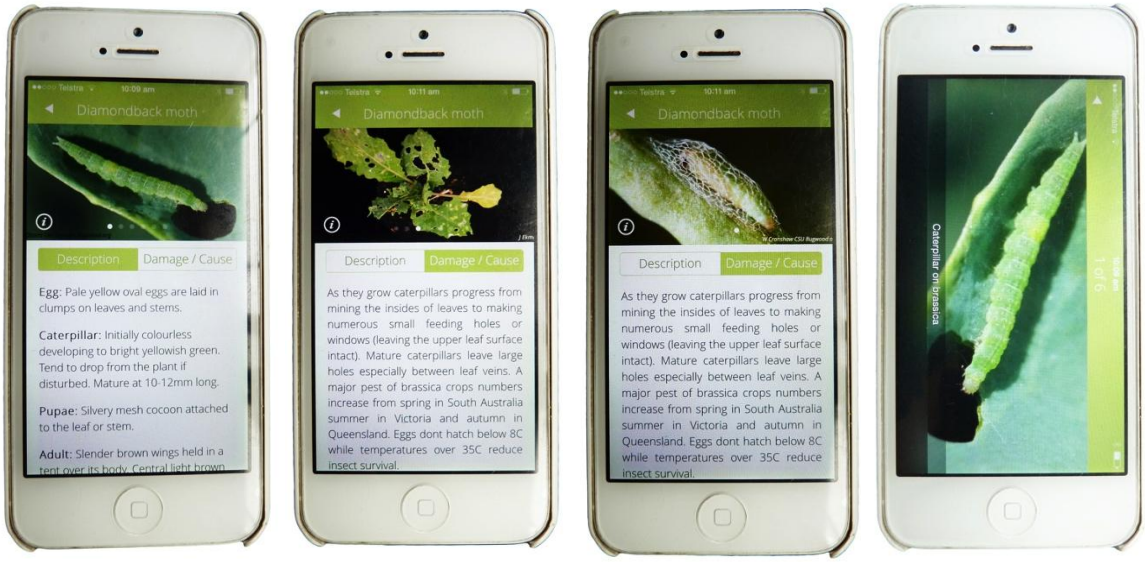

Figure 2 Example of screens relating to a pest entry, including full screen image

Installing the latest update will increase the number of individual entry records to 250: 84 diseases, 67 disorders and 99 insect pests and beneficials (see Appendix 2 for details). These are illustrated with 883 photographs cropped and with pixel resolution adjusted for optimum display on mobile devices. Photographs sourced from outside the immediate project team have the name of the photographer and, where appropriate, their organisation, embedded within them as a credit.

Outputs

Pest and disease field guides

Field guides to brassica and babyleaf crops were printed in June 2014. Over 900 copies have been distributed, with only a few books still available to meet continuing requests.

Field guides to sweet corn, sweetpotato and *Apiaceae* crops (carrots, celery and parsley) have been printed and distribution has commenced. Between 80 -100 copies of each book were distributed at the National Horticulture Convention 2015. There are plans to continue distribution at Field days (eg July field day in Bundaberg for sweetpotato) and through the State agriculture organisations (eg Agric WA for the carrots book). Availability of the books has been promoted through the AUSVEG Weekly update and through HIA communication channels.

Figure 3 Covers of books published in June 2014 (upper row) and June 2015

Publication details as follows:

Title: Pests, Diseases and Disorders of Brassica Vegetables: A field identification guide
Authors: Jenny Ekman, Len Tesoriero & Stuart Grigg
ISBN: 978-0-9925251-1-8
Dewey no: 635.3
Published: June 2014

Title: Pests, Diseases and Disorders of Babyleaf Vegetables: A field identification guide
Authors: Jenny Ekman, Len Tesoriero & Stuart Grigg
ISBN: 978-0-9925251-0-1
Dewey no: 635.5
Published: June 2014

Title: Pests, Diseases and Disorders of Sweetpotato: A field identification guide
Authors: Jenny Ekman & Jerry Lovatt
ISBN: 978-0-9925251-2-5
Dewey no: 635.3
Published: June 2015

Title: Pests, Diseases and Disorders of Sweet corn: A field identification guide
Authors: Jenny Ekman
ISBN: 978-0-9925251-3-2
Dewey no: 635.672
Published: June 2015

Title: Pests, Diseases and Disorders of Carrots, Celery and Parsley: A field identification guide
Authors: Jenny Ekman & Len Tesoriero
ISBN: 978-0-9925251-4-9
Dewey no: 635
Published: June 2015

Pest and disease application ('app')

All of the information from the field guides, as well as some additional entries on other pests and diseases, is coded and available in the app. The final update (scheduled early July 2015) will upgrade the app to OS 8, change a number of minor functions and add a disclaimer which the user must accept before opening the app. As stated, the app currently includes 250 entries and over 880 photographs of pests, diseases and disorders affecting levy paying vegetable crops. The main focus is on materials which are also shown in the field guides. It should therefore be noted that there is currently only limited information relating specifically to solanaceous, cucurbit and allium crops. However brassicas, chards, lettuce (loose leaf types), apiaceae, sweet corn and sweetpotato all have a large number of entries.

The app is an easy and free download available for both Apple and Android platforms (**Figure 4**). It can be found by simply searching for "VegPestID" on any mobile device. Installing the app loads the

entire database onto the memory of the device. Depending on internet connection speed, this may mean photos are slow to appear the first time the app is used. However, it also means it can be used while offline or out of range, important for field usability.

Figure 4 Poster promoting Veg Pest ID app with QR code for instant download

Outcomes

Pest and disease field guides

A total of 1,000 copies of each of 'Pests, Diseases and Disorders of Brassica Vegetables: A field identification guide' and 'Pests, Diseases and Disorders of Babyleaf Vegetables: A field identification guide' were printed in June 2014. The guides have been promoted at industry events, through the AUSVEG weekly e-news and through *Vegetables Australia* magazine. Over 900 of each guide have now been distributed directly to growers, agronomists and other service providers. Some of this distribution has occurred from direct requests, with books mailed to growers. A large number were given out at the 2014 AUSVEG convention. Others have been distributed at field days, workshops and meetings, often with the assistance of local Departmental organisers. For example, Stewart Learmonth, Rachel Lancaster and Brenda Coutts (Agric WA) have distributed around 300 books to growers in WA while Stuart Grigg has distributed at least 200 books to growers in the Werribee, Cranbourne and Gippsland districts of Victoria.

The first two books proved extremely popular with much positive feedback from growers, agronomists and other service providers to industry. For this reason that the steering committee decided that at least two more 'ute guides' would be a useful output from the project.

Three more guides have now been printed and distribution has commenced. Availability of the books is being promoted through HIA, AUSVEG and directly on the AHR website. Electronic versions of the field guides will also be available through the AUSVEG and AHR websites. These will be downloadable as i-books and pdfs.

Pest and disease application ('app')

The app was also promoted at the 2014 AUSVEG convention, however downloads were initially more limited. Reasons for this included:

- Initial problems with downloading images
- Diseases and disorders listed for crops for which there was no photograph of the disease or disorder on that specific crop
- Limited library of pest types and photographs

The first two of these issues have now been addressed.

After initial installing, opening and viewing, all photographs are now correctly referenced through the database and re-load quickly on opening the entry on a specific pest, disease or disorder.

All disease and most disorder entries are now crop specific. So, for example, entries on Anthracnose are listed as 'Anthracnose – brassica', 'Anthracnose – lettuce' and 'Anthracnose – spinach'. Similarly, disorders such as 'Herbicide damage – corn' and 'Herbicide damage – chard' have pictures only of that crop or crop family.

The app was promoted at the 2015 National Horticulture Convention. The response was a lot more positive then previously. We expect uptake will be much greater with the major new improvements. In addition, the app now forms what is effectively a companion e-version to the five books. This should be another factor increasing uptake of this new technology.

Evaluation and discussion

A number of growers (9), service providers (13) and other supply chain members (3) were surveyed at the National Horticulture Convention to find out the types of information they most valued, which of the outputs produced were relevant to them, what they liked about these outputs and how they could be improved.

Perhaps unsurprisingly given that the participants were interested in the books / app, all but two nominated pest and disease information among their top three choices. The next most popular choices were production (13), soil health (10) and postharvest information (9).

Eighteen of the 27 participants said that the app was relevant to their business. The guides on babyleaf, brassicas and carrots, celery and parsley were relevant to 15 of the participants with slightly lower numbers for the books on sweet corn and sweetpotato. This is consistent with the more specific focus of these latter books. It should be noted that only 500 copies were printed of these two publications instead of 1,000 as it was expected demand would be more limited.

Pest and disease field guides

Although this project was intended to simply update and republish old vegetable industry resources, it has actually produced a number of entirely new publications. Moreover, while the initial aim determined by the steering committee was to produce at least three physical publications, the project will actually produce a series of five.

The books produced so far have been extremely popular. At the start of the project there was a strong feeling that books were a slow and old-fashioned method of communication in a world where most answers are found on Google. However, there appears little doubt that many vegetable growers still like to hold a book in their hand, at least for identifying problems in their crop. While they may then search for more information online, flicking through a small book remains a quick and easy first step in identification. It also doesn't need to be charged, and can be seen in bright light out in the field.

The format of the publications was part of the key to their success—clear pictures, minimum text, spiral bound with water resistant paper, a size easily held in the hand and not overfilled with unnecessary information. Following on from comments made on the first books, a measuring ruler and 'problem solver' have been added to the last three to further improve their usefulness.

Participants in the survey scored the books an average of 8.8/10, indicating they felt they were extremely good. The most popular features were the clear pictures and concise information provided. Other comments included that they liked the compact size of the books, that they were attractive and colourful and that they featured a good range of pests and beneficial insects. One lettuce grower said he particularly liked that the pictures were of fancy and babyleaf lettuce "*Even using Google you can usually only find pictures of iceberg. It's really good to see pictures of the diseases on lettuces like the varieties I grow*"

The new books include a number of exotic threats as well as resident pests and diseases. A

wholesaler surveyed commented "*The guide works as a good reference for quality problems (with rots and diseases) especially when we are monitoring imported products*". This feature was also discussed with a Plant Health Australia representative, who was keen to expand on this aspect of the books.

A number of participants suggested that the main way to improve the books would be to add more information on prevention or treatment, perhaps including IPM strategies.

Pest and disease application ('app')

The project has also developed a pest and disease identification app. This is a completely new method of providing information to the vegetable industry. While other apps have been developed for pest and disease identification, these mainly focus on either home gardeners (eg My Garden by Yates) or broadacre crops (eg Insect ID and Weed ID by GRDC, MyPestGuide by DAFWA). There are also apps by fertiliser companies diagnosing nutritional issues in a limited range of horticultural crops (eg CheckIT by Yara) and a version of the IPNI (International Plant Nutrition Institute) photo library which is downloadable for portable devices. In all of these, coverage of vegetable crops is extremely limited. Moreover, many apps are designed to sell product.

As far as we are aware, 'Veg Pest ID' is unique. However, development has not been without significant difficulties. While BreakThrough Apps had previously worked for the vegetable industry, a lot of time was spent discussing how the information could be best presented, what was important and what was a logical way to search for a specific pest or disease. While a searchable database sounds simple enough as a concept, understanding the process flow and overcoming limited flexibility in presentation was quite challenging.

Participants in the survey gave the app an average score of 8.7/10, indicating they thought it was very good. Two participants did, however, score the app lower than the books, perhaps being less comfortable with this technology. Despite this, a number of survey participants commented that they found the app easy to use. A vegetable industry IDO surveyed said "*It's fantastic, easy to navigate and use and has a good looking interface. I like that it's not too content-heavy too*".

The main suggested improvements to the app involved:

- Adding information on crops not currently covered: cucumbers, zucchinis and capsicums were mentioned several times while one allium grower was disappointed to find little information. Six of the 27 survey participants specifically asked for expanded crop coverage. Others did not take the survey as they grew crops which are not included, such as potatoes or beans
- Including more pictures of each pest or disease, particularly photographs that show different lifestages or disease stages
- Providing information on common control or management methods, or possibly linking to that information on a website eg APVMA.
- Adding indications of damage thresholds
- Including pest distribution maps / information
- Improving the quality of some pictures, which were felt to be low quality (which is true)
- Adding an extra category of weeds

Now that the structure has been created, it should be relatively simple to expand the information within. It could be possible in the future to add interactive features, such as the capacity for growers to report influxes of a specific pest. For example, a grower noticing a plague soldier beetle could register this as a sighting at a specific location, effectively alerting other growers in the region that this pest may be arriving in larger numbers.

The excellent MyPestGuide app by DAFWA includes a facility to create a report, including a photograph taken with a mobile phone, which is sent to DAFWA for identification. While this clearly requires a high level of ongoing monitoring and maintenance, such a facility could be another useful addition. This app also includes a problem solver feature—another potential addition—but has the major drawback that only one picture is presented for each pest.

One agronomist asked if it would be possible for them to add extra pictures of pests or diseases, as they came across them. Many agronomists certainly have large photo libraries. Creating some mechanism whereby users could upload photos that would – after some approval process – appear on the app would help to increase engagement with this resource among the wider vegetable industry.

The possibilities of expanding the app are significant. However, to take proper advantage of this, the app needs to be updated regularly, particularly as new software platforms are produced for mobile devices. Ideally, a content management system needs to be added to allow more regular updates. Many of the delays (and costs) in fixing errors and adding extra entries / information could have been avoided if AHR had been able to do these ourselves rather than waiting on the availability of the app developers. The cost of this was estimated at around $8,000.

In summary, while many growers we spoke to agreed that the app was the way of the future, the attraction of printed material remains strong. Both have their place, particularly as aids to identification of pests, diseases and disorders of vegetable crops.

Recommendations

BOOKS

1. The 'ute guides' have proven extremely popular with growers and their service providers. While the app will provide a longer term and more readily updateable and expandable source of pest and disease information, a significant percentage of current members of the vegetable industry appear to prefer a physical, printed item over the electronic version. New or updated ute guides which could be added to the series include:
    a. Solanaceae (Capsicum, chillies and eggplant)
    b. Cucurbits (Cucumbers, pumpkin, squash, zucchini)
    c. Lettuce (NSW DPI book still available, but focused on field grown head lettuce)
    d. Peas and beans (Beans guide still available from QDAF)
    e. Alliums (Leeks, green onion)
2. It has become clear during this project that one of the biggest issues faced by growers is weed control. This is especially the case in mechanically harvested crops such as babyleaf, which are abandoned if weeds take hold. However, of nearly 300 publications referenced, only three fact sheets deal specifically with weed identification and management. Major issues include:
    a. Identification of weeds at seedling stage for early eradication
    b. Avoiding herbicide damage to crops
    c. The role of weeds as sources of viruses and disease
    d. The role of weeds as alternative hosts to pests and / or beneficial insects
    e. Herbicide interactions with different soil types and the effects of temperature and irrigation

    Clear guidelines on weed identification and management within different crops and soil types would be of major benefit to vegetable growers.
3. While the ute guides include information on a number of nutritional disorders on specific vegetable crops, there is still a need for a more general guide to vegetable nutrition. This could build on the book "Plant nutrient disorders vol 3 - Vegetable crops" by Weir and Cresswell (NSW DPI). Although identified as a high priority by the steering committee, the time and resources to republish this particular publication could not be allocated from within the current project. This is largely due to the large number of new digital photographs needed. Moreover, this is not as simple as just photographing symptoms in the field. In this case, symptoms would have to be induced in plants or plants tested in order to be assured that the photograph showed a true example of that specific deficiency / toxicity.

    Such a publication could include:
    a. A diagnostic key for common deficiencies
    b. Specific information on deficiencies in major crop groups

c. Nutrient profiles that could be expected in different soil types plus soil sampling guidelines

d. Fertiliser recommendations by crop and soil type

PEST AND DISEASE APP

One of the major reasons for developing the app was to give vegetable farmers information that is up to date, easily accessible and available for the long term. This has included creating a database of photographic resources of immediate value to vegetable farmers. Perhaps surprisingly, this database is an Australian vegetable industry first, as a similar resource is not known to exist for any other horticultural industry, either in Australia or internationally.

Maintaining and updating this resource will ensure that photographs and information are retained beyond the end of the project, and indeed beyond the careers of individual researchers, consultants, extension staff and others who have contributed materials.

To maximise the value of the app to industry members it needs to be comprehensive, covering each disease or disorder on each crop type. While the 250 records in the database cover most insects, many diseases and some disorders, there is still very little specific information relating to issues with cucurbits, solanaceae and alliums. Nutritional disorders in particular are only lightly dealt with. The app could also be expanded to include more information, extra photographs and links to resources describing control strategies.

It is therefore proposed that the vegetable industry fund an ongoing project to maintain, improve and further develop the pest and disease identification app. This could be for an initial period of three years to greatly expand the app database. The required resources may be re-evaluated after this time, with less time and money required for additions. In this case funding would be needed simply for ongoing hosting and maintenance of the resource. Funding should also be provided for a content management system, which would make regular updates more economical in the long term.

Intellectual Property/Commercialisation

No commercial IP generated

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DAFWA	Rachel Lancaster, Stewart Learmonth, Brenda Coutts
DEPI Vic	Rob Dimsey
IPMC	Andy Ryland
NSW DPI	Len Tesoriero, Sandra McDougall, Valerie Draper, Tony Napier, Lowan Turton
NT DPI&F	Haidee Brown
Peracto	Hoong Pung
QDAF	Jerry Lovatt, John Duff, Mike Hughes
University of Queensland	Jane O'Sullivan

4. *And from the USA*

John Damicone	Oklahoma State University
Lindsey DuToit	Washington State University
Bugwood.org	

Appendices

1. List of industry resources collated as hard copies or electronically
2. List of entries (pests, beneficials, diseases and disorders) included in the app

Appendix 1 – Vegetable industry resources

Legend for area of research

P&D – Pest and Disease Prod – Production Mgmnt – Farm management
Irrig – Irrigation Postharv – Postharvest handling

Area	Title	Author	Year	Organisation	Publication type
Books					
Mgmnt	Safe vegetable production		2002	DPI Vic	Booklet
P&D	Brassica grower's handbook	Heisswolf S	2004	QDAFF	Book 318p
P&D	Controlling invertebrate pests in agriculture	Page J, Horne P	2012	IPM Technologies	Book 128p
P&D	Diseases of vegetable crops in Australia	Persley D, Cooke T, House S	2010	QDAFF	Book 304p
P&D	Integrated Pest Management in greenhouse vegetables	Goodwin, S	2002	NSW DPI	Book 216p
P&D	Integrated Pest Management in lettuce: information guide	McDougall, S & Creek, A	2002	NSW DPI	Book 154p
P&D	Keep it clean - reducing costs and losses in the management of pests and diseases in the greenhouse	Badgery Parker, J and Jarvis, J	2009	NSW DPI	Book 152p
P&D	Revegetation by Design	Taverner, P et al	2006	SARDI	Book 90p
P&D	The Good Bug Book 2nd edition	Papacek et al	2002	NSW DPI	Book 110p
P&D	Vegetable integrated pest management in Tasmania	Wardlaw, F	2004	DPIWE	Book 213p
P&D	Western flower thrips weed management???	Burfield T	20??	SARDI	Booklet
Prod	Australian vegetable growing handbook	Salvestrin, J	1998	NSW DPI	Book 344p
Prod	Brassica growers handbook	Heisswolf S et al	2004	QDAFF	Book
Prod	Capsicum and chilli information kit	QDAFF	1999	QDAFF	Booklets
Prod	Commercial greenhouse cucumber production	Badgery Parker, J & James, L	2010	NSW DPI	Book 216p
Prod	Greenhouse capsicums - a guide to growing export quality hydroponic capsicums in Tasmania	Bentley, Hart	2001	DPI Tasmania	Book 62p
Prod	Managing nutrient solutions in hydroponics			NSW DPI	Book

Area	Title	Author	Year	Organisation	Publication type
Prod	Plant nutrient disorders Vol 3 Vegetable crops	Weir R, Cresswell G	1993	NSW DPI / Inkata Press	Book 105p
Prod	Sweet corn growers handbook	Wright R et al	2005	QDAFF	Book ~300p
Soils	SOILpak for vegtable growers	McMullin, B	2000	NSW DPI	Book 86p
Booklets and Ute guides					
Irrig	Irrigation Scheduling for Vegetable Crops: A Growers Guide		2002	DNRE	Ute guide
Irrig	Irrigation of carrots and onions - best management guidelines	Hickey, M, Hoogers, R, Hulme, J, Philpot, K	2002	NSW DPI	Book 66p
Irrig	Managing water for yield and profit	Jobling J et al	2008	AHR	Booklet / CD
Irrig	Maximising returns from water in the Australian vegetable industry: NSW	Hickey M, Hoogers R	2006	NSW DPI	Booklet 52p
Mgmnt	Being Safe in the Greenhouse	Badgery Parker, J and Jarvis, J	2004	NSW DPI	Booklet 28p
Mgmnt	Biosecurity induction manual for Bundaberg horticultural farms		2010	PHA	Booklet 20p
Mgmnt	Farm biosecurity manual for Nth Adelaide plains veg growers		2010	PHA + Scholefield Robinson	Booklet 53p
Mgmnt	Guidelines for environmental assurance in Australian horticulture	Lovell J	2006	TQA, H4T, Nat Heritage trust	Booklet, checklists, CD
P&D	A guide to common pest and beneficial insects in Brassica crops	Bentley J	1997	DPI Vic	Booklet?
P&D	A handbook of plant diseases in colour Vol 2 field crops	Vock N	1978	QDAFF	Binder
P&D	Advancing the integrated management of diamondback moth in crucifer vegetables	Endersby N et al	2000	SARDI	Booklet 9 sections,
P&D	Best practice control of fusarium pythium and rhizoctonia root rots	Dal Santo, P & Holding, R	2009	AgAware Consult	Booklet 24p
P&D	Best practice control of sclerotinia in beans	Dal Santo, P & Holding, R	2009	AgAware Consult	Booklet 21p
P&D	Best practice control of sclerotinia in lettuce	Dal Santo, P & Holding, R	2010	AgAware Consult	Booklet 26p

Area	Title	Author	Year	Organisation	Publication type
P&D	Best practice downy mildew control in vegetables	Dal Santo, P & Holding, R	2010	AgAware Consult	Booklet 30p
P&D	Best practice powdery mildew control in vegetables	Dal Santo, P & Holding, R	2011	AgAware Consult	Booklet 30p
P&D	Biological controls for sclerotinia diseases		2004	DPI Vic	Booklet 15p
P&D	Brassica best practice ute guide	Dimsey, R et al	2010	DPI Vic	Ute guide 72p
P&D	Brassica problem solver and beneficial identifier	Heisswolf S et al	2004	QDAFF	Booklet 40p
P&D	Field guide to pests, diseases and disorders of vegetable brassicas	Donald, C et al	2000	DPI Vic	Ute guide 85p
P&D	Guide to common diseases and disorders of bunching vegetables in Australia	Kita N, Minchinton E, Murdoch C & Kreidl S	2003	DPI Vic	Ute guide 59p
P&D	Guide to common diseases and disorders of parsley	Minchinton, E, Auer, D, Martin, h, Tesoreiro, L	2006	DPI Vic & NSW DPI	Ute guide 46p
P&D	Handbook of pests, diseases, disorders and beneficials of outdoor head lettuce in New Zealand	Minchin S	2008	Market Access Solutionz	Ute guide 100p
P&D	Identification of insects, spiders and mites in vegetable crops - Trainers handbook	Heisswolf S, Kay I, Walsh B	2010	QDAFF	Booklet 78p
P&D	Identification of insects, spiders and mites in vegetable crops - Workshop manual	Heisswolf S, Kay I, Walsh B	2010	QDAFF	Booklet 86p
P&D	Insect Pest Guide: a guide to identifying vegetable insect pests and their natural enemies in the dry topics	Brown, J	2004	QDAFF	Ute guide
P&D	Integrated management of diamondback moth in crucifers - the handbook	Endersby N et al	19??	SARDI, Vic DPI, many	Ute guide
P&D	Lettuce best practice ute guide	Dimsey, R et al	2010	DPI Vic	Ute guide 62p
P&D	Pests and beneficials in brassica crops	Heisswolf S, Brown E		QDAFF	Ute guide
P&D	Pests of vegetable brassica crops in Western Australia	Learmonth S, Berlandier F, Lancaster R	2003	Ag WA	Booklet 22p

Area	Title	Author	Year	Organisation	Publication type
P&D	Pests, beneficials, diseases and disorders in cucurbits: field identification guide	Napier, T, McDougall, S, Watson, A, Kelly, G	2009	NSW DPI	Ute guide 150p
P&D	Pests, beneficials, diseases and disorders in lettuce: field identification	Goodwin, S, Watson, A, McDougall, S, Creek, A	2003	NSW DPI	Ute guide
P&D	Pests, diseases, disorders and beneficials in greenhouse vegetables: field identification guide	Goodwin, S	2002	NSW DPI	Ute guide 140p
P&D	Sweet corn pests and their natural enemies	Llewellyn, R	2000	QDAFF	Ute guide 70p
P&D	Sweet corn problem solver and beneficial identifier	Wright R et al	2005	QDAFF	Booklets
P&D	Thrips and Tospovirus - a management guide	Persley D et al	2007	QDAFF	Booklet 19p
Prod	Brassica information kit	QDAFF	2004	QDAFF	Booklets
Prod	Good Practice Guide	Vegetables WA	2007	Vegetables WA	Booklet series
Prod	Growing Chinese cabbage in WA	Burt J, Phillips D, Gatter D	2006	DAFWA	Booklet 28p
Prod	Guide to using native plants on the northern Adelaide Plains to benefit horticulture	Wood G et al	2009	SARDI	Ute guide 61p
Prod	Leafy Asian vegetables and their nutrition in hydroponics	Parks S, Murray C	2011	NSW DPI	Booklet 24p
Prod	Optimising yield and shelf life of iceberg and cos lettuce	Titley M et al	2007	AHR	Booklet 20p
Prod	Sweet potato production guide for the Top end	Traynor M	2005	DPIFM	Booklet 13p
Soils	Diagnosing and ameliorating problem soils	Patabendige, D	2005	Ag WA / GRDC	Booklet 14p
Soils	Healthy soils for sustainable vegetable farms	Whitman, H, Anderson, A, Kelly, J, McKenzie, D	2007	Arris, AUSVEG	Ute guide 80p + DVD
Soils	No till permanent bed vegetable production	Rogers G	2002	AHR	Booklet 20p
Soils	Soil management for WA veg growers	Foord, G & Paulin, B	2005	VegWA & DAFWA	Booklet 22p
Soils	Soilwise	Brunton, V	2007	NSW DPI	Ute guide 24p
Software / CDs					

Area	Title	Author	Year	Organisation	Publication type
Irrig	Best management guidelines for irrigated vegetable crops		2003	NSW DPI	CD package
P&D	Brassica integrated crop management CD-ROM	Walsh B et al	2004	QDAFF, SARDI	CD-ROM
P&D	Lettuce crop protection toolkit	McDougall S, Troldahl D, Napier T	2011	NSW DPI	CD-ROM
P&D	Managing Western flower thrips & tomato spotted wilt virus in vegetables			DPI Vic	CD-ROM
P&D	Diamondback moth development calculator	Endersby N, Ridland P	1996	DPI Vic	Computer program
P&D	Diamondback moth sampling plan	Endersby N, Ridland P	1996	DPI Vic	Computer program
P&D	Integrated pest management for brassicas	IHD Knoxfield	2002	Vic DPI	DVD
P&D	Plant parasitic nematodes of Australia	Nobbs J	20??	SARDI	DVD
Irrig	Vegetable irrigation scheduling system	Vegetables WA	2010	Vegetables WA	Software
Mgmnt	VegTool 1.1 program and manual	Kelly G et al	2011	NSW DPI, SR	Program and manual 32p
P&D	Western flower thrips training and information pack	Kay I	2009	QDAFF	DVD
Posters					
Postharv	Asian vegetable names	Ekman J	2007	NSW DPI	Poster
P&D	Best practice IPM - Overview	Dimsey, R et al	2010	DPI Vic, QDAFF	Poster
P&D	Brassica crop protection products	Dimsey, R et al	2010	DPI Vic	Poster
P&D	Carrot defects poster	Pung H, Cox P	1997 ?	Serve-Ag	Poster
P&D	Clubroot poster	Donald C et al	2005	DPI Vic	Poster
P&D	Common pests and diseases of asian leafy brassicas	Tesoriero L, Brunton V	2005	NSW DPI	Poster x 2
P&D	Common pests and diseases of cucumber	Steiner M, James L	2003	NSW DPI	Poster x 2
P&D	Common pests and diseases of lettuce	Tesoriero L, James L	2005	NSW DPI	Poster x 2
P&D	Control of downy mildew on processing peas poster	Pung H, Cross S	2002	Peracto	Poster

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P&D	Impact of insecticides on natural enemies found in brassicas		2005	SARDI	Poster 2p
P&D	Lettuce crop protection products	Dimsey, R et al	2010	DPI Vic	Poster
P&D	Pathogens of importance and their impact on the Australian vegetable industry	Porter I, Donald C, Minchinton E, Wilson L	2007	DPI Vic	Poster
Web based resources					
Irrig	Water use efficiency-Interpretation and training in the use of soil moisture data	Jobling J et al	2009	AHR	Training program - Powerpoints 111slides
Mgmnt	Impact of increased climate variability on the vegetable industry	AHR	2013	www.vegetableclimate.com	Website
Mgmnt	Skills audit tool	Fullelove D	2011	AUSVEG	Web based
Mgmnt	Vegetable Carbon Calculator	Arris, SARDI	2010	www.vegiecarbontool.com.au	Web based
Mgmnt	VegTool 1.1 program and manual	Kelly G et al	2011	NSW DPI, Scholefield Robinson	Program and manual 32p
P&D	Insect keys (aphids, leafhoppers, fruit flies)	Fletcher M	2005	NSW DPI	Online key
P&D	Northern territory insects		20??	DPIFM	Web based
P&D	Northern territory insects		20??	DPIFM	Web based
P&D	White blister on broccoli presentation	Minchinton E et al	2003	DPI Vic	PowerPoint
Prod	Nutrient disorders in greenhouse cucumbers Agfact but no pdf		2004	NSW DPI	Webpage
	Vegetable Resource Database	Trohldahl D	2010	NSW DPI	Web based
Fact sheets					
P&D	Brassica integrated pest and disease management	Jevremov D & Donald C	2003	DPI Vic, Arris	Fact sheet 4p
P&D	Capsicum virus diseases	Persley D, Sharman M, ThomasJ	2005	QDAFF, Arris	Fact sheet 2p
P&D	Control of sclerotinia diseases	Villalta O, Pung H	2005	DPI Vic, Serve-Ag, Arris	Fact sheet 4p
Postharv	Cool chain	Dahlenburg A, Palmer M	2004	SARDI, Arris	Fact sheet 4p

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Mgmnt	Freshcare	Hamilton-Bate C	2004	Freshcare, Arris	Fact sheet 2p
P&D	Greenhouse cucumber diseases	Tesoriero L	2006	NSW DPI, Arris	Fact sheet 4p
P&D	Integrated pest management in celery	Page, J, Horne, P	2004	IPM Tech, Arris	Fact sheet 2p
P&D	Integrated pest management in lettuce	McDougall, S	2004	Arris	Fact sheet 4p
P&D	Integrated pest management sweet corn		2003	Arris	Fact sheet 4p
Irrig	Irrigating vegetable crops with recycled water	Stevens D, Kelly J	2004	Arris	Fact sheet 4p
Irrig	Irrigation management	Hickey, M	2004	NSW DPI, Arris	Fact sheet 4p
P&D	Lettuce aphid	McDougall S, Baker G, DelSanto P, Westcott A	2004	NSW DPI, SARDI, AgAware, Arris	Fact sheet 4p
P&D	Management of carrot diseases	Davison E, McKay A, Jones R	2003	DPI Vic, Arris	Fact sheet 4p
P&D	Minor use program	DalSanto P	2005	AgAware, Arris	Fact sheet 2p
P&D	Pesticide resistance management	Herron G	2005	NSW DPI, Arris	Fact sheet 4p
P&D	Silverleaf whitefly management	Subramaniam S, DeBarro P	2006	QDAFF, CSIRO, Arris	Fact sheet 4p
P&D	Slug control in vegetable crops	Bound S	2005	TIAR, Arris	Fact sheet 2p
Prod	Spray application	Napier T Geitz G	2004	NSW DPI, Arris	Fact sheet 4p
P&D	Weed management	Frost P	2005	ServeAg, Arris	Fact sheet 4p
P&D	Western flower thrips	Burfield, T	2004	SARDI, Arris	Fact sheet 2p
Irrig	1 Soil moisture monitoring	Hickey M	2007	NSW DPI	Fact sheet 4p
P&D	2 White blister		2007	Vic DPI	Fact sheet 4p
Prod	3 Composting on-farm		2007	NSW DPI	Fact sheet 4p
Prod	4 Precision agriculture		2008	Aust centre precision agriculture	Fact sheet 4p
P&D	5 Native vegetation and pest control		2008	SARDI	Fact sheet 4p
Prod	6 Reducing nitrate and nitrite concentrations in vegetable crops	Parks S Blaesing D	2008	NSW DPI / Serve-Ag	Fact sheet 4p
Soils	7 Healthy soil management		2008	various	Fact sheet 4p
P&D	8 Minor use pesticides	Dal Santo P	2008	AgAware Consult	Fact sheet 4p

Area	Title	Author	Year	Organisation	Publication type
P&D	9 Diamondback moth	Baker G et al	2008	SARDI	Fact sheet 4p
P&D	10 Controlling spinosad resistance with WFT	Herron et al	2009	NSW DPI	Fact sheet 4p
P&D	11 Identifying key pests and diseases of Asian vegetables	Tesoreiro L, Dimsey, R et al	2009	Vic DPI, NSW DPI	Fact sheet 4p
Soils	12 Indicators of soil health		2009	Vic DPI	Fact sheet 4p
Prod	13 Gross margin comparison tool for vegetable growers	Thompson L	2009	Scholefield Robinson	Fact sheet 4p
Prod	14 Environmental effects on greenhouse cucumber production	Ekman J, Parks S	2009	NSW DPI	Fact sheet 4p
P&D	15 Minor use permit registration	Dal Santo P	2009	AgAware	Fact sheet 4p
P&D	16 IPM strategies for silverleaf whitefly AND industry biosecurity plans		2010	QDAFF, PHA	Fact sheet 4p
P&D	17 Managing veg disease with silicon AND greenhosue preventive disease management		2010	TIAR, NSW DPI	Fact sheet 4p
Irrig	18 water use efficiency AND soil health management		2010	AHR, DPI Vic	Fact sheet 4p
P&D	19 IPM compatible fungicides and optimising water and nutrients in WA		2010	DAFWA	Fact sheet 4p
Prod + P&D	20 Soilless production systems AND active surveillance of pests and diseases		2010	Food Chain Intel, Vic DPI	Fact sheet 4p
P&D + Prod	21 SAR for disease control in rhubarb and environmentally sustainable use of mineral fertilisers		2010	AHR, DAFWA	Fact sheet 4p
Prod	22 Mechanical harvesting of broccoli AND WFT control with spinosad	Rogers G, Herron G	2010	AHR, NSW DPI	Fact sheet 4p
Postharv + Prod	23 Sweetcorn disinfestation with phosphine + CA AND slug control		2011	ServeAg, IPM Technologies	Fact sheet 4p
P&D + Prod	24 Pesticide residues under protected cropping AND best practice production models	Melville P	2011	AgAware Consulting	Fact sheet 4p
P&D + Soils	25 Managing downy and powdery mildew and white blister AND soil borne disease management	Minchinton E et al	2011	DPI Vic	Fact sheet 4p

Area	Title	Author	Year	Organisation	Publication type
Irrig	26 Better vegetable irrigation AND greenhouse waste water recycling		2011	NSW DPI, Smith G	Fact sheet 4p
P&D + Postharv	27 Integrated weed management brassicas AND residues in export vegetables		2011	Murdoch G, Bodnaruk K	Fact sheet 4p
P&D	28 Thrips management in beans AND systems for limiting soilborne diseases	Ironside D, Pattison T	2011	QDAFF	Fact sheet 4p
P&D + Mgmnt	29 Hippodamia and micromus biocontrol agents AND protected cropping energy efficiency	Pilkington L, Badgery-Parker J	2012	NSW DPI	Fact sheet 4p
P&D	30 Disease resistant sweetcorn AND control of pythium	Fekybelu S and Minchinton E	2012	QDAFF, Vic DPI	Fact sheet 4p
P&D	31 Virus disease control in cucurbits AND IDM for carrot powdery mildew	Coutts B and Watson A	2012	DAFWA, NSW DPI	Fact sheet 4p
Prod	32 Greenhouse best practice AND design of precision irrigation	Ferguson K and Lambert S	2012	SARDI, TIA	Fact sheet 4p
Prod + P&D	33 Comparison of biodegradable and polyethylene mulch AND mass rearing *Orius armatus*	Limpus S and Chilman L	2012	QDAFF, manchil IPM services	Fact sheet 4p
Prod	34 Baby leaf lettuce production under covers AND overcoming onion stunting and brassica stem canker	Britton C and Hall B	2013	Britton Produce, SARDI	Fact sheet 4p
Postharv + P&D	35 Evaluation of washing chemicals AND monitoring and controlling bean root rots	Premier R and Watson A	2013	Global FS, NSW DPI	Fact sheet 4p
P&D	36 Management of virus diseases AND insect pathogens and cuticle hardening	Persley D and Asgari S	2013	QDAFF, Uni of Qld	Fact sheet 4p
P&D	Carrot weevil	Botha, J et al	2001	Ag WA	Fact sheet 2p
P&D	Celery mosaic virus	Latham L	2006	Ag WA	Fact sheet 4p
P&D	IDM strategy for TSWV control in nurseries	Coutts, B, Jones, R	2002	Ag WA	Fact sheet 1p
P&D	IDM strategy for TSWV control in vegetable crops	Coutts, B, Jones, R	2002	Ag WA	Fact sheet 1p
Prod	Incorporation of fertiliser for cauliflower and broccoli crops	Lancaster R	2007	Ag WA	Fact sheet 2p
Prod	Optimum soil pH for crop plants	Hill, P	2002	Ag WA	Fact sheet 4p

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Postharv	Postharvest handling of brassica vegetables	Tan SC	2007	Ag WA	Fact sheet 4p
Prod	Selection of fertigation equipment	Calder T	2006	Ag WA	Fact sheet 7p
P&D	Virus diseases of cucurbit crops	Coutts B	2006	Ag WA	Fact sheet 3p
P&D	Management of lettuce anthracnose	Rogers G, Titley M	2013	AHR	Fact sheet 3p
Mgmnt	Understanding and managing the impacts of climate on the Australian vegetable industry	Rogers G, Montagu K	2013	AHR	Fact sheet 8p
Mgmnt	New uses for vegetable wastes	AHR	2013	AHR	Fact sheet 2p x 8 types
P&D	Beet cyst nematode on vegetables	Vanstone, V	2006	Ag WA	Fact sheet 2p
Irrig	Carrot nutrition and irrigation	Phillips P	2005	Ag WA	Fact sheet 4p
P&D	Carrot rust fly	Botha J, Hardie D, Power G	2001	Ag WA	Fact sheet 2p
P&D	Carrot virus Y	Latham L	2007	Ag WA	Factsheet 3p
P&D	Cavity spot disease of carrots	Davison E, McKay A	1999	Ag WA	Fact sheet 3p
Prod	Fertigation of vegetables in WA	Burt J	2002	Ag WA	Fact sheet 13p
Prod	Growing broad beans in WA	Burt J	2005	Ag WA	Fact sheet 4p
Prod	Growing brussels sprouts in WA	Burt J	2007	Ag WA	Fact sheet 4p
Prod	Growing capsicums and chillies in WA	Burt J	2005	Ag WA	Fact sheet 4p
Prod	Growing celery in WA	Burt J	2005	Ag WA	Fact sheet 8p
Prod	Growing cucumbers in protected cultivation in WA	Burt J		Ag WA	Fact sheet 15p
Prod	Growing english spinach in WA	Burt J	2006	Ag WA	Fact sheet 4p
Prod	Growing fresh runner and dwarf beans in WA	Burt J	2005	Ag WA	Fact sheet 4p
Prod	Growing parsnips in WA	Burt J	2007	Ag WA	Fact sheet 4p
Prod	Growing pumpkins in WA	Burt J	2005	Ag WA	Fact sheet 4p
Prod	Growing rhubarb in WA	Burt J	2005	Ag WA	Fact sheet 3p
Prod	Growing silverbeet in WA	Burt J	2006	Ag WA	Fact sheet 3p
Prod	Growing snow peas and sugar snaps in WA	Burt J	2005	Ag WA	Fact sheet 2p

Area	Title	Author	Year	Organisation	Publication type
Prod	Growing swedes and turnips in WA	Burt J	2007	Ag WA	Fact sheet 9p
Prod	Growing witlof chicory in WA	Burt J	2005	Ag WA	Fact sheet 3p
P&D	Late blight - *Phytophthora infestans* - exotic threat to WA	Burges N, Taylor A, Mackie A, Kumar S	2005	Ag WA	Fact sheet 4p
Postharv	Minimising postharvest losses of carrots	Galati A, McKay A, Chy-Tan S	2005	Ag WA	Fact sheet 3p
Prod	Principles of vegetable crop nutrition on the Swan coastal plain	Phillips et al	2001	Ag WA	Fact sheet 4p
Soils	Soil testing: a guide to fertiliser use	Summers R, Rivers M	2002	Ag WA	Fact sheet 4p
Prod	The 3-phase method for growing broccoli on sandy soils	Phillips D, Reid A, Ramsey H	2009	Ag WA	Fact sheet 4p
Prod	The 3-phase method for growing lettuce on sandy soils	Phillips D, Reid A, Ramsey H	2009	Ag WA	Fact sheet 4p
Soils	Zone management in precision agriculture by matching fertiliser input to crop demand		2003	Ag WA	Fact sheet 8p
P&D	Clubroot factsheets (10)	Donald C et al	2005	DPI Vic	Factsheets 10p
P&D	Clubroot of cruciferous crops	Donald C	2006	DPI Vic	Factsheets 3p
P&D	Cucumber mosaic virus	Dimsey R	2005	DPI Vic	Fact sheet 2p
Irrig	Estimating crop water use with moisture accounting	Qassim A, Ashcroft, B	2006	DPI Vic	Fact sheet 4p
P&D	Integrated control of *Sclerotinia*	Porter I, Villalta O	2005	DPI Vic	Fact sheet 2p
P&D	Managing downy and powdery mildew, anthracnose and white blister	Minchinton E et al	2010	DPI Vic	Fact sheet 4p
P&D	Managing *Sclerotinia* diseases in vegetables	Villalta O, Pung H	2010	DPI Vic	Fact sheet 4p
P&D	Managing soilborne diseases in vegetables	Donald C	2010	DPI Vic	Fact sheet 4p
P&D	Strategy for control of WFT - is WFT in your crop?	Miller J et al	2002	DPI Vic & NSW DPI	Fact sheet 2p
P&D	Common insect pests of cucurbits	Brown H	2003	DPIFM	Fact sheet 6p
Prod	Eggplant (aubergine)	Poffley M	1997	DPIFM	Fact sheet 2p
Irrigation	Fertigation program for continuously harvested cucurbits	Owens G, Traynor M	2006	DPIFM	Fact sheet 3p
Prod	Growing cucumbers in the Top End	Poffley M, Owens G	2006	DPIFM	Factsheets 3p
Prod	Zucchini growing	Poffley M, Owens G	2006	DPIFM	Fact sheet 2p

Area	Title	Author	Year	Organisation	Publication type
Prod	Asian melons	Owens, G	2003	DPIFM	Fact sheet 2p
Soils	Are my soils acid	Fenton, G	1999	NSW DPI	Fact sheet 2p
P&D	Boil smut of corn	Beckingham C, Watson A	2006	NSW DPI	Fact sheet 3p
Prod	Building a greenhouse	Badgery-Parker J	1999	NSW DPI	Fact sheet 2p
Prod	Cabbage growing	Murison J, Napier T	2006	NSW DPI	Fact sheet 7p
P&D	Currant lettuce aphid	McDougall S	2011	NSW DPI	Fact sheet 4p
P&D	Diamondback moth control in Asian leafy brassica crops	Rajakulendran V	2008	NSW DPI	Fact sheet 3p
P&D	Diseases of cucurbit vegetables	Watson A, Napier T	2009	NSW DPI	Fact sheet 6p
Prod	Eggplant growing	Ullio L	2003	NSW DPI	Fact sheet 4p
Prod	Fertiliser calculations	Rose C	2004	NSW DPI	Fact sheet 2p
Prod	Field lettuce production	Napier T	2004	NSW DPI	Fact sheet 16p
P&D	Fungus gnat management in greenhouse crops	Jelinek S	2010	NSW DPI	Fact sheet 5p
P&D	Fusarium cob rot of corn	Watson A	2007	NSW DPI	Fact sheet 2p
Prod	Greenhouse covering materials	Badgery-Parker J	1999	NSW DPI	Fact sheet 2p
Prod	Growing garlic in NSW	Hickey M	2012	NSW DPI	Fact sheet 5p
P&D	Insect pests of crucifer vegetables	Hamilton J, Toffolon R	1987	NSW DPI	Fact sheet 8p
P&D	Insect pests of cucurbit vegetables	Napier T	2009	NSW DPI	Fact sheet 5p
P&D	Lettuce integrated pest management	McDougall S	2011	NSW DPI	Fact sheet 6p
Prod	Light in the greenhouse	Badgery-Parker J	1999	NSW DPI	Fact sheet 2p
P&D	Management options for fusarium wilt of snow peas	Watson A et al	2009	NSW DPI	Fact sheet 3p
P&D	Managing northern leaf blight in sweet corn	Watson A	2007	NSW DPI	Fact sheet 2p
Prod	Managing waste water from intensive horticulture a wetland system	Badgery-Parker J	2002	NSW DPI	Fact sheet 4p
Prod	Organic pumpkin production	Neeson R	2003	NSW DPI	Fact sheet 8p
Prod	Organic vegetable production	Neeson R	2010	NSW DPI	Fact sheet 7p
P&D	Powdery mildew a new disease of carrots	Watson A	2009	NSW DPI	Fact sheet 2p

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Prod	Pumpkin production primefact	Napier T	2009	NSW DPI	Fact sheet 8p
Prod	Silverbeet growing	Wade S	2009	NSW DPI	Fact sheet 8p
P&D	Silverleaf whitefly in vegetables	McDougall S	2009	NSW DPI	Fact sheet 6p
Prod	Snow peas and sugar snap peas agfact	Beckingham C	2001	NSW DPI	Fact sheet 8p
Soils	Soil management for commercial vegetables and small crops	Eldridge, S	2004	NSW DPI	Fact sheet 8p
P&D	Soilborne diseases of beans	Watson A	2009	NSW DPI	Fact sheet 6p
P&D	Two spotted mite control in perilla	Rajakulendran V et al	2010	NSW DPI	Fact sheet 3p
P&D	Vegetable integrated pest management	McDougall S	2011	NSW DPI	Fact sheet 6p
P&D	Western flower thrips and TSWV	Mcdougall S, Tesoriero L	2011	NSW DPI	Fact sheet 7p
P&D	Which thrips is that? A guide to the key species transmitting TSWV	Steiner M et al	20??	NSW DPI	Fact sheet 8p
P&D	Whitefly management in greenhouse vegetable crops	Jelinek S	2010	NSW DPI	Fact sheet 6p
Mgmnt	Business case for IPM in lettuce	McDougall S, Orr L	2011	NSW DPI, RMCG	Fact sheet 7p + Excel calculator
Mgmnt	Plant biosecurity	PHA	2011	Plant Health Australia	Fact sheet 4p
P&D	Aphid transmitted viruses in vegetable crops	Persley, D, Gambley, C	2010	QDAFF	Fact sheet 4p
P&D	Integrated virus disease management	Persley, D, Gambley, C	2010	QDAFF	Fact sheet 6p
Soils	Managing soil erosion in vegetables	Bagshaw, J	2010	QDAFF	Fact sheet 4p
P&D	Tobamoviruses management	Persley, D, Gambley, C	2010	QDAFF	Fact sheet 2p
P&D	Viruses in vegetable crops in Australia	Persley D et al	2010	QDAFF	Fact sheet 6p
P&D	Whitefly transmitted viruses in vegetable crops	Persley, D, Gambley, C	2010	QDAFF	Fact sheet 6p
Mgmnt	A smooth transition - succession planning	RMCG	2011	RMCG / VIDP	Fact sheet 4p
Mgmnt	Accessing online resources	RMCG	2011	RMCG / VIDP	Fact sheet 6p
Mgmnt	Business case new capsicum grader	RMCG	2011	RMCG / VIDP	Fact sheet 7p
Mgmnt	Business case new lettuce planter	RMCG	2011	RMCG / VIDP	Fact sheet 7p + Excel calculator

Area	Title	Author	Year	Organisation	Publication type
Mgmnt	Business case new tractor replacement	RMCG	2011	RMCG / VIDP	Fact sheet 7p + Excel calculator
Mgmnt	Business decision making	Stirling K	2011	RMCG / VIDP	Fact sheet 4p
Mgmnt	Business management: thinking through the numbers	Stirling K	2011	RMCG / VIDP	Fact sheet 4p
Mgmnt	Case study building a sound veg growing business	RMCG	2011	RMCG / VIDP	Fact sheet 7p
Mgmnt	Case study direct sales and food safety	RMCG	2011	RMCG / VIDP	Fact sheet 7p
Mgmnt	Case study supply agreements	RMCG	2012	RMCG / VIDP	Fact sheet 6p
Mgmnt	Climate change: managing variability and carbon	Stirling K	2011	RMCG / VIDP	Fact sheet 4p
Mgmnt	Consumers and markets	Boland AM		RMCG / VIDP	Fact sheet 4p
Mgmnt	Gross margins using VegTool	Stirling K	2011	RMCG / VIDP	Fact sheet 4p
P&D	Managing pesticide resistance	Stirling K	2011	RMCG / VIDP	Fact sheet 4p
P&D	Mega Pests - Crop protection basics	McMichael P et al	2011	RMCG / VIDP	Fact sheet 4p
P&D	Mega Pests - Managing chewing and biting insects	McMichael P, Thompson L, McDougall S	2011	RMCG / VIDP	Fact sheet 4p
P&D	Mega Pests - Managing foliar diseases		2011	RMCG / VIDP	Fact sheet 4p
P&D	Mega Pests - Managing soilborne diseases	McMichael P, Thompson L	2011	RMCG / VIDP	Fact sheet 4p
P&D	Mega Pests - Managing sucking insects	McMichael et al	2011	RMCG / VIDP	Fact sheet 4p
Postharv	Postharvest management for vegetables	Blaesing D	2011	RMCG / VIDP	Fact sheet 4p
Soils	Soil Health	Pattison et al	2011	RMCG / VIDP	Fact sheet 6p
Prod	Spray application basics	Napier T	2011	RMCG / VIDP	Fact sheet 8p
P&D	Thrips and Tospovirus resources		2011	RMCG / VIDP	Fact sheet 4p
Prod	Why cleaning spray tanks is important		2011	RMCG / VIDP	Fact sheet 1p
P&D	Greenhouse vegetable foliar diseases	Ferguson K		SARDI	Fact sheet 2p
P&D	Western Flower thrips	Caon G, Burfield T	2006	SARDI	Fact sheet 4p
Soils	Improving soil health for yield and profit in vegetables	Porter, I	2010	Vic DPI	Fact sheet 4p
Irrig	Irrigation scheduling for vegetable crops	Qassim A, Ashcroft B	2010	Vic DPI	Fact sheet 4p

Area	Title	Author	Year	Organisation	Publication type
P&D	A guide to the prevention and management of clubroot in vegetable brassica crops	Donald, C et al	2000	Vic DPI with Agric WA, QDPI, NSW Ag, DPI Tas	Fact sheet 6p
P&D	A guide to effective weed control in Australian brassicas			VIDP	Fact sheet 6p

Appendix 2 – List of individual records included in the app.

Common name	Scientific name
DISEASES	
Alternaria leaf blight - carrots	*Alternaria* spp.
Alternaria leaf spot - brassica	*Alternaria* spp.
Alternaria leaf spot - lettuce	*Alternaria sonchi*
Anthracnose - brassica	*Colletotrichum dematium*
Anthracnose - lettuce	*Microdochium panattonianum*
Anthracnose - spinach	*Colletotrichum dematium*
Bacterial head rot	*Erwnia* spp. *Pseudomonas* spp.
Bacterial leaf blight - carrots	*Xanthomonas hortorum* pv. *carotae*
Bacterial leaf spot - brassica	*Pseudomonas* spp. *Xanthomonas* spp.
Bacterial leaf spot - celery	*Pseudomonas syringae* pv. *apii*
Bacterial leaf spot - lettuce	*Xanthomonas axonopodis* pv. *vitians X. hortorum* pv. *vitians*
Bacterial soft rot	*Pectobacterium carotovorum*
Bacterial soft rot - carrot family	*Erwinia* spp. *Pectobacterium* spp.
Black leg	*Leptosphaeria maculans*
Black root rot - carrots	*Thielaviopsis basicola Chalaropsis thielavioides*
Black rot - brassica	*Xanthomonas campestris pv. campestris*
Boil smut - corn	*Ustilago maydis*
Brown spot - corn	*Physoderma maydis*
Carrot black rot	*Alternaria radicina*
Cavity spot	*Pythium sulcatum P. violae*
Cercospora spot - carrot	*Cercospora carotae*
Cercospora spot - spinach	*Cercospora* spp.
Cladosporium leaf spot	*Cladosporium variabile*
Club root	*Plasmodiophora brassicae*
Corky root	*Rhizomonas suberifaciens*
Crater rot	*Rhizoctonia carotae*
Crown rot - carrot family	*Fusarium spp. Rhizoctonia* spp.
Damping off - brassica	*Pythium* spp. *Aphanomyces* spp. *Phytophthora* spp.
Damping off - capsicum	*Pythium* spp. *Aphanomyces* spp. *Phytophthora* spp.
Damping off - cucurbit	*Pythium* spp. *Aphanomyces* spp. *Phytophthora* spp.
Damping off - lettuce	*Pythium* spp. *Aphanomyces* spp. *Phytophthora* spp.
Damping off - spinach	*Pythium* spp. *Aphanomyces* spp. *Phytophthora* spp.
Damping off - carrot family	*Rhizoctonia* spp. *Pythium* spp.
Downy mildew - brassica	*Peronospora spp.*

Common name	Scientific name
Downy mildew - lettuce	*Bremia lactucae*
Downy mildew - spinach	*Peronospora farinosa f.sp. spinaciae*
Early blight - celery	*Cercospora apii*
Fusarium cob rot	*Fusarium vertilloides*
Fusarium root rot - sweetpotato	*Fusarium solani*
Fusarium wilt	*Fusarium oxysporum sp. conglutinans*
Grey mould	*Botrytis cinerea*
Head smut	*Sphacelotheca reiliana*
Late blight / Septoria spot - celery	*Septoria apicola*
Leaf curl - celery	*Colletotrichum acutatum C. orbiculare*
Licorice rot	*Mycocentrospora acerina*
Little leaf	*Candidiatus Phytoplasma australasia*
Northern leaf blight / Turcicum blight	*Exserohilum turcicum*
Peppery leaf spot	*Pseudomonas syringae pv. maculicola*
Phoma leaf spot	*Phoma lingam (asexual form of Leptosphaeria maculans)*
Powdery mildew - brassica	*Erysiphe cruciferarum*
Powdery mildew - carrot	*Erysiphe heraclei*
Pox - sweetpotato	*Streptomyces ipomoea*
Rhizoctonia - cucumber belly rot	*Rhizoctonia solani*
Root rot - black	*Thielaviopsis basicola (syn. Chalara elegans)*
Root rot - brassica	*Pythium spp. Aphanomyces spp. Phytophthora spp. Fusarium spp.*
Root rot - lettuce bottom rot	*Rhizoctonia solani*
Rust - common - corn	*Puccinia sorghi*
Rust - polysora - corn	*Puccinia polysora*
Scab - sweetpotato	*Sphaceloma batatas*
Scurf - sweetpotato	*Monilochaetes infuscans*
Septoria leaf spot - lettuce	*Septoria lactucae*
Septoria leaf spot - parsley	*Septoria petroselini*
Southern blight - sweetpotato	*Sclerotium rolfsii*
Stemphylium leaf spot - lettuce	*Stemphylium botryosum f.sp. lactucum*
Stemphylium leaf spot - spinach	*Stemphylium botryosum f.sp. spinacia*
Virus - Apium Y	*Apium virus Y*
Virus - Big vein / Mirafiori	*Big vein virus*
Virus - carrot virus Y	*CarVY*
Virus - celery yellow blotch	*Yellow blotch*
Virus - feathery mottle	*Potyvirus*

Common name	Scientific name
Virus - Johnsongrass mosaic	*Johnsongrass mosaic*
Virus - maize stripe	*Maize stripe*
Virus - mosaic - carrot family	*Celery mosaic Alfalfa mosaic*
Virus - mosaic - brassica	*Tomato spotted wilt virus Turnip mosaic virus*
Virus - mosaic - lettuce	*Lettuce mosaic virus Lettuce necrotic yellows etc*
White blister / white rust	*Albugo candida*
White leaf spot	*Pseudocercosporella capsellae*
White mould - carrot family	*Sclerotinia sclerotiorum S. minor*
White mould - bean	*Sclerotinia sclerotiorum*
White mould - brassica	*Sclerotinia spp.*
Wire stem - bean	*Rhizoctonia solani*
Wire stem - brassica	*Rhizoctonia solani*
Wire stem - lettuce	*Rhizoctonia solani*
Wire stem - spinach	*Rhizoctonia solani*
DISORDERS	
Alligator skin - sweetpotato	
Black heart - celery	Calcium deficiency
Blanking - corn	
Blindness - lettuce	
Bolting - carrot family	Flowering
Boron deficiency - brassica	Hollow stem
Boron deficiency - corn	
Boron deficiency - sweetpotato	
Calcium deficiency - corn	
Tipburn - lettuce	Calcium deficiency
Tipburn - brassica	Calcium deficiency
Chocolate spot	
Cold damage - chard	
Copper deficiency - sweetpotato	
Copper toxicity - lettuce	
Corky root	Enlarged lenticels
Fasciation	Flat stems
Fertiliser burn	
Fertiliser burn - lettuce	
Frost damage - brassica	
Frost damage - lettuce	
Growth cracks - sweetpotato	
Guttation - chard	

Common name	Scientific name
Hail damage - chard	
Hail damage - lettuce	
Herbicide damage - brassica	
Herbicide damage - chard	
Herbicide damage - lettuce	
Herbicide damage - sweetpotato	
Iron deficiency - corn	
Magnesium deficiency - brassica	
Magnesium deficiency - corn	
Magnesium deficiency - cucurbit	
Manganese deficiency - corn	
Manganese toxicity - brassica	
Molybdenum deficiency - brassica	
Nitrogen deficiency - brassica	
Nitrogen deficiency - celery	
Nitrogen deficiency - corn	
Nitrogen deficiency - lettuce	
Nitrogen deficiency - sweetpotato	
Oedema	
Old seed	
Pepper spot	
Pesticide damage - lettuce	
Phosphorus deficiency - brassica	
Phosphorus deficiency - corn	
Phosphorus deficiency - lettuce	
Phosphorus deficiency - sweetpotato	
Potassium deficiency - corn	
Potassium deficiency - brassica	
Potassium deficiency - lettuce	
Potassium deficiency - sweetpotato	
Purpling - broccoli	
Riciness - cauliflower	
Salinity - corn	
Salinity - sweetpotato	
Sulphur deficiency - corn	
Sunburn - sweetpotato	

Common name	Scientific name
Veins on roots	
Warm weather syndrome - brassica	
Waterlogging - apiaceae	
Waterlogging - spinach	
Waterlogging - sweetpotato	
Wind damage - lettuce	
Zinc deficiency - corn	
Zinc deficiency - sweetpotato	
INSECTS AND MITES	
African black beetle	*Heteronychus arator*
Aphid - brown sowthistle	*Uroleucon sonchi*
Aphid - cabbage	*Brevicoryne brassicae*
Aphid - carrot willow	*Cavarilla aegopodii*
Aphid - corn	*Rhopalosiphum maidis*
Aphid - cotton	*Aphis gossypii*
Aphid - currant lettuce	*Nasonovia ribisnigri*
Aphid - green peach	*Myzus persicae*
Aphid - sowthistle	*Hyperomyzus lactucae*
Aphid - turnip	*Lipaphis erysimi*
Assassin bug	*Pristhesancus* spp.
Beet armyworm	*Spodoptera exigua*
Beet webworm	*Spoladea recurvalis*
Big eyed bug	*Geocoris spp.*
Black headed mirid	*Tytthus chinensis*
Brown mirid	*Creontiades pacificus*
Cabbage centre grub	*Hellula hydralis*
Cabbage cluster caterpillar	*Crocidolomia pavonana*
Cabbage white butterfly	*Pieris rapae*
Cluster caterpillar / Tropical armyworm	*Spodoptera litura*
Convolvulus hawk moth	*Agrius convolvuli*
Cotton mealybug	*Phenacoccus solenopsis*
Cricket - black field	*Teleogryllus commodus*
Cricket - mole	*Family Gryllotalpidae*
Cucumber fly	*Bactrocera cucumis*
Cucumber moth	*Diaphania indica*
Cutworm	*Agrotis* spp.

Common name	Scientific name
Damsel bug	*Nabis* spp.
Diamondback moth	*Plutella xylostella*
Dried fruit beetle	*Carpophilus spp*
Earwig - black field	*Nala lividipes*
Earwig - brown	*Labidura truncata*
Earwig - European	*Forficula auricularia*
Flea beetle	*Phyllotreta spp.*
Fungus gnats	*Bradysia spp.*
Glossy shield bug	*Cermatulus nasalis*
Grass blue butterfly	*Zizina labradus*
Green mirid	*Creontiades dilutus*
Green vegetable bug	*Nezara viridula*
Ground beetle	*Carabidae* spp.
Heliothis / native budworm	*Helicoverpa armigera* and *H. punctigera*
Hoverfly	*Syrphidae* spp.
Lacewing - brown	*Micromus tasmaniae*
Lacewing - green	*Mallada signatus*
Ladybird - 28 spot	*Henosepilachna vigintioctopunctata*
Ladybird - fungus eating	*Illeis galbula*
Ladybird - predatory	*Coccinella transversa, Hippodamia variegata, Diomus notescens, Chilocorus circumdatus*
Leafhopper / jassid	Family *Cicadellidae*
Leafminer - brassica	*Liriomyza brassicae*
Leafminer - cineraria	*Chromatomyia syngensiae*
Leafminer - spinach	*Liriomyza chenopodii*
Leafminer - sweetpotato	*Bedellia somnulentella*
Looper	*Chrysodeixis* spp.
Lucerne leafroller	*Merophyas divulsana*
Maize leafhopper	*Cicadulina bimaculata*
Mediterranean fruit fly	*Ceratitis capitata*
Mite - bean spider	*Tetranychus ludeni*
Mite - blue oat	*Penthaleus* spp.
Mite - broad	*Polyphagotarsonemus latus*
Mite - clover	*Bryobia* spp.
Mite - predatory	*Phytoseiulis persimilis*
Mite - redlegged earth mite	*Halotydeus destructor*
Mite - spinach crown / bulb	*Rhizoglyphus* spp.
Mite - two spotted	*Tetranychus urticae*

Common name	Scientific name
Onion maggot	*Delia platura*
Parasitoid wasps	*Trichogramma* spp., *Telenomus* spp., *Diadegma* spp.
Pirate bug	*Orius* spp.
Planthopper	Family *Delphacidae*
Plague soldier beetle	*Chauliognathus lugubris*
Pumpkin beetle	*Aulacophora hilaris* and *A abdominalis*
Queensland fruit fly	*Bactrocera tryoni*
Red and blue beetle	*Dicranolaius bellulus*
Red-shouldered leaf beetle	*Monolepta australis*
Root knot nematode	*Meloidogyne* spp.
Rove beetle	*Paederus* spp.
Rutherglen bug	*Nysius vinitor*
Shore fly	*Family Scatella*
Sorghum head caterpillar	*Cryptoblabes adoceta*
Spined predatory shield bug	*Oechalia schellenbergii*
Springtail	*Collembola* spp.
Staphylinid beetle	*Family Staphilinidae*
Sweetpotato beetle	*Colasposoma sellatum*
Sweetpotato tortoise beetle	*Aspidimorpha* spp.
Symphyla	*Scutigerella* spp.
Tachinid flies	
Thrips - onion, plague, tomato, western flower thrips	*Thrips tabaci, T. imaginis, Frankliniella schultzei, F. occidentalis*
Weevil - apple	*Otiorhynchus cribricollis*
Weevil - Fullers rose	*Asynonychus cervinus*
Weevil - small lucerne	*Atrichonotus taeniatulus*
Weevil - spotted vegetable	*Desiantha diversipes*
Weevil - Sweetpotato	*Cylas formicarius elegantulus*
Weevil - vegetable	*Listroderes difficilis*
Weevil - white fringed	*Naupactus leucoloma*
Whitefly - cabbage	*Aleyrodes proletella*
Whitefly - greenhouse	*Trialeurodes vaporariorum*
Whitefly - silverleaf	*Bemisia tabaci*
Wireworm - true	*Elateridae*
Wireworm - false	*Gonocephalum*