

## **Final Report**

# **Review and extension of avocado pests and their management**

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AV19001

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Review and extension of avocado pests and their management AV19001

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## Public summary

The avocado industry has recognised that a more holistic and integrated approach to pest management is needed to reduce the current reliance on broad-spectrum pesticides. This project was funded to understand how best to support growers by identifying the barriers that are preventing on farm changes to pesticide use and the adoption of Integrated Pest Management (IPM). The initial stage of this project was an industry survey targeting growers, advisors and agronomists. The survey was designed to provide an overview of current practice regarding invertebrate pest control and included questions on pesticide use, key pests of concern and the use of biological and cultural control options. Analysis of the survey confirmed that the regions dealing with fruit spotting bugs (Qld. and NSW) have the highest pesticide use and the highest number of pest species; many of which are secondary pests caused by frequent pesticide applications. As a result of this, adoption and interest in IPM is low in these regions because there is a perception that such pesticide applications are essential. In other regions pesticide use is significantly lower with some farms using less than one application per season. In WA the main pest of concern is six-spotted and research into control options as part of project AV19002 is ongoing but at this stage control is primarily the use of miticides. The second stage of the project was a series of presentations and IPM and spray application workshops. Through these extension and training activities, practical information on improving and incorporating the currently available pest management options in an integrated way was presented. These events were well received and feedback was generally very positive and participants reported increased awareness and understanding and gained new skills. However, from open conversations about the long-term repercussions of continuing with current practice and the apprehension to change due to a lack viable and proven alternatives for FSB control it is clear that more support will be needed for significant on-farm changes to be made.

## Keywords

Avocados, Integrated Pest Management, survey, IPM workshops, spray application.

## Introduction

The widespread adoption of IPM is a goal for many horticultural industries. For the large part this has been driven by awareness and acceptance that the reliance and over use of broad-spectrum pesticides is not a sustainable approach to pest management. The Australian avocado industry has made considerable investment into research and development projects that support IPM but as with many industries there is a gap between IPM research and the uptake of IPM on farms. The reasons for this include, but are not limited to the following:

- the change in practice recommended is potentially high risk or perceived to be high risk
- incorporating the results of research into IPM programs is often outside the scope of individual research projects
- the cost of implementing the change(s) outweigh the immediate benefits (it is easier and cheaper to use an insecticide)
- Lack of support with decision making (who takes responsibility for making decisions that are potentially high risk?)

In addition, IPM is often confusing both in definition and application and without proper support at key decision making times it can be easier to stick with current practice, especially if current practice is delivering adequate results. The aim of this project was to identify ways to overcome these barriers to enable the industry to adopt a more sustainable approach to pest management by reducing the frequency of broad-spectrum pesticide use, the inclusion of pesticides that are more IPM compatible and the uptake of cultural or management practices that help to disadvantage pests and support beneficial species.

The connection between the use of broad-spectrum pesticides and the creation of secondary pests and pest flare is well known and documented by many industries. Aphid flare in potatoes, Lucerne flea in canola and Western flower thrips in strawberries are some examples of pests created by the use of broad-spectrum pesticides. In tree crops where populations of some pest and beneficial species are resident within the orchard even minor disruptions to beneficial populations through repeated exposure to pesticides can lead to an increase in pests such as mites, scale, mealy bugs, thrips and some caterpillar species. This process may take several years but once these pests are well established and more pesticides are then needed growers can end up stuck on a pesticide treadmill that is very difficult to get off. This project was undertaken to provide insight into how best to support sustainable industry practice by targeting growers in regions at the highest risk

to adopt good farm practices. These aims align with SIP outcomes 1,2 and 4.

## Methodology

### Year 1. Survey

The aim of the survey was to assess the pest management practices that are currently being used by the avocado industry and how closely they align with IPM. The survey was designed collaboratively by Dr Newton (DAF) and Ms Faichney (DAF) who provided technical knowledge and expertise specific to avocado pest management, Jessica Page (BRC) and Dr. Paul Horne (IPM Technologies) who have experience in IPM adoption in a wide range of industries, Alison Mathews (DPIRD) provided knowledge of the issues specific to WA and linkages to project AV19002 and Mr Newett with expertise in avocado extension and linkage to project AV17005

The key questions the survey set out to answer were

- What are the current and emerging pests of concern in all avocado growing regions?
- What methods are being used to manage these pests?
- Are the current control methods providing adequate control?
- How confident are consultants in giving IPM advice?
- What is the current level of support for IPM?
- Where do growers and advisors get their pest management information from?

The survey was distributed at industry events and through Avocados Australia and email using Survey Monkey. The target audience for the surveys was growers, agronomists, crop scouts and consultants.

The review and interpretation of the survey results was summarized by the project team and presented as a final report to Hort Innovation

See Appendix 1 - Survey final report

### Year 2. IPM presentations

The second stage of the project was to deliver IPM extension activities and these were divided into three categories

1. **Integrated Pest Management presentations** were produced and delivered by Ian Newton and Ebony Faichney (DAF) as part of the Avocado Regional Forums (in collaboration with project AV17005). The WA presentations were produced and presented jointly with Alison Mathews (DPIRD), and included raising awareness of the project work in AV19002 (six-spotted mite work). The Queensland presentations also raised the awareness of the other work in project 19000 (Citrus Blossom Bug). The presentations covered Western Australia, North and Central Queensland, which represent over 80% of Australia's avocado production area. The presentations were delivered at South WA (Pemberton 22/6/2021), Perth (Wanneroo 24/6/2021), North QLD (Atherton 25/8/2021) and Central QLD (Bundaberg 27/10/2021). Each presentation was individually tailored for each region. The presentations showed the results from the surveys (survey results previously reported) highlighting the particular local pest problems and pesticide use. An interpretation of the survey results was presented with reference to problematic chemical use (particularly the over-use of broad-spectrum chemicals) and the potential build-up of resistance in certain pests. This included an explanation of the mechanisms behind resistance and flare of secondary pests, which could be driven to primary pests. Instruction was given on how to manage pesticide use and rotations to prevent resistance build-up and preserve natural enemies.

See appendices 2 and 3 - Feedback from presentations

2. **IPM workshops**

The initial plan was to run workshops in each production region but due to Covid-19 travel restrictions the

workshops were delivered online via Zoom. The workshops were divided into three sections and these were 1. A background to IPM with examples from other industries 2. The components of IPM (Biological, Cultural and Chemical) and 3. The development of an IPM strategy. The IPM strategy was developed collaboratively with the workshop participants so was unique to each workshop group. The aim of the workshops was to discuss the currently available control options for all pests of concern nominated by the participants and how these options can be applied now and improved on in the future. Below is an example of an IPM strategy developed in a workshop. The main message was to reduce the number of pesticide applications of products coloured red and put more effort into cultural control options which will in turn support populations of beneficial species.

IPM in Avocados September 2021     **Red** – Harmful to beneficials, **Orange** -Moderately harmful, **Green** - Safe

| Pest               | Beneficial                                               | Cultural                                                      | Pesticide<br>(not necessarily registered)                                                                                      |
|--------------------|----------------------------------------------------------|---------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| Fruit spotting bug | <i>Anasatus</i> , Pred. bugs<br>Spiders, Robber flies    | Release <i>Anasatus</i> into susceptible varieties, hedgerows | <b>Lepidex, Lannate, Bulldock</b><br><b>Transform, Trivor, Sivanto</b>                                                         |
| Mites              | Predatory mites and thrips<br>Ladybird species.          | Canopy management                                             | <b>Abamectin, Paramite</b><br><b>Apollo, Vendex</b>                                                                            |
| Planthoppers       | ?                                                        |                                                               | <b>Carbaryl</b>                                                                                                                |
| Loopers            | Parasitic flies and wasps<br>Predatory bugs<br>Lacewings | Tree Height                                                   | <b>Lannate, chlorpyrifos</b><br><b>Spinetoram</b><br><b>Dipel, Altacor</b><br><b>Prodigy;</b><br><b>Vivus (Heliothis only)</b> |
| Heliothis          |                                                          | Tree density                                                  |                                                                                                                                |
|                    |                                                          | Inter-row management                                          |                                                                                                                                |
| Thrips             | Predatory thrips and mites                               | Decrease Dust                                                 | <b>Transform, Spinetoram</b>                                                                                                   |
| Scale              | Parasitic wasps, ladybirds                               | Inter row planting                                            | <b>Trivor, Oils</b>                                                                                                            |

Table 1. Example of an IPM strategy

See appendix 4 – Feedback from IPM workshops

### 3. Spray application workshops See appendices 6 and 7 spray application workshops

In addition to the IPM workshops, spray application workshops were delivered in five locations. These workshops provided theory and practical training to assist attendees in improving the quality of foliar spray applications and achieving optimal efficacy within an IPM program. The training was split into two sessions, a formal presentation and a hands-on in-field workshop.

Topics covered in the workshops included:

- the fundamentals of coverage and theory in optimisation of air-blast applications.
- pest description, damage, lifecycle, beneficials,
- biological control option, and creating beneficial habitat corridors.
- cultural options to make situation less desirable for pests.
- Monitoring and spray thresholds
- tree health and soil health briefly to highlight reduced incidence of pests and disease.
- legal responsibilities for spraying
- how to avoid spray drift
- spray calibration, coverage and timing presentation.
- demonstration checking coverage and reducing spray drift etc.

See appendices 5,6,7 and 8 – Feedback from spray application workshops

## Results and discussion

### Survey results.

The aim of the survey was to assess the pest management practices currently being used by the avocado industry and how closely they align with Integrated Pest Management. To achieve this the survey sought to answer the following key questions.

- What are current and emerging pests of concern in all growing regions?
- What methods are being used to manage these pests?
- Where do growers and advisors get their pest management information from?
- How confident are consultants and growers in IPM decision making?
- What is the current level of support for IPM?

The results of the survey (**Appendix 1**) clearly show that the biggest issue in pest management that the industry is facing is the reliance on broad-spectrum pesticides targeting Fruit Spotting Bugs (FSB) in Queensland and NSW. In these regions, support for IPM is generally low despite recognition that the current approach to pest management is at risk and needs to change. The majority of responses to the survey question, *what future pest issues do you think avocado producers will face?* were directly related to chemical use; withdrawal of pesticides, development of resistance, MRL's and the high cost and reduced efficacy of new products. The most popular solution to these threats, based on survey responses and comments made at the end of the survey, was access to more pesticides.

### IPM presentations.

From the pest management presentations, 349 avocado industry personnel (including growers, advisors, suppliers, and industry bodies) have been advised and updated of the results of the IPM surveys. They are now aware of the major pests for each region, the amount and use of pesticides and level of knowledge of IPM practices. Growers and industry have also been made aware of the issues with the overuse of older broad-spectrum chemicals, the potential rise of resistance issues and subsequent flare of secondary pests, which may give rise of future primary pests. Growers and advisers/suppliers are also more aware on how to manage pesticides better, to reduce pesticide resistance issues and preserve natural enemies. Most participants indicated they would make changes as a result of the forum, but which changes, and if they were pest related was not quantified. Direct individual written responses of the take home message related to pest management were as follows: Pest management and pruning, change spray regime to avoid resistance, use less harsh chemicals, monitor for pests before spraying, spray less and review pesticide spray program to put gentle sprays in earlier.

### IPM workshops

The aim of the IPM workshops was to work with small groups of interested growers and advisors and not to reach a large audience. Working with small groups allows for more in- depth discussion, greater participation and the opportunity to go beyond extension by supporting anyone who is interested to make on farm changes. This approach to supporting IPM adoption has been proven successful in many industries. Unfortunately, in this instance, interest in IPM workshops was very low. This is partly due to disruptions caused by Covid-19 which meant that face to face meetings were not possible and also due to a general lack of interest in IPM. The feedback from the people who did attend was positive but the online delivery made discussions and audience participation difficult. Follow up phone calls and emails with some of the attendees provided valuable insight to some of the barriers to adoption and suggestions for the way forward. Most of the growers who attended the workshops owned small farms and were very keen to use biologicals and not use pesticides. For these growers the biggest problem seemed to be being overwhelmed by all the information they believed was necessary to be able to use IPM. After several discussions it became clear that they were already managing their farms in an IPM way and getting good results yet there was an expectation that it should be more difficult. The need to take action when no action is needed is difficult to overcome, particularly in regards to pesticide use. The negative impact of a pesticide application needs to be weighed against the benefits and included in decision making. Feedback from some advisors who attended the workshops was that IPM will never work in QLD. There were however, some advisors very keen to support IPM adoption but were frustrated by the lack of examples from real farms and saw this as what is needed for the industry to move forward.

### **Spray application workshops**

The spray application workshops were well attended and feedback was very positive. The workshops covered the benefits of using IPM and how to get the best value out of IPM compatible products by improving spray application. This information is important for reducing the amount of pesticide applications needed by increasing effectiveness through better coverage. Better coverage reduces the risk of and slows the development of resistance developing, this is invaluable for growers in WA who have a limited amount of miticides to choose from. The benefits of the spray application workshops apply to all growers whether they are using IPM or not.

### **Discussion**

IPM has a reputation in many industries of not delivering results; it is seen as okay in theory but not practical in the real world. This reputation is in part due to the difficulty of dealing with pests such as fruit-spotting bugs but also with both communicating and applying an “integrated” or “holistic” approach. There is a wealth of IPM extension materials available to the avocado industry, some of which are of very high quality. Information on life cycles, identification, management practices and monitoring tools are vital for the uptake of IPM. The Best Practice Resource is an excellent example of a usable and easily accessible platform for sharing this type of information. However, the difficulty is in combining the information in an integrated and cohesive way that can address the issues of individual farms. Industry funded research and extension projects are expected to reach a wide audience and to be inclusive of the whole industry, and the disadvantage with this is that it leaves little scope to go beyond awareness raising. Too often IPM becomes laden with complex details that can stifle rather than inspire change. This is not meant as a criticism but rather an observation that brings to attention the key issue that the current system is not equipped to deal with, that being, IPM adoption requires more than the transfer of information as at the crux lies a problem relating to human behaviour and not entomology. To support growers to change to a more holistic IPM approach it is necessary to understand the difference between what is typically regarded as extension and what is needed for adoption. Extension primarily involves sharing information and raising awareness through websites, fact sheets, presentations, workshops and field days and adoption involves turning this information into usable on-farm advice. Adoption requires decision making and the most critical on-farm pest management decision involves pesticide use and it is at this point that IPM will most likely fail.

### **Who takes responsibility for making decisions that are potentially high risk?**

The change in practice that is being promoted and encouraged by many research projects and industry funding bodies is the adoption of IPM. However, the uptake and support for IPM continues to remain low in the avocado industry. What is being expected and asked of the industry is a reduction in the use of products that are trusted and working, albeit with significant side effects and to shift to more IPM compatible chemistry and ideally adoption of IPM. To achieve this requires decisions to be made at key times to either not use a pesticide or use one that is more expensive and as yet unproven on that farm. In some cases, this decision will be that of the farm owner but more likely it will rely on the recommendation of an advisor. The importance of educating and including advisors, agronomists and consultants in extension activities is well known and their role in supporting the uptake of new ideas is highly valued. But there needs to be recognition, that in the case of IPM adoption or more specifically reduction in pesticide use targeting FSB, that this decision is very high risk. The role of the advisor is to provide advice that will help to ensure that the crop performs to the growers’ expectations and that the desired yield is achieved. The undesirable position of being responsible for crop loss is more likely to foster conservative decision making than risk taking. In theory IPM decisions are based on monitoring and pesticides are used only when needed, and this is reasonably straight forward when pest pressure is high and the use of a pesticide is the obvious choice, but the hardest and most risky decision (recommendation) to ever have to make is to do nothing even when taking no action at all may well be the best option. Knowing pest life cycles, monitoring methods, and ID guides are all useful tools but from first-hand experience they do very little to alleviate the stress of making a recommendation that goes against normal practice. So what incentive is there for an advisor to take that risk? The answer is very little, unless the advisor has full support from the grower and the responsibility is shared.

There is an expectation of research to provide solutions that are practical, economically viable, as effective as those produced by chemical companies and can be applied within the existing boundaries of current practice. But what happens when these solutions don’t exist? **Fruit spotting bugs are native species, their behaviour is cryptic, they are polyphagous, highly mobile and have been provided with an unlimited food supply and a habitat that favors them over their naturally occurring enemies.** Research has provided information on life cycles, monitoring options, host plants, preferred habitats, dispersal behaviour, natural enemies and made significant steps towards the development of pheromones for monitoring

and trapping. The expectation of research and extension to provide a solution that is practical and easily applied is reasonable but an acknowledgment that there may not be a single solution that will fit nicely within current farming systems is also needed. So, is IPM the right choice for everyone? At present probably it's not. Perhaps it is currently too difficult and the aim for this sector of the industry should simply be to find replacement pesticides as old ones are withdrawn and put more effort into improving pesticide application and timing. This is an option, it's not IPM or necessarily sustainable but will fit more easily into current practice and will address the problem in the shorter-term. This maybe the preferred option for some farms and this is okay.

The results from the survey and discussions during workshops and presentations show that there are growers and advisors with a real interest in trying an alternative approach. Supporting people who are already convinced and are asking for help is where the focus of future work regarding adoption of IPM should lie. The target audience maybe small but examples of successful changes on real farms combined with continued awareness raising extension activities will greatly increase the uptake of IPM. Adoption should be aimed at those keen to change, these people are already convinced they just need help with starting.

## Outputs

**Table 2. Output summary**

| Output                                              | Description                                                                                                                                                                                                        | Detail                                                                                                                                                                                                                                                                                                                           |
|-----------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Pest management survey completed and data analysed. | The survey was designed to assess the current pest management issues, highlight specific areas of concern and to gauge the level of interest in IPM. The target audience were growers, advisors and consultants.   | The final report of the survey results was submitted to Hort Innovation with Milestone 103<br><br><b>See appendix 1</b>                                                                                                                                                                                                          |
| Extension of past and current research projects     | Results of the initial survey presented at regional forums. Presentations tailored for each region.                                                                                                                | Five individual workshops developed and presented at regional forums, 5 presentations held at industry events in Sth WA, Perth, Nth Qld. Central Qld. And SE Qld<br>Attendance, feedback forms, post presentation discussions<br><br><b>See appendices 2 and 3</b> for attendance, feedback forms, post presentation discussions |
| Growers trained in IPM,                             | Workshops attended by growers and advisors/consultants covered all aspects of IPM including pest and beneficial monitoring, decision making and threshold, cultural management options and the role of pesticides. | 5 IPM workshops presented by Paul Horne and Jessica Page were held online on the 6 <sup>th</sup> & 20 <sup>th</sup> Sept., 4 <sup>th</sup> & 18 <sup>th</sup> Oct. and 1 <sup>st</sup> November, 25 people in total attended.<br><br><b>See appendix 4</b> for summary of feedback forms, post workshop discussions,             |
| Growers trained in spray application                | Spray application workshops covered fundamentals of spray application including rates, travel speed and nozzle adjustment followed by on farm spray demonstration.                                                 | 7 Spray workshops were held in Alstonville, Stuarts Point, Childers, Mareeba, Hampton, Manjimup x2<br><br><b>See appendices 5,6,7&amp;8</b> for attendance and feedback                                                                                                                                                          |

## Photos/images/other audio-visual material

Managing Avocado Pests: Current Threats & Future Directions (AV19001): <https://youtu.be/L7HuE8BdeN8>

The presentations have been loaded onto the Best Practice Resources and are available for growers on the Australian Avocados website <https://avocado.org.au/>

## Outcomes

**Table 3. Outcome summary**

| Outcome                                                                 | Alignment to fund outcome, strategy and KPI                                                                                                                                                                                        | Description                                                                                                                                                                                                                                                                                                                                                                     | Evidence                                                                                                                                                                   |
|-------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Increased understanding of current pest management practices and issues | <b>SIP outcome 1</b> – Collecting and promoting evidence of sustainable industry practice<br><b>KPI</b> - Does the survey adequately capture the desired information?<br><b>KPI</b> -Have the surveys reached the target audience? | Industry survey targeting growers, consultants and agronomists                                                                                                                                                                                                                                                                                                                  | M&E data collected has been through regular team communication via email and the first team meeting held in Brisbane.<br><br>Completed surveys                             |
| Contribute to sustainable pest management                               | <b>KPI</b> -Are the workshops well attended?<br><br>Has the project utilized available opportunities?                                                                                                                              | Presentations and workshops have contributed to achieving end of project and intermediate outcomes by engaging with growers and other industry representatives. Workshops and presentations covered the sustainable use of pesticides and their role in IPM programs. Emphasis was placed on the creation of secondary pests through the over use of broad-spectrum pesticides. | Evidence of improved understanding of IPM was obtained via follow up phone calls and emails, attendance sheets and feedback forms. The project team utilized all available |
| Increase awareness of good farm practices                               | <b>KPI</b> -Number of growers indicating an increase in knowledge of how and why a best practice should be implemented                                                                                                             | Workshops and presentations discussed practical ways in which farm practices can be improved by using a combination of cultural controls and reducing reliance on broad-spectrum insecticides.<br><br>Spray application workshops have contributed to improving farm practices by providing practical information on the efficient use of pesticides.                           | opportunities to meet the requirements of the project by engaging with all interested growers and industry representatives.<br><br><b>See appendices.</b>                  |
| Highlight production areas with specific                                | <b>SIP outcome 2</b> – Targeted programs to implement best practice in those areas                                                                                                                                                 | Based on the survey results information regarding the specific needs for each region has been                                                                                                                                                                                                                                                                                   |                                                                                                                                                                            |

|                                                                                                             |                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |
|-------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| problems                                                                                                    | with the highest risk/lowest performance.                                                                                                                                                                                                                                                       | presented at regional forums                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |
| Improved grower understanding of IPM, pesticide application, awareness of new and current research projects | <p><b>SIP outcome 4</b> – Uptake of established on farm good practices tailored to variety/region.</p> <p><b>KPI</b>-Has the project successfully identified the needs of the industry?</p> <p><b>KPI</b>-Do workshop participants have improved understanding of IPM and spray application</p> | <p>IPM has been presented as a range of pest management options that can be developed and improved over time as new information becomes available from current research projects.</p> <p>From the pest management presentations, 349 avocado industry personnel (including growers, advisors, suppliers, and industry bodies) have been advised and updated of the results of the IPM surveys. They are now aware of the major pests for each region, the amount and use of pesticides and level of knowledge of IPM practices. Growers and industry have also been made aware of the issues with the overuse of older broad-spectrum chemicals, the potential rise of resistance issues and subsequent flare of secondary pests, which may give rise of future primary pests. Growers and advisors/suppliers are also more aware on how to manage pesticides better, to reduce pesticide resistance issues and preserve natural enemies.</p> |  |

## Monitoring and evaluation

**Table 4. Key Evaluation Questions**

| Key Evaluation Question                                                 | Project performance                                                                                                                                                                           | Continuous improvement opportunities                                                                                                                                                      |
|-------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. To what extent has the project achieved its expected outcomes?       | The project has achieved the expected outcomes of providing information on where the industry is at in terms of invertebrate pest management and raising awareness of alternative approaches. | The project captured the pest management status as accurately as possible.                                                                                                                |
| 2. How relevant was the project to the needs of intended beneficiaries? | The avocado industry is in need of changes to current pesticide usage. The entire project addressed this need.                                                                                | Engagement with small groups of interested growers and advisors to address the issues that individual farms are facing and provide support for on-farm demonstrations of practice change. |
| 3. How well have intended beneficiaries been engaged in the project?    | The intended beneficiaries have been provided with multiple opportunities to engage with the project                                                                                          |                                                                                                                                                                                           |

|                                                                                                  |                                                                                                   |     |
|--------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|-----|
| 4. To what extent were engagement processes appropriate to the target audience/s of the project? | The project utilized the appropriate and accepted methods of engagement with the target audience. |     |
| 5. What efforts did the project make to improve efficiency?                                      | Delivery of project activities was continually reviewed and modified as needed                    | N/A |

## Recommendations

In addition to the continuation of existing extension activities and further research into specific pests, the suggested next step for the industry is on farm demonstrations of practice change. Seeing is believing and there is no better way to achieve this than by real examples on real farms. The success of on farm demonstrations lies in the collaboration between a grower wanting to make changes, an advisor who is keen to challenge and question the current approach and support from experts as needed. The starting point is for the grower to nominate a section of the farm that will be used as the demonstration site, it doesn't matter where it is, it just needs to be a big enough area to be able to observe differences between it and the rest of the farm. This is a demonstration of decision making that leads to a change in practice, it not a replicated trial and does not need to be. It is participatory approach to research and the aim is to allow advisors and growers and researchers to collectively see the outcomes of the changed practice. Data collection is not necessary because it is an un-replicated demonstration and not a scientific trial, therefore data collection is not relevant, this cannot be emphasized enough. The reason for emphasizing this is that the demonstration should not get bogged down by trying to achieve too much, it needs to be kept simple.

The practice change(s) nominated for the demonstration are decided collectively between the grower, advisor and researcher/expert likewise the assessment of the success or failure with the practice change are also decided collectively.

This approach has been used successfully in other industries and the key elements of that success come from:

- A strong collaboration between interested growers and advisors with support from experts as needed
- Keeping it simple, not everything has to be changed at once.
- It is a demonstration of the results of decisions based on observations compared to standard practice on that farm
- It is about learning from first- hand experience and allowing people to have the confidence to find their own solutions.

Monitoring, thresholds and decision making are the most difficult and confusing aspects of pest management. To deal with this there is a tendency to produce material that aims to provide a set of rules that will make the decision- making process easier but more often than not this ends up being either cumbersome and confusing or simplistic. Decision making requires a descriptive rather than a prescriptive approach and the best way to convey this is through demonstration. If the avocado industry is serious about making changes to pest management, then there is need for a shift in thinking and a questioning of current practice and to address the specific needs of individual farms. The target audience for this type of extension work is in the first instance with small numbers of growers and advisors, which often poses problems with funding. However, once the initial demonstrations have been conducted and have been used as field day sites to show others in the industry then demonstrations with larger groups become possible. The payoff for this type of investment has significant long- term benefits for the whole industry.

## Intellectual property

No project IP or commercialisation to report

## Acknowledgements

The project leader would like to thank the project team Dr. Paul Horne (IPM Technologies), Dr Newton (DAF) and Ms Faichney (DAF) Alison Mathews (DPIRD) Mr Newett (QDAF) Jeremy Bright (NSWDPI) and Chad Simpson (EE Muirs) for bringing their extensive knowledge and expertise to this project.

## Appendices

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# Summary of Avocado Survey

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## Introduction

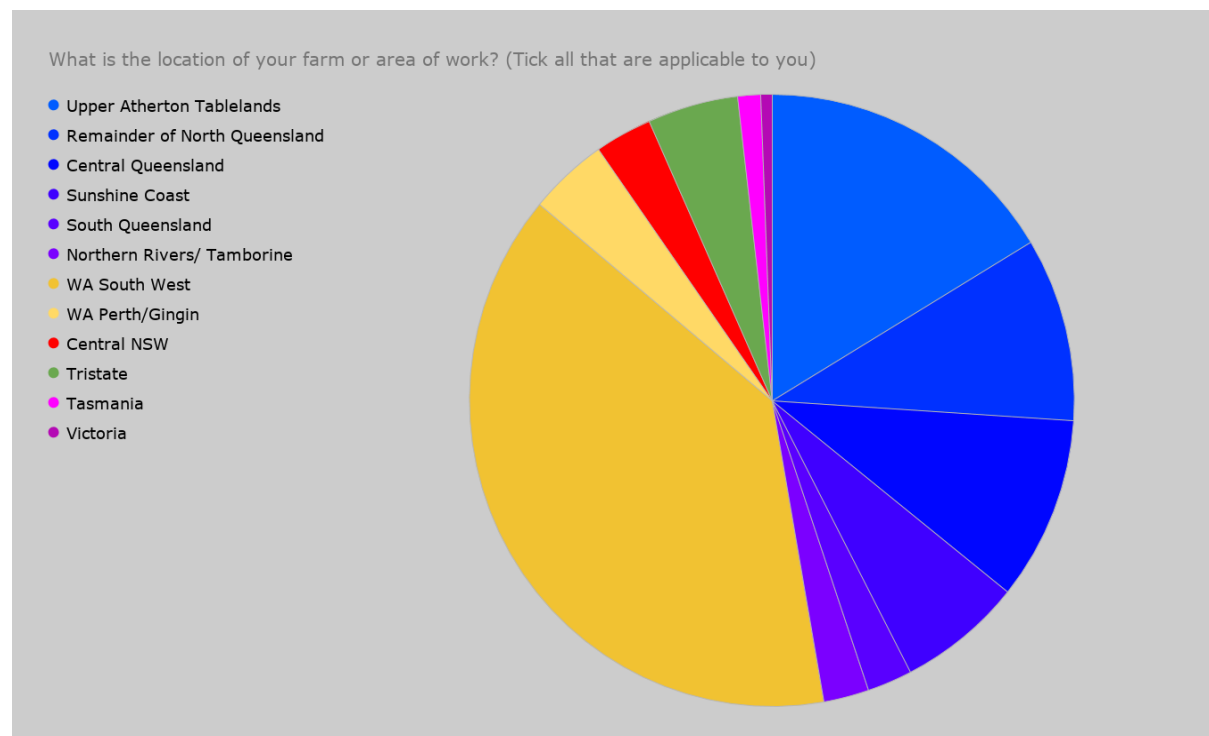
The aim of this survey was to assess the pest management practices currently being used by the avocado industry and how closely they align with Integrated Pest Management. To achieve this the survey sought to answer the following key questions.

- What are current and emerging pests of concern in all growing regions?
- What methods are being used to manage these pests?
- Where do growers and advisors get their pest management information from?
- How confident are consultants and growers in IPM decision making?
- What is the current level of support for IPM?

## Results

### Q1+2 – Farm location and are you a grower/consultant/reseller?

The survey collected a total 152 responses (122 growers, 21 consultants, 9 resellers). The majority of survey respondents were from WA and Queensland followed by Tristate, NSW, Vic and Tas. The number of responses from each region are proportional to the number of growers in these regions.



### Q3 What pests occur in your area/farm?

The responses to the occurrence of pests show that there is a difference between production regions with Queensland and Western Australia recording the widest range of pests. There is a clear distinction between the pest complexes between the east and west coasts. The east coast is dominated by the Fruit Spotting Bugs (FSB and BSB), which are clearly the key pests, other important pests were caterpillars (both leafroller and chewing), thrips and to a lesser extent mites (but more so in QLD). In Western Australia the key pests are garden weevil, which is an establishment pest and mites. Responses from Central NSW, Northern Rivers/Tamborine and Tristate/Vic/Tas indicate that the pest complex in each of these regions is far less than in Queensland and WA with some growers recording no pests at all (20% in Central NSW, 67% Nth. Rivers/Tamborine and 70% Tristate). The top 6 pests by region are shown in Table 1 below.

Table 1. Top 6 responses to occurrence of pests by region

|                                 | 1                       | 2                          | 3                         | 4                        | 5                        | 6                                     |
|---------------------------------|-------------------------|----------------------------|---------------------------|--------------------------|--------------------------|---------------------------------------|
| Atherton /Nth Qld.              | Fruit- spotting bug 97% | Leafroller 95%             | Thrips 87.2%              | Chewing caterpillars 72% | Banana-spotting bug 56%  | Other mites 51%                       |
| Sunshine Coast/Sth/ Central Qld | Fruit spotting bug 88%  | Qld. Fruit fly 48%         | chewing caterpillars 44%, | banana spotting bug 40%  | mites 36%.               | Leaf beetle 24%                       |
| Central NSW                     | Fruit spotting bug 80%  | Citrus blossom bug 60%     | Thrips 60%                | Scale 60%                | Leafroller 40%           | Qld. Fruit fly, Leaf beetle, None 20% |
| Nth Rivers/ Tamborine           | None 67%                | Fruit spotting bug 33%     | Avocado dimpling bug 33%  | Leafroller 33%           | Chewing caterpillars 33% | Thrips + Qld. Fruit fly 33%           |
| Tristate /Vic/Tas               | None 70%                | Light brown apple moth 20% | Chewing caterpillars 10%  | Mites 10%                | Mealybugs 10%            | Thrips 10%                            |
| WA                              | Garden weevil 73%       | Six-spotted mite 33%       | Scale 24%                 | Thrips 24%               | Other mites 16%          | Light brown apple moth 14%            |

### Q. 4,5&6 Monitoring

The survey results indicate that the majority (88%) of growers are monitoring their farms (74% do the monitoring themselves (either property owner or farm employee) and the remainder use crop scouts/consultants). The preferred method of monitoring is direct searching (89%). Other methods are rarely used (Traps 9%, lures 1.5%, baits 0.7%).

### Q.7&8 Confidence in pest and beneficial identification

Many growers are monitoring their farms but confidence with correct identification does not match the high rate of monitoring with only 50% confident in pest ID and 37% confident in beneficial ID. These results were consistent across all growing regions. The survey showed the current confidence level for identification of beneficial species was low, but there was also some lack of confidence in properly identifying pest species. The data also suggests

that there may be some confusion around the difference between Fruit Spotting Bugs and Banana Spotting Bugs and possibly the damage caused by thrips and other damage (e.g. mites, wind rub and other physical damage).

#### Q9. Management practices

Other practices being used for pest management are pest thresholds (56%), spot spraying (50%), pruning and canopy management (53%) removal of infested limbs (23%) and Inter-row plantings (15%).

#### Q. 10&11 Pesticides used and frequency

Table 2. Top 6 responses for pesticides used in each region

|                                          | 1                      | 2             | 3              | 4                      | 5                      | 6                  |
|------------------------------------------|------------------------|---------------|----------------|------------------------|------------------------|--------------------|
| Atherton<br>/Nth Qld.                    | Bulldock 92%           | Transform 85% | Suprathion 85% | Lannate 85%            | Prodigy 74%            | Lepidex 72%        |
| Sunshine<br>Coast/Sth/<br>Central<br>Qld | Bulldock 76%           | Lepidex 72%   | Transform 68%  | Trivior 36%            | Bugmaster 36%          | Prodigy 36%        |
| Central<br>NSW                           | Bulldock 60%           | Transform 60% | Lepidex 60%    | Success Neo<br>40%     | Lannate 40%            | Trivior 20%        |
| Nth Rivers/<br>Tamborine                 | 50% None               | PyGanic 25%   | Dipel 25%      | -                      | -                      | -                  |
| Tristate<br>/Vic/Tas                     | 60% None               | Dipel 14%     | Lannate 10%    | Paraffinic oils<br>10% | Paramite 10%           | Success Neo<br>10% |
| WA                                       | Avatar+<br>Dominex 27% | Torque 27 %   | Lorsban 22%    | Paramite 22%           | Paraffinic oils<br>13% | None 13%           |

The frequency of pesticide use varies considerably with some growers using less than one application per season and others using more than 5 applications per season. Many of the products used are broad-spectrum and not compatible with good IPM. The most frequent use of pesticides is in Queensland with growers using 5 or more pesticide applications per season.

#### Q 12. From which of the following sources do you access pest management information?

The Best Practice Resource is the most popular source of information with 60% of respondents nominating it first followed by Agronomists 57%, first- hand experience 55%, other farmers 51% and field days/workshops 50%.

#### Q 13. What future pest issues do you think avocado producers will face?

Growers and industry generally considered issues around the use of, or access to pesticides as the biggest future threat. Withdrawal of pesticides, pesticide resistance, exotic pests and MRL's were all considered very important issues for the industry.

#### Q.14 Do you need additional tools or information?

65% of respondents said yes

## Q. 15 Comments

Table 3. Summary of comments

|                                                                                                    |
|----------------------------------------------------------------------------------------------------|
| More emphasis on protecting insecticides with different modes of action                            |
| More IPM products needed                                                                           |
| I use monthly sprays of either Bulldock or Lepidex added to fungicide sprays                       |
| Insects getting worse since removal of Endosulfan                                                  |
| Taking chemicals away from growers makes resistance problems worse                                 |
| Need to hang onto old products until new products can replace them                                 |
| More miticides needed because Bulldock flares mites                                                |
| More products like Suprathion that kill a range of pests and can be sprayed multiple times a year. |
| New chemicals are expensive and don't work as well                                                 |
| IPM difficult to adopt because of fruit spotting bug                                               |
| Spray application is a big problem                                                                 |
| Dimethoate is a very important spray, if we lose it there is nothing to replace it                 |
| Increased pests due to loss of Endosulfan                                                          |
| Concern about loss of products leading to resistance developing to remaining products              |
| Growers mostly rely on chemicals rather than biological control                                    |
| New management approaches needed                                                                   |
| Wasps for fruit spotting bug work                                                                  |
| More information needed on biological control                                                      |
| On the look-out for new ideas and better non-chemical methods                                      |
| Current practice of calendar spraying not feasible economically or environmentally                 |
| Need new chemistry /control options                                                                |
| Pesticides expensive and when using get stuck on a treadmill                                       |
| More information on biological control and organic products                                        |
| Focus on biological control should be considered in BPM                                            |
| More information on identification and monitoring X7                                               |

## Discussion

- What is the current level of support for IPM?

One of the aims of this survey was to identify the level of support for integrated pest management. Based on the survey responses the greatest barrier to the adoption of IPM is the need for multiple applications of broad-spectrum products that are mainly targeting fruit spotting- bug. For growers needing to deal with this pest it is the use of products which are highly disruptive to beneficial insects and mites that are of most concern as they create other secondary pests by killing their naturally occurring enemies that would otherwise control them. The survey clearly shows that there is widespread and repeated use of synthetic pyrethroids (SPs), particularly Beta-cyfluthrin (Bulldock™) and other broad-spectrum chemicals. The SPs have a very broad spectrum (they kill most beneficial insects, spiders and predatory mites) and are generally regarded as the most disruptive chemical for adoption of IPM. The secondary pests identified in this survey (caterpillars, thrips and mites) are all known to be flared by the overuse of SPs (and other broad-spectrum chemicals). By their nature, these types of secondary pests are known to become resistant to these chemicals. This is due to their fast generation times and as they are breeding within

the crop they are repeatedly being exposed to the same chemicals. However, the natural enemies often don't develop resistance; this results in a system, where the more the farmer sprays, the worse the secondary pests become which leads to more pesticides being used and growers inevitably end up stuck on a pesticide treadmill. This treadmill makes the adoption of IPM challenging to near impossible even when there is a desire to do so. In regions where there is continued over use of broad-spectrum chemicals the likely result will be widespread resistance and subsequent pesticide failure, a loss of natural biocontrol, secondary pests becoming primary pests and ultimately a farming system failure.

The role of pesticides in IPM is a difficult one to reconcile. IPM theory and extension encourages reliance on beneficial insects and mites as the primary method of control and the use of management or cultural practices to support and encourage them. Pesticides are to be used as a last resort and preference should be given to new chemistry that is "soft" on beneficials. Taking this advice and applying it is not so simple. By breaking IPM down into the three components it is easier to see why adoption of IPM is challenging.

1. Biological control – the current confidence level for identification of beneficial species is 38%. This means that the great majority of respondents (62%) are not confident in the identification of beneficial species in avocados. It is very difficult to make IPM decisions about pesticides when you are not sure if what you are trying to protect is there or not.
2. Cultural control - The impact of cultural control practices on pest management is very difficult to measure especially in the short term and the cost and time needed to implement them requires a level of commitment or "faith" in the long-term gains.
3. Chemical control - Table 3 (below) describes the most used pesticides and the potential effect they have on beneficial species. It is clear that for growers dealing with a wide range of pests switching to IPM would be extremely difficult using the current pesticide program. Currently the most commonly used chemicals (the synthetic pyrethroids and organophosphates) have the highest toxicity to beneficial species.

Table 4. Pesticides in the top 6 for each region showing chemical group and toxicity to beneficial species

| Trade name | Active                 | Chem group | Toxicity to beneficial species |
|------------|------------------------|------------|--------------------------------|
| Avatar     | Indoxacarb             | 22         | Low to moderate                |
| Bulldock   | Beta-cyfluthrin        | 3A         | High                           |
| Dipel      | Bacillus thuringiensis | 11         | Low                            |
| Dominex    | Alpha-cypermethrin     | 3A         | High                           |
| Transform  | Sulfoxaflo             | 4C         | Moderate                       |
| Lannate    | Methomyl               | 1A         | High                           |
| Lepidex    | Trichlorfon            | 1B         | High                           |
| Lorsban    | Chlorpyrifos           | 1A         | High                           |

|             |                          |      |                 |
|-------------|--------------------------|------|-----------------|
| ParaMite    | Etoxazole                | 10B  | Low to moderate |
| Prodigy     | Methoxyfenozide          | 18   | Low             |
| PyGanic     | Pyrethrum                | 3A   | Moderate        |
| Success Neo | Spinetoram               | 5    | Moderate        |
| Suprathion  | Methidathion             | 1B   | High            |
| Torque      | Fenbutatin oxide         | 12A  | Low             |
| Trivor      | Acetemeprid+Pryiproxifen | 4A+7 | Moderate        |

The benefits of IPM can only be achieved when the three components (biological, cultural and chemical) are integrated and this requires a different way of thinking. The dominant theme in the comments section is related to needing more chemistry, needing to hold onto the old chemistry, needing cheap products that work and needing new modes of action to prevent resistance. The barrier to adoption is not just the broad-spectrum products targeting FSB, the barrier to adoption is also a mindset that is looking for a spray- based solution and not an integrated, holistic approach to pest management. A very common reason for low adoption of IPM in many industries is that cheap broad-spectrum products are available, familiar, easy to use and they work (Horne, Page and Nicholson 2008). According to many growers from a range of industries the withdrawal of products such as Endosulfan, Suprathion and PennCap has led to an increase in pest problems and pesticide use. This opinion is completely justified and understandable because in many instances this was true; these products were easy to use and they killed a wide range of pests. Furthermore, their withdrawal has led many growers to use other harder broad-spectrum chemistry (the SPs in particular). Despite the perceived benefits of the old products that have been withdrawn there were also significant concerns regarding their use which is why they are no longer available and why similar products are likely to be withdrawn in the future, some of which are in the top 6 list.

To provide the avocado industry with a long- term sustainable approach to pest management the focus needs to shift from a reactive pest by pest approach to a preventative whole of farm approach. There is no doubt that FSB and related bug species are extremely difficult to manage. Non-chemical control options are limited or are not being used because the value of these options are difficult to measure both in terms of financial investment and efficacy. The newer products available for fruit spotting bug, Trivor and Transform, are not entirely safe to all beneficial species, they are more expensive and may not have the same knockdown effect as older products like Bulldock. Growers are rightly concerned about resistance developing and needing more chemical options from different chemical groups, but the problem is that there are not that many products to choose from, even without imposing IPM compatibility as a criterion for selection. The current resistance management strategies have been developed for older broad-spectrum chemical systems (e.g. the Bulldock label) and have been based on management of resistance in FSB populations, with little regard to managing resistance in secondary pest populations. However, the risk of building up resistance in FSB populations is relatively lower and would likely take a lot longer than it would for the secondary pests (caterpillars, thrips and mites). This is because FSB has a longer lifecycle, is more mobile and breeds outside of the avocado crop; whereas the secondary pests typically have a

shorter lifecycle and breed up within the crops and are therefore exposed to the pesticides for multiple generations. In many instances resistant management strategies are at odds with IPM. The primary reason for this is that older resistance management strategies often include chemicals that are not IPM compatible so rotating through chemical groups does not necessarily support the build-up of beneficial species. Some older resistance management strategies are a calendar-based and have the aim of preserving pesticides whereas IPM is a monitoring-based strategy where pesticides are selected and used as needed with the aim of preserving beneficial arthropods. Both approaches are valid and both approaches can be used to manage resistance but they should not be confused.

## Conclusion

The comments section indicates that many growers, especially those dealing with fruit-spotting bug, recognise that their current pest management situation is at risk and needs to change. The greatest risks identified are the withdrawal of pesticides and the development of resistance. There is also a lack of other options for managing FSB and some growers acknowledge that this is a barrier into the adoption of IPM. This has led to an over reliance on broad-spectrum pesticides, which may be now contributing to secondary pest outbreaks (caterpillars, thrips and mites); without changes, these pests could get significantly worse in the near future. Many of the comments advocate that the solution to this problem lies in finding alternative pesticides rather than changing to using IPM. This suggests that support for IPM is relatively low. IPM has developed a reputation in many industries of not delivering results; it is seen as okay in theory but not practical in the real world. This reputation is in part due to the difficulty in dealing with pests such as fruit-spotting bug but also with both communicating and applying an “integrated” or “holistic” approach. There is a wealth of IPM extension material available, some of which is of very high quality. Information on life cycles, identification, management practices and monitoring tools are vital for the uptake of IPM and the Best Practice Resource is an excellent example of a usable and easily accessible platform for sharing this type of information. The difficulty is being able to pull all the relevant information together in an integrated way. To support growers to change to a more holistic IPM approach it is necessary to understand the difference between what is typically regarded as extension and what is needed for adoption of different management practices. Extension primarily involves sharing information through websites, fact sheets, presentations and field days and adoption involves turning this information into usable on-farm advice. Adoption requires decision making and the most critical on-farm pest management decisions often involve pesticides and it is at this point that growers need the most support. Although the role of pesticides in IPM is to provide back up and support for other control options and not the primary control measure, from a growers’ perspective pesticides are still the mainstay. To support the adoption of IPM and a more holistic approach to pest management a greater understanding of the benefits and limitations of pesticides is needed. Currently there is not a simple answer for managing fruit-spotting bug but there are options that can help to reduce the amount of spray applications

needed. The surveys showed a very high level of monitoring currently being practiced, although confidence with identification could be improved it is a very positive sign as it suggests that the basis for building IPM decision making is already in place. Another positive response in the surveys is that some growers are already using or are at least aware of cultural practices that can minimise pesticide use. The comments section also indicates that some growers are wanting more information and options for biological and other non-chemical control options and are looking for alternatives to relying solely on pesticides.

## Recommendations and next steps

### Extension/education

#### Improving pest and beneficial identification skills.

The survey highlighted a need for improving growers and advisors' skills in both pest and beneficial identification. The BPR is a logical platform for sharing this information to the industry as it was ranked at the top of the list of information sources in the survey. Currently on the BPR website there are only pest species represented, the inclusion of beneficial arthropods would be of value in supporting and raising awareness of IPM. The current avocado extension project AV17005 is looking to update *The avocado problem solver field guide* which has been widely distributed to avocado growers. The guide is primarily designed to identify the cause of symptoms, but where an insect is responsible the pest is also illustrated. It also contains a small section on beneficial insects. Information gathered during AV19001 should be taken into account to influence how this update is done. An Identification guide for mites and related beneficial species will be produced as part of AV19002 and will draw from the results of the survey. Extension activities planned for the second half of this project will include farm walks that will teach growers and advisors identification of pests and beneficial species in orchards using 10X hand lens. Practical monitoring techniques and correct identification are essential for IPM decision making.

#### Improving the uptake of cultural controls.

Cultural or management practices to help reduce pesticide use need to be encouraged. For example, maintaining an open canopy allows light to penetrate into the orchard, this in turn allows for inter-row plantings that encourage beneficial species such as spiders, lacewings, predatory bugs and parasitic wasps. An open canopy also improves the efficiency of spray applications which can reduce the number of pesticide applications needed. Education on the multiple benefits of different management practices need to be reinforced through workshops, extension material and grower case studies. The survey indicated that growers are using pest thresholds (56%), spot spraying (49%), pruning and canopy management (52.6%) removal of infested limbs (23%) and Inter-row plantings (15.3%). How accurate these results are will be determined during the IPM workshops and extension activities in the next stage of the project. Research has shown that orchard design, canopy management, mulching

and farm hygiene have a range of benefits including better pest control but further work is needed to encourage growers to find practical solutions for on-farm application.

### Improving and understanding the use and role of pesticides

Pesticide resistance is well accepted as a major issue for the industry but further education is needed to improve understanding of what pesticide resistance means and what the long-term implications are on the whole system and how to avoid it. The chances of Fruit-spotting bug developing resistance are relatively low due to their wide host range, mobility, long life cycle and because they do not often breed within avocado crops but immigrate from in unsprayed refuges. The emphasis of resistance management and pesticide selection needs to shift to the resident pests that breed within the orchard such as scale, mites, caterpillars and thrips. The overuse of certain chemicals, particularly synthetic pyrethroids, kill the beneficial arthropods that would otherwise keep these pests in check and can cause what is known as secondary pest flare. Depending on the species, this flare can take many years so it can often go unnoticed until the pest starts causing obvious signs of damage. Initially these “new” pests are not associated with the overuse of pesticides. Being resident within the orchard means that all life stages of resident pests are exposed to multiple applications of the same chemicals which greatly increases the risk of the development of resistance. More education is needed on the long-term impact of pesticide use and how repeated use of certain chemicals makes pest problems worse. For growers in WA that listed scale as a pest this should be seen as a warning sign and the criteria for selecting pesticides for mite management should include how compatible the products are with the biological control of potential secondary pests.

The spray workshops planned for the second part of the project are expected to be well received and will provide growers with practical information on improving spray application. In both a conventional spray - based approach or an IPM approach good spray application is essential. Poor spray coverage can lead to spray failures and more spraying and also means pests are exposed to low doses of pesticides which significantly increases the development pesticide resistance.

## Adoption

### IPM workshops

The next stage of the project has been designed to encourage the adoption of more holistic IPM farming practices by providing growers and advisors with the information needed to fill the gaps in knowledge and understanding highlighted in the survey. This will mostly be through extension material, talks at industry events and farm walks. These extension and awareness raising activities are expected to reach a wide audience and will focus on identification, life-cycles, monitoring, resistance management and pest flare. The spray application workshops will provide practical information that can be applied immediately and will improve current spray practices, these workshops are also expected to reach a wide audience.

The successful adoption of IPM often requires more than education and awareness and the reason for this is that too much information can make IPM seem difficult, confusing and risky. IPM workshops that target small groups of interested growers and advisors who are wanting to make changes will focus on taking the information that is currently available and turning it into specific and targeted IPM strategies for the individuals attending the workshops. This means that there will be multiple IPM strategies developed in the second part of the project. The IPM principles remain the same but the details will vary depending on the pests of concern for the participants and how much the participants are prepared to change or are willing to try. The workshops will cover the impact of pesticides on beneficial species and how to use this information when making pesticide decisions that are IPM compatible. The IPM strategies will be developed collaboratively with much of the information coming from the

participants that will be turned into an integrated strategy that deals with all pests nominated. It is the integration of all control options that is critical for IPM adoption. This approach has proven to be highly successful in many industries. Although the target audience of these workshops is small a few successful case studies of real on farm practice change has the potential to be far reaching. The survey confirmed what is known in other industries and that is that growers get much of their information through word of mouth. Agronomists 56.8%, first- hand experience 55.4%, other farmers 50.6% and field days/workshops 50%.

The focus of the workshops will be on applying what is currently known and using the tools that are currently available in a compatible way with a strong emphasis on what can be changed immediately and how to start. The workshops will also pick up on any discrepancies in the survey and will highlight areas in need of further research that will be reported at the end of the project.

## References:

Paul A. Horne, Jessica Page and Cam Nicholson. (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.

## Appendices:

## Achievements

Pest Management presentations were produced and delivered by Ian Newton and Ebony Faichney (DAF) as part of the Avocado Regional Forums (in collaboration with project AV17005). The WA presentations were produced and presented jointly with Alison Mathews (DPIRD), and included raising awareness of the project work in AV19002 (six-spotted mite work). The Queensland presentations also raised the awareness of the other work in project 19000 (Citrus Blossom Bug). The presentations covered Western Australia, North and Central Queensland, which represent over 80% of Australia's avocado production area. The presentations were delivered at South WA (Pemberton 22/6/2021), Perth (Wanneroo 24/6/2021), North QLD (Atherton 25/8/2021) and Central QLD (Bundaberg 27/10/2021). Each presentation was individually tailored for each region. The presentations showed the results from the surveys (survey results previously reported) highlighting the particular local pest problems and pesticide use. An interpretation of the survey results was presented with reference to problematic chemical use (particularly the over-use of broad-spectrum chemicals) and the potential build-up of resistance in certain pests. This included an explanation of the mechanisms behind resistance and flare of secondary pests, which could be driven to primary pests. Instruction was given on how to manage pesticide use and rotations to prevent resistance build-up and preserve natural enemies.

The presentations have been loaded onto the Best Practice Resources and are available for growers on the Australian Avocados website <https://avocado.org.au/>

Examples of the presentations are attached as appendices (**appendix 1 and 2**).

A summary of the number of attendees to the regional forums is given in table 1. There were a total of 349 attendees, of which 59% were growers (or direct farm employees), 28% were advisers/suppliers and the remaining attendees were researchers, extension staff, industry bodies etc. The participants were asked as to which topics were of most interest to them during the forums (they could choose multiple topics, e.g. pollination, water management, industry updates, etc.). Of the overall responses, 41% nominated the 'pest management' presentation of most interest, with up to 59% of most interest in north QLD (probably due to the highest pest pressure).

Individual written responses from the forum surveys are also listed in appendix 3.

**Table 1.** Summary of attendees of pest management presentations as part of regional forums

| Meeting       | Number of Attendees | No. Survey responses | Growers surveyed | Advisors / suppliers | Of most Interest |
|---------------|---------------------|----------------------|------------------|----------------------|------------------|
| Sth WA        | 105                 | 57 (54%)             | 41 (72%)         | 10 (18 %)            | 23 (40%)         |
| Perth         | 40                  | 27 (68%)             | 13 (28%)         | 7 (26%)              | 9 (33%)          |
| Nth QLD       | 104                 | 49 (47%)             | 29* (59%)        | 12 (24%)             | 29 (59%)         |
| Central QLD   | 100                 | 52 (52%)             | 26 (50%)         | 23 (44%)             | 15 (29%)         |
| <b>Totals</b> | <b>349</b>          | <b>185 (53%)</b>     | <b>109 (59%)</b> | <b>52 (28%)</b>      | <b>76 (41%)</b>  |

\* There were at least 55 (53%) growers in attendance in Nth QLD, but not all completed surveys.

## Outputs

Four individual workshops developed and presented at four regional forums, presentations also loaded onto the Best Practice Resources and are available for growers on the Australian Avocados website <https://avocado.org.au/>, Appendix 1 and 2.

## Outcomes

From the pest management presentations, 349 avocado industry personnel (including growers, advisors, suppliers, and industry bodies) have been advised and updated of the results of the IPM surveys. They are now aware of the major pests for each region, the amount and use of pesticides and level of knowledge of IPM practices. Growers and industry have also been made aware of the issues with the overuse of older broad-spectrum chemicals, the potential rise of resistance issues and subsequent flare of secondary pests, which may give rise of future primary pests. Growers and advisers/suppliers are also more aware on how to manage pesticides better, to reduce pesticide resistance issues and preserve natural enemies.

## Issues and Risks

A pest management workshop presentation for central north coast NSW was initially delayed because of flooding, it was then further delayed due to the Delta Covid outbreak in NSW and subsequent state border closures. Similarly, Covid outbreaks and travel restrictions have delayed workshops in far north coast NSW and southern QLD. It is anticipated that these workshop presentations will now proceed in the first half of 2022.

## Appendix 3

The survey also asked: **Do you intend making changes to any aspects of your business as a result of attending and participating in today's activity?**

Most participants indicated they would make changes as a result of the forum, but which changes, and if they were pest related was not quantified. Direct individual written responses, related to pest management were as follows:

### Western Australia

- Pest management and pruning
- Change spraying regimes to avoid resistance

### North QLD

- Less use of harsh chemicals
- Pest monitoring before spraying
- Pest control management and how I can help trees have more flowers and fruitset
- Better pest management
- Spray program
- Spray (*presumably they intend on changing their pesticide spray regime*)

### Central QLD

- Will be reviewing our pesticide spray program to put gentle sprays earlier in the program
- IPM
- Irrigation management and pest management
- Spray less, monitor more

## APPENDIX I: SUMMARY OF FEEDBACK SHEETS – SQ Meeting – 23/02/2022

48 responses

### 1. Please circle which category of attendee you belong to?

|                           |    |
|---------------------------|----|
| Commercial avocado grower | 29 |
| Agricultural supplier     | 5  |
| Consultant                | 5  |
| Researcher                | 5  |
| Carton supplier           | 1  |
| Tafe teacher              | 1  |
| DAF management            | 1  |
| Extension officer         | 1  |

### 2. Please circle which of the presentations were of most interest to you?

|                                                                 |    |
|-----------------------------------------------------------------|----|
| Industry update – John Tyas                                     | 29 |
| Managing avocado pests – Ebony Faichney                         | 28 |
| Supply chain feedback – John Agnew                              | 18 |
| Avocado fruit set – Harley Smith                                | 37 |
| Avocado fruit abscission – Harley Smith                         | 35 |
| Q&A panel on challenges of flowering, pollination and fruit set | 21 |

### 3. How useful did you find this workshop?

|                  |    |
|------------------|----|
| EXTREMELY USEFUL | 7  |
| VERY USEFUL      | 25 |
| USEFUL           | 11 |
| FAIRLY USEFUL    | 3  |
| NOT USEFUL       | 0  |

### 4. Did you feel able to participate?

|    |   |                    |    |                    |    |
|----|---|--------------------|----|--------------------|----|
| NO | 2 | YES (SOME CHANCES) | 20 | YES (MANY CHANCES) | 24 |
|----|---|--------------------|----|--------------------|----|

### 5. Have you established new contacts today and/or had beneficial discussions with others?

|     |    |    |   |
|-----|----|----|---|
| YES | 41 | NO | 4 |
|-----|----|----|---|

### 6. Have you learnt something new about avocado production today?

|     |    |    |   |
|-----|----|----|---|
| YES | 46 | NO | 0 |
|-----|----|----|---|

### 7. Do you intend making changes to any aspects of your business as a result of attending and participating in today's activity? (30)

|     |    |    |   |
|-----|----|----|---|
| YES | 21 | NO | 9 |
|-----|----|----|---|

If yes briefly describe:

- Use of chemicals in fruit consistency
- Orchard management (general) better, greater awareness and need for more proactive practices
- Attend more of any regional meetings also do more research concerning pests, minerals for trees
- Modify methods
- More pruning

- Approach to mango delivery could be improved from drawing on elements of avocado industry
- Monitor pest control
- Carbohydrate levels
- Spotting bug spray
- Use of softer option spray
- Flower removal
- Interesting aspects for future research
- Will trial usage of hormone products
- If we have heavy flowering will look at taking some of them off
- Information will help with the design, execution and reporting of your avocado R, D and E
- Pest monitoring – need for pheromone for FSB
- Consider humidity spray
- Start building up carbohydrates earlier
- Maybe a bit more structure around Q&A panel
- Possibly

#### **8. In running the day, what could we do better?**

- Great job
- Visual great, audio and microphone more than one (speaker 1, and 2 for floor)
- In NSW
- Nothing it was perfect
- Covid compliance was not great – bring on 4 March
- Nothing x2
- All went well
- All things went smoothly. Well done.
- Very well done
- Ran well and on time – well done
- Nothing really
- It was a smooth run as expected
- It is really well done. Maybe some sort of break out and report back session
- All good
- Try to keep orchards stress free before flowering
- Greater focus on strategic pruning
- All really good
- You're doing it well

#### **9. Any other comments:**

- Great day thanks
- Good job
- Well done everyone – very pleased to have had the opportunity to see you in action
- Great day
- Informative and well run
- Overall interesting
- Great to hear research information being presented
- Great day, well run, interesting and informative talks with a good mix of practical and research
- All good
- Please organise more such events and try to engage more students from universities who are interested in avocados

- Keep up the great work
- Morning tea and lunch well presented as individual serves
- As always well run with excellent panel of speakers. Good to see a change from the usual subject of nutrition
- Great day! Thanks!
- Thanks!

## Summary of feedback survey for Avocado IPM workshops 2021

Total number of participants – 25 over 5 workshops

Response range highlighted

Was the information presented clearly?

Not really

Very clear

|   |   |   |   |   |   |   |   |   |    |
|---|---|---|---|---|---|---|---|---|----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|----|

How relevant was the information?

Very relevant

|   |   |   |   |   |   |   |   |   |    |
|---|---|---|---|---|---|---|---|---|----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|----|

Was the sound quality, okay?

|     |    |                   |
|-----|----|-------------------|
| yes | no | Needs improvement |
|-----|----|-------------------|

Do you have a better understanding of IPM after attending the workshop?

Definitely

|   |   |   |   |   |   |   |   |   |    |
|---|---|---|---|---|---|---|---|---|----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|----|

What information was of most interest to you?

Information on FSB was very well explained

The effects of chemicals on beneficials

Discussion on decision making and how to decide when to use an insecticide

The impact of the different pesticides

Practical monitoring advice

Understanding the issues with thresholds

Habitat for beneficials

.....

What additional information would be useful?

Examples of IPM on commercial farms

Examples of IPM in high pressure regions

Barriers to adoption are no real evidence of the success of IPM in FNQ and financial risk of IPM failing is too high

IPM needs to be trialed and demonstrated to growers on large scale commercial farms

Would you recommend the workshop to others?

|     |    |
|-----|----|
| yes | no |
|-----|----|

Thank you for your feedback.

21 Brief:



Don Thorp

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Avocado grower spray application day – 12<sup>th</sup> Oct-

To work with the Muirs team in Mareeba to provide practical tips and ways to improve spray application outcomes in Avocado orchards for the region.

Discussion topics and activities:

The day was well attended with approximately 25 growers, their spray operators and other industry people present.

The session was split into six main segments:

1. A presentation on the fundamentals of successful spray application focussing on key aspects of getting spray droplets to the target and minimising under or over-spraying
2. Tools and inexpensive ways to measure air output and direction, spray pressure, weather conditions in the orchard and water quality
3. Key functions of spray machinery, components, controls, nozzles and fan types of the two brands of sprayer we had at our disposal, and issues to look out for
4. Gaining insight into the challenges and experiences of the group in their applications with discussion and feedback sessions throughout the day
5. An air evaluation demonstration with some simple methods to evaluate their sprayers on-farm
6. Two water sensitive paper spray coverage tests in the orchard (one for each sprayer) and a group discussion on how the outcome could be improved

Outcomes:

The key outcome in any spray day is to have engagement of the attendees so that they can learn and feel confident to make changes to improve application if needed.

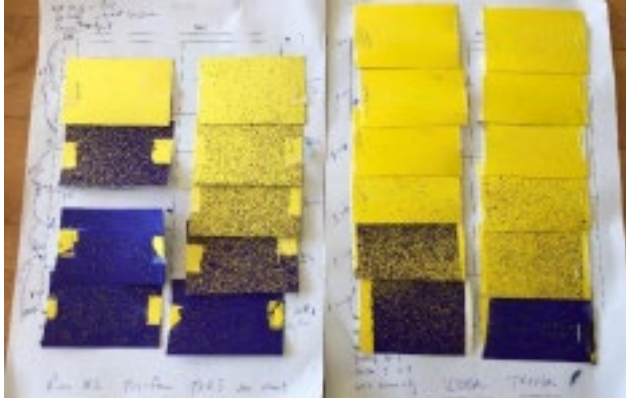
A key objective is to give them simple and useful methods, ideas and tips to help with these improvement strategies. My assessment of the avocado application day is that all the attendees gained some useful knowledge and learned more about the fundamentals of spray application, as well as the sprayers they use in their orchard and simple ways to make adjustments.

Suggestions for the group for their own orchard spray application strategies were: • Doing spray coverage tests to see what results they observe, and not to be scared to make changes

- Using the air adjustments available to fine tune air delivery (if their machine allows) • Using travel speed and/or air speed adjustments to improve coverage
- To consider making adjustments to nozzle output in relationship to the canopy density to improve spray coverage
- Upgrading hoses if a pressure drop is evident from the manifold pressure to nozzle pressure •

Carrying out regular checks and maintenance of their sprayers

- Asking for help if they are in doubt about their application strategy

|                                                                                    |                                                                                                                                                                                                                                |
|------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                    |                                                                                                                                              |
| <p>Above: The attendees were engaged in the practical demonstration</p>            | <p>Above: Matt from Muirs provided some excellent footage from the DJI drone which will be very useful for the grower</p>                                                                                                      |
|  |                                                                                                                                             |
| <p>Above: The IDEAL sprayer Tri-fan was one of two sprayers tested</p>             | <p>Above: Initial coverage results (right) showed improvements were needed. A second test was done (left) with some improvement shown, but further nozzle adjustment will see the results improve in the top of the canopy</p> |

Conclusions from the day:

- ✓ These spray days are vital to the industry to continue educating and encouraging growers to evaluate the performance and results of their spray application. I believe that you cannot manage what you don't measure. Using a simple water-sensitive paper test method is a great

way to measure coverage to allow a decision-making process for improvement.

- ✓ The agricultural industry, horticulture in particular, is at risk of losing vital crop protection chemistry due to under-dosing. By educating growers on how to improve their spray coverage and ensuring they match the dose to their canopy, we can help mitigate this risk.
- ✓ I believe all the attendees came away from the application day with a better understanding of what to do to improve spray application. My thanks to Avocados Australia, IPM and EE Muir & sons for sponsoring the event and inviting me to run the day.



## Alstonville Avocado Spray application workshop – Feb-22

- 12 participants including hosts, Summerland Farms
- Morning session:
  1. Presentation on fundamentals
  2. Group discussion on current practices – application rates, travel speeds etc
  3. Overview of sprayer to be used in practical session
  4. Two practical spray runs using W/S papers



- Afternoon session – third spray run  
using adjusted nozzle set up &  
conclusion

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- Sprayer used for demonstrations – Silvan  
twin turbine fan sprayer fitted with  
Braglia “OR” gun-jets and M82 adjustable

cone jets

- Each fan driving one side of the air chute – 1 chute per side
- Initial two test runs showed some adjustment to nozzle configuration would be beneficial (see picture at right)
- Speed – 4 km/hr
- Spray rate 1350 L/ha
- Nozzle pressure 9-bar
- Tree height 6-6.5 metres, max 7
- Moderate canopy density

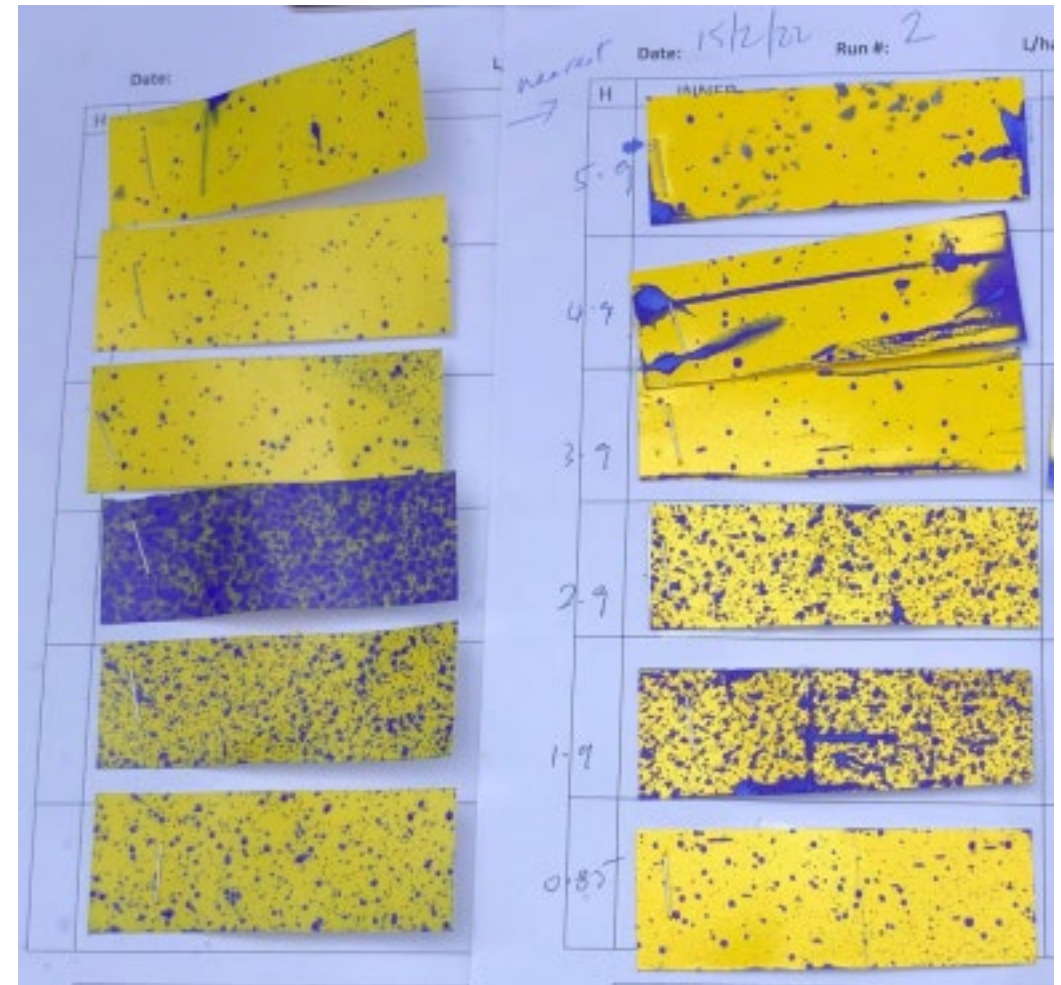
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**Horticultural  
Spraying Specialists**  
*helping growers make better decisions*

## Spray coverage results:

- Far right, second run after some adjustments made
- Near right – third run after further adjustment including changing volume adjustment to the top four nozzles on one side, as well as increasing pressure to 15 bar to meet the nozzle specification
- During the last run, it was discovered one side/fan was not performing as well as the other (less air) – this was on the side we adjusted the spray volume percentage and the pressure
- An improvement in droplet spectrum was observed, but the fan clutch will need inspection to find out why one side has less air than the other



## Conclusion:

- The sprayer tested has the air-throw capability for the trees on the orchard, but some mechanical issue is to be resolved with one fan
  - The nozzle configuration will require further tweaking to improve coverage in the top half of the tree – this is likely to involve a combination of nozzle adjustment and air direction (which is adjustable)
  - The gun-jet nozzles require a minimum of 15-bar pressure to provide adequate atomisation •
- All growers enjoyed the workshop – feedback was that they all learned a good deal from the

experience, as did the team from Summerland Farm



Above:

1. A close-up shot of the spray pattern prior to adjustments being made
2. It is clear from this photo that nozzle set up needed (and still needs) work to improve coverage



21<sup>st</sup> Oct-21 Brief:



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Avocado grower spray application days – 19<sup>th</sup> &

To work with the Muirs team from Bundaberg, Caboolture & Kingaroy to provide practical tips and ways to improve spray application outcomes in Avocado orchards in Childers and Hampton districts.

Discussion topics and activities:

In Childers we had 22 growers & staff attend. The day was held at Pierson Farms, approx. 65ha of avocados planted. Their orchard looked excellent – Mick does a great job there. In Hampton, we had around the same number of attendees (approx. 22-25) & we were hosted by Avos R Us at their orchard in the Hampton ranges. Both locations were ideal for the purpose of the spray application workshops.

As per the previous session in Mareeba, the sessions were split into six main segments: 1. A presentation on the fundamentals of successful spray application focussing on key aspects of getting spray droplets to the target and minimising under or over-spraying

2. Tools and inexpensive ways to measure air output and direction, spray pressure, weather conditions in the orchard and water quality

3. Key functions of spray machinery, components, controls, nozzles and fan types 4. Gaining insight into the challenges and experiences of the group in their applications with discussion and feedback sessions throughout the day

5. An air evaluation demonstration with some simple methods to evaluate their sprayers on-farm

6. A water sensitive paper spray coverage test in the orchard with a group discussion on how the outcome might be improved. At Hampton we had two sprayers which was a great way to demonstrate how important it is for growers to set up their machines according to their situation

Outcomes:

The key outcome in any spray day is to have engagement of the attendees so that they can learn and feel confident to make changes to improve application if needed.

In Childers, the engagement was excellent from the growers and industry people who attended. We tested Micks Tornado sprayer (fitted with an air volute). In Hampton we had two different sprayers which provided a great opportunity to compare and test the applications of both units.

Suggestions for the group for their own orchard spray application strategies were: • Doing spray coverage tests to see what results they observe, and not to be scared to make changes

- Use the air adjustments available to fine tune air delivery (if their machine allows) •

Use travel speed and/or air speed adjustments to improve coverage

- To consider making adjustments to nozzle output in relationship to the canopy density to improve spray coverage

- To consider lifting application volume (L/ha) to help improve coverage in large & dense canopies

- Carrying out regular checks and maintenance of their sprayers
- Asking for help if they are in doubt about their application strategy



Above: Checking coverage of the Tornado sprayer in Childers



Above: Mick had the sprayer very clean for us & ready to use. This is quite a key aspect of good application – maintaining equipment



Above: Coverage could be improved in the tops – we discussed this as a group

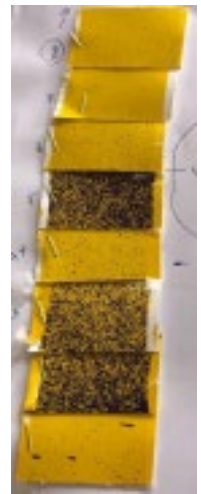
Above: The attendees heading back to look at the application result



Above: At the Hampton application day, we tested a multi-fan sprayer for tall trees. This unit has a lot of potential to do an excellent job



Above: Trees up to 8 metres, with heavy canopy, can be a challenge. At Right: Some work is needed to improve coverage in the tops



Conclusions from the two application days in Childers & Hampton:

- ✓ As mentioned at the conclusion of the Avocado application day in Mareeba, these spray application days are vital to the industry to continue educating and encouraging growers to evaluate the performance and results of their spray application.
- ✓ In general, it seems growers know that coverage in the tops of trees is difficult, and that their sprayers are not achieving good results in larger trees due to tree height & density. We found that by discussing this as a group, it was evident that fruit quality in the top of the trees is where most of their issues arise. Encouraging them to check coverage and to make some simple changes will really improve their outcomes for fruit quality.

## Stuarts Point Avocado Spray application workshop – Feb-22

- 21 participants including hosts, Tolsons family farm - Avorama
- Session information:
  1. Presentation on fundamentals
  2. Group discussion on current practices – application rates, travel speeds etc
  3. Overview of two sprayers to compare differences in set up
  4. Two practical spray runs using W/S papers
  5. Debrief and group discussion of results, application rates, label information, adjuvants etc





- Sprayer used for demonstration and water sensitive paper tests – Croplands 4-fan per side Quantum Mist sprayer • Trees – 10 metre row spacing; up to 8m height • Travel speed 6 km/hr; fan RPM's 2700
- Application rate 500 L/ha\*. Grower uses DuWett adjuvant in the spray program
- Spraying pressure 120psi (8.3 bar)\*
- Nozzles – Albuz TVI\* (\*more information in conclusion section) • Weather – perfect spraying conditions, Delta T = 5.6 • Two passes – first pass deemed inaccurate due to sprayer not being up to pressure
- Relatively open canopy in places – due to chunk pruning



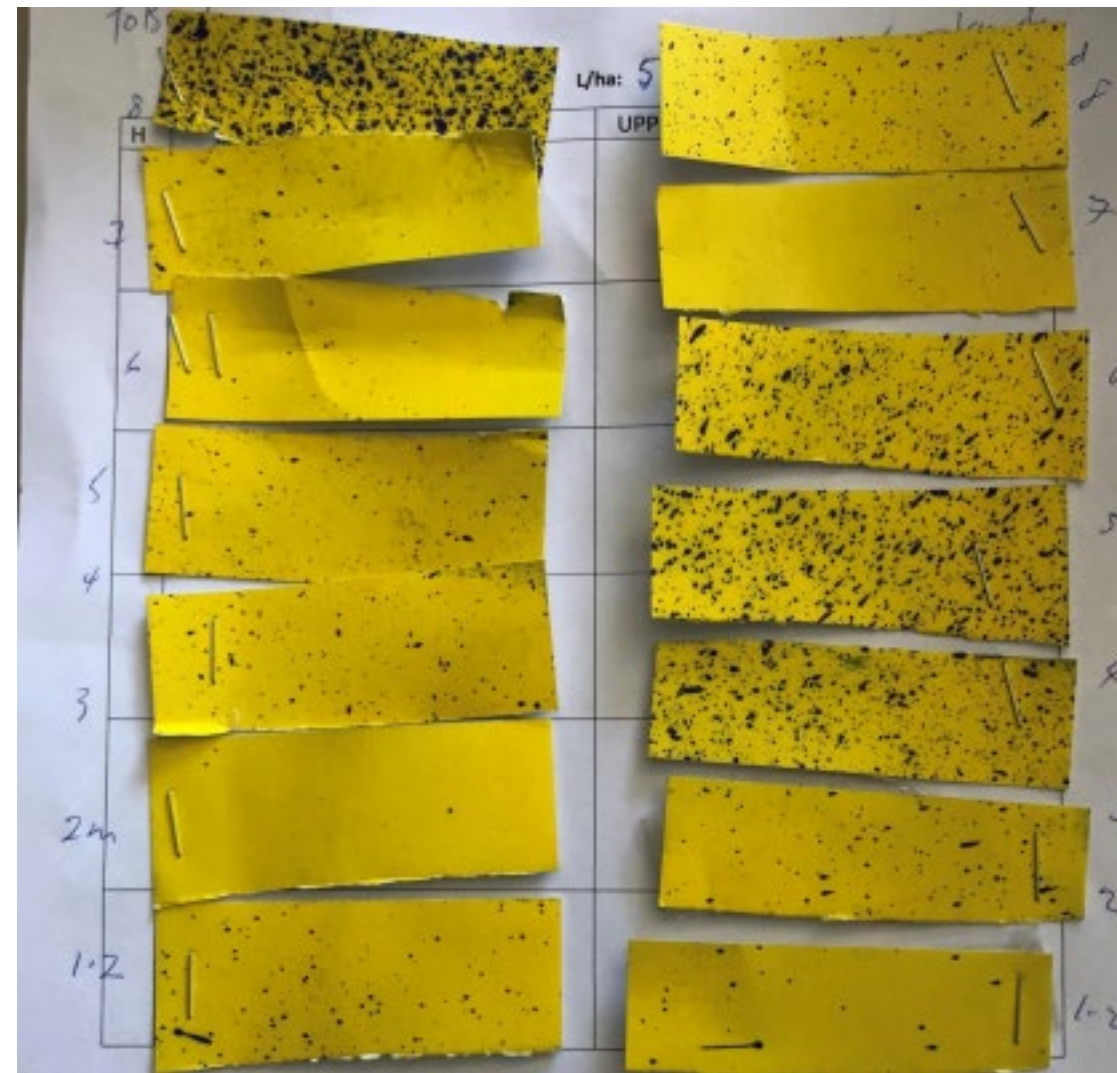
techniques employed at Tolson's orchard

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## Spray coverage results:

- Visual interpretation was that the spray plume was relatively even using the individual fans up a tower (Croplands Quantum Mist Tower sprayer)
- At right – coverage patchy, needs improving
- Group discussion – where droplets reached the W/S papers on the pole test, coverage was acceptable for the application rate (500 L/ha)
- Pole placed near tree centre – slightly offset
- Some areas were quite heavily shaded by canopy
- Droplet spectrum interpreted as Medium to Coarse (aligns with TVI nozzle data)
- There is no doubt coverage could be much improved – see the conclusion & summary



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## Conclusion:

- Interestingly, the grower is using a 3X concentrate spray strategy = 500 L/ha, also using DuWett adjuvant to improve wetting/product spread. This was the first time in the workshops we have come across this strategy being used
  - Visual assessment of leaf coverage was that the DuWett was doing it's job. Some leaf burn on leaf edges was evident from previous sprays – possibly due to the effect of DuWett causing some chemical migration to leaf edges
  - Coverage could certainly be improved (see slide 3); strategies could include:
    1. Fan adjustment to be more perpendicular to canopy (currently fans are angled back by 15-20 degrees)
    2. Lift bottom fans up and adjust the others upwards accordingly
    3. Exchange the TVI nozzles for more conventional cone-jets to provide droplets in the fine/medium spectrum – this should provide the opportunity for the air to carry the droplets further into the canopy
    4. Adjust speed and/or application rate (from 3X/500 L/ha to 2X/750 L/ha, for example)
- Above: Spray Pole near tree centre

## Summary:

- It shows clearly that measuring spray application using methods such as W/S paper will lead to big improvements in spray efficacy on farm
- All growers in our workshop said they learned a lot from the session – including the grower whose sprayer we tested
- The TVI nozzles fitted to the Croplands machine are recommended to be used above 10-bar; currently they are operating at somewhere between 7 to 8 bar at the nozzle (out of specification)
- There are simple, basic steps growers can employ to maximise their spray application efficacy. Teaching these steps will make a big difference to fruit quality, pack-outs and crop health



