FINAL REPORT

For Public Release

Part 1 - Summary Details

CRDC ID: CRDC1803

Project Title: Use of area wide management, IPM, detergents and oils for the suppression of whitefly population in cotton for the reduced reliance and use of chemical controls

Project Start Date: 01/07/2017

Project Completion Date: 30/06/2019

Research Program: 1 Farmers

Part 2 – Contact Details

Administrator: Laura Smith

Organisation: Elders Rural Service

Postal Address: 11 Banna Ave. Griffith NSW 2680

Ph: 0269692900 Fax: 0269692955 E-mail: laura.smith2@elders.com.au

Principal Researcher: Emma Ayliffe, Agronomist

Organisation: Summit Ag

Postal Address: 5 Harvest Court, Yoogali, NSW

Ph: 0458307347 Fax: E-mail: emma.ayliffe@summitag.com.au

Supervisor: (Name & position of senior scientist overseeing the project).

Organisation:

Postal Address:

Ph: Fax: E-mail:

Researcher 2: (Name & position of additional researcher or supervisor).

Organisation:

Postal Address:

Ph: Fax: E-mail:

Signature of Research Provider Representative:

Date submitted: _____

Part 3 – Final Report

(The points below are to be used as a guideline when completing your final report)

Background

1. Outline the background to the project.

The aim of this project is to review whitefly management strategies that have been used in the northern growing regions and extend on this work for the south. The project looked at a range of management options that included the use of commercial detergents and crop oils applied throughout the cotton season to help suppress the whitefly population and prevent the need to use, or the number of uses, of chemical intervention in season along with the use of releases of parasitic wasps to help reduce populations. By reducing the reliance on chemical control, we aim to increase the longevity of these products in the cotton production system, as well as for the wider agriculture community in this region. This includes horticulture production. It will also improve our social licences to operate by using more sustainable management techniques.
The overall aim of the project was to demonstrate that we can manage insect problems without causing flare in the whitefly population. That whitefly can be controlling using non-traditional chemical methods. That the northern techniques used for monitoring in the south were relevant and get this idea replicated across the industry in the southern valleys, including horticulture. With the reduction of whitefly hopefully we will see an improvement in the quality of the cotton harvested, which is becoming a significant concern to the Australian producer.
After the completion of this project we hope that this information will help to improve the profitability and sustainability of our growers, as well as extending the opportunities of cotton production in Southern Australia. The project involved researching and monitoring whitefly populations in fields, providing a demonstration of the techniques and options that we have that adhere to IPM and extend the message throughout the Southern Valleys cotton industry and across wider industries.

Objectives

2. List the project objectives and the extent to which these have been achieved, with reference to the Milestones and Performance indicators.

1.1 Field site demonstrating soft control options - Area wide management group was formed around the Whitton region. Each of these participants, participated in the release of parasitoids as well as provided an insecticide history for the season. The IREC field station year one showcased a replicated oils trial and release. It repeated the use of common oil in year 2 as well as a broadscale release program. One of these farms also applied oils in their mix to offer a comparison to this as a management technique. Unfortunately, we were unable to get sticky cotton info due to rain events across both sites and both years that aided in the breakdown of any honey dew.

2.1 Year-Round whitefly monitoring – sticky trap network deployed with geographic spread, as well as crop spread. One pumpkin crop close to Whitton was monitored in the second year to see if there were whitefly correlations.

2.2 1st year releases at the IREC field station where undertaken with samples collected and sent to Jamie. Year 2 the area wide management group was established and drones where utilised to apply parasitoids. Year 2 the team from Bugs for Bugs assisted in identifying parasitised insects.

3.1 Adoption pathways – working with IREC and Kieran O'Keefe, the project was showcased at the IREC field station both years for growers, as well as "pop-up" field days after sprays and applications to give growers the opportunity to get into the field. The NSW DPI team have been in touch with the project throughout and will continue to work with Tim Green as he extends his work into the valleys. Articles have been published in spotlight, presented at the cotton conference as well as the local research updates.

3.2 Throughout this project we have worked alongside the Irrigation Research Extension Committee to ensure that the project was seen across broad sectors as well as working on farm with melon and pumpkin growers.

4.1 Validation of the SLW Matrix – data provided to ACRI to integrate. Conversations with researchers underway but the use of the nymph monitor appears to be more reliable.

Methods

3. Detail the methodology and justify the methodology used. Include any discoveries in methods that may benefit other related research.

- Sticky traps are not a reliable method of monitoring whitefly population
- Monitoring of whitefly using industry standards, monitoring whitefly nymphs on node 8 were the most consistent and easiest to monitor
- Sprays were made as recommended by research; a lot of sprays went out at over 100L/ha which makes application across larger areas difficult and would likely results in grower resistance
- Parasitoid releases as per industry standards. Issues with supply and timing of committing to the wasps at the start of the year.

Results

4. Detail and discuss the results for each objective including the statistical analysis of results.

Year 1

Population Monitoring

Sticky traps were placed out on the edge of cotton fields in locations as shown on the map, as well as 3 other locations for shorter terms. These were changed weekly and the removed stick traps visually assessed for whitefly.

Over the period we looked at both the blue and yellow sticky traps to see if there were any benefits from using one over the other, or in combination. The yellow sticky traps were the better option for whitefly, as expected, and the blue ones seemed to continuously get saturated with thrips and therefore the decision was made to no longer utilize them.
The first whitefly on a sticky trap was seen in September in a grape vine, as it was only a one off, we are not really sure if there was a population or it was a one off that was just in the wrong place at the wrong time.

Over time the amount of time required to maintain the 7 locations (travel and reliability of people we asked to help) meant that we reduced this to 4 sites that we monitored more thoroughly. The first whitefly were detected in December, not long before they were first detectable in field. By mid-January the whitefly numbers on the cards became very high and therefore difficult to count.

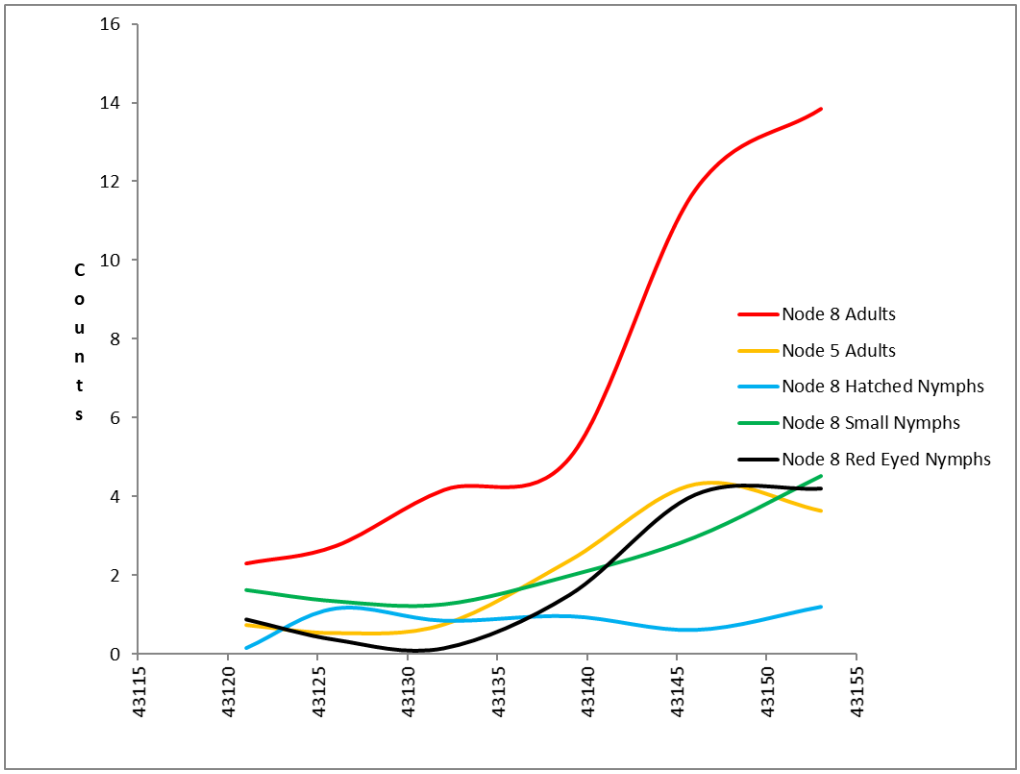
One location was between a cotton and melon field. The visual population on cards increased here very quickly compared to the other sites. Due to staff changes and water prices, we are possibly not

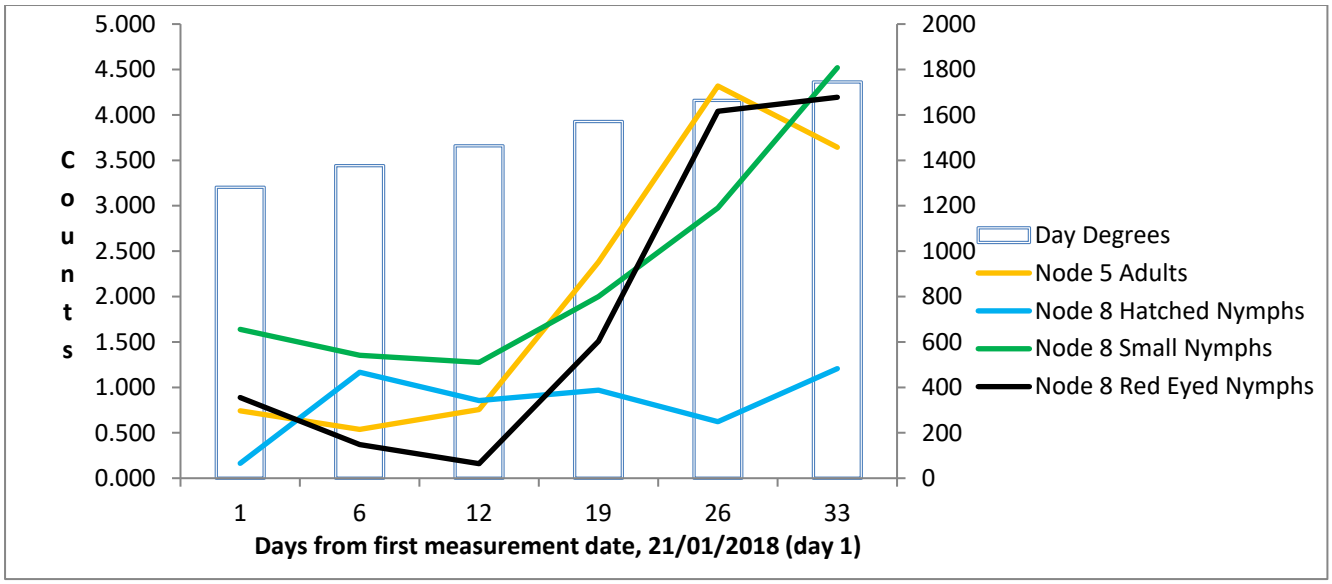
going to be able to source a melon grower as close this year but would like to try and look at vine monitoring a bit more closely.

Soft Whitefly Management

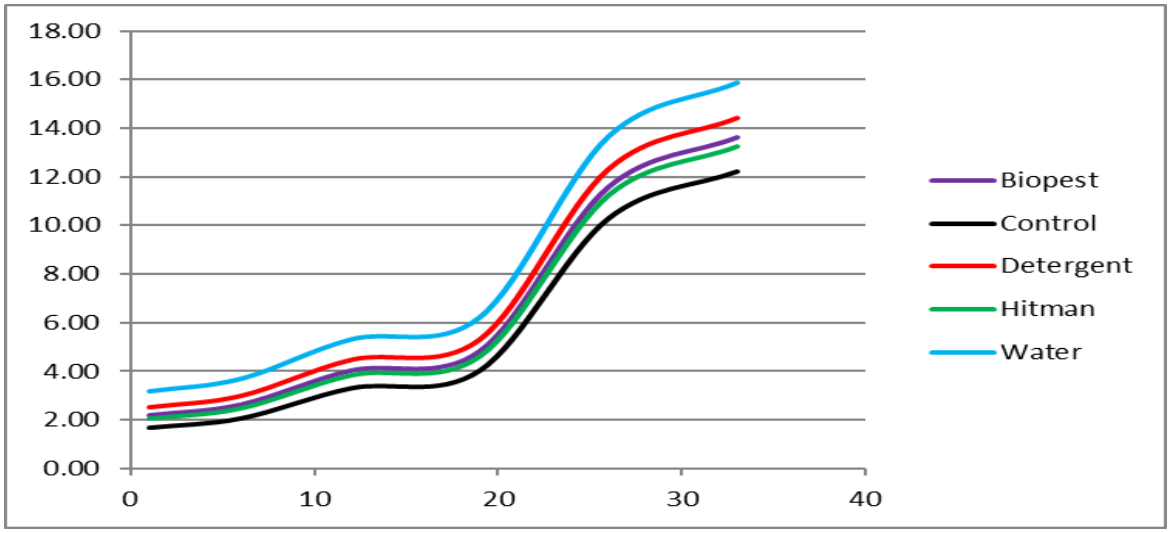
Spraying and monitoring were done as indicated above. The data was then collated and compared both in terms of trend in the population based on the monitoring as well as per treatment.

Below are the trends that were seen at each sampling site by adult or nymph. The blue bars represent the spray timings. The red line is the number of adults detected at node 8 which is the population that increased the quickest. Node 5 adults are tracked on the yellow line which can be seen to have a much more gradual increase, but due to the location in the crop that was sampled would likely have been much more influenced by the climatic conditions at the time of sampling. The green line represents the number of small (non-red eyed nymphs) on node 8 which also produced a slowly increasing curve. The black line shows the red eyed nymphs which can be seen here to build up more slowly. The light blue lines are for the hatched nymphs on node 8 which can be seen to hold reasonably steady across the period.





Below is the whitefly population by treatment. The data was transformed in to a spline graph that allowed all of the data to be aggregated and compared. The scale on the x-axis is the days post the first counts. It can be seen here that the trends across all the treatments for the whitefly population are nearly identical with the difference at the end of the treatment period relative to the starting population, indicating there was no significant differences caused by the different treatments compared to the control. The Y-axis shows true count numbers.



Talking to Richard Sequeira in regards to the results, the process of application could possibly be changed to make the products work better. To achieve this would involve changing the spray application method to droppers. There are two key limitations with this, one it is not practical in the middle of summer when planes are preferred due to the soil moisture and two, it takes the practicality of application with other chemistries, especially roundup, and difficult to implement easily on farm.

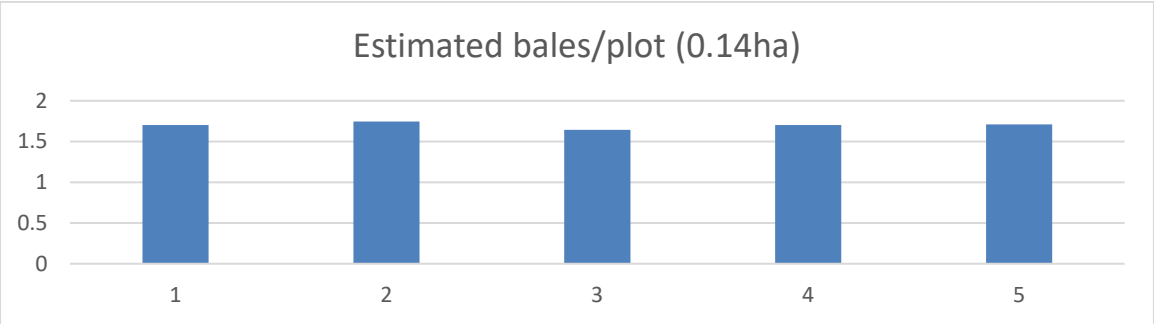
Commercial Chemical Whitefly Management

Using the commercial spray threshold of a 2.5% increase in nymphs on node 8 in 7 days. This threshold was met in mid-February and it was decided to take the opportunity to utilise the site to

showcase the two whitefly control options in Diafenthiuron (Receptor) and Pyriproyfen (Lascar) and run an informal get together with local interested agronomists to look at the population differences. These two treatments were monitored weekly also with no significant differences in population detected, although it is important to note that we did see a general drop off in whitefly towards the end of the season across the valley, thought to be environmentally influenced. As this was a demonstration only there is no statistical analysis. Agronomists were invited to join a walk-through of the site 14 days post application.

Final Yield

Each trial plot was picked individually and then the modules weighed to work out approximate yield per plot and then average per treatment. There was no significant difference between any of the treatments which is good as it means any of the techniques used didn't have a negative impact on the crops.



Above 1 = Biopest, 2 = Hitman, 3 = Control, 4 = Detergent, 5 = Water

Honeydew Assessments

There were no honeydew assessments undertaken this year as there where very low levels of whitefly at the site with no honeydew spotting visible on open cotton. It was decided that there would be no benefits from the assessments to the data sets.

Parasite Release

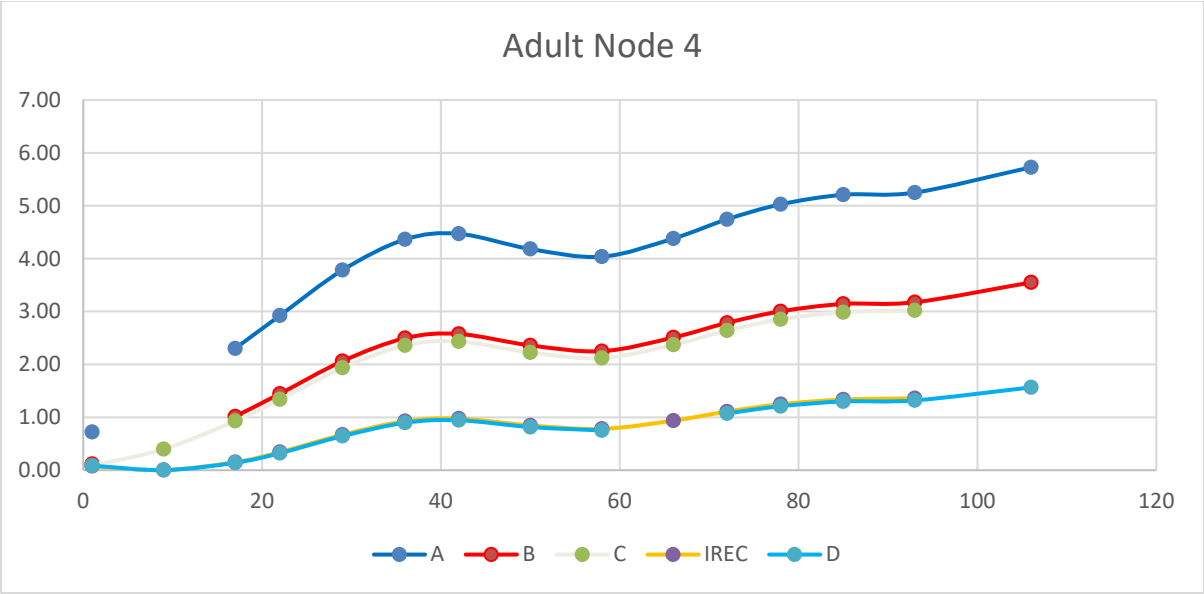
A population of Eretmocerus hayati where release on the 24/01/2018 with 350 vials hand placed across the IREC field station. The aim was to repeat this release over the summer 2-3 more times to try and build a background population. Unfortunately, we had issues sourcing enough Hayati for further releases due to the demand further north.

From samples of wasps sent to Jamie Hopkinson (QDAF) early indications were, that as much as 70% of the whitefly nymph population was parasitised, which likely indicates some level of background population. There was also evidence of a native mite parasitising some nymphs which is exciting.

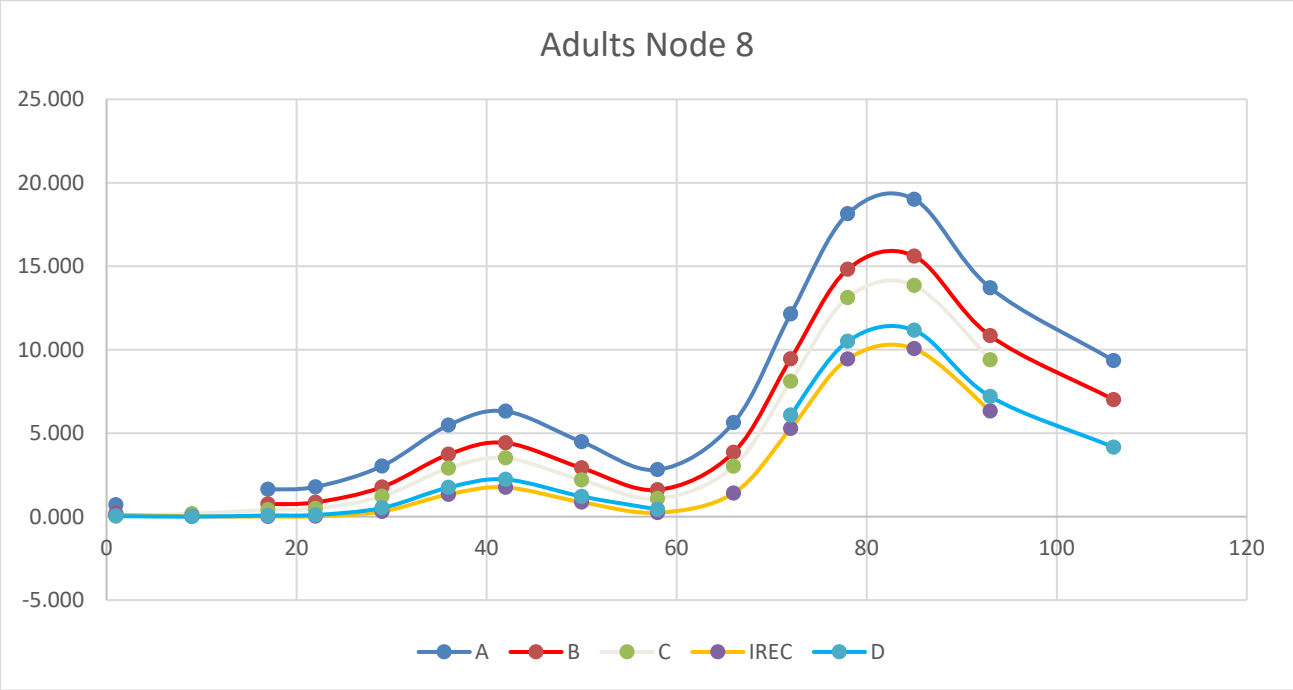
Year 2

Population Monitoring

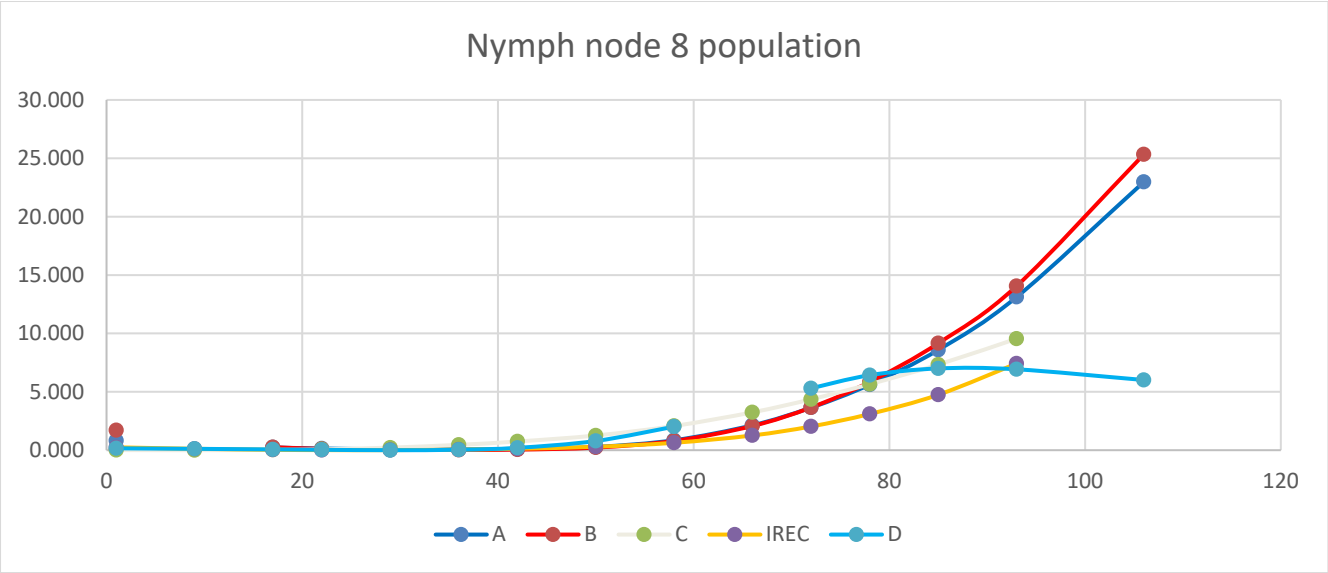
Sticky traps were used at 4 locations for the season to see if early season detection could be made. From the data we collected, the whitefly captured on the sticky traps was no different in timing to the whitefly spotted in the field visually. The site A & B were geographically isolated away from where the releases were made, and offered our comparison sites to the fields where releases occurred. The other 3 sites (C, IREC and D) were where whitely parasitoids were released.
The weekly whitefly counts where taken and analysed.



Above: Adult whitefly counts node 4 over time. This data was analysed using a common spline, the data showed that the linear and non-linear trends are common.



Above: Adult whitefly counts node 8 over time. This data was analysed using a common spline, the data showed that the linear and non-linear trends are common. From the adult populations, it was possible to determine that the trend for the whitefly adults in either the released or non-released sites were consistent and there were no real differences.

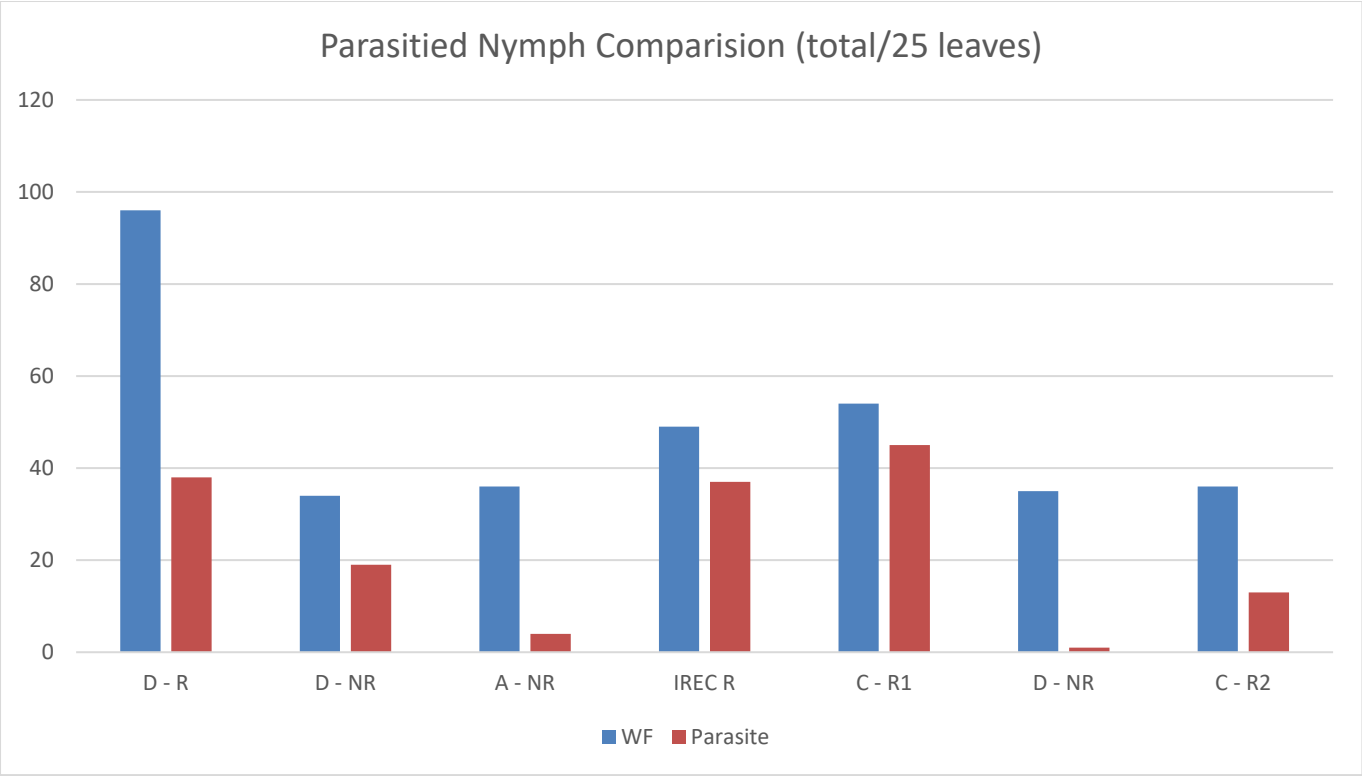


Above: Nymph population node 8 over time. This data was analysed using a common spline. The data showed the linear effects were common, but the non-linear were not. This indicated that the population where parasites were released, the nymph population stabilized or decreases, while the untreated fields, the nymph populations continued to climb.

Leaf samples were taken 8 weeks post release to assess parasitism of nymphs. Leaf samples were taken from untreated farms fields where releases were made as well as fields on farms where releases were made on adjacent fields. These leaves were then analysed under a microscope to assess the nymphs. Photos were taken and assessed with the assistant of Paul Jones from Bugs for Bugs.

Above: Parasitised nymph.

Once counts where completed each of the sites where compared against one another to determine the significance in the number of parasitised nymphs vs unparasitised.



Above: Total nymph counts taken from leaves where WF are alive unparasitized nymphs.

site differences						
D - R						
D - NR	P=0.378					
A - NR	P=0.020	P=0.007				
IREC R	P=0.029	P=0.477	P<0.001			
C - R	P=0.009	P=0.302	P<0.001	P=0.768		
D - NR	P<0.001	P<0.001	P=0.362	P<0.001	P<0.001	
C - R	P=0.383	P=0.394	P=0.060	P=0.065	P=0.032	P=0.003
	D - R	D - NR	A - NR	IREC R	C - R	D - NR

Above: significance table for Chai Squared Tests

Field Comparisons

The table above shows the field comparisons between the different fields. From the information above some of the interesting things to observe are, that there is no significant difference in the number of parasitised leaves found on either field at site D, even though only one had nymphs released indicating the mobility of the parasitiods on the farm.

Site A wasn't significantly different to the release blocks, but this farm also would have had a Pegusus spray just prior to sampling that may have influenced this result, as under the microscope more nymphs may have be categorized as dead compared the visual inspections.

Site D NR is the same field that was monitored every week, which reflects the drop in nymph numbers even without a release at the end of the season. There was not significant difference

between the rest of the release fields. There was also no significant difference between the no release fields excluding D NR.

From this, it is possible to say that where the releases occurred and the soft chemistries maintained, there were more parasitised nymphs than the fields that weren't.

Statistical description:
Counts of adults and nymphs at different nodes (nodes 4 & 8 for adults and node 8 for nymphs) were analysed by a smoothing spline approach as described in Verbyla, Cullis, Kenward, and Welham (1999) with a linear effect of day and site fitted as fixed effects. The smoothing splines are useful for investigating nonlinearity in the data by separating into linear and nonlinear trend. Data was transformed before analysis with the square root transformation being the most appropriate.
Leaf examination of Whitefly and parasites was performed by Chisquare association between the various sites.

All statistical analyses were performed using GENSTAT (18th Edition, VSN International Ltd, Hemel Hempstead, UK).

Reference

Verbyla AP, Cullis BR, Kenward MG, Welham SJ. 1999. The analysis of designed experiments and longitudinal data by using smoothing splines. *Applied Statistics* **48**, 269-311.

Outcomes

5. Describe how the project's outputs will contribute to the planned outcomes identified in the project application. Describe the planned outcomes achieved to date.

This work has allowed growers in the southern valleys to see firsthand, the use of oils and the release of parasitoids. It has exposed them to and set the expectations of what to see after the releases have occurred.

6. Please describe any:-

a) technical advances achieved (eg commercially significant developments, patents applied for or granted licenses, etc.);

b) other information developed from research (eg discoveries in methodology, equipment design, etc.); and

c) required changes to the Intellectual Property register.

NA

Conclusion

7. Provide an assessment of the likely impact of the results and conclusions of the research project for the cotton industry. What are the take home messages?

This research has provided producers Australia wide with some background information, particularly with regards to the releases of parasitoids into cotton. It has allowed us to explore the challenges associated with this management technique, as well as the benefits. It has also allowed us to explore a wider use of oils.
The take home messages from this project are:

- Oils and parasitoids offer another tool in the toolbox for whitefly management
- That the parasitoids will move out of released fields if the whitefly population is large enough
- Patience is needed when deploying biological control
- Benefits associated with the releases include, that growers are more thoughtful about the insecticides they use, as they have paid for the wasps and therefore the follow through generally is the soft chemistry options which helps to prevent flares as well

Extension Opportunities

8. Detail a plan for the activities or other steps that may be taken:
   (a) to further develop or to exploit the project technology.
   (b) for the future presentation and dissemination of the project outcomes.
   (c) for future research.

Spotlight would like to run a story, and have also been in touch with the land newspaper. We are working with IREC to put this report out as well as may look to present it at the next cotton conference if it is of relevance. This year we will look to go back to sites of releases to see if there are any parasitoid carryover as probono work. A number of growers will look to continue releases so we will continue to keep in touch with them and monitor success.

9. A. List the publications arising from the research project and/or a publication plan. (NB: Where possible, please provide a copy of any publication/s)

Attached is our final trial report.

B. Have you developed any online resources and what is the website address?

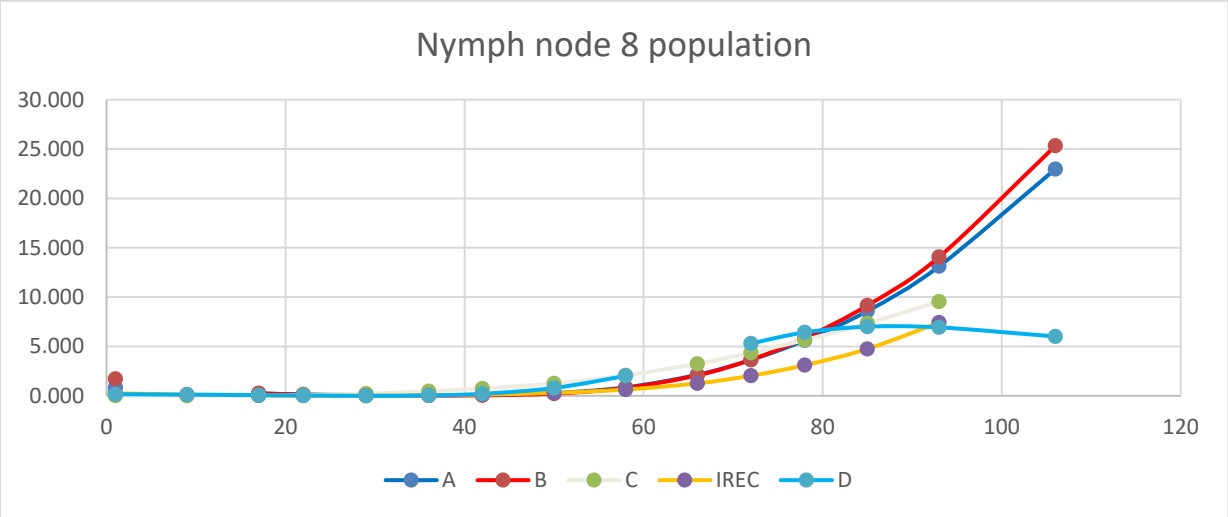
Part 4 – Final Report Executive Summary

Provide a one-page summary of your research that is not commercial in confidence, and that can be published on the internet. Explain the main outcomes of the research and provide contact details for more information. It is important that the Executive Summary highlights concisely the key outputs from the project and, when they are adopted, what this will mean to the cotton industry.

This two-year trial aimed to explore soft management options for whitefly management in the southern valleys. The drivers of this were, managing the risks associated with sticky cotton and the wider industry impacts that were occurring to neighbouring industries such as horticulture. The first year of the trial focused on the use of oils and detergents as a means of control in a small plot, replicated trial at the Irrigation Research Extension Committee Farm, coupled with sticky trap

monitoring and a small area of parastoid wasps, *Eretmocerus hayati,* released. The results from the first year found that there was no benefit from the use of sticky traps in terms of trying to detect a whitefly population earlier. There was also no significant difference between the detergent and oil treatments.

Second year trial looking at the best soft management options after consultation with the wider growing community in the Whitton region, the project direction was changed to broadscale management of whitefly through a combination of soft pesticide applications, oils and the release of *Eretmocerus hayati* across a wide area to try and influence populations. Sticky traps where used again to try and detect populations earlier. Once again, the sticky traps proved to be of no benefit in the early detection of whitefly. Higher levels of parasitism were achieved where releases were made as expected but from the data collected it was possible to see that the release of the whitefly parasitoids resulted in higher levels of parasite nymphs and a lower whitefly population by the end of the period. It was also possible to see that other fields on the farm where parasites were released, but not directly released on had spikes in the parasitism levels as well as reduced overall whitefly nymph numbers, consistent with the fields that had the releases.



The data collected, shows that there was some success in the use of parasitiods for helping reduce the numbers of viable nymphs. Some of the challenges that we will continue to face going forward, are the need to commit to using the wasps at the start of the season when there is no way of knowing what the end of season pressure will be like, and the issues around getting the wasps due to northern demand. There was also an issue with some growers opting to spray fields early rather than allow the parasitised field run their course so we had to remove some data. Overall, the practice change of heading towards the use of beneficials from this work appears viable and this provides some confidence to the growers that they can offer some level of control.