

# **Horticulture Innovation Australia**

## **Final Report**

### **Time of flowering and pollination relevant to orchard weather conditions in Northern NSW – A Growers Trial Group**

Robbie Commens  
Australian Macadamia Society Limited

Project Number: MC12011

MC12011

This project has been funded by Horticulture Innovation Australia Limited with co-investment from GHD and fund from the Australian Government.

Horticulture Innovation Australia Limited (Hort Innovation) makes no representations and expressly disclaims all warranties (to the extent permitted by law) about the accuracy, completeness, or currency of information in *Time of flowering and pollination relevant to orchard weather conditions in Northern NSW – A Growers Trial Group*.

Reliance on any information provided by Hort Innovation is entirely at your own risk. Hort Innovation is not responsible for, and will not be liable for, any loss, damage, claim, expense, cost (including legal costs) or other liability arising in any way (including from Hort Innovation or any other person's negligence or otherwise) from your use or non-use of *Time of flowering and pollination relevant to orchard weather conditions in Northern NSW – A Growers Trial Group* or from reliance on information contained in the material or that Hort Innovation provides to you by any other means.

ISBN 978 0 7341 3947 4

Published and distributed by:  
Horticulture Innovation Australia Limited  
Level 8, 1 Chifley Square  
Sydney NSW 2000  
Tel: (02) 8295 2300  
Fax: (02) 8295 2399

© Copyright 2016

# Contents

Summary .....	3
Keywords.....	4
Introduction .....	5
Methodology .....	6
Outputs .....	9
Outcomes .....	10
Evaluation and Discussion.....	12
Recommendations.....	14
Scientific Refereed Publications .....	15
Intellectual Property/Commercialisation .....	16
References.....	17
Appendix .....	18
Acknowledgements.....	19

## Summary

Climatic conditions during peak flowering have often been related to poor macadamia yields in northern rivers NSW without any specific information on what the climatic issues were; heat, rain or wind. This project was established with the ambitious goal of assisting macadamia growers achieve a greater understanding of these issues through a Grower Trials Group (GTG).

All of the growers in the macadamia GTG had an interest in canopy management, and they already had on-farm canopy management trials occurring. The growers were focused on canopy management as they saw that as a key opportunity for improving pollination, and ultimately production. The GTG project absorbed these trials and provided a structure for them to operate in. With assistance from the NSW DPI, the individual grower's trials were reviewed and adjusted (*if needed*) to ensure they included a suitable on-farm control for comparison. The macadamia GTG project operated over 6 seasons, from 2011 through to 2016, and comprised of eight (8) like-minded, productivity focused and data inclined growers in the northern rivers of NSW. They all collected data in relation to; commercial yields, timing of flowering and climatic conditions.

The commercial orchard production data generated from this project had a significant positive impact on the Australian macadamia industry over the past 3 years. The GTG project assisted the industry develop the Integrated Orchard Management (IOM) concept through the hosting of industry study tours and providing detailed production data obtained through this project, and then supported the extension of the IOM concept out to the wider industry by acting as host orchards as part of the annual IOM field trips.

The project also assisted to highlight an opportunity for improved flower monitoring in orchards, as the project found that across a common variety the flower location in the canopy had a stronger influence on timing of flowering, more so than regional differences. As most northern rivers NSW orchards are tall and mature, with the majority of the productive zone (*where flowers turn into mature nuts*) is in the top 2m of the canopy, this project found that making timing decisions based on flowers lower in the canopy (*that were visible from the ground*) was flawed and risked missing key crop protection periods.

This project, and the modest associated resources (*\$60,000 in total stretched over 6 harvest seasons*) provided a structure for the growers to operate within, support and expertise to understand key trial parameters, a platform to work within a team of like-minded people, and assistance to ensure data was collected in a systematic manner. Without the industry investment it is likely that the growers would not have been able to collect the detailed level of data they have, and it is likely that the industry would not have been able to leverage that information to benefit the entire industry as it did. This project has been a substantial industry asset that has added immense value. All of those involved in this project should be congratulated and thanked on behalf of all growers and the wider industry.

## **Keywords**

grower trials, macadamia pollination, macadamia, climatic conditions, northern NSW, canopy management

## Introduction

Climatic conditions during peak flowering have often been related to poor yields in the past without any specific information on what the climatic issues were; heat, rain or wind. To manage this risk growers felt they needed a greater understanding on 2 key issues; the local climatic conditions and the timing of peak flowering on their orchards. This project was established with the ambitious goal of assisting growers achieve a greater understanding of both of these issues through a grower trials group.

A group of like minded, productivity focused and data inclined growers in the northern rivers of NSW came together to form what the macadamia industry commonly referred to as *the Growers Trial Group*. Through this project the growers were able engage the assistance of NSW DPI (*to help the growers to collect data in a scientific and suitable manner*) a project manager (*to help the growers set up the trials, the weather stations and the time lapse cameras in a timely manner*) and a project assistant (*to methodically download data from the hardware in the orchard – weather stations and time lapse cameras*). This project, and the modest associated resources (*\$60,000 in total stretched over 6 harvest seasons*) provided a structure for the growers to operate within, support to understand key trial parameters, a platform to work within a team of likeminded people, and assistance to ensure data was collected in a systematic manner.

The Growers Trial Group (GTG) collected commercial harvest yield data over 6 seasons, from 2011 through to 2016. In addition to the commercial yield data the project also collected orchard specific climatic data (*through weather stations on orchards*) and peak anthesis data (*through the use of time lapse photos of flowering to view flowering progression*). The goal of the project was to gain a greater understanding of the effect canopy management options may have on the flowering period, and consequently the related crop.

The growers involved in this initiative included; David Rodgers, David and Ann Anderson, Peter Stransky, Henri Bader, Graeme Fleming, Bob Howard, Neil Jung and Hugh Harris. Each grower had a unique focus/interest in their orchard, and consequently had different trials. By working together as a group however, they felt they were able to stay focused, share ideas, compare data and discuss a range of possible scenarios in an informed manner (*with data, not simply relying on memory*).

## Methodology

The project was focused on determining if the weather events in the orchard had an effect on the success of pollination at the time of flowering, and to investigate if any canopy management practices assisted to improve pollination and increase yield. This projects methodology has evolved throughout the life of the project, in accordance to the growers' requests, abilities, commercial orchard parameters, expectations and the capability of the equipment utilised.

The groups (*and projects*) administration and reporting was undertaken by the AMS (*project leader Robbie Commens*), with technical data analysis and trial set up assistance from the NSW DPI. The project had a modest amount of funds to engage a project leader (Mr John Allen) to assist growers with; the set-up of trials in the orchard, setting up and calibrating the relevant equipment in the orchard in a timely manner each season (*time lapse cameras are fitted to the high parts of the canopies prior to flowering*), and ensure the various points of data were collected annually. It also invested in engaging a project assistant to regularly download the weather station data on all sites (*this is undertaken by Scott Hill*). Both of these roles were very much part time based, with both the project leader and project assistant often subsidising the time invested in the project over and above the amount that they were funded. NSW DPI volunteered their time and expertise at no cost to the project.

It is important to note that this project was not a randomly selected fully replicated scientific trial of a single specific treatment. Rather, it was a Grower Trial Group (GTG) project with passionate grower volunteers offering their time and commercial orchards.

The eight (8) growers involved in the GTG were commercial macadamia growers, and that remained their highest priority – their commercial macadamia production business. And, as they were commercial macadamia growers with their own commercial macadamia orchards, they had a range of perspectives and practices in place to achieve their common goal (*of increased production through improved understanding of pollination*). They all had existing on farm trials and an interest in canopy management, as the growers felt this (*canopy management*) was an important management aspect to help improve pollination. However, the forms of canopy management varied across each orchard. A summary of the cross section of trials is listed below;

Grower	Trial (treatment)
Harris	25% tree removal ( <i>every second tree in every second row removed</i> )
Anderson	25% tree removal ( <i>every second tree in every second row removed</i> )
Jung	Limb Removal on the western part of the orchard
Jung	Limb removal on the center part of the orchard
Rodgers	33% row removal (every third row removed)
Howard	50% tree removal (every second tree in every row)
Fleming	Limb Removal

As all of the growers in the GTG had an interest in canopy management, and they already had on-farm trials occurring, the GTG project absorbed these trials and provided a structure for them to operate in. With assistance from the NSW DPI, the individual grower's trials were reviewed and adjusted (*if needed*) to ensure they were suitable. The main area of adjustment was to ensure a suitable control was left in place on each orchard. This was a distinct and important aspect of the GTG structure, as when an opportunity to increase production presents itself growers usually apply it

across the entire orchard. However, thanks to assistance of the NSW DPI the growers involved in the growers trial group were able to ensure a suitable control comparison was left within the orchard.

The grower trials were set up to capture data that would help provide information to determine if local weather events in the orchard had an effect on the success of pollination at the time of flowering. The three key points of measurement identified were; commercial yields, timing of flowering and climatic conditions. The methods used to collect data for each area were;

- Commercial yields
  - o Growers agreed to collect commercially harvest yields within their trial and control areas (*as identified and outlined by NSW DPI*).
  - o Growers worked with NSW DPI to ascertain commercial yields based on their harvesters, with measurements of the harvester field bins and the associated Nut In Shell (NIS) weights undertaken by NSW DPI at the start of the GTG project on all orchards and across all harvesters.
  - o It was the grower's responsibility to record the commercial yields for their control and trial separately each harvest round.
  - o Growers would work with NSW DPI to extrapolate the captured commercial yields into an estimated yield of NIS/Ha for the season.
  - o This information was captured annually.
- Timing of flowering
  - o Time lapse cameras were purchased through this project to capture detailed flower progression across the orchards.
  - o The time lapse cameras used were *Brinno GardenWatchCam* cameras. They were water proof, and able to capture images on a range of time periods.
  - o The project manager trialed a range of time periods, with an image every hour being selected as the most suitable (*the cameras had a day only option that was selected, so no photos were taken at night*).
  - o Each orchard had two (2) time lapse cameras as part of the trial, with one in the control part of their orchard and one in the trial area of their orchard.
  - o The time lapse cameras proved to be successful in capturing flower progression during the peak flowering period as the project manager would;
    - ensure cameras were in the productive part of the canopy across the growers trial group orchards prior to the peak flowering period (*often >10m high in the tree on some orchards due to tree size*).
    - Positioned the cameras within the canopy to capture multiple racemes
    - Removed the cameras each season after flowering to minimize the risk of damage
    - Downloaded the images, and categorized them specific to each orchard
  - o It was understood by the GTG that these time lapse cameras had a life expectancy of no more than 5 years (*which was the original length of the project, meaning that the equipment would have served its purpose and effectively have no value past the life of the project*).
- Climatic conditions
  - o Weather stations were set up on the orchards to capture climatic data.
  - o It was understood by the GTG that these weather stations had a life expectancy of 5 years (*which was the original length of the project, meaning that the equipment*



*would have served its purpose and effectively have no value past the life of the project).*

- The weather stations purchased were *Davis Vantage Pro 2* devices. These stations were purchased as they were promoted to have the capacity for multiple measurements across multiple areas within a single location. Consequently, the GTG weather stations were set up to record climatic data in the trial and in the control areas of a single orchard.
- Initially the project manager coordinated the collection of the weather data through quarterly downloads, however due to the inconsistency of the stations a project assistant was engaged to download data monthly.

*\*please note – the weather stations proved to be very inconsistent with the data collection. It was assumed that weather stations would be suitable to be exposed to the weather, however this was not the experience of the GTG. The weather stations consistently dropped out of signal during peak data collection periods and meant that the data collected was compromised.*

Growers involved in the GTG met twice annually to discuss results, observations and areas for improvement for the upcoming season. The AMS coordinated these meetings, and utilized the information captured at these meetings to develop industry communications on the GTG projects progress, and assist the wider industry gain benefit from the GTG project (*please refer to previous milestone reports for further information*).

The trials and data collection were undertaken over six (6) seasons, from 2011 to 2016.

## Outputs

Key outputs developed from this project include; industry news bulletin articles, commercial grower yield data on a range of canopy management options (*promoted at industry field trips*).

## Outcomes

### *Commercial orchard data that assisted to develop and support IOM*

A major benefit that the industry has received as a result of this project is detailed, and specific commercial data on a specific commercial orchard comparing specific commercial management practices. This data (*predominantly the commercial yield data*) adds huge value to the wider industry, and had a significant positive impact on the Australian macadamia industry over the past 3 years.

A major point of contention in the industry in 2010 was the issue of canopy management and the associated options available to growers (*tree removal, row removal, hedging, limb removal, skirting, etc*). NSW DPI undertook extensive canopy management trials over an extensive period of time (*from 2002 to 2010 through various projects*), and were able to provide detailed canopy management related trial production data to growers. However, the results from these NSW DPI trials were not readily accepted by growers in the northern rivers of NSW as they were contradictory to what growers felt they were achieving in their commercial orchards. NSW DPI research data indicated that tree removal was not a commercially viable option due to loss of production over an extended period of time. Yet growers were undertaking extensive tree removal at the time. NSW DPI research also indicated that limb removal was not a commercially viable option due to the high cost and minimal yield improvements. Yet growers were investing in and undertaking limb removal across the industry. And NSW DPI research indicated that hedging, with adjustments to the timing of hedging, was a viable commercial option. Yet growers were moving away from hedging due to the associated and compounding negative aspects that hedging delivers (*such as increasing tree height*).

Consequently, the macadamia industry suffered from strong differences in opinion in regards to canopy management options and commercial results. Research results and recommendations were quite different to commercial observations, practices and recommendations in 2010. This project initiated in 2012, and has helped to bridge the gap between research and commercial growers by capturing some commercial yield data on commercial orchards across a range of commercial canopy management practices.

Since the 2010 period when this issue was hotly contentious, the Australian Macadamia Industry has developed a new Integrated Orchard Management (IOM) guide (*associated with HIA funded projects MC10003 and MC14007*) that helps growers identify the most suitable canopy management practices based on their orchards stage and desired outcomes. This has helped to dispel the previous contention, and break what was previously seen as a single standalone issue (*canopy management*) into an overarching and intricately linked Integrated Orchard Management (IOM) program (*canopy, orchard floor and drainage management all linked together into IOM*). The IOM initiative highlighted that the driver for certain canopy management practices were undertaken by growers not to improve the canopy, but rather to improve the orchard floor and/or the drainage management. And vice versa. The bridge had been built between the two previously opposing groups, and the IOM initiative has been very well received by the Australian industry and widely adopted. As an industry stakeholder stated recently, "*there have been tectonic shifts in orchard management over the past 3 years since IOM was introduced*".

This project (GTG) assisted the industry develop and extend the IOM concept in two (2) specific ways. Firstly, it helped to develop the IOM initiative as it provided detailed data to industry

investigative committees (*the evolution of the 2 tonne task force*). Industry representatives visited many of the GTG orchards as part of the industry investigative committee study tour in 2013 and 2014. The data that the GTG growers could provide allowed the industry investigative committee to delve deeper into an individual issue. A unique and powerful industry asset that ultimately helped to develop the IOM initiative.

And secondly, it supported the extension of IOM initiative out to the wider industry as the GTG growers hosted industry field trips. The GTG orchards that were involved in the annual Integrated Orchard Management (*IOM*) field trips were able to provide; actual harvested yield data differences between their control and trial areas of their orchard (*for example, within row tree removal compared to no tree removal*), details on the timing of management operations, details on phenological observations during the previous seasons (*including when peak anthesis was year to year on their orchard*) and a commercial assessment of the costs and associated returns from a canopy management practice. And they provided this information in grower language, from a commercial orchard perspective. A very valuable link between the scientific data (*often very rigorous but can be overwhelming*) and the average growers "estimates" or "guesses".

Understandably this has proven to be of high value to other growers. This is evident when talking to growers on the field trips, as the feedback is that the growers on the field tours are far more receptive and interested in the GTG growers' data as not only observations or gut feel is presented, but production data, timing and costings are presented also. Responses from the industry survey support this, "*David Rodgers (a member of the GTG) was the only grower who backed up his canopy management program with actual production figures and dollar figures to support his method of canopy management. Other growers (not in the GTG) spoke in generalities to support their canopy management programs.*"

#### *Timing of flowering within the canopy of mature orchards*

Another key outcome from this project was the identification of a major point of difference in timing of flowering in an orchard. At the start of the project the growers involved (*and the wider industry*) expected that the region would have a major influence on the timing of peak anthesis (*on a common variety*). However, this project was able to highlight that there was often quite similar peak anthesis periods year to year on a common variety across regions. Rather, the GTG agreed from the data collected within this project that the main point of difference for peak anthesis for a common variety was the location of the flower within the canopy. With flowers at the bottom of the canopy often weeks behind those at the top of the canopy.

This is a major outcome, as many growers make timing decisions on agronomic and crop protection practices based on flowers that are lower in the canopy that are visible from the ground. Yet the majority of the production, especially in tall mature orchards (*the majority of the northern rivers of NSW*), occurs in the top 2m of the canopy. And that is often 8 to 12 metres off the ground (*and difficult for growers to see from the ground*).

This project has highlighted a potential flaw in the current grower monitoring systems used (*\*note, professional consultants likely understand this already and monitor the productive zone of the canopy*). And identified a possible opportunity for improvement in the future with the monitoring of flowers throughout the canopy, with an emphasis to understand the productive part of the canopy (the top 2m).

# Evaluation and Discussion

## *GTG member feedback*

The GTG growers stated that they obtained great value by being involved in this project. There was unanimous agreement that involvement in the group added value to their own business, either in the form of increased production, decreased input costs, a greater understanding of a key opportunity and/or avoiding making the “wrong” decision (*based on GTG meetings and discussions with other growers many growers did not implement a certain canopy management strategy such as within row tree removal*). A summary of the comments the growers stated is below;

- *I was able to increase my production from the lessons learnt from the other growers in the GTG*
- *It has given me a different perspective on a range of issues, particularly canopy management*
- *The GTG meetings have been a catalyst for new ideas*
- *There is a need to trial and quantify the results before implementing a major practice change across the entire orchard. Being involved in the GTG has allowed me to do that*
- *It has helped me to move away from the mindset of business as usual, and question what I do and why I do it. I have been able to reflect on my current practices and identify key areas to improve on*
- *Seeing the flowers in great detail with the time lapse cameras has helped focus a greater amount of my attention on flowers. They are so vulnerable and important, we need to do everything we can to protect them so we get a good crop at the end of the year.*
- *GTG have given me new ideas, and allowed me to talk and share ideas with other likeminded growers*
- *Well done to David Rodgers (one of the growers) for driving this initiative, it has been well worthwhile*
- *My involvement in the GTG has increased clarity through production data, and that has given me an increased amount of confidence to act*
- *The GTG has helped to consolidate and validate my ideas and thoughts*
- *GTG has helped to validate the direction I wanted to go on my own orchard.*

It was evident and obvious that the growers involved in the GTG got great value out of their investment of time, energy and resources into being involved with the grower trials group. They all wanted to be involved in the next phase of the project (*if there is a next phase after 2016, when this current project concludes*). And as mentioned above in the outcome section, the wider industry benefitted greatly from this project with GTG input into the development of the IOM initiative and assistance in extending the IOM initiative out to the wider industry.

## *Discussion on weather stations*

This projects methodology had to evolve over time, in part due to the challenges faced with the weather stations. Commercial weather stations were purchased, and the supplier was engaged to assist with hardware and software configuration. Yet the stations proved to be inconsistent at best. Essentially, the weather stations did not perform and the associated climatic data analysis could not be undertaken. This was disappointing for all involved, but presents an opportunity for other grower trial groups across all of horticulture looking to undertake similar trials in the future. It would be recommended to hire sophisticated data loggers from research agencies rather than purchase “commercial” weather stations.

### *Summary*

The GTG project, through a modest industry investment of \$60,000 over the life of the project (*an average annual investment of less than \$12,000*), has helped the industry take a positive step forward. The industry investment helped to provide a structure for the GTG trials, it provided human resources to assist in setting up the trials, provided financial resources for the growers to obtain specific tools, collect relevant data and meet regularly to discuss progress. Without the modest industry investment, it is likely that the passionate growers would not have been able to achieve the level of detail they have, and the industry would not have been able to leverage that information to benefit the wider industry as it did. This project has been a substantial industry asset that has added immense value. Indeed, the work of a few has assisted to benefit the many. All of those involved in this project should be congratulated and thanked on behalf of all growers and the wider industry.

# Recommendations

Key recommendations from this project are;

- Do not rely on commercial weather stations
  - o Avoid commercial weather stations as part of industry trials, rather engage the use of professional data loggers from research agencies.
  
- Continue to invest in grower trials
  - o Industry investment into assisting growers undertake on-farm trials in a structured manner delivers high value data and increases the potential for strong financial returns across the entire industry.
  - o Growers all across the macadamia industry, and all across horticulture, are undertaking on-farm trials across a huge range of areas (*not just canopy management as the case for this project*). Yet these trials are often overlooked or not known about. And consequently there is not any defined structure to assist them.
  - o As mentioned previously, when growers see an opportunity to increase production they usually apply that across their entire orchard. The GTG structure and system enabled a suitably qualified and experienced human resource to work with commercial growers to leave a control area on their orchard to compare against, outline suitable data collection points and methods and helped the growers progress through the trials. This is the key point of difference that a structured grower trial system provides.
  - o It is important to note that the control area need not be a substantial size, rather a size that is comparable and relevant. This means that growers can apply the new initiative across 95% of their orchard and place themselves in a position to benefit handsomely. It also means that the grower can assess if an improvement was actually achieved against the 5% area that was designated as the control. And this benefits both that grower and the wider industry, provided the data is captured accordingly. This is the key point of difference and the key opportunity that formally investing into assisting grower trials delivers.

## **Scientific Refereed Publications**

N/A



# Intellectual Property/Commercialisation

N/A

## References

N/A

## **Appendix**

Please refer to the WeTransfer file with a flowering video example. The files are quite large, hence only 2 files have been sent through as an example of the data captured.

## **Acknowledgements**

It is important to acknowledge and thank the growers involved in this project, as well as those involved in helping them;

- David Rodgers
- David and Ann Anderson
- Graeme Fleming
- Bob Howard
- Peter Stransky
- Neil Jung
- Hugh Harris
- David Robertson (NSW DPI)
- Trevor Olsen (NSW DPI)
- Jeremy Bright (NSW DPI)
- Scott Hill (project assistant)
- John Allen (project manager)