Hort Innovation

Final Report

Macadamia Regional Variety Trials Series 3, Phase 2

Project leader:

Dougal Russell

Delivery partner:

Department of Agriculture and Fisheries, Queensland

Project code:

MC11001

Project:

Macadamia Regional Variety Trials Series 3, Phase 2 – MC11001

Disclaimer:

Funding statement:

This project has been funded by Hort Innovation, using the macadamia research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

Publishing details:

ISBN 978 0 7341 4417 1

Published and distributed by: Hort Innovation

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1 Chifley Square
Sydney NSW 2000

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www.horticulture.com.au

Content

Summary

The Regional Variety Trials (RVT's) Series 3 Phase 2 Hort Innovation project aims to evaluate 20 CSIRO breeding lines with industry standards (344, 268, 741, 816 and A16) and five Hidden Valley Plantation bred selections in a range of sites around Queensland and New South Wales. In this project we measured yield, kernel quality and tree performance to ultimately release new varieties to the macadamia industry.

Initially, ten sites were planted in 2008 between Macksville in NSW and Mackay in central QLD. Two of those sites have now been abandoned because of management issues and change of ownership. Acacia Plateau near Casino in NSW was decommissioned in 2011 and McLean's Ridges at the end of 2014, the latter is still being farmed by the new owner under a Material Transfer Agreement. The remaining eight sites include Mackay and Emerald in the north, Childers, Bundy Sugar, Decortes and Booyan in the Bundaberg region, and Macksville and Alstonville in NSW. In 2014, Wirrawilla near Bundaberg, was included in the project. This site was previously an Abnormal Vertical Growth (AVG) trial site that included all the test and standard varieties. In November 2015 the Childers site was devastated by a storm and will not be assessed from 2015 on. All sites have 180 trees with six reps of each variety except for Childers with 120 trees, and Wirrawilla with 160 trees.

Trees are strip harvested to year six and harvested five times in years seven, eight and nine. At harvest four, nuts are collected from the ground and bagged, remaining nuts in the tree are stripped out and bagged separately, effectively making harvest five.

All nuts from all trees are bagged at each harvest, weighed and then sampled. The nuts are dehusked and weighed again before oven drying to 1.5% moisture content. Individual tree yields are calculated from the sampling process. Samples are stored in air tight barrels at 4^{C} for kernel assessment at the end of the season. Tree heights and widths are measured at each site each year.

In this project yield, kernel quality and tree performance were measured. More in-depth studies determined tree susceptibility to insects and pathogens, Abnormal Vertical Growth (AVG), kernel oil profiles and macadamia shelf life to ultimately make decisions on releasing new varieties to the macadamia industry.

Four new macadamia varieties have been selected in consultation with the Macadamia Industry Variety Improvement Committee (MIVIC) and commercialised by the Department of Agriculture and Fisheries (DAF) from the CSIRO group of 20 while a further four varieties are being commercialised by HVP. The four DAF varieties are currently known as

MIV1-G. A large, precocious tree with high yields and kernel recovery (KR) of 40%+. Suitable for Bundaberg and Northern Rivers.

MIV1-P. A small to medium, precocious tree suitable for high density planting. More suitable to Bundaberg but produces heavy crops in NSW. KR in the high 30's.

MIV1-J. Medium to large tree with large nuts and high KR (44%) more suited to the Bundaberg region.

MIV1-R. Medium size tree that crops well in northern NSW with a KR of 37%.

Public summary

Macadamia is Australia's most successful indigenous agricultural commodity. Although initial development through breeding and agronomic research was carried out in Hawaii at the Hawaii Agricultural Experiment Station (HAES) during the 20th century, this work has been furthered in Australia. New varieties were developed in Hawaii, tested in previous regional variety trials and planted widely over the past 40 years in the then fledgling Australian industry with varying success. Local macadamia breeding programs were also developing and releasing varieties such as the A series from Hidden Valley Plantations although the bulk of varieties grown were Hawaiian. Variable performance of these Hawaiian varieties in Australia led to the establishment of the National Macadamia Breeding Program by the CSIRO.

From the first generation of macadamia seedlings 20 genotypes were selected to be included in Regional Variety Trials Series 3 along with five standard varieties (HAES 741, HAES 344, HAES 816, HAES 246 and A16. Five superior clones from the Hidden Valley Plantations (HVP) breeding program were also included. These 30 genotypes were planted and tested in locations in QLD (Mackay, Emerald, three sites in Bundaberg, and Childers) and NSW (Alstonville, McLean's Ridges and Macksville) for nine years. Information on yield, nut and tree characteristics and kernel performance was collected and, using sophisticated genetic analysis, developed recommendations to the Australian macadamia industry. The 30 genotypes were grafted onto two rootstocks, H2 seedling and Beaumont cuttings, in a number of the blocks to test influence on yield and tree performance in different environments. There was no consistent rootstock x scion interaction meaning that in some locations, some traits, in different years showed some significant rootstock effect.

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Keywords

Macadamia; variety assessment; genetic analysis; production; yield

Introduction

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) began breeding new macadamia varieties in 1996 (Hardener and McConchie, 2003) which until this time predominately came from the Hawaiian Agriculture Experiment Station, in Hawaii. The macadamia industry in Australia during the eighties and nineties was still in its fledgling stage as world production was dominated by Hawaii. Australian growers at this time were benefiting from taxation incentives (Ainsbury, 1996; Perryman, 1997) to invest in agricultural pursuits and became "producers". Many farms started from investments from city professionals and those looking for a life-style change which in turn kicked started the industry.

During the 1980's the industry was centered on the warm wet climate of the Northern Rivers of NSW with the industry relying on varieties bred in Hawaii. *Macadamia tetraphylla* evolved in rainforests on red volcanic soils of the Northern Rivers region of NSW while further to the north from the Gold coast to Maryborough, *Macadamia integrifolia* dominated (Hardner et. Al., 2009). In the late 1990's sugar cane farms in the Bundaberg region of Queensland were being converted into macadamia orchards using these same varieties with differing success. Bundaberg has a drier climate with free draining sandy soils, not as suited to the Hawaiian bred material. HAES 344 was the most widely planted variety and in this environment is quite susceptible to Abnormal Vertical Growth (AVG) (O'Farrell et. Al., 2016). The elite selections in this project were from the CSIRO breeding program B1.1

The Regional Variety Trials (RVT's) Series 3 Phase 2 Hort Innovation project aims to evaluate 20 CSIRO breeding lines with industry standards (344, 268, 741, 816 and A16) and five Hidden Valley Plantation bred selections in a range of sites around Queensland and New South Wales.

Initially, ten trials were planted between March 2008 and March 2009 in NSW and QLD. New South Wales trials were planted in Alstonville (AL) McLean's Ridges (MR), Acacia Plateau and Macksville (MV) in the south. Acacia Plateau near Casino, in NSW was decommissioned in 2011 and McLean's Ridges at the end of 2014, the latter is still being farmed by the new owner under a Material Transfer Agreement with DAF. The remaining QLD sites are in Mackay (MA) and Emerald (EM) in the north, Childers (CH), Decortes (B1), Booyan (B2) and Bundy Sugar (B3), in the Bundaberg region. In 2014, Wirrawilla (WW) near Bundaberg, was included in the project. This site was previously an Abnormal Vertical Growth (AVG) trial site that included all the test and standard varieties except for HAES 741 and HAES 246. In the course of 10 years, four sites changed ownership, three sites were damaged by cyclones and two RVT in Childers destroyed by a storm.

Childers RVT had been the most productive and precocious site of all RVTs however in October 2015 a severe storm cell devastated the region with very high winds, hail and rain. Many trees were literally ripped out of the ground. All trees suffered severe hail damage, limb and crop loss. The site was abandoned following this storm.

In March 2017 Cyclone Debbie struck the Mackay region dumping up to one metre of rain in one 24hr period. At the Mackay RVT near Homebush, most of the crop dropped to the ground to be washed away in the flooding rain with all crop lost. Mackay RVT was not harvested in 2017 however will be harvested in 2018

In early November 2017 a storm severely damaged the Wirra Willa site with some trees snapped at the trunk, many have limb and branch damage. This trial has been seriously compromised for future AVG evaluation and harvest data into the future.

In this project yield, kernel quality and tree performance were measured. More in-depth studies determined tree susceptibility to insects and pathogens, Abnormal Vertical Growth (AVG), kernel oil profiles and macadamia shelf life to ultimately make decisions on releasing new varieties to the macadamia industry.

This report details the analysis, process of determining variety release, variety performance in each block and variety descriptions, which have been accomplished during the macadamia regional variety trial series 3 phase2 project MC11001.

Methodology

Trial Layout

All sites were planted between March 2008 and March 2009. Each site has 180 trees with six replicates of 30 genotypes except for Childers with 120 trees, and Wirrawilla with 160 trees. Trial sites are laid out on a nine row by 20 tree format except for Childers with nine rows of 15 trees, Wirrawilla four rows of 40 trees and Alstonville with 10 row of 18 trees. Twenty CSIRO bred genotypes selected from the B1.1 progeny breeding program, five standard varieties (HAES 344, HAES 741, HAES 816, HAES 246 and A16) and five Hidden Valley Plantation selections were planted at each site (Table 1). Scions were grafted onto two rootstocks, Beaumont cuttings and H2 seedlings, in Mackay, Decortes, Booyan, Childers and Alstonville. H2 seedling was the only rootstock at Emerald, Bundy Sugar, Wirra Willa and Macksville.

Regional Variety Trials Genotypes on Test

Industry Standards	Variety Code	CSIRO B1.1 Elite Selections	Variety Code	Hidden Valley Plantations	Variety Code
HAES 246	29	A	15	A376	1
HAES 344	26	B	7	A403	3
HAES 741	27	C	2	A422	5
HAES 816	9	D	28	A447	22
A16	10	E	17	A538	8
		F	11		
		G	14		
		H	25		
		I	12		
		J	6		
		K	16		
		L	30		
		M	18		
		N	24		
		O	20		
		P	21		
		Q	4		
		R	23		
		S	19		
		T	13		

Trees were strip harvested to year six and harvested five times at six weekly intervals in years seven, eight and nine to determine nut drop pattern. At harvest four, nuts were collected from the ground and bagged. The remaining nuts in the tree were stripped out and bagged separately, effectively making harvest five.

All nuts from all trees are bagged at each harvest, weighed and then sampled. During the course of this project the sampling regime changed from composite samples, combining sub-samples from each replicate tree in a bucket and then resampling again. This would give 30 samples for the site, or one

sample for each variety.

To ensure more rigorous statistical analysis the procedure was changed to sampling every tree. This was carried out in the field in the remote locations or back in the shed for the Bundaberg and Alstonville sites. A much greater degree of accuracy ensued as every bag was dehusked and weighed and a 2kg sample taken. All remaining nuts are returned to the grower.

Once the nuts are dehusked, weighed and sampled they are oven dried over six days (two days at 35c, two days at 45c and two days at 55c) to between 1% and 1.5% moisture content. Individual tree yields are calculated from the sampling process.

% husk = (Sample WNIS / Sample WNIH) x 100

% DNIS = 100 – ((DNIS/WNIS) x 100) (after 6 days of drying)

Total DNIS @10% moisture = (Total WNIH x (sample WNIH x (% DNIS /100))) x 1.09

Where WNIS = Wet Nut in Shell; WNIH = Wet Nut in Husk; DNIS = Dry Nut in Shell@1.5%

One to two kilogram samples are stored in air tight barrels at 4^{C} for kernel assessment at the end of the season, usually October. Individual tree heights, widths and depth are measured at each site, each year and tree spheroid canopy calculated.

((4/3) x 3.1416 x (H/2) x ((W x D)/4))

Where H = Tree Height; W = Tree Width along the row; D = Depth within the row

The RVT harvest season begins in the Bundaberg region in late February / early March, followed by Emerald and Alstonville in April and Macksville in May. Harvesting continues at six weekly intervals until the last harvest in Alstonville in September. Tree measurements are usually in October and November or during the last harvests at Emerald, Mackay and Macksville to save an extra return journey.

Kernel assessment is carried out at the end of each season as per the Australian macadamia Kernel assessment manual (2011). Characters measured are:

Nut and Kernel Weight

Kernel Recovery

Wholes

Reject Kernel

Commercial Kernel

Premium Kernel

Quality Disorders

During the course of the RVT3 project nut samples from Alstonville RVT were sent to Cropwatch Independent Laboratories NSW, for kernel assessment and rapid shelf life testing. Samples from Bundaberg were sent to Suncoast Gold Macadamias, Gympie for kernel assessment and roasting tests.

Multi Environment Trial (MET) across sites analysis

All data collected from the Regional Variety Trial sites is collated and analysed. Regional Variety Trial sites perform differently depending on location, management, climate and soil type. Within each site there are many variables that impact on the performance of a variety such as competition from neighbours, accidental harvesting of some rows, slope and broken limbs which are all examples of environmental impact on a tree.

Multiple Environment Trial (MET) analysis accounts for these "environmental" effects and aligns the data to a purely genetic effect. The data in this report has been transformed into the genetic performance of each variety using Best Linear Unbiased Prediction analysis or BLUP.

Multi-environment trial (MET) analyses were performed across sites and years (2013-2017) using linear mixed models accounting for spatial and temporal correlation. The analyses were performed in ASReml®. Variety effects were correlated across environments (sites and years) and best linear unbiased predictions (BLUPs) were predicted for each variety (Appendix, 1 Chapter 3).

Trait Valuing and Discounted Cash Flow

During the course of 2016 Craig Hardner (QAAFI and chair), David Bell (Hidden Valley Plantations), Shane Mulo (DAF), Grant Bignell (DAF), Bruce Topp (QAAFI), Mobashwer Alam (QAAFI) and Dougal Russell (DAF) met to develop a method which would simplify the RVT variety selection process and provide a tool for selecting seedlings from the QAAFI 2nd Generation Macadamia Breeding, MC14000. Originally, economic modelling from benchmarking projects over the past 5 -10 years was thought to be an efficient way of predicting the performance of the new varieties. This was using past yield curves to age 20 and aligning the current RVT data to year 8 along those curves. At year 8 the RVT's are outperforming the industry top 25% of farms identified by benchmarking making it difficult to align those curves to the current data. The next approach looked into developing an economic model using the benchmark and current data to consider dollar values for growers at year 8 and year 20. The dollar valuing of traits (positive and negative) show the profitability when comparing the test varieties. It also compares profit to the top 25% of industry farms and the average of the standards in the trials (Appendix 1, Chapter 4).

Supplementary trial growers also collected data throughout the year that, although not statistically measured or in designed trials, aided in the trait valuing process of the economic model. Grower comments on performance are very important when considering desirable characteristics the new varieties must achieve.

Outputs

2015

Consultants Meeting 2015

Initial results were presented from the 2014 harvest to the Macadamia Consultants Meeting on the 10th of June. Childers RVT was chosen to show four methods of calculating yield and how the rankings of the varieties change depending on the method of measuring yield, the year, and on environmental and management issues.

MIVIC Field Walk

On September 23rd the Macadamia Industry Variety Improvement Committee (MIVIC) met in Bundaberg for farm walks at three RVT trial sites. The group were asked to record kernel and tree characteristics at Childers, tree characteristics, including Abnormal Vertical Growth (AVG) at Wirrawilla and view the trees at Booyan. On the 24th of September the committee met at the Bundaberg Research Station to discuss the future timelines and activities leading up to variety release in 2017.

2016

AMS News Bulletin, May 2016

The May edition of the Australian Macadamia Society News Bulletin gave a rundown of the February field walks in Bundaberg and Alstonville. This keeps the industry informed of the latest data and opinion on the new varieties under test in the Regional Variety Trials. More than 130 growers came to see the performance of potential new varieties for the macadamia industry. At each of the field walks growers were shown the best performing industry, HVP varieties and commercial standards, and given their vital statistics.

February MIVIC Meeting

After the field walks a meeting of the Macadamia Industry Variety Improvement Committee was convened on February 19 at the Wollongbar Research Centre at Wollongbar, northern NSW. Results from grower ratings at the previous field walks in Bundaberg and Alstonville were presented. A timeline of activities were discussed including a test of Ethaphon on the new industry varieties, 2016 harvests, flowering trials, PBR application and the development of economic weights as a means of selecting varieties for commercialisation.

Presentation to MIVIC of results of harvest and activities during 2016. MIVIC also received a report detailing the state of the RVT sites, analysis of harvest results and individual tree and nuts data.

Presentation to the Supplementary Growers Meeting held on November 30 on RVT results, grower results and comments from the February field walks in Bundaberg and Alstonville. This built up a picture of the importance of their results and how they are being used in the valuing of traits used in the economic modelling of variety performance.

Results were presented on the state of the RVT project at the Australian Macadamia Society's conference in the "speed dating, meet the researcher" session at Caloundra on 19th October.

2017

Factsheets for the four new varieties G, P, R, and J (Appendix 1, Chapter 16).

AMS News Bulletin article detailing the grower field walks in Bundaberg and Alstonville, May 2017.

Abstract for 2017 International Research Symposium, Hawaii, 13th–14th September 2017. **Four new macadamia varieties for the Australian industry.**

New Macadamia Varieties for Australia, June 7th , presentation to approximately 100 consultants, researchers and processors at the annual macadamia consultants meeting in Brisbane.

Appendix 1 details Nut in Shell Yield, Kernel Yield, Cumulative Kernel Yield, Tree Size and Canopy Efficiency results from all RVT sites (Chapters 5 to 13). Supplementary grower results (Chapter 14) are presented as well as variety and block performance characteristics (Chapter 15 and variety descriptions (Appendix 2, Chapter 18).

Outcomes

Release of new varieties

- The macadamia industry is seeking superior genetics adapted to local environments with increased yield and resistance to Abnormal Vertical Growth. These new varieties will have the capacity to increase yield and provide security against AVG.
- RVT test sites were in the major and expanding production regions. Testing in growth regions increases grower confidence in planting the new varieties. Successful grower field walks in Bundaberg and Alstonville RVTs showcased MIV1-G, MIV1-P, MIV1-J and MIV1-R and has helped fuel grower demand.
- MIVIC recommended varieties not only based on yield data over time and environmental performance, but also using economic trait valuing and modelling to derive 20 year Discounted Cash Flow comparisons.
- A commercialisation selection panel made up of AMS, Hort Innovation and DAF representatives determined the Queensland Strawberry Growers Association (QSGA) as the commercialisation partner to harness nursery production, management of mother stock and promotion of new varieties to the industry.
- QSGA are handling orders of the new varieties. Initial tree orders are for varieties G and P for the Bundaberg region although there have been enquiries from Maryborough and the Norther Rivers of NSW. QSGA will report tree sales to the DAF Business Manager annually.
- Plant Breeders Rights Part 1 have been granted to the new varieties, final Part 2 is to be granted early in the 2019 harvest season.

Genotyping new varieties

- Macadamia varieties introduced into Australia over the past 40 years have been propagated and sold to growers with limited confidence of true-to-type trees. Growers pay for trees and plant on trust that the nursery is supplying the actual variety they paid for. DAF, over the course of this project and with the collaboration of the Southern Cross University, genotyped MIV1-G, MIV1-P, MIV1-J and MIV1-R and all mother stock trees from RVT's and grower supplementary plantings. This ensures QSGA nurseries will have true-to-type planting material and growers "get what the pay for".

Targeted lessons learnt from RVT3

- Sampling – This is the most important factor in data analysis. The better the data collected the more rigorous the analysis. During the course of RVT3 we have changed the sampling regime from compiled samples to sampling every tree at every harvest. RVT4 will have this same sampling and processing regime for genetic analysis.
- Plot size – RVT3 had only 1 tree plots. These could be influenced by neighbours being larger or nuts dropping from neighbours, confusing the harvest and subsequent sampling. Plots in RVT4 will be a minimum 3 tree plots with tree and yield measurements taken from the middle tree in the plot to avoid contamination from neighbours.
- Replication - Supplementary trials in RVT3 were single variety mass plantings. RVT4 will give macadamia growers the opportunity to plant 10 to 20 tree plots of a number of the new genotypes on test, in a randomised replicated array. Common standards will be inter-planted to enable statistical relevance.

Monitoring and evaluation

MC11001 had no formal monitoring and evaluation plan as it was submitted under the previous HAL project proposal system. However, the project has been overseen and driven by the Macadamia Industry Variety Improvement Committee (MIVIC).

Key evaluation criteria are

- Two MIVIC meetings each year where variety performance is discussed and agenda set for the next 12 months. MIVIC makes decisions on data to collect, which blocks to harvest and ultimately decide varieties to release.
- MIVIC also guides future evaluation and makes recommendations on methodology which has been incorporated into the Mandatory Response Table for RVT4.
- Grower field walks in major production regions. At field walks growers can see the new varieties and compare directly with standards. Information is provided on yield and ranking of the varieties and they can see the trees for themselves.
- At both grower and MIVIC field walks the participants are urged to complete evaluation forms (Appendix 1, Chapter 17) which are collated with comments and ratings of variety performance. Information from these field walks is presented in the AMS Newsletter.

Recommendations

With the experience and knowledge gained from RVT3 a new round of testing can be smoother, cheaper and offer greater statistical rigor.

Further MET analysis will help to understand the best environment/s and how many locations are required for the new project. Project biometrician, Dr. Joanne De Faveri is also thinking about the amount of replication required to give significant differences between genotypes. She does believe that there is enough replication with 6 reps but sees very large variation between year and sites. There was a temptation to go to 3 or 6 tree plots however Joanne advised against increased plot size due to tree expense and unnecessary data collection

RVT4 is looking to have a number of components.

1. Test 23 new B1.2 superior selections.

MIVIC and the breeding team went through the best performing B1.2's and selected out the top 23 from genotypic and phenotypic data. Breeding lines or new varieties could also be tested in the RVT 4. With standard industry varieties and releases from RVT3.

2. Complete the Decortes private RVT with harvesting and statistical analysis. There are 2 years remaining with some promising varieties coming through. This trial will need to be harvested 2 more times with statistical analysis on the data to date, and for the final selection process.

3. Complete RVT 3 harvest and analysis of Emerald, Mackay and Macksville. These have been the slow blocks to come into production as they were planted later and grown in atypical macadamia environments. At least 1 – 2 years of data needs to be collected.

4. Revisit RVT3 trial sites (perhaps Booyan and Decortes) at year 12, 13 and 14. At year 8 some of the blocks (Wirra and Booyan) were thought to have stabilised in variety ranking however in 2017 these blocks have again changed rankings which could be to do with biennial bearing from heavy cropping. Evaluating the trees again will be a good comparison for year 8 and 9 performance.

5. Supplementary grower RVTs

Grower, mass planted trials of new material will provide useful information on yield, insect and disease susceptibility and tree performance. We will be looking for growers with weight cells on their harvesters so a row or part row of each variety can be picked up in a single run.

These recommendations were made to the February 8th MIVIC meeting in 2018.

Publications

Macadamia Variety "G" Fact Sheet. Department of Agriculture and Fisheries, April 2017.

Macadamia Variety "P" Fact Sheet. Department of Agriculture and Fisheries, April 2017.

Macadamia Variety "J" Fact Sheet. Department of Agriculture and Fisheries, April 2017.

Macadamia Variety "R" Fact Sheet. Department of Agriculture and Fisheries, April 2017.

E. Howell, D. Russell, M. Alam and B. Topp., 2016 **Variability of initial and final nut setting in Macadamia superior selections through different pollination methods.** Poster presentation ISHS meetings, Cairns 2016.

D. Russell; J. De Faveri; C. Hardner; D. Bell; S. Mulo ; G. Bignell and B. Topp 2017.- **Four new macadamia varieties for the Australian industry.** Poster and abstract. International Macadamia Conference, Hawaii, October 2017

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Intellectual property, commercialisation and confidentiality

Commercialisation of the first release of Macadamia varieties is on track with the timetable provided to the industry. The Macadamia Varieties expression of interest (EOI) process has been completed with the selection of an interested commercial partner to enter into contract negotiations. The evaluation panel consisted of five members including industry, DAF and HIA representation to ensure the selection of a suitable commercial partner that would have the industries best interests on their agenda.

Queensland Strawberry Growers Association are the commercialisation partner with DAF in providing these new macadamia varieties to industry. Plant Breeders Rights Part 1 has been granted for MIV1-G, MIV1-R, MIV1-J and MIV1-P.

Acknowledgements

This project is funded through Horticulture Innovation Australia and overseen by MIVIC. We thank current members of that group (David Bell, Lindsay Bryan, Chris Searle, Jolyon Burnett, Mark Hickey, Ian McConachie, Scott Alcott, Kevin Quinlan, Clayton Mattiazzi, Bruce Topp and Vino Rajandran from Hort Innovation) for their input and advice in the project. We also gratefully acknowledge the assistance of the RVT property owners and managers, and the supplementary growers below.

RVT Co-operators		**Supplementary Co-operators**	
Organisation	Contact	Organisation	Contact
Bundy Sugar	Sean Cox	Alloway Nurseries	Ray Norris
Dymocks	Chris Cook	Gray Plantations	Kim Wilson
FNC	Adrian Walsh	MFM	Scott Alcott
Gray Plantations	Kim Wilson	Tregeagle	Steve McLean
Hinkler Park	Clayton Mattiazzi	TW Dorey & Sons PTY LTD	Ken Dorey
MFM	Scott Alcott		
NSW DPI	Craig Maddox		

Special thanks to Rachel Abel (DAF), Rod Daley (DAF), Paul O'Hare (DAF - retired), Joanne De Faveri (DAF), Russ Stevenson (DAF – retired), Grant Bignell (DAF), Bruce Topp (QAAFI), Mobashwer Mohmand (QAAFI), Olufemi Akinsanmi (QAAFI), Craig Maddox (NSW DPI), David Robinson (NSW DPI), Mark Hickey NSW DPI), Lindsay Bryen, Darren Harris (Hinkler Park).

Appendices

Appendix 1. Macadamia Regional Variety Trials Series 3 Phase 2 – Final Report.

Appendix 2. Chapter 18. Macadamia Variety Descriptor Index

Appendix 3. Factsheets MIV1G, MIV1-J, MIV1-P and MIV1-R

Macadamia Regional Variety Trials Series 3 Phase 2 - MC11001

Final Report

Dougal Russell, Rachel Abel, Rod Daley and Joanne De Faveri

AUSTRALIAN MACADAMIA SOCIETY

Hort Innovation

Queensland Government

Media Summary

Macadamia is Australia's most successful indigenous agricultural commodity. Although initial development through breeding and agronomic research was carried out in Hawaii at the Hawaii Agricultural Experiment Station (HAES) during the 20th century, this work has been furthered in Australia. New varieties were developed in Hawaii, tested in previous regional variety trials and planted widely over the past 40 years in the then fledgling Australian industry with varying success. Local macadamia breeding programs were also developing and releasing varieties such as the A series from Hidden Valley Plantations although the bulk of varieties grown were Hawaiian. Variable performance of these Hawaiian varieties in Australia led to the establishment of the National Macadamia Breeding Program by the CSIRO.

From the first generation of macadamia seedlings 20 genotypes were selected to be included in Regional Variety Trials Series 3 along with five standard varieties (HAES 741, HAES 344, HAES 816, HAES 246 and A16. Five superior clones from the Hidden Valley Plantations (HVP) breeding program were also included. These 30 genotypes were planted and tested in locations in QLD (Mackay, Emerald, three sites in Bundaberg, and Childers) and NSW (Alstonville, McLean's Ridges and Macksville) for nine years. Information on yield, nut and tree characteristics and kernel performance was collected and, using sophisticated genetic analysis, developed recommendations to the Australian macadamia industry. The 30 genotypes were grafted onto two rootstocks, H2 seedling and Beaumont cuttings, in a number of the blocks to test influence on yield and tree performance in different environments. There was no consistent rootstock x scion interaction meaning that in some locations, some traits, in different years showed some significant rootstock effect.

Four new macadamia varieties have been identified and commercialised by the Department of Agriculture and Fisheries (DAF) from the CSIRO group of 20 while a further four varieties are being commercialised by HVP. The four DAF varieties are currently known as

MIV1-G. A large, precocious tree with high yields and 40+ kernel recovery. Suitable for Bundaberg and Northern Rivers.

MIV1-P. A small to medium, precocious tree suitable for high density planting. More suitable to Bundaberg but produces heavy crops in NSW. KR in high 30's.

MIV1-J. Medium to large tree with large nuts and high KR (44%) more suited to the Bundaberg region.

MIV1-R. Medium size tree that crops well in northern NSW with a KR of 37%.

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Table and Figure Index

1. Introduction

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) began breeding new macadamia varieties in 1996 (Hardener and McConchie, 2003) which until this time predominately came from the Hawaiian Agriculture Experiment Station, in Hawaii. The macadamia industry in Australia during the eighties and nineties was still in its fledgling stage as world production was dominated by Hawaii. Australian growers at this time were benefiting from taxation incentives (Ainsbury, 1996; Perryman, 1997) to invest in agricultural pursuits and became "producers". Many farms started from investments from city professionals and those looking for a life style change which in turn kicked started the industry.

During the 1980's the industry was centred on the warm wet climate of the Northern Rivers of NSW with the industry relying on varieties bred in Hawaii. *Macadamia tetraphylla* evolved in rainforests on red volcanic soils of the Northern Rivers region of NSW while further to the north from the Gold coast to Maryborough, *Macadamia integrifolia* dominated (Hardner et. Al., 2009). In the late 1990's sugar cane farms in the Bundaberg region of Queensland were being converted into macadamia orchards using these same varieties with differing success. Bundaberg has a drier climate with free draining sandy soils, not as suited to the Hawaiian bred material. HAES 344 was the most widely planted variety and in this environment is quite susceptible to Abnormal Vertical Growth (AVG) (O'Farrell et. Al., 2016). The elite selections in this project were from the CSIRO breeding program B1.1

The Regional Variety Trials (RVT's) Series 3 Phase 2 HIA project aims to evaluate 20 CSIRO breeding lines with industry standards (344, 268, 741, 816 and A16) and five Hidden Valley Plantation bred selections in a range of sites around Queensland and New South Wales.

Initially, ten trials were planted between March 2008 and March 2009 in NSW and QLD. New South Wales trials were planted in Alstonville (AL) McLean's Ridges (MR), Acacia Plateau and Macksville (MV) in the south. Acacia Plateau near Casino, in NSW was decommissioned in 2011 and McLean's Ridges at the end of 2014, the latter is still being farmed by the new owner under a Material Transfer Agreement with DAF. The remaining QLD sites are in Mackay (MA) and Emerald (EM) in the north, Childers (CH), Decortes (B1), Booyan (B2) and Bundy Sugar (B3), in the Bundaberg region. In 2014, Wirrawilla (WW) near Bundaberg, was included in the project. This site was previously an Abnormal Vertical Growth (AVG) trial site that included all the test and standard varieties except for HAES 741 and HAES 246. In the course of 10 years, four sites changed ownership, three sites were damaged by cyclones and two RVT in Childers destroyed by a storm.

Childers RVT had been the most productive and precocious site of all RVTs however in October 2015 a severe storm cell devastated the region with very high winds, hail and rain. Many trees were literally ripped out of the ground. All trees suffered severe hail damage, limb and crop loss. The site was abandoned following this storm.

In March 2017 Cyclone Debbie struck the Mackay region dumping up to one metre of rain in one 24hr period. At the Mackay RVT, near Homebush, most of the crop dropped to the ground to be washed away in the flooding rain with all crop lost. Mackay RVT was not harvested in 2017 however will be harvested in 2018

In early November 2017 a storm severely damaged the Wirra Willa site with some trees snapped at the trunk, many have limb and branch damage. This trial has been seriously compromised for future AVG evaluation and harvest data into the future.

In this project yield, kernel quality and tree performance were measured. More in-depth studies determined tree susceptibility to insect and pathogen, Abnormal Vertical Growth (AVG), kernel oil profiles and macadamia shelf life to ultimately make decisions on releasing new varieties to the macadamia industry.

This report details the analysis, process of determining variety release, variety performance in each block and variety descriptions, which have been accomplished during the macadamia regional variety trial series 3 phae2 project MC11001.

Acknowledgements

This project is funded through Horticulture Innovation Australia and overseen by MIVIC. We thank current members of that group (David Bell, Lindsay Bryan, Chris Searle, Jolyon Burnett, Mark Hickey, Ian McConachie, Scott Alcott, Kevin Quinlan, Clayton Mattiazzi, Bruce Topp and Vino Rajandran from Hort Innovation) for their input and advice in the project. We also gratefully acknowledge the assistance of the RVT property owners and managers, and the supplementary growers below.

RVT Co-operators		**Supplementary Co-operators**	
Organisation	Contact	Organisation	Contact
Bundy Sugar	Sean Cox	Alloway Nurseries	Ray Norris
Dymocks	Chris Cook	Gray Plantations	Kim Wilson
FNC	Adrian Walsh	MFM	Scott Alcott
Gray Plantations	Kim Wilson	Tregeagle	Steve McLean
Hinkler Park	Clayton Mattiazzi	TW Dorey & Sons PTY LTD	Ken Dorey
MFM	Scott Alcott		
NSW DPI	Craig Maddox		

Special thanks to Rachel Abel (DAF), Rod Daley (DAF), Paul O'Hare (DAF - retired), Joanne De Faveri (DAF), Russ Stevenson (DAF – retired), Grant Bignell (DAF), Bruce Topp (QAAFI), Mobashwer Mohmand (QAAFI), Olufemi Akinsanmi (QAAFI), Craig Maddox (NSW DPI), David Robinson (NSW DPI), Mark Hickey NSW DPI), Lindsay Bryen, Darren Harris (Hinkler Park).

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2. Data Collection

Trial Layout

All sites were planted between March 2008 and March 2009. Each site has 180 trees with six replicates of 30 genotypes except for Childers with 120 trees, and Wirrawilla with 160 trees. Trial sites are laid out on a nine row by 20 tree format except for Childers with nine rows of 15 trees, Wirrawilla four rows of 40 trees and Alstonville with 10 row of 18 trees. Twenty CSIRO bred genotypes selected from the B1.1 progeny breeding program, five standard varieties (HAES 344, HAES 741, HAES 816, HAES 246 and A16) and five Hidden Valley Plantation selections were planted at each site (Table 1). Scions were grafted onto two rootstocks, Beaumont cuttings and H2 seedlings, in Mackay, Decortes, Booyan, Childers and Alstonville. H2 seedling was the only rootstock at Emerald, Bundy Sugar, Wirra Willa and Macksville.

Table 1 Genotypes on test in the Regional Variety Trials

Regional Variety Trials Genotypes on Test

Industry Standards	Variety Code	CSIRO B1.1 Elite Selections	Variety Code	Hidden Valley Plantations	Variety Code
HAES 246	29	A	15	A376	1
HAES 344	26	B	7	A403	3
HAES 741	27	C	2	A422	5
HAES 816	9	D	28	A447	22
A16	10	E	17	A538	8
		F	11		
		G	14		
		H	25		
		I	12		
		J	6		
		K	16		
		L	30		
		M	18		
		N	24		
		O	20		
		P	21		
		Q	4		
		R	23		
		S	19		
		T	13		

Trees were strip harvested to year six and harvested five times at six weekly intervals in years seven, eight and nine to determine nut drop pattern. At harvest four, nuts were collected from the ground and bagged, the remaining nuts in the tree are stripped out and bagged separately, effectively making harvest five.

All nuts from all trees are bagged at each harvest, weighed and then sampled. During the course of this project the sampling regime changed from composite samples, combining sub-samples from each replicate tree in a bucket and then resampling again. This would give 30 samples for the site, or one sample for each variety (figure 2-1) .

Figure 2-1 Original sampling method using composites from the 6 replicate trees, mixed in a bucket, then taking 2 kg sample.

To ensure more rigorous statistical analysis the procedure was changed to sampling every tree. This was carried out in the field in the remote locations or back in the shed for the Bundaberg and Alstonville sites. A much greater degree of accuracy ensued as every bag was dehusked and weighed and a 2kg sample taken. All remaining nuts are returned to the grower.

Once the nuts are dehusked, weighed and sampled they are oven dried over six days (two days at 35c, two days at 45c and two days at 55c) to between 1% and 1.5% moisture content. Individual tree yields are calculated from the sampling process.

% husk = (Sample WNIS / Sample WNIH) x 100

% DNIS = 100 – ((DNIS/WNIS) x 100) (after 6 days of drying)

Total DNIS @10% moisture = (Total WNIH x (sample WNIH x (% DNIS /100))) x 1.09

Where WNIS = Wet Nut in Shell; WNIH = Wet Nut in Husk; DNIS = Dry Nut in Shell@1.5%

One to two kilogram samples are stored in air tight barrels at 4^{C} for kernel assessment at the end of the season, usually October. Individual tree heights, widths and depth are measured at each site, each year and tree spheroid canopy calculated.

((4/3) x 3.1416 x (H/2) x ((W x D)/4))

Where H = Tree Height; W = Tree Width along the row; D = Depth within the row

Table 2 presents the number of trees harvested, average NIS yield for each tree in each block, and total weight of NIS harvest for each RVT site in years 2015 – 2017.

The RVT harvest season begins in the Bundaberg region in late February / early March, followed by Emerald and Alstonville in April and Macksville in May. Harvesting continues at six weekly intervals until the last harvest in Alstonville in September. Tree measurements are usually in October and November or during the last harvests at Emerald, Mackay and Macksville to save an extra return journey. A summary of harvest by year appears in table 2.

Kernel assessment is carried out at the end of each season as per the Australian macadamia Kernel assessment manual (2011). Characters measured are:

Nut and Kernel Weight

Kernel Recovery

Wholes

Reject Kernel

Commercial Kernel

Premium Kernel

Quality Disorders

During the course of the RVT3 project nut samples from Alstonville RVT were also sent to Kim Jones at Cropwatch Independent Laboratories, Wardell NSW, for kernel assessment and rapid shelf life testing. While samples from Bundaberg were sent to Suncoast Gold Macadamias, Gympie for kernel assessment and roasting tests.

Literature Cited

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Table 2 Harvest Summaries 2015 - 2017

Regional Variety Trials Yield

Summary of 2015, 2016 and 2017 Harvest Nut in Shell at 10% MC

	Total Trees Harvested 2015	Total Trees Harvested 2016	Total Trees Harvested 2017	Average Tree NIS (10%) kg 2015	Average Tree NIS (10%) kg 2016	Average Tree NIS (10%) kg 2017	Total Weight of Harvest @ 10% MC (kg) 2015	Total Weight of Harvest @ 10% MC (kg) 2016	Total Weight of Harvest @ 10% MC (kg) 2017
MA Mackay	170	172		1.66	2.76	#DIV/0!	282.48	474.24	0.00
EM Emerald	172	176	172	3.10	5.21	2.29	533.04	917.65	393.24
B1 Decortes	176	178	178	4.00	7.25	9.16	703.19	1,290.30	1,630.78
B2 Booyan	180	180	180	7.05	9.39	8.06	1,268.91	1,689.89	1,450.40
B3 Bundy Sugar	146	145	145	5.47	7.79	5.81	799.11	1,130.07	842.66
CH Childers	101			8.44		#DIV/0!	852.21	0.00	
AL Alstonville	166	160	166	9.82	7.84	11.04	1,629.80	1,254.51	1,832.60
MV Macksville	87	167	173	0.63	4.40	2.85	54.83	734.43	492.70
Wirra RVT	144	143	144	6.75	10.78	6.83	971.86	1,542.15	983.83
Totals	**1342**	**1321**	**1158**	**5.29**	**6.84**	**6.59**	**7,095.42**	**9,033.25**	**7,626.20**

33 Blocks harvested in 2015
30 Blocks harvested in 2016
31 Blocks harvested in 2017

Total Trees Harvested	**4994**	**4897**	**5100**

3. Data Analysis

Multi Environment Trial (MET) across sites analysis

All data collected from the Regional Variety Trial sites is collated and analysed. Regional Variety Trial sites perform differently depending on location, management, climate and soil type. Within each site there are many variables that impact on the performance of a variety such as competition from neighbours, accidental harvesting of some rows, slope and broken limbs which are all examples of environmental impact on a tree.

Multiple Environment Trial (MET) analysis accounts for these "environmental" effects and aligns the data to a purely genetic effect. The data in this report has been transformed into the genetic performance of each variety using Best Linear Unbiased Prediction analysis or BLUP.

Multi-environment trial (MET) analyses were performed across sites and years (2013-2017) using linear mixed models accounting for spatial and temporal correlation. The analyses were performed in ASReml®. Variety effects were correlated across environments (sites and years) and best linear unbiased predictions (BLUPs) were predicted for each variety.

MET analysis across Sites and Years for DNIS (10%).

2013-2017

Raw data plotted over time for each variety (each line represents the average for a site). Line colour is the site while each point is the year.

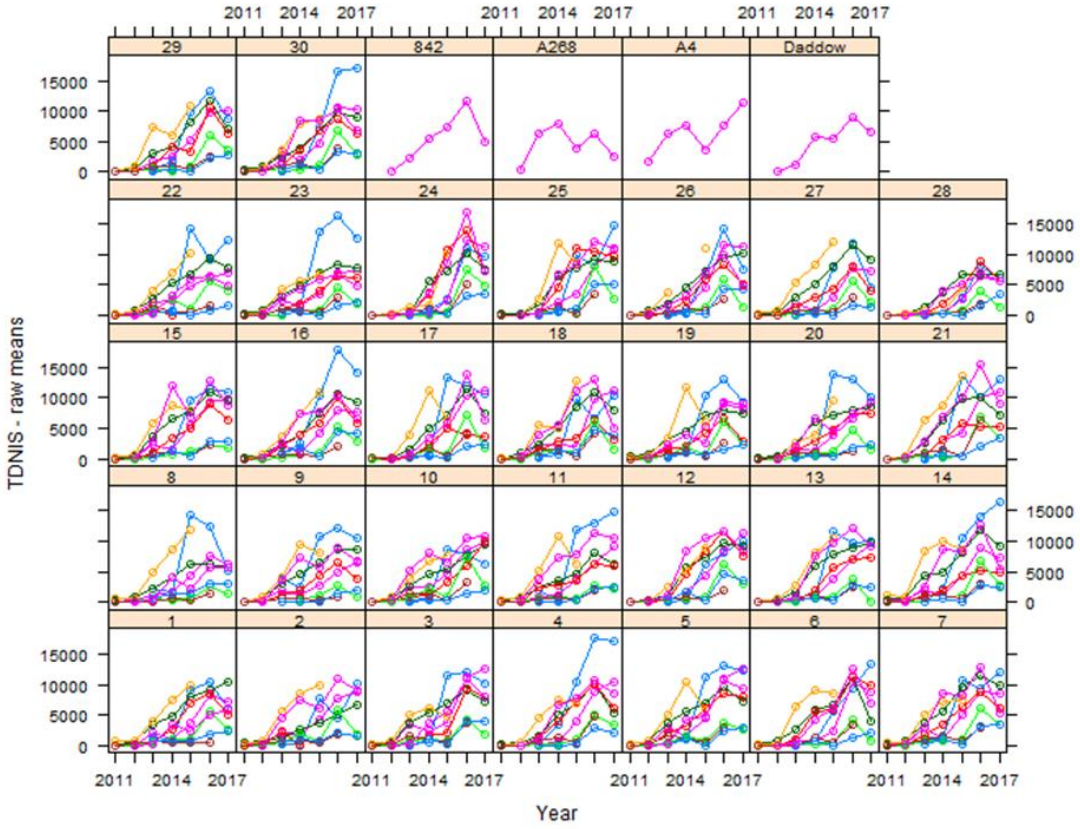

Figure 3-1 Raw data plotted over time.

Below (figure 3-2) is a heat map of site correlations between sites, rootstocks and years. Highly correlated sites are in the dark red while negatively correlated sites are in blue.

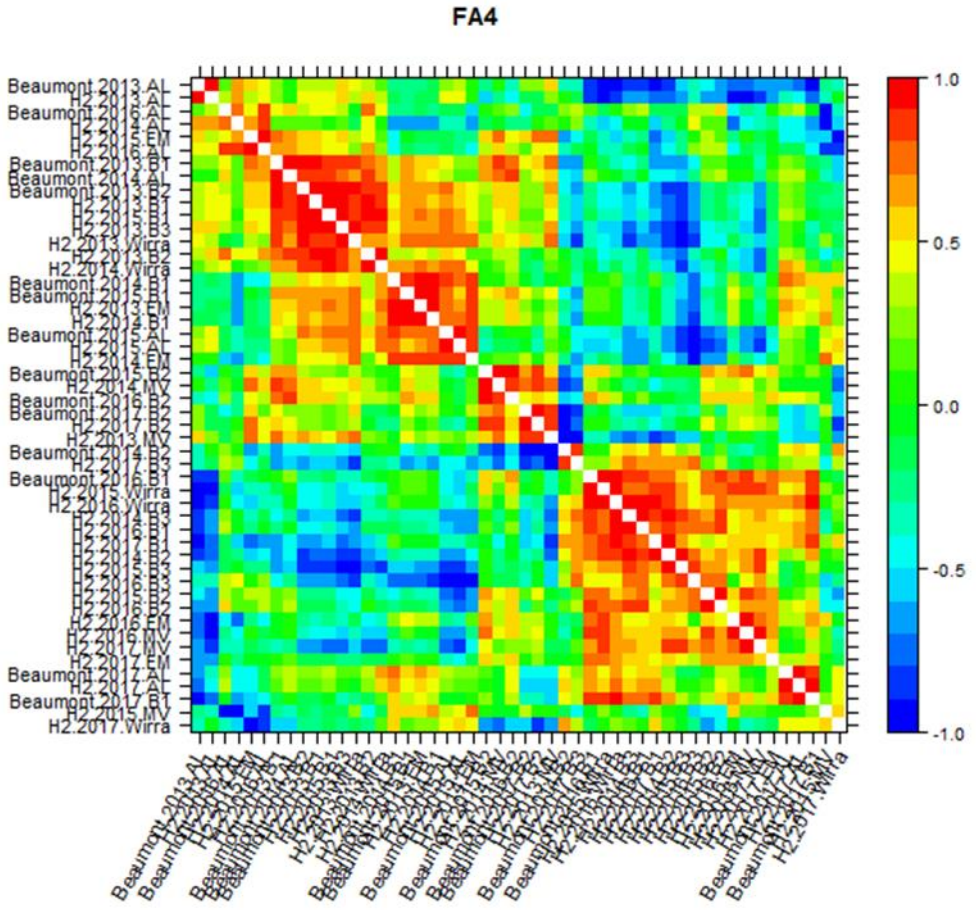

Figure 3-2 Heat map of site correlation between sites.

A comment from the biometrician

”Here I fitted a FA4 (factor analytic) and we explained near 100% variance (%VAF) BUT we are starting to see that perhaps this is not enough… there are 35 Site by Year levels and I could fit many more than 4 factors. It is time consuming and seems to be overfitting (to some) but I believe we may need to fit more factors to get the genetic correlations to stabilize.”

Below (figure 3-3) is a dendrogram of relatedness among the sites over time.

The final figure below (figure3-4) shows predictions or Best Linear Unbiased Predictions (BLUPs) for each variety at each site at each year.

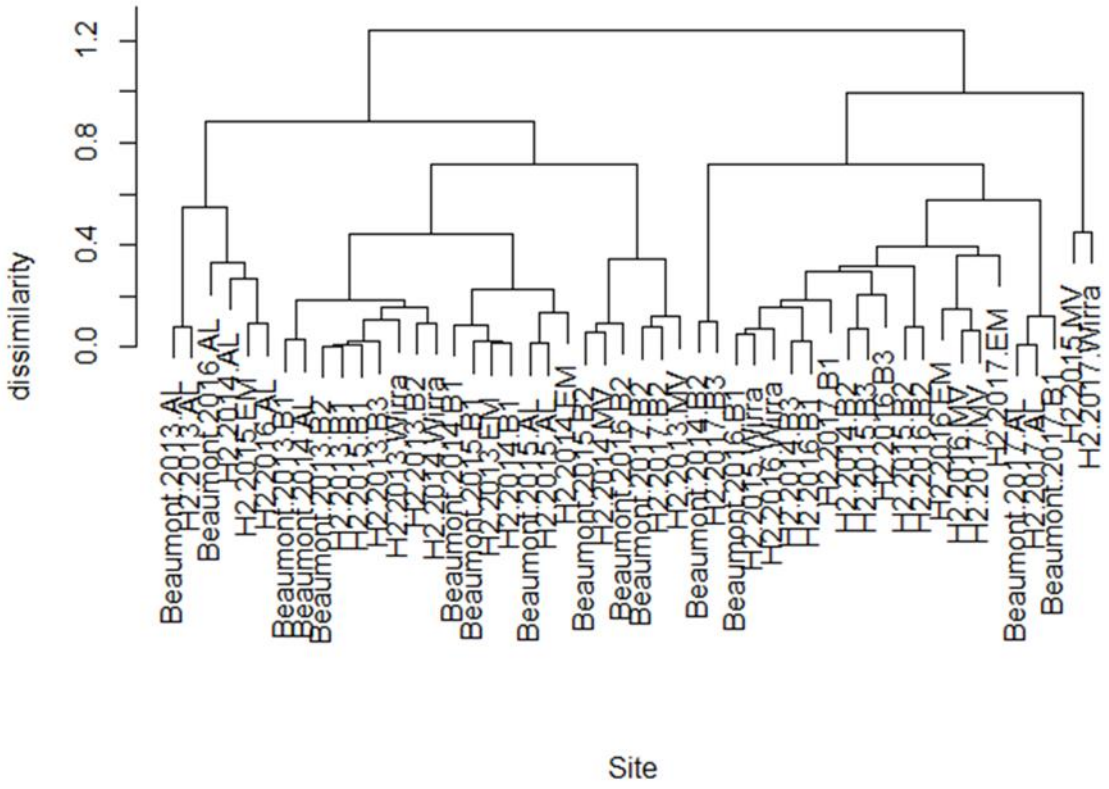

Figure 3-3 Dendrogram of relatedness between sites over time.

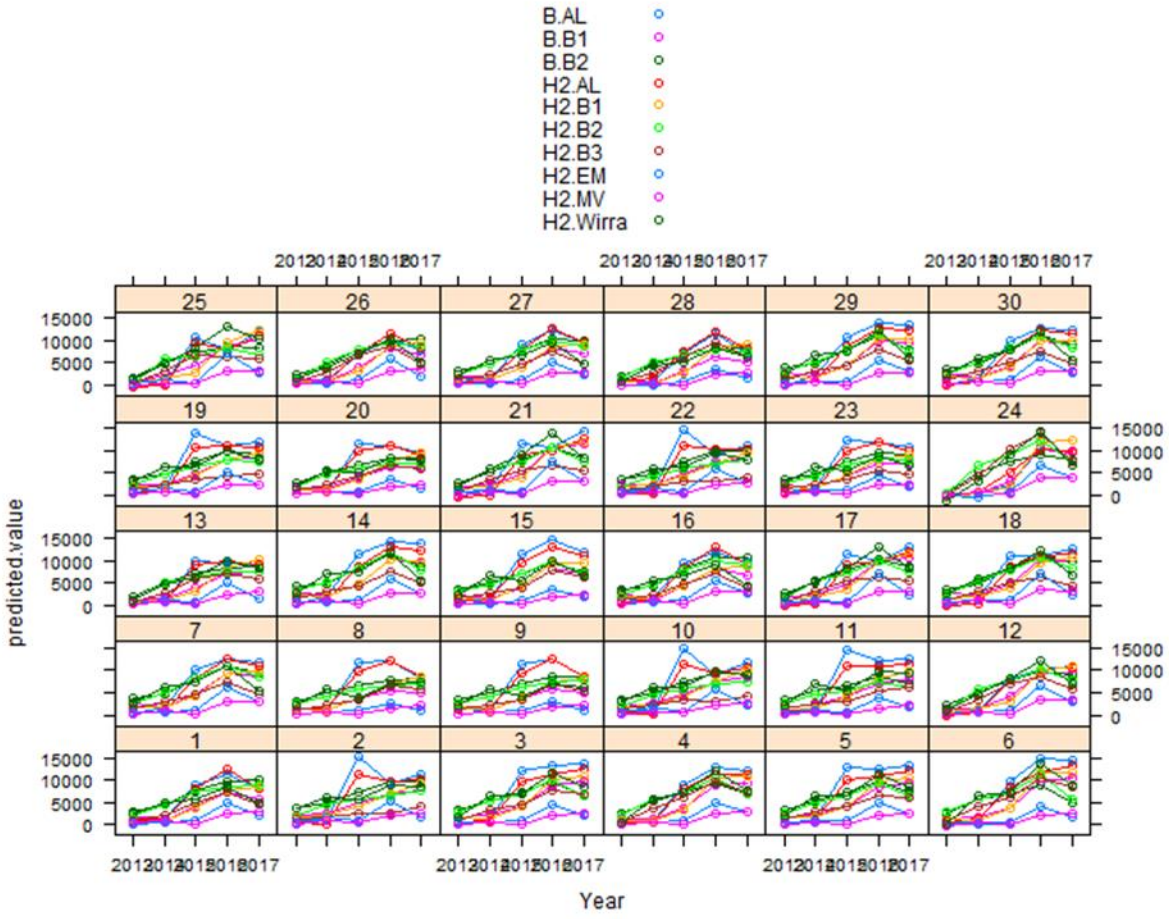

Figure 3-4 Variety Yield over time and block.

4. Trait Valuing and Discounted Cash Flow

During the course of 2016 Craig Hardner (QAAFI and chair), David Bell (Hidden Valley Plantations), Shane Mulo (DAF), Grant Bignell (DAF), Bruce Topp (QAAFI), Mobashwer Alam (QAAFI) and Dougal Russell (DAF) met to develop a method which would simplify the RVT variety selection process and provide a tool for selecting seedlings from the QAAFI 2nd Generation Macadamia Breeding, MC14000. Originally, economic modelling from benchmarking projects over the past 5 -10 years was thought to be an efficient way of predicting the performance of the new varieties. This was using past yield curves to age 20 and aligning the current RVT data to year 8 along those curves. At year 8 the RVT's are outperforming the industry top 25% of farms identified by benchmarking making it difficult to align those curves to the current data. The next approach looked into developing an economic model using the benchmark and current data to consider dollar values for growers at year 8 and year 20. The dollar valuing of traits (positive and negative) show the profitability when comparing the test varieties, it also compares profit to the top 25% of industry growers and the average of the standards in the trials.

Supplementary trial growers also collected data throughout the year that, although not statistically measured or in designed trials, aided in the trait valuing process of the economic model. Grower comments on performance are very important when considering desirable characteristics the new varieties must achieve.

Trait Valuing - The Financial Planner (Shane Mulo and Grant Bignell)

Using available yield and quality data from the regional variety trials, future cash flow forecasts were modelled using the *Financial Planner for Macadamia* software. A discounted cash flow analysis over a fixed period was modelled based on the yield potential of each selection. As the *Financial Planner for macadamia* software had gained prior acceptance within the industry it was important that the software model was incorporated into the final selection tool to validate scenarios.

A major limitation of the software as a selection tool was the limited scope for manipulating the impact of individual traits. The Financial Planner was used to develop base-line cost-only discounted cash flows which were based on average cost of production data collected between 2013 and 2016 as part of the "Benchmarking the macadamia industry 2015 -2018". Costs were based on benchmark data for farms with above average productivity which equated to approximately 3.5 tonnes of nut-in-shell per hectare. Other assumptions included no inflation, price growth or periodic costs over the fixed term with no initial or final investment costs or values. Standard density-based growth models were used to determine the transition from non-bearing to bearing costs.

Selections from the regional variety trials were ranked by cumulative saleable kernel yield, however specific varietal traits with economic significance needed to be overlayed in the analysis prior to deciding on which selections were released. The impact of phenotypic traits were modelled using a discounted cash flow approach to derive a trait-adjusted cash flow.

DCF Methodology – David Bell

The methodology of the Discounted Cash Flow (DCF) calculation is an extension of the work from two previous projects.

Firstly, (Coverdale et al 1999; Hardener et al, 2006) showed that selections could be ranked according to their projected Nett Present Value (NPV) in a whole farm model. They constructed a theoretical model of a 40Ha farm running for 20 years, with parameters aligning with traits in the selection program. For each of the parameters test values were applied to the model and weightings for the relative importance of traits were determined by observing the resulting changes to the NPV output. These weightings then were used in a weighted selection index for the actual ranking.

Secondly, an industry Benchmarking project (Slaughter and Mulo, 2012) recorded and summarised actual financial data from farms representing 5% of the Australian industry. A financial model was constructed using the summary data as a foundation. The purpose was a decision aid for farmers, and thus it could handle a broad range of farm & management scenarios. While similar in principle to NPV model, the use case was very different and outputs between the two systems are not directly comparable.

The DCF calculation uses a simplified version of the financial model that is constructed such that the whole model fits on a single row of a spreadsheet. The output of an individual row given the same assumptions is identical to financial model. It uses financial model data as base assumptions and key parameter cells are filled with data recorded in the selection testing program. Thus it processes experimental data in such a way to output a best guess of future real world performance. The spreadsheet can process an unlimited number of test selections, new rows just need to be added by copying down. Once processed they can be ranked and analysed with standard spreadsheet functions.

The calculation can also evaluate a number of less tangible traits, both advantageous and disadvantageous, that are not in the NPV or financial models. To do this it uses the principle that DCFs with the same assumptions, time period and discount rate can be added directly. It calculates a Base DCF using yield, kernel recovery & tree size, then other traits are calculated as Component DCFs and added to the Base. The Component DCF for a given trait is calculated at a notional value of 1 on a linear scale of Severity. Traits are evaluated according to their Severity scales and then

$$\text{Total DCF}(s) = \text{Base\_DCF}(s) + \text{Sum} (\text{Component\_DCF}(t) * \text{Severity}(s,t)).$$

In practice the DCFs were run on two time periods, eight years with actual data (DCF8) and twenty years with projected yield & tree size data (DCF20). The Component DCFs had relatively little impact on the rankings, however they were useful in highlighting selections with agronomic faults that could hinder adoption – selections with several faults would have large negative Component DCFs.

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5. Mackay (MA) Kim Wilson

Figure 5-5-1 Windblown trees, Mackay 2015.

The northern most RVT site was planted in the Mackay region at 116 Masottis Road, Homebush on the 5th of March, 2008. The site is sugarcane land that is being converted over to macadamia orchards throughout the valley. This site is a grey to brown Sodosol with low nutrient value. Trees are generally smaller and windblown from the south-east, generally leaning to the north-west due to prevailing winds.

Mackay was harvested on May 26th and 27th, 2015. The trees here are small and leaning from the prevailing wind. Nutrition seems poor, there are signs of canker in some trees and AVG was seen on 344 for a second year. Graham Wessling was away in the 2014/15 summer which happened to be dry so with less monitoring and less watering the tree have suffered. Trees in 2015 averaged 3-5kg nut in husk. Yield dropped off from 2014 in every variety in 2015.

There was significant wild pig damage in this block which has probably contributed in some way to the poor yields.

The Mackay site is in a wind susceptible area. Many of the trees in the trial are at an angle, roughly to the north-west. Tree growth improved from 2015 with more targeted nutrition and orchard maintenance. Some of the 344 trees have symptoms of Abnormal Vertical Growth (AVG). Variety 7 (B) seems to have a very distinct crown growth, turkey-neck shape. Variety 21(P) is productive and late.

Figure 5-2 344 with some symptoms of AVG at year 6, Mackay 2014.

Mackay was strip harvested on the 28th of June, 2016 and not harvested in 2017 due to the damage from Cyclone Debbie. In 2018 the Mackay was harvested on the 2nd of May and again on the 2nd of August. Sadly, the second harvest was not possible due to the block being already harvested and pruned.

Top 5 Rankings	5	4	3	2	1
2015 Kernel Yield	A376	246	344	B	G
2016 Kernel Yield	Q	A403	E	N	P
2017 Kernel Yield					
Cumulative Kernel Yield	H	E	A403	A16	P

RVT Site	Yield Measure	Rank 5	Rank 4	Rank 3	Rank 2	Rank 1
Mackay (MA)	2015 Kernel Yield	A376	246	344	B	G
	2016 Kernel Yield	Q	A403	E	N	P
	Cumulative Kernel Yield 2011 - 2016	H	E	A16	A403	P

MA Analysis

2015 Analysis

There were 2 rootstocks grown at MA. An initial fixed effect analysis was performed to test the effect of Rootstock and test if there may be any Rootstock by Variety interaction (some varieties performing better on one rootstock than another etc). The anova table below shows that there was no Rootstock effect (on mean DryNIS) (P=0.199) and there was also no significant Rootstock by Variety interaction (P=0.715). There was a clear difference between Varieties (P<0.001).

	Df	denDF	F.inc	Pr
(Intercept)	1	15.9	1.484e+03	3.853024e-17
Rootstock	1	28.3	1.728e+00	1.992260e-01
ID	29	84.7	2.715e+00	2.019988e-04
pltime	1	107.7	6.216e-02	8.035838e-01
Rootstock:ID	28	90.4	8.230e-01	7.152883e-01

It was interesting to note however that when fitting the random effect analysis I tested to see if there was any difference in genetic variance between the two rootstocks and it was shown that there was significantly higher genetic variance with H2 rootstock than Beaumont rootstock. The genetic variance component for H2 rootstock was 7430.4 while the genetic variance component for Beaumont RS was 1172.01. This is telling us that the varieties are showing greater variation on H2 than Beaumont at this site.

	gamma	component	std.error	z.ratio	constraint
Rep!Rep.var	1.011929e-07	2.031203e-03	2.716540e-04	7.4771686	Boundary
at(Rootstock, Beaumont):ID!ID.var	5.838861e-02	1.172010e+03	2.239904e+03	0.5232413	Positive
at(Rootstock, H2):ID!ID.var	3.701684e-01	7.430235e+03	3.772351e+03	1.9696565	Positive
R!variance	1.000000e+00	2.007258e+04	2.684516e+03	7.4771686	Positive
R!Col.cor	-6.534250e-02	-6.534250e-02	9.647493e-02	-0.6773003	Unconstrained
R!Row.cor	1.720401e-01	1.720401e-01	9.334520e-02	1.8430521	Unconstrained

2016 Analysis

An initial fixed effect analysis (Variety X Rootstock as fixed effects) showed a significant Rootstock x Variety interaction and a significant Variety effect.

The genetic correlation between Rootstocks is 0.76 so they are not giving exactly the same variety rankings but are similar. The genetic variances are similar between the 2 Rootstocks ($1.5x10^6$ for Beaumont and $1.6x10^6$ for H2).

NIS Yield 2011 - 2015

Genetic correlations between years:

	2011	2012	2013	2014	2015	2016
2011	1.000	0.709	-0.077	0.552	-0.119	-0.019
2012	0.709	1.000	0.606	0.521	-0.171	-0.076
2013	-0.077	0.606	1.000	0.406	-0.178	0.256
2014	0.552	0.521	0.406	1.000	-0.205	0.769
2015	-0.119	-0.171	-0.178	-0.205	1.000	-0.311
2016	-0.019	-0.076	0.256	0.769	-0.311	1.000

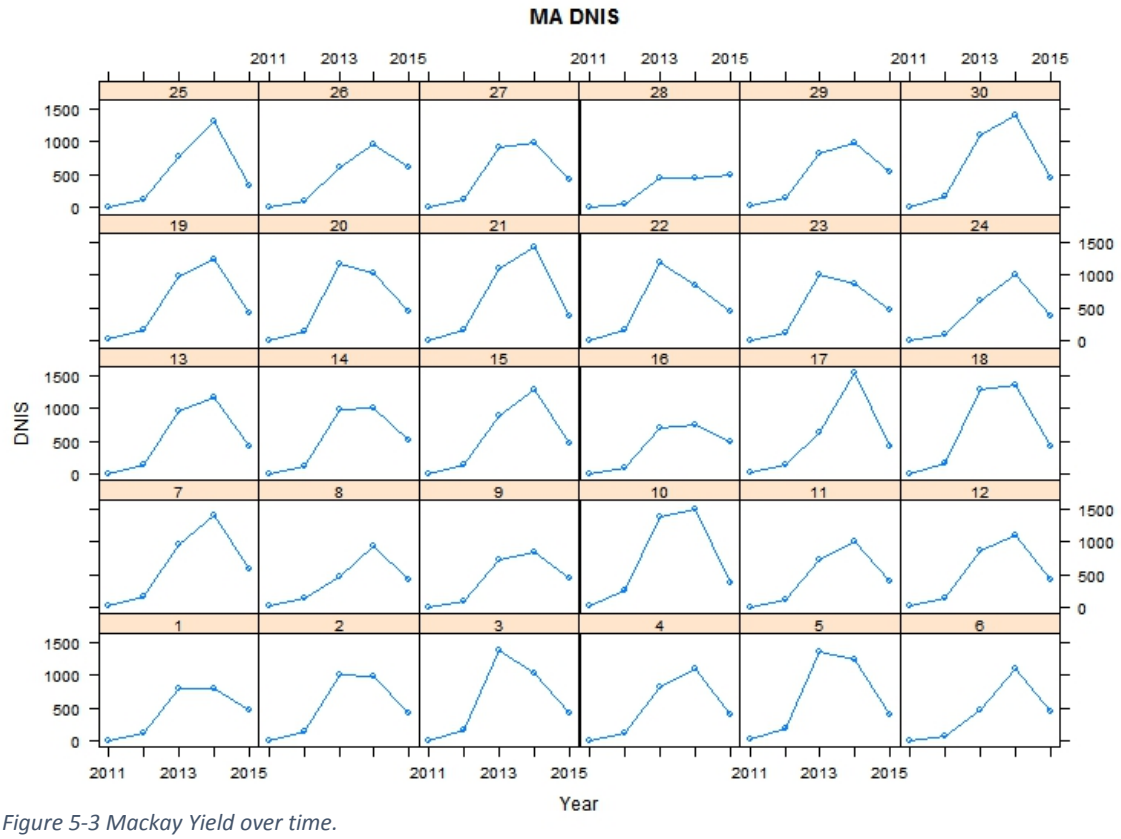


Figure 5-3 Mackay Yield over time.

Mackay Cumulative Kernel Yield

BLUP's for MA yield for each variety over time is given below in figures 5-3 and 5-4. Trait summary data for the Mackay RVT is presented in table 3.

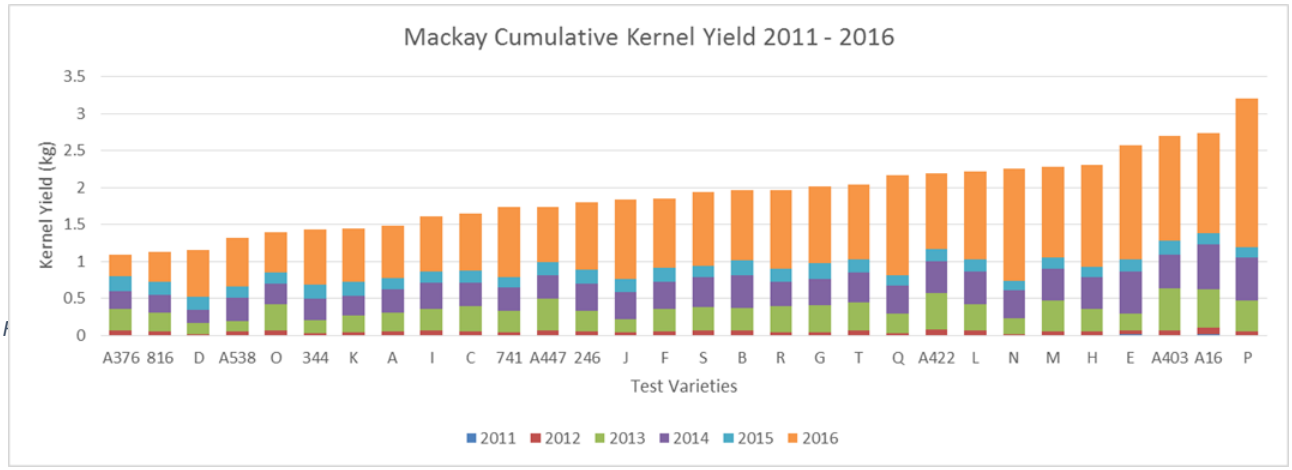


Table 3 Mackay summary variety performance.

Mackay (MA) Regional Variety Trial Trait		NIS Yield Year 8 (grams)	Kernel Recovery (KR) %	Kernel Yield (grams) Year 8	Cumulative Kernel Yield 2013 - 2016 (kg)	Kernel Canopy Efficiency (g/m3)	Tree Volume (m3) Year 8	Kernel kg/ha Year 8	% Whole Kernel	% Premium Kernel	% Commercial Kernel
Variety Code	**ID Number**										
A376	1	693	41.2	262	1.027	8.9	29.6	82	39.7	86.8	2.4
C	2	2178	37.3	746	1.595	51.1	14.6	234	36.6	93.4	2.6
A403	3	3548	44.2	1439	2.631	54.4	26.5	451	43.3	95.8	1.8
Q	4	4563	34.0	1425	2.135	52.7	27.1	446	32.7	90.9	7.2
A422	5	2886	39.9	1055	2.112	47.1	22.4	330	36.9	92.2	3.2
J	6	3068	39.7	1118	1.794	43.2	25.9	350	16.0	92.2	2.9
B	7	2837	35.5	924	1.897	31.0	29.8	289	25.7	87.1	4.4
A538	8	1834	36.4	612	1.265	28.2	21.7	192	32.3	85.4	7.2
816	9	1203	40.1	442	1.077	16.9	26.1	138	37.7	87.7	6.0
A16	10	3237	41.7	1238	2.631	68.0	18.2	388	25.5	94.8	2.0
F	11	2026	44.5	826	1.788	31.8	26.0	259	28.2	92.7	3.8
I	12	2140	36.7	721	1.550	36.4	19.8	226	43.4	93.4	2.9
T	13	2489	41.8	955	1.976	35.7	26.8	299	21.3	92.9	2.5
G	14	3028	39.5	1098	1.969	40.3	27.3	344	32.1	92.2	1.8
A	15	2529	30.8	714	1.435	26.3	27.1	223	33.3	92.2	1.9
K	16	2145	37.2	733	1.416	34.3	21.4	229	40.1	86.3	2.2
E	17	3998	39.6	1453	2.509	74.6	19.5	455	27.2	93.4	2.8
M	18	3971	34.9	1271	2.230	60.4	21.0	398	38.9	85.0	2.1
S	19	2732	35.8	898	1.877	56.4	15.9	281	25.3	95.2	1.2
O	20	1661	34.3	523	1.340	33.9	15.4	164	29.0	83.6	7.7
P	21	5623	39.0	2011	3.152	96.9	20.8	629	34.7	95.2	1.5
A447	22	1868	40.2	689	1.682	39.3	17.6	216	26.3	92.0	3.7
R	23	2906	38.2	1018	1.931	38.5	26.5	319	44.5	85.9	2.7
N	24	4627	34.7	1473	2.237	60.9	24.2	461	28.9	96.2	1.3
H	25	3745	40.7	1400	2.252	64.2	21.8	438	24.9	94.1	2.0
344	26	2827	32.0	831	1.410	28.6	29.0	260	29.5	87.2	6.3
741	27	2909	34.4	919	1.697	33.7	27.3	288	34.9	86.7	4.6
D	28	2042	38.3	718	1.146	21.5	33.4	225	29.3	85.6	5.1
246	29	2700	37.0	916	1.755	29.6	31.0	287	48.4	82.6	10.0
L	30	3599	34.5	1139	2.157	51.4	22.1	356	34.5	95.3	2.1

6. Emerald (EM) Clayton Mattiazzi and Darren Harris

Emerald RVT site was planted on the 25th of March, 2009, a year after most of the other RVT sites. The Soil type is Chromosol, characterised as non-gravelly and sandy-clay.

Emerald RVT was strip harvested and sampled on the 25th and 26th of May, 2015. Trees at this site are medium to large and quite productive compared with last year. In 2014 there were problems with flower caterpillar however an improved spray and irrigation regime have seen the block improve immensely. Trees averaged 8-10kg nut in husk at harvest. Row 18 was harvested accidently prior to the RVT harvest. This block was planted about one year after Childers and is consequently a year behind.

Hinkler Park are the new owners of the Emerald RVT, taking over in March 2016 from the Walter family. The site was harvested three times in 2016, March 21st and 14th June for pick-up and separate strip harvest. The site was unkept in 2016 for the first harvest due to the change of ownership but vastly better for harvest two. This is a very hot, dry site with some trees showing signs of tip burn and particularly hard husks in 741. Nut size is generally smaller due to the climate. H2 is the only rootstock at Emerald. Emerald was harvested three times in 2017 with harvest two from the ground and harvest three stripped out of the trees. Harvest one was May 2, harvest two and three on July 26. Similarly in 2018 the trees were harvested three times with the first harvest on 30th April followed by two harvests on the 16th and 17th of July.

Figure 6-1 2016 Emerald harvest.

The Emerald RVT has picked up over the past three seasons (2016, 2017 and 2018) with the trees looking healthy with little leaf burn. Irrigation and canker treatment are the principal reasons this block is improving in tree health. Canker had been a significant problem in past years (figure 6-2). The crop was light in 2016 and 2017 and moderate in 2018. Although the trees had picked up in 2017 there may have been irrigation issues when the block was not watered for three weeks during the flowering season in 2016. In 2017 the most productive tree in the block was variety Q (7.808kg NIS) followed by variety N (6.219kg NIS). The table below (table 4) gives the top five variety rankings for NIS for years 2015, 2016 and 2017.

Figure 6-2 Typical canker symptoms.

Phenotype observations indicate 14-4 (25), 16-15 (28), 11-10 (16) and 14-11 (27) are probable map errors.

Table 4 Top 5 ranked varieties 2015 - 2017.

RVT Site	Yield Measure	Rank 5	Rank 4	Rank 3	Rank 2	Rank 1
Emerald (EM)	2015 Kernel Yield	K	L	O	816	G
	2016 Kernel Yield	L	G	E	A16	H
	2017 Kernel Yield	A376	G	A447	246	N
	Cumulative Kernel Yield 2013 - 2017	L	E	A447	H	A16

Yield, tree and kernel quality traits are given in table 5.

Emerald Cumulative Kernel Yield

A16, A447 variety H and variety E have the highest cumulative kernel yield from 2013 to 2017 (figure 6-3) while variety N and MIV1-J have the greatest tree volumes (figure 6-5).

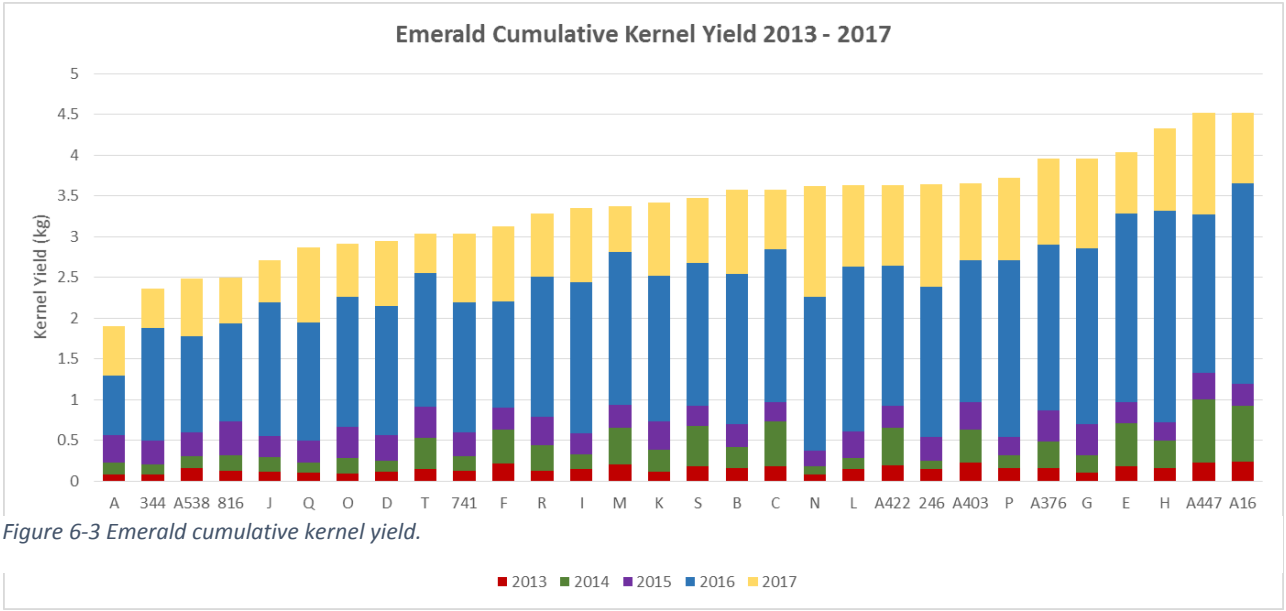


Figure 6-3 Emerald cumulative kernel yield.

Emerald Kernel Recovery

There was a significant variety effect for kernel recovery at Emerald in 2017. Table 5 lists kernel recovery for 2015, 2016 and 2017. The climate in Emerald has a significant effect on nut size and kernel recovery across all varieties compared to other sites. For example 816 in 2017 had a KR of 39.6% while at Booyan in in the same year the KR was 44.4%.

KR

Sig Variety effect (P<0.001)

H2=0.874

Table 5 Emerald kernel recovery 2015 - 2017.

Variety	KR 2015	KR 2016	KR 2017
A376	37.9	42.3	41.7
C	36.8	34.8	34.3
A403	37.3	42.2	43.1
Q	28.6	30.7	31.4
A422	37.0	37.3	40.0
J	32.6	36.2	35.2
B	33.1	33.7	34.5
A538	36.5	37.1	39.4
816	37.7	40.7	39.6
A16	34.7	39.1	36.9
F	41.5	39.2	40.9
I	32.2	33.5	32.8
T	39.7	43.1	40.3
G	38.7	38.8	40.6
A	26.6	28.3	29.9
K	37.2	37.8	33.5
E	35.9	36.0	36.4
M	34.9	34.6	32.4
S	31.9	32.2	33.9
O	32.7	36.0	36.0
P	30.6	35.2	35.5
A447	35.5	38.4	39.6
R	38.0	38.7	37.7
N	31.6	28.8	33.7
H	35.9	36.7	37.9
344	28.1	27.8	27.8
741	33.0	31.8	36.3
D	37.2	38.6	39.5
246	32.9	33.6	37.9
L	35.6	34.0	35.8

Emerald Nut Drop Pattern

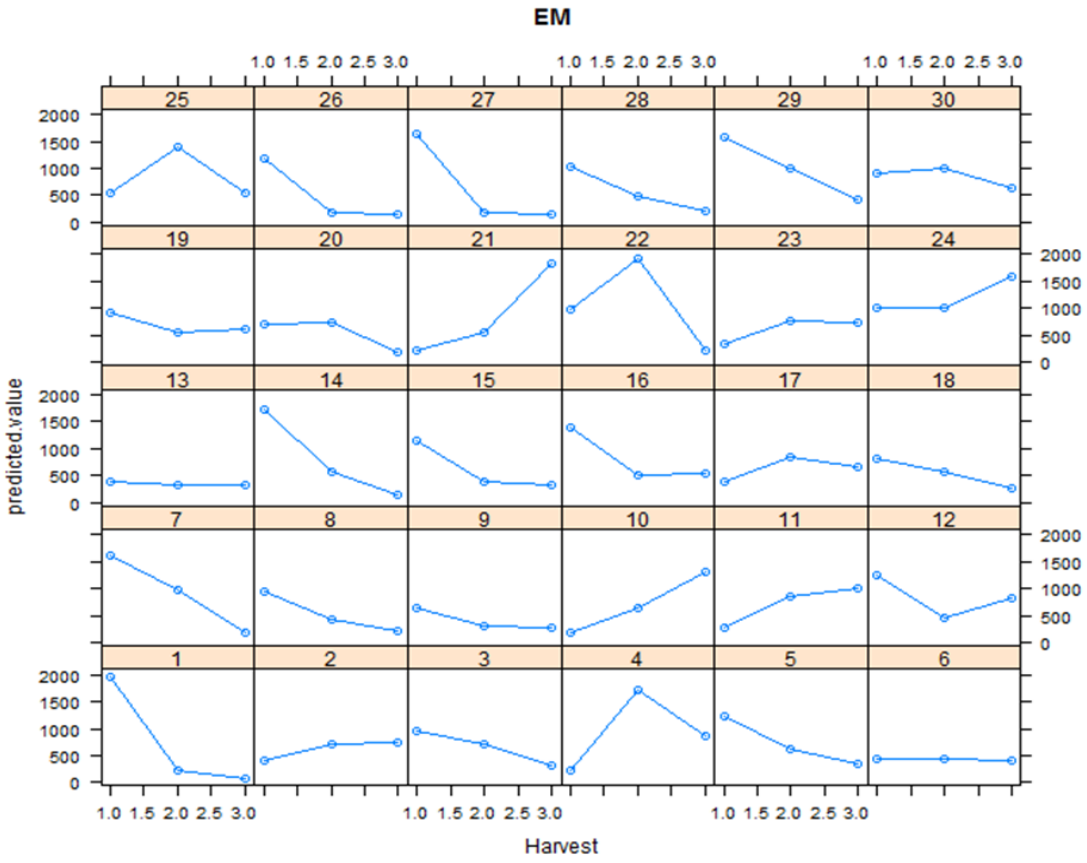


Figure 6-4 Emerald nut drop pattern 2017

Emerald Kernel Yield KG per Hectare

(NIS x KR) x 312.5

Kernel yield per hectare is calculated using individual tree NIS kernel yield by 312.5 trees. This equates to an 8 m x 4m planting design which is the industry standard.

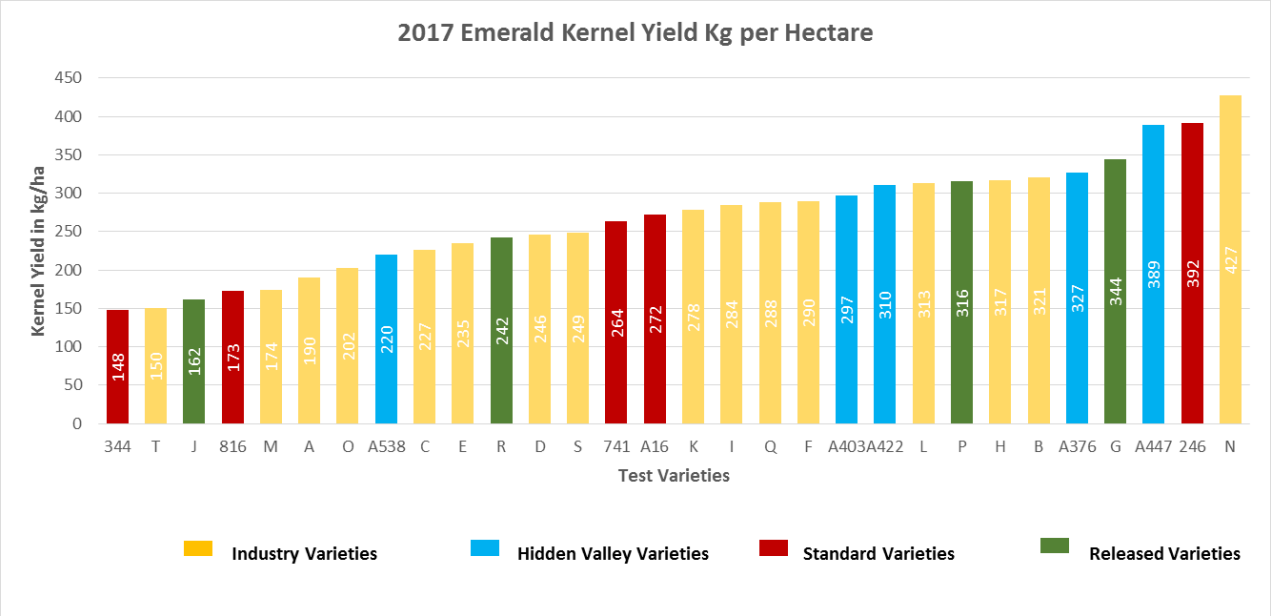


Figure 6-4 Estimated Emerald kernel yield per hectare in 2017.

Emerald Kernel Yield Efficiency

The combination of tree size and yield determines how efficient the tree is at producing a crop. Kernel recovery (KR) or percentage of kernel to shell increases tree efficiency as high KR can mean a tree can produce less nuts per unit volume. Small trees with moderate to high KR have a high kernel yield efficiency. Figure 6-5 shows the variety effect of size and yield with A447 and MIV1-P having the best kernel yield per unit volume.

Significant Variety effect in 2017.

	gamma	component	std.error	z.ratio	constraint
Rep!Rep.var	1.011929e-07	3.809585e-04	5.193677e-05	7.335043	Boundary
ID!ID.var	2.576516e-01	9.699747e+02	3.908342e+02	2.481806	Positive
R!variance	1.000000e+00	3.764676e+03	5.132452e+02	7.335043	Positive
R!Col.cor	1.226823e-01	1.226823e-01	9.972448e-02	1.230212	Unconstrained
R!Row.cor	4.282320e-01	4.282320e-01	7.749178e-02	5.526160	Unconstrained

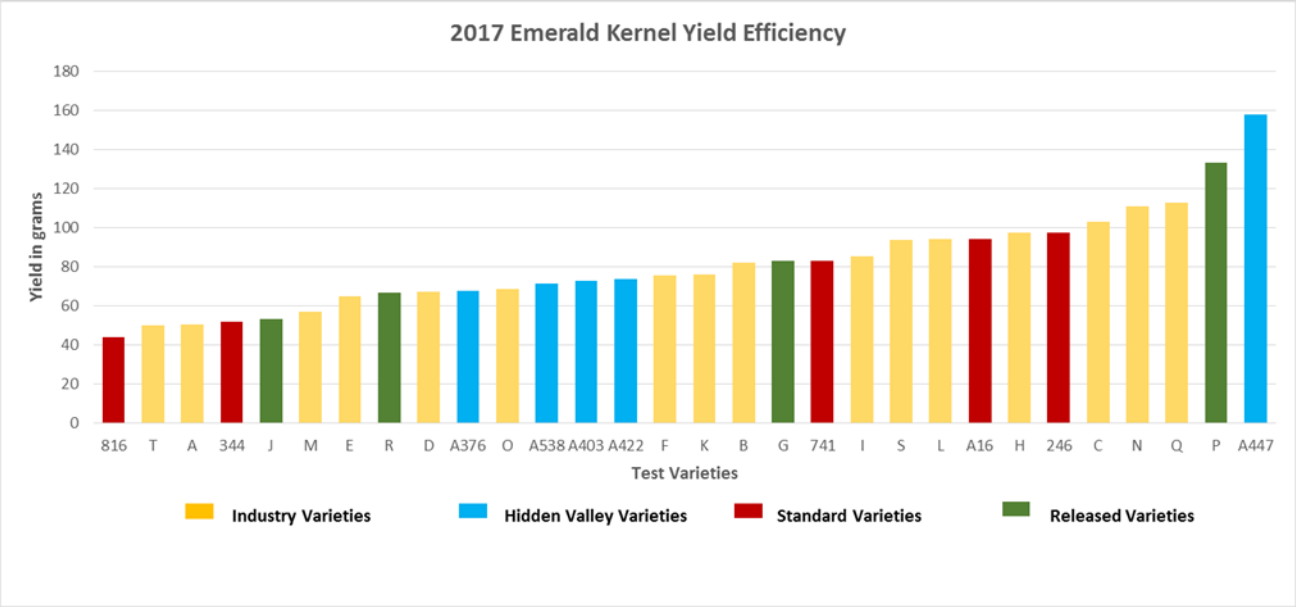


Figure 6-6 Emerald kernel yield efficiency.

Emerald Tree Volume

Significant Variety effect in 2017.

	gamma	component	std.error	z.ratio	constraint
Rep!Rep.var	0.01170583	1.63840969	2.94483038	0.5563681	Positive
ID!ID.var	0.24109826	33.74538998	15.24022749	2.2142314	Positive
R!variance	1.00000000	139.96529637	16.98473289	8.2406534	Positive
R!Col.cor	0.03715798	0.03715798	0.09473003	0.3922513	Unconstrained
R!Row.cor	0.21967596	0.21967596	0.07877293	2.7887241	Unconstrained

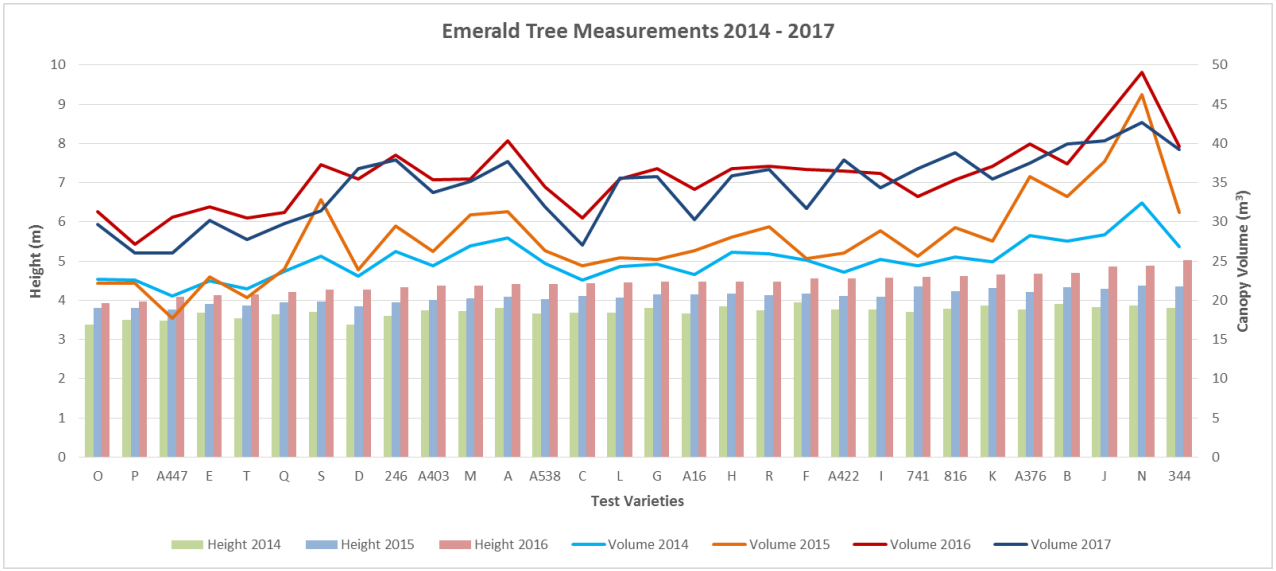


Figure 6-5 Emerald canopy volume.

Table 6 Emerald summary variety performance.

Emerald (EM) Regional Variety Trial

Trait		NIS Yield Year 9 (grams)	Kernel Recovery (KR) %	Kernel Yield (grams) Year 9	Cumulative Kernel Yield 2013 - 2017 (kg)	Kernel Canopy Efficiency (g/m3)	Tree Volume (m3)	Kernel kg/ha	% Whole Kernel
Variety Code	**ID Number**								
A376	1	2508	41.7	1047	3.951	67.5	37.5	328	27.1
C	2	2115	34.3	725	3.573	103.2	27.0	227	27.4
A403	3	2206	43.1	950	3.657	72.6	33.8	297	23.3
Q	4	2931	31.4	921	2.864	112.5	29.8	288	33.9
A422	5	2484	40.0	993	3.635	73.7	37.9	311	37.7
J	6	1474	35.2	518	2.712	53.3	40.4	162	18.0
B	7	2971	34.5	1026	3.571	82.2	40.0	321	13.9
A538	8	1790	39.4	706	2.485	71.6	31.9	221	26.6
816	9	1396	39.6	554	2.490	44.1	38.8	173	17.3
A16	10	2358	36.9	870	4.519	94.4	30.3	272	22.9
F	11	2271	40.9	928	3.126	75.8	31.8	291	16.2
I	12	2773	32.8	910	3.345	85.1	34.4	285	41.0
T	13	1193	40.3	481	3.030	49.9	27.7	151	17.4
G	14	2707	40.6	1100	3.955	82.8	35.7	344	31.6
A	15	2037	29.9	608	1.898	50.3	37.7	190	28.9
K	16	2661	33.5	891	3.411	76.0	35.4	279	35.9
E	17	2068	36.4	752	4.038	65.1	30.2	235	21.6
M	18	1723	32.4	558	3.372	57.0	35.1	175	28.1
S	19	2346	33.9	795	3.474	93.7	31.4	249	18.3
O	20	1796	36.0	647	2.909	68.7	29.7	203	19.4
P	21	2848	35.5	1010	3.721	133.0	26.0	316	25.0
A447	22	3145	39.6	1246	4.513	157.8	26.1	390	13.1
R	23	2053	37.7	774	3.286	66.7	36.7	242	47.5
N	24	4055	33.7	1366	3.622	110.7	42.7	428	27.2
H	25	2676	37.9	1014	4.331	97.3	35.9	317	18.9
344	26	1704	27.8	474	2.356	51.6	39.2	148	21.0
741	27	2326	36.3	844	3.033	82.8	36.8	264	28.3
D	28	1995	39.5	788	2.939	67.4	36.8	247	23.9
246	29	3313	37.9	1254	3.636	97.4	37.9	393	31.4
L	30	2798	35.8	1001	3.631	94.1	35.6	313	30.3

Emerald Flowering Data, 2017

Flowering data including 5%, 50% and 90% of racemes open were recorded weekly by Darren Harris in 2017 (Figure 6-6). 50% bloom is denoted by the yellow stripe.

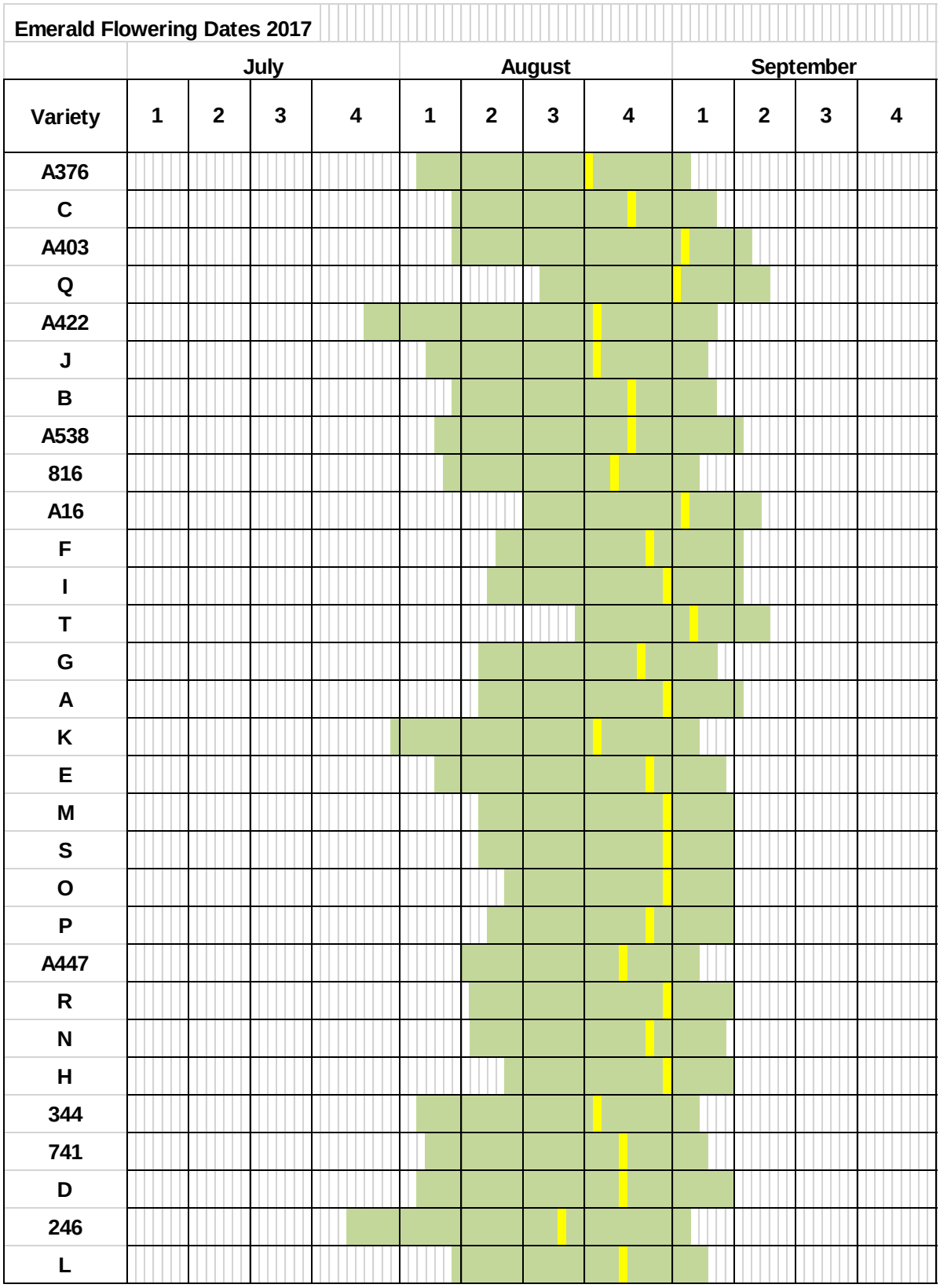


Figure 6-6 Emerald flowering dates 2017.

Figure 6-7 Emerald flowering dates and duration for 2017.

Variety	ID	5% BLOOM	50% BLOOM	90% (FULL) BLOOM
A376	1	2/08/17	22/8/17	2/9/17
C	2	7/08/17	27/8/17	5/9/17
A403	3	7/08/17	2/9/17	9/9/17
Q	4	16/08/17	1/9/17	10/9/17
A422	5	28/07/17	23/8/17	5/9/17
J	6	3/08/17	23/8/17	4/9/17
B	7	7/08/17	27/8/17	5/9/17
A538	8	5/08/17	27/8/17	8/9/17
816	9	6/08/17	25/8/17	3/9/17
A16	10	16/08/17	2/9/17	10/9/17
F	11	12/08/17	29/8/17	8/9/17
I	12	11/08/17	31/8/17	8/9/17
T	13	21/08/17	3/9/17	10/9/17
G	14	10/08/17	28/8/17	5/9/17
A	15	10/08/17	31/8/17	8/9/17
K	16	31/07/17	23/8/17	3/9/17
E	17	5/08/17	29/8/17	6/9/17
M	18	10/08/17	31/8/17	7/9/17
S	19	10/08/17	31/8/17	7/9/17
O	20	13/08/17	31/8/17	7/9/17
P	21	11/08/17	29/8/17	7/9/17
A447	22	8/08/17	26/8/17	3/9/17
R	23	9/08/17	31/8/17	7/9/17
N	24	9/08/17	29/8/17	6/9/17
H	25	13/08/17	31/8/17	7/9/17
344	26	3/08/17	23/8/17	3/9/17
741	27	4/08/17	26/8/17	4/9/17
D	28	3/08/17	26/8/17	7/9/17
246	29	26/07/17	19/8/17	2/9/17
L	30	7/08/17	26/8/17	4/9/17

7. Decortes (B1) - Scott Alcott MFM

The Decortes RVT was planted on the 17th of March, 2008 and is situated on Eardleys Road, Welcome Creek, 19.4 km to the north-west of Bundaberg. The soil type is typically a dark grey Kandosol, characterised by poor nutrition and depleted organic matter. The Decortes RVT site is managed by Mac Farm Management (MFM) by Scott Allcott. There are two rootstocks, H2 seedling and Beaumont cuttings, planted in the site with six replicates of the 30 varieties.

Decortes had considerable damage on January 26, 2013 when cyclone Oswald came inland down the QLD coast with sever winds and torrential rain. Many of the trees were damaged with limbs broken and quite a few trees blown over. These were righted at the time and consequently saved. There are few trees missing in the block but it has taken time to recover.

At harvest four in 2015 it is believed the grower had harvested the nuts off the ground before the RVT harvest. There were few, if any nuts on the ground since the previous harvest six weeks earlier and still many nuts in the trees. The analysis reflects this missing data.

Figure 7-1 Decortes harvest 2016.

Harvest one was 10th March, harvest two 2nd May, Third harvest 1st July and fifth harvest 12th August.

The Decortes site has improved in 2016 having recovered from cyclone Oswald. The crop is estimated to be about ¾ or more of its full potential. Nut drop started earlier than in 2015 and continued well into August. Perhaps the warm dry autumn and early winter started the nut drop, followed by cool temperatures kept more nuts in the tree longer.

Decortes was harvested March 8, April 19, May 24, and July 26 and 27 for harvests four and five.

In 2017 Decortes had its best crop to date with the trees finally catching up to Booyan. The season started three weeks later than 2016 with most of the nuts of dropping early. Harvest three was relatively light however there were still nuts in the late varieties at harvest five. The most productive tree in the block was variety N (17.325 kg NIS) with A442 (15.476 kg NIS) second.

Harvest dates in 2017 were March 27, May 15, July 3, August 14 and August 22. The top 5 ranking genotypes are listed below in table 6.

Phenotype data indicates tree 23-1 is not reflective of A403 being larger and lighter brown.

Table 7 Decortes top 5 ranked varieties 2015 - 2017.

RVT Site	Yield Measure	Rank 5	Rank 4	Rank 3	Rank 2	Rank 1
Decortes (B1)	2015 Kernel Yield	246	G	A16	A447	A538
	2016 Kernel Yield	P	A442	E	J	A403
	2017 Kernel Yield	H	E	F	A422	A403
	Cumulative Kernel Yield 2011 - 2017	E	P	A422	A16	A403

2016 NIS Analysis

An initial fixed effect analysis showed a Significant Rootstock by Variety interaction (P=0.008) and a significant Variety effect.

```
$Wald
             Df denDF   F.inc            Pr
(Intercept)   1  11.4 691.000 1.407696e-11
Rootstock     1  70.5   1.466 2.300063e-01
ID           29  56.3   7.498 7.551145e-11
pltimef       2  80.6   1.927 1.522078e-01
Rootstock:ID 29  68.0   2.029 8.807481e-03
```

A random effects analysis correlating the genetic effects on the two Rootstocks gave the following results:

```
                                    gamma    component    std.error  z.ratio    constraint
Rep!Rep.var                  2.695469e-07 9.787295e-01 1.428489e-01 6.851500      Boundary
Col!Col.var                  1.915050e-01 6.953581e+05 4.820081e+05 1.442627      Positive
Rootstock:ID!Rootstock.cor   8.833760e-01 8.833760e-01 1.750590e-01 5.046160 Unconstrained
Rootstock:ID!Rootstock.Beaumont 6.231216e-01 2.262566e+06 9.756030e+05 2.319146      Positive
Rootstock:ID!Rootstock.H2    8.179070e-01 2.969835e+06 1.107588e+06 2.681354      Positive
R!variance                   1.000000e+00 3.631018e+06 5.299596e+05 6.851500      Positive
R!Col.cor                    1.852089e-01 1.852089e-01 9.932949e-02 1.864592 Unconstrained
R!Row.cor                    1.546545e-01 1.546545e-01 1.055476e-01 1.465258 Unconstrained
```

The genetic correlation between Rootstocks was 0.88. The genetic variance for H2 Rootstock was $3.0x10^6$ while the genetic variance for Beaumont Rootstock was $2.3x10^6$.

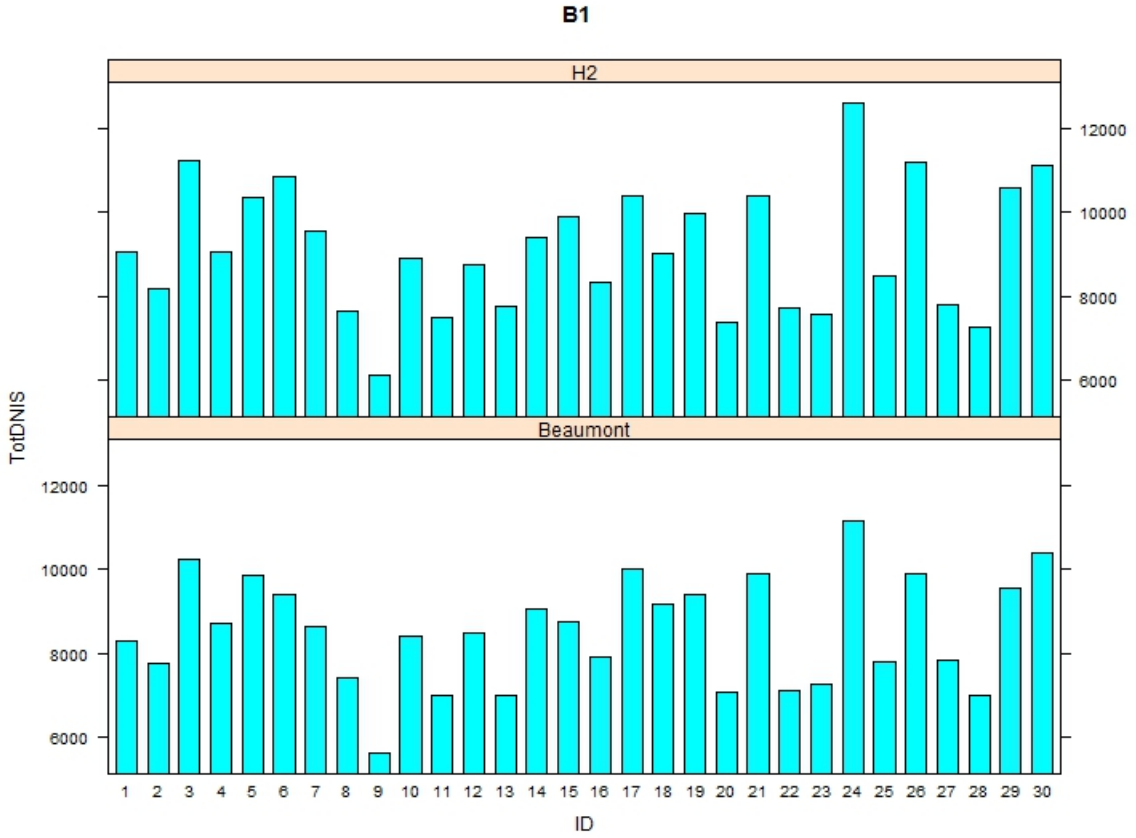


Figure 7-2 Decortes variety predictions on H2 and Beaumont rootstocks 2016

Decortes Nut in Shell Yield 2017

A varieties perform well at Decortes with A422 and A403 from Hidden Valley Plantations the best NIS yields in 2017 (figure 7-2).

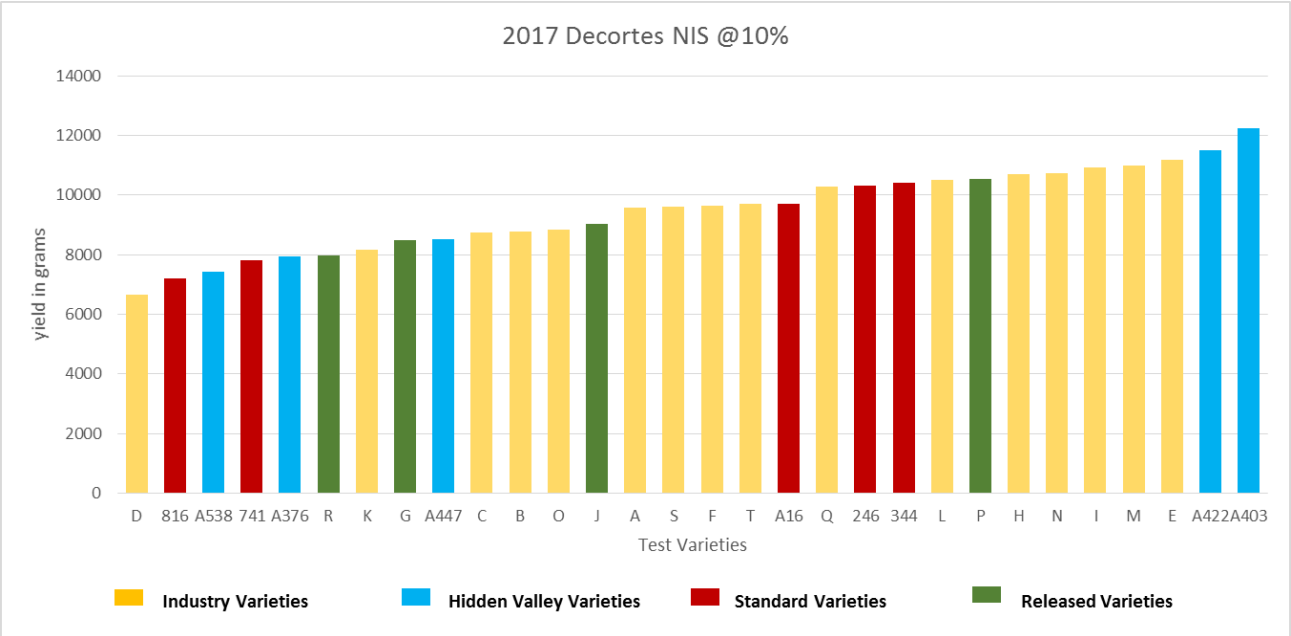


Figure 7-3 Decortes NIS yield 2017.

Decortes Kernel Yield

Again A series varieties are the best performers for kernel yield in 2017 and it is interesting to note that 816 with a high KR is in the bottom five for kernel yield. Figure 7-3 show kernel yield per

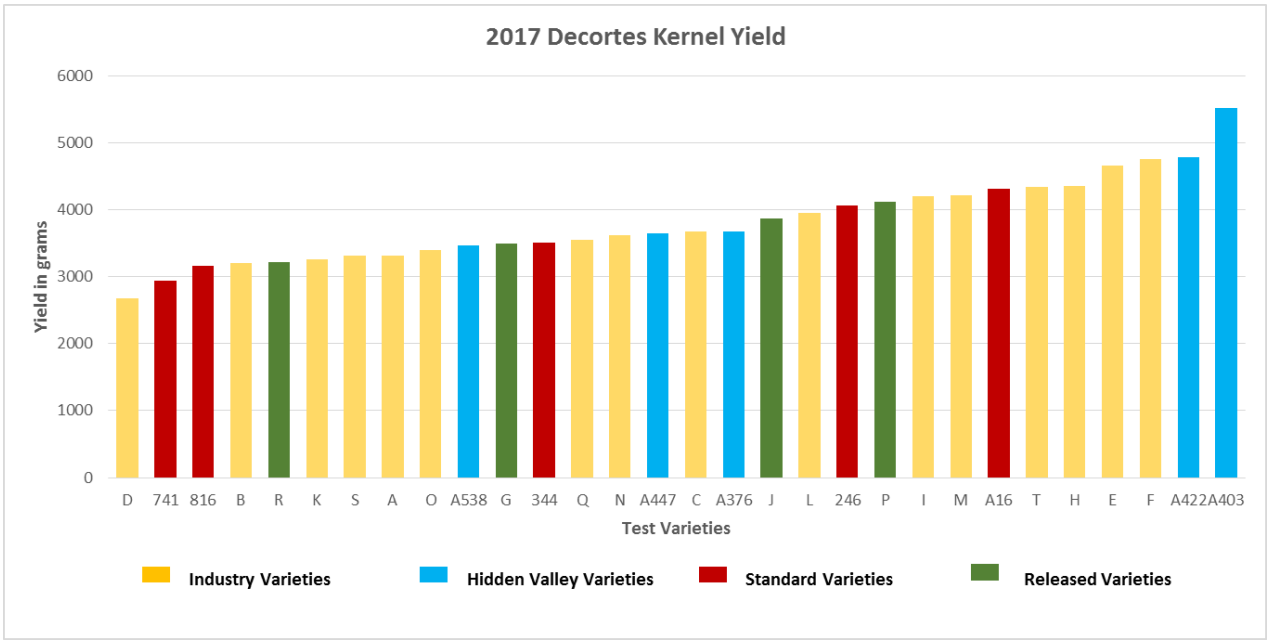


Figure 7-4 Decortes kernel yield 2017.

variety for 2017 while figure 7-5 estimates kernel yield per hectare for 2017.

Decortes Kernel Tonnes per Hectare

(NIS x KR) x 312.5

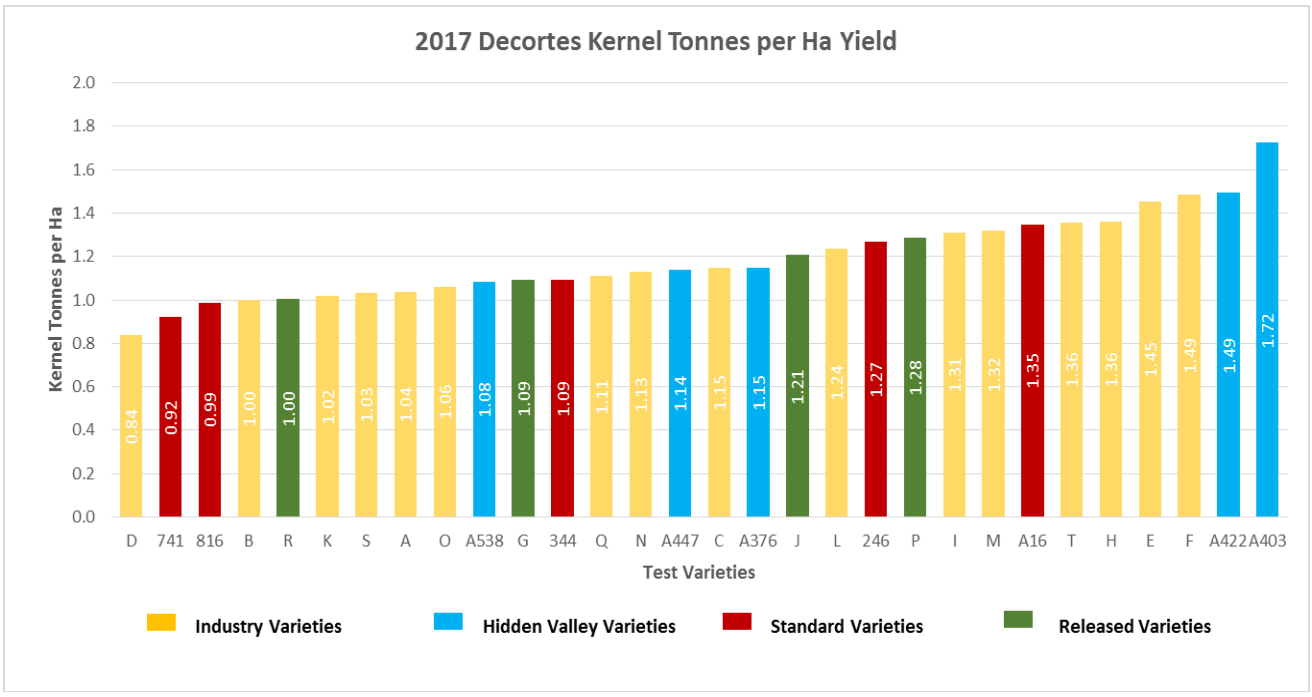


Figure 7-5 Decortes estimated kernel yield/ha.

Decortes Cumulative Kernel Yield

Cumulative kernel yield can be seen in figure 7-6. A403 is the standout however the next 10 ranked varieties vary by one kilogram.

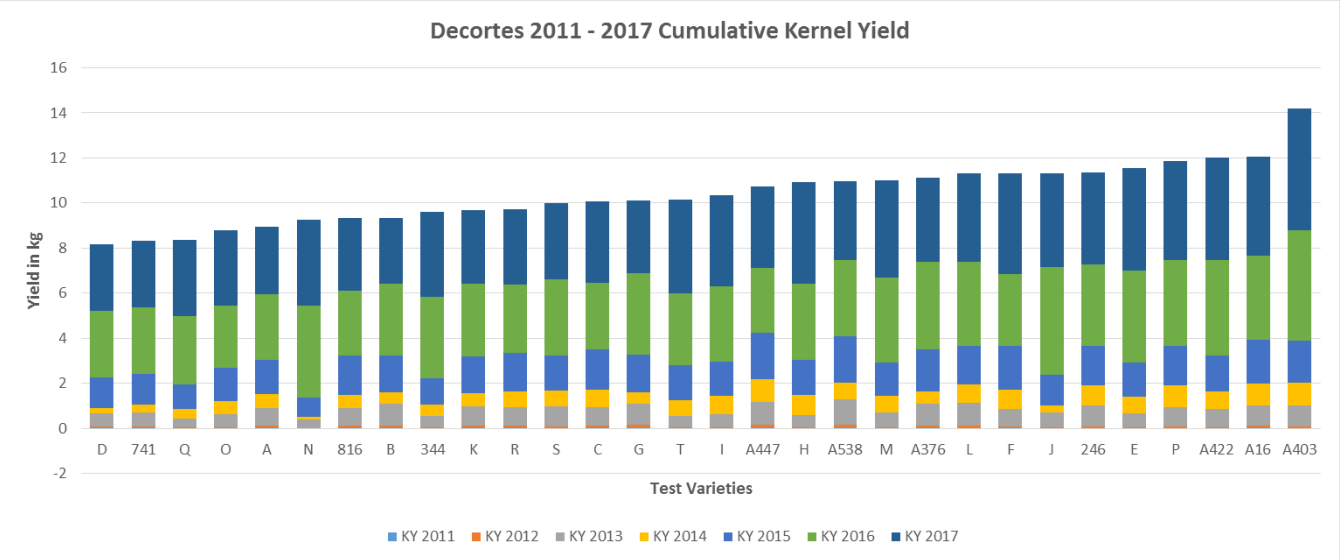


Figure 7-6 Decortes cumulative kernel yield 2011 - 2017.

Figure 7-7 shows the effect of Cyclone Oswald in 2013and 2014 with all varieties dropping off in production and then recovering to some extent in 2015.

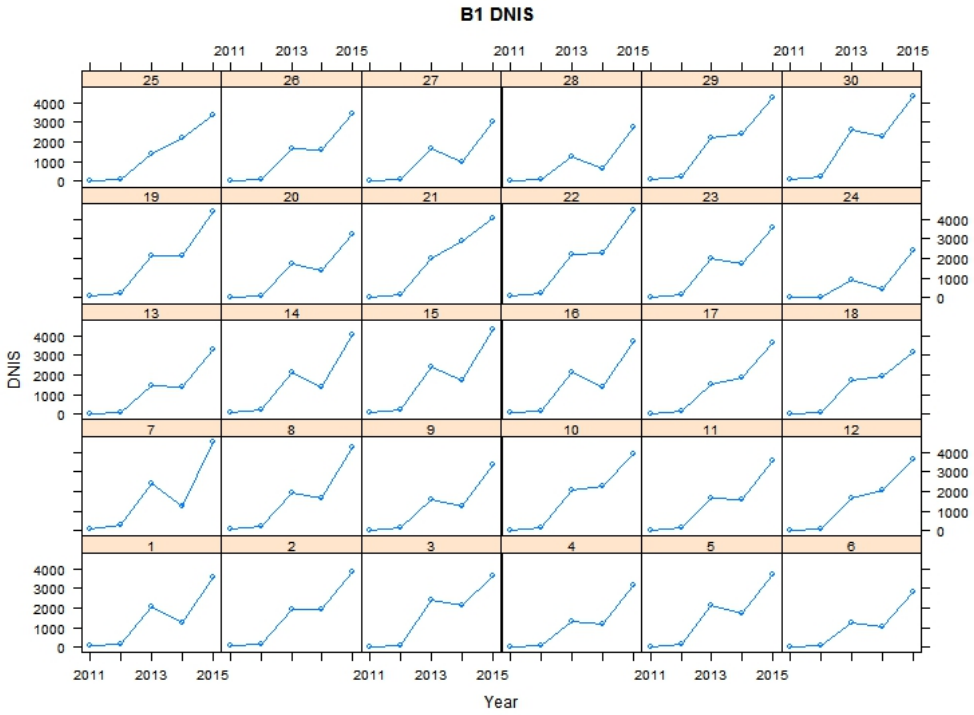


Figure 7-7 Decortes yield from 2011 - 2015.

Decortes Kernel Yield Efficiency

Significant Variety effect but no significant Rootstock effect.

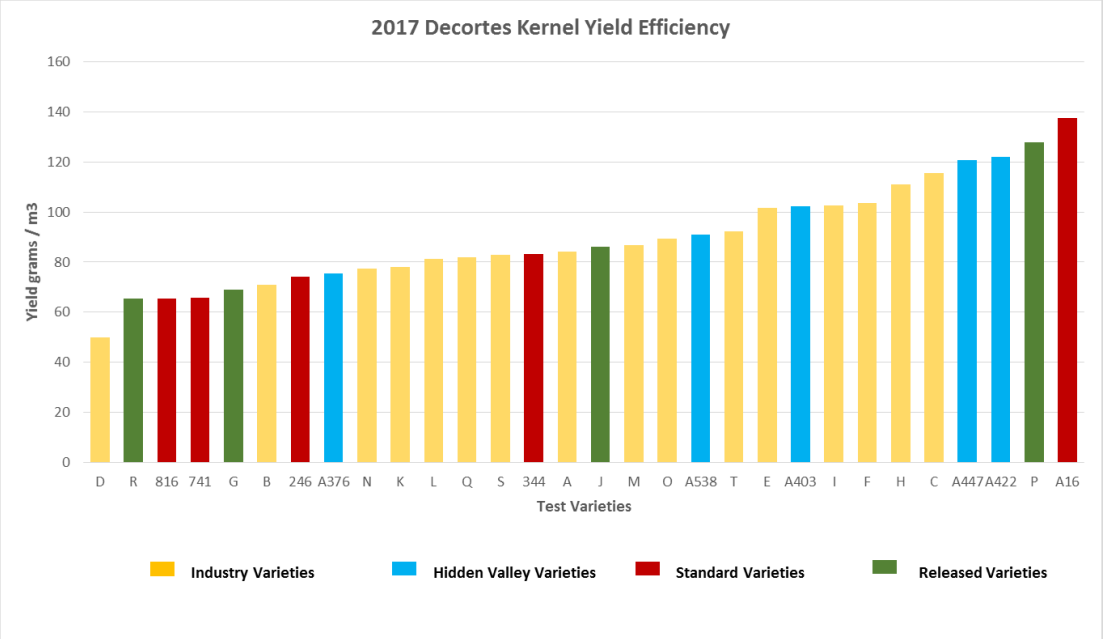


Figure 7-8 Decortes 2017 kernel yield efficiency.

Decortes Nut Drop Pattern

Nut drop patterns in 2017 for the 30 varieties are shown below in figure 7-4. The data is presented as BLUPs. 344 (26), 741 (27), T (13) and A376 peak at the second harvest in 2017 while A422 (5) and M (18) are notable late varieties.

Genetic correlations between harvests 1-5 (5 strip)

	1	2	3	4	5
1	1.000	1.000	-0.965	-0.954	-0.784
2	1.000	1.000	-0.964	-0.954	-0.785
3	-0.965	-0.964	1.000	0.999	0.592
4	-0.954	-0.954	0.999	1.000	0.562
5	-0.784	-0.785	0.592	0.562	1.000

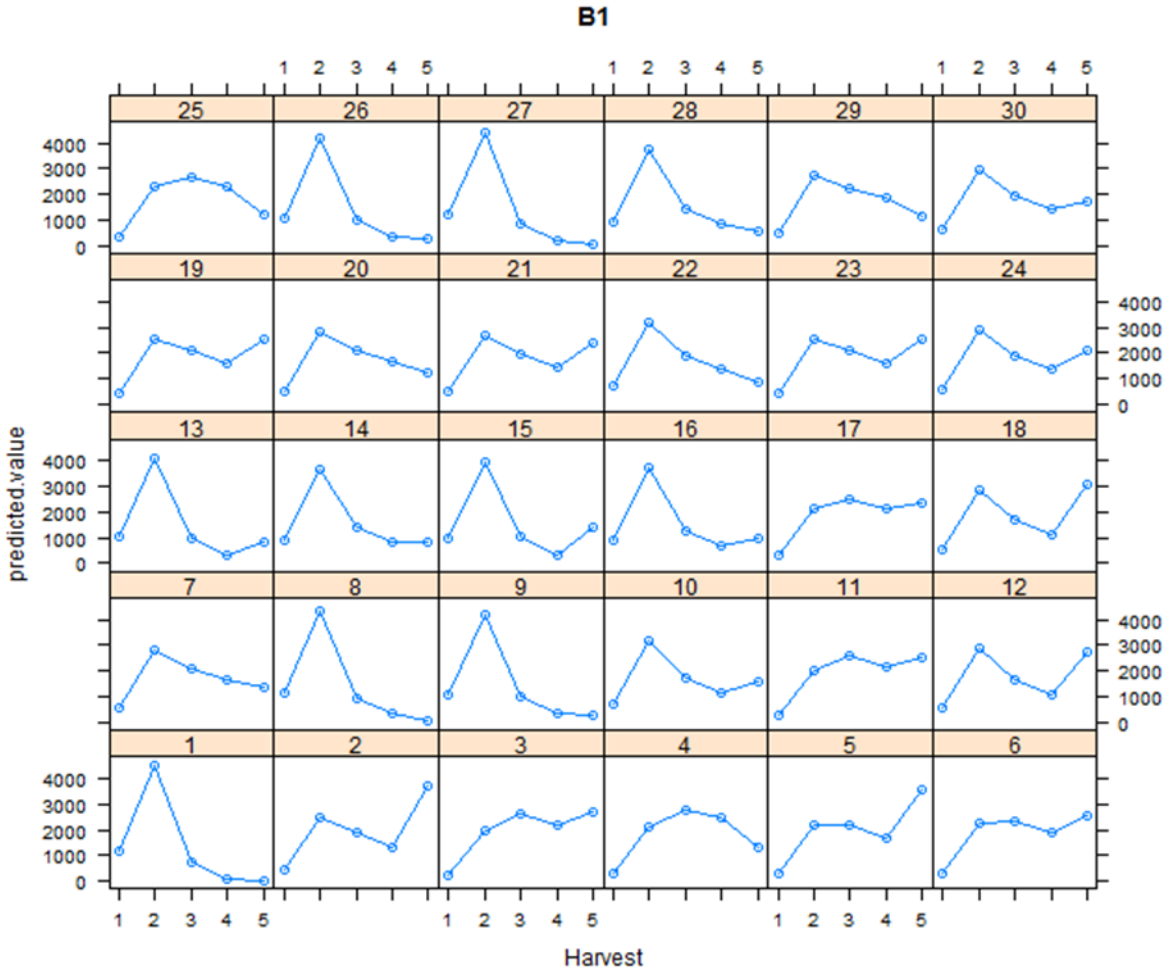


Figure 7-9 Decortes nut drop pattern 2017.

Decortes Tree Volume

Tree size and shape at Decortes has been influenced by Cyclone Oswald in 2013 as the trees took at least three years to recover and form any sort of hedge along the row. Rootstocks had a significant influence on tree size with Beaumont cuttings reducing tree size. Figure 7-8 shows an average of the two rootstocks across the 30 varieties for height and volume from 2014 – 2017.

Significant Variety effect and significant Rootstock effect.

```
$Wald
            Df denDF  F.inc           Pr
(Intercept)  1   4.0 376.00 3.891908e-05
Rootstock    1  50.6  19.76 4.812019e-05
```

```
  Rootstock predicted.value standard.error est.status
1  Beaumont        39.43786       2.341088  Estimable
2        H2        45.87503       2.312079  Estimable
```

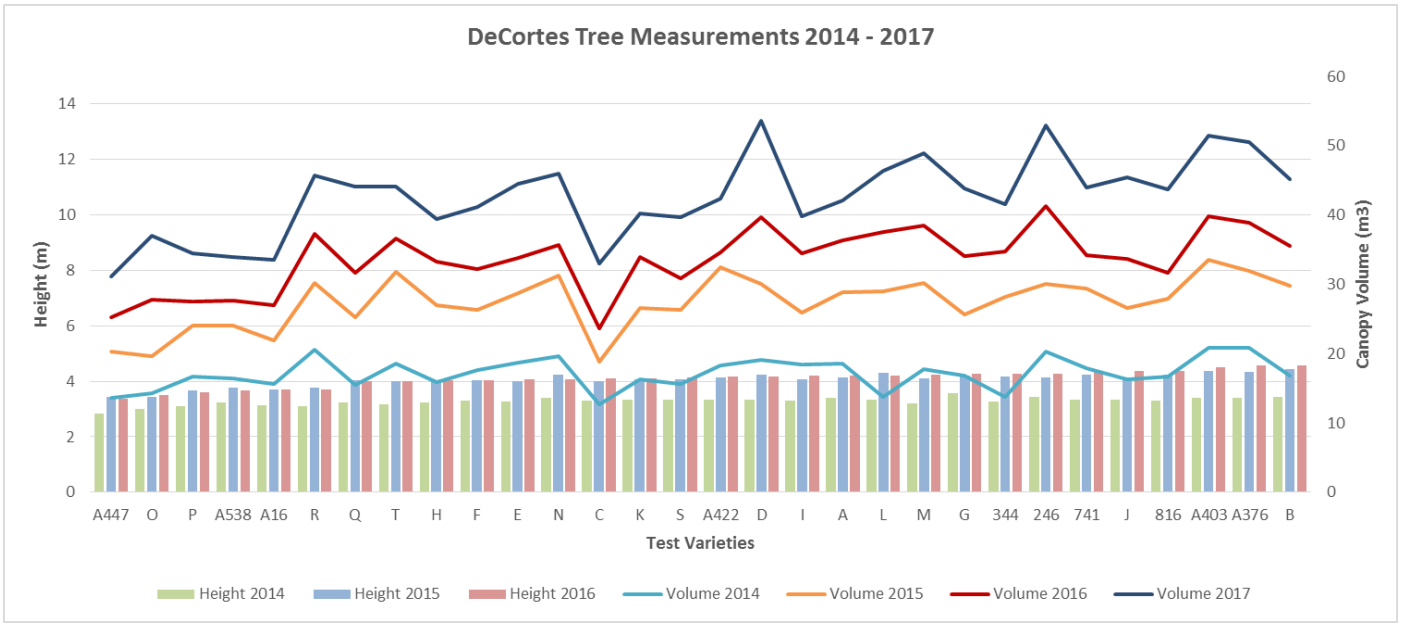


Figure 7-10 Decortes tree heights and volume 2014 - 2017.

Decortes Kernel Recovery 2016 - 2017

There was no significant rootstock effect but a significant variety effect.

Table 8 Decortes kernel recovery 2016 and 2017.

Variety	KR 2016	KR 2017
A376	46.0	46.3
C	39.2	42.0
A403	44.2	45.1
Q	34.4	34.5
A422	41.3	41.6
J	46.5	42.7
B	35.8	36.5
A538	45.1	46.6
816	44.5	43.9
A16	44.5	44.4
F	43.6	49.4
I	38.7	38.5
T	43.3	44.8
G	42.4	41.1
A	34.5	34.6
K	38.9	39.9
E	42.1	41.6
M	36.7	38.4
S	35.9	34.5
O	36.9	38.4
P	39.6	39.0
A447	41.0	42.7
R	39.5	40.3
N	33.5	33.6
H	39.8	40.7
344	33.8	33.6
741	37.0	37.6
D	38.9	40.2
246	38.4	39.3
L	36.4	37.6

Table 9 Decortes summary variety performance.

DeCortes (B1) Regional Variety Trial

Trait		NIS Yield Year 9 (grams)	Kernel Recovery (KR) %	Kernel Yield (grams) Year 9	Cumulative Kernel Yield 2011 - 2017 (kg)	Kernel Canopy Efficiency (g/m3)	Tree Volume (m3)	Kernel kg/ha	20 year Estimated Discounted Cash Flow (DCF)
Variety Code	ID Number								
A376	1	7945	46.3	3679	11.140	75.6	50.6	1,152	$86,833.27
C	2	8734	42.0	3672	10.083	115.7	32.9	1,149	$83,485.72
A403	3	12243	45.1	5517	14.185	102.2	51.5	1,727	$102,914.69
Q	4	10297	34.5	3554	8.350	81.9	44.1	1,113	$56,112.56
A422	5	11497	41.6	4778	12.030	122.2	42.4	1,495	$88,220.33
J	6	9042	42.7	3863	11.332	86.0	45.4	1,209	$108,579.74
B	7	8775	36.5	3202	9.326	70.9	45.1	1,002	$67,980.81
A538	8	7430	46.6	3462	10.970	91.0	34.0	1,084	$93,300.84
816	9	7195	43.9	3159	9.318	65.5	43.7	989	$59,897.58
A16	10	9712	44.4	4309	12.046	137.7	33.5	1,349	$99,518.28
F	11	9632	49.4	4754	11.311	103.6	41.2	1,488	$64,306.95
I	12	10915	38.5	4198	10.360	102.7	39.8	1,314	$71,762.67
T	13	9697	44.8	4343	10.144	92.4	44.1	1,359	$65,648.01
G	14	8501	41.1	3493	10.126	69.1	43.9	1,093	$92,049.04
A	15	9573	34.6	3313	8.935	84.1	42.0	1,037	$64,252.61
K	16	8162	39.9	3257	9.667	78.2	40.3	1,019	$65,988.06
E	17	11168	41.6	4650	11.553	101.8	44.6	1,455	$94,206.48
M	18	10994	38.4	4217	11.012	86.9	48.9	1,320	$61,010.23
S	19	9600	34.5	3308	9.993	82.9	39.7	1,035	$75,709.36
O	20	8847	38.4	3395	8.790	89.5	37.0	1,063	$60,670.38
P	21	10546	39.0	4111	11.867	128.0	34.5	1,287	$94,942.88
A447	22	8534	42.7	3647	10.738	120.7	31.1	1,141	$81,581.74
R	23	7959	40.3	3211	9.716	65.4	45.7	1,005	$56,057.47
N	24	10750	33.6	3617	9.245	77.3	45.9	1,132	$59,868.43
H	25	10705	40.7	4352	10.922	111.0	39.5	1,362	$66,283.45
344	26	10428	33.6	3503	9.591	83.3	41.6	1,096	$52,265.53
741	27	7818	37.6	2942	8.341	65.7	44.0	921	$53,768.06
D	28	6660	40.2	2679	8.173	49.8	53.6	839	$48,676.56
246	29	10307	39.3	4056	11.344	74.1	52.9	1,269	$85,689.80
L	30	10518	37.6	3956	11.307	81.1	46.4	1,238	$73,260.96

8. Booyan (B2) – Adrian Walsh FNC

Booyan (B2) RVT site was planted on the 18th March 2008. It is situated at Welcome Creek, 19.8km north-north-east of the Bundaberg CBD. The soil type is similar to Decortes, a dark grey, sandy Kandsol. Booyan survived Cyclone Oswald well in 2013 as the orchard trees were pulled back up very quickly after the storm. Figure 8-4 shows little effect of the crops in 2013 and 2014 which is quite different to Decortes where all the trees went down in production for those years.

Booyan is the most consistent block of the Bundaberg regional variety trials. Of all the sites in all regions this is the only block with a full complement of 180 trees. By 2016 the trees were starting to form a hedge but still smaller in general than Wirrawilla or Alstonville. In 2016 Booyan was harvested March 7, April 18, May 23, and July 25 and 26 for harvest four and five respectively.

The 2017 Booyan crop was down on 2016 which in part could be due to biennial bearing as 2016 was a big year, and accidental grower pick-up at harvest three may have also contributed to the lower yields. Only three rows could be harvested and weighed at harvest three so yield predictions were developed for those six missing rows. Estimates of yield are difficult for heavy producing, late selections compared to early maturing varieties where the majority of the crop has dropped pre-harvest three. Some later maturing varieties can be as much as 1/2 of the yield at harvest three. Mistletoe is also becoming a real issue in 2017 and given the infection rate on much of the orchard there will be significant tree architecture and yield effects in the future (figure 8-1).

Figure 8-1 Booyan mistletoe infestation 2017.

Booyan was harvested in 2017 on March 27, May 15, July 3, August 15 and August 22.

By 2016 or year 8 Booyan was thought to have settled into a consistent yield pattern. MET analysis below indicated that variety rankings were thought to have stabilised as per the biometrician statement below.

Phenotyping in B2 indicates map errors for trees 30-15 (4), 35-8 (6), 34-11 (11), 29-14 (12), 30-2 (16), 33-7 (16), 36-18 (16) and 34-16 (25). Some confusion with 32-16 (27).

The top 5 ranked varieties from 2015 to 2017 are listed below in table 6.

Table 10 Booyan top 5 ranked varieties 2015 - 2017.

RVT Site	Yield Measure	Rank 5	Rank 4	Rank 3	Rank 2	Rank 1
Booyan (B2)	2015 Kernel Yield	A403	G	T	P	A376
	2016 Kernel Yield	K	A376	246	J	G
	2017 Kernel Yield	F	A16	T	816	A376
	Cumulative Kernel Yield 2011 - 2017	246	816	J	A376	G

Booyan 2016 Analysis

An initial fixed effect analysis shows no significant overall Rootstock effect however the Rootstock x Variety interaction was almost significant (P=0.055). There was a significant Variety effect.

Figure 8-2 Booyan harvest 2016.

```
$Wald
              Df denDF    F.inc           Pr
(Intercept)    1   3.5 3175.000 2.354280e-06
Rootstock      1   4.6    3.703 1.175629e-01
ID            29  92.2    4.244 6.086121e-08
pltimef        2 100.7    7.285 1.109233e-03
Rootstock:ID  28  93.4    1.575 5.522315e-02
```

A final random effects analysis correlating the genetic effects over the two rootstocks gave the following variance components and Variety predictions (BLUPs):

```
                                      gamma     component    std.error    z.ratio    constraint
Rep!Rep.var                    2.538853e-07  9.411160e-01 1.277713e-01  7.3656282      Boundary
Col!Col.var                    7.874586e-02  2.918995e+05 2.372683e+05  1.2302507      Positive
Rootstock:ID!Rootstock.cor     7.068741e-01  7.068741e-01 2.558203e-01  2.7631669 Unconstrained
Rootstock:ID!Rootstock.Beaumont 5.122237e-01  1.898739e+06 8.861793e+05  2.1426129      Positive
Rootstock:ID!Rootstock.H2      5.767677e-01  2.137994e+06 8.992191e+05  2.3776125      Positive
R!variance                     1.000000e+00  3.706855e+06 5.032640e+05  7.3656282      Positive
R!Col.cor                      9.291100e-02  9.291100e-02 1.122214e-01  0.8279255 Unconstrained
R!Row.cor                     -1.032195e-01 -1.032195e-01 1.006999e-01 -1.0250210 Unconstrained
```

The genetic correlation between Rootstocks was 0.71 (so high but not exactly the same variety rankings for the two rootstocks). The genetic variances were similar for the 2 rootstocks ($1.9x10^6$ for Beaumont and $2.1x10^6$ for H2).

Booyan Cumulative NIS Yield

The chart below (figure 8-2) shows cumulative nut in shell yield from 2011 to 2017. 2017 NIS yields have been included however these could have been influenced by harvest 3 being picked by the

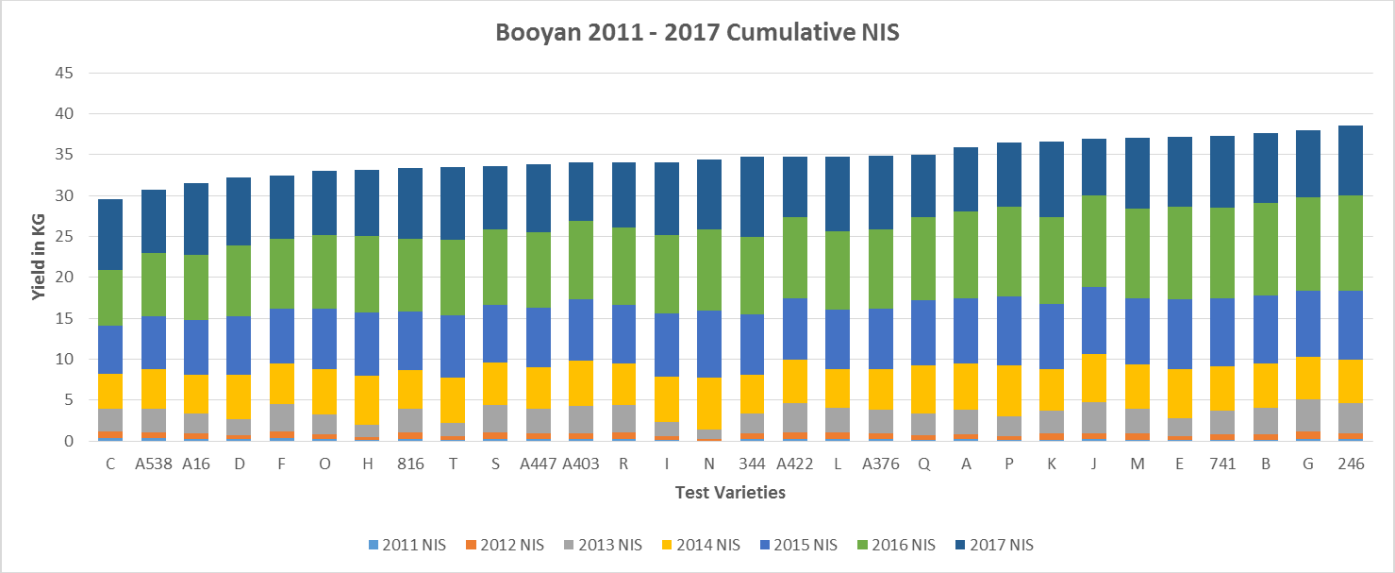


Figure 8-3 Booyan cumulative nut in shell 2011 - 2017.

grower. Following on from this chart is the analysis for NIS 2011 – 2016 where the biometrician believes the yield rankings have settled with a correlation of 0.965 between 2015 and 2016.

2011 - 2016 genetic analysis of NIS yield.

The genetic correlation matrix (from the FA2 model) is given below. It can be seen that the early harvests are highly negatively correlated with the later harvests. This is telling us that we cannot use the early harvests to predict the best varieties for later years. In fact it could be better to select the worst in the early years! The last 3 harvests (2014, 2015, 2016) are highly correlated (0.847 (2014&2015), 0.677 (2014&2016), 0.965 (2015&2016)) so **things have stabilized a lot which is good**.

	2011	2012	2013	2014	2015	2016
2011	1.000	0.881	0.585	-0.992	-0.774	-0.579
2012	0.881	1.000	0.899	-0.815	-0.382	-0.126
2013	0.585	0.899	1.000	-0.478	0.061	0.322
2014	-0.992	-0.815	-0.478	1.000	0.847	0.677
2015	-0.774	-0.382	0.061	0.847	1.000	0.965
2016	-0.579	-0.126	0.322	0.677	0.965	1.000

The genetic variances for each year are as follows:

2011	2012	2013	2014	2015	2016
5529.138	30512.645	555126.939	255890.067	566758.792	1850633.636

The plot below gives the predictions for each Variety for each year.

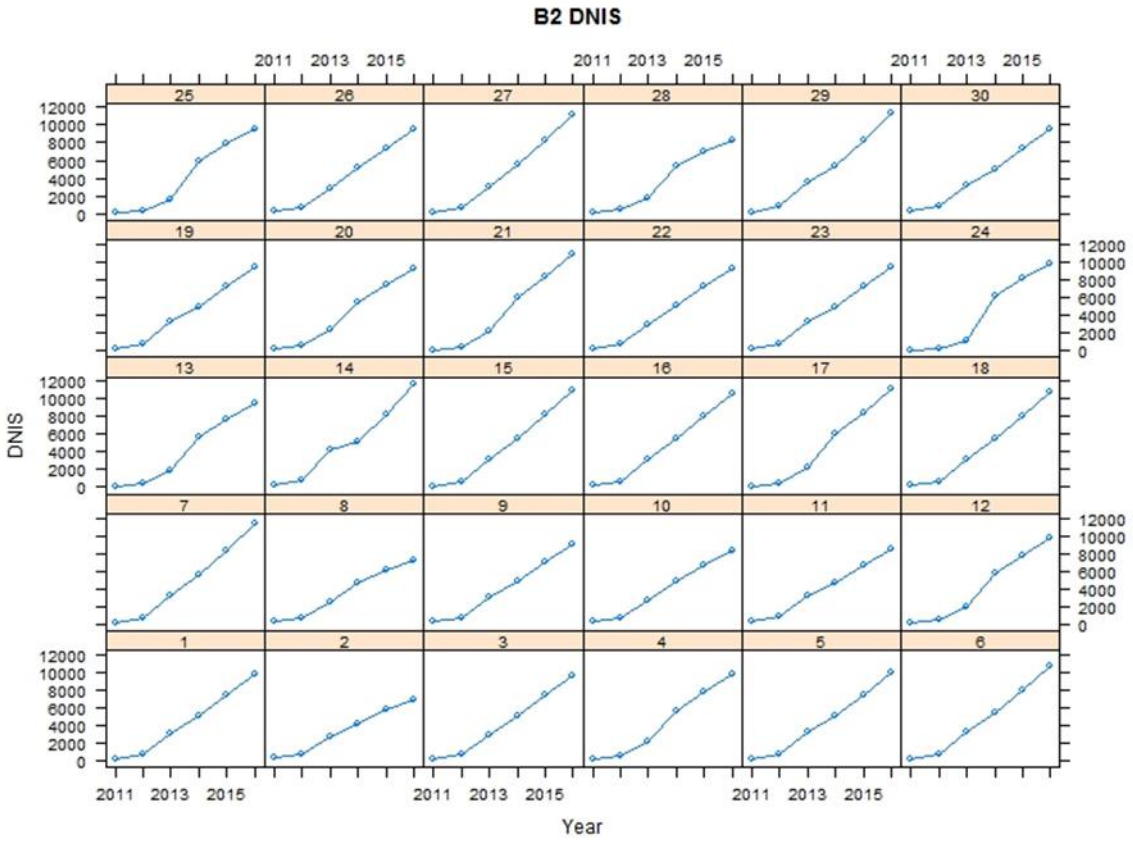


Figure 8-4 Booyan yield by year 2011 - 2016.

Booyan Kernel Recovery for 2015, 2016 and 2017

Kernel recovery is a relatively stable trait across years as it is highly genetically correlated. Rankings are similar year to year as seen in table 8 below.

Table 11 Booyan kernel recovery 2015 - 2017.

Variety	KR 2015	KR 2016	KR 2017
A376	46.1	46.2	44.4
C	37.1	38.7	38.2
A403	43.7	42.1	41.0
Q	33.9	30.3	32.1
A422	41.0	40.5	39.0
J	42.4	44.0	38.0
B	36.4	35.6	33.8
A538	45.3	46.2	43.6
816	44.3	45.2	44.4
A16	42.0	42.1	43.0
F	44.4	45.7	46.2
I	36.0	38.6	34.7

T	43.3	43.6	42.3
G	43.3	42.9	41.7
A	31.3	32.1	32.7
K	38.5	40.1	36.2
E	36.0	35.9	35.4
M	36.1	35.1	32.2
S	34.6	33.6	32.5
O	36.9	37.1	36.5
P	40.8	38.9	35.8
A447	42.3	39.9	39.2
R	40.0	39.4	37.3
N	33.8	31.8	30.2
H	39.8	40.3	39.6
344	36.0	34.2	33.0
741	38.3	38.3	34.8
D	39.8	38.5	38.2
246	39.6	38.9	35.6
L	35.8	35.7	34.8

Booyan Cumulative Kernel Yield

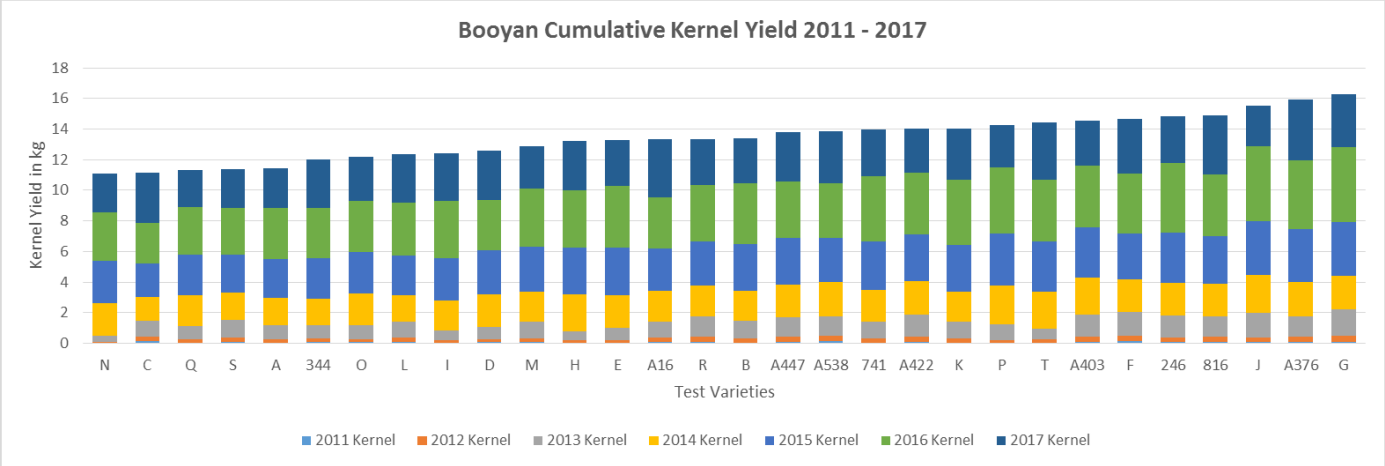


Figure 8-4 Booyan cumulative kernel yield 2011 - 2017.

Booyan Nut Drop Pattern

Nut drop patterns for 2016 and 2017 are detailed below and show yearly variability. As the harvests are generally at similar times in the year the nut drop pattern differences between the varieties could be attributed to seasonal climate variation.

2016 Nut Drop Pattern

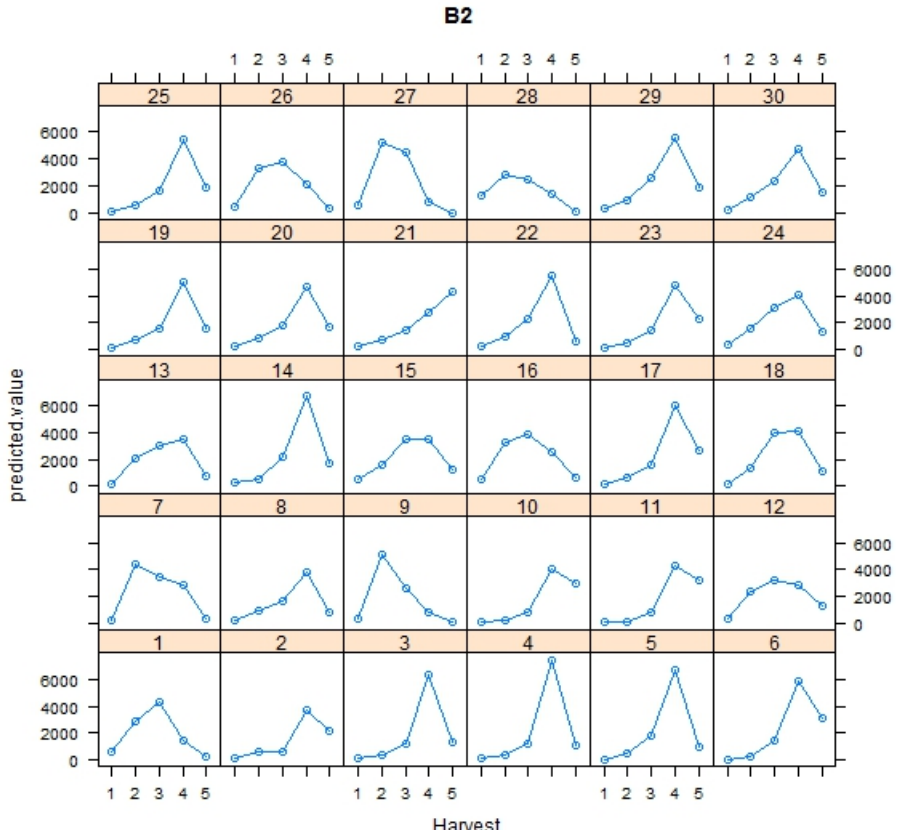


Figure 8-5 Booyan 2016 nut drop pattern.

2017 Nut Drop Pattern

Genetic correlations between harvests 1-5 (5 strip) – may be problems with many Harvest 3 trees missing. Later maturing varieties might be more compromised than early maturing genotypes.

	1	2	3	4	5
1	1.000	0.488	-0.997	-0.940	-0.117
2	0.488	1.000	-0.554	-0.757	-0.924
3	-0.997	-0.554	1.000	0.963	0.194
4	-0.940	-0.757	0.963	1.000	0.450
5	-0.117	-0.924	0.194	0.450	1.000

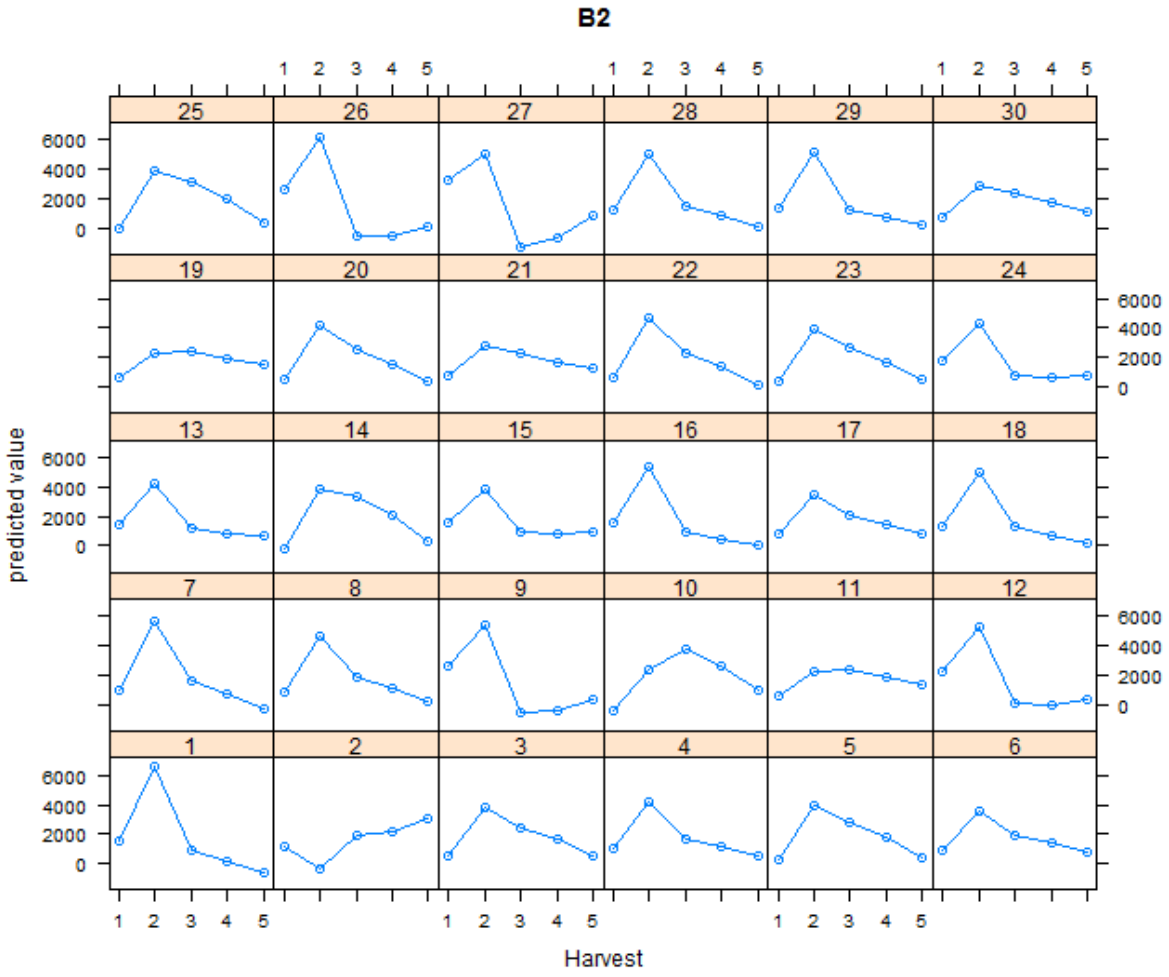


Figure 8-6 Booyan 2017 nut drop pattern.

Booyan Kernel Yield Efficiency

A447, MIV1-P, MIV1-G and A16 were the most efficient yield varieties at yea8 in 2016 (figure 8-7). Variety N on the other hand is a very large tree with heavy crops but inefficient production. Both

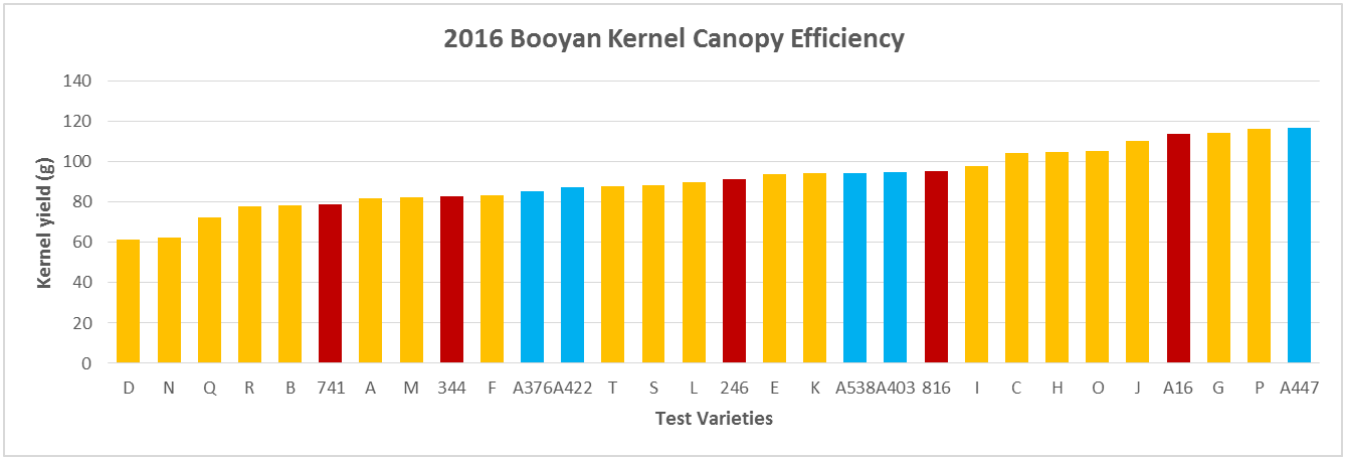


Figure 8-7 Booyan kernel yield efficiency 2016.

A447 and MIV1-P are both small trees however MIV1-G is a large tree producing the same kernel per cubic metre.

Booyan Canopy Volume

Canopy volume showed no significant Rootstock or Rootstock x Variety effect in 2016. Tree height showed no significant Rootstock effect or Rootstock x Variety interaction. There was a significant Variety effect.

In 2017 there was a significant Variety effect but no significant rootstock effect. Variety C at the Booyan site are the smallest volume trees. Variety R is one of the shorter trees but due to its width and depth has quite a large volume (figure 8-8). Trees below are ordered by 2016 tree height.

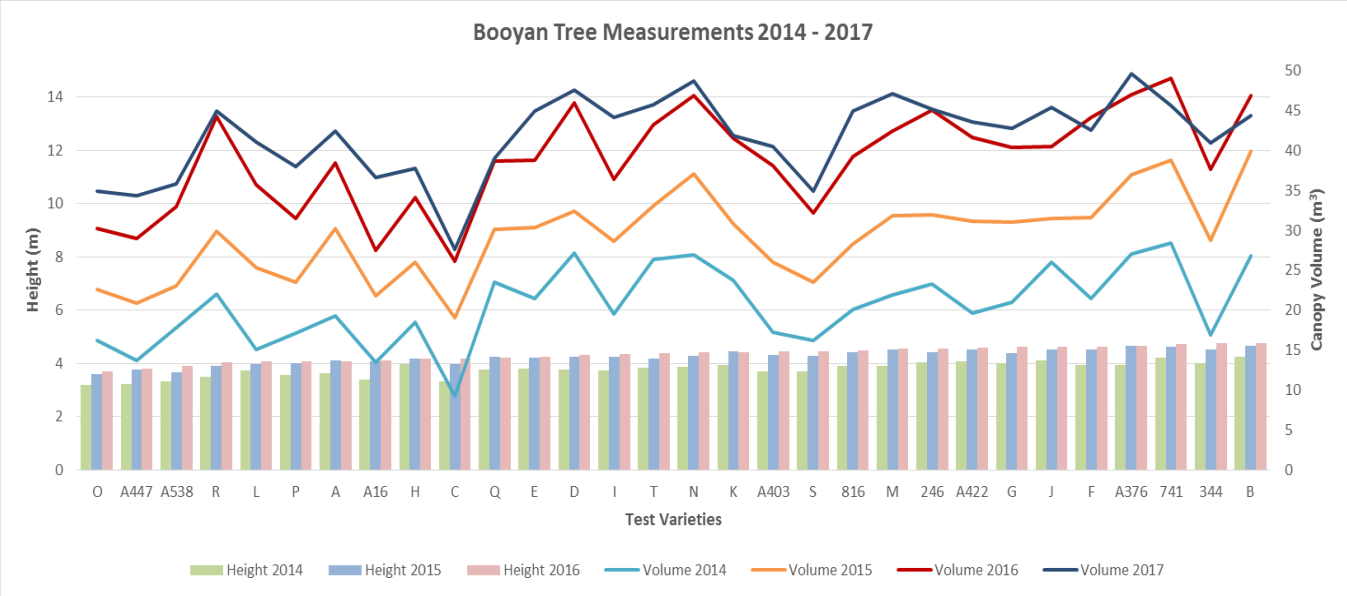


Figure 8-8 Booyan tree heights and volume 2014 - 2017.

Table 12 Booyan summary variety performance.

Booyan (B2) Regional Variety Trial Trait		NIS Yield Year 9 (g) 2017	Kernel Recovery (KR) % 2017	Kernel Yield (grams) Year 9	Cumulative Kernel Yield 2011 - 2017 (kg)	Kernel Canopy Efficiency (g/m3)	Tree Volume (m3) 2017	Kernel kg/ha 2017	% Whole Kernel 2016	% Premium Kernel 2016	% Commercial Kernel 2016	% Reject 2016	20 year Estimated Discounted Cash Flow (DCF) Trait
Variety Code	**ID Number**												
A376	1	9629	44.4	4277	15.913	87	49.6	1,339	47.7	85.4	3.8	11.3	$134,235.71
C	2	8158	38.2	3119	11.155	101	27.6	976	47.7	86.2	1.3	11.1	$90,761.78
A403	3	7529	41.0	3090	14.519	74	40.5	967	58.6	88.6	2.5	10.3	$143,056.87
Q	4	6658	32.1	2134	11.337	56	39.0	668	61.1	64.5	18.2	15.4	$82,324.18
A422	5	7808	39.0	3043	14.049	69	43.5	953	70.8	93.0	3.0	8.4	$127,650.63
J	6	6368	38.0	2422	15.540	47	45.4	758	41.8	89.8	2.5	9.8	$147,927.92
B	7	9294	33.8	3145	13.366	71	44.4	984	30.0	91.6	2.5	9.1	$104,845.97
A538	8	6798	43.6	2961	13.858	79	35.8	927	48.5	90.2	4.0	9.2	$115,325.97
816	9	8434	44.4	3743	14.871	90	45.0	1,172	59.8	81.6	7.4	11.8	$132,558.83
A16	10	8992	43.0	3866	13.324	106	36.6	1,210	45.2	83.7	5.9	11.4	$120,851.92
F	11	7633	46.2	3530	14.634	80	42.6	1,105	42.6	85.6	5.5	10.9	$106,149.52
I	12	9222	34.7	3196	12.393	71	44.1	1,000	50.6	83.4	4.3	11.6	$106,745.66
T	13	9527	42.3	4027	14.439	87	45.7	1,261	37.2	91.9	2.8	8.9	$121,269.52
G	14	9078	41.7	3788	16.278	91	42.8	1,186	49.8	82.1	7.3	11.1	$155,873.93
A	15	9119	32.7	2982	11.444	69	42.4	933	48.1	79.1	1.8	14.6	$93,643.87
K	16	8966	36.2	3248	14.051	81	41.8	1,017	54.4	84.3	4.4	11.7	$121,796.88
E	17	7784	35.4	2759	13.299	62	44.9	864	49.4	74.4	13.8	12.7	$116,939.02
M	18	8310	32.2	2676	12.903	57	47.1	838	50.6	85.8	4.5	10.9	$107,284.16
S	19	8235	32.5	2677	11.367	73	34.9	838	42.2	77.5	1.1	15.2	$97,804.46
O	20	8483	36.5	3093	12.161	86	34.9	968	43.5	77.2	6.7	13.8	$110,544.06
P	21	8266	35.8	2961	14.263	76	38.0	927	47.3	81.4	3.7	12.7	$149,641.02
A447	22	7833	39.2	3071	13.820	92	34.3	961	46.8	74.2	9.1	14.5	$133,196.26
R	23	8286	37.3	3090	13.337	68	44.9	967	56.9	86.3	3.4	11.0	$108,475.21
N	24	7899	30.2	2388	11.113	49	48.7	747	50.6	79.0	4.5	13.7	$74,159.72
H	25	8592	39.6	3399	13.199	93	37.7	1,064	43.9	90.2	4.9	9.0	$120,459.74
344	26	9672	33.0	3188	12.029	78	41.0	998	44.3	81.0	7.9	11.9	$80,156.29
741	27	8988	34.8	3126	13.957	69	45.6	979	36.8	88.1	3.0	10.5	$116,640.25
D	28	7456	38.2	2850	12.570	58	47.6	892	40.5	92.5	1.2	9.1	$136,351.00
246	29	7475	35.6	2660	14.825	57	45.2	833	56.9	88.6	2.8	10.3	$92,358.71
L	30	8700	34.8	3025	12.342	73	41.1	947	54.0	81.5	7.5	11.7	$93,415.59

9. Bundy Sugar (B3) – Sean Cox

Bundy Sugar or B3 was planted the 29th of October, 2008, nearly 6 months following the other Bundaberg sites. The soil is a poorly drained, sandy, Kandosol that had previously grown sugar cane before changing over to macadamia. The site is on Bingarra Birthamba Road, 21.9 km west of Bundaberg.

Bundy Sugar is a block in recovery. At the end of 2013 the site was suffering from significant salt and spray burn to nearly every tree. Thirty-five trees have died due to the extreme chloride toxicity and water logging. In early 2014 the trees were in very poor health (figure 9-1) but were recovering at later harvests and into 2015 before this issue could be rectified. By the later harvests in 2015 the orchard was looking much better with fresh growth and good production on many of the trees. In 2015 Varieties 21, 24 and 25 had significant numbers of nuts left in the trees at harvest 5. It was also noted that B3 was quite late coming into flower compared to the other Bundaberg sites which could also account for the late nut drop.

Figure 9-1 Bundy Sugar typical tree decline.

Harvest dates were 11th March, 6th May, 30th June, 11th August and 5th harvest 11th August.

Tip burn, leaf drop and tree deaths re-occurred in 2016 (figure 9-2). The trees are not healthy so consequently the yields were low. Sean Cox established a lot of drainage works over the 2015 / 2016 summer. Bundy Sugar has only H2 rootstock and is mechanically pruned each year.

2016 Harvests were March 9, April 20, May 25, August 10 and 11 for

Figure 9-2 Bundy Sugar leaf burn.

Bundy Sugar had a light crop in 2017. Thirty-five trees have now died in this trial, many of the remaining trees are sick with severe tip burn. Harvest three was very light and quite wet under the trees although drainage works was carried out at the end of 2015.

Bundy Sugar was harvested on March 28, March 16, July 4, August 16 and August 23 in 2017. Table 13 provides a quick snapshot of kernel yield variety rankings from 2015 – 2017 and cumulative yield over time. Although this site is difficult to align with performance of other Bundaberg sites it is still an important data point for variety performance. Varieties A376, T, H and MIV1-J have been

consistent yielders at Bundy Sugar. Detailed variety performance traits for Bundy Sugar are presented in table 15.

Table 13 Bundy Sugar Top 5 ranked varieties 2015 - 2017.

RVT Site	Yield Measure	Rank 5	Rank 4	Rank 3	Rank 2	Rank 1
Bundy Sugar (B3)	2015 Kernel Yield	E	T	A376	A447	H
	2016 Kernel Yield	H	I	A376	N	J
	2017 Kernel Yield	A422	F	T	H	J
	Cumulative Kernel Yield 2013 - 2017	H	J	N	T	A376

Bundy Sugar NIS Yield 2017

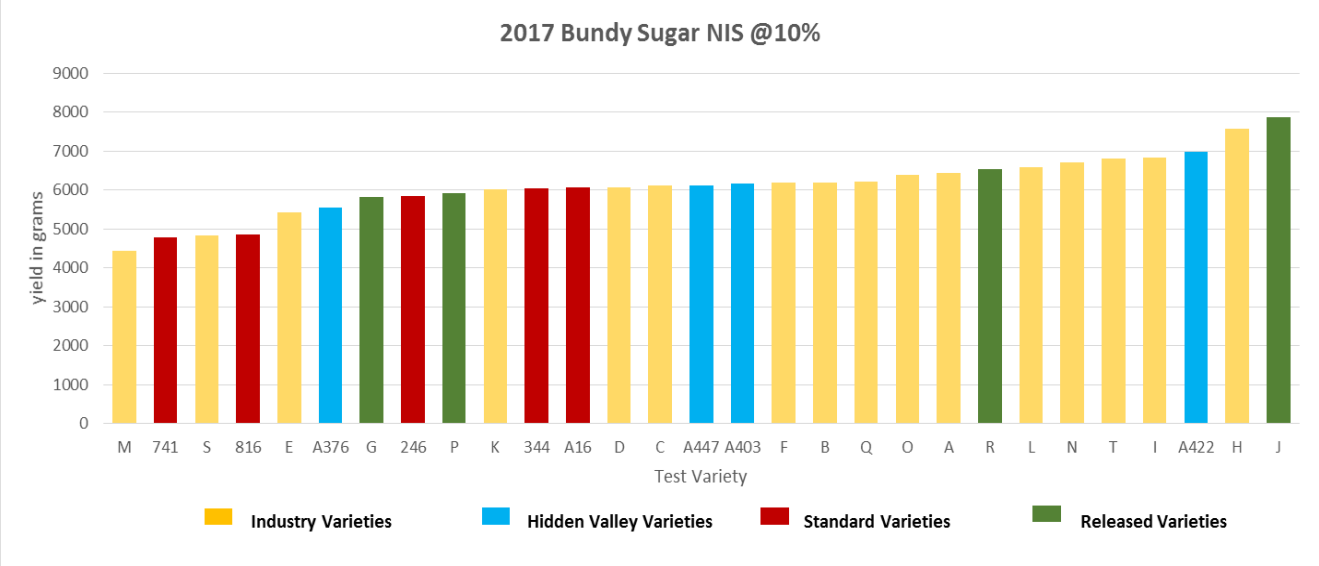


Figure 9-3 Bundy Sugar NIS yield 2017.

Kernel Recovery 2015 - 2017

Kernel recovery for 2015 – 2017 are detailed in table 14. KR is genetically controlled so the rankings will be pretty similar from site to site. Environmental factors such as temperature and rainfall play a significant role in determining the size of the nuts as we see in Emerald where the varieties are generally smaller. However rankings will still be pretty similar across sites.

2017 Bundy Sugar kernel yield (figure 9-4), tonnes per hectare (figure 9-5) and cumulative kernel yield (figure 9-6) show the yield range across varieties. MIV1-J had double the yield of M and almost two times the yield of 741 in 2017. A376 had a light year in 2017 after a stronger 2016 and over time has the highest cumulative kernel yield.

Table 14 Bundy Sugar kernel recovery 2015 - 2017.

Variety	KR 2015	KR 2016	KR 2017
A376	49.9	49.4	48.8
A403	42.8	41.6	42.2
Q	35.1	38.0	33.0
A422	41.3	42.7	40.8
J	44.3	48.9	45.1
B	36.7	37.5	35.5
816	44.9	46.5	46.6
A16	43.2	41.4	42.1
F	45.4	48.3	47.3
I	36.6	38.9	39.4
T	43.8	43.8	47.4
G	44.5	43.8	43.3
A	32.9	36.5	32.9
K	36.0	37.4	39.7
E	45.8	41.5	41.2
M	36.2	44.3	35.6
S	35.6	43.3	37.4
O	37.3	40.4	38.1
P	41.5	40.2	40.6
R	39.0	40.4	39.9
N	34.5	39.6	35.5
H	44.4	42.8	43.0
344	34.6	39.0	35.7
741	37.7	43.9	36.9
D	39.6	38.6	36.4
246	38.8	40.1	39.6
L	37.4	38.7	38.3

Bundy Sugar Kernel Yield

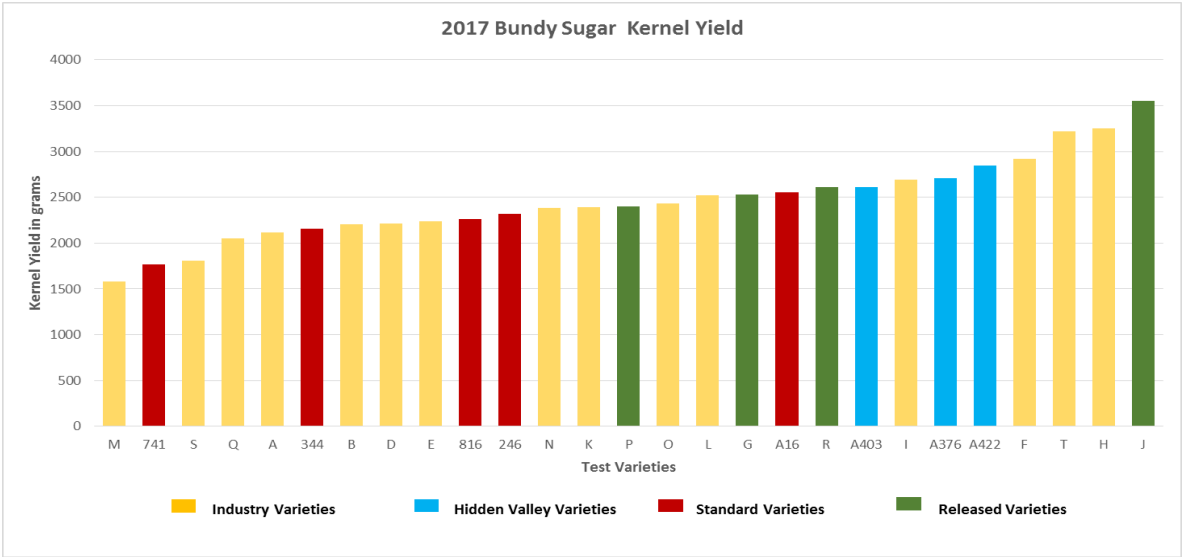


Figure 9-4 Bundy Sugar kernel yield 2017.

Bundy Sugar Kernel Tonnes per Hectare

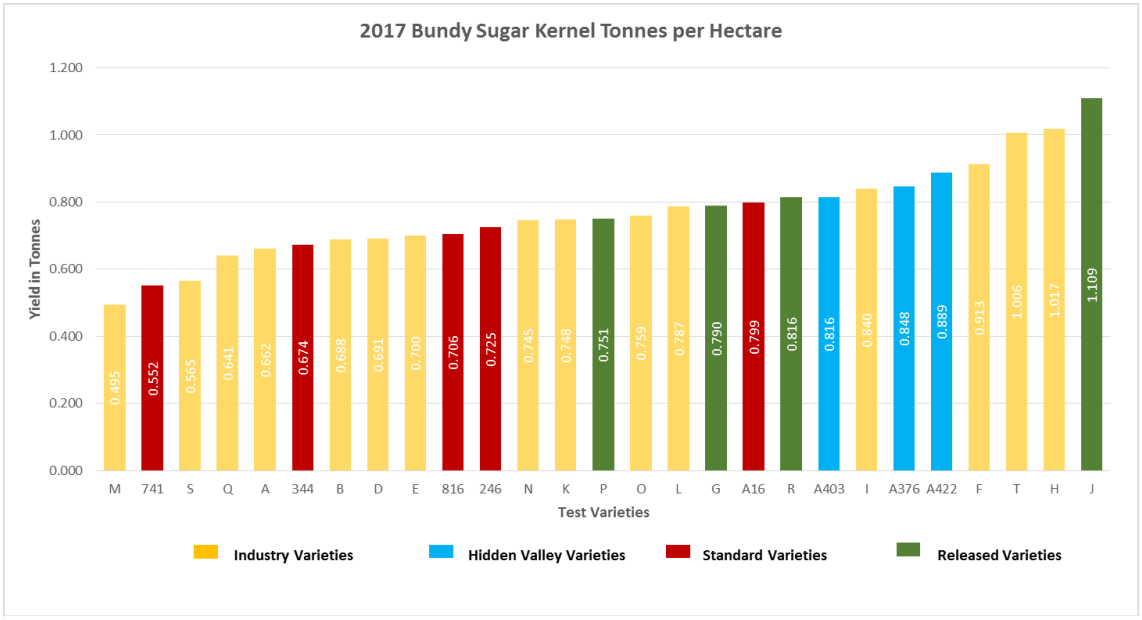


Figure 9-5 Bundy Sugar kernel t/ha 2017.

Bundy Sugar Cumulative Kernel Yield

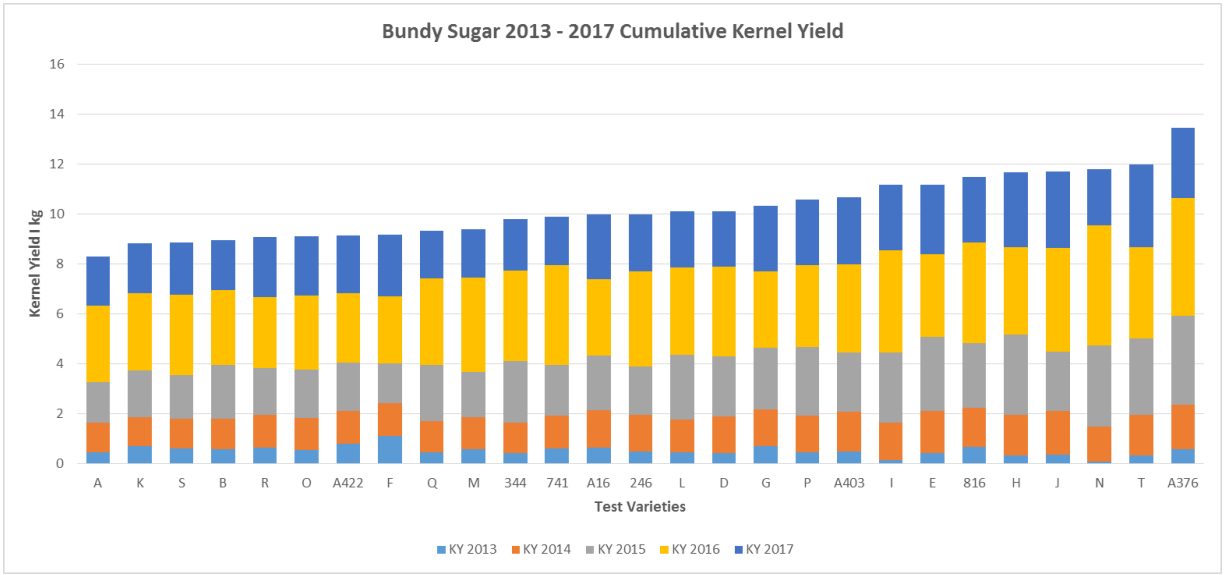


Figure 9-6 Bundy Sugar cumulative kernel yield 2013 - 2017.

Bundy Sugar Nut Drop Pattern

Nut drop patterns vary slightly over time depending on the season and date of harvests. At Bundy Sugar it is interesting to note that usual late varieties such as a MIV1-P (variety 21), MIV1-G (variety 14) and A16 (variety 10) are usually late maturing in harvests 4 and 5. In 2017, with more tree health decline from soil saturation, these varieties tended to drop early as seen in figure 9-7.

Genetic correlations between harvests 1-5 (5 strip)

	1	2	3	4	5
1	1.000	0.366	0.402	-0.518	-0.012
2	0.366	1.000	-0.705	-0.986	-0.935
3	0.402	-0.705	1.000	0.575	0.911
4	-0.518	-0.986	0.575	1.000	0.861
5	-0.012	-0.935	0.911	0.861	1.000

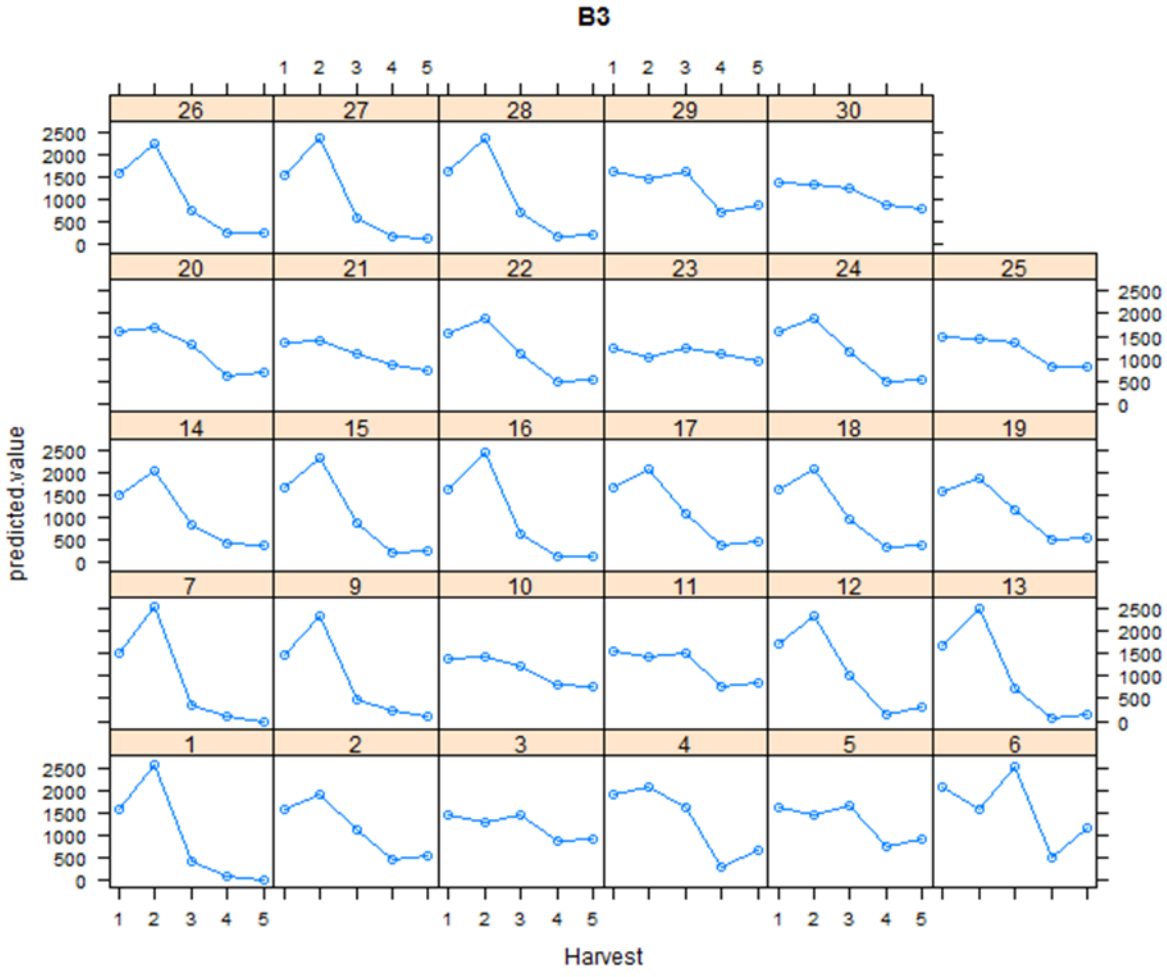


Figure 9-7Bundy Sugar nut drop pattern 2017.

Bundy Sugar Kernel Yield Efficiency

Varieties MIV1-P, A422 are two of the smaller varieties on test in RVT3 sites and are usually canopy efficient as seen in other blocks. 741 has very poor canopy efficiency at Bundy Sugar (figure 9-8).

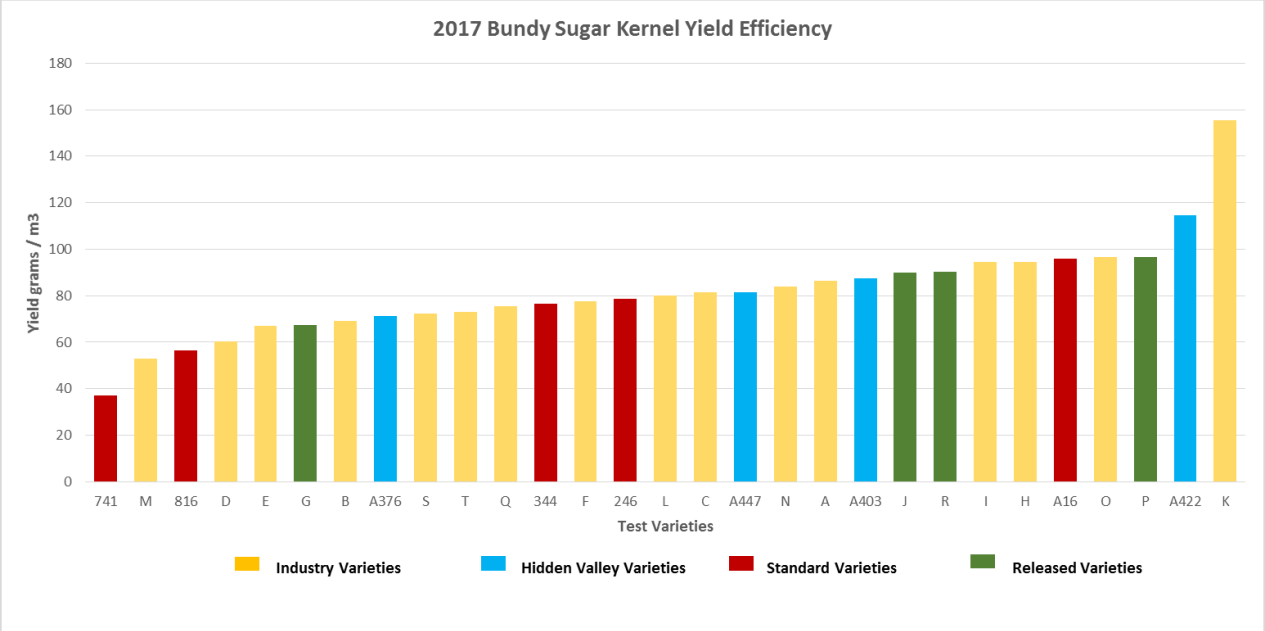


Figure 9-8 Bundy Sugar kernel yield efficiency 2017.

Bundy Sugar Tree Volume

There was a significant Variety effect in 2017. Bundy Sugar is pruned each year which can explain why all the tree heights are around 4m..In the figure below tree volume for 2017 is generally lower than 2016 which could be explained by 2016 measurements were take prior to pruning and 2017 measurements were taken after pruning.

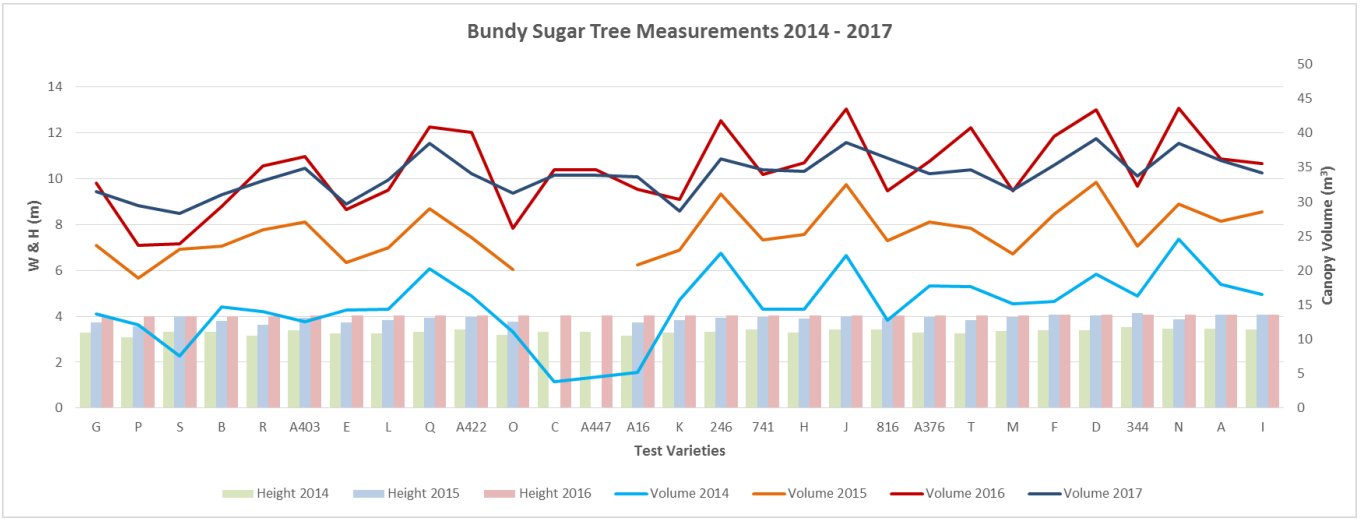


Figure 9-9 Bundy Sugar tree heights and volume 2014 - 2017.

Table 15 Bundy Sugar summary variety performance.

Bundy Sugar (B3) Regional Variety Trial

Trait		NIS Yield Year 9 (grams)	Kernel Recovery (KR) %	Kernel Yield (grams) Year 9	Cumulative Kernel Yield 2011 - 2017 (kg)	Kernel Canopy Efficiency (g/m3)	Tree Volume (m3)	Kernel kg/ha year 9 (2017)	20 year Estimated Discounted Cash Flow (DCF)
Variety Code	**ID Number**								
A376	1	5559	48.8	2712	13.453	71.3	34.1	849	$126,461.19
C	2	6119							$98,449.15
A403	3	6178	42.2	2610	10.656	87.6	34.9	817	$77,528.34
Q	4	6211	33.0	2050	9.337	75.5	38.5	642	$65,235.80
A422	5	6973	40.8	2844	9.136	114.5	34.1	890	$86,320.07
J	6	7869	45.1	3550	11.716	90.0	38.6	1,111	$132,931.81
B	7	6200	35.5	2202	8.961	69.2	31.0	689	$73,558.91
816	9	4847	46.6	2259	11.496	56.3	36.4	707	$96,095.22
A16	10	6068	42.1	2557	9.990	96.0	33.6	800	$85,409.56
F	11	6185	47.3	2923	9.185	77.5	35.3	915	$43,479.51
I	12	6822	39.4	2688	11.175	94.4	34.2	841	$110,735.36
T	13	6801	47.4	3220	11.971	73.0	34.6	1,008	$113,237.03
G	14	5833	43.3	2528	10.336	67.5	31.5	791	$81,619.68
A	15	6449	32.9	2120	8.292	86.3	36.0	663	$75,555.70
K	16	6020	39.7	2393	8.828	155.4	28.6	749	$63,249.49
E	17	5436	41.2	2240	11.178	67.2	29.7	701	$93,423.93
M	18	4445	35.6	1584	9.399	53.1	31.7	496	$83,288.51
S	19	4837	37.4	1807	8.873	72.2	28.3	566	$71,261.91
O	20	6382	38.1	2430	9.097	96.5	31.2	761	$95,693.10
P	21	5921	40.6	2404	10.572	96.8	29.5	752	$92,501.67
A447	22	6119							$95,695.51
R	23	6543	39.9	2610	9.064	90.2	33.0	817	$70,260.40
N	24	6719	35.5	2385	11.787	83.8	38.5	747	$128,424.99
H	25	7576	43.0	3255	11.673	94.4	34.4	1,019	$113,668.44
344	26	6037	35.7	2156	9.801	76.5	33.7	675	$73,294.94
741	27	4783	36.9	1767	9.889	37.1	34.6	553	$93,797.53
D	28	6076	36.4	2213	10.115	60.5	39.2	693	$85,423.22
246	29	5854	39.6	2320	9.999	78.5	36.2	726	$89,302.57
L	30	6579	38.3	2518	10.110	80.1	33.1	788	$81,362.53

10. Childers (CH) Clayton Mattiazzi Hinkler Park

Childers regional variety trial was the most precocious site until 2014, or year six. The site, planted on the 19th of March 20108, is situated 14.1 km from Childers and 43.3 km from Bundaberg. Rich red ferrosol soils are common to the Childers region and have contributed to the high growth rate and subsequent heavy cropping at this site (figures 10-1, 10-2 and 10-5).

Figure 10-1 Childers rich red soil and prolific growth, 2015.

Childers RVT has four replicates of each of the 30 varieties on test giving a total of 120 trees. In 2015 a number of trees in the block were genotyped for paternity analysis. From this study it was discovered that HVP variety A403 was actually HVP A422 both genetically and subsequently phenotypically. Consequently all A403 results are actually A422.

Childers was a single strip harvest in 2014 and harvested 5 times throughout the 2015 season. Harvest dates were as follows: 1st harvest was 12th March, 2nd harvest 7th May, 3rd harvest on 2nd of July and final two harvests, 4 and 5 on July 2nd. Harvest 5 is a strip harvest of remaining nuts in the tree.

Prior to 2015 Childers had been the best performing block in overall yield and individual tree yields. However, in 2015 yield on some varieties dramatically decreased. One possible explanation is biennial bearing as a carry-over from the heavy production years previously.

Figure 10-2 Compositing samples from the 30 varieties, 2014.

HPV varieties have performed well at Childers in the red soil as well as 816 although the DAF varieties MIV1-G and MIV1-P had also cropped well in those early years.

The Childers site was abandoned in 2015 after a severe storm.

Table 16 Childers top 5 variety yields, 2015.

RVT Site	Yield Measure	Rank 5	Rank 4	Rank 3	Rank 2	Rank 1
Childers (CH)	2015 Kernel Yield	A376	P	A447	A538	M
	Cumulative Kernel Yield 2011 - 2015	A538	G	A376	F	816

Childers Storm Damage 2015

Figure 10-3 Childers hail damage after the 2015 storm.

On October 28, 2015, a severe storm went through the Childers region travelling from the northwest through the RVT site and onto macadamia farms either side of the Bundaberg Childers road. All trees were severely hail damaged (figure 10-3) with shredded leaves, pitted trunks and nuts knocked to the ground or damaged. This storm damaged or destroyed 94 of the 120 trees in the site(figure 10-4). Twelve of the 26 undamaged trees were left leaning after the storm and a further five of these trees were completely uprooted. All trees at the site were rated for damage (0 – no damage; 1 – branch damage; 2- limb damage; and 3 trunk damage), trees leaning (0 – 3 scale with 3 lying flat or almost) and trees uprooted. Thirty-nine trees in the block were leaning, 24 of these were on Beaumont cutting rootstocks and 15 on H2 seedling rootstocks, and a total of 15 were completely uprooted, 14 on Beaumont stocks and 1 H2 stock. Some trees were blown over and relatively undamaged implying that the rootstock gave way before the tree felt the full force of the storm. There were 34 trees either undamaged or with some branch damage (rating 0 or 1) of which 23 were on H2 stock and 11 on Beaumont.

Figure 10-4 Childers storm damage 2015.

Rootstocks at this site seemed to have an effect on yield with H2 having a much heavier yield than Beaumont, and also there may have been some impact of tree damage with many more Beaumont cutting rootstocks uprooted than H2. The biometrician is not totally convinced that the rootstock is final answer as blocking for statistical reference meant the Beaumont cutting rootstock rows were outside H2 seedling rows, perhaps feeling more force of the storm.

Figure 10-5 Childers 2014 harvest.

Cumulative Yield 2011 - 2015

There seems to be a decrease between 2014 & 2015 for many of the varieties. On first thoughts this may have something to do with the Rootstock effect we can see at 2015, or is this biannual bearing (figures 10-6 and 10-7)?

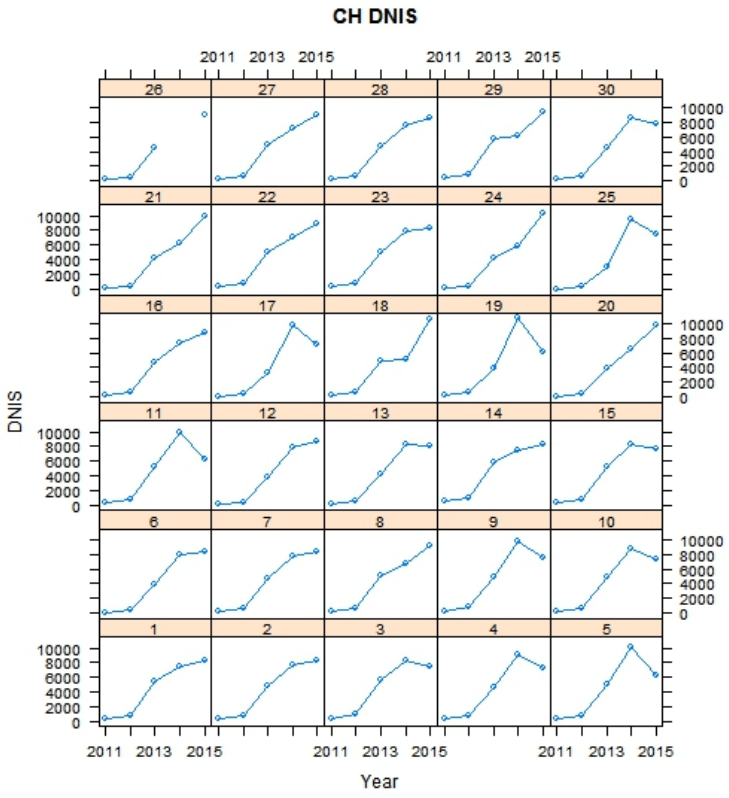


Figure 10-6 Childers NIS yield 2011 - 2015.

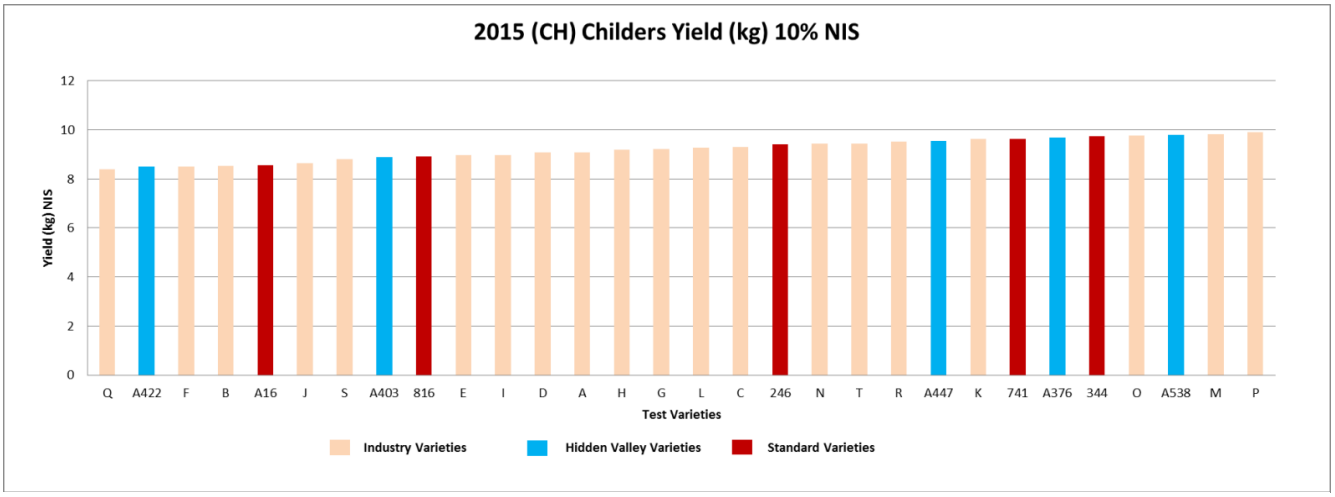


Figure 10-7 Childers NIS yield 2015.

Childers Rootstock Analysis 2015

"An initial fixed effect analysis showed a significant overall Rootstock effect and significant Variety effects but no significant Rootstock by Variety interaction. There was also a significant effect of planting time.

One possible issue with this site is that the Beaumont rootstocks are on the outside Columns of the trial in Col46, 47 & 52, 53 while the H2 rootstocks are in the internal Columns 48, 49, 50, 51. There is a random Column effect included in the model but the higher effect for H2 is still apparent.

Another possible explanation could be soil type as Childers is the only "red soil" site in QLD and the rootstocks behave differently". (Comments from Joanne DE Faveri)

Figure 10-8 shows clearly the rootstock effect with H2 out-yielding Beaumont.

Variety Code	Variety
1	A376
2	C
3	A403
4	Q
5	A422
6	J
7	B
8	A538
9	816
10	A16
11	F
12	I
13	T
14	G
15	A
16	K
17	E
18	M
19	S
20	O
21	P
22	A447
23	R
24	N
25	H
26	344
27	741
28	D
29	246
30	L

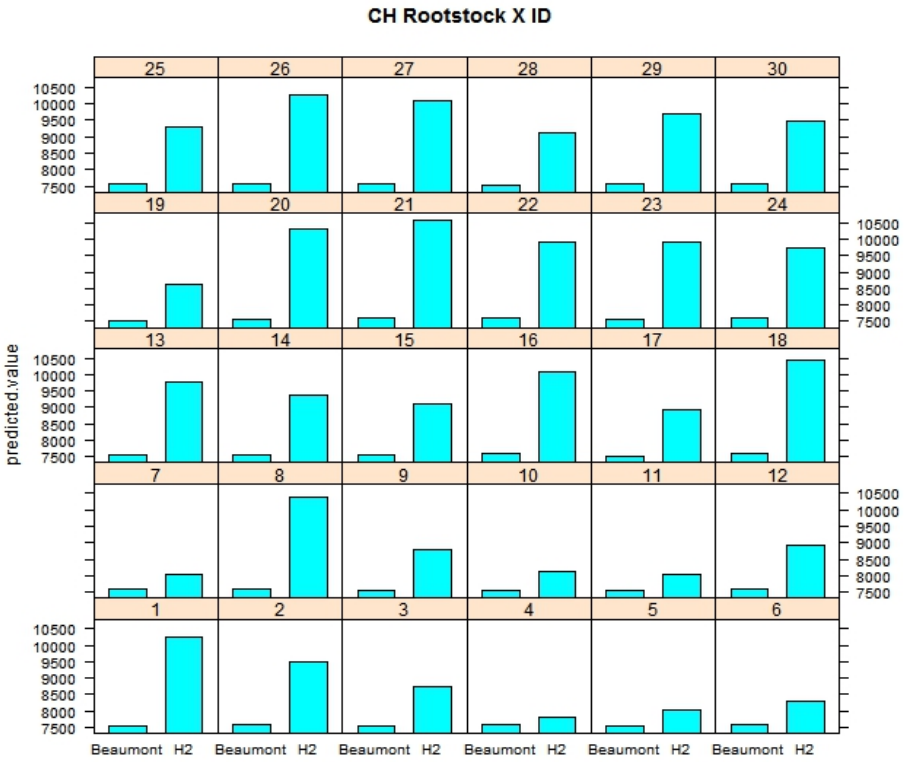


Figure 10-8 Childers rootstock analysis.

Childers Nut Drop Pattern 2015

Standard varieties are 9 (816), 10 (A16), 26 (344), 27 (714) and 29 (246)

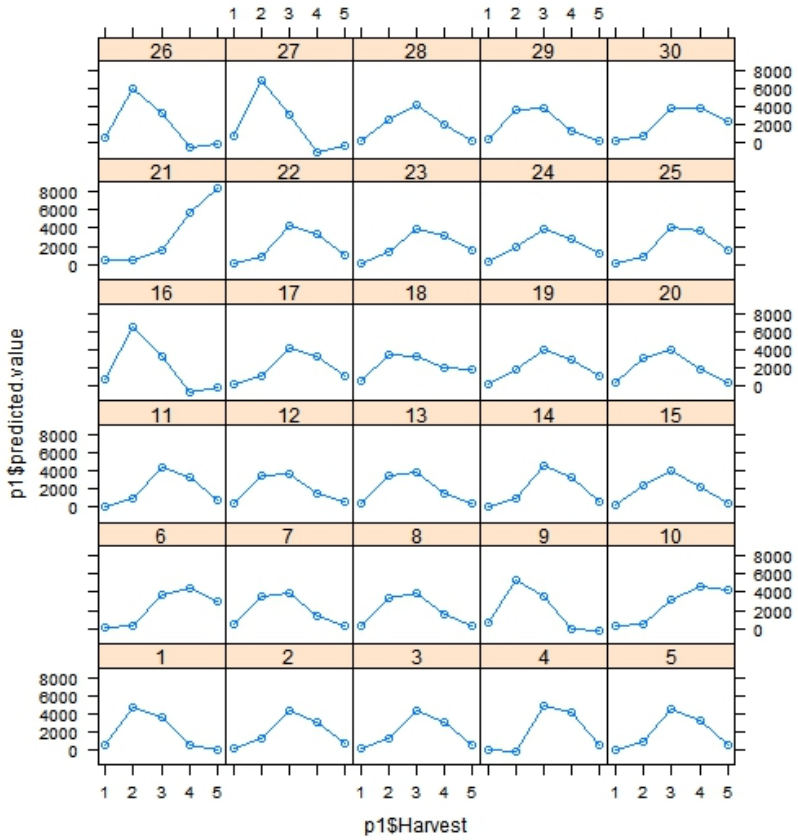


Figure 10-9 Childers nut drop pattern.

Childers Kernel Assessment

Initial fixed effects analysis shows a significant Variety (ID) effect and a significant Rootstock but no significant Rootstock x Variety interaction. This needs to be interpreted with caution as not all varieties are present for Rootstock H2 (Variety 13 or T is missing).

The Rootstock predicted means show a small increase in % kernel recovery for H2 than Beaumont.

Varieties F (46.3%), 816 (46.1%) and A376 (45.4%) had the highest kernel recoveries (Table 17).

Childers Cumulative Kernel Yield 2011 – 2015

Figure 10-10 and table 17detail cumulative kernel yield for the Childers site from 2011 to 2015. Missing from this graph is 344 which was inadvertently returned to the grower at sampling time. Interesting to note that A422 and A403 (probably both A422) had a bad year in 2015 while M and P had considerably better production in 2015 than 2014.

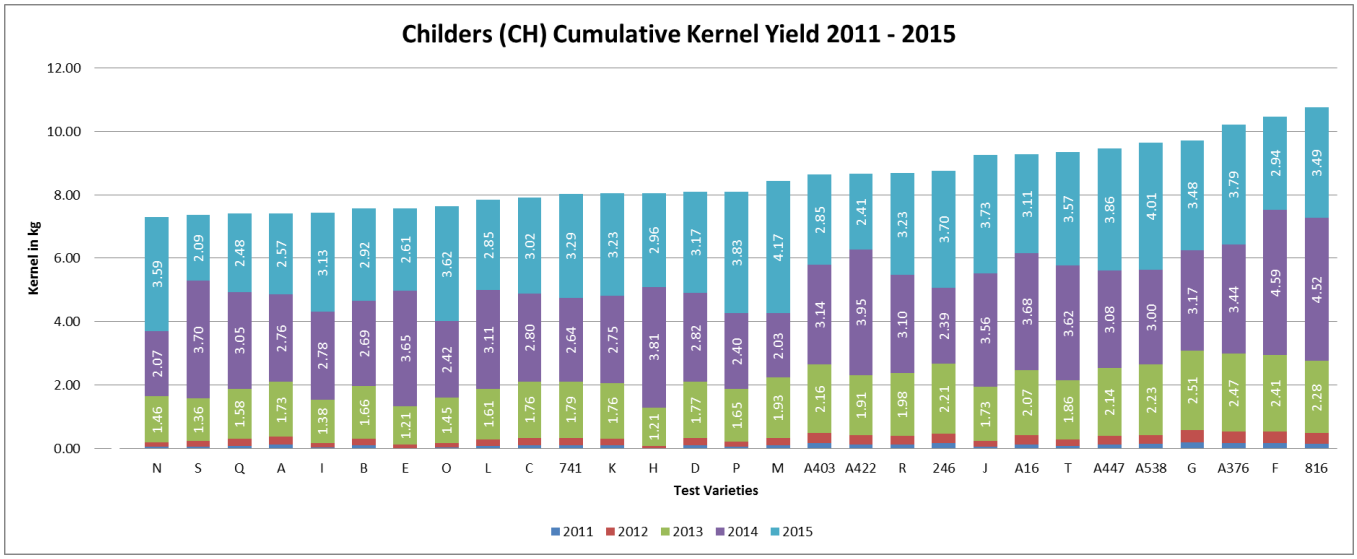


Figure 10-10 Childers cumulative kernel yield 2011 - 2015.

Childers Canopy Kernel Efficiency 2015.

As at all the sites the most efficient, and smaller, trees were A447, P and O (figure 10-11). In later years at other sites variety C was also a small efficient tree.

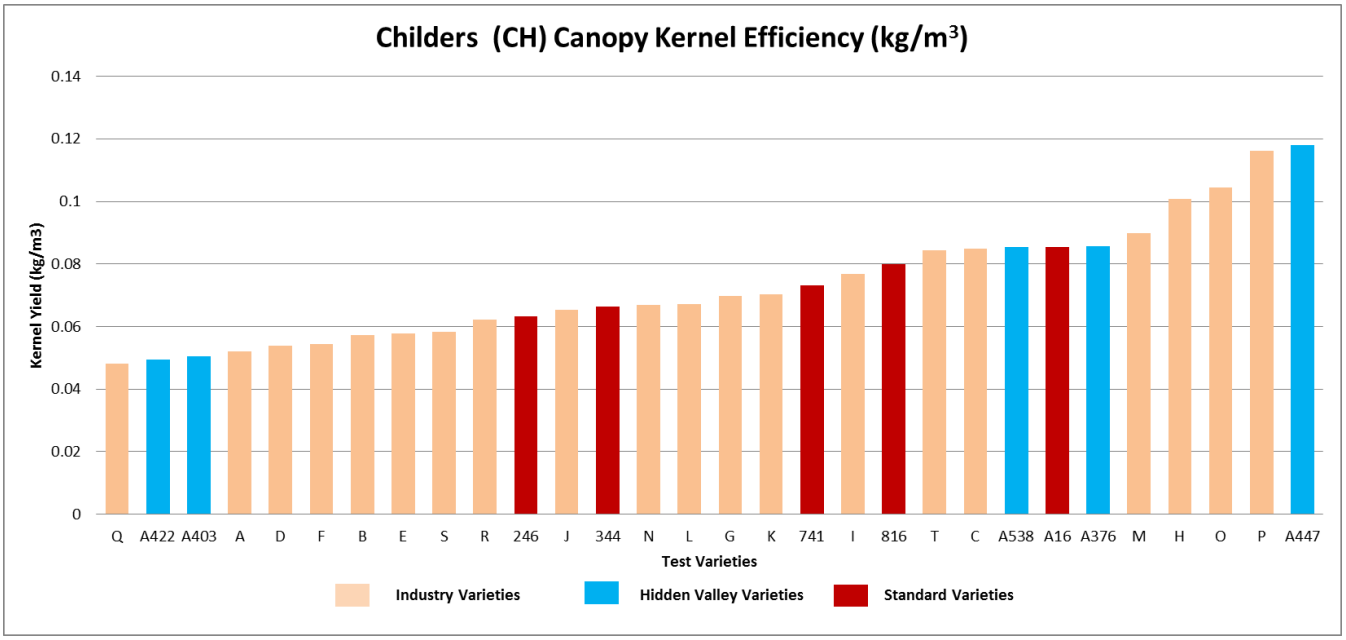


Figure 10-11 Childers canopy kernel efficiency 2015.

Childers Tree Height and Volume 2015

Tree heights and volume for 2015 are presented below (figure 10-12). The varieties are ordered by tree height with 344 the tallest trees in the block.

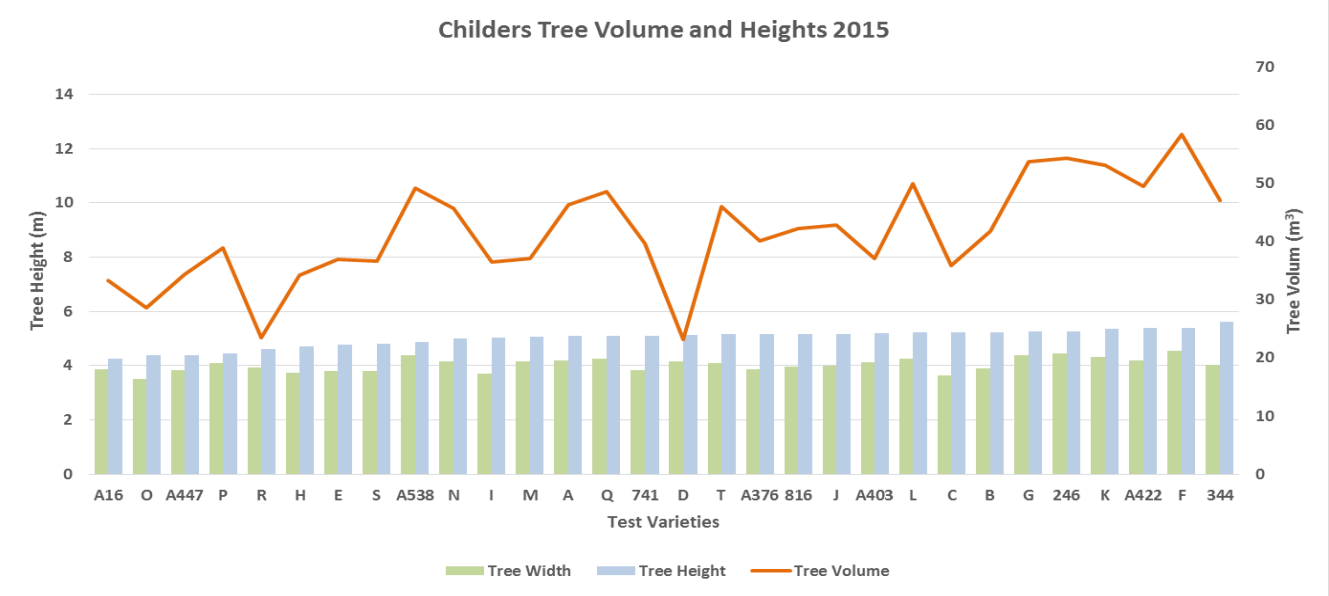


Figure 10-12 Childers tree volume and heights, 2015.

Table 17 below highlights variety performance characteristics of the 30 varieties at the Childers RVT. This table has records up to 2015 with estimates of the 20 year Discounted Cash Flow (DCF) included.

Table 17 Childers summary variety performance.

Childers (CH) Regional Variety Trial

Trait		NIS Yield Year 7 (grams)	Kernel Recovery (KR) %	Kernel Yield Year 7 (grams)	Cumulative Kernel Yield 2011 - 2015 (kg)	Kernel Canopy Efficiency (g/m3) raw data	Tree Volume Year 7 (m3) raw data	Kernel kg/ha	Estimated Discounted Cash Flow (DCF) based on Year 7
Variety Code	**ID Number**								
A376	1	9,693	45.4	4,039	10.218	85.6	40.18	1,264	**$191,177.68**
C	2	9,298	36.0	3,072	7.907	85.0	35.87	961	**$140,471.21**
A403	3	8,873	37.7	3,068	8.636	50.6	37.14	960	**$135,812.99**
Q	4	8,382	33.8	2,600	7.415	48.1	48.56	814	**$109,475.65**
A422	5	8,490	38.8	3,018	8.673	49.5	49.55	945	**$133,884.46**
J	6	8,650	44.0	3,495	9.246	65.3	42.80	1,094	**$183,830.27**
B	7	8,527	34.6	2,710	7.568	57.2	41.85	848	**$129,040.46**
A538	8	9,794	43.8	3,940	9.648	85.3	49.26	1,233	**$174,918.33**
816	9	8,922	46.1	3,776	10.760	79.9	42.21	1,182	**$189,962.54**
A16	10	8,549	41.8	3,279	9.269	85.5	33.26	1,026	**$161,109.23**
F	11	8,494	46.3	3,607	10.474	54.5	58.38	1,129	**$148,411.19**
I	12	8,980	35.7	2,937	7.439	76.7	36.45	919	**$135,327.85**
T	13	9,451	43.7	3,787	9.338	84.5	46.02	1,185	**$173,229.83**
G	14	9,228	42.3	3,581	9.723	69.9	53.80	1,121	**$156,635.70**
A	15	9,076	33.1	2,758	7.418	52.1	46.25	863	**$112,179.02**
K	16	9,632	37.0	3,270	8.048	70.4	53.09	1,023	**$127,826.51**
E	17	8,970	36.8	3,026	7.578	57.9	36.95	947	**$136,656.53**
M	18	9,824	39.1	3,525	8.438	89.8	37.06	1,103	**$158,727.80**
S	19	8,811	34.3	2,775	7.369	58.4	36.59	869	**$112,920.96**
O	20	9,754	36.8	3,294	7.640	104.5	28.65	1,031	**$159,202.95**
P	21	9,903	38.4	3,490	8.096	116.2	38.87	1,092	**$158,713.84**
A447	22	9,548	43.2	3,786	9.472	118.0	34.31	1,185	**$182,304.71**
R	23	9,512	39.3	3,429	8.697	62.2	23.51	1,073	**$151,621.74**
N	24	9,430	34.9	3,017	7.294	66.9	45.70	944	**$132,350.00**
H	25	9,191	39.7	3,345	8.055	100.8	34.18	1,047	**$151,176.50**
344	26	9,733	33.9	3,029	0	66.4	47.15	948	**$0.00**
741	27	9,641	36.8	3,258	8.034	73.1	39.62	1,020	**$148,431.52**
D	28	9,069	37.1	3,084	8.086	53.8	23.13	965	**$141,333.74**
246	29	9,416	38.9	3,358	8.756	63.3	54.39	1,051	**$148,920.98**
L	30	9,278	36.3	3,090	7.840	67.1	49.94	967	**$119,280.48**

11 Wirra Willa (WW) – Scott Allcott (MFM)

The Wirra Willa RVT was planted on the 2nd of December, 2008. This site is a free draining, sandy Kandosol, 14.2km NNW of Bundaberg. Many of the surrounding trees at this site are severely compromised with Abnormal Vertical Growth (AVG) and was initially planted as a test for the industry and HVP varieties for AVG. To date only some of the 344 trees exhibit signs of AVG with three industry varieties at the western end of the block showing only possible symptoms. This block has the largest trees of all the Bundaberg sites. In 2016 there was some minor tree trimming as hedging along the rows. At the time pf planting standard varieties (A4, A268, 842 and Daddow) were also included. All trees are on H2 rootstock.

This trial does not have Beaumont rootstock (only H2 and also some AVG / non AVG rootstocks). These trees were grafted onto cuttings from AVG infected and non-infected sources.

Wirra Willa was harvested 5 times throughout the 2015 season beginning 10th March, harvest 2 on the 5th of May, harvest 3 on the 30th of June, harvests 4 and 5 on the 10th of August. Harvest 5 is a strip harvest.

In 2016 Wirra Willa was harvested March 8, April 18, May 24, July 28 for harvests four and five.

In 2017 Wirra Willa had a lighter crop which could be a biennial bearing pattern as a "left-over" from the heavy 2016 crop. Trees at this trial site look healthy except for 344 which many trees showing symptoms of Abnormal Vertical Growth (AVG).

The block has been rated for AVG by Pat O'Farrell, Chris Searle and Olufemi Akinsanmi over the past 4 years. These results are presented in Chapter 14.

In 2017 trees were harvested on March 27, March 15, July 3, August 15 and August 22.

In early November 2017 a storm severely damaged the block with some trees snapped at the trunk, many have limb and branch damage. This trial may not have useful results on yield or AVG for a number of seasons. .

Table 18 Wirra Willa top 5 rankings for kernel yield.

RVT Site	Yield Measure	Rank 5	Rank 4	Rank 3	Rank 2	Rank 1
Wirra Willa (WW)	2015 Kernel Yield	J	A447	T	F	816
	2016 Kernel Yield	T	E	F	J	P
	2017 Kernel Yield	T	A422	H	A16	F
	Cumulative Kernel Yield 2011 - 2017	A16	G	T	P	F

Wirra Willa Nut in Shell Yield

MIV1-P, A16 and variety are the consistent yielders at this site, even in a light year while MIV1-G,

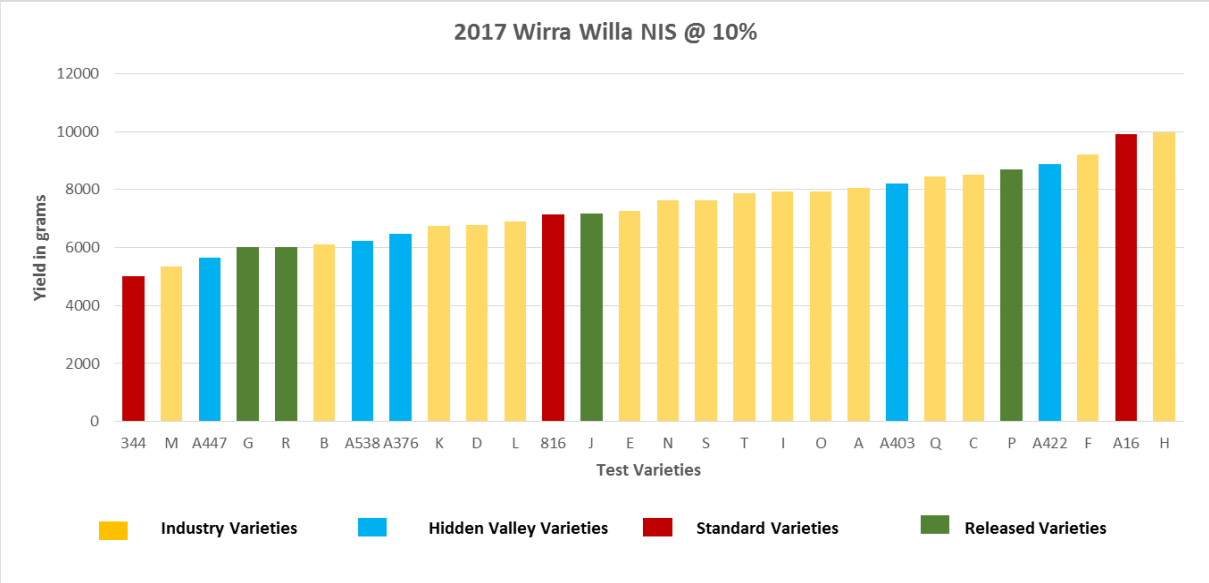


Figure 11-0-1 Wirra Willa 2017 NIS yield.

MIV1-J and 816 had lighter crops in 2017 (figure 11-1)

Wirra Willa Kernel Recovery 2015 - 2017

Table 19 Kernel recovery % 2015 - 2017.

Variety	KR 2015	KR 2016	KR 2017
A376	42.0		39.1
C	35.6	38.8	36.5
A403	38.9	41.5	40.7
Q	32.5	34.0	33.4
A422	39.8	42.6	41.2
J	41.6	46.3	43.5
B	35.2	37.9	34.1
A538	38.7	44.6	43.4
816	44.8	45.7	47.0
A16	40.6	45.0	43.8
F	46.6	47.5	47.3
I	37.3	39.1	37.0
T	41.8	44.5	46.1
G	40.3	41.4	40.1
A	32.1	33.6	33.2
K	35.1	33.6	35.6
E	36.7	40.4	38.3
M	35.0	38.0	36.4
S	34.0	37.3	36.2
O	37.5	39.6	41.3
P	39.8	41.5	36.9
A447	41.7	43.4	42.2
R	40.9	40.6	40.1
N	32.9	34.4	31.6
H	40.8	42.3	42.0
344	32.4	34.2	32.8
D	40.7	38.9	40.1
L	33.5	35.6	35.9

There are slight variations in kernel recovery from year to year but the variety rankings stay pretty similar. KR is a trait in macadamia that is highly genetic rather than environmentally influenced.

High KR ultimately influences kernel yield as figures 11-2 and 113 show. Variety F is a consistent high performer in all blocks due to its nut size, crop load and ultimately kernel recovery (figures 11-2, 11-3 and 11-4)

Wirra Willa Kernel Yield

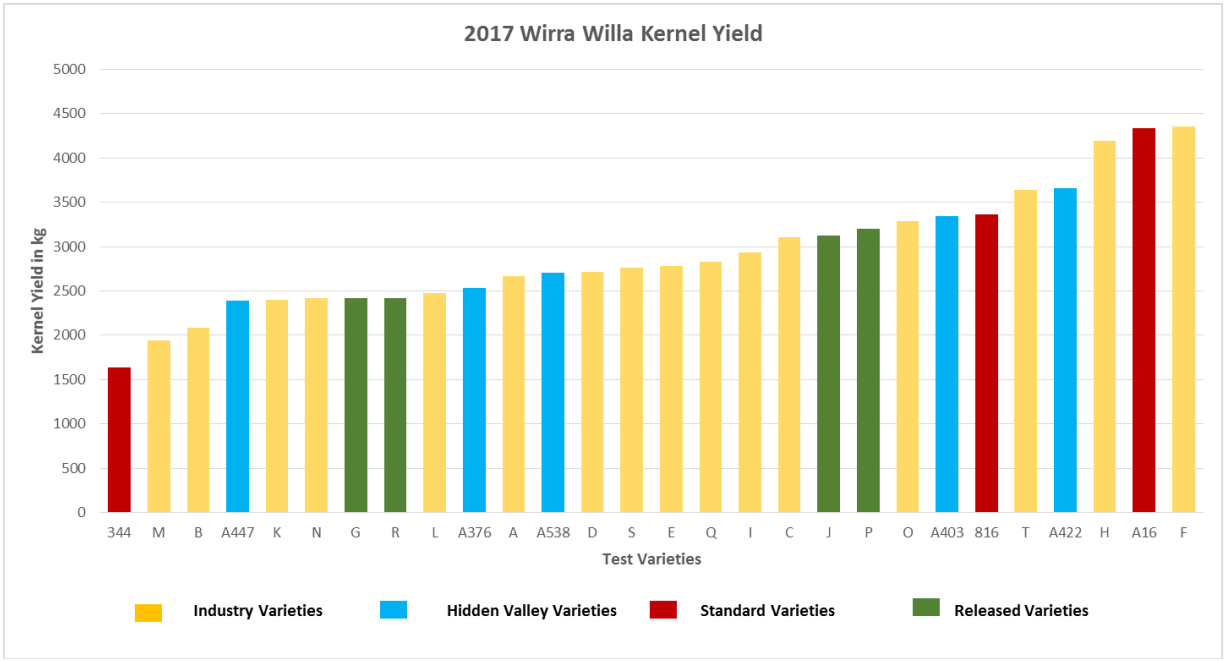


Figure 11-0-2 Wirra Willa 2017 kernel yield.

Wirra Willa Kernel KG per Hectare

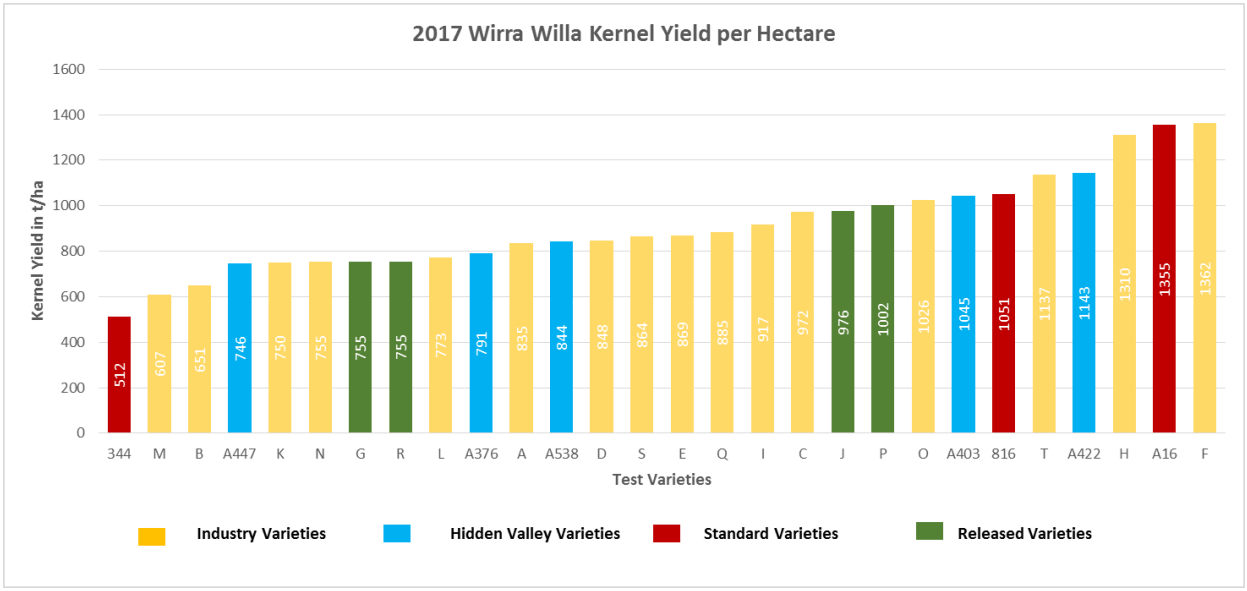


Figure 11-0-3 Wirra Willa kernel kg / ha 2017.

Wirra Willa Cumulative Kernel Yield 2012 – 2017

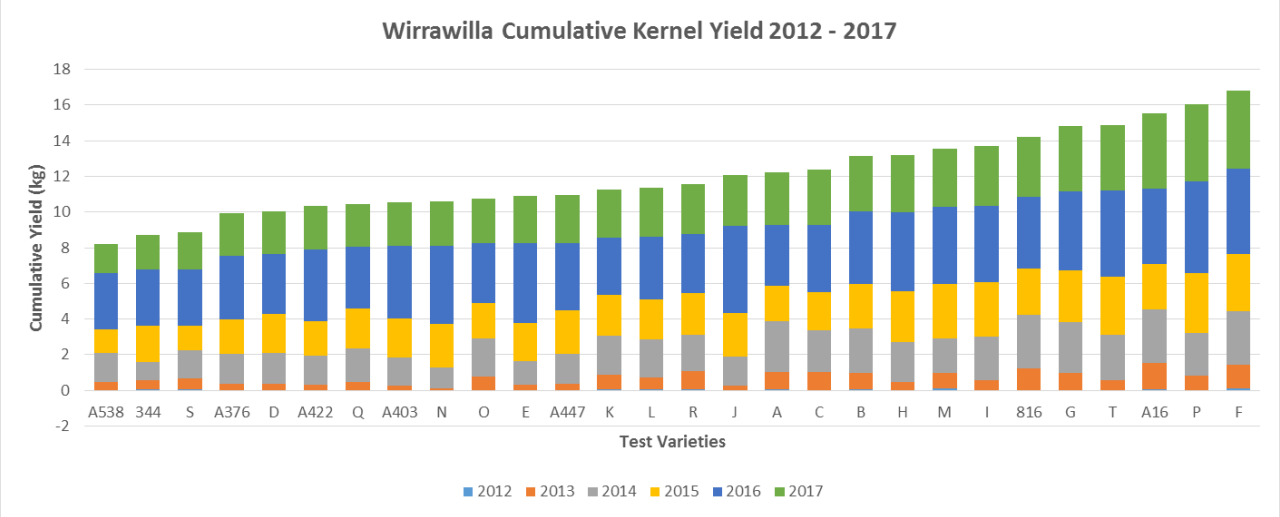


Figure 11-0-4 Wirra Willa cumulative kernel yield 2012 - 2017.

Wirra Willa Kernel Yield Efficiency

Significant Variety effect

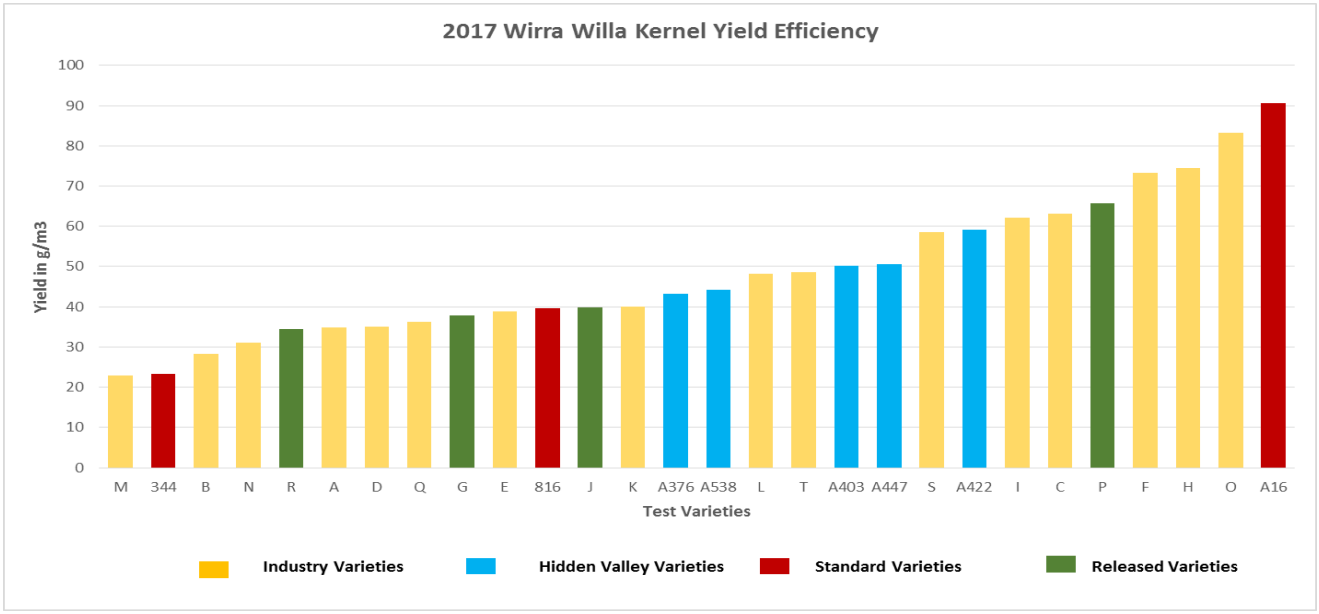


Figure 11-0-5 Wirra Willa kernel yield efficiency 2017.

Wirra Willa Tree Volume

Trees at Wirra Willa are the largest of the Bundaberg RVT sites (figure 11-6). Varieties N, 816 and 344 are tallest with the greatest volume but quite low canopy efficiency (m^3). The tree a nd row spacings here are 8 x 4m forming a dense, tall hedge. There was some side and top t rimming in 2016.

Significant variety effect in 2017

	gamma	component	std.error	z.ratio	constraint
Rep!Rep.var	0.01147202	4.5845898	8.59846506	0.5331870	Positive
ID!ID.var	0.23323190	93.2069693	51.31737374	1.8162849	Positive
R!variance	1.00000000	399.6321604	53.81218087	7.4264257	Positive
R!Col.cor	-0.10078861	-0.1007886	0.11356486	-0.8874983	Unconstrained
R!Row.cor	-0.16882705	-0.1688271	0.09410352	-1.7940568	Unconstrained

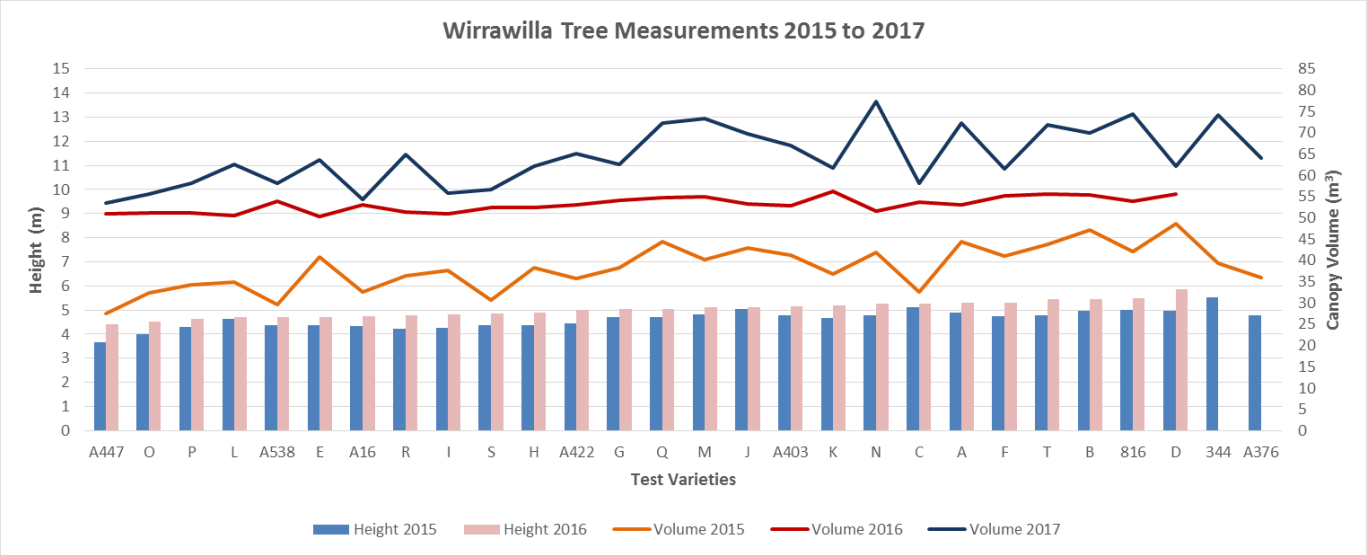


Figure 11-0-6 Wirra Willa tree measurements 2015 - 2017.

Wirra Willa Storm Damage 2017

Wirra Willa experienced a trial ending storm in November 2017 as seen in figures 11-7, 11-8 and 11-9 below. In the aftermath of the storm the block was rated for limb and trunk damage twice, in November and December. In December there was a clearer view of the final damage after the clean-up. Tree ratings (table 20) indicate that the AVG prone 344 was the most badly affected variety with A376, Daddow and MIV1-G not quite as damaged. Smaller, compact varieties such as MIV1-P and variety C, and more spreading varieties MIV1-J, I and F had much less damage.

Figure 11-0-7 Limb and branch breakage at Wirra Willa after the November 7th Storm.

Figure 11-8 Trees down and limbs broken after the November 7 storm at Wirra Willa.

Figure 11-9 After the clean-up, 2 344 trees snapped off at the trunk. Wirra Willa storm November 7, 2017.

Table 20 Wirra Willa mean tree damage ratings, 2017.

Variety	Nov-17 Damage Rating	Dec-17 Damage Ratings
816	2.0	1.8
842	1.5	1.3
344 (344/AVG)	2.0	2.0
344 (344/non-AVG)	3.0	3.0
344 (A16/AVG)	1.0	2.0
344 (A268/AVG)	3.0	4.5
344 (A268/non-AVG	3.0	4.0
344 (AVG)	1.8	2.6
344 (non-AVG)	1.8	2.1
A	2.8	2.8
A16	2.3	3.3
A268	1.3	1.7
A376	3.0	2.5
A4	0.8	1.3
A403	1.7	1.7
A422	1.0	1.5
A447	2.0	3.0
A538	1.0	1.8
B	2.0	2.3
C	0.3	0.7
D	2.5	3.5
Daddow	2.0	3.0
E	2.3	3.0
F	0.5	0.5
G	2.3	3.3
H	2.3	2.8
I	0.7	1.0
J	0.3	0.5
K	2.3	2.7
L	2.3	3.0
M	1.5	2.3
N	1.3	1.8
O	1.5	2.5
P	0.8	1.0
Q	1.8	2.3
R	2.5	3.3
S	1.0	1.0
T	2.0	3.0

Rating Scale Nov	
0	No damage
1	Basic
2	Branch
3	Trunk
4	Laying down

Rating Scale Dec	
0	No damage
1	Basic
2	Branch
3	Trunk < 1/2 tree damaged
4	Trunk > 1/2 tree damaged
5	Removed

Table 21 Wirra Willa summary variety performance traits.

Wirra Willa (WW) Regional Variety Trial Trait		NIS Yield Year 9 (grams)	2017 Kernel Recovery (KR) %	Kernel Yield (grams) Year 9	Cumulative Kernel Yield 2013 - 2017 (kg)	Kernel Canopy Efficiency (g/m3)	Tree Volume (m3)	Kernel kg/ha	Estimated Discounted Cash Flow (DCF)	% Whole Kernel	% Premium Kernel	% Commercial Kernel
Variety Code	**ID Number**											
A376	1	6469	42.0	2531	10.041	43.1	64.0	792	$105,370.11	44.0	95.0	3.3
C	2	8528	35.6	3110	12.367	63.1	58.1	974	$121,377.10	39.0	96.5	3.0
A403	3	8225	38.9	3346	11.456	50.1	67.1	1,047	$108,212.48	50.7	95.8	3.0
Q	4	8463	32.5	2831	10.857	36.3	72.4	886	$81,649.12	45.7	96.5	3.0
A422	5	8874	39.8	3659	11.544	59.1	65.2	1,145	$109,847.58	54.0	95.8	3.1
J	6	7185	41.6	3125	12.332	39.7	69.7	978	$134,701.76	21.4	95.4	2.9
B	7	6112	35.2	2082	12.058	28.3	69.9	652	$106,761.94	17.2	95.8	3.0
A538	8	6225	38.7	2701	9.224	44.2	58.1	845	$86,491.66	33.1	94.1	3.4
816	9	7150	44.8	3363	14.204	39.6	74.3	1,053	$118,476.32	33.1	96.5	3.0
A16	10	9904	40.6	4334	15.579	90.6	54.4	1,357	$141,508.59	30.6	94.7	3.1
F	11	9216	46.6	4359	16.699	73.2	61.6	1,364	$136,534.59	28.1	93.2	3.9
I	12	7936	37.3	2934	13.264	62.2	55.7	918	$128,423.06	49.9	95.6	3.3
T	13	7890	41.8	3639	14.854	48.6	71.9	1,139	$143,783.71	17.2	94.7	3.1
G	14	6023	40.3	2416	13.545	37.9	62.6	756	$134,323.17	19.8	96.0	2.9
A	15	8050	32.1	2671	11.917	34.9	72.3	836	$84,491.02	36.5	92.1	3.7
K	16	6743	35.1	2398	10.908	40.0	61.7	751	$84,386.71	49.9	94.8	3.5
E	17	7268	36.7	2782	11.021	38.8	63.6	871	$108,001.67	20.6	96.3	3.0
M	18	5342	35.0	1944	12.127	22.9	73.4	608	$133,877.44	21.5	96.5	3.0
S	19	7638	34.0	2763	9.518	58.6	56.7	865	$77,846.89	38.2	96.5	3.0
O	20	7951	37.5	3283	11.501	83.2	55.6	1,028	$97,563.02	38.1	91.4	4.2
P	21	8682	39.8	3206	14.891	65.8	58.0	1,004	$170,544.42	39.0	94.6	3.4
A447	22	5653	41.7	2388	10.632	50.6	53.5	747	$125,443.06	25.0	95.1	3.1
R	23	6024	40.9	2417	11.094	34.4	64.9	757	$97,180.20	47.3	93.3	3.8
N	24	7631	32.9	2415	10.528	31.1	77.4	756	$105,785.07	28.1	95.7	3.1
H	25	9981	40.8	4193	14.186	74.4	62.1	1,312	$126,682.71	30.6	92.9	3.8
344	26	4999	32.4	1638	8.349	23.3	74.2	513	$68,930.22	29.8	92.7	3.7
D	28	6768	40.7	2712	10.355	35.1	62.1	849	$74,332.14	29.7	96.5	3.0
L	30	6894	33.5	2475	11.014	48.1	62.6	775	$94,001.13	28.9	94.7	3.4

12. Alstonville (AL) – NSW DPI

The Alstonville RVT at the Centre for Tropical Fruit (CTH), Alstonville, was planted on the 25th of March 2008. The site is a red, volcanic Ferrosol, gently sloping to the east that overlooks the Ballina coastline. This is the most susceptible block to wind and storm damage of all RVT sites. A serious storm in 2011 downed approximately 6 trees that were subsequently replanted. From 2014 onwards there has been storm damage to a number of trees as in 2017 with either limb damage and more trees blown over (figure 12-1). These events are part of the natural cycle of weather in the Norther Rivers rather than catastrophic events as in some of the other RVT sites. The combination of red volcanic soil and high rainfall means that this block is dryland with no irrigation.

Figure 12-0-1 Alstonville storm damage 2017.

Rat damage has been an issue at the Alstonville RVT since 2014 when a high percentage of the crop was affected. In 2015 there was a significant increase on yield due in-part to rat monitoring and baiting by the NSW DPI with a 3 to 5 fold increased NIS yield on some varieties. Trees at the site averaged 9.82kg NIS in 2015, 7.84kg in 2016 and 11.4kg in 2017. Yield reductions in 2016 were noticed around the north coast region and corresponded with other trials at the CTH. These reduced yields could have been compounded by biennial bearing effect from the large 2015 crop. Alstonville is up to 4 weeks behind Bundaberg in some years. In 2017 the site was harvested on April 26, June 5, July 26 and September 4 for harvests four and five. Damage was minimal in 2017.

The standard varieties (741, A16, 344, 816 and 246) were poorly ranked for NIS in 2017 (figure 12-2) however the high kernel recovery of 816 moved it into the top 10 for kernel yield (figure 12-3). Seven varieties produced over 1.5t/ha or kernel at Alstonville in 2017 with F estimated to produce nearly 2 t/ha. Variety F seems to the most consistent kernel yield producer however with such a heavy stick-tight problem it would be unsuitable for this region. Variety F had the highest cumulative kernel yield from 2013 to 2017 with two other industry varieties MIV1-G and MIV1-R very consistent over time (table 22 and figures 12-3 and 12-4). Alstonville was the most productive site in 2017 with 1.8t NIS harvested from 166 trees.

Phenotyping of AL samples indicates 57-12 (11), 60-18 (15), 60-16 (17), 62-18 (16), 64-16 (28) and possibly 56-2 (7) are potential map errors.

Table 22 Alstonville top 5 varieties 2015 - 2017.

RVT Site	Yield Measure	Rank 5	Rank 4	Rank 3	Rank 2	Rank 1
Alstonville (AL)	2015 Kernel Yield	R	O	E	A447	A538
	2016 Kernel Yield	A403	K	816	G	F
	2017 Kernel Yield	L	Q	J	G	F
	Cumulative Kernel Yield 2013 - 2017	A538	R	G	816	F

Alstonville 2017 Nut in Shell Yield.

In 2016 initial fixed effects analysis shows no significant Rootstock effect or Rootstock x Variety interaction. There was a significant Variety effect for NIS yield.

Below (figure 12-2) are the 2017 NIS yields for the 30 varieties averaged over the two rootstocks.

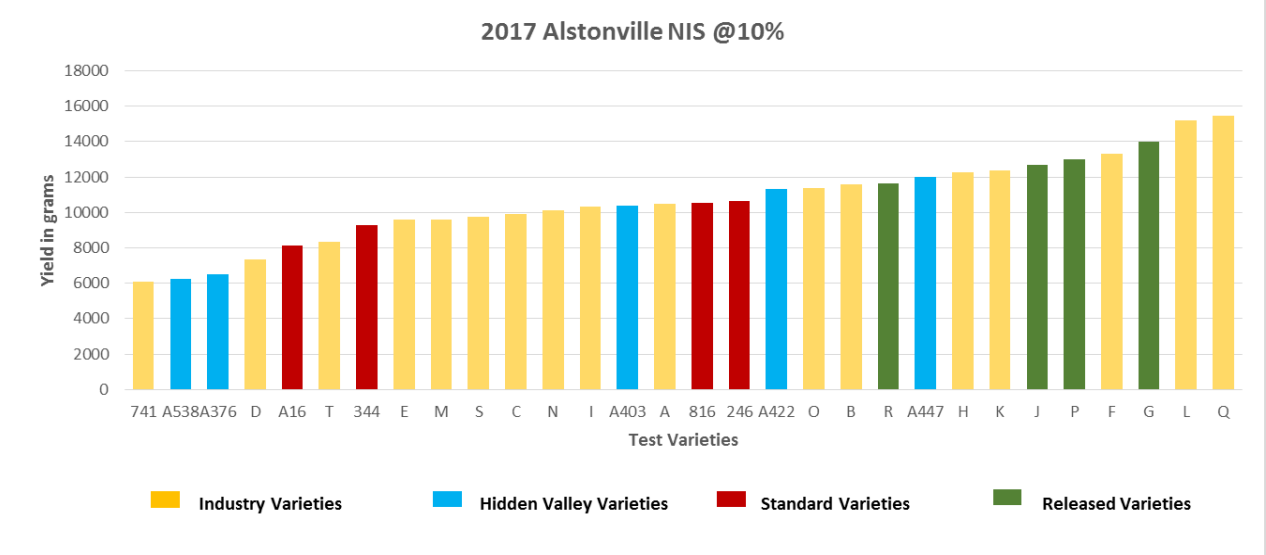


Figure 12-0-2 Alstonville NIS yield 2017.

Alstonville Kernel Recovery 2015 – 17

Table 23 Alstonville kernel recovery 2015 - 2017.

Variety	2015 KR	2016 KR	2017 KR
A376	45.4	44.2	45.8
C	36.3	32.5	37.4
A403	44.3	42.1	42.6
Q	34.5	32.0	35.4
A422	40.5	38.6	39.7
J	42.4	42.3	43.3
B	36.4	35.1	35.7
A538	44.2	41.5	41.5
816	46.5	45.7	47.6
A16	40.9	39.2	36.3
F	45.7	48.8	46.9
I	34.1	31.8	32.2
T	40.4	37.4	41.3
G	43.1	40.3	41.8
A	33.6	31.6	32.8
K	32.9	34.1	34.4
E	38.4	36.5	33.6
M	37.2	33.4	36.2
S	32.9	32.9	35.5
O	36.1	36.8	37.7

P	37.4	33.9	36.1
A447	43.7	39.8	40.3
R	38.8	36.9	38.2
N	31.5	31.2	31.5
H	36.1	36.0	38.7
344	34.4	33.6	35.0
741	35.0	37.9	38.5
D	35.9	35.3	36.1
246	40.3	37.8	37.5
L	34.7	33.5	34.4

Alstonville Shell Diameter and Thickness – Craig Maddox, March, 2017

NSW DPI measured diameter and shell thickness on 30 nut samples from each of the varieties in 2017 (table 24). There is a strong correlation of 0.874 between thickness and KR which is to be expected.

Table 24 Alstonville nut measurements 2017.

Variety	CTH NSW RVT v code	trees	ave mm diameter	sd D mm	ave mm thckness	sd T mm	2017 KR
A376	1	5	24.0	0.7	1.7	0.2	45.82367
C	2	4	23.7	0.4	2.2	0.1	37.35863
A403	3	7	23.1	1.6	1.7	0.2	42.55122
Q	4	4	24.4	1.1	2.3	0.2	35.39146
A422	5	5	24.3	0.9	1.9	0.1	39.70715
J	6	4	27.3	1.0	1.8	0.0	43.27232
B	7	5	24.5	0.6	2.0	0.2	35.70023
A538	8	5	23.9	0.8	1.7	0.1	41.46885
816	9	6	25.7	0.5	1.7	0.3	47.60219
A16	10	4	25.3	0.5	2.0	0.1	36.25843
F	11	6	23.9	0.6	1.4	0.3	46.91517
I	12	4	25.2	0.8	2.1	0.3	32.18915
T	13	3	24.1	0.4	1.7	0.1	41.30265
G	14	7	25.1	0.8	1.9	0.1	41.79022
A	15	8	24.8	0.7	2.5	0.1	32.77445
K	16	5	24.1	0.5	2.1	0.4	34.44115
E	17	7	27.2	1.1	2.2	0.4	33.59419
M	18	6	25.7	0.8	2.3	0.1	36.205
S	19	5	25.6	1.4	2.1	0.3	35.50138
O	20	6	27.6	1.3	2.2	0.2	37.6925
P	21	5	25.3	0.2	2.2	0.3	36.14968
A447	22	5	25.1	0.5	1.8	0.2	40.30713
R	23	5	25.3	0.6	2.1	0.2	38.20087
N	24	7	25.6	0.5	2.4	0.1	31.50025
H	25	6	23.9	1.8	2.0	0.1	38.74153
344	26	4	24.1	0.8	2.2	0.1	34.95353
741	27	6	23.2	0.5	1.9	0.2	38.5016
D	28	4	25.6	1.2	2.1	0.2	36.08976
246	29	5	24.0	0.5	1.9	0.1	37.45548
L	30	6	24.4	0.6	2.2	0.1	34.41059

Alstonville Kernel Yield 2017.

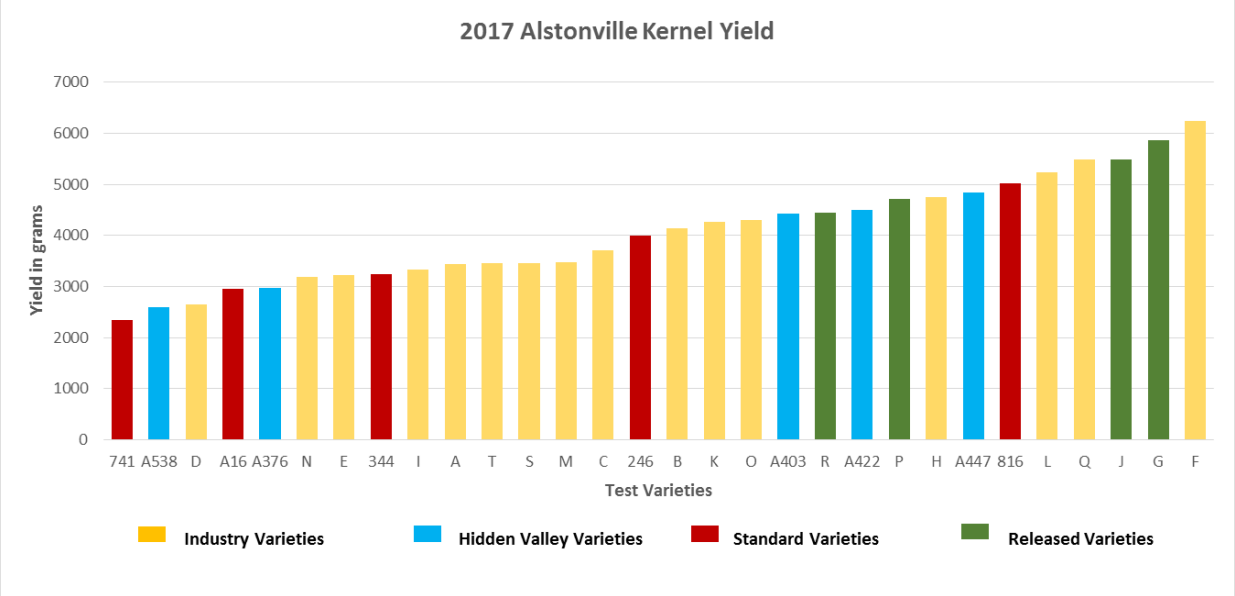


Figure 12-0-3 Alstonville 2017 kernel yield.

Kernel Tonnes per Hectare

(NIS x KR) x 312.5 trees per ha.

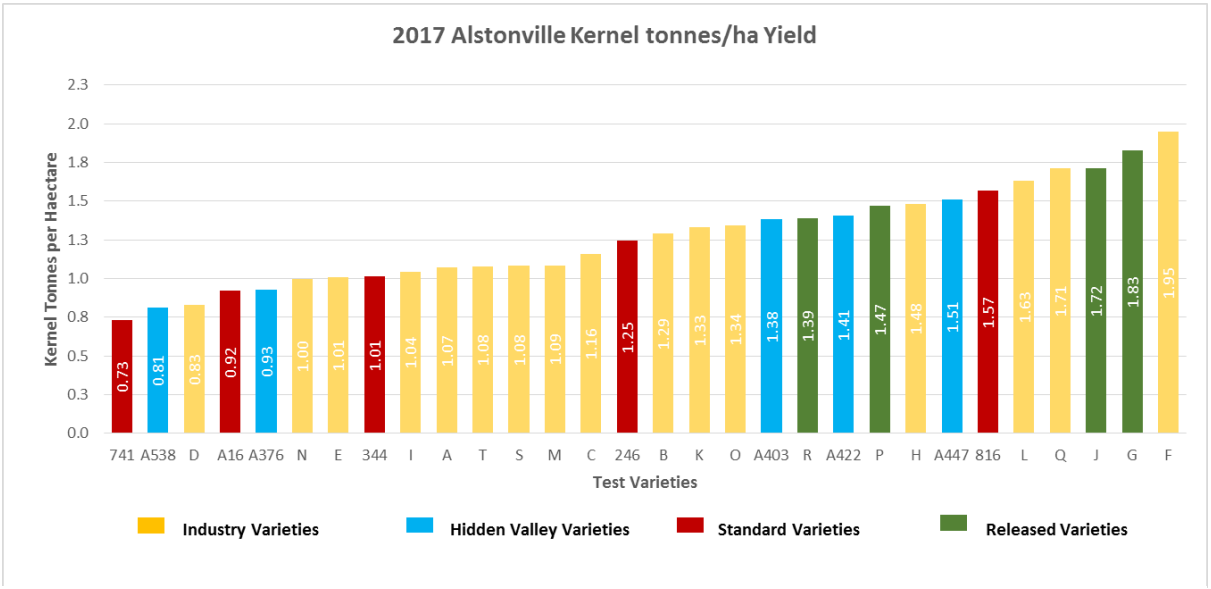


Figure 12-0-4 Alstonville 2017 kernel t/ha.

Alstonville Nut Drop Pattern

MIV-1-P is the latest dropping variety at the Alstonville site while 344, A376 and variety I were the earliest(figure 12-5). This ranking of nut drop is pretty consistent with the other RVT sites in QLD and NSW.

Genetic correlations between harvest times in 2017.

	1	2	3	4	5
1	1.000	-0.963	-0.040	0.585	0.965
2	-0.963	1.000	-0.231	-0.781	-1.000
3	-0.040	-0.231	1.000	0.787	0.223
4	0.585	-0.781	0.787	1.000	0.777
5	0.965	-1.000	0.223	0.777	1.000

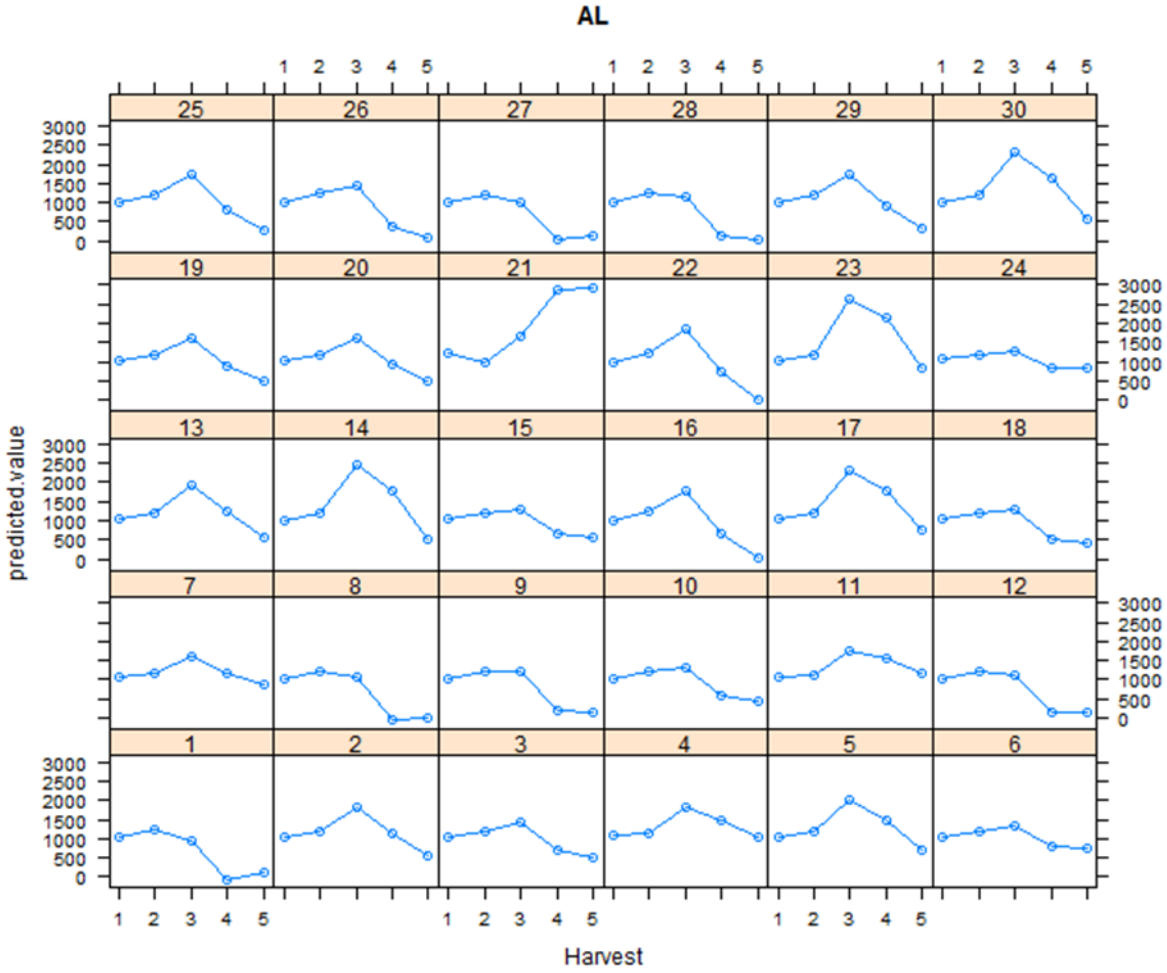


Figure 12-0-5 Alstonville nut drop pattern 2017.

Alstonville Cumulative Kernel Yield

Variety F had the highest cumulative kernel yield from 2013 – 2017, ahead of 816 MIV1-G, MiV1- R and A358 (figure 12-6). MIV1-G and MIV1-R were specifically selected through the economic weights process because of their suitability to the Northern Rivers. G and R also performed well at the Dorey supplementary trial at Newrybar in 2017 that also helped to reinforce this selection.

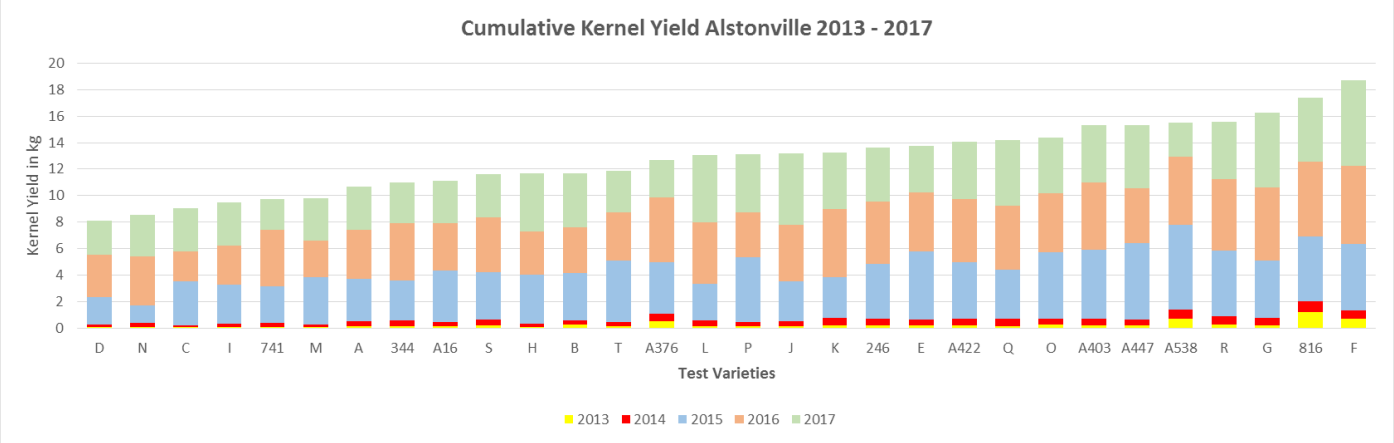


Figure 12-0-6 Alstonville cumulative kernel yield 2013 - 2017.

Figure 12-0-7 Alstonville harvest 2017. Each tree has an individual bag that is weighed, sampled, dehusked and stored for kernel assessment. 1.832 tonnes NIS were harvested in 2017.

Alstonville Kernel Yield Efficiency

Significant Variety effect but no significant Rootstock effect in 2017.

It is interesting to note that wield efficiency is just confined to the smaller trees. Variety MIV1-G had the best canopy efficiency even though it is a larger tree (figures 12-8 and 12-10).

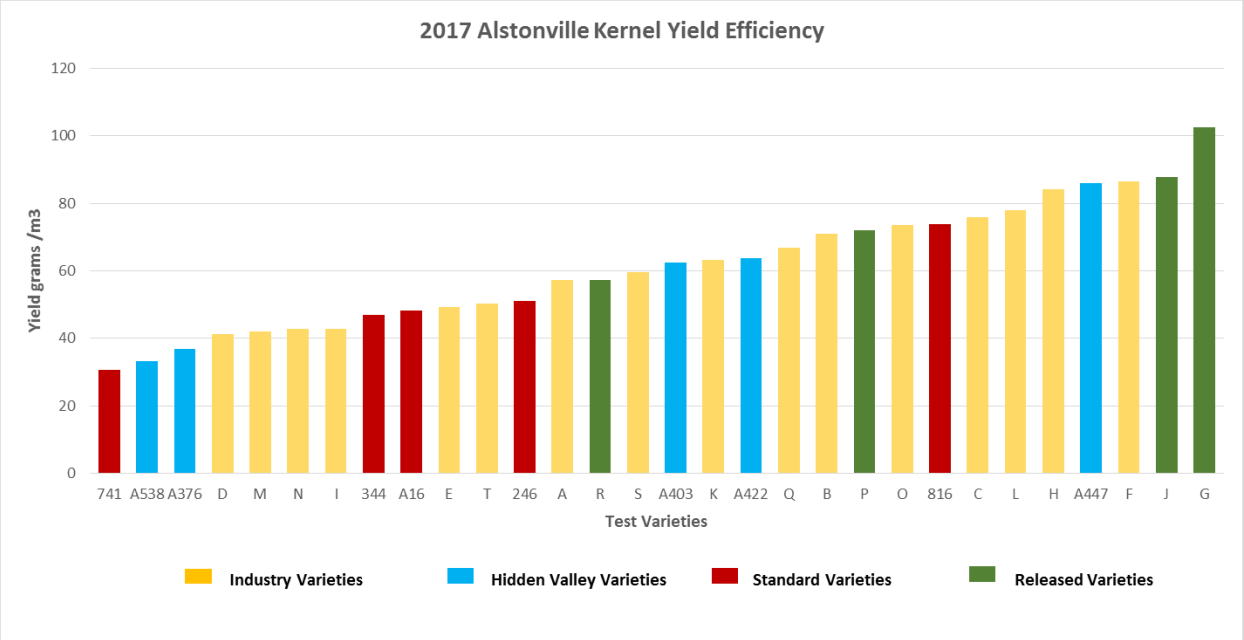


Figure 12-0-8 Alstonville kernel yield efficiency.

In 2015 there were some interesting characteristics noted in the new varieties that could change orthodox thinking in future orchards. Indications are that some varieties are high yielding, compact trees with small canopy. These trees stand out and are easily noticed in the orchard row, even at 7 years of age. Orchards of the future will be high yielding small trees at closer spacings

Lindsay Bryen and Kevin Quinlan made a comment on tree size in 2018 observing that

“Variety C is a selection of interest and attracted our attention. C is one of the smallest trees at the Alstonville site and all other RVTs except Bundy sugar. It produces a lot of NIS per canopy volume. Low TKR possible in the 35% category – Alstonville has a range that is not explained. Possibly suitable for closer plantings and the NIS trade. Worth some further investigation”.

Alstonville Tree Volume

Significant Variety effect but no significant Rootstock effect.

```
$Wald
             Df denDF     F.inc            Pr
(Intercept)   1   5.5 792.10000 3.500042e-07
Rootstock     1   5.9   0.02221 8.864680e-01
```

Figure 12-0-9 Alstonville tree measurements 2017.

Trees at the Alstonville RVT are the tallest of all sites averaging around 5.5m for 9 years of age. Alstonville also has the largest volume of all sites with the largest trees over 70m^3.

Biometrician's comments

"Canopy volume in 2016 had no significant overall Rootstock effect however there is a close to significant Rootstock x Variety interaction (P=0.055). The genetic correlation between Rootstocks = 0.44 (not high) and the genetic variance for Beaumont is much lower (18.9) than for H2 rootstock (79.6).

Tree height had no significant Rootstock or Rootstock x Variety interaction however there was a significant variety effect."

Figure 12-10 below shows final predictions averaged for two rootstocks. Varieties are ordered by 2016 height.

Table 25 summarises performance for 2017 characteristics and cumulative yield for Alstonville RVT. Included are 20 year Discounted Cash Flows based on at least 4 years of RVT data.

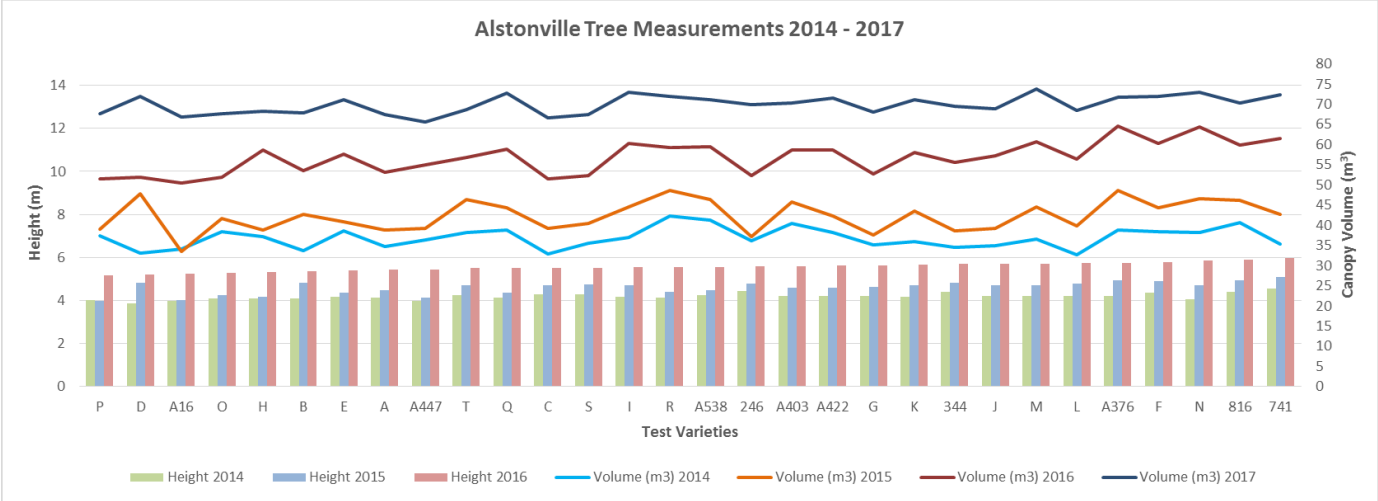


Figure 12-0-10 Alstonville tree volume 2014 - 2017.

Table 25 Alstonville summary variety performance traits.

Alstonville (AL) Regional Variety Trial Trait		NIS Yield Year 9 (grams)	Kernel Recovery (KR) %	Kernel Yield (grams) Year 9	Cumulative Kernel Yield 2013 - 2017 (kg)	Kernel Canopy Efficiency (g/m3)	Tree Volume (m3)	Kernel kg/ha	Estimated Discounted Cash Flow (DCF20)	% Whole Kernel	% Premium Kernel	% Commercial Kernel	% Reject Kernel
Variety Code	**ID Number**												
A376	1	6,480	45.8	2970	12.807	37.0	71.7	928	**$131,047.57**	32.5	94.7	2.8	2.6
C	2	9,935	37.4	3712	9.506	76.0	66.6	1,160	**$67,910.99**	43.2	94.6	2.7	3.0
A403	3	10,403	42.6	4427	15.389	62.5	70.4	1,383	**$151,635.60**	40.0	94.3	3.6	0.7
Q	4	15,478	35.4	5478	14.692	66.8	72.7	1,712	**$115,495.11**	56.0	93.0	4.7	1.4
A422	5	11,334	39.7	4500	14.206	63.8	71.5	1,406	**$141,125.90**	50.6	95.4	2.9	0.7
J	6	12,684	43.3	5488	13.283	87.7	68.9	1,715	**$114,324.37**	26.4	92.8	3.2	4.4
B	7	11,587	35.7	4137	11.755	71.0	67.9	1,293	**$94,254.21**	27.2	91.3	4.3	4.6
A538	8	6,265	41.5	2598	15.512	33.1	71.2	812	**$177,740.58**	27.3	93.0	3.8	3.3
816	9	10,539	47.6	5017	17.576	73.8	70.2	1,568	**$167,943.39**	45.3	92.3	3.4	6.9
A16	10	8,130	36.3	2948	10.885	48.4	66.8	921	**$110,930.91**	36.6	93.1	4.0	2.2
F	11	13,289	46.9	6234	18.474	86.6	71.9	1,948	**$178,055.72**	33.9	91.6	5.2	2.6
I	12	10,353	32.2	3333	9.550	42.9	72.9	1,041	**$74,346.72**	52.6	87.3	4.5	14.8
T	13	8,353	41.3	3450	12.180	50.2	68.7	1,078	**$117,813.54**	37.7	94.2	3.2	2.3
G	14	14,010	41.8	5855	16.458	102.5	68.0	1,830	**$169,773.31**	31.4	94.9	2.8	2.2
A	15	10,480	32.8	3435	10.833	57.2	67.5	1,073	**$92,897.42**	45.8	91.0	4.9	4.3
K	16	12,384	34.4	4265	13.268	63.2	71.0	1,333	**$119,132.93**	46.4	95.9	2.3	1.7
E	17	9,591	33.6	3222	13.445	49.3	71.1	1,007	**$124,156.73**	23.4	93.5	3.7	2.4
M	18	9,596	36.2	3474	10.080	42.1	73.7	1,086	**$75,234.78**	33.9	92.6	2.9	7.7
S	19	9,740	35.5	3458	11.840	59.5	67.4	1,081	**$97,937.10**	32.5	93.8	3.3	2.7
O	20	11,393	37.7	4294	14.482	73.6	67.7	1,342	**$141,711.75**	33.1	93.8	3.0	4.4
P	21	13,017	36.1	4706	13.441	71.9	67.7	1,470	**$118,367.13**	41.1	92.4	4.5	2.8
A447	22	12,006	40.3	4839	15.400	86.1	65.5	1,512	**$158,294.97**	27.6	93.9	3.5	1.7
R	23	11,616	38.2	4437	15.693	57.3	71.9	1,387	**$146,586.98**	44.0	93.9	3.0	3.6
N	24	10,135	31.5	3192	8.563	42.8	72.9	998	**$50,104.48**	37.3	95.4	2.9	0.7
H	25	12,258	38.7	4749	12.007	84.3	68.3	1,484	**$93,413.80**	26.3	94.9	2.6	2.6
344	26	9,264	35.0	3238	11.142	46.9	69.5	1,012	**$110,727.27**	33.1	93.8	3.7	1.4
741	27	6,077	38.5	2340	9.752	30.7	72.3	731	**$95,356.23**	23.4	95.1	3.1	0.7
D	28	7,337	36.1	2648	8.170	41.1	71.9	827	**$63,343.33**	23.8	94.5	3.0	2.3
246	29	10,647	37.5	3988	13.562	51.2	70.0	1,246	**$143,597.35**	35.2	92.3	4.7	3.2
L	30	15,190	34.4	5227	13.213	78.0	68.5	1,633	**$108,822.62**	32.0	93.0	4.6	1.7

13. Macksville (MV) – Dymock's Farms, Chris Cook

Macksville RVT was planted on 4th of November 2008. It is a cool, frosty site in winter and has recorded a -5.5 frost in July, 2018 (figure 13-2). The late planting date and the cool site has set this block back at least 2 years compared to Alstonville and Bundaberg regions. The Macksville RVT is situated at Eungai Creek approximately 21km south of Macksville. This RVT site is facing south and down slope in a high rainfall belt, in excess of 1200mm a year requiring no irrigation. At the bottom of the slope some trees have died due to wet soil conditions while quite a few are infected with Phytophthora cinnamomi (canker). Canker is an issue at this site especially away from the top of the slope (figure 13-1). Trees at the western part of the trial, rows 90 – 93, have been slow growing and late to crop however there were some good harvests in 2017 and 2018 and the trees are picking up.

Figure 13-0-2 Macksville RVT on a frosty morning, 2018.

Figure 13-0-1 Macksville trunk canker.

2017 was a wet season at the Macksville site with trees growing well at the top of the ridge with other still dying at the bottom of the slope. Trees at the top north-east corner are the strongest, row 85-1 to 5; 86- 1 to 5; 87-1 to 5 and 88- 1 to 5. Power lines also go over these very trees.

Macksville was harvested three times in 2017, May 29, August 2 and August 3 for harvest 3. This block is considerably later than Bundaberg and even 2 weeks later than Alstonville, consequently harvest three is usually heavy requiring most trees to have remaining nuts stripped out (figure 13-5).

2017 Harvest was still light in comparison to the other RVT sites with variety H, the heaviest NIS, only recording 3.6kg figure 13-3). Kernel recovery (table 27) has rearranged the NIS yield rankings significantly (figure 13-3) with variety H number one followed by three A Series HVP varieties A403, A376 and A538, variety F at number five

Table 26 Macksville top 5 varieties 2015 - 2017.

RVT Site	Yield Measure	Rank 5	Rank 4	Rank 3	Rank 2	Rank 1
Macksville (MV)	2015 Kernel Yield	A422	A376	L	I	K
	2016 Kernel Yield	H	F	344	I	A403
	2017 Kernel Yield	F	A538	A376	A403	H
	Cumulative Kernel Yield 2013 - 2017	A422	H	I	K	A403

Macksville NIS yield 2017

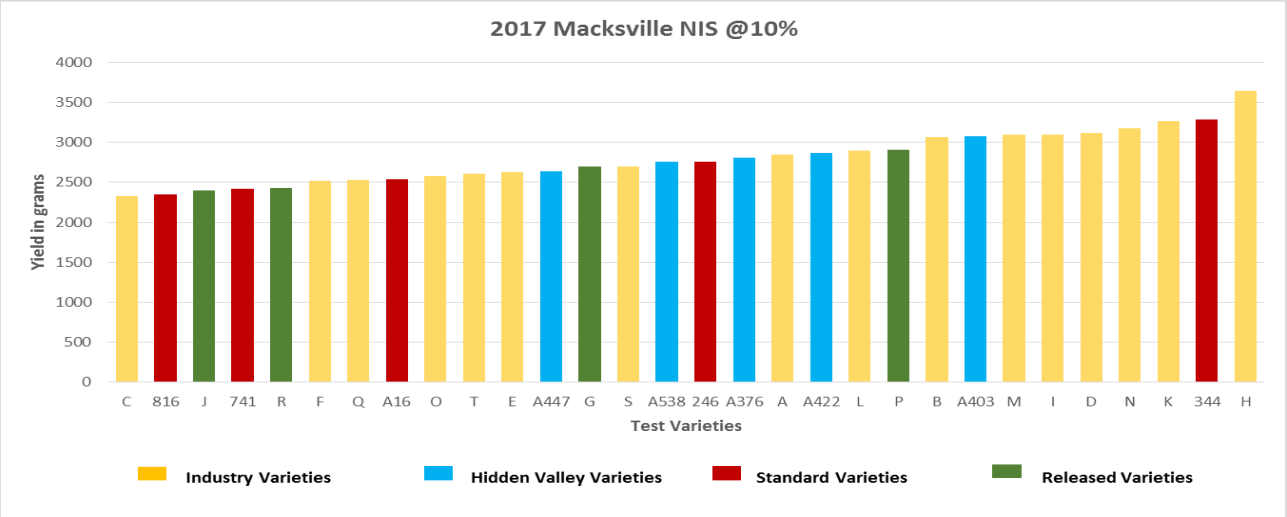


Figure 13-0-3 Macksville NIS yield 2017.

Macksville Kernel Recovery

Table 27 Macksville kernel recovery 2017.

Variety	KR 2016	KR 2017
A376	39.8	43.4
C	35.9	35.4
A403	42.5	41.5
Q	34.0	36.6
A422	41.2	39.3
J	39.7	40.6
B	33.9	34.7
A538	42.6	44.1
816	41.9	43.4
A16	38.2	39.3
F	45.0	47.5
I	36.6	35.5
T	39.3	38.9
G	40.7	41.9
A	33.4	31.8
K	34.2	33.1
E	36.2	36.0
M	36.1	33.4
S	32.9	32.8
O	34.5	36.2
P	37.3	37.3
A447	37.5	39.4

R	37.5	38.2
N	33.3	31.9
H	38.7	38.3
344	34.4	34.4
741	35.5	35.0
D	37.0	38.1
246	35.2	34.4
L	34.7	32.2

Macksville Kernel Yield

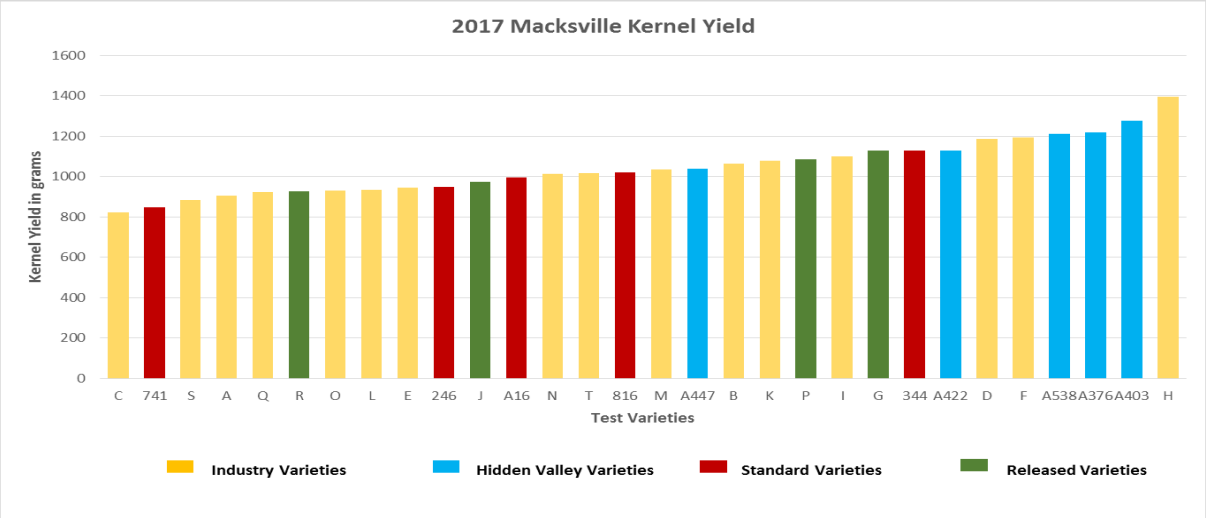


Figure 13-0-4 Macksville kernel yield 2017.

Macksville Nut Drop Pattern

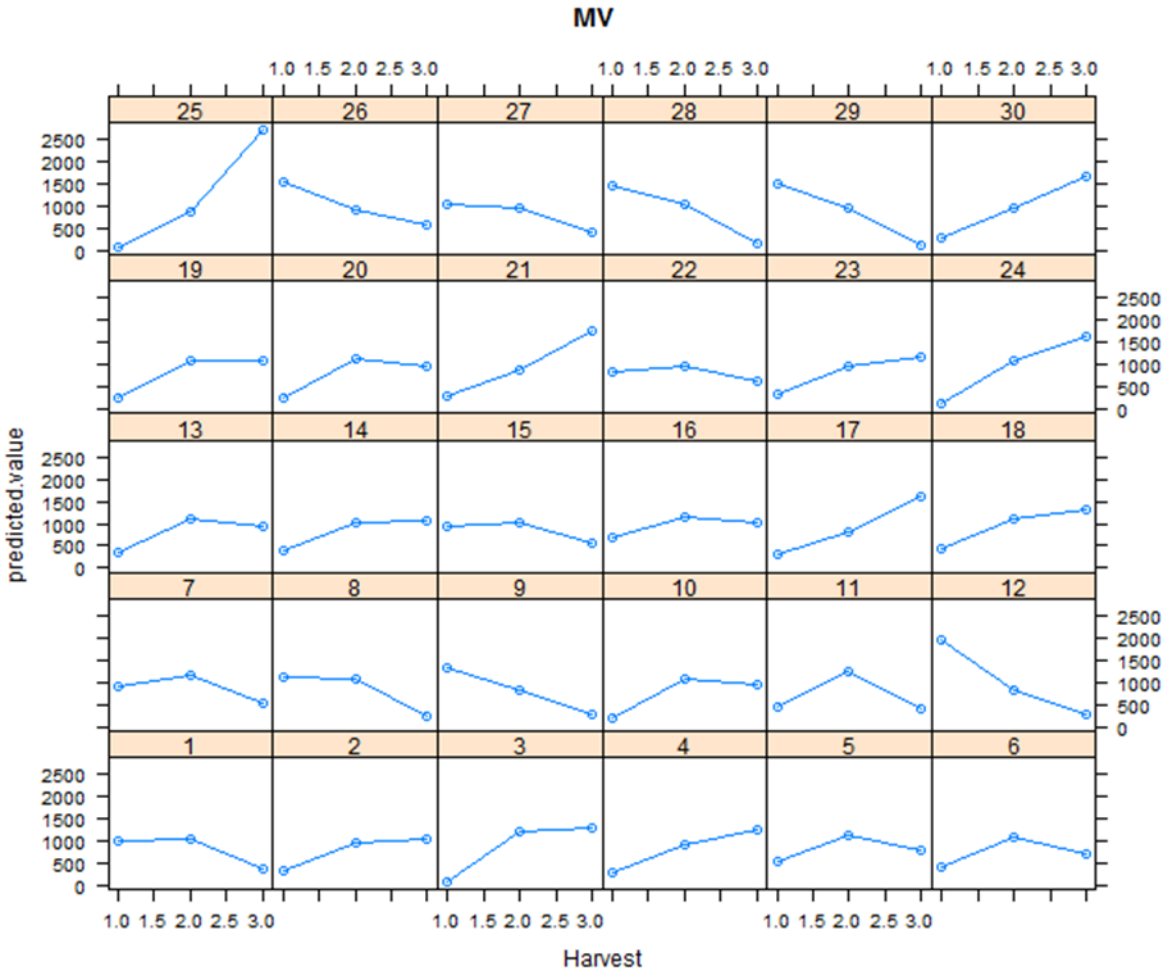


Figure 13-0-5 Macksville nut drop pattern 2017.

Macksville Cumulative Kernel Yield

Over five years A403 has the most consistent kernel yield with K a close second (figure 13-6). Variety H had the highest kernel yield in 2017. Variety H has had this pattern in other RVT blocks at a similar stage of production. In the first 2 main fruiting years H is a high performer but steadily drops off. A sprinter, not a stayer. It will be interesting to see if this pattern continues.

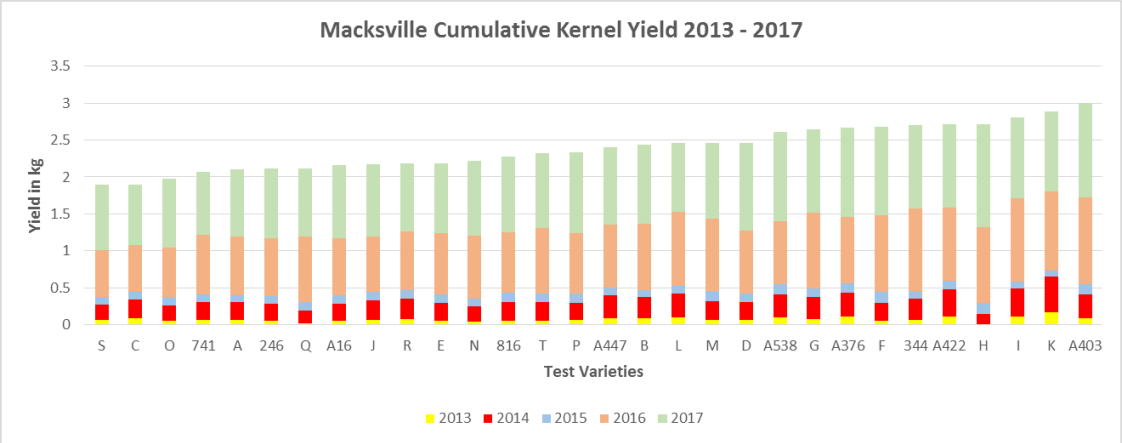


Figure 13-0-6 Macksville cumulative kernel yield 2013 - 2017.

Macksville Kernel Yield KG per Hectare

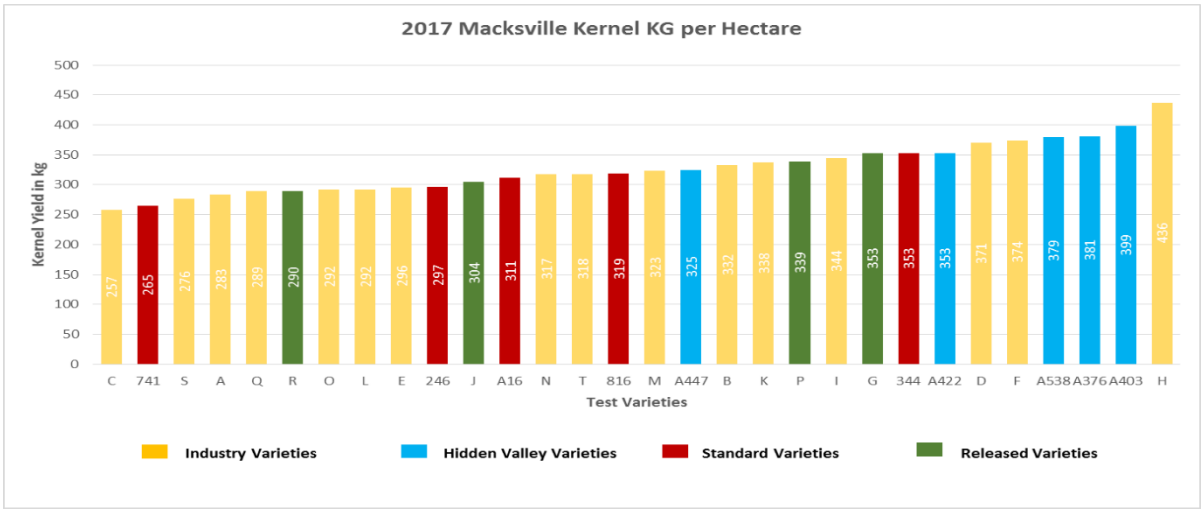


Figure 13-0-7 Macksville Kernel kg/ha.

Figure 13-0-8 Macksville harvest 2017.

Macksville Tree Volume

No significant Variety effect in 2017 but a significant variety effect in 2016. Below are 2017 analysis.

	gamma	component	std.error	z.ratio	constraint
Rep!Rep.var	0.04688343	3.1159797	4.80325521	0.6487225	Positive
ID!ID.var	0.06645476	4.4167355	3.66051703	1.2065879	Positive
R!variance	1.00000000	66.4622870	8.27115329	8.0354317	Positive
R!Col.cor	0.16347551	0.1634755	0.09146791	1.7872444	Unconstrained
R!Row.cor	0.30049500	0.3004950	0.07883755	3.8115719	Unconstrained

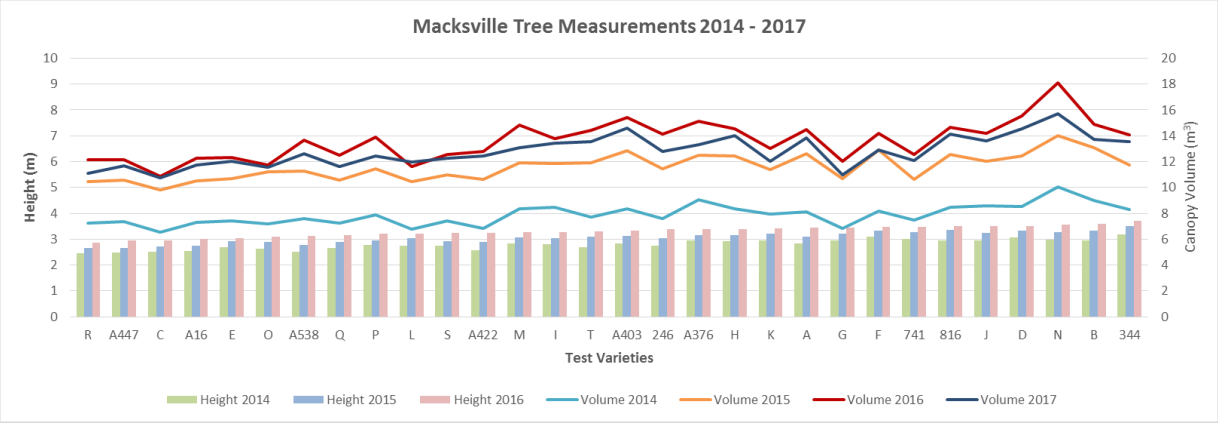


Figure 13-0-9 Macksville tree measurements 2014 - 2017.

Table 28 Macksville summary performance traits.

Macksville (MV) Regional Variety Trial Trait		NIS Yield Year 9 (grams)	Kernel Recovery (KR) %	Kernel Yield (grams) Year 9	Cumulative Kernel Yield 2011 - 2017 (kg)	Kernel Canopy Efficiency (g/m3)	Tree Volume (m3)	Kernel kg/ha	% Whole Kernel
Variety Code	ID Number								
A376	1	2,807	43.4	1218	2.672	215.0	13.3	381	38.4
C	2	2,328	35.4	823	1.897	195.8	10.7	258	41.6
A403	3	3,071	41.5	1276	2.999	188.4	14.6	399	40.3
Q	4	2,528	36.6	926	2.120	205.3	11.6	290	38.8
A422	5	2,870	39.3	1129	2.714	277.9	12.4	354	43.9
J	6	2,397	40.6	974	2.171	128.6	13.6	305	34.9
B	7	3,068	34.7	1064	2.433	227.3	13.7	333	34.9
A538	8	2,753	44.1	1213	2.609	203.1	12.6	380	37.1
816	9	2,352	43.4	1021	2.276	142.9	14.1	319	36.3
A16	10	2,538	39.3	996	2.161	223.5	11.8	312	39.4
F	11	2,517	47.5	1196	2.681	175.4	12.9	374	37.2
I	12	3,100	35.5	1101	2.807	242.4	13.4	345	40.7
T	13	2,612	38.9	1017	2.327	208.0	13.5	318	37.4
G	14	2,694	41.9	1128	2.649	245.4	11.0	353	37.4
A	15	2,846	31.8	906	2.098	205.9	13.8	284	37.6
K	16	3,262	33.1	1080	2.884	363.9	12.0	338	42.2
E	17	2,624	36.0	946	2.189	232.4	12.0	296	37.3
M	18	3,094	33.4	1035	2.465	254.4	13.1	324	40.9
S	19	2,700	32.8	885	1.891	259.9	12.3	277	38.4
O	20	2,574	36.2	933	1.973	247.9	11.6	292	40.6
P	21	2,911	37.3	1085	2.329	250.5	12.4	340	43.2
A447	22	2,637	39.4	1039	2.397	325.8	11.7	325	35.4
R	23	2,431	38.2	928	2.184	218.5	11.1	290	41.1
N	24	3,179	31.9	1015	2.224	219.6	15.7	318	37.2
H	25	3,648	38.3	1397	2.720	258.8	14.0	437	37.2
344	26	3,281	34.4	1129	2.707	254.0	13.5	353	39.0
741	27	2,421	35.0	847	2.067	159.9	12.1	265	33.1
D	28	3,112	38.1	1186	2.465	183.9	14.6	371	34.0
246	29	2,759	34.4	950	2.118	226.9	12.8	297	38.6
L	30	2,897	32.2	934	2.457	307.1	12.0	292	41.8

14. Supplementary Grower Evaluation

Remaining trees after the planting of the trial sites were offered to growers for mass planting and local evaluation. Five growers took up this option with 2 growers in Bundaberg (MFM and Alloway), two growers in the Northern Rivers (Tregeagle managed by Steve McLean and Dorey's at Newrybar) and in Mackay near the RVT. Variety C is the only variety missing from the grower supplementary plantings.

At the end of season's 2014. 2015 and 2016 the growers met and discussed results from their properties as well as being updated on the RVT results for the year.

Each season the growers were asked to fill in rating charts and return to DAF. Huskspot was rated from 0 – 5 as per table (29) and recorded on table (30). Table (30) records important traits of estimated yield, husk spot, canker, stick tights, tree habit, canopy density explains the rating

Table 29 Supplementary grower Husk Spot rating scale.

Husk Spot Rating Scale			
Rating	**Lesions**	**Immature Nut Drop**	**Description**
0	0	0	No husk spot symptoms on the tree and no husk spot lesion on nuts on the ground
1	✓	0	Few, about 1 in 10 nuts on tree with husk spot, no nuts with husk spot on the ground
2	✓	✓	1 in 10 nuts on tree with symptoms and few nuts on ground have lesions
3	✓✓	✓	2 in 10 nuts on tree with symptoms and few nuts on ground have lesions
4	✓✓✓	✓✓	nearly all nuts on tree with husk spot and moderate nut drop with husk spot
5	✓✓✓	✓✓✓	nearly all nuts on tree with husk spot and heavy nut drop with husk spot

Supplementary grower trials are an important addition to regional variety trial data collection as growers candidly comment on performance from experience. Secondly, RVT harvests strip trees completely of nuts for total yield results that doesn't allow for the evaluation of stick tights remaining in the trees and ensuing husk spot infection.

Grower feedback results are summarised for years 2014, 2015 and 2016 in Figures14-3 to 14-10 and table (31).

Table 30 Supplementary grower evaluation form.

Selection Evaluation Form

Year:

Grower Name:

Please return forms by 30th September to:
Dougal Russell, DAFF 47 Mayers Road,
Nambour QLD 4560
or email
to: dougal.russell@daf.qld.gov.au

Selection **When** **Units**	**Estimated yield per tree** **Feb** (kgs)	**Husk spot severity** **Feb** (0 to 5)	**Phytophora severity** **Aug** (0 to 5)	**Stick tight severity** **Aug** (0 to 5)	**Tree Habit** **Aug** (1 to 5)	**Canopy Density** **Aug** (1 to 5)	**Tree Size** **Aug** (1 to 5)	**Overall Commercial Potential** **Aug** (1 to 9)	**Good comments** (please note any good points you noticed)	**Bad comments** (please note any bad points you noticed)

Estimated yield:	Estimate the tree yield of nut-in-shell in kilograms OR pick-up nuts and weigh NIS @ 10% moisture
Stick tight severity:	Rate the level of stick tights from 0 (none) to 5 (severe)
Husk spot severity:	Rate the level of husk spot symptoms from 0 (none) to 5 (severe)
Phytophora severity:	Rate the level of phytophora symptoms from 0 (none) to 5 (severe)
Tree habit:	Rate tree habit from 1(upright) to 5 (spreading)
Canopy density:	Rate canopy density from 1 (open) to 5 (dense)
Tree size:	Rate the tree size from 1 (very small) to 5 (very large)
Commercial potential:	Rate the overall commercial potential from 1 (low potential) to 9 (excellent potential) with 7 being commercially acceptable

2014 and 2015 Supplementary Grower Comments and Ratings of AMS Varieties

Table 31 Supplementary grower comments 2014 and 2015.

Variety	MFM 2014	MFM 2015	Tregeagle 2014	Mackay	Alloway
A			1 Severe Canker?	Some germination on tree, Extremely bad mealy bug infestation, 34 planted originally but only 17 left	twiggy
B			Only 1 rep, 5 replacements	Very irregular sized trees ranging from small and dense to large and open	
C			3 severe, bad canker		
D				Bigger sized nuts	
E	Bunching, insect damage	Strong open tree, big nut. Sticktights, bunching	MDB evident	Evidence of sticktights	little dororthy dieback
F	Sticktights	Open tree, OK crop	Handling conditions well. MNB bunches, Husk spot 1 tree	Fully developed in size but still very immature	cull out
G	Bunching	Medium nut size. Bunching nut	2 poor small replacements, 3 severe canker	Excessive mites/Thrips damage on nuts	
H		Small nut	2 severe canker, 1 replacement needed	Quite a few stick tights from last season still present	
I			2 severe canker, 2 evident, 2 replacements	V-small nut size Still very immture	Dorothy dieback, Raceme colapse
J			1 Severe Canker, 4 evident	Big nuts, still quite immature	falling over
K		Small nut	6 severe canker		

L	Bunching		1 severe canker, 1 evident		
M	Bunching	Bunching	4 severe canker, 2 replacements	Quite small nuts V-immature, still gooey inside	
N		Medium to large nut	3 severe canker, 1 replacement		
O	Hungry tree		3 severe canker		twiggy
P	Good nut	Too open, lack of fruit wood	Light canker		
Q	No nut		Biggest, healthy tree in general. 1 severe canker, 1 light. 1 replacement, variable trees	Bigger sized nuts	
R			4 light, 1 severe canker		
S	Good tree		3 light canker		
T			3 severe canker, trunk galls on all		Bleeding, dieback (dororthy dieback)

Below are graphs of mean ratings for yield and tree characters for the 20 industry varieties (figures 14-1 to 14-8). RVT variety yield has included real yield data from 2014 from the best performing site, Childers, and the worst, Macksville (figure 14-1).

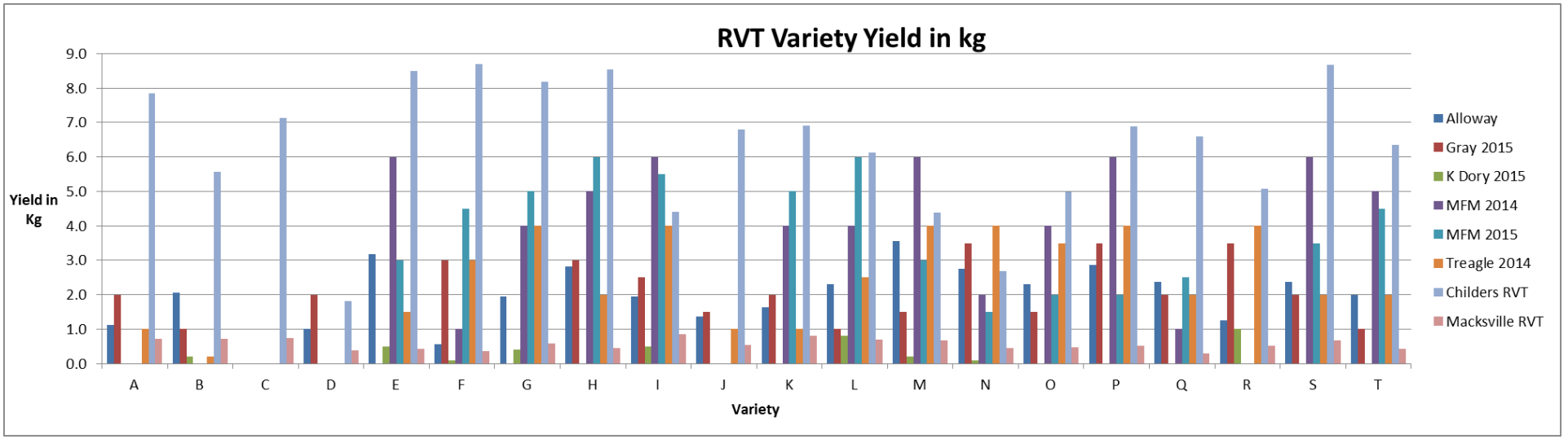


Figure 14-1 Supplementary grower yield ratings.

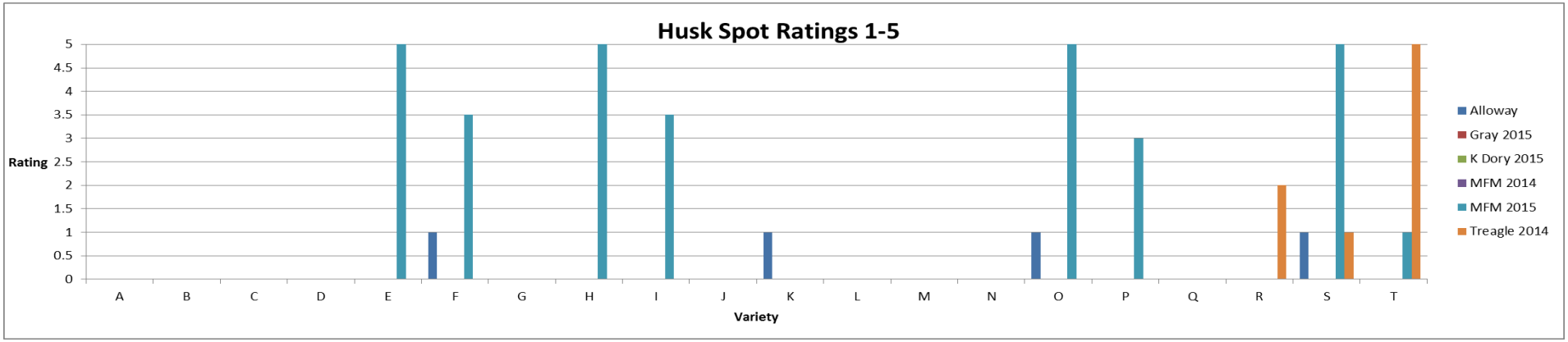


Figure 14-2 Supplementary grower Husk Spot ratings.

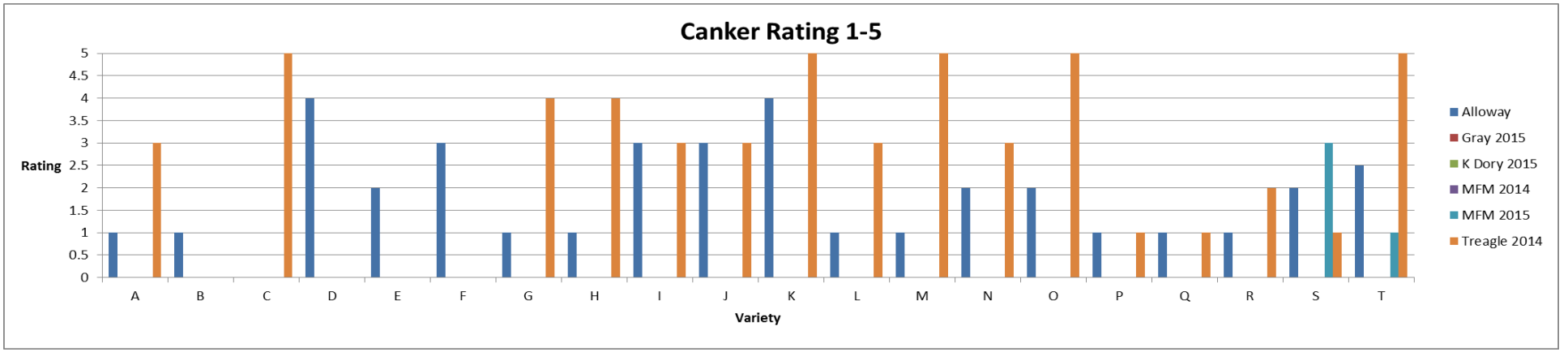


Figure 14-3 Supplementary grower Canker ratings.

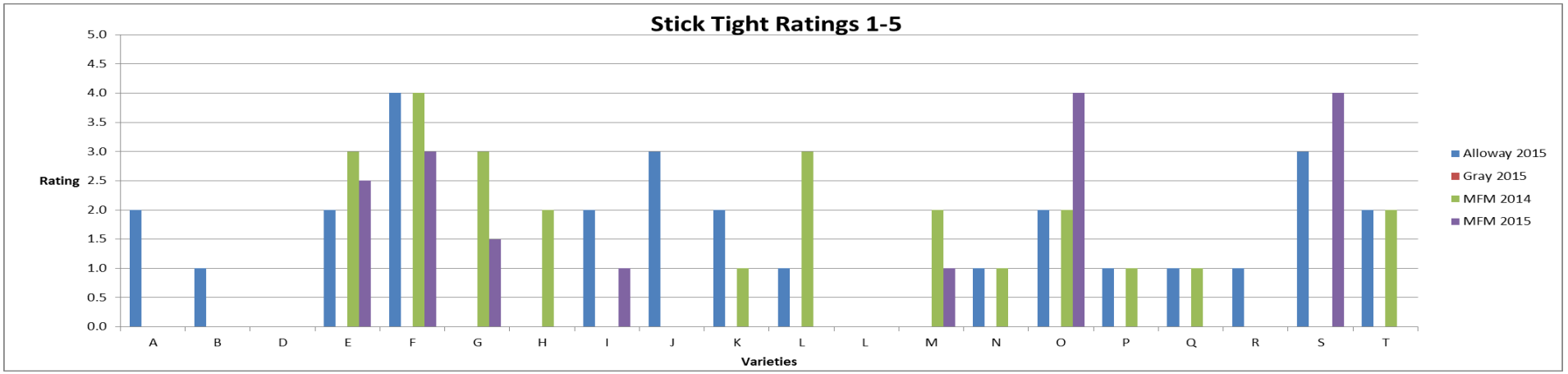


Figure 14-4 Supplementary grower Stick Tight ratings.

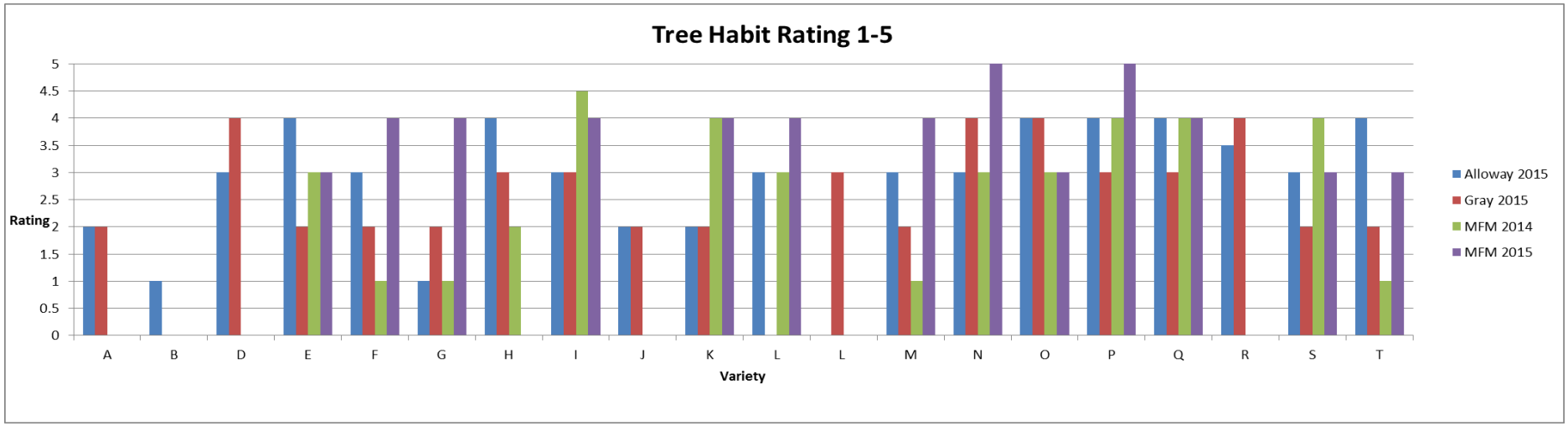


Figure 14-5 Supplementary grower Tree Habit ratings.

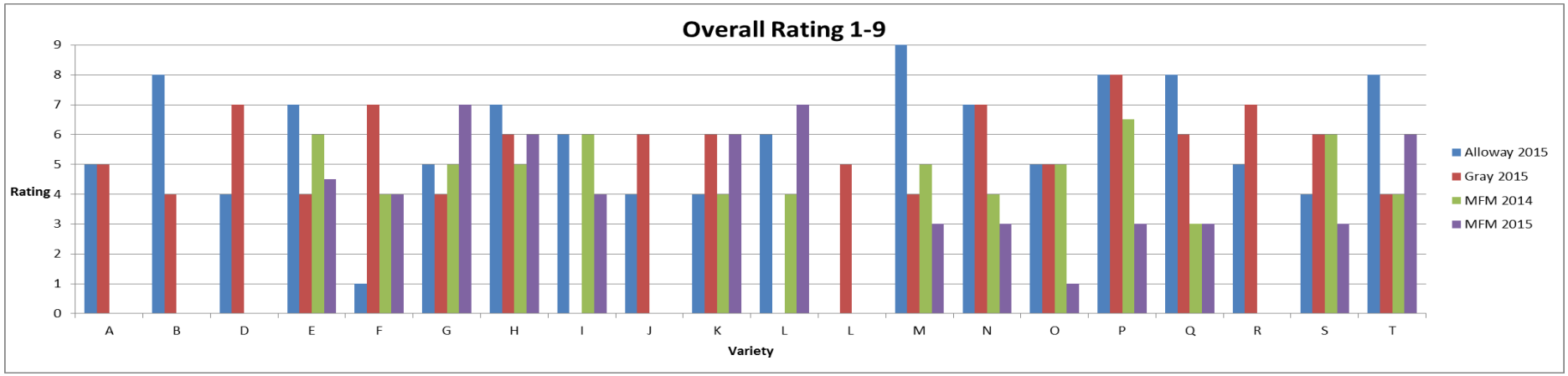


Figure 14-6 Supplementary grower Overall rating.

2016 Grower Ratings Combined

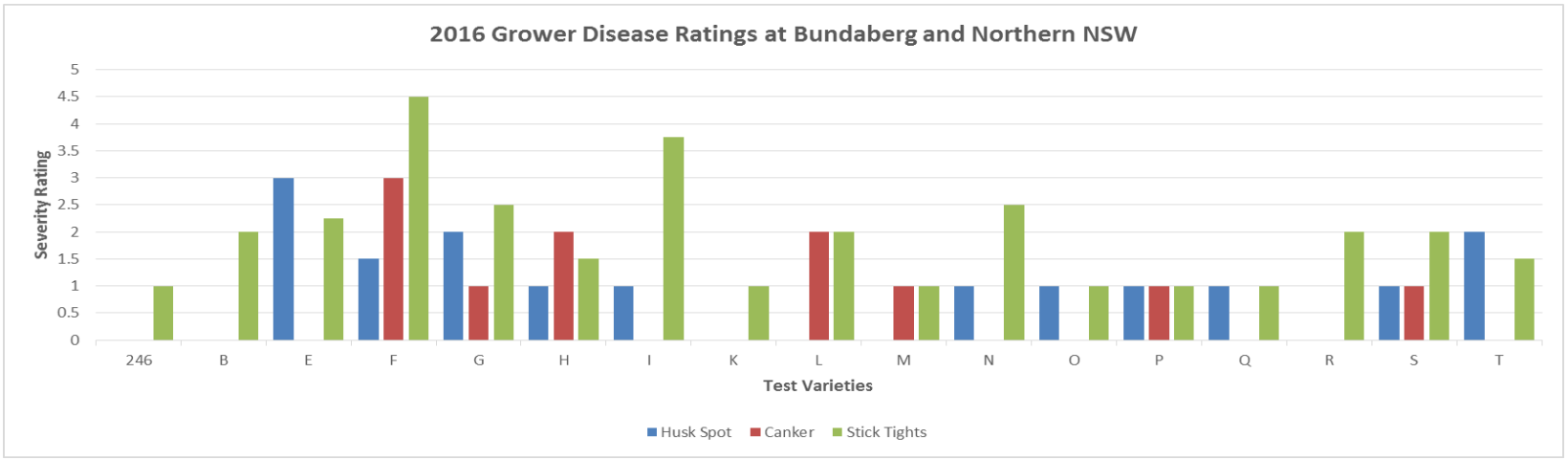


Figure 14-7 Supplementary grower 2016 Disease ratings.

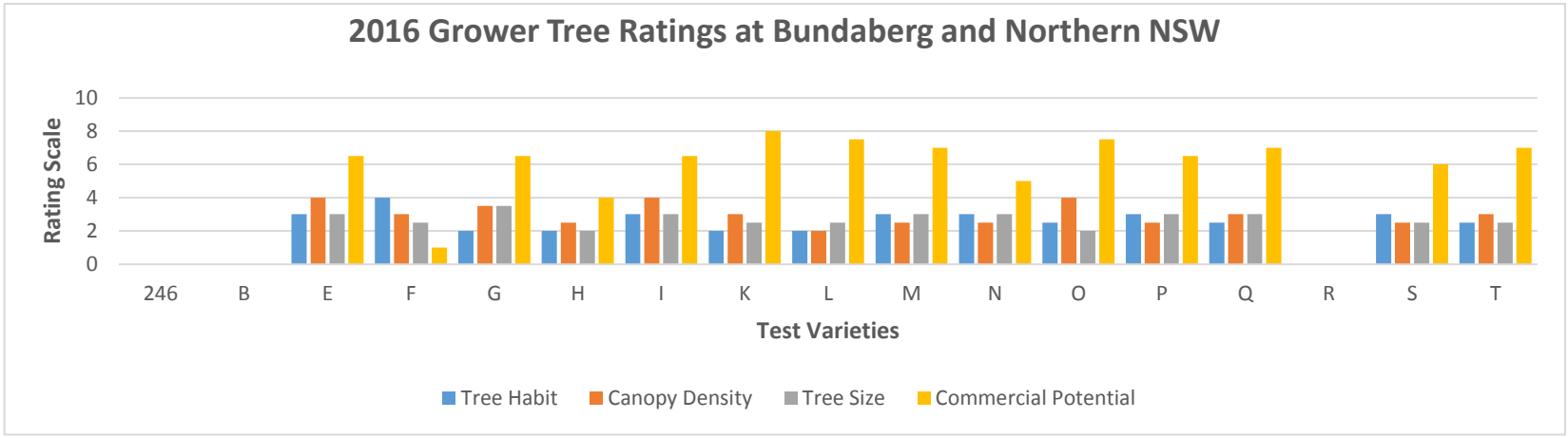


Figure 14-8 Supplementary grower Tree ratings 2016.

15. Variety Performance

Snapshot of variety NIS yield across sites.

2017 Regional Variety Trials Nut in Shell Yield in Grams

Code	EM	B1	B2	B3	WW	AL	MV
A376	2508	7945	9629	5559	6469	6480	2807
C	2115	8734	8158	6119	8528	9935	2328
A403	2206	12243	7529	6178	8225	10403	3071
Q	2931	10297	6658	6211	8463	15478	2528
A422	2484	11497	7808	6973	8874	11334	2870
J	1474	9042	6368	7869	7185	12684	2397
B	2971	8775	9294	6200	6112	11587	3068
A538	1790	7430	6798		6225	6265	2753
816	1396	7195	8434	4847	7150	10539	2352
A16	2358	9712	8992	6068	9904	8130	2538
F	2271	9632	7633	6185	9216	13289	2517
I	2773	10915	9222	6822	7936	10353	3100
T	1193	9697	9527	6801	7890	8353	2612
G	2707	8501	9078	5833	6023	14010	2694
A	2037	9573	9119	6449	8050	10480	2846
K	2661	8162	8966	6020	6743	12384	3262
E	2068	11168	7784	5436	7268	9591	2624
M	1723	10994	8310	4445	5342	9596	3094
S	2346	9600	8235	4837	7638	9740	2700
O	1796	8847	8483	6382	7951	11393	2574
P	2848	10546	8266	5921	8682	13017	2911
A447	3145	8534	7833	6119	5653	12006	2637
R	2053	7959	8286	6543	6024	11616	2431
N	4055	10750	7899	6719	7631	10135	3179
H	2676	10705	8592	7576	9981	12258	3648
344	1704	10428	9672	6037	4999	9264	3281
741	2326	7818	8988	4783	7338	6077	2421
D	1995	6660	7456	6076	6768	7337	3112
246	3313	10307	7475	5854	7338	10647	2759
L	2798	10518	8700	6579	6894	15190	2897

Key	
EM	Emerald
B1	DeCortes
B2	Booyan
B3	Bundy Sugar
WW	Wirra Willa
AL	Alstonville
MV	Macksville

The darker the shading the higher the ranking

Hexanal Results from Cropwatch Independent Laboratories

Rapid Shelf-Life Test

2016 notes from Kim Jones for interpretation.

Yes I have found 344 to have a shorter shelf life than others and consistently comes up worse than A16. 100ppm approximates to a PV of about 3.0 meq and where consumers notice the stale flavours. So anything over 100ppm would be marginal. The rate of oxidation depends on a number of factors, including tree health and post-harvest handling so what you are looking for here is a comparative result rather than an absolute result. The cultivars with low hex values (less than 50ppm) would have significantly longer shelf life than any around the 100ppm.

Table 32 Rapid shelf life Hexanal results 2016.

			25/11/2016				
Variety	**ID**	**Tree**	**Hexanal (PPM)**	**Variety**	**ID**	**Tree**	**Hexanal (PPM)**
A422	5	62-12	9.46	L	30	59-18	60.08
P	21	56-4	11.76	A	15	57-3	60.84
T	13	58-2	12.53	344	26	63-18	63.14
816	9	59-12	19.43	A16	10	57-1	65.44
I	12	62-11	20.20	A	15	63-7	68.51
C	2	57-10	21.27	B	7	60-7	70.81
816	9	62-17	23.27	246	29	56-3	71.58
H	25	59-16	27.10	M	18	58-3	73.11
E	17	55-2	29.40	246	29	63-8	73.88
Q	4	55-4	30.17	G	14	59-17	76.18
N	24	62-16	34.00	B	7	61-18	76.95
A447	22	54-5	35.54	A376	1	58-1	79.25
P	21	63-11	36.30	L	30	62-8	79.25
A422	5	61-14	38.60	S	19	57-4	86.92
741	27	54-4	39.37	A447	22	60-6	86.92
K	16	54-2	40.14	R	23	60-8	86.92
T	13	59-11	41.67	A376	1	63-14	86.92
G	14	55-5	43.97	A538	8	63-17	96.12
A538	8	62-9	43.97	E	17	63-9	99.19
I	12	54-1	43.97	K	16	61-10	101.49
N	24	59-15	45.51	A403	3	58-6	107.62
741	27	59-8	45.51	J	6	57-2	107.62
R	23	54-18	47.04	F	11	59-10	109.16
J	6	60-10	47.81	O	20	62-10	112.22
C	2	63-6 + 54-15	51.64	D	28	63-13	112.99
C	2	54-15	56.24	A16	10	63-16	115.29
A403	3	61-7	59.31	344	26	61-11	118.36
D	28	58-11	59.31	M	18	60-9	126.03
Q	4	62-6	60.08	F	11	54-3	149.80

Table 33 Rapid shelf life Hexanal results 2017.

		26/09/2017	9/10/2017				26/09/2017	9/10/2017
Variety	**SampleID**	**PPM**	**PPM**		**Variety**	**SampleID**	**PPM**	**PPM**
H	59-16-25-H	19.71	4.04		K	54-2-16-K	6.96	50.92
J	60-10-6-J	17.39	17.73		M	58-3-18-M	18.55	55.73
A447	60-6-22-A447	5.80	20.87		A403	AL 58-6	5.80	55.73
T	59-11-13-T	6.96	22.07		O	62-10-20-O	15.07	60.54
G	59-17-14-G	10.43	25.68		D	AL-63-13	-5.79	60.54
A16	57-1-10-A16	11.59	26.88		M	60-9-18-M	13.91	61.74
E	63-9-17-E	12.75	26.88		A	63-7-15-A	8.12	61.74
741	AL59-8	16.23	26.88		816	56-14-9-816	35.93	62.94
T	60-17-13-T	18.55	30.49		E	55-2-17-E	10.43	64.14
R	54-18-23-R	9.27	31.69		B	61-18-7-B	10.43	66.55
H	61-8-25-H	16.23	31.69		A403	61-7-3-A403	24.34	71.35
344	63-18-26-344	17.39	31.69		C	57-10-2-C	19.71	78.57
J	57-2-6-J	9.27	32.89		A538	AL 62-9	6.96	79.77
G	55-5-14G	10.43	34.09		246	63-8-29-246	11.59	80.97
816	59-12-9-816	13.91	35.29		O	63-14-20-O	25.50	90.58
N	59-15-24-N	25.50	36.50		A376	58-1-1-A376	10.43	95.39
I	62-11-12-I	6.96	36.50		A422	62-12-5-A422	10.43	100.20
741	AL54-4	20.86	37.70		L	59-18-30-L	16.23	114.62
N	AL-62-16	-5.79	37.70		I	54-1-12-I	3.48	118.23
A	57-3-15-A	16.23	40.10		K	AL-61-10	17.39	119.43
S	63-12-19-S	11.59	40.10		F	54-3-11-F	23.18	121.84
S	57-4-19-S	15.07	41.30		Q	55-4-4-Q	17.39	138.66
A447	54-5-22-A447	5.80	42.51		B	60-7-7-B	20.86	144.67
R	60-8-23-R	22.02	42.51		A538	AL 63-17	15.07	166.31
L	62-8-30-L	16.23	42.51		P	AL 56-4	13.91	173.52
A422	61-14-5-A422	10.43	43.71		D	AL 61-9	15.07	214.39
246	56-3-29-246	8.12	44.91		Q	62-6-4-Q	24.34	267.27
P	63-11-21-P	16.23	48.52		A376	AL 62-14	15.07	282.90
A16	63-16-10-A16	4.64	48.52		C	54-15-2-C	16.23	287.70
344	AL 58-5	18.55	49.72					

Some comments from Kim Jones are noted below. Kim is commenting on Hexanal results from 2016 and 2017 and trying to determine if there are any of the 30 varieties that stand out as having poor shelf-life.

Shelf life can be affected by many things, including tree health, time on the ground, maturity at harvest, post harvest storage and handling. Seasonal variations can also impact different cultivars to varying degrees. Assuming that all reps in the same year, had the same post harvest handling, eg picked up on the same day, dehusked on the same day and stored under the same conditions the variations in hexanal concentrations may be due to a real difference in potential shelf between cultivars or due to other factors such as kernel maturity, tree health, one bad kernel in the sample, the % of whole and half kernels in the sample. Half kernels may produce hexanal at a faster rate

than whole kernels. This still needs further work, but it has been shown that chips have a shorter shelf life than long whole kernels. Although every effort was made to ensure that only premium kernel was used for these trial in some instances a single kernel that has a hidden defect such as brown centre or small insect sting can produce hexanal at a rate that will skew the results. Where ever possible only whole kernels were used, but in some instances where the % whole was low of the sample provided was small some half and broken kernels were included in the hexanal sample.

Considering the above limitations of only 1 rep for each tree and usually only two trees giving in most cases 2 reps per CV per year we need to look for consistency between the reps and across the years. With such a small sample size it the results are not statistically analysable, but a careful look at the data does suggest that further investigation to understand the causes of the results. Specifically:

Conclusion: In general it appears that most cultivars have an adequate shelf life. There are individual reps that exhibit shorter or reduced shelf life, however without more reps or more year's data the cause of this shorter shelf life cannot be attributed to cultivar genetics. There are some cultivars that need to be looked at closely including A376, F, and O. These three cultivars consistently have higher hexanal levels than other cultivars. The high levels of hexanal for individual trees including tree no. 61-10, and 63-17 may indicate trees under stress. These should be checked in the trial for visible signs of deficiency of higher insect or disease pressure.

Wirra Willa Abnormal Vertical Growth (AVG) Ratings 2017

Table 34 Wirra Willa AVG Results 2013 - 2017

Mean AVG Ratings over time.

Variety	2013 AVG	Jan-16 AVG	Aug-17 AVG
816	0.0	0.0	0.0
842	0.3	0.0	0.0
344 (344/AVG)	3.0	1.0	2.0
344 (344/non-AVG)	2.5	2.0	2.0
A	0.1	0.0	0.3
A16	0.0	0.0	0.0
A268	0.0	0.0	0.0
A376	0.0	0.0	0.0
A4	0.0	0.0	0.0
A403	0.0	0.0	0.0
A422	0.3	0.0	0.0
A447	0.0	0.0	0.0
A538	0.0	0.0	0.0
B	0.5	0.0	0.0
C	0.0	0.0	0.0
D	0.0	0.0	0.0
Daddow	0.0	0.0	0.0
E	0.0	0.0	0.0
F	0.1	0.0	0.0
G	0.4	0.0	0.0
H	0.0	0.0	0.0
I	0.0	0.0	0.0
J	0.0	0.0	0.0
K	0.0	0.3	0.0
L	0.4	0.5	0.3
M	1.0	0.0	0.0
N	0.0	0.0	0.0
O	0.0	0.0	0.0
P	0.0	0.0	0.0
Q	0.0	0.3	0.0
R	0.0	0.0	0.0
S	0.5	0.0	0.0
T	0.0	0.0	0.0

Regional Variety Trial Disease Ratings Wirrawilla and Alstonville 2016

Table 35 Alstonville and Wirra Willa disease ratings 2016.

	Wirrawilla			Alstonville		
Variety	**AVG Score (0 - 2)**	**Husk Spot Score (0 - 5)**	**Husk Rot Score (0 - 2)**	**Mean % of nuts with Husk Spot**	**Mean % FSB loss**	**Mean TKR %**
A	0	0.25	0.5	2.67	1.3	29.9
B	0	0	0.5	1.18	0	33.9
C	0	0	0	1.11	0	34
D	0	0	0	0.00	0	34.3
E	0	0.5	0.25	6.19	0.5	39.1
F	0	2	0	0.55	2.5	46
G	0	0	0.5	0.47	1	42.6
H	0	1	1	0.90	1.7	35
I	0	1	0	0.45	2.5	32
J	0	0.25	0.25	0.00	0.4	44.8
K	0.33	0	0.66	0.97	2	33.6
L	0	0	0.25	1.24	0.6	30.9
M	0	1.5	0	1.38	0.5	32.2
N	0	1.75	1	1.34	1.4	30
O	0	0	0	0.83	0.6	37.4
P	0	0	0	2.33	0	34.8
Q	0.25	0.75	0	2.65	0.8	32.8
R	0	0.25	0.25	0.56	2.2	37.8
S	0	0	0	5.50	2.7	32.8
T	0	0.5	0	0.83	0	37.1
344	1.36	0.23	0.27	0.00	1.7	34.5
A16	0	2	0.5	2.49	1.7	39.7
816	0	0.25	0.25	0.27	5	44.1
246				0.67	0.7	37.9
741				0.56	0.8	37.9

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG – Dougal Russell and Pat O'Farrell.
Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights – Femi.
Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR – Femi.
AL percentages calculated on 2 nut collections between 150 and 450 nuts.

Flowering Data – Alloway and Wirra

2016 Flowering Alloway High Density

Table 36 Alloway flowering times 2016.

Genotype	July				August				Sept				Oct			
Week Starting									*5th*	*12th*	*19th*	*26th*				
741									*5	25	100					
344									*5	25	100					
246									*5	25	90					
203										5	25					
A									*5	25	90					
B									*5	50	100					
D									*5	50	100					
E										5	100					
F									*5	25	100					
G									*5	50	100					
H									*5	75	100					
I									*5	25	75	100				
J									*5	25	75	100				
K										5	50	100				
L									*5	50	100					
M									*5	75	100					
N										5	100					
O										5	100					
P									*5	75	100					
Q									*5	50	100					
R										5	75	100				
S										5	50	100				
T										5	90	100				

*Estimate

NOTES

- More compact flowering this season, Temperatures higher through winter
- Low to non-existent bees/insects in orchard during pollinations so OP may be affected?
- Rain on the 14/9 while bagging varieties for self and crossing 344, 741, 246, P, Q, M. Racemes appeared “sweaty” and could affect the FNS?
- Racemes on parents control crosses possibly too far gone for successful pollinations, possibly low FNS

2015 Alloway flowering notes

Table 37 Alloway flowering times 2015.

Genotype	July				August				Sept				Oct			
741																
344																
246																
203																*
A																
B																
D						*										
E																
F																
G																
H																
I																
J																
K																
L						*										
M							*									
N							*									
O																
P							*									
Q							*									
R							*									
S																
T								*								

Wirra Willa Flowering 2015

Table 38 Wirra Willa flowering times 2015.

Variety	June				July				August				September				October			
268																				
816																				
842																				
344a																				
344n																				
A																				
A16																				
A268																				
A376																				
A4																				
A403																				
A422																				
A447																				
A538																				
B																				
C																				
D																				
Daddow																				
E																				
F																				
G																				
H																				
I																				
J																				
K																				
L																				
M																				
N																				
O																				
P																				
Q																				
R																				
S																				
T																				

Standard Varieties Hidden Valley Varieties Industry Varieties

Ethrel Application at Bundaberg 2016

Table 39 Ethrel application results 2016.

Rate 94ml / 100l 1600l / ha

Variety	Suitability	Rating (1-5)	Leaf Drop	Comment
E	OK	2.5	Very little leaf drop	Rating 2-3, Rate too low
F	Poor	1	Some Leaf drop	Rate too low
G	OK	3	Very little leaf drop	Rate not quite enough
H	OK	3.5	Some Leaf drop	Rating 3-4
I	OK	3	Some Leaf drop	
K	OK	3	Some Leaf drop	
L	OK	3	Some Leaf drop	
M	OK	2	Some Leaf drop	Rate too low
N	OK	2	Some Leaf drop	Rate too low
O	OK	3	Very little leaf drop	
P	OK	3.5	Some Leaf drop	Rating 3-4
Q	OK	3.5	Some Leaf drop	Rating 3-4
S	OK	3.5	Some Leaf drop	Rating 3-4
T	OK	3	Some Leaf drop	

This trial was conducted by MFM in Bundaberg using a regular treatment of Ethrel. Results from this small test indicate there is variation in response to Ethrel with some varieties dropping nuts differently to other varieties and varying degrees of leaf drop. We will conduct this trial again on an RVT site in 2017 and measure the drop rate and volume.

The following paper was presented at the MIVIC variety selection meeting held in December 2016 by Dr Craig Hardner (UQ) and Dr Joanne De Faveri DAF).

Issues affecting use of RVT3.2 yield data for selection of elite individuals

Craig Hardner and Joanne De Faveri (unpublished).

Introduction

- Aim is to use candidate means in RVT for annual NIS and canopy diameter along planting row predicted from analyses undertaken by Jo deFaveri to make predictions of candidate means for age of canopy management and longer term yield
- Canopy growth model assumes canopy management is required after canopy diameter across row exceeds 6 years.
- Assume observed relationship between yield and canopy size (e.g. yield efficiency, NIS/projected canopy area, YE) is maintained at later ages.

Data quality

There were several issues that impacted on the quality of the yield data from the 9 sites (Table 1).

- Yield at Alstonville (AL) in 2013 and 2014 (age 5 and 6 years) was compromised by rat predation.
- The trial at the Decortes (B1) site was severely impacted in 2013, and while yield in this year (age 5) doesn't seem to have been depressed, yield in 2014 (age 6) and 2015 (age 7) are somewhat lower than other sites in the Bundaberg region.
- The trial at Bundaberg sugar (B3) site was affected by salt and spray burn in 2013 (age 5) and 2014 (age 6).
- The trial at the Childers (CH) site was lost to cyclone damage after the 2015 (age 7) harvest.
- The trial at the Emerald site (EM) was planted 1 year later than trials at the other sites. This trial was affected by flower caterpillar in 2014 (age 5) and part of harvest was missing for the 2015 (age 6) harvest.
- The trial at the Mackay (MA) site was severely impacted by poor nutrition and management and yield in 2013, 2014 and 2015 (ages 5-7) appear to be severely depressed, and the trial appears to be 3 years behind in production compared to more productive trials
- The trial at Macksville (MV) has suffered from poor management and poor flowering due to frost and yields have been depressed for all years.

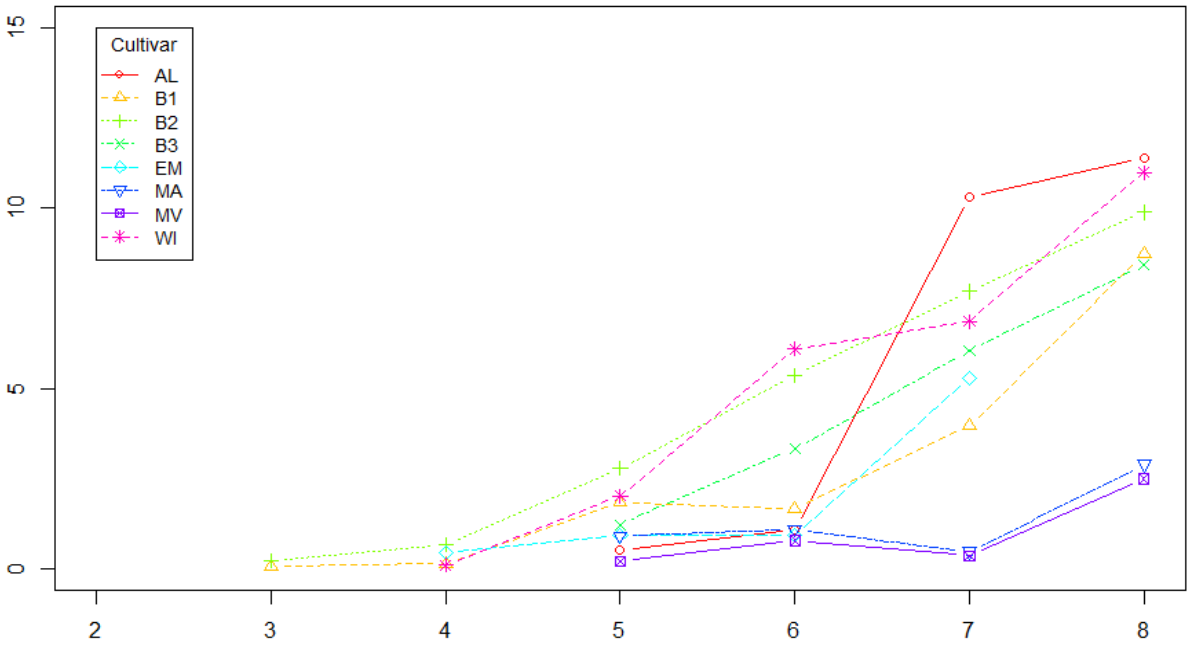


Figure 1. Average yield per tree between 3 and 8 years of age for trials at 8 sites.

Table 1. Summary of observed issues affecting yield at different Sites by Age

Site	Age 5	Age 6	Age 7	Age 8
AL	Affected by rat predation?	Some of NIS removed by rats	ok	ok
B1	Trial damaged by cyclone?	Yield affected by cyclone damage	ok	ok
B2	ok	ok	ok	ok
B3	Trees affected by salt and spray burn	Still sick	ok	ok
CH	ok	ok	ok	Trial lost to cyclone damage
EM	Flower caterpillar damage	Part of harvest missing	ok	2017 harvest
MA	Affect by poor nutrition	Affected by poor nutrition	Affected by poor nutrition	ok
MV	Poor growth and low production	Poor growth and low production	Poor growth and low production	Poor growth and low production
WW	ok	ok	ok	ok

In summary, the only data that are likely to reflect yield form standard productions systems are

AL: year 7 & 8

B1: year 7 & 8

B2: years 5, 6, 7 & 8

B3: years 7 & 8

WW: years 5, 6, 7 and 8

GxE in yield

Results

Prediction means of candidates for cumulative yield between year 7 and 8 (Figure 1, Table 2) at Al was poorly correlated with predicted candidate means at B1 (-0.03), B2 (0.21) and WW (-0.28), and moderately negatively correlated with predicted candidate means at B3 (-0.46). Predicted candidate means at B3 were poorly correlated with candidate means at B1 (0.19), B2 (0.08) and WW (0.25).

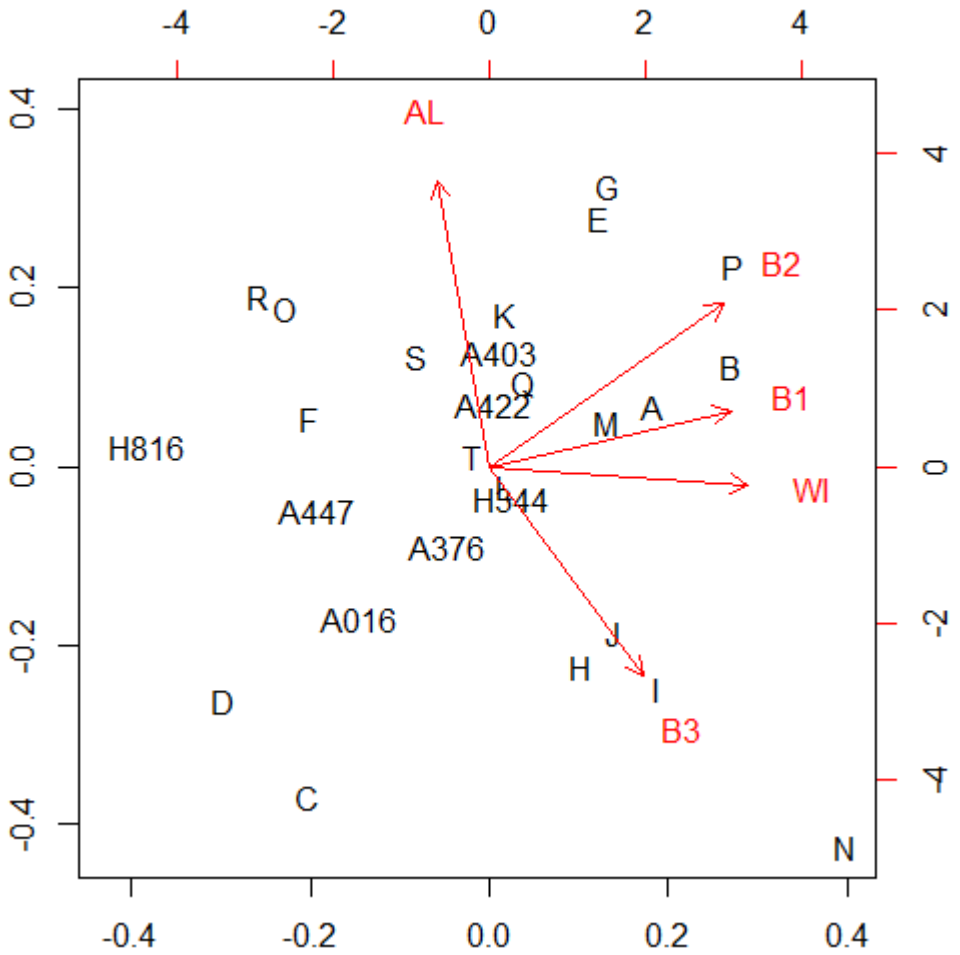


Figure 1. Biplot of first 2 dimensions of principal component analysis of predicted clonal means for canopy diameter at 8 years at 5 sites (AL, B1, B2, B3 and WW) (P1+P2 = 72% variance explained). Vectors represent sites, and points represent selections. Performance of a selection at a particular location is given by the perpendicular projection form the selection point onto the site vector.

Table 2. Average predicted cumulative NIS yield between ages 7 and 8 for 25 selections and 5 commercial cultivars at AL, 3 sites at Bundaberg (B), and across the 4 sites (GM), sorted by overall performance. Highlighted in green are the top 5 performance individuals in each group.

	AL	B	GM
K	26.2	16.2	21.2
P	23.3	18.8	21.0
E	24.4	17.4	20.9
G	24.1	17.7	20.9
Q	25.4	16.3	20.9
O	25.7	14.5	20.1
A403	23.7	16.2	19.9
R	25.4	14.5	19.9
B	21.6	18.0	19.8
F	24.1	15.1	19.6
A	21.8	17.3	19.5
A422	23.1	15.8	19.5
A538	25.9	12.6	19.2
T	22.0	16.2	19.1
S	22.7	15.3	19.0
L	22.1	15.8	19.0
H246	21.8		
H741	20.2		
H344	21.7	16.0	18.8
H816	22.9	13.7	18.3
M	18.8	17.7	18.2
A447	21.8	14.5	18.1
I	19.0	16.9	17.9
A376	20.2	15.3	17.8
H	19.0	16.4	17.7
N	17.0	18.0	17.5
J	17.6	16.6	17.1
A016	18.7	15.0	16.9
C	16.7	14.3	15.5
D	17.1	13.7	15.4

Implications for selection

- What does aNIS yield at AL represent? Are clonal values for aNIS yield at AL correlated with production orchards in NNSW?
- What does aNIS yield at B3 represent? Does it represent performance in salt affected sites? How important is prediction for salt affected sites.

GxAge interaction in yield

Results

Predicted candidate means of NIS yield per tree at year 7 were reasonably correlated with yield at 8 years at B2, B3 and WW (Table 2, Figure 4, 5 and 6), however, candidate means at year 7 at Al and B1 were poorly correlated with yield at 8 years (Table 3, Figure 2 & 3).

Table 3. Summary of pairwise Age-Age genetic correlations between Ages, within Sites. Green shading indicates correlations > 0.5, yellow indicates correlations between 0.3 and 0.5.

Site	r.5_6	r.6_7	r.7_8	r.5_7	r.6_8	r.5_8
AL			0.19	0.27		0.22
B1			-0.14			0.08
B2	-0.07	0.71	0.95	0.10	0.47	0.27
B3			0.70			
WI	0.66	0.27	0.81	-0.09	0.10	-0.27

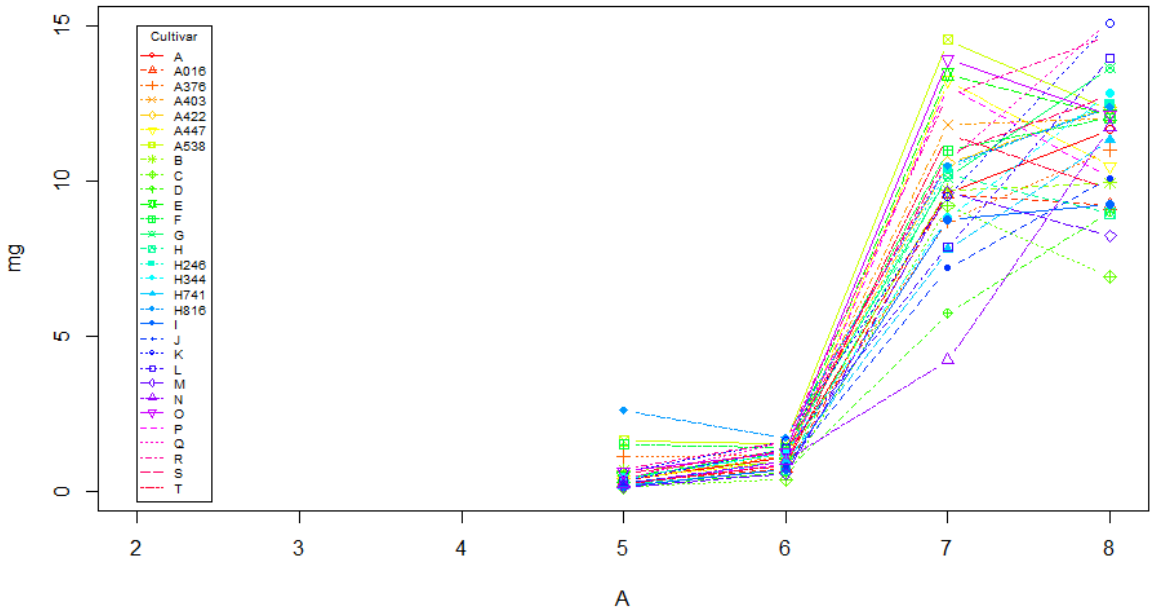


Figure 2. Annual NIS yield per tree by age for 30 candidates at AL

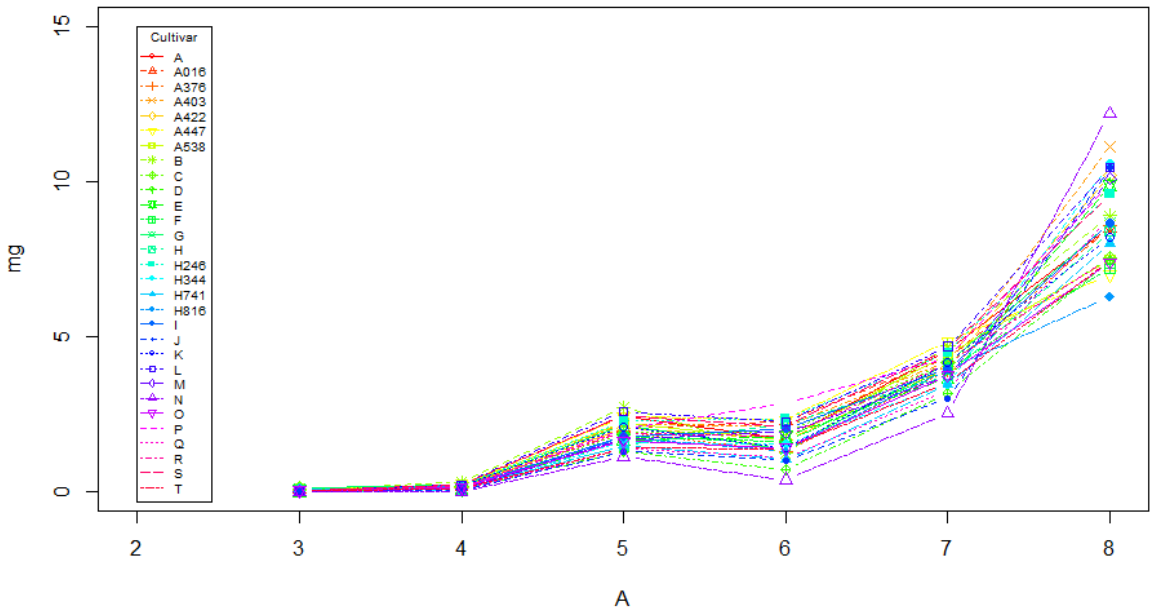


Figure 3. Annual NIS yield per tree by age for 30 candidates at B1

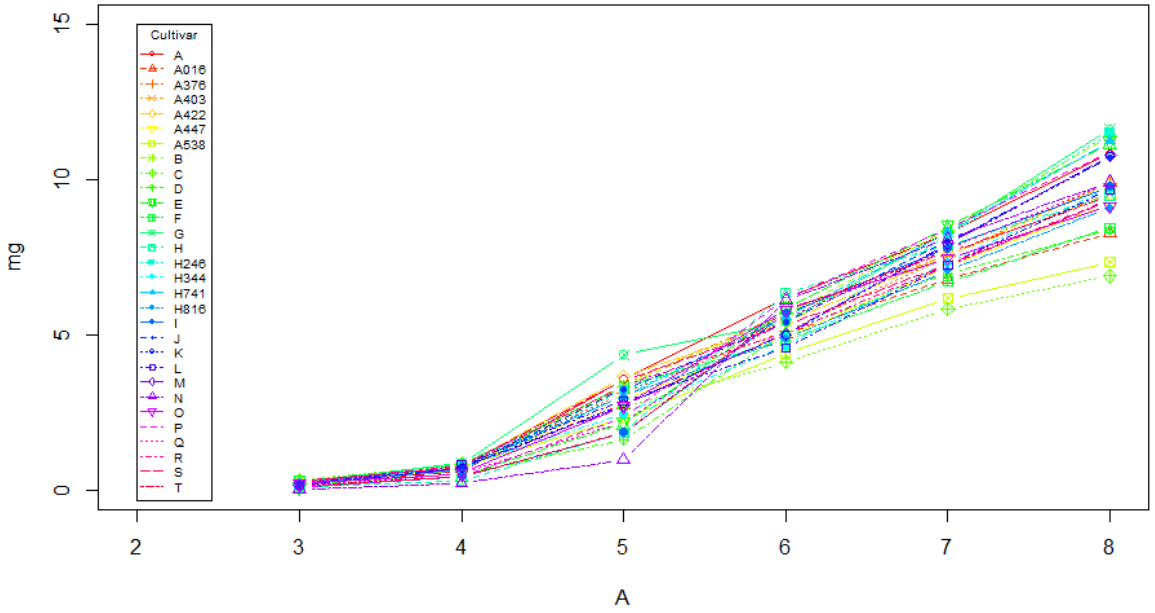


Figure 4. Annual NIS yield per tree by age for 30 candidates at B2

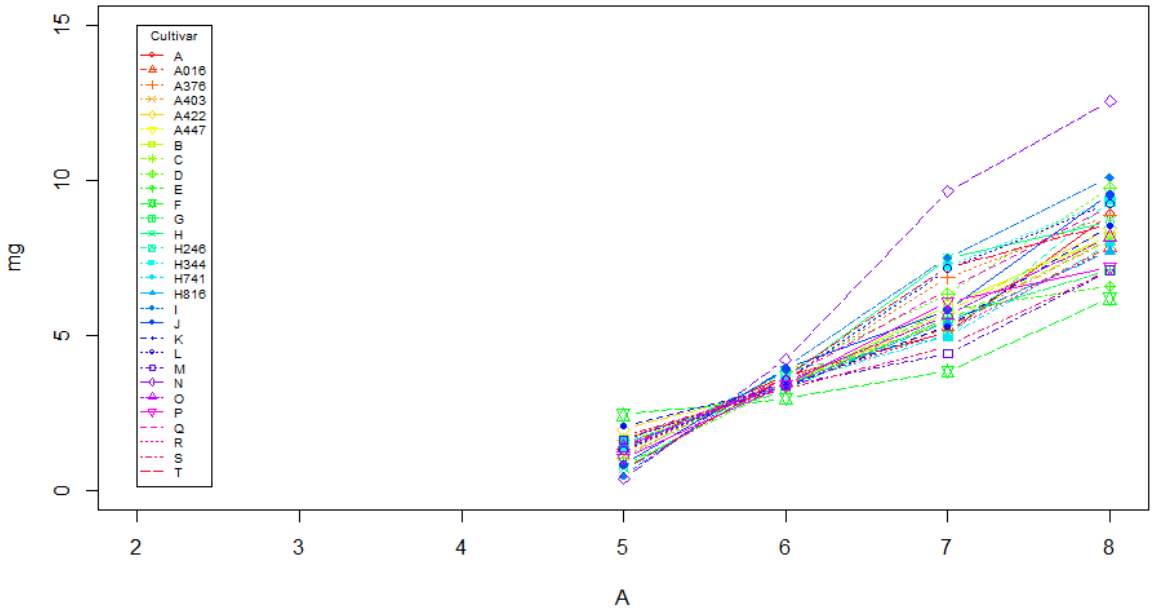


Figure 5. Annual NIS yield per tree by age for 30 candidates at B3

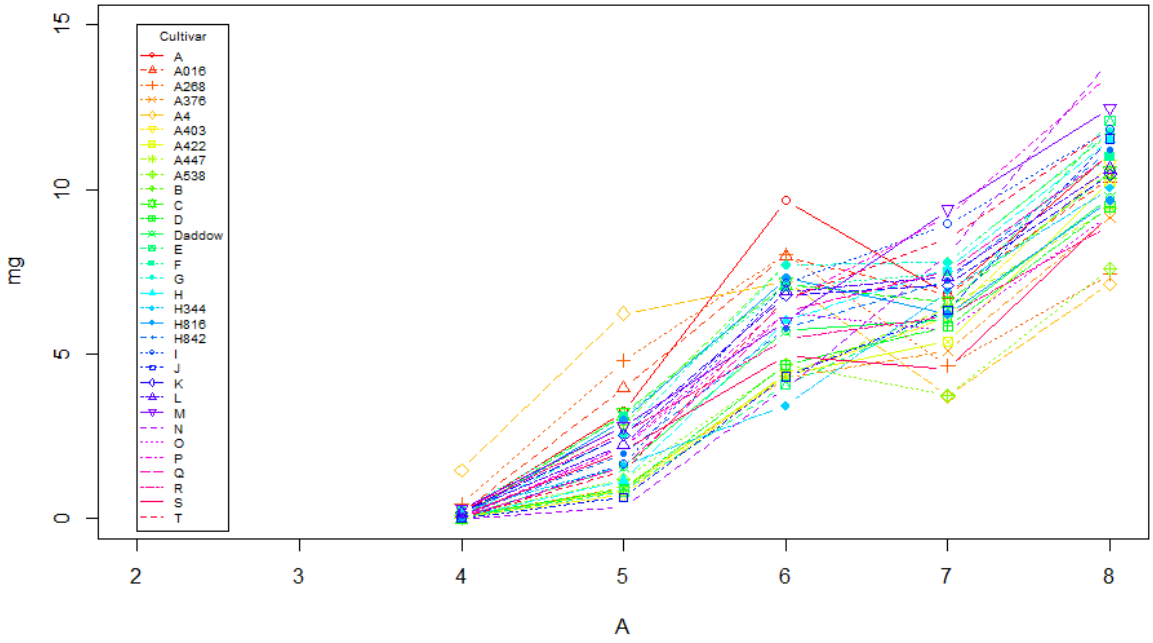


Figure 6. Annual NIS yield per tree by age for 30 candidates at WW

Implications for selection

- How will yield at Al and B1 settle down in the longer term?
- Does interaction at AL reflect biennial bearing? Will this pattern continue?

Canopy diameter growth model

Results

Site means across the 8 sites relatively linear with maximum of 4.5 m at 8 years (Figure 7)

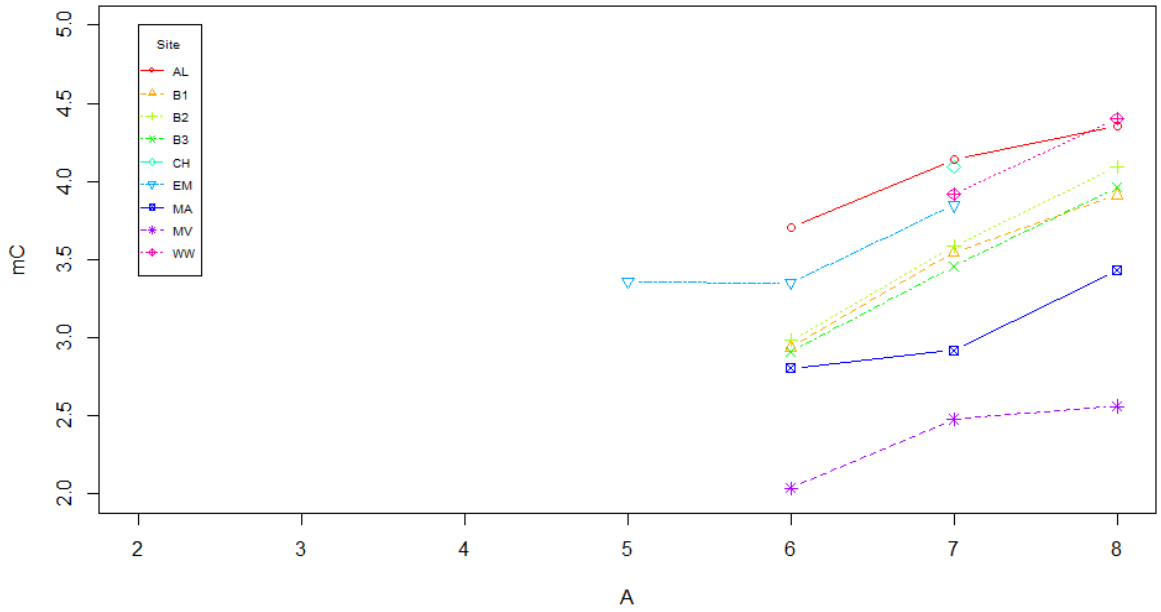


Figure 7. Mean of canopy diameter by age at 8 sites

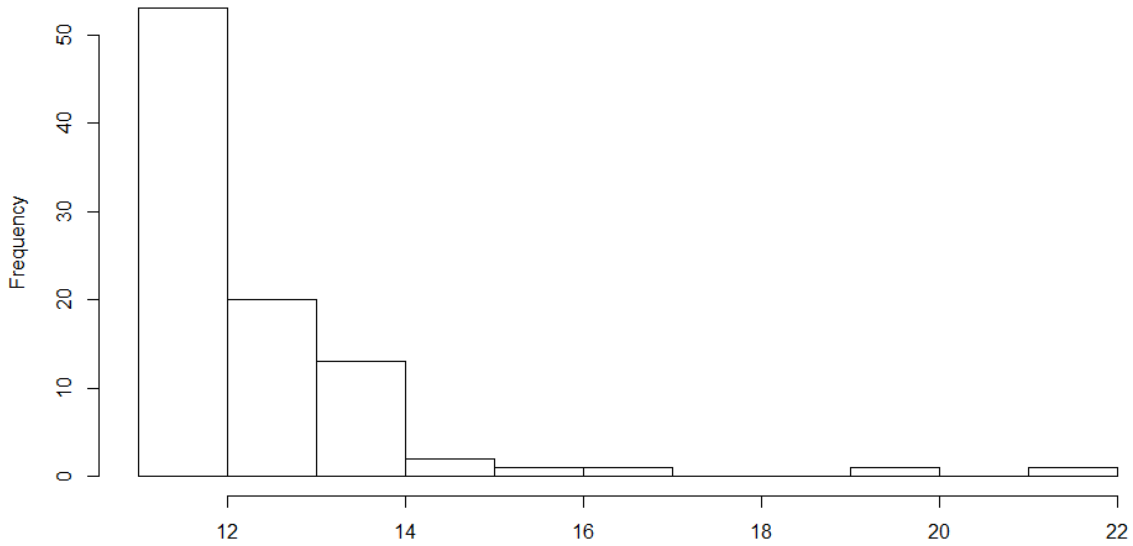


Figure 8. Predicted age at which canopy diameter exceeds 6 m using growth model based on growth in canopy diameter along row between 6 and 8 years.

Implications for selection

- How well is canopy diameter along planting row correlated with canopy diameter across planting row?
- Projection of canopy diameter across planting row by age based on growth in canopy diameter along planting row appear to underestimate growth

GxA in YE

Results

Similar to yield, predicted candidate means for YE at AL and B1 only poorly correlated between age 7 and 8, but reasonable well correlated at B2, B3 and WW (Table 4, Figures 9, 10, 11, 12 and 13).

Table 4. Pairwise correlations of predicted clonal means for YE between Ages, by Site. Green shading indicates correlations > 0.5.

Site	r.6_7	r.7_8	r.6_8
AL		0.20	
B1		0.00	
B2	0.83	0.84	0.59
B3		0.60	
WW		0.80	

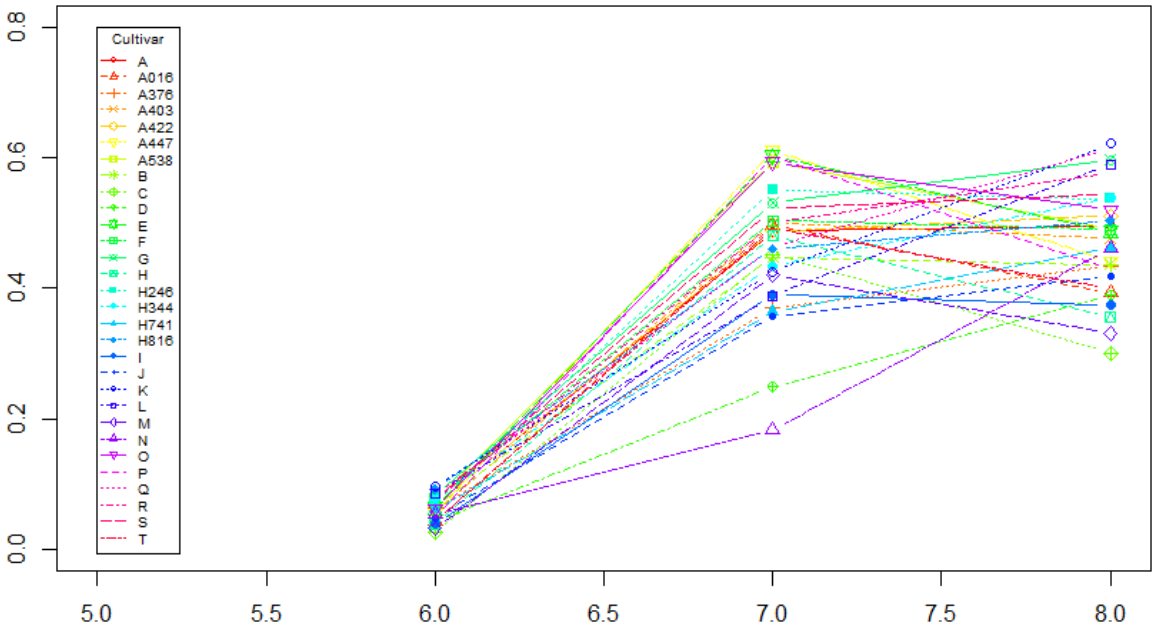


Figure 9. Predicted clonal means for YE by Age for 30 candidates at AL.

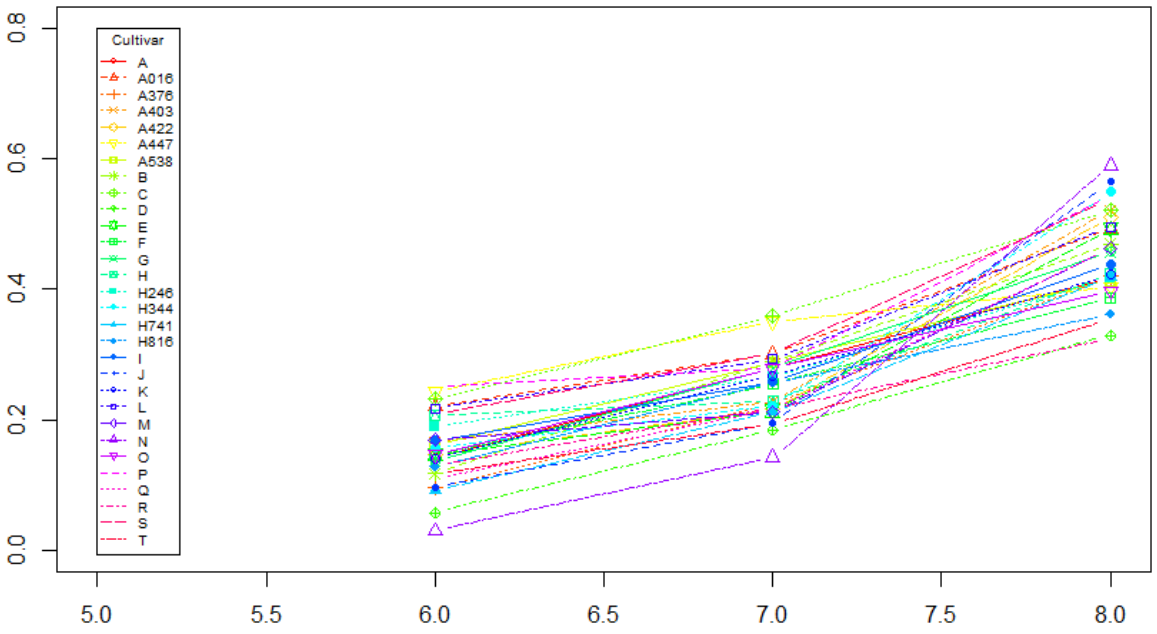


Figure 10. Predicted clonal means for YE by Age for 30 candidates at B1 (r = 0.13).

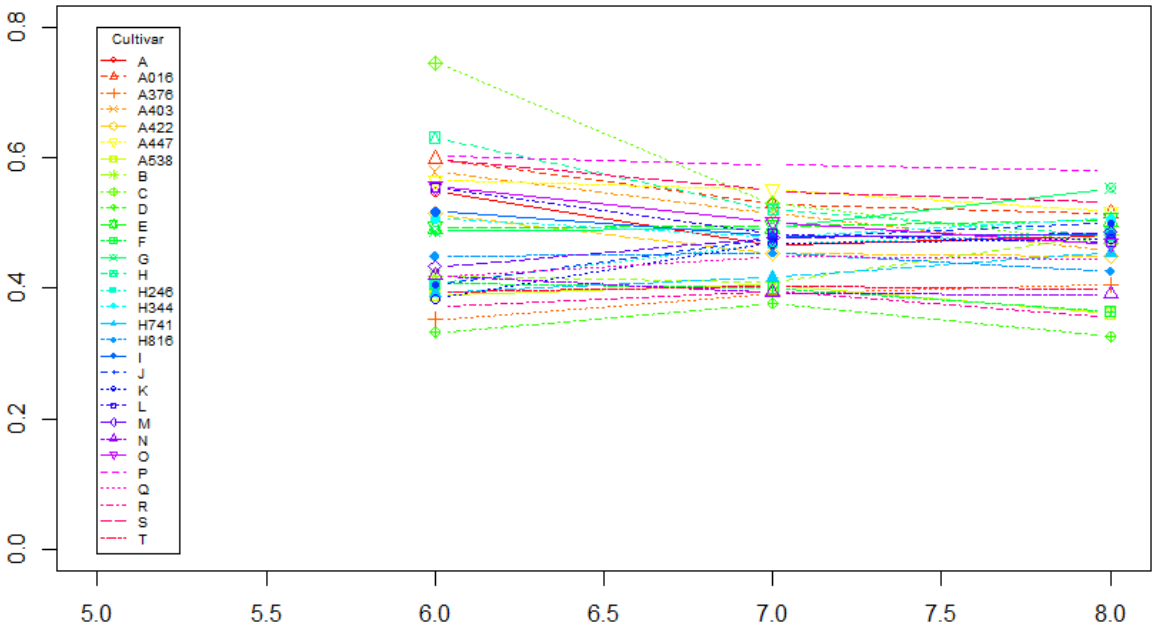


Figure 11. Predicted clonal means for YE for 30 candidates by Age at B2.

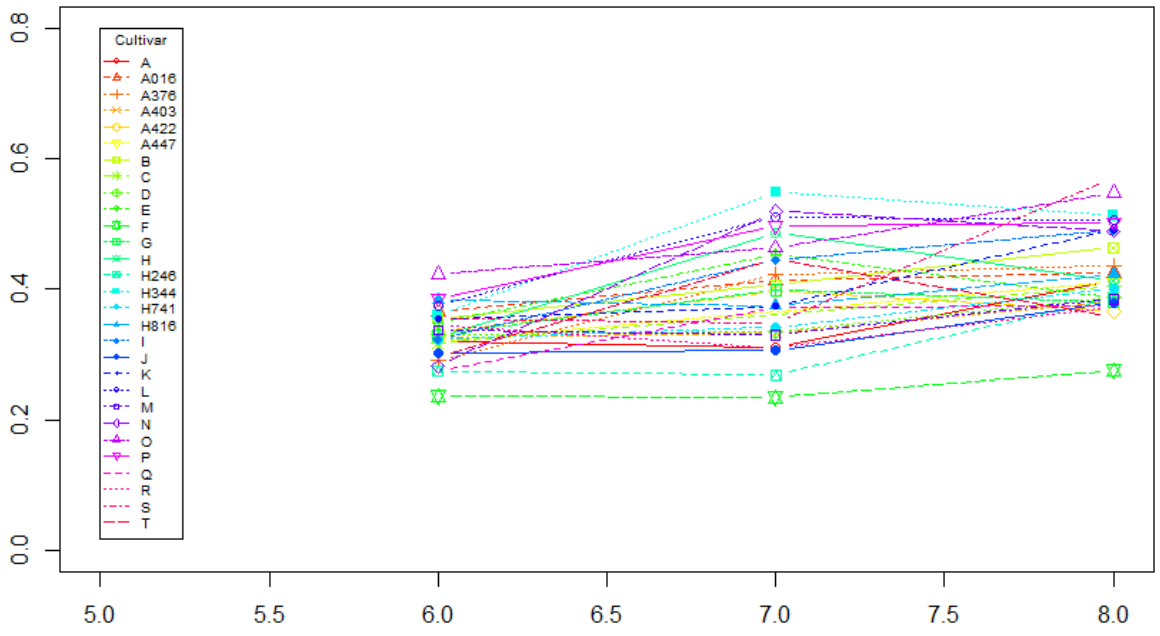


Figure 12. YE by Age for 30 candidates at B3

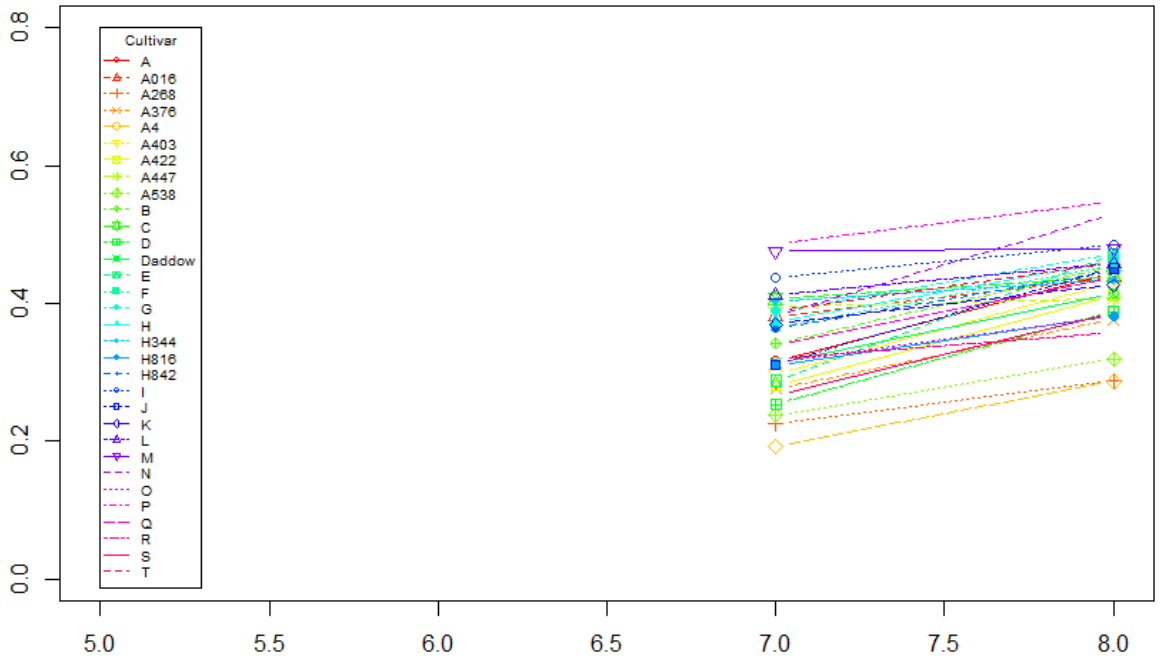


Figure 13. YE by Age for 30 candidates at WWs.

Implications for selection

- How will yield at Al and B1 settle down in the longer term?
- Does interaction at AL reflect biennial bearing? Will this pattern continue?

Summary of implications of results for selection

- Uncertainty about the cause of the strong GxE in NIS. Is yield at AL representative of yield for NNSW?
- What is relevance of yield at B3?
- How stable over the longer term are candidate rankings for annual NIS yield, and YE at B2, B3 and WW?
- Considerable uncertainty of longer term annual NIS yield, and YE at Al and B1.
- Absolute values of candidate means of canopy diameter along planting row is likely not to under estimate absolute values of canopy diameter across planting rows and hence over estimate age at which canopy management commences
- 1-2 years assessment of annual NIS yield required to improved confidence in predictions
- Assessment of canopy diameter across and along planting row required to develop reasonable predictions of age at which canopy management commences
- Assessment of data form other RVT trials required to confirm or reject hypothesis that candidate ranking for yield in NNSW is not well correlated with candidate ranking of yield in Bundaberg

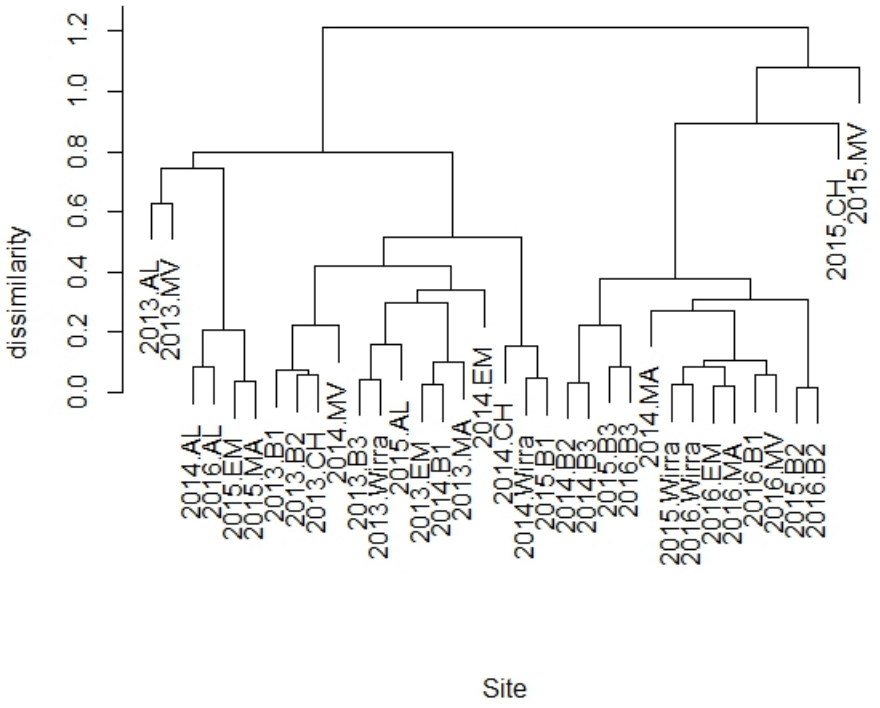
MET analysis across all Sites and Years for DNIS:

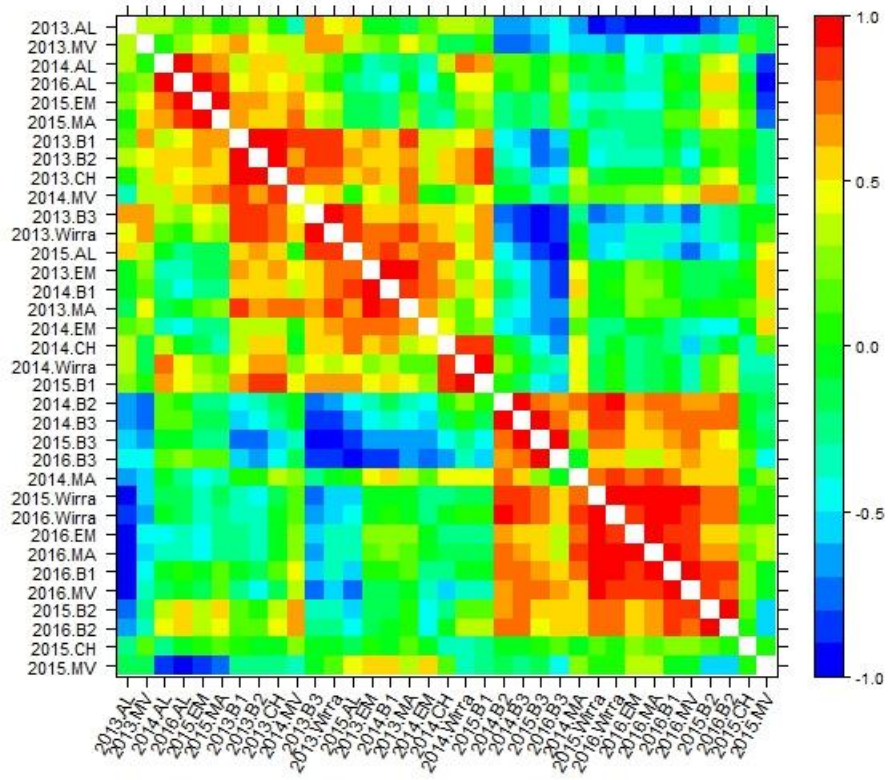
Excluded 2011 & 2012 as little data and little genetic variance:

DNIS data from 35 Site Year combinations

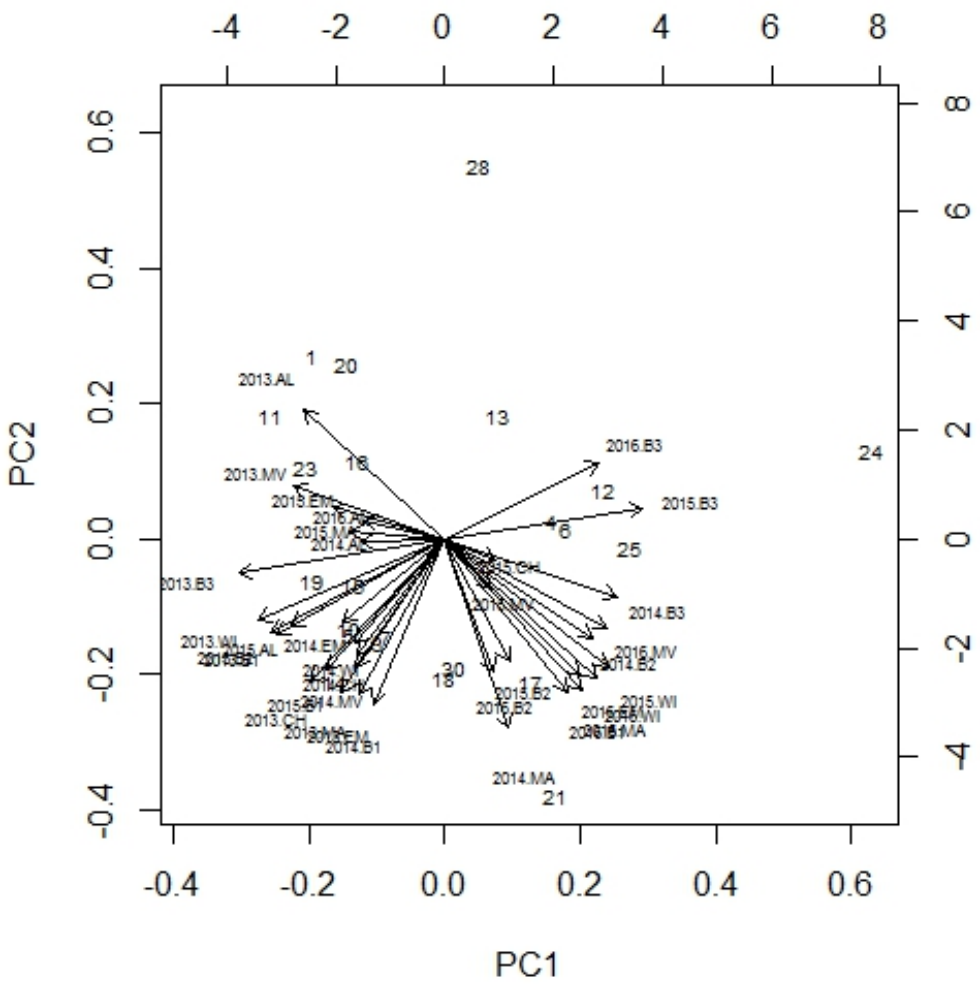
```
[1] "2013.AL"    "2013.B1"    "2013.B2"    "2013.B3"    "2013.CH"    "2013
.EM"    "2013.MA"    "2013.MV"    "2013.Wirra" "2014.AL"    "2014.B1"
[12] "2014.B2"    "2014.B3"    "2014.CH"    "2014.EM"    "2014.MA"    "201
4.MV"    "2014.Wirra" "2015.AL"    "2015.B1"    "2015.B2"    "2015.B3"
[23] "2015.CH"    "2015.EM"    "2015.MA"    "2015.MV"    "2015.Wirra" "201
6.AL"    "2016.B1"    "2016.B2"    "2016.B3"    "2016.EM"    "2016.MA"
[34] "2016.MV"    "2016.Wirra"
```

Dendrogram from cluster analysis from multi-site multi-year analysis across Sites and Years (using fa4 genetic model) and separable at (Site):ar1h(Year):ar1(Col):ar1(Row) Residual model.





The following is a biplot from a principal components analysis of the BLUPs for each Variety from each Site by Year. It shows which Site by Years are correlated (the angle between the arrows reflects the correlation) and also how the varieties perform at these SiteYears.


PC1
PC2
-0.4
-0.2
0.0
0.2
0.4
0.6
-4
-2
0
2
4
6
8
28
1
20
2013.AL
11
13
2016.B3
24
2013.MV
23
16
12
2015.B3
6
25
2013.B3
19
2014.B3
2016.MV
2014.B2
2015.WI
2013.CH
2014.MA
21
2014.B1

16. Variety Fact Sheets

Department of Agriculture and Fisheries

VARIETY "G" FACTSHEET

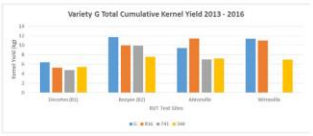
BACKGROUND

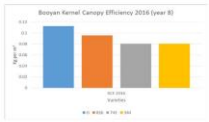
Variety "G" is a new Macadamia variety released to the industry as a result of the National Macadamia Industry Variety Improvement program. Data has been collected on the new macadamia varieties in Regional Variety Trials (RVT's) across production regions in Queensland and New South Wales. These trials have been measuring kernel, tree, disease and processing qualities for the past 2 years and nut-in-shell yield for 4 years. The data presented below comes from these trial sites.

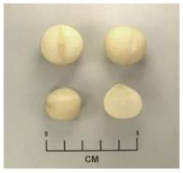
8 year old variety "G" tree at Booyan

DESCRIPTION

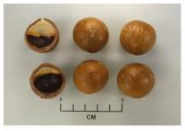
Variety "G" is a precocious, medium to tall, spreading tree with a moderately dense canopy. Cumulative kernel yield over the past 4 years at the Booyan RVT site (2013 – 2016) was 11.7 kg compared with 816 (10kg), 741 (9.9kg) and 344 (7.6kg). "G" has a canopy efficiency (grams of kernel per m^3 of tree volume) of more than 111 grams at the Booyan RVT trial site compared to 816 with 95g, 741 with 80g and 344 with 80g/m^3 from 8 year old trees.







Variety "G" kernel



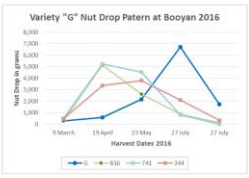
Variety "G" nut and shell

Horticulture Innovation Australia

Queensland Government

Variety "G" has a kernel recovery between 40.3% and 42.9% in the Bundaberg region compared with 816 (45%), 741 around 38% and 344 at 34%.

"G" flowers mid-season with a nut drop pattern mid- to late season with the peak in July.



"G" has a low to moderate rating of sticktights (2.5 out of 5 rated by growers) and low susceptibility to husk spot (<1 out of 5) from disease ratings at Bundaberg sites, Booyan and Wirrawilla. Trials at Wirrawilla with 8 year old trees show no evidence of Abnormal Vertical Growth (AVG) and rated 0 out of 2 while the industry standard 344 rated 1.36 out of 2.

Growers at recent field days commented on the open tree form and the yield potential of "G" in Alstonville and Bundaberg sites. Growers in Alstonville rated its commercial potential at 7.22 out of 9, 816 was rated 6.85 and 741, 6.66 out of 9. At the Booyan RVT site variety "G" had an average rating for commercial potential of 7.04 out of 9 while 741 averaged 7.21 out of 9.

Variety G Yield and Tree Comparison
Booyan RVT Site, 2016

Variety	G	816	741	344
Kernel Recovery (%)	42.9	45.2	38.3	34.2
Cumulative Kernel Yield (kg) 1	11.684	9.976	9.901	7.577
kernel Canopy Efficiency (g/m3) 2	114	95	78	83
Tree Volume (m3)	40.4	39.2	49	37.7
Kernel KG per Ha (estimated) 3	1,443	1,172	1,205	976

1 - Cumulative Kernel Yield 2013 -
2 - 2016 (year 8) Kernel Canopy Efficiency
3 - Estimated kernel yield (kg/ha) for 312.5 trees per ha or 8m x 4m

DISCLAIMER

The above information is sourced from the eight Regional Variety Trial (RVT) sites in Queensland and New South Wales. This is the best available information on variety performance with a maximum age of eight years old. Each RVT site is randomised and replicated with yield data collected from 2013 to 2016. The information provided here may not be suitable for all sites or regions as varieties perform differently in different locations. The Queensland Department of Agriculture and Fisheries, and Horticulture Innovation Australia provides the above information as a guide only and take no responsibility for the performance of the varieties on individual farms.

Department of Agriculture and Fisheries

VARIETY "J" FACTSHEET

BACKGROUND

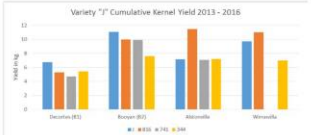
Variety "J" is a new Macadamia variety released to the industry as a result of the National Macadamia Industry Variety Improvement program. Data has been collected on the new macadamia varieties from Regional Variety Trials (RVT's) across production regions in Queensland and New South Wales. These trials have been measuring kernel, tree, disease and processing qualities for the past 2 years and nut-in-shell yield for 4 years.

8 year old variety "J" at Booyan

DESCRIPTION

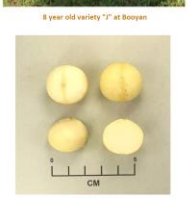
Variety "J" is a moderately large, spreading tree. Tree volumes at Booyan, Bundaberg, are 40.5m^3 while 816 is 39.2m^3, 741, 49m^3 and 344, 37.7m^3 for 8 year old trees.

Variety "J" has a cumulative kernel yield for the 4 years 2013 to 2016 of 11.041kg for 8 year old trees at the Booyan RVT. In the same trial site 816 had 9.976kg, 741 had 9.901kg and 344 had 7.577kg.



Variety "J" has a kernel recovery of 46% in the Bundaberg region compared with 816 (45%), 741 (38%) and 344 at 34%. Trees of "J" have a canopy efficiency of 106g/m^3 at the Booyan RVT site. At the same site 816 was 95g/m^3, 741 was 78g/m^3 and 344 was 83g/m^3.

"J" flowers mid-late season in September with a peak harvest season in July in Bundaberg. Nut drop is mid to late season. Most of the nuts fall in July in Booyan.



Variety "J" kernel

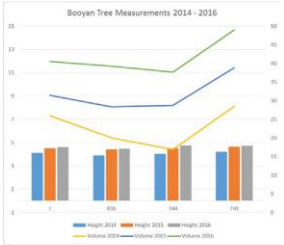
Variety "J" nut and shell

Horticulture Innovation Australia

Queensland Government

"J" is a similar size tree to 816 but smaller than 741 and out-yielding these industry standards in some blocks in Bundaberg.

Trees of "J" have a low rating (0.25 out of 5) for husk spot at Wirrawilla however it does have a low to moderate level of sticktights. Trials at Wirrawilla with 8 year old trees show no evidence of Abnormal Vertical Growth (AVG) and rated 0 out of 2 while the industry standard 344, rated 1.36 out of 2.



Variety "J" Yield and Tree Comparison
Booyan

Variety	J	816	741	344
Kernel Recovery (%)	44	45.2	38.3	34.2
Cumulative Kernel Yield (kg) 1	11.041	9.976	9.901	7.577
kernel Canopy Efficiency (g/m3) 2	106	95	78	83
Tree Volume (m3)	40.5	39.2	49	37.7
Kernel KG per Ha (estimated) 3	1,398	1,172	1,205	976

1 - Cumulative Kernel Yield 2013 - 2016
2 - 2016 (year 8) Kernel Canopy Efficiency
3 - Estimated kernel yield (kg/ha) for 312.5 trees per ha or 8m x 4m

DISCLAIMER

The above information is sourced from the eight Regional Variety Trial (RVT) sites in Queensland and New South Wales. This is the best available information on variety performance with a maximum age of eight years old. Each RVT site is randomised and replicated with yield data collected from 2013 to 2016. The information provided here may not be suitable for all sites or regions as varieties perform differently in different locations. The Queensland Department of Agriculture and Fisheries, and Horticulture Innovation Australia provides the above information as a guide only and take no responsibility for the performance of the varieties on individual farms.

Department of Agriculture and Fisheries

VARIETY "P" FACTSHEET

BACKGROUND

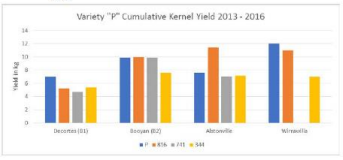
Variety "P" is a new Macadamia variety released to the industry as a result of the National Macadamia Industry Variety Improvement program. Data has been collected on the new macadamia varieties in Regional Variety Trials (RVT's) across production regions in Queensland and New South Wales. These trials have been measuring kernel, tree, disease and processing qualities for the past 2 years and nut-in-shell yield for 4 years. The data presented below comes from these trial sites.

DESCRIPTION

Variety "P" is a precocious, small to medium, spreading tree with a moderately dense canopy. At the Booyan RVT site in Bundaberg at year 8 variety "P" has a tree volume of 31.4m³, while 816 is 39.2m³, 741 is 49m³ and 344 is 37.7m³. At the Alstonville RVT site variety "P" has a tree volume of 51.4m³, while 816 is 59.9m³, 741 is 61.5 and 344 is 55.5m³ at year 8.

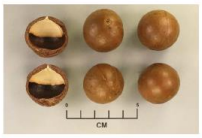
Based on RVT data "P" had a cumulative kernel yield over 4 years from 2013 to 2016 at Booyan of 10.1kg, while 816 was 10.4kg, 741 was 10.2kg and 344 was 7.9kg.

Variety "P" has kernel recovery of 39% at Booyan compared with 816 (45%), 741 at 38% and 344 at 34%.



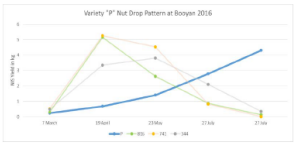
8 year old variety "P" at Booyan.

Variety "P" kernel.

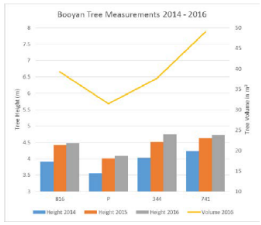


Variety "P" nut and shell.

"P" flowers mid-season with a late nut drop pattern. Most nuts fall from mid-July on. Early indications are "P" is responsive to Ethrel® treatment to assist even nut drop, with minimal leaf loss.



As variety "P" is a small tree, planting density could be increased to 400 trees (or more) per hectare rather than the industry standard of 312 trees per hectare. This could increase productivity at an earlier age.



Trees of "P" have a low rating (1 out of 5) for husk spot and sticktights, even though it drops its nuts late. At the Wirrawilla RVT site "P" had no symptoms of Abnormal Vertical Growth (AVG) and rated 0 out of 2. The standard industry variety 344, rated 1.36 out of 2 for AVG at the same site.

Rapid Hexanal testing, or storage ability, indicated kernel of "P" had an average Hexanal measurement of 24.03ppm while 816 measured 21.35ppm, 741 42.44ppm and 344 with 90.75ppm. Less than 50ppm Hexanal is considered to have a longer shelf life than 100ppm or above.

Growers at field days in Booyan and Wirrawilla, Bundaberg, rated "P" as 6.83 and 7.67 out of 9 respectively for commercial potential. 741 at Booyan was rated 7.21 out of 9 while 344 was rated 6.21 at Wirrawilla. At the NSW Alstonville site growers rated "P" 5.3 out of 9 while 741 was rated 6.85 and 816 6.38 out of 9. Worry about tree density was a common topic of "P" at Alstonville.

Variety "P" Yield and Tree Comparison				
Booyan				
Variety	P	816	741	344
Kernel Recovery (%)	38.9	45.2	38.3	34.2
Cumulative Kernel Yield (kg) 1	9.907	9.976	9.901	7.577
kernel Canopy Efficiency (g/m3) 2	123.1	95	78	83
Tree Volume (m3)	31.4	39.2	49	37.7
Kernel KG per Ha (estimated) 3	1,147	1,172	1,205	976
Kernel KG per Ha (estimated) 4	1,467			
1 - Cumulative Kernel Yield 2013 -				
2 - 2016 (year 8) Kernel Canopy				
3 - Estimated kernel yield (kg/ha) for 312.5 trees per ha or 8m x 4m				
4 - Estimated kernel yield (kg/ha) for 400 trees per ha				

DISCLAIMER

The above information is sourced from the eight Regional Variety Trial (RVT) sites in Queensland and New South Wales. This is the best available information on variety performance with a maximum age of eight years old. Each RVT site is randomised and replicated with yield data collected from 2013 to 2016. The information provided here may not be suitable for all sites or regions as varieties perform differently in different locations. The Queensland Department of Agriculture and Fisheries, and Horticulture Innovation Australia provides the above information as a guide only and take no responsibility for the performance of the varieties on individual farms.

Horticulture Innovation Australia

Queensland Government

Department of Agriculture and Fisheries

VARIETY "R" FACTSHEET

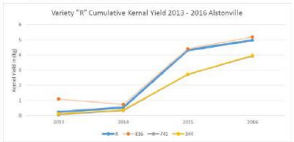
BACKGROUND

Variety "R" is a new Macadamia variety released to the industry as a result of the National Macadamia Industry Variety Improvement program. Data has been collected on the new macadamia varieties in Regional Variety Trials (RVT's) across production regions in Queensland and New South Wales. These trials have been measuring kernel, tree, disease and processing qualities for the past 2 years and nut-in-shell yield for 4 years. The data presented below comes from these trial sites.

DESCRIPTION

Variety "R" is a medium to large size, spreading tree. Tree volume at year 8 in Alstonville in northern NSW is 59m³, similar to 816 but smaller than 741 at 61m³, 344 at year 8 had a tree volume of 55m³.

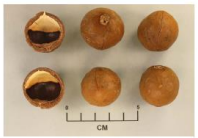
Variety "R" has a cumulative kernel yield per tree for years 2013 to 2016 of 10.063kg while 816 had a cumulative kernel yield of 11.416kg, 741 had 7.040kg and 344 7.182kg.



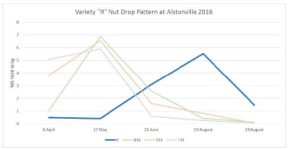
Variety "R" has a kernel recovery of 37% in Alstonville compared with 816 (45.7%), 741 (38%) and 344 at 34%. "R" flowers mid-late season in August/September at Bundaberg sites. Peak harvest season at the Alstonville RVT site is in August while 816, 741 and 344 peak in May/June.

8 year old variety "R" at Booyan

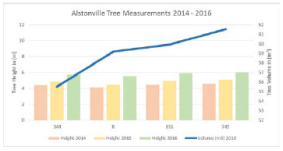
Variety "R" kernel



Variety "R" nut and shell



"R" is a similar size tree to 816 but smaller than 741. The spreading nature of R increases tree volume. 344 has a smaller tree volume of 55.5m³



than "R" at 59.2 m³, 816 of 59.9m³ and 741at 61.5m³.

Trees of "R" have a low rating (0.25 out of 5) for husk spot at Wirrawilla however it does have a low to moderate level of sticktights (2 out of 5). It shows no signs of Abnormal Vertical Growth (AVG) in Bundaberg trials.

Independent kernel assessment for Variety "R" from the Alstonville RVT site in 2016 had 67.9% whole kernel while 816 had 63.2%, 741 had 36.2 and 344 had 39.8% whole kernel from the same site.

Growers at a recent field walk in Alstonville rated Variety "R" 6.37 out of 9 while 816 was rated 6.38 and 741 rated at 6.85.

Variety "R" Yield and Tree Comparison				
Alstonville				
Variety	R	816	741	344
Kernel Recovery (%)	36.9	45.7	37.9	33.6
Cumulative Kernel Yield (kg) 1	10.065	11.416	7.04	7.182
Canopy Kernel Efficiency (g/m3) 2	72	91	67	65
Tree Volume (m3)	59.2	59.9	61.5	55.5
Kernel KG per Ha (estimated) 3	1,349	1,516	1,278	1,236
1 - Cumulative Kernel Yield 2013 - 2016				
2 - 2016 (year 8) Kernel Canopy Efficiency				
3 - Estimated kernel yield (kg/ha) for 312.5 trees per ha or 8m x 4m				

DISCLAIMER

The above information is sourced from the eight Regional Variety Trial (RVT) sites in Queensland and New South Wales. This is the best available information on variety performance with a maximum age of eight years old. Each RVT site is randomised and replicated with yield data collected from 2013 to 2016. The information provided here may not be suitable for all sites or regions as varieties perform differently in different locations. The Queensland Department of Agriculture and Fisheries, and Horticulture Innovation Australia provides the above information as a guide only and take no responsibility for the performance of the varieties on individual farms.

Horticulture Innovation Australia

Queensland Government

17. Events and Publications

Events

Consultants Meeting, 10th June 2015

Consultants Meeting 7th June 2017

DAF Breeders Meeting June 2015

Grower Field Walk Bundaberg, February 2016 – 25 growers.

Grower Field Walk Alstonville, February 2016 - >100 growers at 2 field walks.

Regional Variety Trial Field Walks - February 2016

Two sets of field walks were held at the Bundaberg and Alstonville RVT sites. Twenty-five growers attended the two Bundaberg sites, Booyan (B2) and Wirra, to look at the best performing industry bred selections, Hidden Valley Plantation (HVP) and standard industry varieties (Figure 3). Both sites were visited on the same day. Growers were shown the best three breeding selections, one standard industry variety and the best HVP variety. Growers were asked to fill in a rating sheet and evaluated the trees for estimated yield, Husk Spot severity, Stick Tight severity, tree size and overall commercial potential. Grower comments were also registered.

Similarly, in Alstonville, there were two separate field walks with more than 100 growers. At the Alstonville site there were five industry bred varieties displayed and two commercial standard varieties

Yield results from the two regions show varieties perform differently at different locations. This is the Genotype by Variety interaction, or G x E effect. What ranks well for yield in Bundaberg doesn't necessarily perform the same in Alstonville. Grower's perception of how they will perform at the two regions also varies. Varieties O and P commercial potential were rated quite differently between the regions because of canopy density. Although the growers did like the small tree size there were 125 comments on the density of these small trees at Alstonville. In the rich volcanic soils of the Alstonville plateau the small tree varieties were far too dense compared to the two sites in Bundaberg and were rated accordingly by the growers (Figures 4, 5 and 6). Variety G was well liked in both regions.

There is still one more year of harvesting in 2016 before any commercialisation decisions on the new varieties can be made. Grower assessments provide important backup information to objective yield measurements and post-harvest kernel assessment. All this data will aid in selecting potential new varieties for release in 2017. The Australian macadamia industry is currently valued at $250M and new varieties are seen as underpinning future industry growth.

Figure 17-1 Grower field walk Bundaberg 2016.

Inspecting new macadamia varieties at Booyan, Bundaberg. Trees were rated by the growers for potential yield, husk spot and stick tights, tree size and commercial potential. A story board of cumulative kernel yield, canopy kernel efficiency and estimated tonnes per hectare can be seen in the background

Rating 7 is considered commercial.

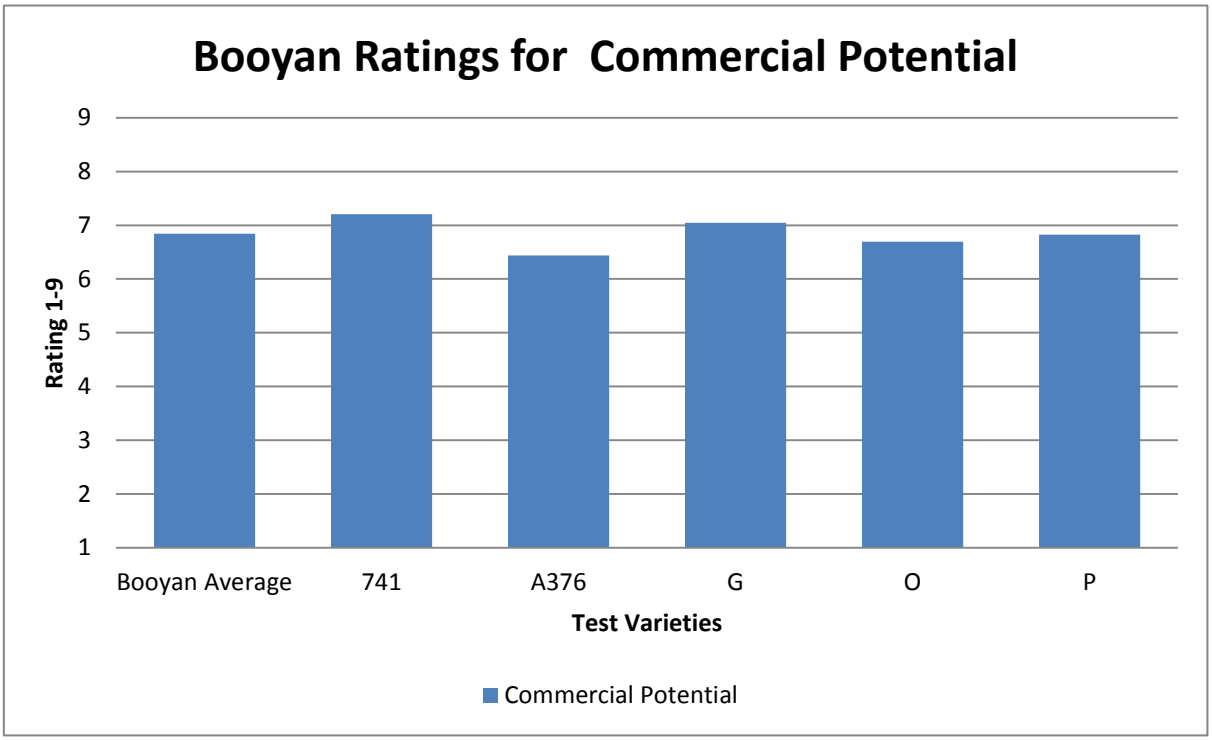


Figure 17-2 Grower ratings for commercial potential, Booyan 2016.

Rating 7 is considered commercial.

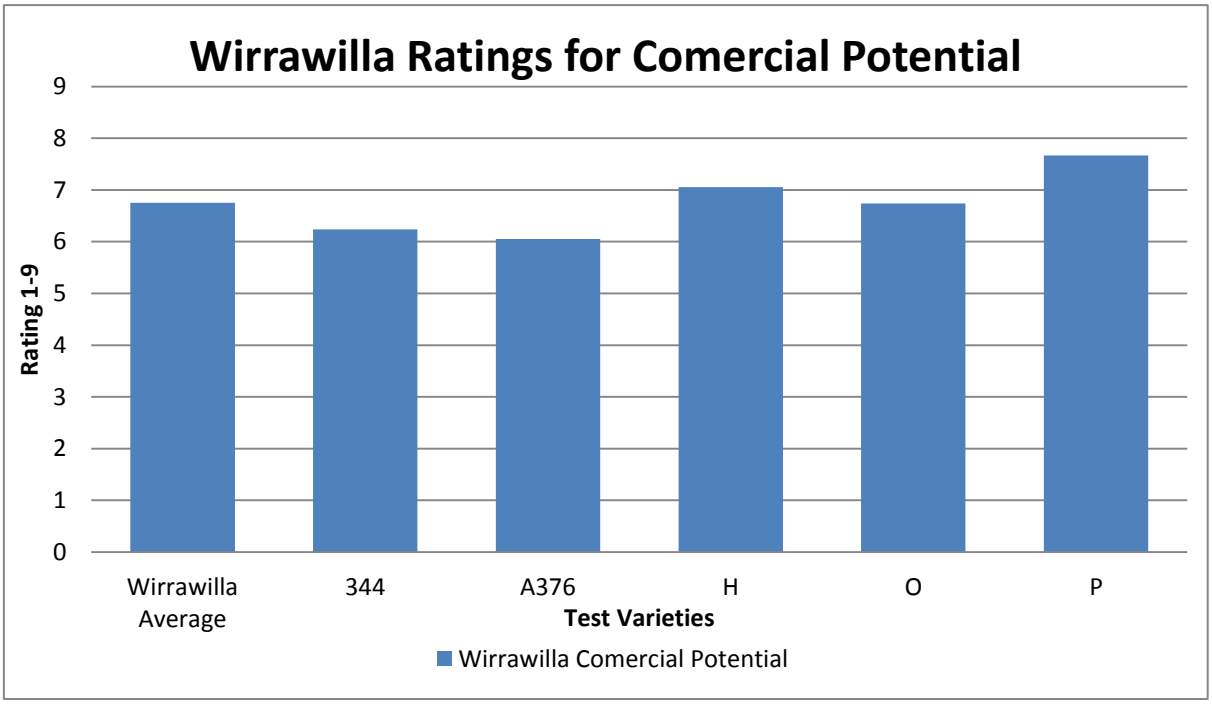


Figure 17-3 Grower ratings for commercial potential, Wirrawilla 2016.

Figure 6. Summary of grower ratings for Commercial Potential for new macadamia varieties at Alstonville, NSW. Rating 7 is considered commercial.

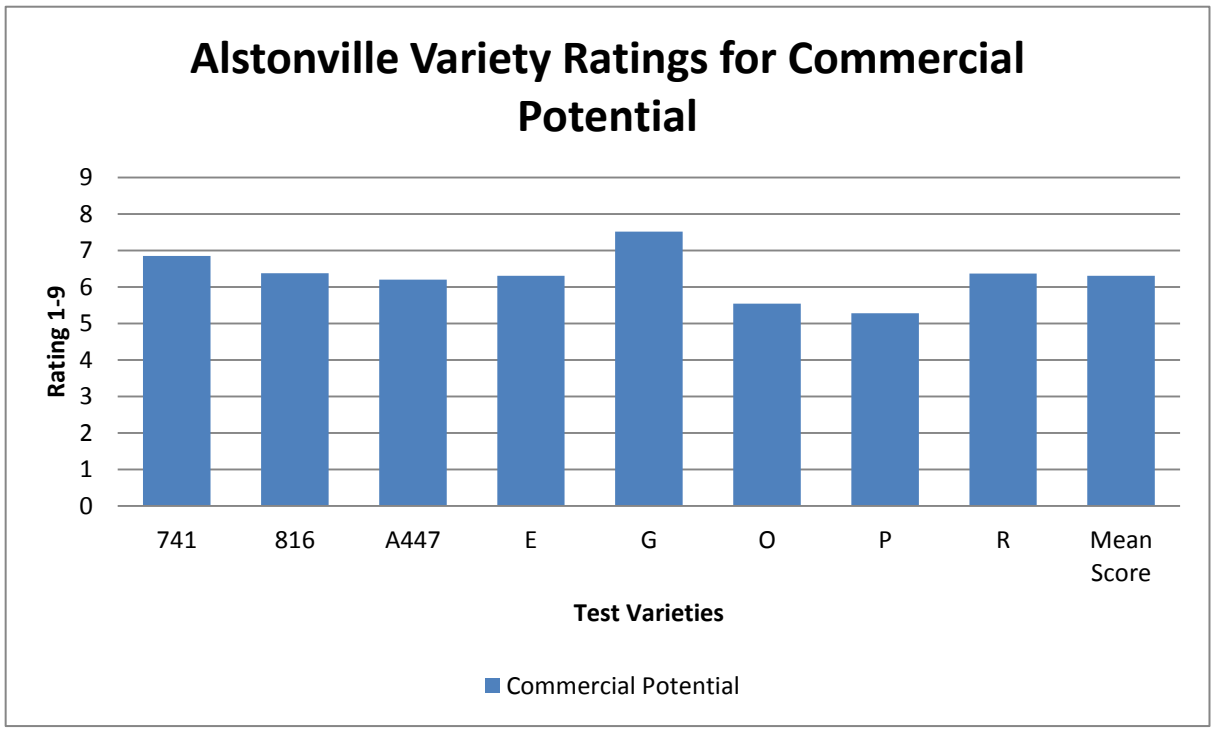


Figure 17-4 Grower ratings for commercial potential, Alstonville, 2016.

Grower Field Walk Bundaberg – 2nd March 2017

Grower Field Walk Alstonville 23rd March 2017

Regional Variety Trial Field Walks - March 2017

Growers evaluated the recently released, elite macadamia selections from the industry breeding program at Regional Variety Trial (RVT) field walks in March in Bundaberg and Alstonville. Varieties G, P and J have been chosen for release by the Macadamia Industry Varietal Improvement Committee (MIVIC) based on their performance to date in the Bundaberg region. Varieties G and R have been chosen for the northern rivers region based on their superior performance in Alstonville. The new selections were compared with the industry standards 741 and 816 in both locations.

Figure 17-5 Grower field walk Bundaberg 2017.

Bundaberg – 2nd March

MIVIC members and local macadamia growers rated the new selections at the RVT

sites at DeCortes and Booyan and at a nearby supplementary grower trial site.

There was strong interest in selection G and very strong interest in selection P. Husk spot was not rated as an issue on DeCortes and Booyan.

On the two RVT sites, growers estimated selection P had a higher yield to 816, in fact the highest estimated yield of the varieties assessed, but the tree canopy volume was only 50 to 60% of 816. P and G rated higher for overall commercial potential compared with 741 and 816 (Figure 5). G is considered a medium to large, productive and open tree while P is small to medium, spreading and precocious.

Grower comments for P included:

- "Very open tree, excellent yield and canopy".
- "Most promising"
- "Suitable as a high density tree"

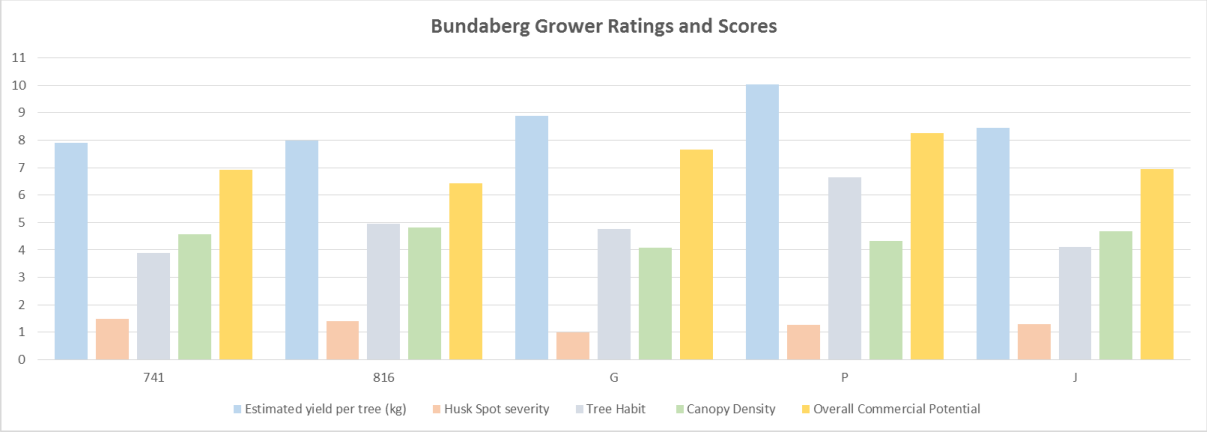


Figure 17-6 Mean grower rating and scores Bundaberg 2017.

Alstonville – 23rd March

NSW growers and MIVIC rated selection G the best performing variety compared to the industry standards (Figure 6). Growers considered G to have higher commercial potential (mean rating of 7.6) than 741 (6.5) and 816 (6.9). P did not rate as highly in Alstonville (7.6 out of 9) as it did in Bundaberg as growers considered the dense canopy may impede light and spray penetration. P had the densest canopy with a mean rating of 7.6 compared with G (5.9) and 741 (5.1). It is important to note that the canopy of P was not rated as dense (mean score of 4.3 out of 9) at the Bundaberg RVT sites.

Grower comments about selection G included:

- "Crops well from top to bottom"
- "Even yield throughout tree, no nut on outside - suitable to hedge".

Results from the grower evaluations indicate that selections G and P are more suited to the Bundaberg region while G is suited to Alstonville. Feedback from the field walks indicates that G is considered an "all-rounder" being precocious and high yielding in both locations. P appears to be best suited to the Bundaberg coastal plain.

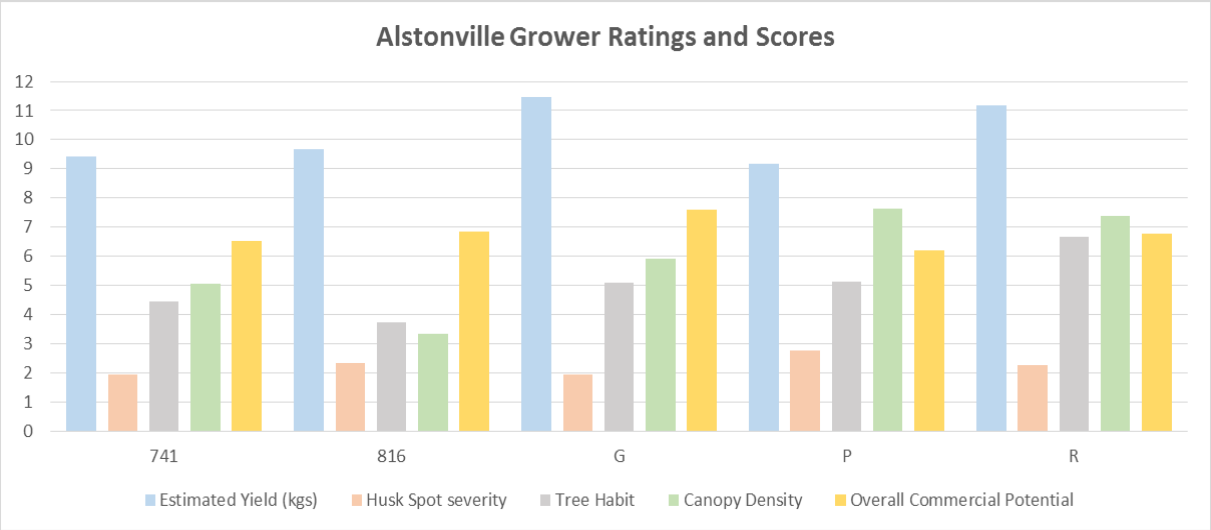


Figure 17-8 Mean grower rantings, Alstonville 2017.

Figure 17-7 Grower field walk, Alstonville 2017.

MIVIC Field Walk, 23rd September 2015

MIVIC Field Walk 14th February 2016

MIVIC Variety Selection Meeting, 1st December 2016.

MIVIC Field Walk, 2nd March 2017

QAAFI Breeding Review November 2017

Supplementary Growers Meeting December 2014

Supplementary Growers Meeting December 2015

Supplementary Growers Meeting 30th November 2016

Publications

Macadamia Variety Fact Sheets – MIV1-G, MIV1-J, MIV1-P and MIV1-R

D. Russell; J. De Faveri; C. Hardner; D. Bell; S. Mulo ; G. Bignell and B. Topp 2017.- **Four new macadamia varieties for the Australian industry.** Poster and abstract. International Macadamia Conference, Hawaii, October 2017

E. Howell, D. Russell, M. Alam and B. Topp., 2016 **Variability of initial and final nut setting in Macadamia superior selections through different pollination methods.** Poster presentation ISHS meetings, Cairns 2016.

D. Russell, R, Daley, J. De Faveri, G. Bignell and P. O'Hare, 2015. **Macadamia Varieties for the 21st Century - Regional Variety Trials UPDATE**.AMS News Bulletin, Nov., 43 (4):69-70.

Dougal Russell, and Paul O'Hare,. 2017. **Regional Variety Trial Field Walks for 2017.** AMS News Bulletin, May 2017.

18. Macadamia Variety Descriptor Index

Regional Variety Trial
Series 3 - Phase 2

MACADAMIA VARIETY DESCRIPTOR INDEX

Dougal Russell, Rachel Abel and Rod Daley

Department of Agriculture and Fisheries

Maroochy Research Facility, Nambour and Bundaberg Research Facility, Bundaberg

AUSTRALIAN MACADAMIA SOCIETY

Horticulture Innovation Australia

Queensland Government

Variety A376

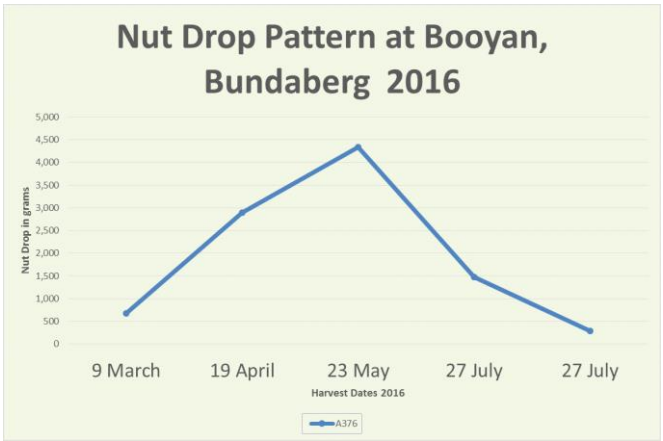
Test Genotype 1

Tree Traits

Tree Shape	Variable tree shape
Tree Height	Tall
Tree Canopy	Very large, moderate density canopy
Nut Drop Pattern	Early / Mid
Tree Sticktights	Few sticktights
Nuts - Bunching	Few compressed to slightly open bunches
Nut Clustering	Many singles

AVG Score (0 - 2) 0

Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern A376

Leaf Traits

Leaf Whorls	Primarily 3 leaf whorls with occasional 4 leaf whorls
Leaf Shape	Short, medium width leaf with a variable oblanceolate shape
Petiole Length	Medium to long petiole
Leaf Tip Shape	Slightly pointed to rounded tip
Leaf Spine	Zero to few spines in variable location on leaf
Leaf Undulation	Moderate undulations

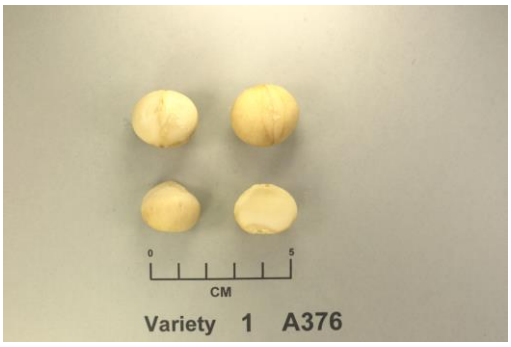
Variety A376

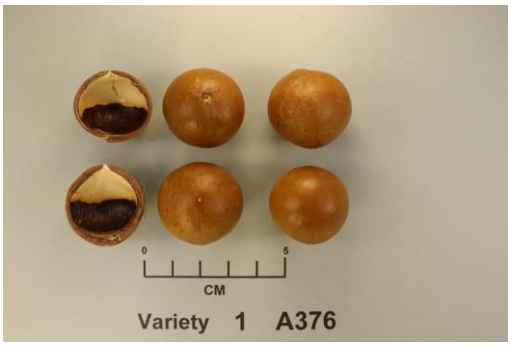
Test Genotype 1

Nut Traits

Husk Stalk Widt	Thin stalk
Husk Thickness	Medium husk thickness
Surface	Light green husk, rough primarily near apical point
Apical Point	Medium size, generally in-line apical point
Neck	Large neck
Shell Flecking	Few blocky flecks
Shell Suture	Suture distinct near micropile
Shell Shape	Smooth, slight elipsoid with ridge near hilum and grooves
Shell Micropile	Medium micropile with halo
Shell Hilum	Small hilum
Shell Colour	Glossy, dark brown hue
Kernel Recovery	Very High
Kernel Size	Large
Kernel Whole	Mid range % of whole nuts

Mean TKR % 44.2





Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016: 0

Husk Rot Score (0 - 2) Wirrawilla 2016: 0

Mean % of nuts with Husk Spot Alstonville 2016

Mean % FSB loss Alstonville

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

Variety C

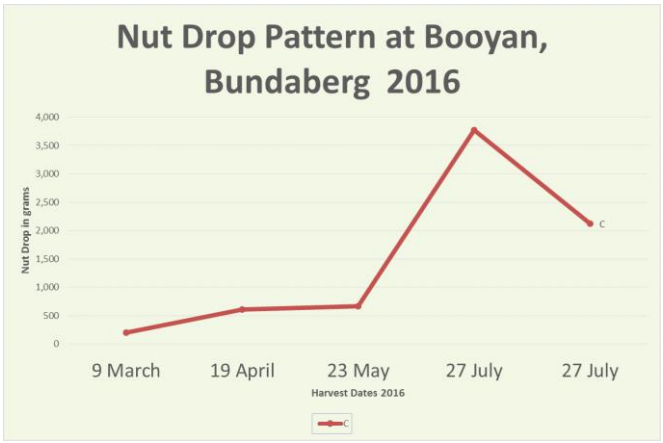
Test Genotype 2

Tree Traits

Tree Shape	Upright, oval to columnar
Tree Height	Medium height
Tree Canopy	Very small, open canopy
Nut Drop Pattern	Consistent, variable peak
Tree Sticktights	Few sticktights
Nuts - Bunching	Few compressed bunches
Nut Clustering	Primarily singles and doubles

AVG Score (0 - 2) 0

Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern C

Leaf Traits

Leaf Whorls	3 Leaf Whorls
Leaf Shape	Medium to short length, medium width leaf with a oblanceolate shape
Petiole Length	Short petiole
Leaf Tip Shape	Pointed to slightly pointed tip
Leaf Spine	Variable number of spines located on tip or all around leaf
Leaf Undulation	Low undulations

Variety C

Test Genotype 2

Nut Traits

Husk Stalk Widt	Thin stalk
Husk Thickness	Medium husk thickness
Surface	Smooth husk
Apical Point	Small, offset apical point
Neck	Small neck
Shell Flecking	Moderate blocky flecks
Shell Suture	Suture distinct near micropile
Shell Shape	Lightly textured, slight elipsoid with bulge and dent
Shell Micropile	Medium micropile with halo
Shell Hilum	Small hilum
Shell Colour	Dull, light brown hue
Kernel Recovery	Moderate to high
Kernel Size	Small to medium
Kernel Whole	Greater % of whole nuts

Mean TKR % 34

Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016	0	Husk Rot Score (0 - 2) Wirrawilla 2016	0
Mean % of nuts with Husk Spot Alstonville 2016	1.11	Mean % FSB loss Alstonville	0

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

Variety A403

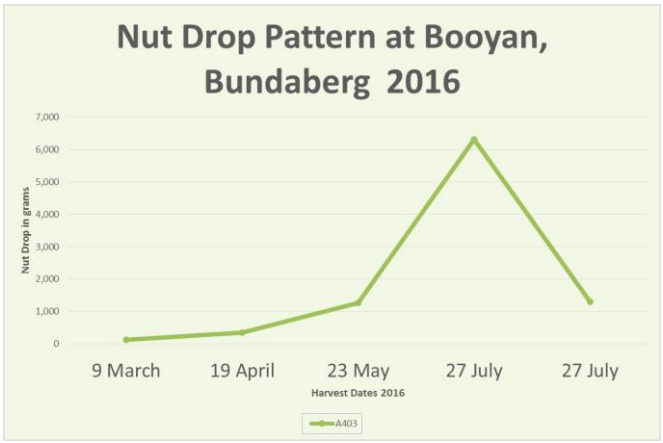
Test Genotype 3

Tree Traits

Tree Shape	Generally round
Tree Height	Medium height
Tree Canopy	Medium to large, moderate density canopy
Nut Drop Pattern	Consistent, generally mid peak
Tree Sticktights	Moderate to few sticktights
Nuts - Bunching	Moderate levels of compressed to slightly open bunching
Nut Clustering	Many singles with some doubles and triples

AVG Score (0 - 2) 0

Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern A403

Leaf Traits

Leaf Whorls	Primarily 3 leaf whorls with occasional 4 leaf whorls
Leaf Shape	Short to medium length, medium width leaf with a oblanceolate shape
Petiole Length	Medium petiole
Leaf Tip Shape	Slightly pointed to rounded tip
Leaf Spine	Moderate level of spines located all around the leaf
Leaf Undulation	Moderate undulations

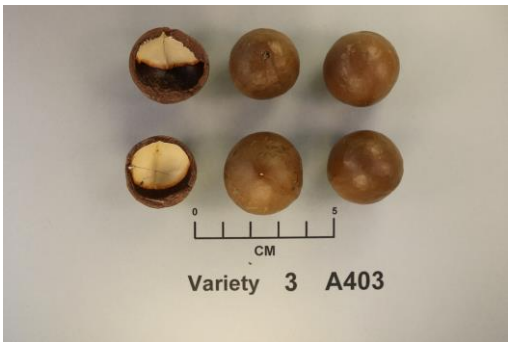
Variety A403

Test Genotype 3

Nut Traits

Husk Stalk Widt	Medium stalk
Husk Thickness	Medium husk thickness
Surface	Smooth husk
Apical Point	Medium to large apical point
Neck	Medium neck
Shell Flecking	Few blocky flecks near hilum
Shell Suture	Suture not distinct
Shell Shape	Smooth, slight elipsoid with bulge, ridge near hilum and grooves
Shell Micropile	Medium micropile
Shell Hilum	Small hilum
Shell Colour	Very dark brown hue
Kernel Recovery	High
Kernel Size	Medium
Kernel Whole	Greater % of whole nuts

Mean TKR % 42.6



Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016 0

Husk Rot Score (0 - 2) Wirrawilla 2016 0

Mean % of nuts with Husk Spot Alstonville 2016

Mean % FSB loss Alstonville

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

Variety Q

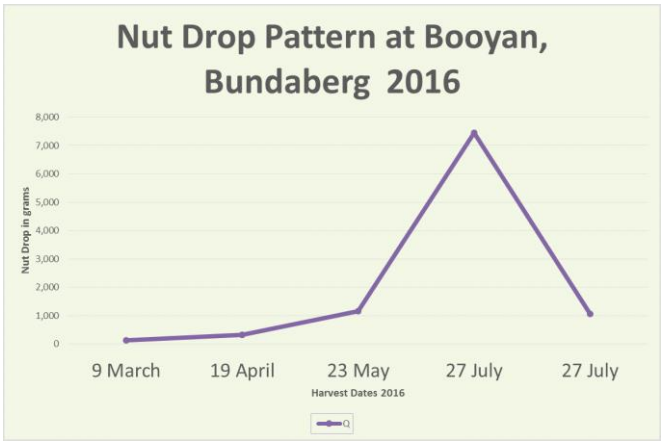
Test Genotype 4

Tree Traits

Tree Shape	Round
Tree Height	Short
Tree Canopy	Dense, variable volume canopy
Nut Drop Pattern	Consistent, mid to late peak
Tree Sticktights	Few sticktights
Nuts - Bunching	Few compressed to open bunches
Nut Clustering	Variable raceme number

AVG Score (0 - 2) 0.25

Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern Q

Leaf Traits

Leaf Whorls	Primarily 3 leaf whorls with occasional 4 leaf whorls
Leaf Shape	Medium to long length, medium width leaf with a variable shape
Petiole Length	Short to medium petiole
Leaf Tip Shape	Variable tip shape
Leaf Spine	Moderate level of spines located all around the leaf
Leaf Undulation	Extensive undulations

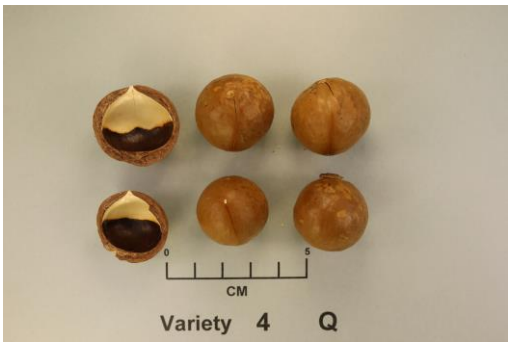
Variety Q

Test Genotype 4

Nut Traits

Husk Stalk Widt	Medium to thick stalk
Husk Thickness	Medium to thick husk
Surface	Smooth husk
Apical Point	Small to medium, occassionally off-set
Neck	Small to no neck
Shell Flecking	Moderate blocky flecks near hilum
Shell Suture	Suture distinct near micropile
Shell Shape	Lightly textured, round with slight bulge
Shell Micropile	Very large micropile with halo
Shell Hilum	Small hilum
Shell Colour	Glossy, light brown hue
Kernel Recovery	Moderate
Kernel Size	Small
Kernel Whole	Greater % of whole nuts

Mean TKR % 32.8



Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016	0.75	Husk Rot Score (0 - 2) Wirrawilla 2016	0
Mean % of nuts with Husk Spot Alstonville 2016	2.65	Mean % FSB loss Alstonville	0.8

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

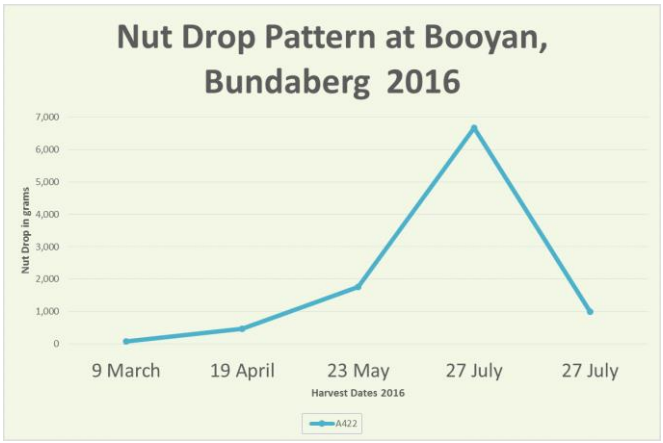
Variety A422

Test Genotype 5

Tree Traits

Tree Shape	Round	AVG Score (0 - 2) 0
Tree Height	Medium height	
Tree Canopy	Medium canopy volume with moderate density	
Nut Drop Pattern	Consistent, generally mid peak	
Tree Sticktights	Few sticktights	
Nuts - Bunching	Few open bunches	
Nut Clustering	Primarily singles and doubles	

Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern A422

Leaf Traits

Leaf Whorls	3 Leaf Whorls
Leaf Shape	Wide, medium length leaf with oblanceolate shape
Petiole Length	Medium to long petiole
Leaf Tip Shape	Generally rounded tip
Leaf Spine	Moderate to many spines located all around the leaf
Leaf Undulation	Extensive undulations

Variety A422

Test Genotype 5

Nut Traits

Husk Stalk Widt	Thin to medium stalk
Husk Thickness	Thin husk
Surface	Smooth, dull, dark green husk
Apical Point	Medium, in-line apical point
Neck	Medium neck
Shell Flecking	Few blocky flecks near hilum
Shell Suture	Suture not distinct
Shell Shape	Smooth, round with bulge
Shell Micropile	Large micropile
Shell Hilum	Small hilum
Shell Colour	Glossy, dark brown hue
Kernel Recovery	High
Kernel Size	Small to medium
Kernel Whole	Greater % of whole nuts

Mean TKR % 40.5

Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016 0

Husk Rot Score (0 - 2) Wirrawilla 2016 0

Mean % of nuts with Husk Spot Alstonville 2016

Mean % FSB loss Alstonville

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

Variety J

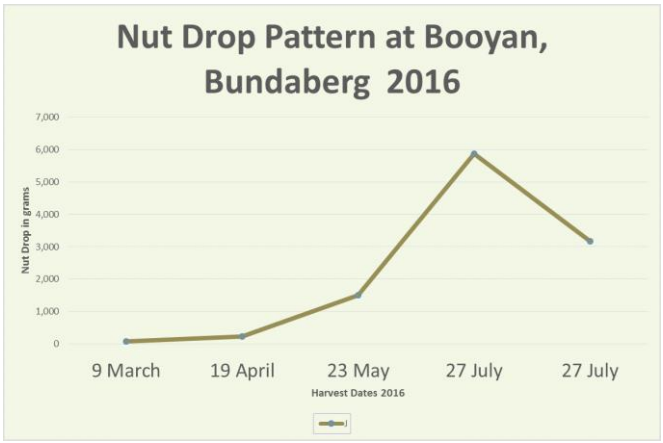
Test Genotype 6

Tree Traits

Tree Shape	Slightly spreading to round
Tree Height	Tall
Tree Canopy	Very large, moderate density canopy
Nut Drop Pattern	Consistent, mid to late peak
Tree Sticktights	Moderate to few sticktights
Nuts - Bunching	Few compressed to open bunches
Nut Clustering	Primarily singles and doubles

AVG Score (0 - 2) 0

Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern J

Leaf Traits

Leaf Whorls	Primarily 3 leaf whorls with occasional 4 and 5 leaf whorls
Leaf Shape	Short, wide variable shaped leaf
Petiole Length	Short petiole
Leaf Tip Shape	Slightly pointed to rounded tip
Leaf Spine	Variable number of spines located all around leaf
Leaf Undulation	Moderate undulations

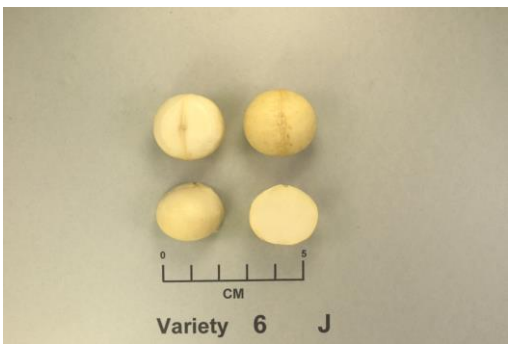
Variety J

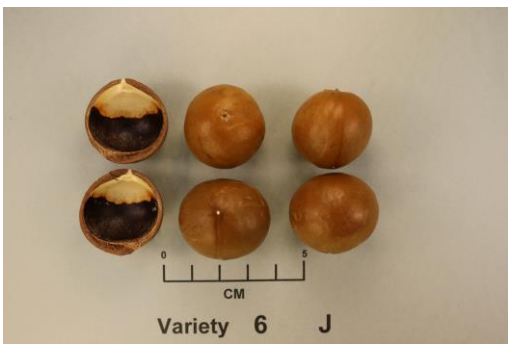
Test Genotype 6

Nut Traits

Husk Stalk Widt	Thick stalk
Husk Thickness	Medium husk thickness
Surface	Smooth husk
Apical Point	Small to medium, off-set apical point
Neck	Small to no neck
Shell Flecking	No flecking
Shell Suture	Suture sometimes cracked
Shell Shape	Smooth, round with ridge near hilum and one groove
Shell Micropile	Very large micropile
Shell Hilum	Medium hilum
Shell Colour	Glossy, light brown hue
Kernel Recovery	High
Kernel Size	Very Large
Kernel Whole	Lower % whole nuts

Mean TKR % 44.8





Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016	0.25	Husk Rot Score (0 - 2) Wirrawilla 2016	0.25
Mean % of nuts with Husk Spot Alstonville 2016	0.00	Mean % FSB loss Alstonville	0.4

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

Variety B

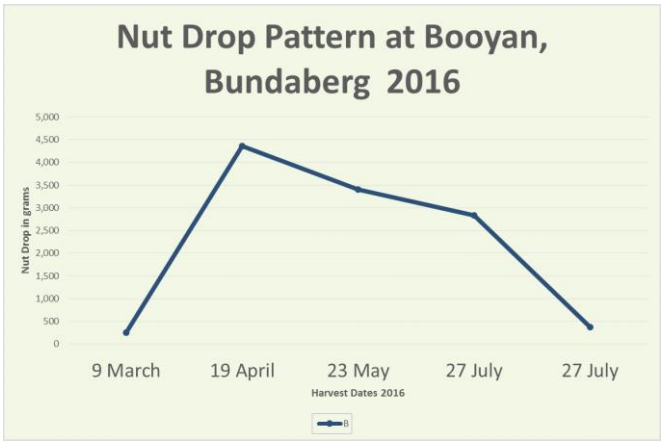
Test Genotype 7

Tree Traits

Tree Shape	Round with a turkey neck
Tree Height	Tall
Tree Canopy	Variable canopy volume with moderate density
Nut Drop Pattern	Generally consistent, early to mid peak
Tree Sticktights	Few sticktights
Nuts - Bunching	Few slightly open bunches
Nut Clustering	Variable raceme number

AVG Score (0 - 2) 0

Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern B

Leaf Traits

Leaf Whorls	3 Leaf Whorls
Leaf Shape	Narrow, medium length leaf with oblanceolate shape
Petiole Length	Short petiole
Leaf Tip Shape	Pointed to slightly pointed tip
Leaf Spine	Moderate level of spines located all around the leaf
Leaf Undulation	Moderate undulations

Variety B

Test Genotype 7

Nut Traits

Husk Stalk Widt	Medium to thick stalk
Husk Thickness	Medium husk thickness
Surface	Smooth, light green husk
Apical Point	Small, in-line apical point
Neck	Small to no neck
Shell Flecking	Moderate blocky to striped fleck
Shell Suture	Suture prone to cracking
Shell Shape	Smooth, round with slight bulge and grooves
Shell Micropile	Small micropile
Shell Hilum	Medium hilum with adhered husk
Shell Colour	Dull, dark brown hue
Kernel Recovery	Moderate to high
Kernel Size	Medium
Kernel Whole	Lower % whole nuts

Mean TKR % 33.9

Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016	0	Husk Rot Score (0 - 2) Wirrawilla 2016	0.5
Mean % of nuts with Husk Spot Alstonville 2016	1.18	Mean % FSB loss Alstonville	0

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

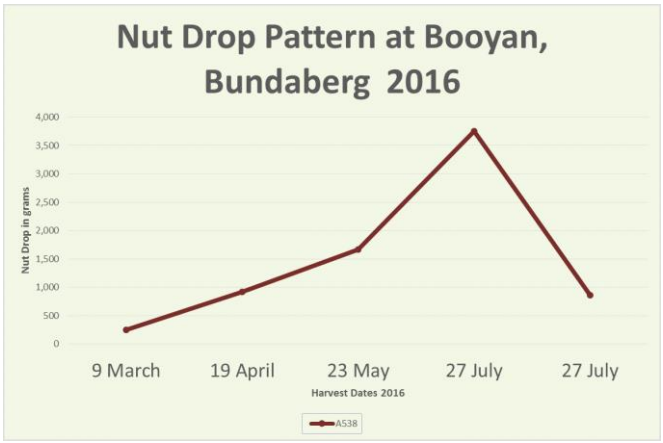
Variety A538

Test Genotype 8

Tree Traits

Tree Shape	Slightly spreading to slightly upright	AVG Score (0 - 2)	0
Tree Height	Very Short		
Tree Canopy	Small, dense canopy		
Nut Drop Pattern	Early / Mid		
Tree Sticktights	Moderate to many sticktights		
Nuts - Bunching	Few generally open bunches		
Nut Clustering	Singles, doubles and triples very common		

Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern A538

Leaf Traits

Leaf Whorls	Primarily 3 leaf whorls with a few 4 leaf whorls
Leaf Shape	Medium to long, wide leaf with an elliptic shape
Petiole Length	Medium to long petiole
Leaf Tip Shape	Pointed tip
Leaf Spine	Many spines located all around the leaf
Leaf Undulation	Moderate undulations

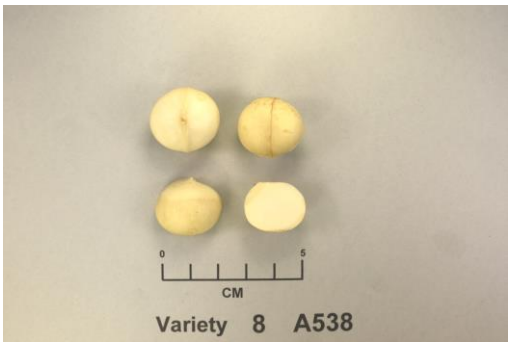
Variety A538

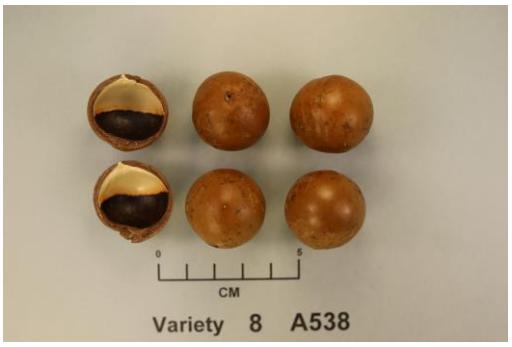
Test Genotype 8

Nut Traits

Husk Stalk Widt	Medium to thick stalk
Husk Thickness	Thick husk
Surface	Smooth husk
Apical Point	Medium to large, slightly off-set apical point
Neck	Small to medium neck
Shell Flecking	Few blocky flecks
Shell Suture	Distinct suture
Shell Shape	Smooth, elipse with ridge near hilum and one groove
Shell Micropile	Medium micropile
Shell Hilum	Small hilum with halo
Shell Colour	Glossy, dark brown hue
Kernel Recovery	High
Kernel Size	Medium to large
Kernel Whole	Mid range % of whole nuts

Mean TKR % 41.9





Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016: 0

Husk Rot Score (0 - 2) Wirrawilla 2016: 0

Mean % of nuts with Husk Spot Alstonville 2016

Mean % FSB loss Alstonville

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

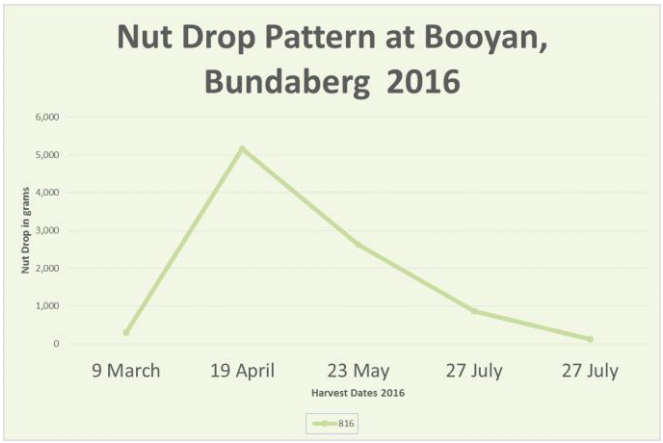
Variety 816

Test Genotype 9

Tree Traits

Tree Shape	Variable tree shape	AVG Score (0 - 2)	0
Tree Height	Very Tall		
Tree Canopy	Medium to very large, moderately open canopy		
Nut Drop Pattern	Early / Mid		
Tree Sticktights	Moderate sticktights		
Nuts - Bunching	Few generally open bunches		
Nut Clustering	Singles common		

Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern 816

Leaf Traits

Leaf Whorls	3 Leaf Whorls
Leaf Shape	Medium to long, narrow leaf with oblanceolate shape
Petiole Length	Medium to long petiole
Leaf Tip Shape	Rounded tip
Leaf Spine	Zero to few spines generally located basally
Leaf Undulation	Moderate undulations

Variety 816

Test Genotype 9

Nut Traits

Husk Stalk Widt	Thick stalk
Husk Thickness	Medium husk thickness
Surface	Lightly textured, light green husk
Apical Point	Small to medium, off-set apical point
Neck	Medium neck
Shell Flecking	Few blocky flecks
Shell Suture	Distinct suture
Shell Shape	Lightly textured and round
Shell Micropile	Small micropile with halo
Shell Hilum	Small hilum
Shell Colour	Dull, light brown hue with distinct white film
Kernel Recovery	Very High
Kernel Size	Large to very large
Kernel Whole	Mid range % of whole nuts

Mean TKR % 44.1

Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016	0.25	Husk Rot Score (0 - 2) Wirrawilla 2016	0.25
Mean % of nuts with Husk Spot Alstonville 2016	0.27	Mean % FSB loss Alstonville	5

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

Variety A16

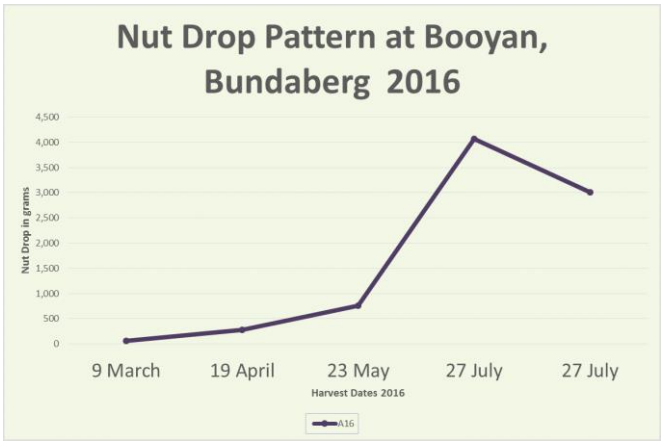
Test Genotype 10

Tree Traits

Tree Shape	Oval
Tree Height	Short
Tree Canopy	Very small, slightly dense canopy
Nut Drop Pattern	Consistent, variable peak
Tree Sticktights	Few sticktights
Nuts - Bunching	Few generally open bunches
Nut Clustering	Generally singles and doubles

AVG Score (0 - 2) 0

Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern A16

Leaf Traits

Leaf Whorls	Primarily 3 leaf whorls with consistent 4 leaf whorls
Leaf Shape	Short, wide variable elliptic shaped leaf
Petiole Length	Short petiole
Leaf Tip Shape	Pointed to slightly pointed tip
Leaf Spine	Few spines generally located at tip
Leaf Undulation	Moderate undulations

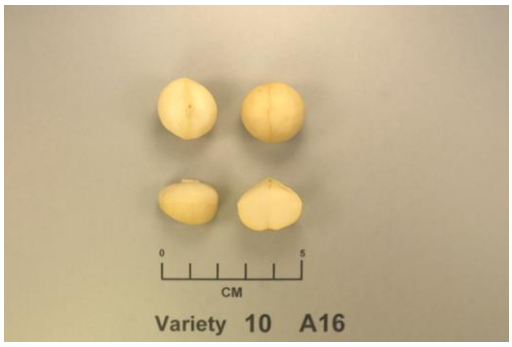
Variety A16

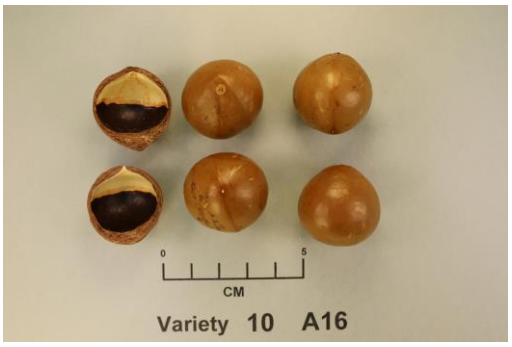
Test Genotype 10

Nut Traits

Husk Stalk Widt	Thick stalk
Husk Thickness	Thick husk
Surface	Smooth, dark green husk
Apical Point	Medium, in-line apical point
Neck	Small neck
Shell Flecking	Moderate blocky to striped fleck near micropile
Shell Suture	Distinct suture
Shell Shape	Smooth, elipse with prominent bulge and dent. Ridge near pointed hilu
Shell Micropile	Large micropile
Shell Hilum	Medium hilum
Shell Colour	Glossy, dark brown hue
Kernel Recovery	High, variable
Kernel Size	Medium to large
Kernel Whole	Mid range % of whole nuts

Mean TKR % 39.7





Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016	2	Husk Rot Score (0 - 2) Wirrawilla 2016	0.5
Mean % of nuts with Husk Spot Alstonville 2016	2.49	Mean % FSB loss Alstonville	1.7

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

Variety F

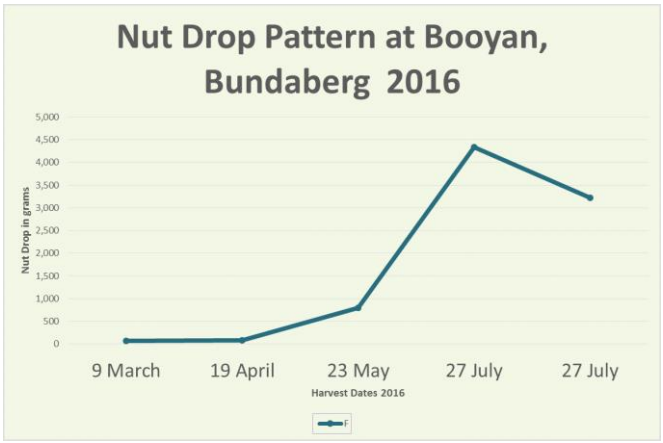
Test Genotype 11

Tree Traits

Tree Shape	Slightly spreading, round tree
Tree Height	Tall
Tree Canopy	Medium canopy volume with moderate density
Nut Drop Pattern	Generally mid / late
Tree Sticktights	Many sticktights
Nuts - Bunching	Few to moderate levels of generally open bunches
Nut Clustering	Mostly singles

AVG Score (0 - 2) 0

Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern F

Leaf Traits

Leaf Whorls	Primarily 3 leaf whorls with consistent 4 leaf whorls
Leaf Shape	Medium to short, medium width leaf with oblanceolate shape
Petiole Length	Medium petiole
Leaf Tip Shape	Slightly pointed to rounded tip
Leaf Spine	Few to moderate spines generally located all around leaf
Leaf Undulation	Low undulations

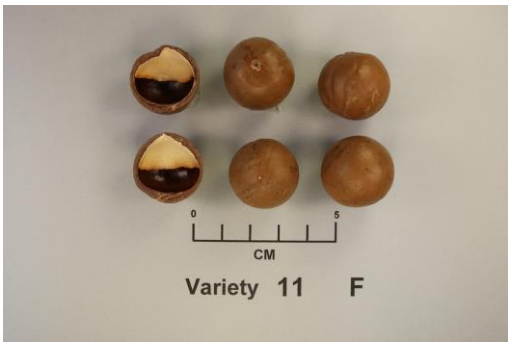
Variety F

Test Genotype 11

Nut Traits

Husk Stalk Widt	Medium stalk
Husk Thickness	Medium husk thickness
Surface	Rough husk
Apical Point	Large, off-set apical point
Neck	Medium neck
Shell Flecking	Few blocky to striped flecks
Shell Suture	Distinct suture
Shell Shape	Smooth, round with ridge near hilum and one wide groove
Shell Micropile	Medium micropile
Shell Hilum	Small hilum
Shell Colour	Glossy, very light brown hue
Kernel Recovery	Very High
Kernel Size	Medium to large
Kernel Whole	Lower % whole nuts

Mean TKR % 46



Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016	2	Husk Rot Score (0 - 2) Wirrawilla 2016	0
Mean % of nuts with Husk Spot Alstonville 2016	0.55	Mean % FSB loss Alstonville	2.5

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

Variety I

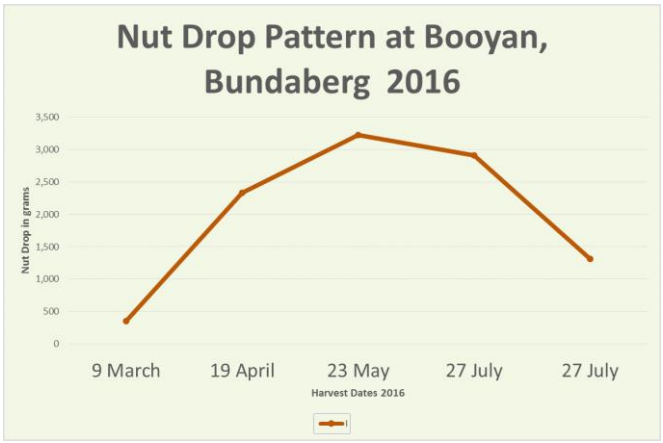
Test Genotype 12

Tree Traits

Tree Shape	Round to pyramid
Tree Height	Medium height
Tree Canopy	Dense, variable volume canopy
Nut Drop Pattern	Early / Mid
Tree Sticktights	Few sticktights
Nuts - Bunching	Few compressed bunches
Nut Clustering	Primarily singles and doubles

AVG Score (0 - 2) 0

Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern I

Leaf Traits

Leaf Whorls	3 Leaf Whorls
Leaf Shape	Medium to long, wide leaf with an oblanceolate shape
Petiole Length	Short petiole
Leaf Tip Shape	Variable tip shape
Leaf Spine	Zero to moderate level of spines variablly located on leaf
Leaf Undulation	Low undulations

Variety I

Test Genotype 12

Nut Traits

Husk Stalk Widt	Thin to medium stalk
Husk Thickness	Medium husk thickness
Surface	Smooth husk
Apical Point	Generally small, off-set apical point
Neck	Small neck
Shell Flecking	Moderate blocky to striped flecks
Shell Suture	Distinct suture
Shell Shape	Smooth, round to slight elipse with prominent bulge and grooves
Shell Micropile	Very large micropile
Shell Hilum	Medium hilum with adhered husk
Shell Colour	Glossy, brown hue
Kernel Recovery	Moderate to high
Kernel Size	Very small to small
Kernel Whole	Greater % of whole nuts

Mean TKR % 32

Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016	1	Husk Rot Score (0 - 2) Wirrawilla 2016	0
Mean % of nuts with Husk Spot Alstonville 2016	0.45	Mean % FSB loss Alstonville	2.5

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

Variety T

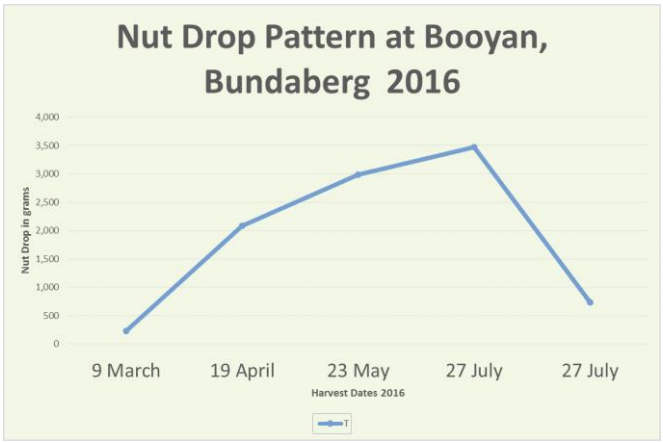
Test Genotype 13

Tree Traits

Tree Shape	Generally round
Tree Height	Medium height
Tree Canopy	Medium to large, moderate density canopy
Nut Drop Pattern	Early / Mid
Tree Sticktights	Moderate to few sticktights
Nuts - Bunching	Few to moderate levels of compressed bunches
Nut Clustering	Primarily singles and doubles

AVG Score (0 - 2) 0

Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern T

Leaf Traits

Leaf Whorls	3 Leaf Whorls
Leaf Shape	Wide, medium length leaf with oblanceolate shape
Petiole Length	Short petiole
Leaf Tip Shape	Rounded tip
Leaf Spine	Few spines located basally to all around the leaf
Leaf Undulation	Extensive undulations

Variety T

Test Genotype 13

Nut Traits

Husk Stalk Widt	Thick stalk
Husk Thickness	Thick husk
Surface	Smooth husk
Apical Point	Small to medium, generally in-line apical point
Neck	Small neck
Shell Flecking	Few striped flecks near micropile
Shell Suture	Distinct suture often cracked
Shell Shape	Smooth, round with slight bulge and many grooves
Shell Micropile	Small micropile
Shell Hilum	Medium hilum with adhered husk
Shell Colour	Dull, very dark brown hue
Kernel Recovery	High
Kernel Size	Medium to large
Kernel Whole	Lower % whole nuts

Mean TKR % 37.1

Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016	0.5	Husk Rot Score (0 - 2) Wirrawilla 2016	0
Mean % of nuts with Husk Spot Alstonville 2016	0.83	Mean % FSB loss Alstonville	0

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

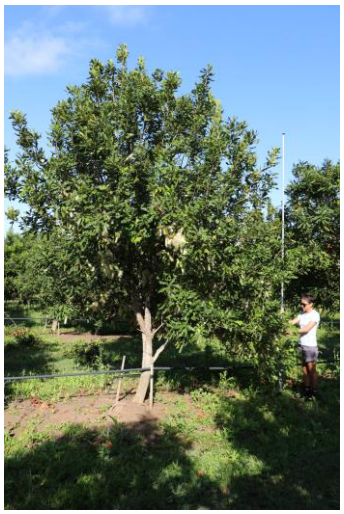
Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

Variety G

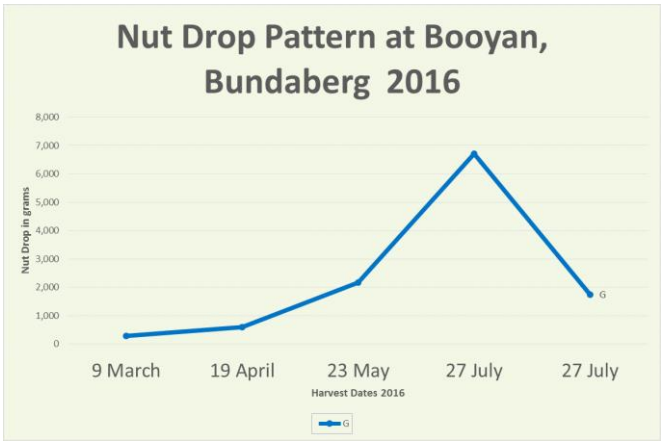
Test Genotype 14

Tree Traits

Tree Shape	Slightly spreading to slightly upright	AVG Score (0 - 2) 0
Tree Height	Medium height	
Tree Canopy	Moderately open, medium canopy volume	
Nut Drop Pattern	Mid / Late, but variable	
Tree Sticktights	Few sticktights	
Nuts - Bunching	Moderate levels of compressed bunches	
Nut Clustering	Primarily singles and doubles	



Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern G

Leaf Traits

Leaf Whorls	Primarily 3 leaf whorls with occasional 4 leaf whorls
Leaf Shape	Narrow, medium length leaf with oblanceolate shape
Petiole Length	Short to medium petiole
Leaf Tip Shape	Variable tip shape
Leaf Spine	Few to many spines located all around the leaf
Leaf Undulation	Extensive undulations

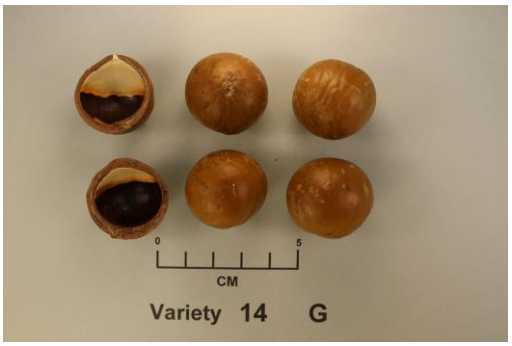
Variety G

Test Genotype 14

Nut Traits

Husk Stalk Widt	Thick stalk
Husk Thickness	Thin husk
Surface	Smooth husk
Apical Point	Small apical point
Neck	Small neck
Shell Flecking	Few blocky flecks
Shell Suture	Distinct suture often cracked
Shell Shape	Smooth, round with slight bulge and many grooves
Shell Micropile	Medium micropile
Shell Hilum	Large hilum with adhered husk
Shell Colour	Glossy, brown hue
Kernel Recovery	High
Kernel Size	Medium to large
Kernel Whole	Mid range % of whole nuts

Mean TKR % 42.6



Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016	0	Husk Rot Score (0 - 2) Wirrawilla 2016	0.5
Mean % of nuts with Husk Spot Alstonville 2016	0.47	Mean % FSB loss Alstonville	1

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

Variety A

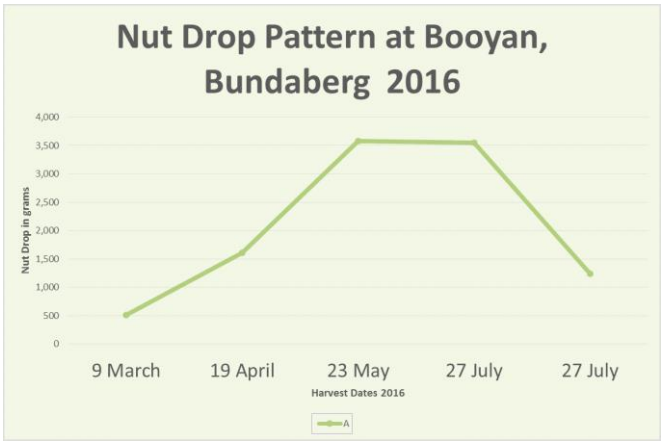
Test Genotype 15

Tree Traits

Tree Shape	Upright, pyramid to round
Tree Height	Medium height
Tree Canopy	Medium to large, dense canopy
Nut Drop Pattern	Early / Mid
Tree Sticktights	Moderate to many sticktights
Nuts - Bunching	Few generally open bunches
Nut Clustering	Mostly singles with doubles and triples

AVG Score (0 - 2) 0

Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern A

Leaf Traits

Leaf Whorls	3 Leaf Whorls
Leaf Shape	Short, medium width leaf with a variable obovate shape
Petiole Length	Short to medium petiole
Leaf Tip Shape	Slightly pointed to rounded tip
Leaf Spine	Few spines generally located at the tip
Leaf Undulation	Low undulations

Variety A

Test Genotype 15

Nut Traits

Husk Stalk Widt	Thick stalk
Husk Thickness	Thin husk
Surface	Smooth husk
Apical Point	Small, generally in-line apical point
Neck	Medium neck
Shell Flecking	Variable blocky flecks
Shell Suture	Distinct suture
Shell Shape	Smooth, round with slight bulge and one groove
Shell Micropile	Medium micropile
Shell Hilum	Small hilum
Shell Colour	Glossy, dark brown hue
Kernel Recovery	Moderate
Kernel Size	Small
Kernel Whole	Mid range % of whole nuts

Mean TKR % 29.9

Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016	0.25	Husk Rot Score (0 - 2) Wirrawilla 2016	0.5
Mean % of nuts with Husk Spot Alstonville 2016	2.67	Mean % FSB loss Alstonville	1.3

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

Variety K

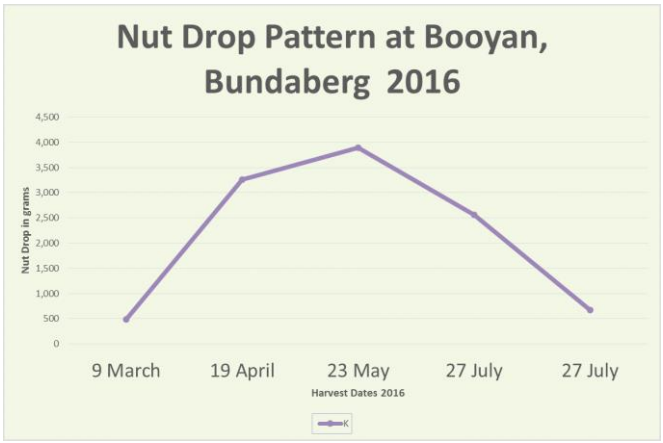
Test Genotype 16

Tree Traits

Tree Shape	Slightly upright blocky shape
Tree Height	Medium height
Tree Canopy	Small, dense canopy
Nut Drop Pattern	Early / Mid
Tree Sticktights	Few sticktights
Nuts - Bunching	Moderate levels of generally open bunches
Nut Clustering	Primarily singles and triples

AVG Score (0 - 2) 0.33

Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern K

Leaf Traits

Leaf Whorls	3 Leaf Whorls
Leaf Shape	Medium to long, medium width leaf with a oblanceolate shape
Petiole Length	Medium petiole
Leaf Tip Shape	Slightly pointed to rounded tip
Leaf Spine	Few to many spines located all around the leaf
Leaf Undulation	Extensive undulations

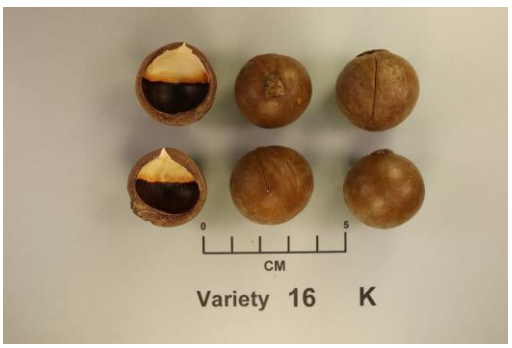
Variety K

Test Genotype 16

Nut Traits

Husk Stalk Widt	Medium to thick stalk
Husk Thickness	Medium husk thickness
Surface	Smooth husk
Apical Point	Medium, off-set apical point
Neck	Medium neck
Shell Flecking	No flecking
Shell Suture	Distinct suture
Shell Shape	Smooth, round with slight bulge and many grooves
Shell Micropile	Small micropile
Shell Hilum	Medium hilum with adhered husk
Shell Colour	Dull, dark brown hue
Kernel Recovery	Moderate to high
Kernel Size	Small
Kernel Whole	Greater % of whole nuts

Mean TKR % 33.6



Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016	0	Husk Rot Score (0 - 2) Wirrawilla 2016	0.66
Mean % of nuts with Husk Spot Alstonville 2016	0.97	Mean % FSB loss Alstonville	2

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

Variety E

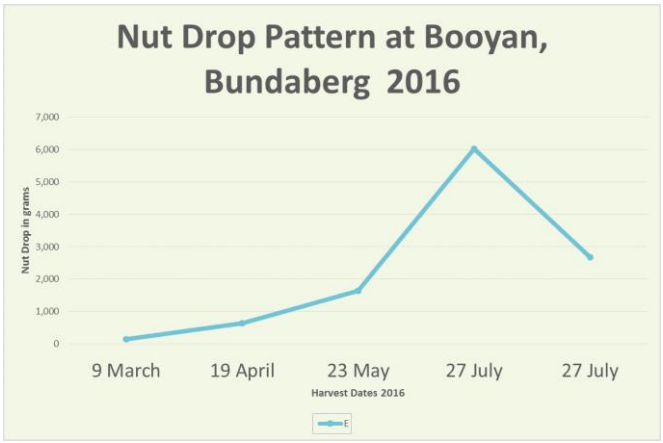
Test Genotype 17

Tree Traits

Tree Shape	Upright to round
Tree Height	Short
Tree Canopy	Small to medium, moderate density canopy
Nut Drop Pattern	Mid / Late
Tree Sticktights	Moderate to few sticktights
Nuts - Bunching	Few to moderate levels of tight bunches
Nut Clustering	Primarily singles and triples

AVG Score (0 - 2) 0

Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern E

Leaf Traits

Leaf Whorls	Primarily 3 leaf whorls with consistent 4 leaf whorls
Leaf Shape	Medium to short, medium width leaf with a oblanceolate shape
Petiole Length	Short to medium petiole
Leaf Tip Shape	Slightly pointed to rounded tip
Leaf Spine	Few spines located at tip to all around the leaf
Leaf Undulation	Moderate undulations

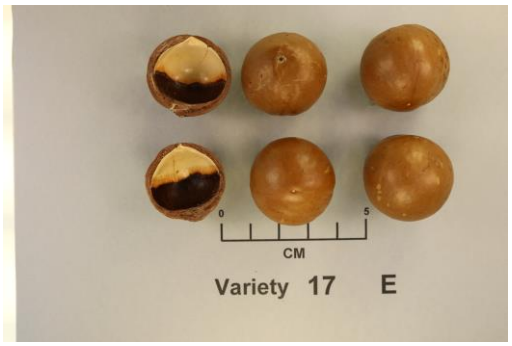
Variety E

Test Genotype 17

Nut Traits

Husk Stalk Widt	Very thick stalk
Husk Thickness	Thick husk
Surface	Smooth husk
Apical Point	Large apical point
Neck	Large neck
Shell Flecking	Moderate blocky flecks
Shell Suture	Suture sometimes cracked
Shell Shape	Lightly textured, round with ridge near hilum and wide groove
Shell Micropile	Medium micropile
Shell Hilum	Medium hilum
Shell Colour	Glossy, light brown hue
Kernel Recovery	Moderate to high
Kernel Size	Large
Kernel Whole	Lower % whole nuts

Mean TKR % 39.1



Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016	0.5	Husk Rot Score (0 - 2) Wirrawilla 2016	0.25
Mean % of nuts with Husk Spot Alstonville 2016	6.19	Mean % FSB loss Alstonville	0.5

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

Variety M

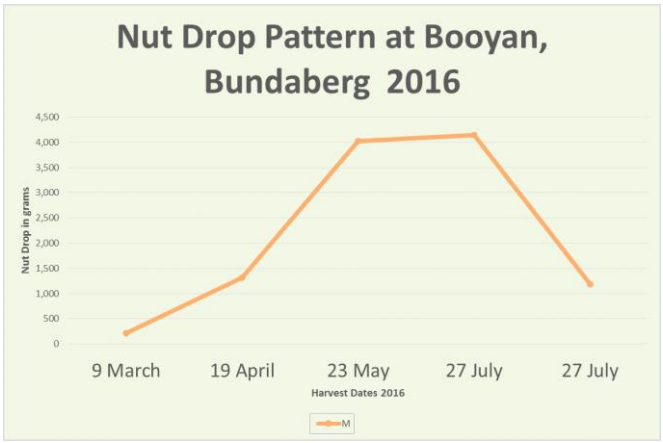
Test Genotype 18

Tree Traits

Tree Shape	Round to slightly upright
Tree Height	Medium height
Tree Canopy	Large, open canopy
Nut Drop Pattern	Early / Mid, sometimes consistent
Tree Sticktights	Few sticktights
Nuts - Bunching	Many tight bunches
Nut Clustering	

AVG Score (0 - 2) 0

Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern M

Leaf Traits

Leaf Whorls	3 Leaf Whorls
Leaf Shape	Long, medium width leaf with variable oblanceolate shape
Petiole Length	Medium petiole
Leaf Tip Shape	Variable tip shape
Leaf Spine	Few spines located basally
Leaf Undulation	Extensive undulations

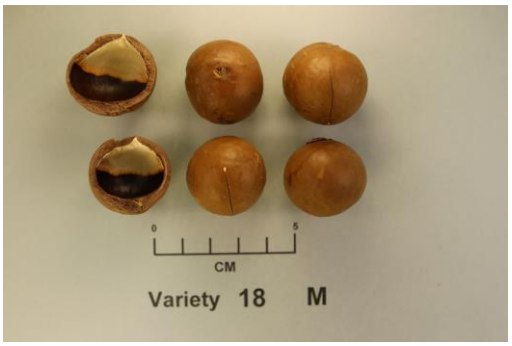
Variety M

Test Genotype 18

Nut Traits

Husk Stalk Widt	Medium to thick stalk
Husk Thickness	Medium husk thickness
Surface	Smooth husk
Apical Point	Small, offset apical point
Neck	Small to no neck
Shell Flecking	Few blocky flecks
Shell Suture	Suture sometimes cracked
Shell Shape	Smooth, round with many grooves
Shell Micropile	Large micropile, tendancy to be open in some conditions
Shell Hilum	Medium hilum
Shell Colour	Dark brown hue
Kernel Recovery	Moderate to high
Kernel Size	Small to medium
Kernel Whole	Mid range % of whole nuts

Mean TKR % 32.2



Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016	1.5	Husk Rot Score (0 - 2) Wirrawilla 2016	0
Mean % of nuts with Husk Spot Alstonville 2016	1.38	Mean % FSB loss Alstonville	0.5

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

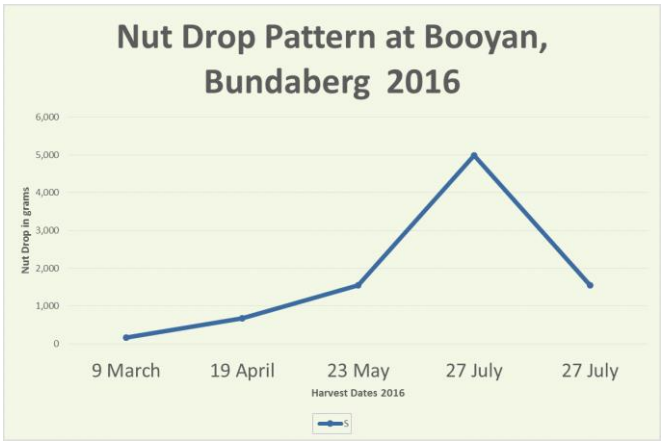
Variety S

Test Genotype 19

Tree Traits

Tree Shape	Upright, variable shaped tree	AVG Score (0 - 2) 0
Tree Height	Short	
Tree Canopy	Very small, variable density canopy	
Nut Drop Pattern	Variable mid peak	
Tree Sticktights	Few sticktights	
Nuts - Bunching	Moderate levels of compressed to slightly open bunches	
Nut Clustering	Primarily singles and triples	

Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern S

Leaf Traits

Leaf Whorls	3 Leaf Whorls
Leaf Shape	Medium to long, wide leaf with oblanceolate shape
Petiole Length	Short petiole
Leaf Tip Shape	Pointed to slightly pointed tip
Leaf Spine	Few to moderate spines generally located all around leaf
Leaf Undulation	Moderate undulations

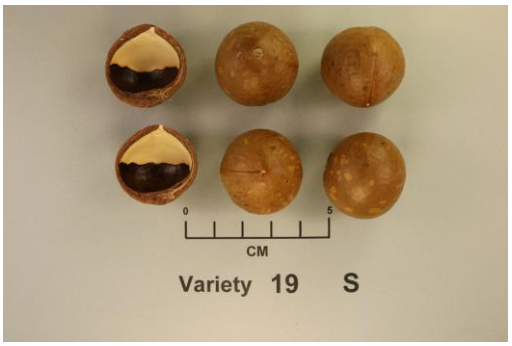
Variety S

Test Genotype 19

Nut Traits

Husk Stalk Widt	Medium to thick stalk
Husk Thickness	Thick husk
Surface	Smooth husk
Apical Point	Small, in-line apical point
Neck	Small neck
Shell Flecking	Many blocky to striped flecks
Shell Suture	Distinct suture near micropile, sometimes cracked
Shell Shape	Lightly textured, round with slight bulge
Shell Micropile	Very large micropile
Shell Hilum	Medium hilum
Shell Colour	Light brown hue
Kernel Recovery	Moderate to high
Kernel Size	Medium to large
Kernel Whole	Mid range % of whole nuts

Mean TKR % 32.8



Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016	0	Husk Rot Score (0 - 2) Wirrawilla 2016	0
Mean % of nuts with Husk Spot Alstonville 2016	5.50	Mean % FSB loss Alstonville	2.7

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

Variety O

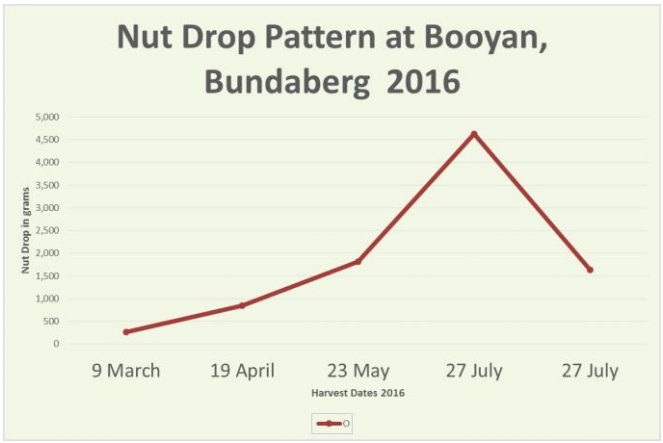
Test Genotype 20

Tree Traits

Tree Shape	Variable tree shape
Tree Height	Very Short
Tree Canopy	Very small, dense canopy
Nut Drop Pattern	Generally mid season
Tree Sticktights	Moderate sticktights
Nuts - Bunching	Not prone to bunching
Nut Clustering	Many singles with some doubles and triples

AVG Score (0 - 2) 0

Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern O

Leaf Traits

Leaf Whorls	Primarily 3 leaf whorls with occasional 4 leaf whorls
Leaf Shape	Short, wide leaf with obovate shape
Petiole Length	Medium to long petiole
Leaf Tip Shape	Rounded tip
Leaf Spine	Zero to few spines located all around the leaf
Leaf Undulation	Low undulations

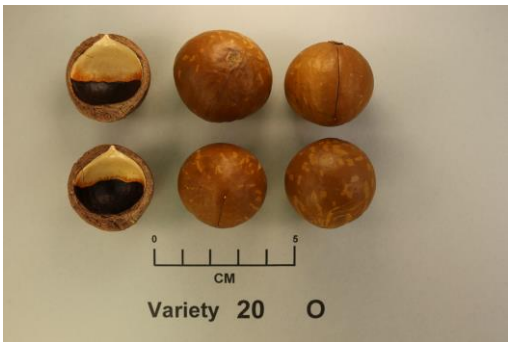
Variety O

Test Genotype 20

Nut Traits

Husk Stalk Widt	Thin stalk
Husk Thickness	Very thick husk
Surface	Rough husk
Apical Point	Large, in-line apical point
Neck	Large neck
Shell Flecking	Many blocky to striped flecks
Shell Suture	Distinct suture
Shell Shape	Smooth, round to slight elipse with ridge near hilum
Shell Micropile	Small micropile
Shell Hilum	Large hilum with adhered husk
Shell Colour	Glossy, very vibrant dark brown hue
Kernel Recovery	Moderate to high
Kernel Size	Large to very large
Kernel Whole	Lower % whole nuts

Mean TKR % 37.4



Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016	0	Husk Rot Score (0 - 2) Wirrawilla 2016	0
Mean % of nuts with Husk Spot Alstonville 2016	0.83	Mean % FSB loss Alstonville	0.6

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

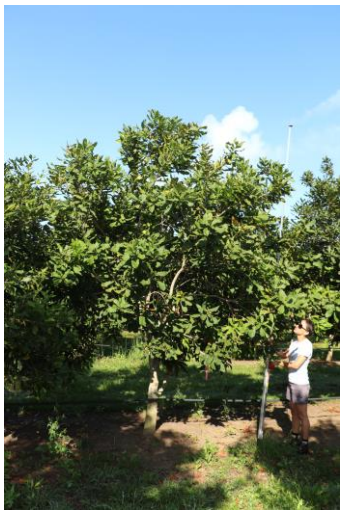
Variety P

Test Genotype 21

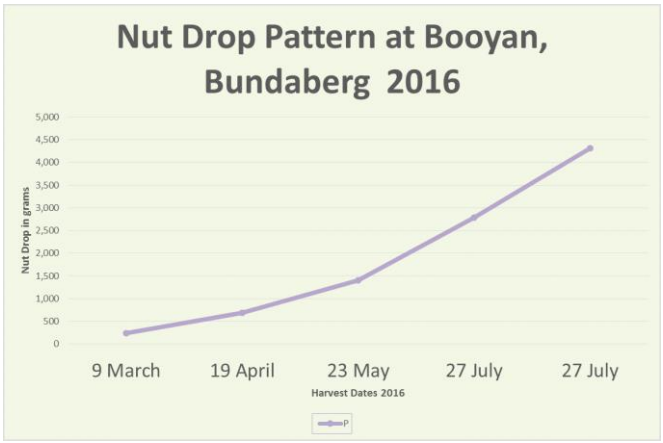
Tree Traits

Tree Shape	Round
Tree Height	Very Short
Tree Canopy	Very small, slightly dense canopy
Nut Drop Pattern	Consistent, late peak
Tree Sticktights	Few sticktights
Nuts - Bunching	Many variable bunches
Nut Clustering	Variable raceme number

AVG Score (0 - 2) 0



Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern P

Leaf Traits

Leaf Whorls	Primarily 3 leaf whorls with some 4 and 5 leaf whorls
Leaf Shape	Long, very wide leaf with variable oblanceolate shape
Petiole Length	Short petiole
Leaf Tip Shape	Pointed to slightly pointed tip
Leaf Spine	Few spines located at tip to all around the leaf
Leaf Undulation	Moderate undulations

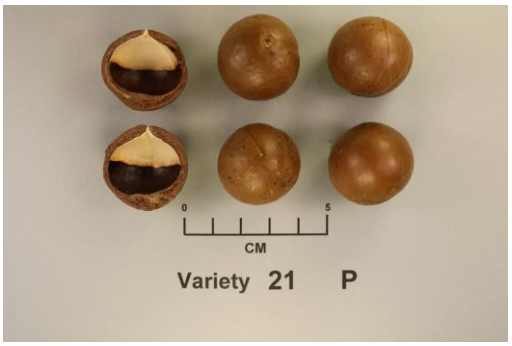
Variety P

Test Genotype 21

Nut Traits

Husk Stalk Widt	Thin stalk
Husk Thickness	Very thin husk
Surface	Smooth, dull husk
Apical Point	Medium to large apical point
Neck	Small neck
Shell Flecking	Few blocky to striped flecks
Shell Suture	Distinct suture
Shell Shape	Smooth, round with slight bulge and one groove
Shell Micropile	Large micropile
Shell Hilum	Medium hilum
Shell Colour	Glossy, brown hue
Kernel Recovery	Moderate to high
Kernel Size	Medium
Kernel Whole	Mid range % of whole nuts

Mean TKR % 34.8



Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016	0	Husk Rot Score (0 - 2) Wirrawilla 2016	0
Mean % of nuts with Husk Spot Alstonville 2016	2.33	Mean % FSB loss Alstonville	0

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

Variety A447

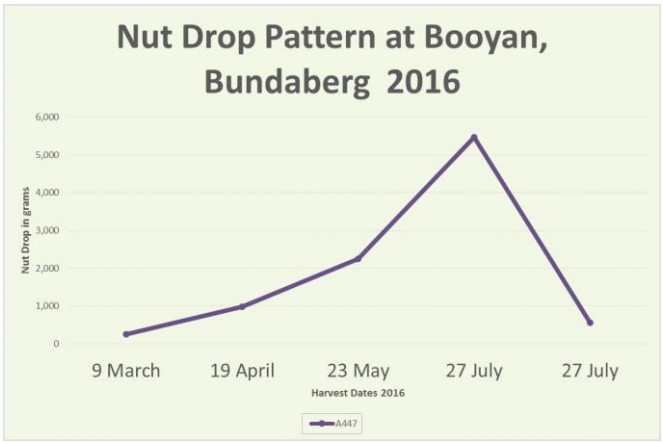
Test Genotype 22

Tree Traits

Tree Shape	Upright, round to blocky
Tree Height	Very Short
Tree Canopy	Very small, variable canopy density
Nut Drop Pattern	Early / Mid
Tree Sticktights	Moderate to few sticktights
Nuts - Bunching	Moderate levels of open bunches
Nut Clustering	Variable raceme number

AVG Score (0 - 2) 0

Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern A447

Leaf Traits

Leaf Whorls	Primarily 3 leaf whorls with occasional 2 leaf whorls
Leaf Shape	Long, medium width leaf with oblanceolate shape
Petiole Length	Long petiole
Leaf Tip Shape	Pointed tip
Leaf Spine	Moderate to many spines located all around the leaf
Leaf Undulation	Moderate undulations

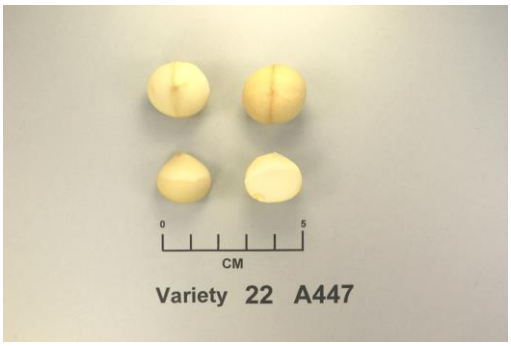
Variety A447

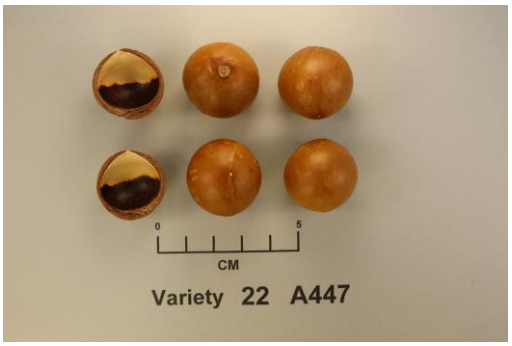
Test Genotype 22

Nut Traits

Husk Stalk Widt	Thin stalk
Husk Thickness	Thin husk
Surface	Lightly textured husk
Apical Point	Medium, generally in-line apical point
Neck	Medium neck
Shell Flecking	Moderate blocky flecks
Shell Suture	Distinct suture near micropile
Shell Shape	Smooth, round with ridge near hilum
Shell Micropile	Large micropile
Shell Hilum	Variable hilum size with halo
Shell Colour	Glossy, light brown hue
Kernel Recovery	High
Kernel Size	Medium to large
Kernel Whole	Lower % whole nuts

Mean TKR % 40





Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016 0.67

Husk Rot Score (0 - 2) Wirrawilla 2016 0

Mean % of nuts with Husk Spot Alstonville 2016

Mean % FSB loss Alstonville

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

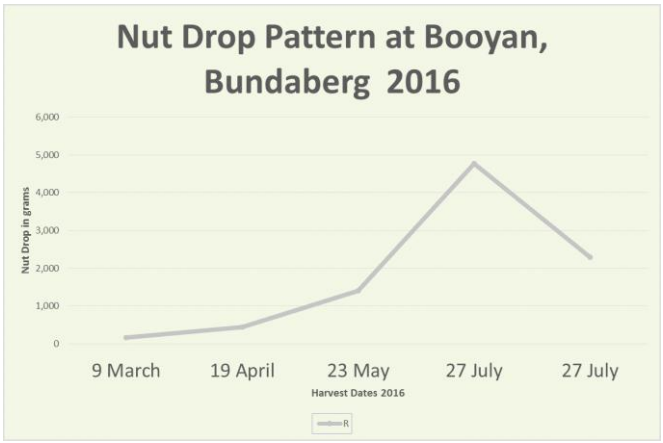
Variety R

Test Genotype 23

Tree Traits

Tree Shape	Slightly spreading, generally round	AVG Score (0 - 2) 0
Tree Height	Short	
Tree Canopy	Medium to large, dense canopy	
Nut Drop Pattern	Mid / Late, sometimes consistent	
Tree Sticktights	Few sticktights	
Nuts - Bunching	Few to moderate levels of compressed to slightly open bunches	
Nut Clustering	Variable raceme number	

Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern R

Leaf Traits

Leaf Whorls	3 Leaf Whorls
Leaf Shape	Long, medium width leaf with variable oblanceolate shape
Petiole Length	Long petiole
Leaf Tip Shape	Pointed to slightly pointed tip
Leaf Spine	Few to many spines located all around the leaf
Leaf Undulation	Extensive undulations

Variety R

Test Genotype 23

Nut Traits

Husk Stalk Widt	Medium to thick stalk
Husk Thickness	Medium to thick husk
Surface	Smooth husk
Apical Point	Small to medium, in-line apical point
Neck	Large neck
Shell Flecking	Few blocky flecks
Shell Suture	Suture sometimes cracked
Shell Shape	Lightly textured, round to slight elipse with slight bulge
Shell Micropile	Small micropile
Shell Hilum	Large hilum with adhered husk
Shell Colour	Brown hue
Kernel Recovery	Moderate to high
Kernel Size	Medium
Kernel Whole	Greater % of whole nuts

Mean TKR % 37.8

Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016	0.25	Husk Rot Score (0 - 2) Wirrawilla 2016	0.25
Mean % of nuts with Husk Spot Alstonville 2016	0.56	Mean % FSB loss Alstonville	2.2

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

Variety N

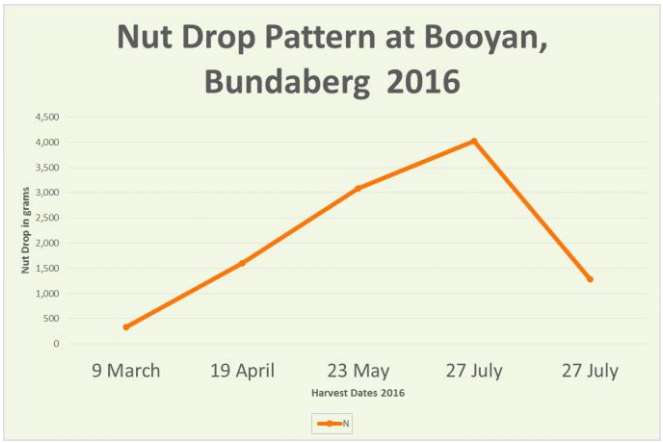
Test Genotype 24

Tree Traits

Tree Shape	Slightly spreading to blocky
Tree Height	Tall
Tree Canopy	Very large, moderate density canopy
Nut Drop Pattern	Consistent, generally mid peak
Tree Sticktights	Moderate sticktights
Nuts - Bunching	Moderate levels of compressed to slightly open bunches
Nut Clustering	Variable raceme number

AVG Score (0 - 2) 0

Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern N

Leaf Traits

Leaf Whorls	Primarily 3 leaf whorls with occasional 4 leaf whorls
Leaf Shape	Medium length and width leaf with oblanceolate shape
Petiole Length	Medium to long petiole
Leaf Tip Shape	Slightly pointed to rounded tip
Leaf Spine	Moderate to many spines located all around the leaf
Leaf Undulation	Low undulations

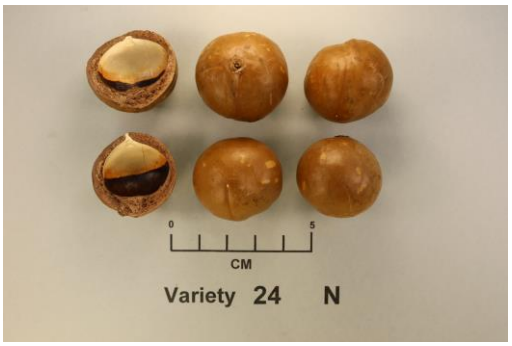
Variety N

Test Genotype 24

Nut Traits

Husk Stalk Widt	Medium to thick stalk
Husk Thickness	Medium husk thickness
Surface	Lightly textured husk
Apical Point	Medium, off-set apical point
Neck	Medium neck
Shell Flecking	Few blocky to striped flecks
Shell Suture	Distinct suture
Shell Shape	Smooth, round with bulge. Ridge near hilum and wide groove
Shell Micropile	Medium micropile
Shell Hilum	Medium hilum
Shell Colour	Brown hue
Kernel Recovery	Moderate
Kernel Size	Small
Kernel Whole	Mid range % of whole nuts

Mean TKR % 30



Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016	1.75	Husk Rot Score (0 - 2) Wirrawilla 2016	1
Mean % of nuts with Husk Spot Alstonville 2016	1.34	Mean % FSB loss Alstonville	1.4

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

Variety H

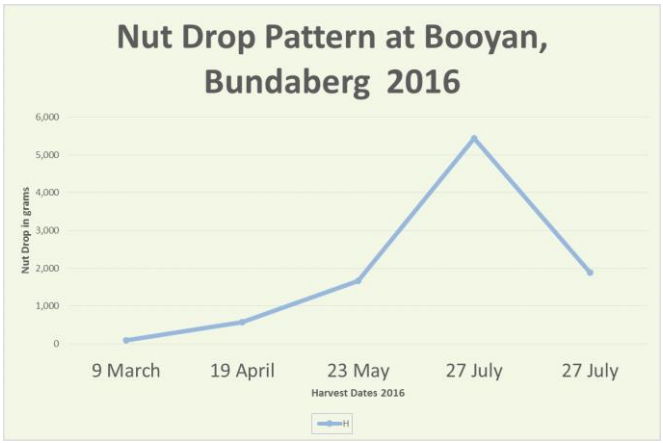
Test Genotype 25

Tree Traits

Tree Shape	Rounded to upright
Tree Height	Short
Tree Canopy	Small to medium, moderate density canopy
Nut Drop Pattern	Generally mid season
Tree Sticktights	Sticktights Absent
Nuts - Bunching	Moderate levels of compressed bunches
Nut Clustering	Many singles with some doubles and triples

AVG Score (0 - 2) 0

Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern H

Leaf Traits

Leaf Whorls	Primarily 3 leaf whorls with a few 4 leaf whorls
Leaf Shape	Short, wide leaf with obovate shape
Petiole Length	Short petiole
Leaf Tip Shape	Slightly pointed to rounded tip
Leaf Spine	Few spines located at the tip
Leaf Undulation	Low undulations

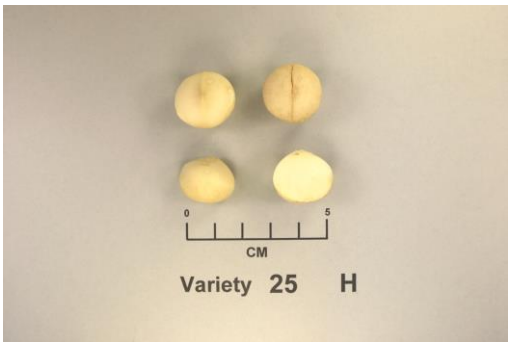
Variety H

Test Genotype 25

Nut Traits

Husk Stalk Widt	Medium stalk
Husk Thickness	Thick husk
Surface	Slightly rough husk
Apical Point	Small, slightly off-set apical point
Neck	Small neck
Shell Flecking	Many blocky to striped flecks near micropile
Shell Suture	Distinct suture sometime cracked
Shell Shape	Smooth, slight elipse with slight bulge. Ridge near hilum and many groo
Shell Micropile	Small micropile
Shell Hilum	Medium hilum with adhered husk
Shell Colour	Glossy, very light brown hue
Kernel Recovery	High
Kernel Size	Small to medium
Kernel Whole	Lower % whole nuts

Mean TKR % 35



Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016	1	Husk Rot Score (0 - 2) Wirrawilla 2016	1
Mean % of nuts with Husk Spot Alstonville 2016	0.90	Mean % FSB loss Alstonville	1.7

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

Variety 344

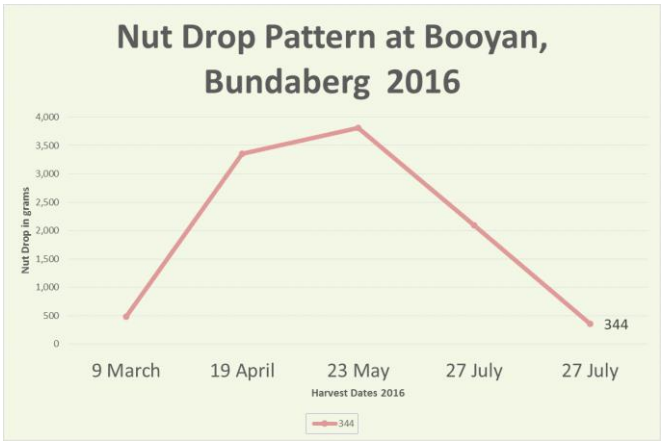
Test Genotype 26

Tree Traits

Tree Shape	Rounded to upright
Tree Height	Very Tall
Tree Canopy	Medium to large, slightly open canopy
Nut Drop Pattern	Early
Tree Sticktights	Few sticktights
Nuts - Bunching	Moderate levels of compressed to open bunches
Nut Clustering	Variable raceme number

AVG Score (0 - 2) 1.36

Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern 344

Leaf Traits

Leaf Whorls	3 Leaf Whorls
Leaf Shape	Short, very narrow leaf with oblanceolate shape
Petiole Length	Medium petiole
Leaf Tip Shape	Pointed to slightly pointed tip
Leaf Spine	Generally few spines generally located basally, often with a single spine
Leaf Undulation	Moderate undulations

Variety 344

Test Genotype 26

Nut Traits

Husk Stalk Widt	Medium stalk
Husk Thickness	Medium husk thickness
Surface	Lightly textured, dull light green husk
Apical Point	Small to medium, off-set apical point
Neck	Small neck
Shell Flecking	Moderate blocky to striped flecks near hilum
Shell Suture	Distinct suture
Shell Shape	Smooth, round with bulge and grooves
Shell Micropile	Medium micropile
Shell Hilum	Medium hilum
Shell Colour	Dull, brown hue
Kernel Recovery	Moderate
Kernel Size	Small
Kernel Whole	Lower % whole nuts

Mean TKR % 34.5

Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016	0.23	Husk Rot Score (0 - 2) Wirrawilla 2016	0.27
Mean % of nuts with Husk Spot Alstonville 2016	0.00	Mean % FSB loss Alstonville	1.7

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

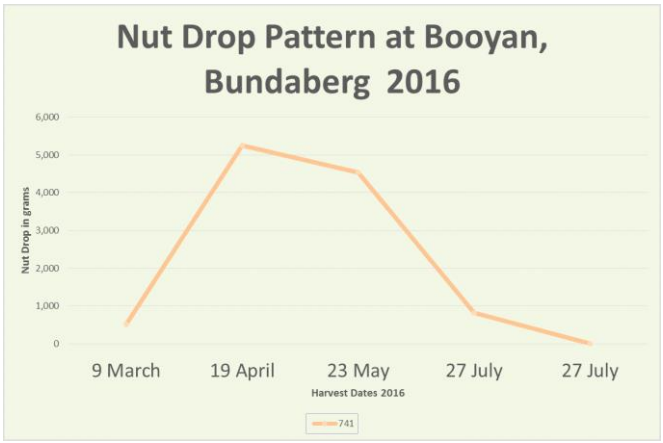
Variety 741

Test Genotype 27

Tree Traits

Tree Shape	Rounded to slightly spreading	AVG Score (0 - 2)
Tree Height	Tall	
Tree Canopy	Medium to large, moderate density canopy	
Nut Drop Pattern	Early	
Tree Sticktights	Few sticktights	
Nuts - Bunching	Few generally open bunches	
Nut Clustering	Primarily singles and doubles	

Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern 741

Leaf Traits

Leaf Whorls	3 Leaf Whorls
Leaf Shape	Narrow, medium length leaf with oblanceolate shape
Petiole Length	Medium to long petiole
Leaf Tip Shape	Variable tip shape
Leaf Spine	Few spines located all around the leaf
Leaf Undulation	Moderate undulations

Variety 741

Test Genotype 27

Nut Traits

Husk Stalk Widt	Medium to thick stalk
Husk Thickness	Medium husk thickness
Surface	Smooth, dark green husk
Apical Point	Medium to large, off-set apical point
Neck	Medium neck
Shell Flecking	Moderate blocky to striped flecks
Shell Suture	Suture sometimes cracked
Shell Shape	Smooth, round with ridge near hilum
Shell Micropile	Medium micropile
Shell Hilum	Small hilum
Shell Colour	Glossy, very dark brown hue
Kernel Recovery	Moderate to high, variable
Kernel Size	Small
Kernel Whole	Lower % whole nuts

Mean TKR % 37.9

Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016

Mean % of nuts with Husk Spot Alstonville 2016 0.56

Husk Rot Score (0 - 2) Wirrawilla 2016

Mean % FSB loss Alstonville 0.8

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

Variety D

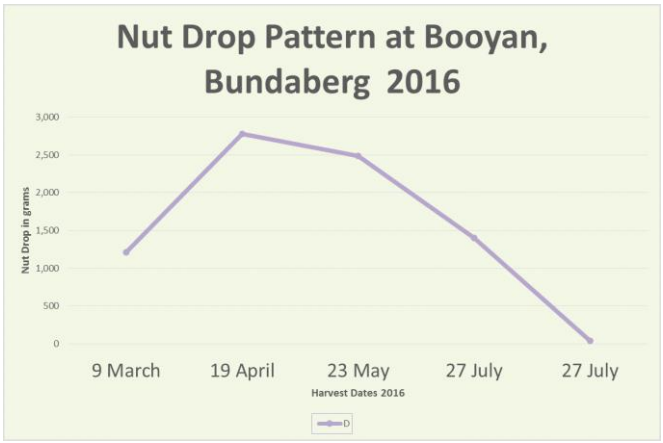
Test Genotype 28

Tree Traits

Tree Shape	Rounded to slightly spreading
Tree Height	Medium height
Tree Canopy	Very large, dense canopy
Nut Drop Pattern	Early / Mid
Tree Sticktights	Few sticktights
Nuts - Bunching	Few generally open bunches
Nut Clustering	Variable raceme number

AVG Score (0 - 2) 0

Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern D

Leaf Traits

Leaf Whorls	3 Leaf Whorls
Leaf Shape	Medium to long, medium width leaf with a oblanceolate shape
Petiole Length	Medium to long petiole
Leaf Tip Shape	Variable tip shape
Leaf Spine	Few to moderate spines generally located basally to all around leaf
Leaf Undulation	Extensive undulations

Variety D

Test Genotype 28

Nut Traits

Husk Stalk Widt	Medium to thick stalk
Husk Thickness	Thin husk
Surface	Smooth husk
Apical Point	Large, off-set apical point
Neck	Large neck
Shell Flecking	No flecking
Shell Suture	Distinct suture sometime cracked
Shell Shape	Smooth, round with slight bulge
Shell Micropile	Small micropile
Shell Hilum	Medium hilum with adhered husk
Shell Colour	Dull, dark brown hue with white film
Kernel Recovery	Moderate to high
Kernel Size	Large
Kernel Whole	Lower % whole nuts

Mean TKR % 34.3

Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016	0	Husk Rot Score (0 - 2) Wirrawilla 2016	0
Mean % of nuts with Husk Spot Alstonville 2016	0.00	Mean % FSB loss Alstonville	0

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

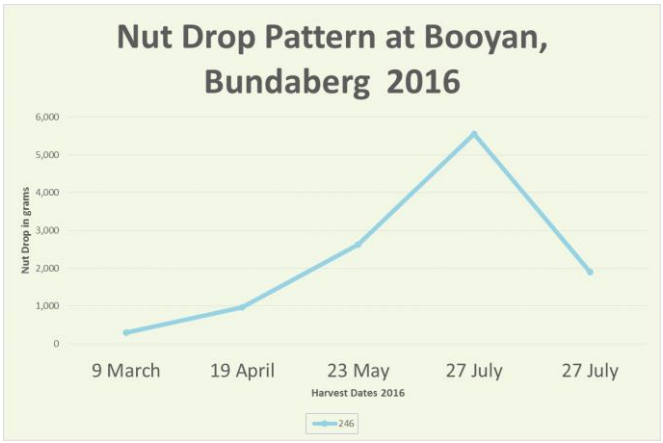
Variety 246

Test Genotype 29

Tree Traits

Tree Shape	Rounded to slightly spreading	AVG Score (0 - 2)
Tree Height	Medium height	
Tree Canopy	Large, moderate density canopy	
Nut Drop Pattern	Early / Mid	
Tree Sticktights	Few sticktights	
Nuts - Bunching	Variable levels of generally open bunches	
Nut Clustering	Variable raceme number	

Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern 246

Leaf Traits

Leaf Whorls	3 Leaf Whorls
Leaf Shape	Medium to long, narrow leaf with oblanceolate shape
Petiole Length	Medium to long petiole
Leaf Tip Shape	Slightly pointed to rounded tip
Leaf Spine	Few to moderate levels of spines located basally to all around the leaf
Leaf Undulation	Extensive undulations

Variety 246

Test Genotype 29

Nut Traits

Husk Stalk Widt	Medium to thick stalk
Husk Thickness	Medium husk thickness
Surface	Smooth, dark green husk
Apical Point	Small, offset apical point
Neck	Variable neck
Shell Flecking	Occasional blocky flecks
Shell Suture	Suture not distinct
Shell Shape	Smooth, round with slight bulge and many grooves
Shell Micropile	Small to medium micropile
Shell Hilum	Medium hilum
Shell Colour	Dull, brown hue
Kernel Recovery	Moderate to high
Kernel Size	Small
Kernel Whole	Greater % of whole nuts

Mean TKR % 37.9

Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016

Mean % of nuts with Husk Spot Alstonville 2016 0.67

Husk Rot Score (0 - 2) Wirrawilla 2016

Mean % FSB loss Alstonville 0.7

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

Variety L

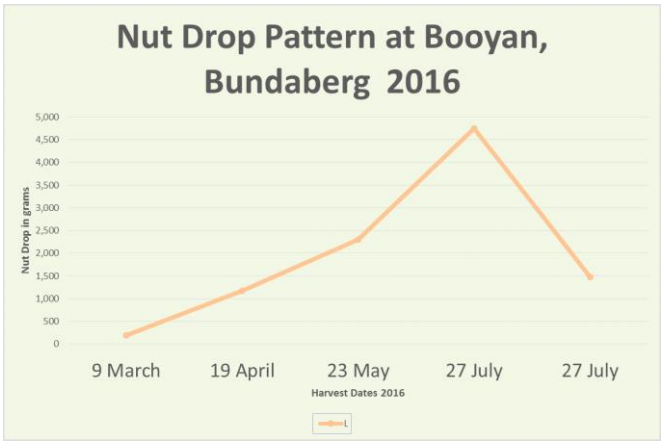
Test Genotype 30

Tree Traits

Tree Shape	Upright, round to blocky
Tree Height	Medium height
Tree Canopy	Small to medium, open canopy
Nut Drop Pattern	Variable. Sometimes consistent, sometimes mid / late
Tree Sticktights	Few sticktights
Nuts - Bunching	Moderate levels of compressed to open bunches
Nut Clustering	Variable raceme number

AVG Score (0 - 2) 0

Year 8 Tree at Booyan, Bundaberg 2016



Nut Drop Pattern L

Leaf Traits

Leaf Whorls	3 Leaf Whorls
Leaf Shape	Medium to long, medium width leaf with variable oblanceolate shape
Petiole Length	Medium to long petiole
Leaf Tip Shape	Generally pointed tip
Leaf Spine	Few to moderate levels of spines located basally to all around the leaf
Leaf Undulation	Extensive undulations

Variety L

Test Genotype 30

Nut Traits

Husk Stalk Widt	Medium stalk
Husk Thickness	Medium husk thickness
Surface	Smooth husk
Apical Point	Small, offset apical point
Neck	Small neck
Shell Flecking	No flecking
Shell Suture	Suture sometimes cracked near micropile
Shell Shape	Smooth, round with slight bulge and many grooves
Shell Micropile	Pinhead micropile
Shell Hilum	Medium hilum
Shell Colour	Very dark brown hue
Kernel Recovery	Moderate to high
Kernel Size	Small to medium
Kernel Whole	Mid range % of whole nuts

Mean TKR % 30.9

Trait Scores

Husk Spot Score (0 - 5) Wirrawilla 2016	0	Husk Rot Score (0 - 2) Wirrawilla 2016	0.25
Mean % of nuts with Husk Spot Alstonville 2016	1.24	Mean % FSB loss Alstonville	0.6

AVG Rating 0 - 2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of AVG

Husk Spot ratings 0 - 5 scale with 0 no symptoms and 5 premature nut drop and sticktights

Husk Rot ratings 0 -2 scale with 0 no symptoms, 1 possible symptoms and 2 definite signs of HR

VARIETY "G" FACTSHEET

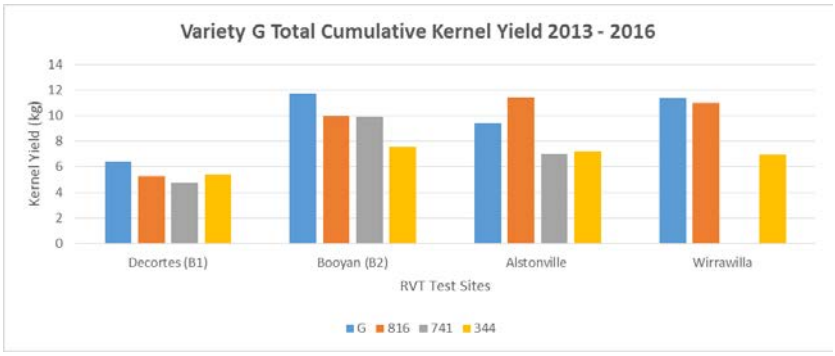
BACKGROUND

Variety "G" is a new Macadamia variety released to the industry as a result of the National Macadamia Industry Variety Improvement program. Data has been collected on the new macadamia varieties in Regional Variety Trials (RVT's) across production regions in Queensland and New South Wales. These trials have been measuring kernel, tree, disease and processing qualities for the past 2 years and nut-in-shell yield for 4 years. The data presented below comes from these trial sites.

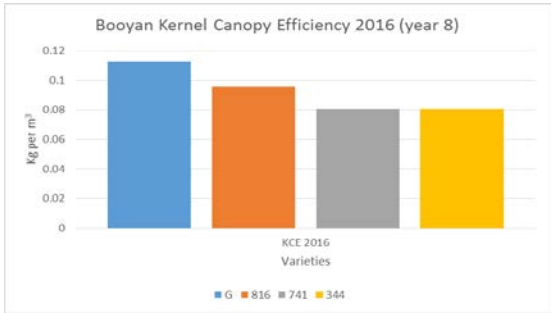
8 year old variety "G" tree at Booyan

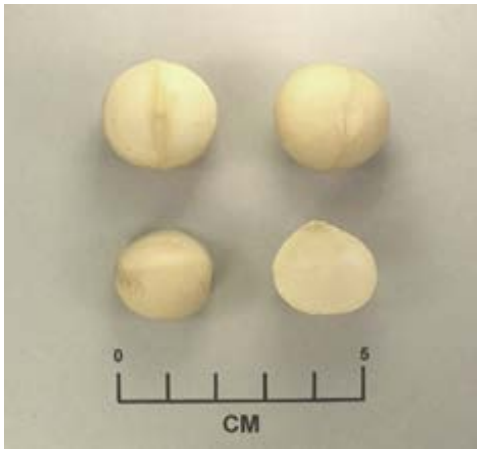
DESCRIPTION

Variety "G" is a precocious, medium to tall, spreading tree with a moderately dense canopy. Cumulative kernel yield over the past 4 years at the Booyan RVT site (2013 – 2016) was 11.7 kg compared with 816 (10kg), 741 (9.9kg) and 344



(7.6kg). "G" has a canopy efficiency (grams of kernel per m^3 of tree volume) of more than 111 grams at the Booyan RVT trial site compared to 816 with 95g, 741 with 80g and 344 with 80g/m^3 from 8 year old trees.





Variety "G" kernel

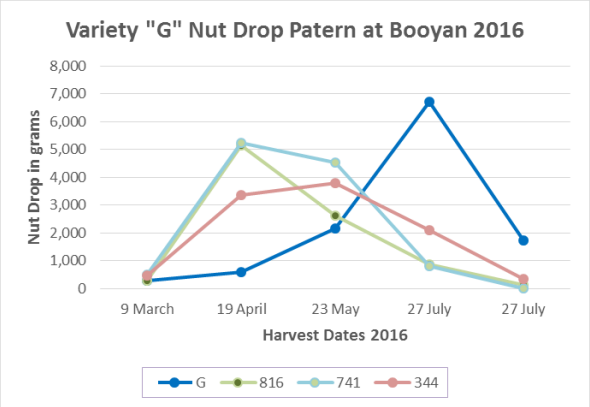
Variety "G" nut and shell

Horticulture Innovation Australia

Queensland Government

Variety “G” has a kernel recovery between 40.3% and 42.9% in the Bundaberg region compared with 816 (45%), 741 around 38% and 344 at 34%.

“G” flowers mid-season with a nut drop pattern mid- to late season with the peak in July.



“G” has a low to moderate rating of sticktights (2.5 out of 5 rated by growers) and low susceptibility to husk spot (<1 out of 5) from disease ratings at Bundaberg sites, Booyan and Wirrawilla. Trials at Wirrawilla with 8 year old trees show no evidence of Abnormal Vertical Growth (AVG) and rated 0 out of 2 while the industry standard 344 rated 1.36 out of 2.

Growers at recent field days commented on the open tree form and the yield potential of “G” in Alstonville and Bundaberg sites. Growers in Alstonville rated its commercial potential at 7.22 out of 9, 816 was rated 6.85 and 741, 6.66 out of 9. At the Booyan RVT site variety “G” had an average rating for commercial potential of 7.04 out of 9 while 741 averaged 7.21 out of 9.

Variety G Yield and Tree Comparison				
Booyan RVT Site, 2016				
Variety	**G**	**816**	**741**	**344**
Kernel Recovery (%)	42.9	45.2	38.3	34.2
Cumulative Kernel Yield (kg) 1	11.684	9.976	9.901	7.577
kernel Canopy Efficiency (g/m3) 2	114	95	78	83
Tree Volume (m3)	40.4	39.2	49	37.7
Kernel KG per Ha (estimated) 3	1,443	1,172	1,205	976
1 - Cumulative Kernel Yield 2013 -				
2 - 2016 (year 8) Kernel Canopy Efficiency				
3 - Estimated kernel yield (kg/ha) for 312.5 trees per ha or 8m x 4m				

DISCLAIMER

VARIETY "J" FACTSHEET

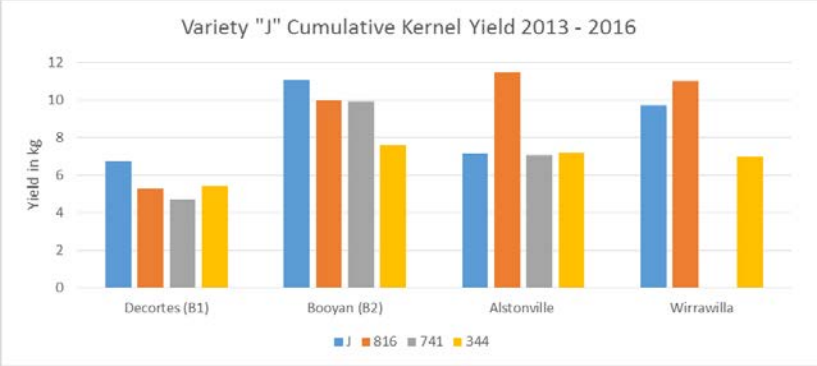
BACKGROUND

Variety "J" is a new Macadamia variety released to the industry as a result of the National Macadamia Industry Variety Improvement program. Data has been collected on the new macadamia varieties from Regional Variety Trials (RVT's) across production regions in Queensland and New South Wales. These trials have been measuring kernel, tree, disease and processing qualities for the past 2 years and nut-in-shell yield for 4 years.

DESCRIPTION

Variety "J" is a moderately large, spreading tree. Tree volumes at Booyan, Bundaberg, are 40.5m^3 while 816 is 39.2m^3, 741, 49m^3 and 344, 37.7m^3 for 8 year old trees.

Variety "J" has a cumulative kernel yield for the 4 years 2013 to 2016 of 11.041kg for 8 year old trees at the Booyan RVT. In the same trial site 816 had 9.976kg, 741 had 9.901kg and 344 had 7.577kg.

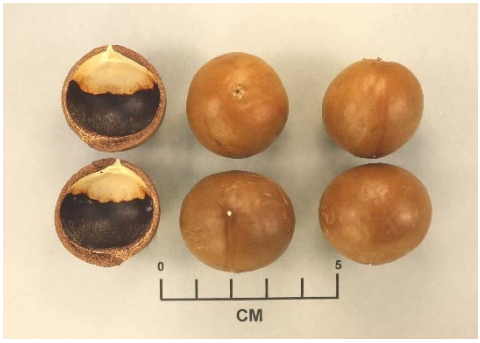


Variety "J" has a kernel recovery of 46% in the Bundaberg region compared with 816 (45%), 741 (38%) and 344 at 34%. Trees of "J" have a canopy efficiency of 106g/m^3 at the Booyan RVT site. At the same site 816 was 95g/m^3, 741 was 78g/m^3 and 344 was 83g/m^3.

"J" flowers mid-late season in September with a peak harvest season in July in Bundaberg. Nut drop is mid to late season. Most of the nuts fall in July in Booyan.

8 year old variety "J" at Booyan

Variety "J" kernel



Variety "J" nut and shell

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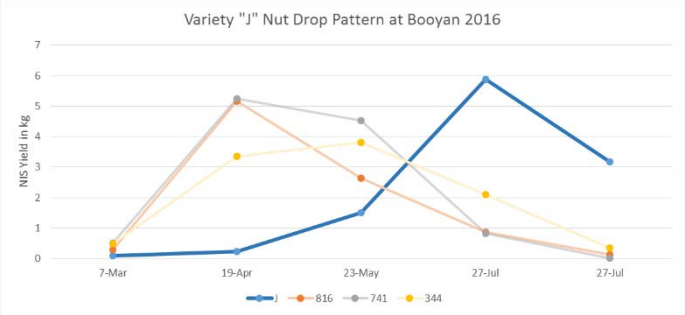
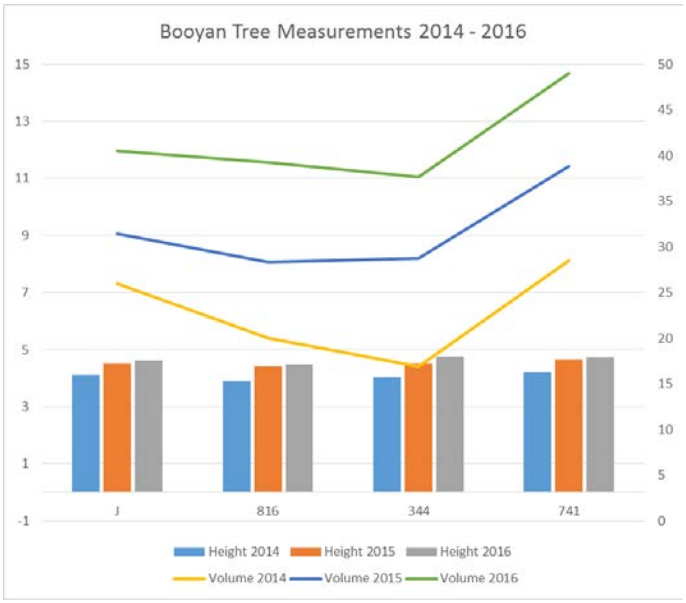


Variety "J" Yield and Tree Comparison				
Booyan				
Variety	**J**	**816**	**741**	**344**
Kernel Recovery (%)	44	45.2	38.3	34.2
Cumulative Kernel Yield (kg) 1	11.041	9.976	9.901	7.577
kernel Canopy Efficiency (g/m3) 2	106	95	78	83
Tree Volume (m3)	40.5	39.2	49	37.7
Kernel KG per Ha (estimated) 3	1,398	1,172	1,205	976
1 - Cumulative Kernel Yield 2013 - 2016				
2 - 2016 (year 8) Kernel Canopy Efficiency				
3 - Estimated kernel yield (kg/ha) for 312.5 trees per ha or 8m x 4m				

"J" is a similar size tree to 816 but smaller than 741 and out-yielding these industry standards in some blocks in Bundaberg.

Trees of "J" have a low rating (0.25 out of 5) for husk spot at Wirrawilla however it does have a low to moderate level of sticktights. Trials at Wirrawilla with 8 year old trees show no evidence of Abnormal Vertical Growth (AVG) and rated 0 out of 2 while the industry standard 344, rated 1.36 out of 2.



DISCLAIMER

The above information is sourced from the eight Regional Variety Trial (RVT) sites in Queensland and New South Wales. This is the best available information on variety performance with a maximum age of eight years old. Each RVT site is randomised and replicated with yield data collected from 2013 to 2016. The information provided here may not be suitable for all sites or regions as varieties perform differently in different locations. The Queensland Department of Agriculture and Fisheries, and Horticulture Innovation Australia provides the above information as a guide only and take no responsibility for the performance of the varieties on individual farms.

VARIETY "P" FACTSHEET

BACKGROUND

Variety "P" is a new Macadamia variety released to the industry as a result of the National Macadamia Industry Variety Improvement program. Data has been collected on the new macadamia varieties in Regional Variety Trials (RVT's) across production regions in Queensland and New South Wales. These trials have been measuring kernel, tree, disease and processing qualities for the past 2 years and nut-in-shell yield for 4 years. The data presented below comes from these trial sites.

8 year old variety "P" at Booyan.

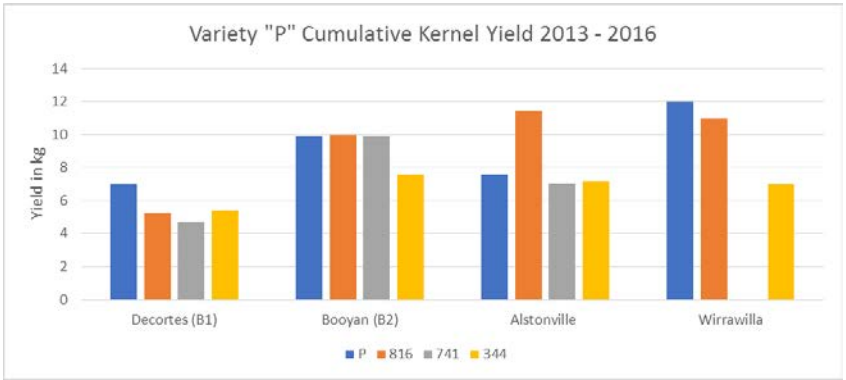
DESCRIPTION

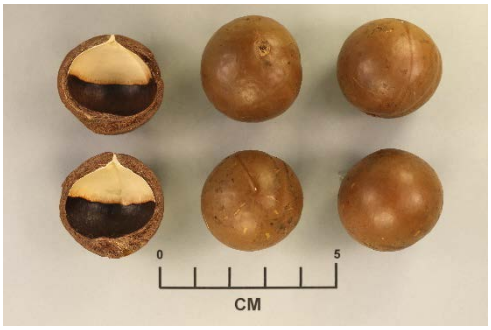
Variety "P" is a precocious, small to medium, spreading tree with a moderately dense canopy. At the Booyan RVT site in Bundaberg at year 8 variety "P" has a tree volume of 31.4m^3, while 816 is 39.2m^3, 741 is 49m^3 and 344 is 37.7m^3. At the Alstonville RVT site variety "P" has a tree volume of 51.4m^3, while 816 is 59.9m^3, 741 is 61.5 and 344 is 55.5m^3 at year 8.

Based on RVT data "P" had a cumulative kernel yield over 4 years from 2013 to 2016 at Booyan of 10.1kg, while 816 was 10.4kg, 741 was 10.2kg and 344 was 7.9kg.

Variety "P" has kernel recovery of 39% at Booyan compared with 816 (45%), 741 at 38% and 344 at 34%.

Variety "P" kernel.



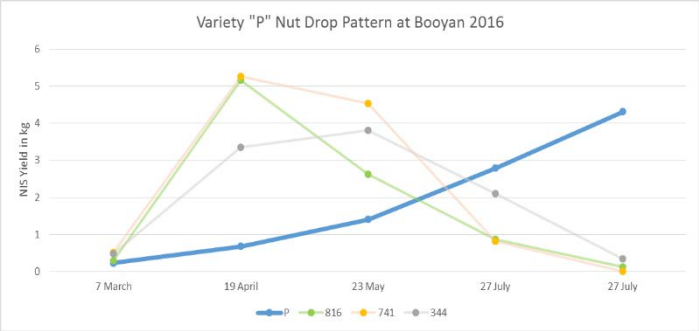


Variety "P" nut and shell.

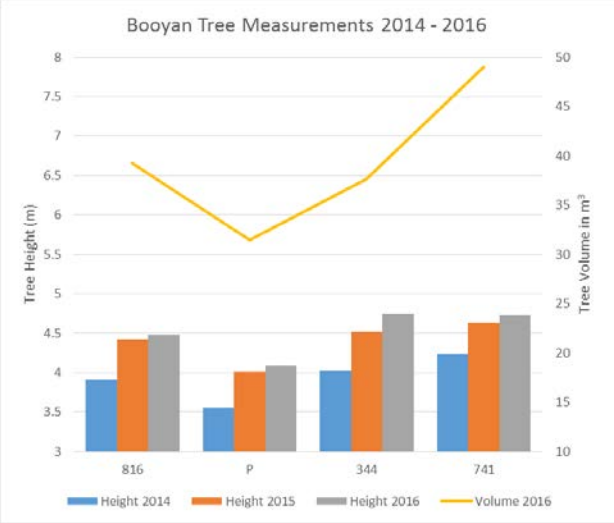
Horticulture Innovation Australia

Queensland Government

"P" flowers mid-season with a late nut drop pattern. Most nuts fall from mid-July on. Early indications are "P" is responsive to Ethrel® treatment to assist even nut drop, with minimal leaf loss.



As variety "P" is a small tree, planting density could be increased to 400 trees (or more) per hectare rather than the industry standard of 312 trees per hectare. This could increase productivity at an earlier age.



Trees of "P" have a low rating (1 out of 5) for husk spot and sticktights, even though it drops its nuts late. At the Wirrawilla RVT site "P" had no symptoms of Abnormal Vertical Growth (AVG) and rated 0 out of 2. The standard industry variety 344, rated 1.36 out of 2 for AVG at the same site.

Rapid Hexanal testing, or storage ability, indicated kernel of "P" had an average Hexanal measurement of 24.03ppm while 816 measured 21.35ppm, 741 42.44ppm and 344 with 90.75ppm. Less than 50ppm Hexanal is considered to have a longer shelf life than 100ppm or above.

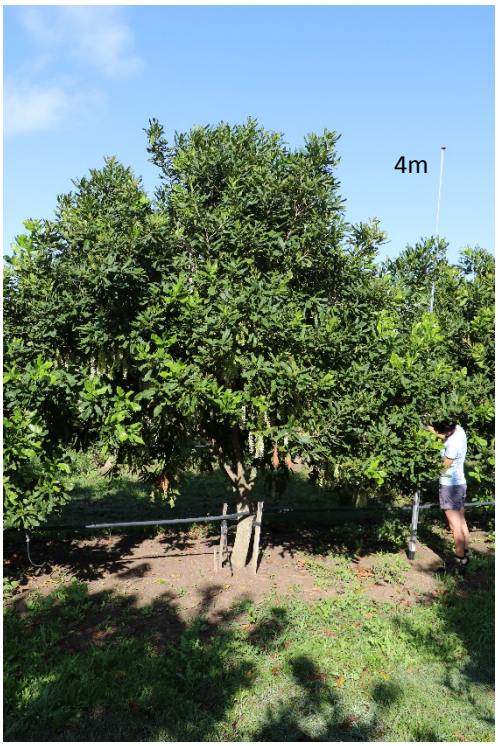
Growers at field days in Booyan and Wirrawilla, Bundaberg, rated "P" as 6.83 and 7.67 out of 9 respectively for commercial potential. 741 at Booyan was rated 7.21 out of 9 while 344 was rated 6.21 at Wirrawilla. At the NSW Alstonville site growers rated "P" 5.3 out of 9 while 741 was rated 6.85 and 816 6.38 out of 9. Worry about tree density was a common topic of "P" at Alstonville.

Variety "P" Yield and Tree Comparison				
Booyan				
Variety	**P**	**816**	**741**	**344**
Kernel Recovery (%)	38.9	45.2	38.3	34.2
Cumulative Kernel Yield (kg) 1	9.907	9.976	9.901	7.577
kernel Canopy Efficiency (g/m3) 2	123.1	95	78	83
Tree Volume (m3)	31.4	39.2	49	37.7
Kernel KG per Ha (estimated) 3	1,147	1,172	1,205	976
Kernel KG per Ha (estimated) 4	1,467			
1 - Cumulative Kernel Yield 2013 -				
2 - 2016 (year 8) Kernel Canopy				
3 - Estimated kernel yield (kg/ha) for 312.5 trees per ha or 8m x 4m				
4 - Estimated kernel yield (kg/ha) for 400 trees per ha				

VARIETY "R" FACTSHEET

BACKGROUND

Variety "R" is a new Macadamia variety released to the industry as a result of the National Macadamia Industry Variety Improvement program. Data has been collected on the new macadamia varieties in Regional Variety Trials (RVT's) across production regions in Queensland and New South Wales. These trials have been measuring kernel, tree, disease and processing qualities for the past 2 years and nut-in-shell yield for 4 years. The data presented below comes from these trial sites.

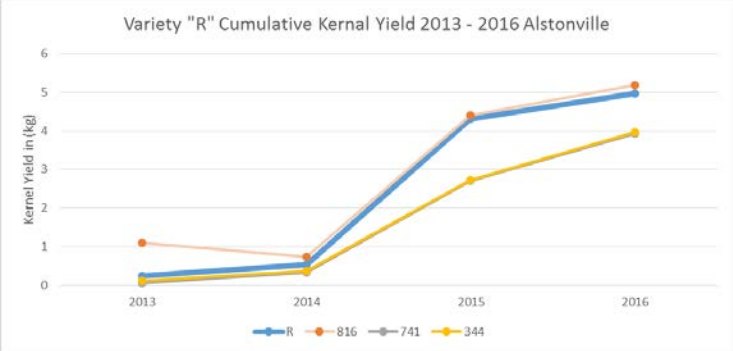


8 year old variety "R" at Booyan

DESCRIPTION

Variety "R" is a medium to large size, spreading tree. Tree volume at year 8 in Alstonville in northern NSW is 59m^3, similar to 816 but smaller than 741 at 61m^3, 344 at year 8 had a tree volume of 55m^3.

Variety "R" has a cumulative kernel yield per tree for years 2013 to 2016 of 10.063kg while 816 had a cumulative kernel yield of 11.416kg, 741 had 7.040kg and 344 7.182kg.



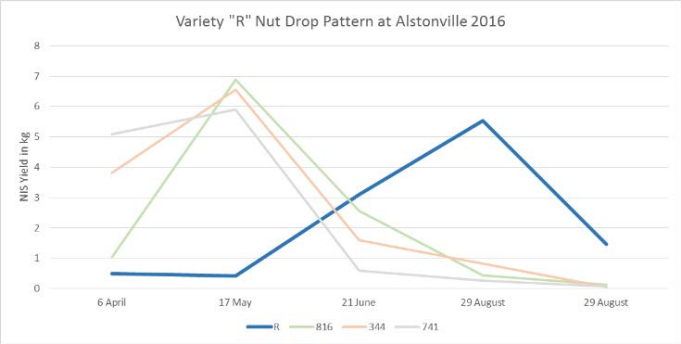
Variety "R" has a kernel recovery of 37% in Alstonville compared with 816 (45.7%), 741 (38%) and 344 at 34%. "R" flowers mid-late season in August/September at Bundaberg sites. Peak harvest season at the Alstonville RVT site is in August while 816, 741 and 344 peak in May/June.

Variety "R" kernel

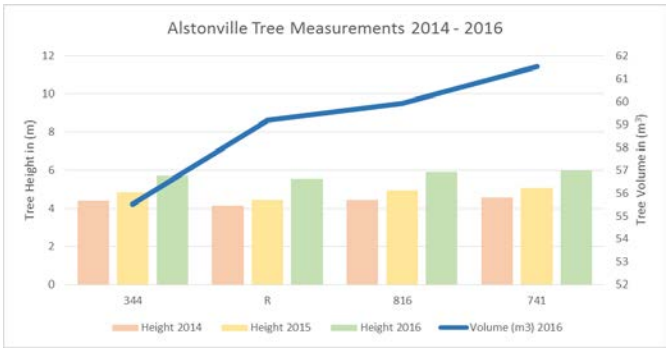
Variety "R" nut and shell

Horticulture Innovation Australia

Queensland Government



"R" is a similar size tree to 816 but smaller than 741. The spreading nature of R increases tree volume. 344 has a smaller tree volume of 55.5m^3



than "R" at 59.2 m^3, 816 of 59.9m^3 and 741at 61.5m^3.

Trees of "R" have a low rating (0.25 out of 5) for husk spot at Wirrawilla however it does have a low to moderate level of sticktights (2 out of 5). It shows no signs of Abnormal Vertical Growth (AVG) in Bundaberg trials.

Independent kernel assessment for Variety "R" from the Alstonville RVT site in 2016 had 67.9% whole kernel while 816 had 63.2%, 741 had 36.2 and 344 had 39.8% whole kernel from the same site.

Growers at a recent field walk in Alstonville rated Variety "R" 6.37 out of 9 while 816 was rated 6.38 and 741 rated at 6.85.

Variety "R" Yield and Tree Comparison				
Alstonville				
Variety	**R**	**816**	**741**	**344**
Kernel Recovery (%)	36.9	45.7	37.9	33.6
Cumulative Kernel Yield (kg) 1	10.065	11.416	7.04	7.182
Canopy Kernel Efficiency (g/m3) 2	72	91	67	65
Tree Volume (m3)	59.2	59.9	61.5	55.5
Kernel KG per Ha (estimated) 3	1,349	1,516	1,278	1,236
1 - Cumulative Kernel Yield 2013 - 2016				
2 - 2016 (year 8) Kernel Canopy Efficiency				
3 - Estimated kernel yield (kg/ha) for 312.5 trees per ha or 8m x 4m				

DISCLAIMER

Four New Macadamia Varieties for Australia

D. Russell[1]; J. De Faveri[1]; C. Hardner[2]; D. Bell[3]; S. Mulo[1] ; G. Bignell[1] and B. Topp[2]

[1]Department of Agriculture and Fisheries (DAF)

[2]Queensland Alliance for Agriculture and Food Innovation (QAAFI) UQ

[3]Hidden Valley Plantations (HVP)

Background

- Australian macadamia industry - >AU$200 M
- World's largest producer 2016
- Current industry varieties mainly Hawaiian and HVP
- Current varieties are large trees and slow economic break even

Trial Design

- 8 Regional Variety Trial sites in QLD and NSW planted 2008 and 2009
- 20 Industry, 5 standard and 5 HVP varieties
- Harvested from 2013 - 2016
- Disease and insect evaluation
- Oil profile, shelf life and sensory analysis

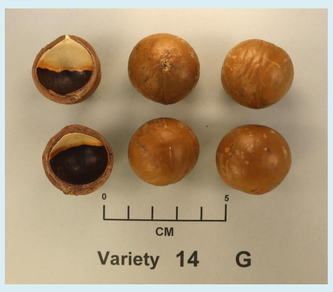
Selection Process

- MET Analysis and BLUPs of yield and tree data collected for 4 years
- Benchmarking data valued a dollar change in trait
- 20 year economic trait modelling
- Industry advisory committee make the final decision on release
- Plant Breeder's Rights applications

Variety Traits

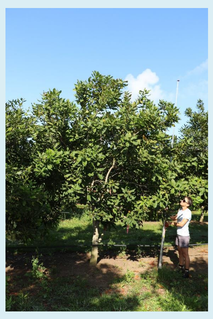
Variety 'G'

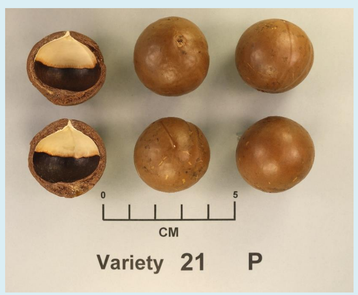
- Precocious and high canopy efficiency
- Medium to tall spreading tree
- All-rounder for Bundaberg and Northern Rivers
- Mid to late season nut drop

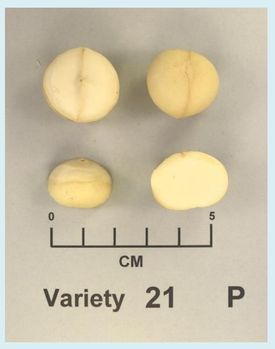


Variety 'P'

- Small to medium size, spreading tree
- Precocious, produces similar yield to HAES 741 on a tree 33% smaller
- Late season nut drop

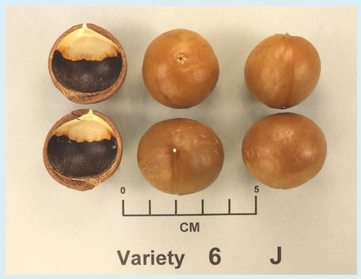






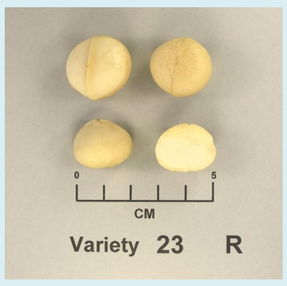
Variety 'J'

- Precocious and highly productive
- Medium to large tree
- Ranked 2 at Booyan RVT
- Mid – late season nut drop
- High kernel recovery



Variety 'R'

- Suited to Northern Rivers, NSW
- Performs well on coastal plain, NSW
- Out-yielding HAES 246 at year 6
- Medium size tree, late season nut drop



Yield and Tree Comparison for Booyan, Bundaberg

Variety	G	P	J	816	741	344	246
Kernel Recovery (%)	42.9	38.9	44	45.2	38.3	34.2	38.9
Cumulative Kernel Yield (kg) [1]	11.684	9.907	11.041	9.976	9.901	7.577	9.938
Kernel Canopy Efficiency (g/m^3) [2]	114	123	106	95	78	83	91
Tree Volume (m^3)	40.4	31.4	40.5	39.2	49	37.7	45
Kernel kg per ha (estimated) [3]	1,443	1,147	1,398	1,172	1,205	976	1,284
Kernel kg per ha (estimated) [4]		1467					
Estimated 20 year DCF for 1ha of orchard [5]	$155,874	$149,641	$147,928	$132,559	$116,640	$80,156	$136,351

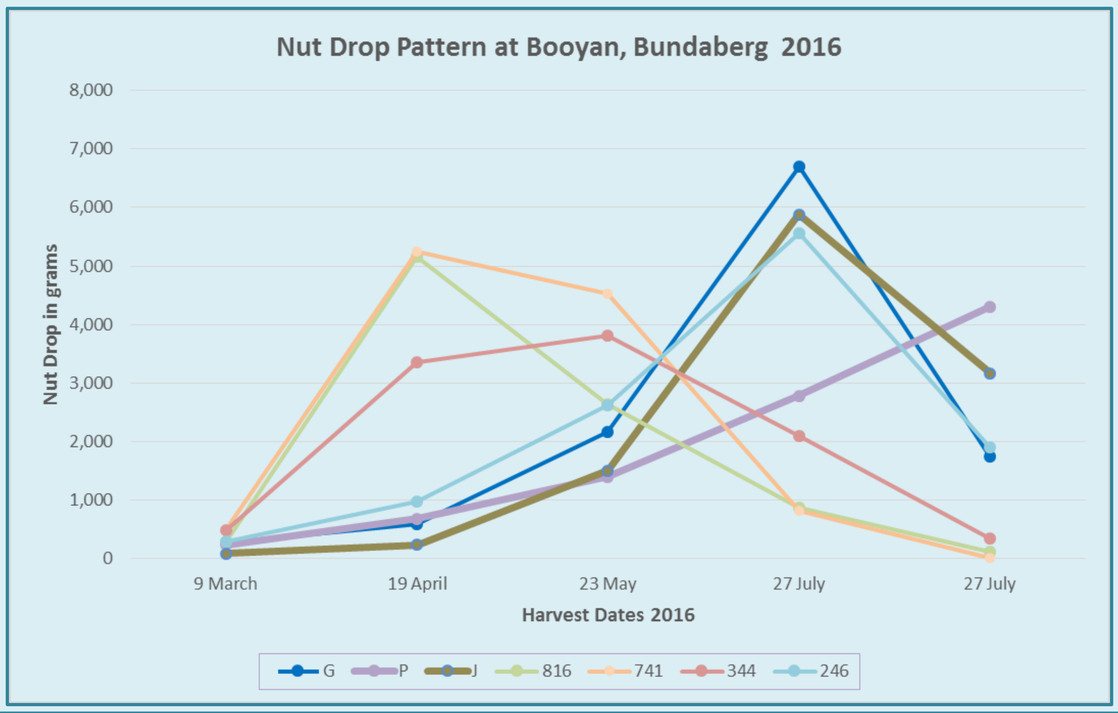
1 - Cumulative Kernel Yield 2013 - 2016

2 - 2016 (year 8) Kernel Canopy Efficiency

3 - Estimated kernel yield (kg/ha) for 312.5 trees per ha or 8m x 4m at year 8

4 - Estimated kernel yield (kg/ha) for400 trees per ha at year 8

5 - Year 20 Discounted Cash Flow for 1ha of orchard (average of standards $125,126)



Acknowledgements

Valued assistance from Rachel Abel (DAF), Rod Daley (DAF), Paul O'Hare (DAF), Craig Maddox (NSW DPI) David Robinson (NSW DPI), Lindsay Bryen, Russ Stevenson and RVT site managers throughout QLD and NSW.

AUSTRALIAN MACADAMIA SOCIETY

H. V. P.

Queensland Alliance for Agriculture & Food Innovation

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Regional Variety Trial Field Walks for 2017

Dougal Russell and Paul O'Hare, DAF, Nambour

Growers evaluated the recently released, elite macadamia selections from the industry breeding program at Regional Variety Trial (RVT) field walks in March in Bundaberg and Alstonville. Varieties G, P and J have been selected for release by the Macadamia Industry Varietal Improvement Committee (MIVIC) based on their performance to date in Bundaberg. Varieties G and R have been selected based on their performance in Alstonville. The new selections were compared with the industry standards 741 and 816 in both locations. The trials were planted in 2008 and have been harvested for four years so far.

Growers estimated the nut-in-shell yield of the new selections and rated them from 1 to 9 for husk spot severity, tree habit, canopy density and commercial potential:

- Husk spot – selections were rated from 1 (no husk spot present) up to 9 (severe husk spot present).
- Tree habit – trees were rated from 1 (very upright) to 9 (very spreading).
- Canopy density – tree canopies were rated from 1 (very open) to 9 (very dense).

Commercial potential – selections were rated from 1 (no potential) to 9 (excellent potential) with 7 considered to be commercially acceptable.

Bundaberg Field Walk – 2nd March

MIVIC members and local macadamia growers rated the new selections at the RVT sites at DeCortes and Booyan (Figure 1) and at a nearby supplementary grower trial site.

Figure 1. Growers at the Bundaberg RVT Field Walk

There was strong interest in selection G and very strong interest in selection P. Husk spot was not rated as an issue on any of the varieties being assessed.

On the two RVT sites, growers estimated selection P had a higher yield to 816, in fact the highest estimated yield of the varieties assessed, but the tree canopy volume was only 50 to 60% of 816. P and G rated higher for overall commercial potential compared with 741 and 816 (Figure 2). G is considered a medium to large, productive and open tree while P is small to medium, spreading and precocious.

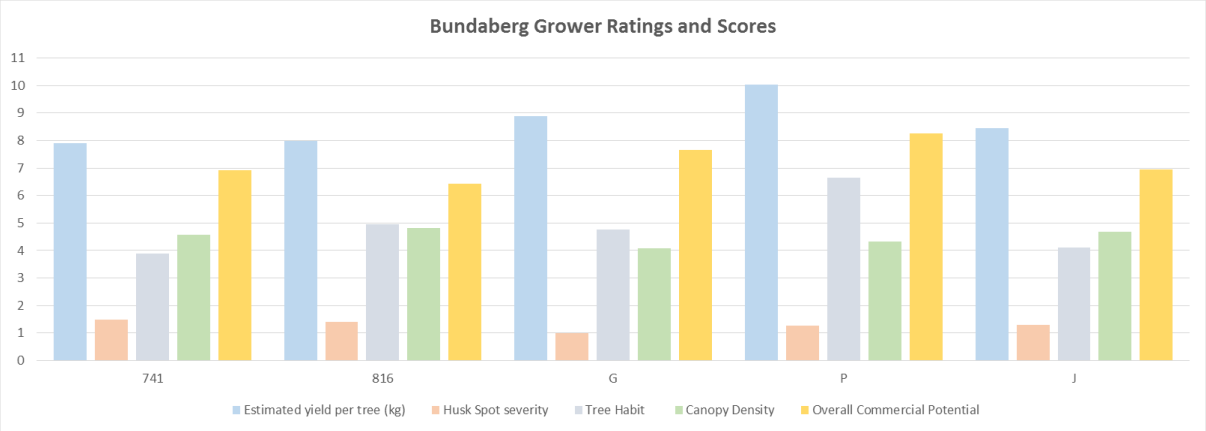

Figure 2. Mean grower ratings and scores for Bundaberg Field Walk

Grower comments for P included:

- "Very open tree, excellent yield and canopy".
- "Most promising"
- "Suitable as a high density tree"

Alstonville Field Walk – 23rd March

NSW growers and members of MIVIC also rated the selections for yield, husk spot susceptibility, tree growth habit, canopy density and commercial potential at the Alstonville RVT field walk on the 23rd of March (Figure 3).

Figure 3. Growers attending the Alstonville Field Walk.

The growers present rated selection G as the best performing variety compared to the industry standards. Growers considered G to have higher commercial potential (mean rating of 7.6) than 741 (6.5) and 816 (6.9). P did not rate as highly in Alstonville as it did in Bundaberg due to its canopy density as it was considered that this may impact on light and spray penetration. P had the densest

canopy with a mean rating of 7.6 compared with G (5.9) and 741 (5.1). It is important to note that the canopy of P was not rated as dense at the Bundaberg RVT sites.

Grower comments about selection G included:

- "Crops well from top to bottom"
- "Even yield throughout tree, no nut on outside - suitable to hedge".

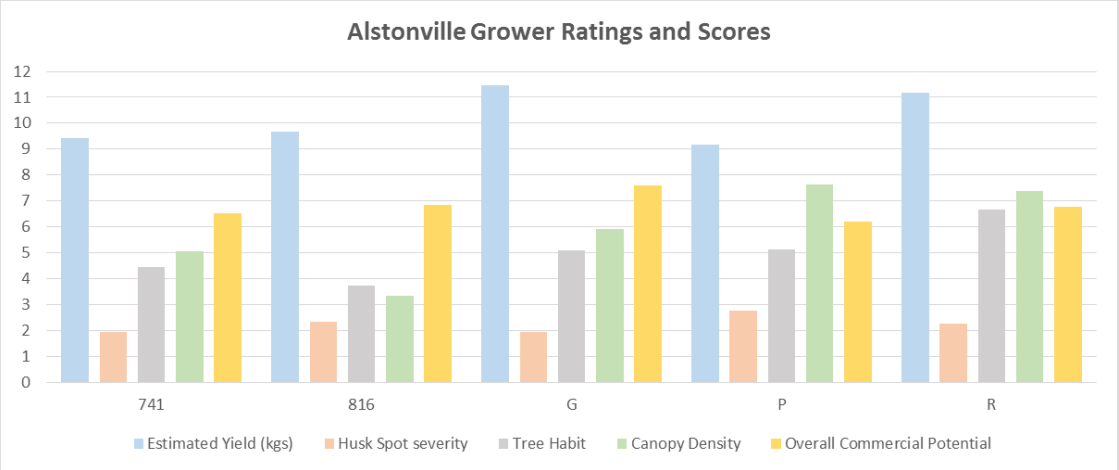

Figure 4. Mean grower ratings and scores for Alstonville Field Walk.

Results from the grower evaluations indicate that selections G and P are more suited to the Bundaberg region while G is suited to Alstonville. Feedback from the field walks indicates that G is considered an "all-rounder" being precocious and high yielding in both locations. P appears to be best suited to the Bundaberg coastal plain.

Growers in both QLD and NSW have taken the opportunity to order trees of the new varieties through the Expression of Interest process with the Queensland Department of Agriculture and Fisheries (DAF). For further information on the ordering process please contact the DAF Business Manager Jodie Campbell at Jodie.Campbell@daf.qld.gov.au.

All RVT's will be harvested again in 2017 to confirm yield and quality results. This will also provide more information on the performance of the selections in Emerald, Mackay and Macksville where the trials are one year younger.