5th Australian Almond Research & Development Forum & Field Day

AL14007 Almond Productivity: Tree Architecture and Development of New Growing Systems

Dr Grant Thorp, Plant & Food Research

October 30th - 31st, 2019

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Introduction

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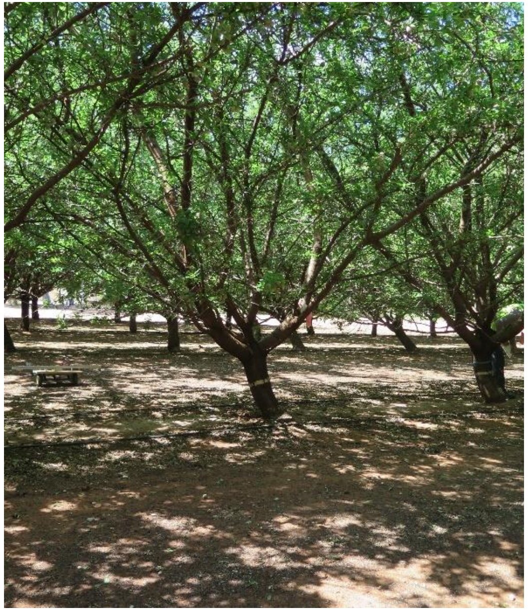
- Background
- People and resources
- Traditional growing systems – the need for change
- Current model for high density almond orchards
- Tree architecture – what are we looking for?



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Goals for high density almonds

"Double yields without increasing costs"

- Increase productive **yield** per hectare and grower **profit**, with improved nut **quality**
- Involve no or minimal additional **cost** to the grower
- Reduce the time taken to produce the first commercial crop and reach **break-even point** on the orchard investment
- Be suited to "**shake and catch**" harvesting

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Tree Architecture and New Growing Systems

First projects established from 2014 on commercial sites across SE Australia

(first trials at ABA Loxton planted in 2018)

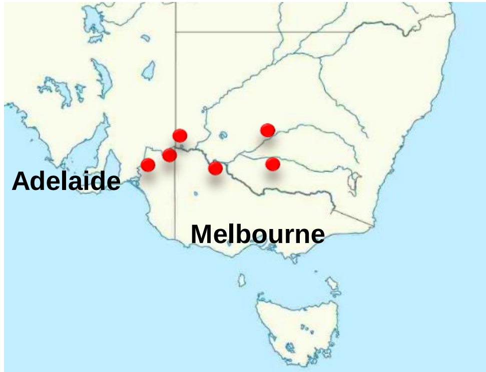
"Understanding the principles before setting the rules"

Objectives have been to:

- Better understand the **limitations to traditional growing systems** based on existing cultivars and rootstocks, and to identify changes to increase orchard productivity over the longer-term
- Investigate options to **redesign orchards of the future**, with new cultivars and rootstocks and new growing systems
- Work alongside almond breeders to **identify architectural traits** associated with high productivity and suitability for more intensive growing systems

Research blocks in Australia and California

Location:	Commercial partner:
South Australia	
Loxton North	Almond Board of Australia
Paringa	Amaroo Farm, Select Harvest Ltd
Teal Flat	Lacton Farm
Victoria	
Lindsay Point	CMV Farms
Robinvale	Carina West, Select Harvest Ltd
New South Wales	
Darlington Point	Kerarbury Farm, OLAM Edible Nuts
Hillston	Mooral Farm, RFM Ltd
Robinvale	Carina West, Select Harvest Ltd
California (Almond Board of California)	
Fowler	Burchell Nursery
Wolfskill	University of California, Davis
Fresno	California State University



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Almond research team and collaborators:

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PFR Australia:	Grant Thorp, Ann Smith, Michael Coates, David Traeger, Belinda Jenkins, Andrew Granger
PFR New Zealand:	Carlo van den Dijssel, Andrew Barnett, Vincent Mangin, Edouard Perie, Michael Blattmann, Patrick Snelgar, Jill Stanley, Stuart Tustin
MADEC	Renmark Harvest Labour Service
University of Adelaide:	Michelle Wirthensohn
UQ Queensland:	Neil White
Australia:	Anthony Wachtel, ABA Staff, Ben Brown, John Kennedy, Daryl Winter, Lacton Farm, CMV Farms, Select Harvest, OLAM, RFM Ltd, Mossmont Nursery, Growtek Nursery
California:	John Slaughter, Kaylan Roberts (Burchell Almond Genetics), Grant Zaiger (Zaiger Genetics), Gurreet Brar (CSU Fresno), Bruce Lampinen, Tom Gradziel (UC Davis)
Spain:	Ignasi Batlle and Xavier Miarnau (IRTA), Maria Jose Rubio Cabetas (CITA)

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Limitations with traditional growing systems

Selective limb removal and reflective ground covers:

"Increased light interception and yield in lower canopy zones …

… but did not increase total yield"

'Nonpareil'

Treatment	Year/Tree age	2015 6th leaf	2016 7th leaf	2017 8th leaf	2018 9th leaf
		Kernel weight (t/ha)[1,2]			
Control		2.6	5.6	4.3	4.1
Pruned + Reflective covers		3.1	5.7	4.6	4.7
	Significance	NS	NS	NS	NS

[1] Adjusted to 5.0 % moisture content

[2] Based on 556 trees/ha (6.0 x 3.0 m spacing)

Significance: NS = not significant

Limitations with traditional growing systems

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Selective limb removal and reflective ground covers:

"Increased light interception and yield in lower canopy zones …

… but did not increase total yield …

… and increased variability in crop maturity"

'Nonpareil'

2018 (9th leaf) Treatment	**Crop in lower canopy zone** Fresh weight (kg/tree)	Kernel moisture (%)	**Main crop** Kernel moisture (%)
Control	1.08	25.3	4.3
Pruned + Reflective covers	4.17	24.5	4.3
Significance	*	NS	NS

Based on 556 trees/ha (6.0 x 3.0 m spacing)

Significance: NS = not significant; * = $P<0.05$

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Changing to a narrow canopy

Experience from other tree crops is that a narrow canopy will have better light distribution and so more even crop maturity …

… and will enable higher yields by having more rows and more trees per ha.

‘Nonpareil’

Kernel weight (t/ha)[1,2]

Treatment (Year/Tree age)	2015 3rd leaf	2016 4th leaf	2017 5th leaf	2018 6th leaf
Control	0.49	3.9	3.8	5.1
Narrow pruned	0.54	3.2	3.2	4.5
Significance	NS	NS	NS	NS

[1] Adjusted to 5.0 % moisture content

[2] Based on 556 trees/ha (6.0 x 3.0 m spacing)

Significance: NS = not significant

Changing to a narrow canopy

“Narrow pruning”. Suitable for all tree types, including “standard tree” from nursery, grow as per normal practice for one or two years, then winter prune using heading cuts to cut back strong branches growing out into the row

Narrow pruned

Heading cuts used to produce new fruiting wood

With pruning

No pruning

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Yield makes a difference – 3rd leaf trees

Shasta®

Narrow Prune

Control - Not pruned

'Carina'

Narrow Prune

Control - Not pruned

Yield makes a difference – 3rd leaf trees

All trees spring-budded in December 2015 and planted in winter 2016 at 7 x 4.25 m spacing (336 trees per ha). All trees headed back to 90 cm. No pruning in Year 1.

Cultivar	Treatment	Kernel weight (t/ha)[1] 336 trees/ha
'Carina'	Control	1.5
	Pruned	1.4
	Significance	NS
'Nonpareil'	Control	0.8
	Pruned	0.6
	Significance	NS
Shasta®	Control	1.9
	Pruned	1.7
	Significance	NS

[1] Adjusted to 5.0 % moisture content

Significance: NS = not significant

Yield makes a difference – 3rd leaf trees

All trees spring-budded in December 2015 and planted in winter 2016 at 7 x 4.25 m spacing (336 trees per ha). All trees headed back to 90 cm. No pruning in Year 1.

Cultivar	Treatment	Kernel weight (t/ha)[1] 336 trees/ha	556 trees/ha	667 trees/ha
'Carina'	Control	1.5	2.3	2.7
	Pruned	1.4		
	Significance	NS	**	**
'Nonpareil'	Control	0.8	1.0	1.3
	Pruned	0.6		
	Significance	NS	NS	*
Shasta®	Control	1.9	2.9	3.4
	Pruned	1.7		
	Significance	NS	**	**

[1] Adjusted to 5.0 % moisture content

Significance: NS = not significant; *P<0.05; **P<0.01

Yield makes a difference – 4th leaf trees

Shasta®

Narrow Prune

Control - Not pruned

'Carina'

Narrow Prune

Control - Not pruned

Starting with unpruned trees from the nursery

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Pruned Unpruned


Unpruned trees ready for planting

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Starting with unpruned trees from the nursery

Shasta®

Congestion of scaffold branches as a consequence of heading cuts too low on the tree

Control – heading cut at 90 cm

Central leader – no pruning

Starting with unpruned trees from the nursery

Shasta®

'Carina'

Shasta®

'Carina'

Leader-release pruning

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Before and after pruning to stimulate extension of the central leader

Planted August 2018

Narrow pruning along the rows, no pruning between trees

‘Vela’ trees in October 2019
‘Controller 9.5’ rootstock

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Current model for high density almonds

"Double yields without increasing costs"

Current model based on narrow central leader trees:

- Rows 4.5 m wide (across row)
- Trees 2.0 m apart (along row)
- Trees 5.0 m high x 2.5 m wide (2.0 m wide alley way)

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Current projects at ABA Experimental Orchard

High Density Trial

- Application of our model "high density" system based on narrow, central leader trees, established and maintained with minimal pruning

Pruning Responses

- Testing various training/pruning systems, starting in the nursery, to produce central leader trees and to promote precocity and high yields with new cultivars and rootstocks

Architectural Studies

- Phenotyping architectural traits for high productivity, to provide tools for almond breeders to select new cultivars better adapted for future high density orchards (University of Adelaide)

Tree architecture for high density orchards

Architectural traits required for narrow, central leader trees in high density orchards

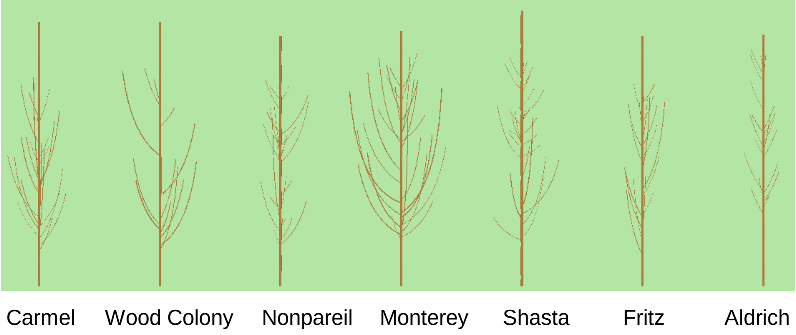
Quantitative data

Tree height		Branching		Trunk diameter		
Planted tree ht (m)	CL extension length (m)	Primary branches below transition Count (>8mm)	Branches above Transition zone Count	Trunk @ 50 cm diameter (mm)	Trunk diameter below transition (mm)	Trunk diameter above transition (mm)

Qualitative data

Trunk	Scaffold branches				Axillary shoots (current year)					
					Dards (mainly sylleptic)			Subterminal (mainly proleptic)		
(central leader dominance)	Vigour (length)	Strength (diameter)	Number (count)	Orientation (angle)	(count)	(length)	(diameter)	(count)	(length)	(diameter)
1 = weak	1 = short	1 = weak	1 = few	1 = horizontal	1 = few	1 = short	1 = weak	1 = few	1 = short	1 = weak
2 = moderate	2 = medium	2 = medium	2 = medium	2 = mixed	2 = medium	2 = medium	2 = medium	2 = medium	2 = medium	2 = medium
3 = strong	3 = long	3 = strong	3 = numerous	3 = upright	3 = numerous	3 = long	3 = strong	3 = numerous	3 = long	3 = strong

Architectural traits



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