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PROJECT ID: 18.HORT30.THORP

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Tree architecture – important traits for new almond varieties

Project summary

Research is underway in California and Australia to redesign almond orchards using more intensive management systems and new varieties to increase orchard productivity and grower profits.

The approach requires a fresh look at orchard design. Our key research hypothesis is that orchard yields and grower profits can be doubled by planting trees at high density and growing these trees with minimal pruning to produce a slender pyramid tree shape that optimizes orchard light interception, crop yield and quality.

A major consideration is that many of the current varieties in California and Australia are not compatible with this type of orchard intensification. New varieties are required that have architectural attributes better suited to high density orchards and to new pruning/training systems required to sustain high yields over the long term.

An important question in this research is can the breeding cycle for trees with high productivity be accelerated by screening for desired architectural traits in 1st leaf trees budded onto clonal rootstocks and by screening for desired fruit bearing traits in 2nd and 3rd leaf trees?

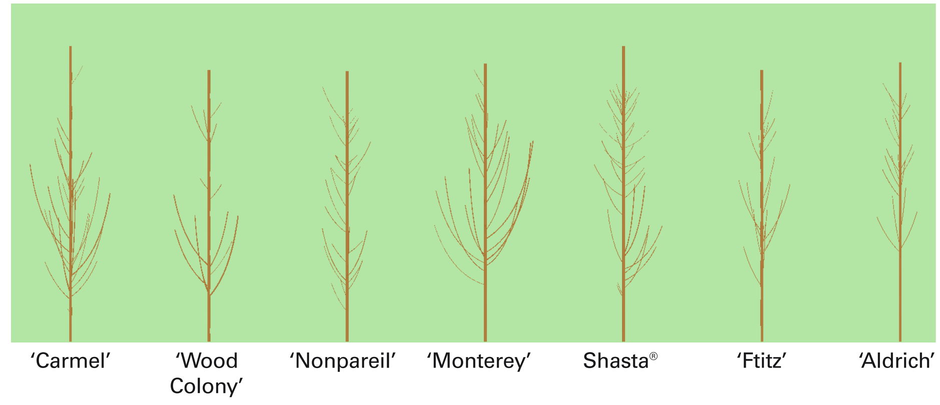
Tree architecture

Understanding tree architecture, or the natural growth habit of trees and their responses to manipulation, is fundamental to orchard system design and developing new management systems specific for each crop and variety. By understanding tree architecture, we are better able to describe physiological mechanisms and to identify/quantify architectural traits determining/limiting productivity.

As with many *Prunus* spp., almond trees generally exhibit a strong basitonic growth habit that produces a set of very large scaffold branches near the base of the tree. With heavy cropping varieties this can result in unstable fruiting canopies that require considerable pruning and training to maintain productivity. While this growth habit is suited to traditional large-tree growing systems, it is not suited to more intensive small-tree growing systems.

"At the same time as we redesign almond orchards, we need to redesign almond varieties!"

A compact, upright tree with excurrent branching (left) will be easier to manage in high density blocks than trees with wide, spreading canopies and decurrent branching (right). These differences are obvious within the first two years of tree growth.

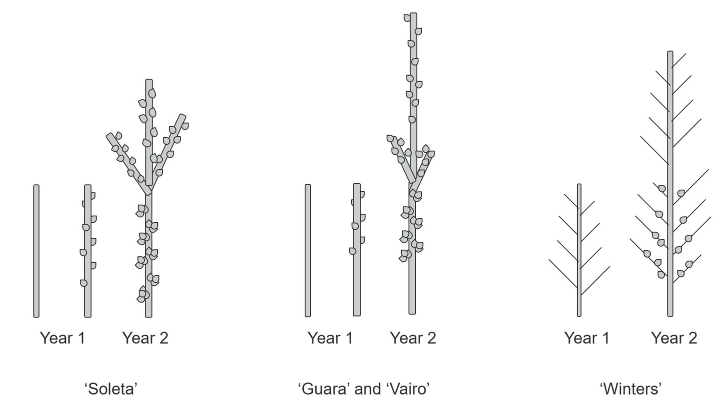


First-leaf trees in the nursery show a range of branching habits typical for each variety. Desired attributes for central leader trees would be to have uniform branching, evenly distributed along the trunk, as tends to happen with 'Nonpareil' and Shasta®.

Uniform extension of the central leader is desired at the transition zone between one growth flush and the next (left); compared with poor central leader development caused by dominant axillary branching (centre) or weak terminal bud development (right).

Tree architecture among breeding populations can easily be observed in years 1 and 2. Would it accelerate the breeding pipeline if trees with negative architectural traits were eliminated before the trees produced their first crop?

While strong axillary shoot production is important to increase the number of potential fruiting sites, these shoots (dards) need to be robust enough to survive in low light conditions and sustain high productivity. This attribute can be identified in second-leaf trees.



Bud and spur development on contrasting varieties. Is strong axillary growth in year 1 at the expense of strong bud and spur development in years 1 and 2, respectively?

Seedlings from breeding populations growing on their own roots typically show large variation in vigour (left), which is not seen in commercial trees on clonal rootstocks (right). Would it make the breeding pipeline more efficient if all breeding progeny were budded and evaluated on clonal rootstocks?

Strong branching from terminal and subterminal buds can produce long barren sections of wood; this undesirable habit can be observed in second-leaf trees.

Long-term viability of spurs will be important for sustained high productivity, as will the generation of new fruiting wood. At what stage in the breeding cycle can we predict spur longevity?

Examples of qualitative and quantitative data that can be used when screening breeding populations for desired architectural traits in the first- and second-leaf trees budded on clonal rootstocks.

Qualitative data:

Trunk	Scaffold branches				Axillary shoots (current year)					
					Dards (mainly sylleptic)			Subterminal (mainly proleptic)		
Dominance of central leader	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

Quantitative data:

Tree height		Branching		Trunk diameter		
Planted tree ht	Extension of central leader	Primary branches below transition	Branches above Transition zone	Trunk @ 50 cm diameter	Trunk diameter below transition	Trunk diameter above transition
(m)	(m)	Count (>8mm)	Count	(mm)	(mm)	(mm)

Project Collaborations:

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Acknowledgement

This project has been funded by the Almond Board of California and by Hort Innovation, using the almond research and development levy and contributions from the Australian Government.