Varieties and Rootstocks
Major Varieties: In California

About 30 commercial varieties grown in California, but >98% of production comes from 13 major varieties.

Cross Pollinated

- Non-pareil
- Monterey
- Wood Colony
- Aldrich
- Butte
- Padre
- Carmel
- Fritz

- Sonora
- Price
- Winters
- Supareil

New, Self Pollinated, increasingly being planted:

- Shasta® (Burchell Nursery)
- Independence® (Zeiger Genetics/Dave Wilson Nursery)
New varieties

• Sweetheart (New release: UC)
• Yorizane (USDA-ARS)
• Pyrenees® (Burchell Nursery)
Independence ® : (Zeiger genetics)

• Moderate vigour,
• Self fertile,
• Upright to spreading growth habit
• Blooms with Non-pareil
• Harvests 2-3 days before Non-pareil
Yorizane: (USDA-ARS)

- Self fertile
- Blooms with Non pareil
- Harvests with Non pareil
- Slightly weeping growth habit
- Kernel size and color similar to Non pareil
- Soft shell
Shasta ® : (Burchell Nursery)

• Blooms with or slightly ahead of Nonpareil. Harvests with or slightly ahead of Nonpareil.

• Good for shelled or in-shell use

• Yield data from the Burchell Nursery website:
  • 6th leaf: 272 trees/ha, 3093 kg/ha
  • 6th leaf: 346 trees/ha, 3940 kg/ha

• Diffuse branching, upright habit

• Strong central leader, suitable for central leader training
Pyrenees ®

• Comes from Burchell Nursery
• Self-fertile
• Moderate vigour
• Open growth habit
• Blooms 3 days after Non pareil
• Harvests late-mid season (2-3 weeks after Non-pareil)
• Spur bearing type
• Strong lateral growth
# Almond Cross-Compatibility Chart

This chart has been developed from our own observations, all gathered from information found in trade and scientific publications. However, its accuracy cannot be guaranteed and is subject to change as new information is made available.

<table>
<thead>
<tr>
<th>RUBY (+9)</th>
<th>MISSION (+8)</th>
<th>BUTTE (+13)</th>
<th>LIVINGSTON (+12)</th>
<th>WOOD COLONY (+3)</th>
<th>MONTEREY (+2)</th>
<th>MERCEDES (+2)</th>
<th>CARMELO (+1)</th>
<th>FRITZ (+1)</th>
<th>ALDRICH (+9)</th>
<th>PRICE (+6)</th>
<th>NONPAREIL (+9)</th>
<th>AVALON (+3)</th>
<th>MARCONA (+3)</th>
<th>SONORA (+9)</th>
<th>WINTERS (+4)</th>
<th>NEPLUS ULTRA (+9)</th>
</tr>
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</tr>
</tbody>
</table>
Major Varieties: In Europe

Spanish:
• Guara
• Soleta
• Marcona
• Moncayo
• Belona
• Antonieta
• Glorieta
• Marta
• Penta

French:
• Desmayo
• Largueta
• Diamar
• Vairo
• Marinada
• Conatanti
• Tarraco
• Ferraduel
• Ferragnès
• Lauranne

Italian:
• Tuono
• Cristomorto
Growth Habits
Guara

- Self fertile
- Late flowering
- By Spanish Institute CITA.
- One of the most common varieties in Spain, similar to Tuono.
- Tree has an average growth and open shape.
- Adapts well to different climate and soil characteristics.
- The nut is medium-sized and it has hard shell.
Soleta

• Medium vigor tree
• Slightly upright growth habit
• Suitable for high density planting.
• Blooms 3 days before ‘Guara’,
• Bearing on spurs. Very high flower density.
• Hard shell
Diamar

• Blooms 20 days after ‘Guara’,
• Average flower density
• Ripening a week after ‘Guara’.
• Hard shell
Avijor

• Vigorous tree
• Upright growth habit
• Late flowering (2-3 days later than Guara)
• Self-fertile
• Semi-hard shell
<table>
<thead>
<tr>
<th>Spanish Varieties</th>
<th>Location</th>
<th>Vigor</th>
<th>Growth Habit</th>
<th>Branching density</th>
<th>Bloom time</th>
<th>Self-compatible?</th>
<th>Harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonpareil</td>
<td>U.S.</td>
<td>high</td>
<td>upright to spreading</td>
<td>medium</td>
<td>mid</td>
<td>No</td>
<td>early</td>
</tr>
<tr>
<td>Constanti</td>
<td>IRTA</td>
<td>high</td>
<td>medium-upright</td>
<td>medium</td>
<td>late</td>
<td>Yes</td>
<td>medium (end Aug)</td>
</tr>
<tr>
<td>Marinada</td>
<td>IRTA</td>
<td>medium</td>
<td>medium-upright</td>
<td>medium- scarce</td>
<td>Very late (+33d Desmayo Largueta)</td>
<td>Yes</td>
<td>medium (early Sept)</td>
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<tr>
<td>Tarraco</td>
<td>IRTA</td>
<td>medium</td>
<td>medium-erect</td>
<td>medium- scarce</td>
<td>Very late (+35d Desmayo Largueta)</td>
<td>No</td>
<td>medium-</td>
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<tr>
<td>Vairo</td>
<td>IRTA</td>
<td>high</td>
<td>medium</td>
<td>medium</td>
<td>late</td>
<td>Yes</td>
<td>early (mid-late Aug.)</td>
</tr>
<tr>
<td>Selection '29-148'</td>
<td>IRTA</td>
<td>medium</td>
<td>medium</td>
<td>medium</td>
<td>very late</td>
<td>Yes</td>
<td>early (early Sept.)</td>
</tr>
<tr>
<td>Selection '30-297'</td>
<td>IRTA</td>
<td>medium</td>
<td>high</td>
<td>medium-low</td>
<td>very late</td>
<td>Yes</td>
<td>late (mid-Sept)</td>
</tr>
<tr>
<td>Belona</td>
<td>CITA</td>
<td>high</td>
<td>semi-opening</td>
<td>average- scarce</td>
<td>late</td>
<td>Yes</td>
<td>medium</td>
</tr>
<tr>
<td>Guara</td>
<td>CITA</td>
<td>very high</td>
<td>open, weeping</td>
<td>average- scarce</td>
<td>late</td>
<td>Yes</td>
<td>early (mid Aug.)</td>
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<tr>
<td>Mardia</td>
<td>CITA</td>
<td>slightly semi-opening</td>
<td>medium</td>
<td>extra late (+25 d NP)</td>
<td>Yes</td>
<td>early</td>
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<tr>
<td>Soleta</td>
<td>CITA</td>
<td>medium</td>
<td>semi-opening</td>
<td>intermediate</td>
<td>extra late (+22d NP)</td>
<td>Yes</td>
<td>medium-late</td>
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<tr>
<td>Vialfas</td>
<td>CITA</td>
<td>low</td>
<td>open</td>
<td>abundant</td>
<td>late (+8d NP)</td>
<td>Yes</td>
<td>early (-1d NP)</td>
</tr>
<tr>
<td>Antoneta</td>
<td>CEBAS-C</td>
<td>high</td>
<td>open</td>
<td>abundant</td>
<td>late (+8d NP)</td>
<td>Yes</td>
<td>intermediate (+13d NP)</td>
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<tr>
<td>Makako</td>
<td>CEBAS-C</td>
<td>high</td>
<td>balanced</td>
<td>abundant</td>
<td>late (+24d NP)</td>
<td>Yes</td>
<td>intermediate (+13d NP)</td>
</tr>
<tr>
<td>Marta</td>
<td>CEBAS-C</td>
<td>high</td>
<td>upright</td>
<td>balanced</td>
<td>late (+8d NP)</td>
<td>Yes</td>
<td>early (+3d NP)</td>
</tr>
<tr>
<td>Penta</td>
<td>CEBAS-C</td>
<td>inter-</td>
<td>balanced</td>
<td>abundant</td>
<td>extra late (+26d NP)</td>
<td>Yes</td>
<td>early (+7d NP)</td>
</tr>
<tr>
<td>Selection 'D00-</td>
<td>CEBAS-C</td>
<td>high</td>
<td>balanced</td>
<td>balanced</td>
<td>extra late (+21d NP)</td>
<td>Yes</td>
<td>early (+4d NP)</td>
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<tr>
<td>360'</td>
<td>CEBAS-C</td>
<td>high</td>
<td>balanced</td>
<td>balanced</td>
<td>early (+0d NP)</td>
<td>Yes</td>
<td>very early (-3d NP)</td>
</tr>
<tr>
<td>Selection 'D01-</td>
<td>CEBAS-C</td>
<td>high</td>
<td>balanced</td>
<td>balanced</td>
<td>early (+0d NP)</td>
<td>Yes</td>
<td>intermediate (+16 NP)</td>
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<td>188'</td>
<td>CEBAS-C</td>
<td>high</td>
<td>balanced</td>
<td>balanced</td>
<td>early (+19d NP)</td>
<td>Yes</td>
<td>intermediate (+16 NP)</td>
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<tr>
<td>Selection 'D06-</td>
<td>CEBAS-C</td>
<td>inter-</td>
<td>balanced</td>
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<td>extra late (+19d NP)</td>
<td>Yes</td>
<td>intermediate (+16 NP)</td>
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<tr>
<td>795'</td>
<td>CEBAS-C</td>
<td>high</td>
<td>balanced</td>
<td>balanced</td>
<td>early (+19d NP)</td>
<td>Yes</td>
<td>intermediate (+16 NP)</td>
</tr>
</tbody>
</table>
Almond Rootstocks
What is the best rootstock?

• Anticipate possible problems with site

• If no specific biological, chemical or physical soil challenges are present, rootstock choice may not make much difference as long as planting density is appropriate.
Common issues that rootstocks address

• Soil salinity
• Waterlogging
• Nematodes
• Soil borne fungi
• Freeze
• Tree Vigor
• Bloom time

Peach rootstock
Peach-Almond hybrids
Plum based rootstocks
Multispecific/complex hybrids
Peach almond hybrids tolerate marginal soils better, have higher vigor, sensitive to wet feet.
Plum based hybrids tolerate wet soils better, have compatibility issues with many scions.
Complex hybrids tolerate some nematodes well.

<table>
<thead>
<tr>
<th>Rootstock</th>
<th>Country</th>
<th>Genetic origin</th>
<th>Features</th>
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<tbody>
<tr>
<td>Guardian</td>
<td>USA</td>
<td>Peach</td>
<td></td>
</tr>
<tr>
<td>Nemaguard</td>
<td>USA</td>
<td>Peach</td>
<td></td>
</tr>
<tr>
<td>Bright's hybrid</td>
<td>USA</td>
<td>Peach Almond Hybrid</td>
<td></td>
</tr>
<tr>
<td>Krymsk</td>
<td>Russia</td>
<td>Plum</td>
<td></td>
</tr>
<tr>
<td>Viking</td>
<td>USA</td>
<td>Complex hybrid</td>
<td></td>
</tr>
<tr>
<td>Atlas</td>
<td>USA</td>
<td>Complex hybrid</td>
<td></td>
</tr>
<tr>
<td>Garnet</td>
<td>Spain</td>
<td>Peach Almond Hybrid</td>
<td></td>
</tr>
<tr>
<td>Controller-6</td>
<td>USA</td>
<td>Peach</td>
<td></td>
</tr>
<tr>
<td>Rootpac-20</td>
<td>Spain</td>
<td>Plum hybrid</td>
<td>Growth controlling, suitable for SHD</td>
</tr>
<tr>
<td>Rootpac-R</td>
<td>Spain</td>
<td></td>
<td>Good for heavy soils, tolerates wet feet, good survival with Armillaria</td>
</tr>
<tr>
<td>Rootpac-40</td>
<td>Spain</td>
<td></td>
<td>Peach/almond hybrid, medium vigour, moderately salinity tolerant</td>
</tr>
<tr>
<td>Marianna 2624</td>
<td>Plum</td>
<td></td>
<td>Good for heavy soils; compatibility issues</td>
</tr>
<tr>
<td>Hansen 536</td>
<td>Plum</td>
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<tr>
<td></td>
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<td>Peach Almond Hybrid</td>
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</table>
Nemaguard

- Advantages
  - “Immune” to rootknot nematode
  - Vigorous rootstock
  - Compatible with all almond varieties
  - Performs well in sandy loam & loam soils
  - “Decent” anchorage
  - Growers are familiar with it
Disadvantages

Susceptible to:

• Ring & root lesion nematodes
• Bacterial canker
• High soil pH / high lime
• Salt (sodium, chloride, boron)
• Phytophthora / “wet feet”
• Oak root fungus
• Crown gall
• “Heart” rot / wood decay fungi
Garnem
Peach/Almond Hybrids

Includes Hansen, Garnem, Nickels, Bright’s Hybrid Cornerstone, Titan Hybrid, Paramount

- Better than peach in soils with high pH, B, Na or Cl
- May take in less N, K & B; more Ca & Mg
- Highly susceptible to bacterial canker
- High vigor: Good for Carmel, Wood Colony
- Too much vigor for Nonpareil, Padre etc.
- Very good anchorage
- Resistant to rootknot nematode
Peach / Almond Hybrids

Disadvantages

• Highly susceptible to bacterial canker
• Highly susceptible to ring nematode
• Too much vigor with vigorous varieties
Interspecific/complex Hybrids

• Includes Atlas & Viking
• Better than peach in soils with high pH & chloride
• May offer some of same benefits as P/A hybrids without susceptibility to bacterial canker or phytophthora
• Not more vigor than Nemaguard
Interspecific/complex Hybrids

Viking (peach x almond x plum x apricot)

- Similar in size to nemaguard
- Resistant to rootknot nematode
- **Tolerant to ring nematode**
- Bacterial canker tolerance is similar to Lovell but with higher yields
- More tolerant to high pH, sodium & chloride than peach rootstocks
- Better anchorage than nemaguard or Lovell
- *Unknown tolerance to saturated soils
- **Susceptible to dehydration at planting
Rootstock Influence on Tree Size

- Julior
- Empyean 2
- Empyean 101
- Krymsk 86
- Lovell
- Nemaguard
- Guardian
- Avimag
- Atlas
- Viking
- Paramount
- Cornerstone
- Empyean 1
- Hansen
- Nickels

Trunk Circumference (cm)
Specific Challenges…

• Ring nematodes (bacterial canker)

• Viking or Lovell
Ring Nematode

Peach / almond hybrids & Julior are highly susceptible to ring nematodes

ring nematodes / 250 cc soil
A Comparison of Almond Rootstocks for Incidence of Bacterial Canker

Escalon, CA 2005 (8th leaf)

- Peach / almond hybrid rootstocks are very susceptible to bacterial canker
- Viking, Lovell & Guardian are tolerant
Specific Challenges...

• Alkaline / salty soil or water

• Peach / almond hybrid
  • not if heavy soil or ring nematodes
  • Hansen, Nickels, Bright’s, Titan, Cornerstone, etc.

• Atlas (not if ring nematodes)
• Viking
• Empyrean 1
Tree Planting: Berms?

Flat:
- Easiest to use with equipment
- Use only in soils with quick drainage (loamy sands-sands)

Standard Berm:
- 8”+ in height, 5’ wide
- Drains water away from crown, keeps roots out of water
- Issues with harvest, weeds, equipment
- Generally recommended

Raised Bed:
- 20”+ in height, 11’ wide
- Possible use in shallow soils
- Increase in yield v/s berm
- Issues with equipment
- Experimental, but feasible
Tree Planting - Method

- Dig a big hole
- Plant high
  - Highest root should be covered with a few inches of soil
  - Graft union must be above soil line
  - Allow 3-4 inches for settling
- Tank in the tree with 3-5 gallons of water
  - Re-tank if needed (i.e. hot weather)
- Trim branches, high heading cut (36”+)
Tree Planting - Problems
Tree Planting - Problems