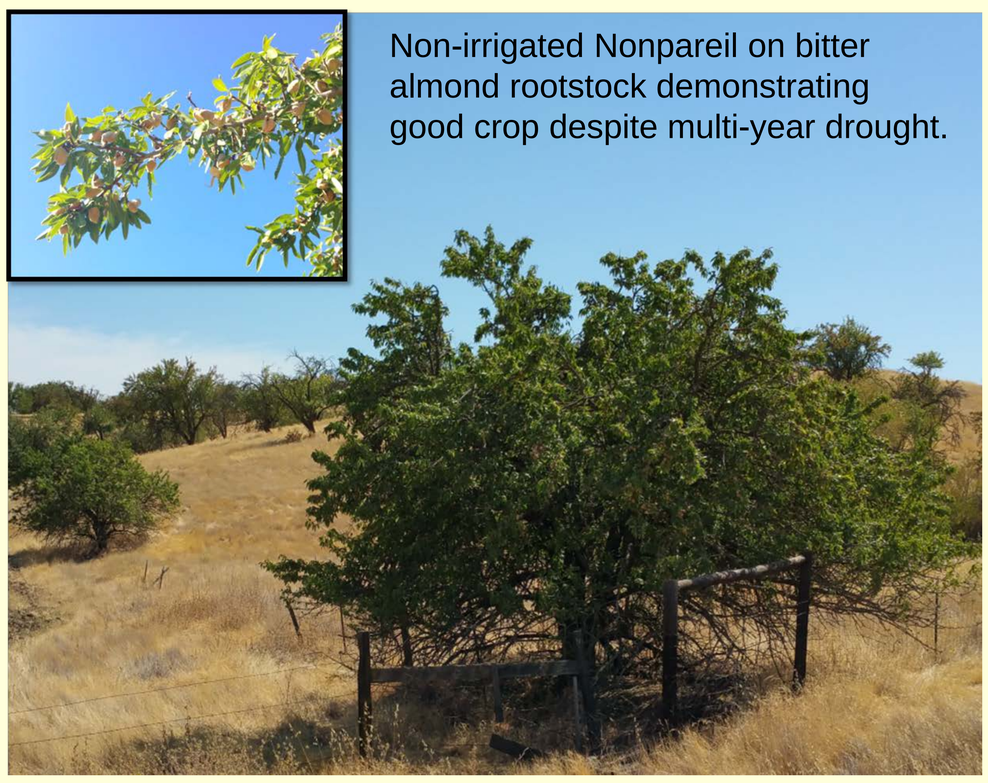
Rootstock Breeding

Project Leader: Tom Gradziel

Cooperating Personnel: J. Adaskaveg, M. Aradhya, B. Beede, G. Browne, P. Brown, J. Chaparro, J. Connell A. Dandekar, R. Duncan, D. Doll, B. Johnson, E.P. Johnson, D. Kluepfel A. Langford, B. Lampinen, J. Preece, G. Thorp, A. Volder, A. Westphal, M. Yaghmour, Burchell, Sierra Gold and Fowler Nurseries, and Wonderful Farms.

Location: Plant Sciences, University of California/ Davis

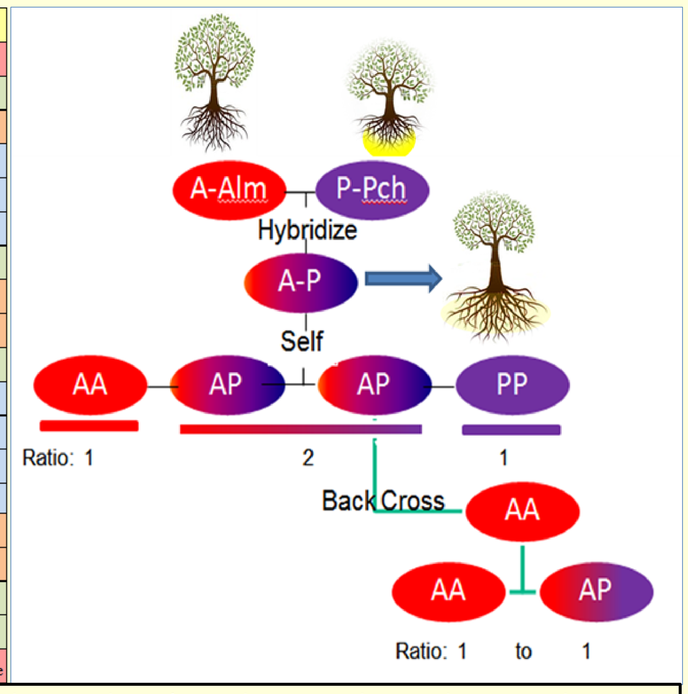


Non-irrigated Nonpareil on bitter almond rootstock demonstrating good crop despite multi-year drought.

Introduction and Approach

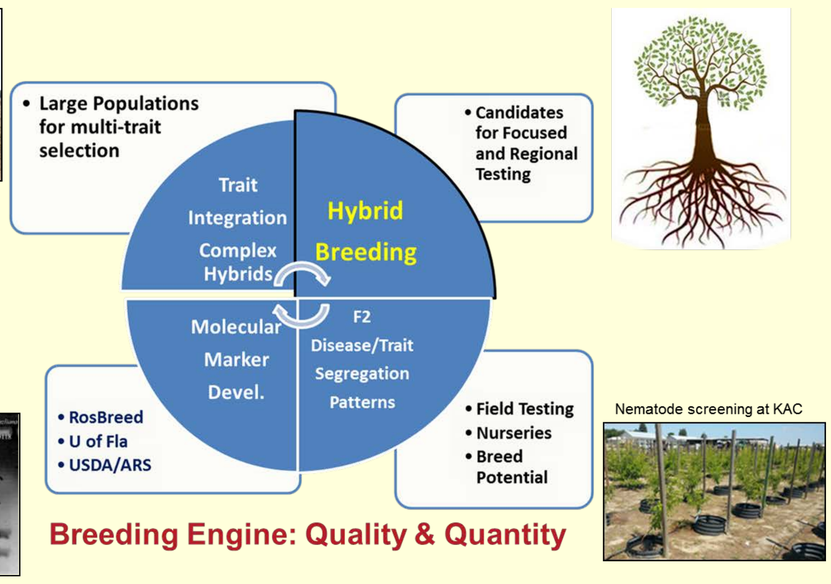
Changes in planting and cultural practices have led to the need for a new generation of rootstocks with improved disease and environmental stress resistance. Responding to this need, a number of public and private efforts have been initiated to research, develop and test new rootstocks for California tree crops. Germplasm derived from interspecies hybrids is often pursued to attain the greatest range of vigor and desirable horticultural traits. However, the development of such exotic germplasm is often difficult and time-consuming and the genetic and genomic interactions can be complex and unpredictable. As part of the long-term UCD almond and peach genetic improvement programs, breeding lines have been developed combining almond, peach and plum as well as related Prunus species. Selections within this germplasm have demonstrated traits which are promising for continued rootstock improvement.

Item	Genetic background
Atlas	Almond, Peach, P. davidiana, Plu8m
Bright Hybrid	Almond, Peach, P. davidiana
Cadaman	Peach x P. davidiana
Citation	Almond, Plum
Compass	P. besseyi x P. americana
Controller 5	P. salicina x Peach
Cornerstone	Peach x Almond
Empyrean#1	Peach x P. davidiana
Flordaguard	Peach x P. davidiana
Hansen 536	Almond, Peach, P. davidiana
Hiawatha	P. besseyi x P. salicina
Ishtara	P. cerasifera, P. saliciana, Peach
Krymsk#86	Peach x P. cerasifera
Marianna 2624	P.munsoniana x P. cerasifera x P. hortulana
Nemaguard	Peach x P. davidiana
Nemared	Peach x P. davidiana
Nickels	Almond, Peach, P. davidiana
Paramount	Peach x Almond
Viking	Almond, P. blireiana, P. cerasifera, P. Mume

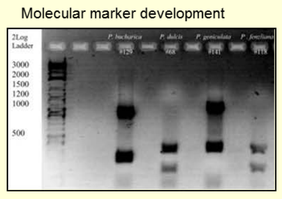


Most commercially established and emerging almond rootstocks are interspecies hybrids. Hybridization allows the simultaneous recombination of major disease/stress resistance genes from both species parents while also conferring improved hybrid vigor to the rootstock/scion. Because this hybrid vigor can mask the effect of major resistance genes, inheritance patterns in progeny populations are analyzed to identify major genes by their expected inheritance ratios (1:2:1 in selfed- and 1:1 in backcross progeny). By this approach, the most effective individuals within specific species can be identified for use as commercial rootstocks as well as further breeding progress.

2017 Interspecific hybrids at UCD
Large populations required for:
-accurate molecular mapping
-recombine the numerous traits required for commercial success



Molecular marker development



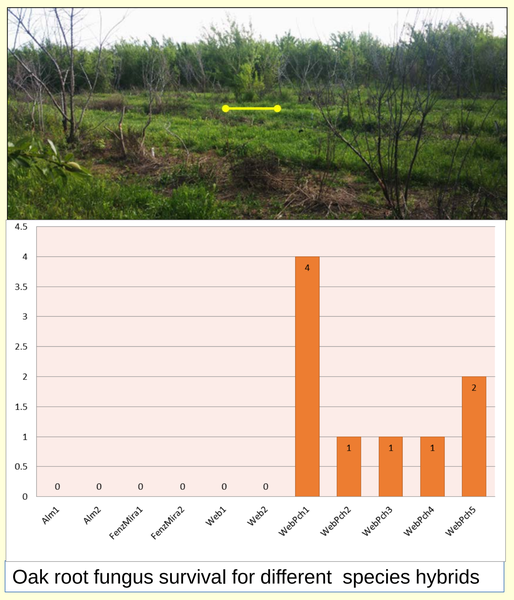
Nematode screening at KAC

Promising interspecies hybrids as well as segregating progeny populations are entered into the breeding cycle for assessment of individual hybrid rootstock potential as well as it's further breeding potential (based on gene inheritance patterns). Segregating progeny populations are also required for the development of molecular markers for desired resistance traits. The ability to consistently develop large breeding populations both improves marker development efficiency as well as allowing effective recombination of not only the desired major resistance gene but also the myriad of other genes required for commercial success.

Trait	Cooperator	Material under evaluation	*Speciesevaluated*	Status
Heat Tolerance	M. Gilbert	15 clones	*a, f, m, p, w*	Under analysis
Botryophaeria resistance	J. Chaparro (U. Fla)	40 cl., 100 sdlings	*a, b, f, m, pd, p, plsp, t, tr, w*	Field plots established with preliminary results
Root lesion Ring, and Root-knot nematode	A. Westphal	25 clones	*a, dv, m, p, t, w*	Field plots established for 7 cl. with 19 clones propagated.
Phytophthora	Greg Browne	3 clones	*pl*	Plants established
Crown gall	D. Kluepfel	~200 seedlings	*p, t,*	>100 sdlings in field, ~100 sdlings greenhouse,
Salinity tolerance	P. Brown	12 clones	*d, a, , f, m, p, t, w*	Greenhouse testing
Botryophaeria, Oxyporus and other wood rot diseases	Rizzo/Johnson	15 clones	*d, a, , f, m, p, t, w*	10 clones under test with 10 to 20 additional clones to be added
Effect on scion architecture	Fowler/Wonderful	7 clones	*a, dv,*	Field plots in commercial production
Nonpareil Compat. & Replant decline	Burchell Nursery	50 clones	*a, b, dv, m, p, plsp, s, t, w*	Field testing
Replant decline	Sierra Gold Nursery	20 clones & ~1000 seed	*a, dv, m, p, s, t, w*	Field testing
Dryland culture	A. Langford	Almond seedlings	*d*	Field testing
Armillaria	In-house	~200 seedlings	*d, p*	Seed being prepared for planting
Asphyxia	In-house	~100 seed	*d, p*	Seed being prepared for planting
Verticillium & Phytophthora	In-house	6 cl. & ~240 sdlings	*d, p*	Seed being prepared for planting
Architecture & disease	In-house	90 cl., ~40, 000 sdlings	*a, b, dv, m, p, s, t, w*	Field testing
High density plantings.	G. Thorp, Australia	20 cl., ~400 seedlings	*d, , f, m, p, w*	12 clones propagated, >1000 crosses (hybrids and F2's)
Tissue culture, plant-regeneration, transformation	Abhaya Dandekar	~200 developing seed; 6 clones	*d, p, dv*	Ease of in-vitro regeneration underway

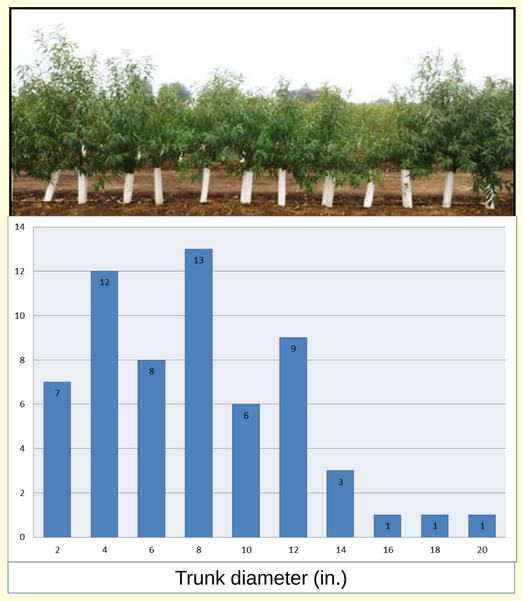
Almond {P.dulcis} (d), Peach {P.persica} (p), P.argentea (ar), P.fenzliana (f), P.mira (m), P.webbii (w),
P.bucharica (b), P.pedunculata (pd), Plum spp. (pl), P.tangutica (t), P.triloba (tr), P.davidiana (dv), P.scoparia (s)

Summary of interspecies germplasm currently being evaluated by the breeding program and collaborating labs. Individuals showing promise as commercial rootstocks will move directly into regional trials. Individuals identified as having breeding potential based on progeny performance/inheritance patterns will be targeted for molecular marker assessment as well as future hybridization following selection of both a complementary species as well as individual within that species showing the most promising potential for both specific (i.e. targeted traits) as well as general (comprehensive rootstock performance) combining ability.



Oak root fungus survival for different species hybrids

Screening for oak root fungus resistance in natural armillaria hot-spots. Progeny derived from different P. webbii by peach hybrids (WebPch) show higher survival rates after six years of growth though the general low frequencies and absence of clear inheritance patterns suggest low breeding potential. [Surviving trees identified in the upper photo by underlying in yellow].



Trunk diameter (in.)

Progeny population distribution in trunk diameter (as an indicator of hybrid vigor) in an interspecies hybrid derived from the same almond and peach parents, showing significant variation in individual progeny performance.

[Image at top shows 2017 UCD plantings of representative trees from a peach by *P. mira* hybridization after one season of growth].