Breeding PD Resistant Winegrapes

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PD Resistance Breeding

- Lenoir (Jacquez, Black Spanish) a *V. aestivalis* x *V. vinifera* hybrid
- 100s of years of breeding hindered by multigenic resistance – Blanc du Bois
- We discovered single dominant gene for resistance in *V. arizonica* (b43-17)
- b43-17 was collected by Olmo in Monterrey Mexico and we stumbled upon it!
Walker Grape Breeding Program

• Olmo gave me seeds from 12 populations of *V. rupestris x M. rotundifolia*

• Tested for resistance to phylloxera, dagger nematode, root-knot nematode, PD

• Plants had small amounts of tomentum on internodes and petioles

• Strong resistance, but odd ratios of resistant to susceptible
rupestris x rotundifolia

- 2002 - began mapping these resistances in sibling matings – first with RAPD and AFLP markers and then in 2006 with SSR markers…
- First discovery – they were not rupestris x rotundifolia!
- Used DNA markers to fingerprint all possible pollen sources – rupestris x Mexican Vitis spp.
- AJEV (2007) 58:494-498
PD Resistance of Olmo’s Mexican Collections
First grape collecting lesson – “leaves of three, let it be”
Southwest *Vitis* germplasm

- *V. girdiana*- Ash Meadows Salt Flats
- *V. girdiana*- Lake Meade
- *V. arizonica*- Zion National Park
- *V. arizonica*- Las Vegas, NV
Mapping and Characterizing PD Resistance — Summaira Riaz

- *V. arizonica/candicans* b43-17 has single dominant gene for resistance to PD and it’s homozygous.
- All progeny from crosses to b43-17 are resistant to PD.
- Genetically mapped PD resistance (*PdR1*), to chromosome 14. Linked markers have been used for marker-assisted selection (MAS).
Riaz et al. 2006. Theor Appl Genet 113:1317-1329
New gene constructs were prepared with grape promoters, and under testing.
Marker-Assisted Selection for *PdR1*

- DNA extracted from seedlings
- Aggressive growing techniques to get flowers and fruit in year 2
- Two year cycle with marker-assisted selection (MAS)
- Select for lack of symptoms and low bacterial levels
- F1 = 50% *vinifera*; BC1 = 75%; BC2 = 88%; BC3 = 94%; BC4 = 97%
- Optimizes classical breeding – not GMOs
Breeding Objectives

• Develop large seedling populations at the 97% *vinifera* level in diverse, high quality *vinifera* winegrape backgrounds

• Intercross advanced high quality selections with *Xf* resistance from other resistance sources

• Use and map multigenic resistances *V. arizonica/girdiana* b42-26 and others

• Characterize additional unique resistances to make broadly and durably resistant varieties
Proven Potential of Classical Breeding

F8909-08 to 97% *vinifera* in about 12 yrs

From peppery, herbaceous wines with blue-purple pigments to high quality *vinifera* characters
Field Testing PD Resistant Selections

- Wines have been made ... compared with wine from classic *vinifera* cultivars made at the same small scale
- 75%, 88%, 94% and 97% *vinifera* at Beringer/Yountville along the Napa River have been inoculated multiple times
- Small scale wines have been made since 2010 with Davis and Napa fruit
- 88% and 94% in Fredericksburg TX, Auburn AL (88%), and Gainesville, FL (94%).
- 2014 – new plots in Temecula, Napa (2X), Texas and Alabama
Napa $PdR1b$ (94% vinifera) vs pure vinifera
07355-075 along Napa River
62.5% Cab Sauv, 12.5% Carig, 12.5% Chard

Not yet in large scale field trials

Late bloom, mid-season ripening

Small berries, small clusters

Medium productivity
62.5% Cab Sauv, 12.5% Carig, 12.5% Chard

Temecula, Sonoma 75, Silverado

Early bloom, early ripening

Small - medium berries, medium large clusters

High productivity
50% Zin, 25% Petite Sirah, 12.5% Cab Sauv

Caymus 1125, Temecula, Silverado

Late bloom, mid-season ripening

Relatively large berries, large clusters

Moderate-low productivity
50% Petite Sirah, 25% Cab Sauv

Caymus 375, Sonoma,

Early bloom, early ripening

Relatively large berries, medium large clusters

Medium productivity
50% Sylvaner, 12.5% Cabernet Sauvignon, Carignane, Chardonnay

Not yet in large scale field trials

Mid-season bloom and ripening

Large berries, loose medium clusters

High productivity
Stacking PD Resistance Lines

• 2006 & 2008 crossed $PdR1a \times PdR1b$ – no decrease in mean Xf levels.

• 2011 crossed 97% $v$ inifera $PdR1b \times 75\%$ $v$ inifera 
  b42-26 lines to create 86% $v$ inifera

• 2014 crossed 97% $v$ inifera $PdR1b \times 88\%$ $v$ inifera 
  b42-26 line to create ~ 92% $v$ inifera

• Added $PdR2$ b40-14 from Chihuahua V. arizonica 
  and many other sources
2017 and Beyond

- Broaden the *V. vinifera* background – acidity, color, tannins, aromatics, ripening profiles

- Add Powdery Mildew from multiple sources and advanced backcross generations
New Powdery Mildew Resistance Loci

- Gene stacking
- Co-evolving pathogen (?)
- Different mechanisms (?)
- Host-adapted PM strains (Musc4)
- Interactions of these if combined (?)
White Winemaking

Small lots – 15-300 lbs: Goal to express fruit flavors using a reductive style
Fruit harvested ≈ 22 Brix; juice TA ~8 g/l and wine ~7 g/l; YAN 250 ppm to 350 ppm;

Generous use of dry ice; 50 ppm SO$_2$ at crush; Yeast: QA23

Fermentation temp: 52° F; No MLF; DO measured at all steps

Racked with 35 ppm SO$_2$ added; Cold stabilized; Bottled in December using screwcaps with tin liners
Red Winemaking

Maximize color and balance tannin extraction

Fruit harvested ≈ 24 to 26 Brix; must ~7.5 g/l and wine ~5.8 g/l.; 25 ppm SO₂ at crush; acid and nutrient additions as necessary

Yeast: EC1118; co-inoculation with Viniflora Oenos for MLF; fermentation temp: 85 to 72° F

Small lots made within larger research fermentor (TJ’s); limited temp control; punched down twice a day; larger lots fermented in TJ’s, pump-over 3 times a day; Pressed at dryness (<2 g/L of sugar);

Racked, 35 ppm SO₂ added; Bottled in December using screwcaps with Saranex liners
Thanks!
09338-016

- Highly resistant to Pierce’s disease.
- Wines from Davis fruit only, well ranked.
- Small berries, small compact clusters; mod to late bloom, ripens mid-season; moderate productivity.
- Comments on wine: light straw-gold color, apple-melon, lychee, floral aromas, pineapple, green apple, juicy, well-balanced; Sauvignon blanc like
09314-102

- Highly resistant to PD.
- Early bloom and the fruit ripens early; has small to medium berries and relatively large clusters; it is highly productive.
- Reminiscent of Sauvignon blanc to some others more like Chardonnay
- Tasting comments have included: light straw to clear color, citrus, lime, tropical, gooseberry golden delicious apple flavors; bright fruit, slightly bitter.
09331-047

- Highly resistant to PD; commercial scale wines have been made
- Blooms relatively late, but ripens mid-season; berries are medium, clusters are well-filled and relatively large.
- More productive with cane pruning
- Highly ranked from Davis and Napa fruit.
- Tasting comments include: medium dark red purple; berry pie, cassis, black olive, herbal, dried hay, coffee, vegetal like Cabernet Sauvignon, moderate tannins, soft finish.
Wines with characteristics of both Cabernet Sauvignon and Petite Sirah.

Commercial scale wines have been made from Napa.

Early budbreak, bloom, and ripening.

Berries are relatively large and the well-filled clusters are medium in size.

Highly resistant to PD

Only 94% to be released; tasting notes include: dark-red purple color, bright red fruit, raspberry, cherry, ripe, tannic, elegant.