Breeding PD Resistant Winegrapes



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Xylella fastidiosa



http://cygnus.tamu.edu/Texlab/Pierce/EM-xylella2.jpeg



Pierce's Disease

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#
 V.#nustangensis#
 Hybrid'

 V.#pirizonica#
 V.#iparia,#/.#acerifolia#
 Hybrid'

 V.#perlandieri,#/.#tinerea#
 V.#upestris#
 Claire Heinitz

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)





Krivanek et al. 2005. Theor Appl Genet 111:110-119 Riaz et al. 2006. Theor Appl Genet 113:1317-1329

Testing PdR1 – Cecilia Agüero



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, midseason 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* x *PdR1b* no decrease in mean Xf levels.
- 2011 crossed 97% vinifera PdR1b x 75% vinifera
 b42-26 lines to create 86% vinifera
- 2014 crossed 97% vinifera PdR1b x 88% vinifera
 b42-26 line to create ~ 92% vinifera
- 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



White Winemaking

Small lots – 15-300 lbs: Goal to express fruit flavors using a reductive style

Fruit harvested \approx 22 Brix; juice TA \sim 8 g/l and wine \sim 7 g/l; YAN 250ppm to 350 ppm;

Generous use of dry ice; 50 ppm SO₂ at crush; Yeast: QA23

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

Racked with 35 ppm SO₂ added; Cold stabilized; Bottled in December using screwcaps with tin liners

Red Winemaking

Maximize color and balance tannin extraction

Fruit harvested \approx 24 to 26 Brix; must \sim 7.5 g/l and wine \sim 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



- ➢ 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



- ≻ 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.



- Highly resistant to PD; commercial scale wines have been made
- Blooms relatively late, but ripens midseason; 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 wellfilled 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.

