Controlling Pierce’s Disease with Molecular and Classical Breeding

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BREEDING FOR PD RESISTANCE

- Lenoir (Jacquez, Black Spanish) an accidental cross of V. aestivalis x V. vinifera; Blanc du Bois wine grape with Cardinal as last vinifera parent

- Many resistant cultivars/selections exit, but often moderate resistance and multigenic control

- We discovered single dominant gene for resistance in V. arizonica (b43-17), which has served as the foundation of our PD 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, but odd segregation ratios
- Plants had small amounts of tomentum on internodes and petioles, and set viable seeds
- Strong resistance, but …
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
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
Studying *PdR1* function – 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 very 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 create 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

- Vines inoculated and wines made … 75%, 88%, 94% and 97% *vinifera* along the Napa River have been inoculated multiple times

- Small scale wines have been made since 2010 with Davis and Napa fruit, compared with wine from classic *vinifera* cultivars made at the same small scale

- 88% and 94% in Fredericksburg TX, Auburn AL (88%), and Gainesville, FL (94%).

- 2014 to 2016 – new plots in Temecula, Santa Barbara, Napa (4X)
NAPA PDR1B (94% VINIFERA) VS PURE VINIFERA
09338-016

- 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
09314-102

- 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
07355-075

- 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 cluster
- High productivity
SOUTHWEST VITIS GERMPLASM

V. girdiana- Ash Meadows Salt Flats

V. girdiana- Lake Meade

V. arizonica- Zion National Park

V. arizonica- Las Vegas, NV
European Conference on Xylella fastidiosa 2017: finding answers to a global problem
STACKING PD RESISTANCE LINES

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

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

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

- Added $PdR2\ b40-14$ from Chihuahua $V.\ arizonica$ and many other sources
2017 AND BEYOND

- Broaden the use of *V. vinifera* cultivars – 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 pathogens
- Different mechanisms
- Host-adapted PM strains (Musc4)
- Interactions of these if combined
THANK YOU!