SUMMARY FINAL REPORT FOR CDFA AGREEMENT NUMBER 15-0425-SA

PROJECT TITLE: Breeding Pierce's disease resistant winegrapes.

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REPORTING PERIOD: July 2015 to June 2018

BRIEF BACKGROUND

One of the most reliable and sustainable solutions to plant pathogen problems is to create resistant plants. We are using a classical plant breeding technique called backcrossing to bring PD resistance from wild grape species into a diverse selection of elite winegrape backgrounds. Over the 15 years preceding this current grant period, we identified a single dominant Pierce's disease (PD) resistance loci, *PdR1*, from *Vitis arizonica/candicans* b43-17 and created thousands of plants over 4 backcross generations to create PD resistant wine selections that are 97% *vinifera*, have good wine quality and are highly resistant to PD. Resistance has been verified in both the rapid greenhouse screen we developed and in field trials in PD hotspots around California and the southern PD region of the US. Our resistant vines have remained symptom free in these field trials for over a decade. Twenty of the most promising PD resistant scion selections and three rootstocks have been sent to Foundation Plant Services for certification. Wines have been made from this generation for six vintages and have been well received in industry professional tastings. We have tested over three hundred wild *Vitis* species accessions to identify unique sources of PD resistance, developed mapping populations in twenty, and screened some of them through the BC2 level to identify new sources of PD resistance that could be combined with *PdR1* resistance.

OBJECTIVES

1. Identify unique sources of PD resistance with a focus on accessions collected from the southwestern United States and northern Mexico. Develop F1 and BC1 generations from the most promising new sources of resistance. Evaluate the inheritance of resistance and utilize progeny from the most resistant sources to create mapping populations.

2. Provide support to the companion mapping/genetics program by establishing and maintaining mapping populations, and using the greenhouse screen to evaluate populations and selections for PD resistance.

3. Develop advanced lines of PD resistant winegrapes from unique resistance sources through four backcross generations to elite *V. vinifera* cultivars. Evaluate and select on fruit quality traits such as color, tannin content, flavor, and productivity. Complete wine and fruit sensory analysis of advanced selections.

4. Utilize marker-assisted selection (MAS) to stack (combine) different resistance loci from the BC4 generation with advanced selections containing *PdR1*. Screen for genotypes with combined resistances, to produce new PD resistant grapes with multiple sources of PD resistance and high quality fruit and wine.

2015-2018 ACCOMPLISHMENTS

Objective 1 – Identify unique sources of PD resistance.

- We found that most wild accessions from the southwestern United States (SWUS) and Mexico have PD resistance located on chromosome 14 (Ch14), the same region as *PdR1*.
- A number of other accessions appear to have PD resistance on Ch8 where our companion breeding project identified *PdR2* from *V. arizonica/girdiana* b42-26. There also appears to be a group of accessions with multigenic PD resistance.
- Our efforts are now focused in on 3 resistance sources: ANU67, b41-13 and T03-16 for use in mapping alternative PD resistance genes. We have developed and screened F1 and BC1 populations from these resistance sources to facilitate genetic mapping efforts.

- We continue to screen *Vitis* species accessions from the PD zone with our rapid greenhouse screen to identify promising new sources of resistance.
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Objective 2 – Provide support to our mapping/genetics program.

- We made 53 F1 & BC1 crosses to PD resistant *Vitis* species that produced 8,087 seeds and planted 1,633 of the seedling vines to the field.
- We provided 1,030 greenhouse screen resistance results, comprised of both ELISA titers and PD phenotypic symptoms, on 919 different genotypes.
- We developed and began the testing of 9 intercross and 3 selfed populations in the T03-16 multigenic resistance line. Very preliminary indications are that the high level of resistance of the source parent can be recovered by intercrossing the F1 generation.
- These results contributed to the publication of: Riaz, S., K. Huerta-Acosta, A.C. Tenscher and M.A. Walker. 2018. Genetic characterization of *Vitis* germplasm from the southwestern US and Mexico to expedite Pierce's disease-resistance breeding. Theor. Appl. Genet. 131:1589-1602.

Objective 3 – Develop advanced PD resistant winegrapes and evaluate for fruit and wine quality.

- Six more 97% *vinifera PdR1*b scion selections were sent to FPS for certification.
- Five selections at this level are in pre-release to California grapevine nurseries for expansion of graftable material and sale to growers as early as 2020.
- We performed a total of 1,849 field evaluations on new selections at various stages of advancement.
- Fifty-three sets of berry and juice sensory evaluation were performed on 20 of the most advanced selections.
- ETS Laboratories provided 45 sets of detailed grape berry chemical analyses on 20 different *PdR1* genotypes. Analyses included those on color, phenolic profiles, yeast nutrition and mineral composition as well as organic acids, sugars and pH.
- We made 59 different wine lots from 22 different selections that produced 1,261 bottles for both near and long term sensory analysis.
- Nine formal tastings were conducted in which we presented 34 different wines to 145 tasters. Wines were also presented in less formal settings to numerous industry groups. In all settings they have been well received.

Objective 4 – Utilize MAS to stack different PD resistance loci with *PdR1*

- The Spring 2016 pollination season was the first time we successfully stacked *PdR1* with *PdR2* at the 96% *vinifera* level.
- Many additional crosses to a more diverse group of elite *vinifera* cultivars were competed in 2017. This Spring 328 genotypes were shown to have both *PdR1* and *PdR2*. This was verified and they selections were planted.
- We completed the greenhouse screening on the first 77 genotypes from 2016 crosses and identified 7 with excellent resistance. Testing of 30 other hermaphrodite individuals is underway.
- The initial screenings for field performance and grape berry sensory evaluation begin this fall.

In conclusion, we continue to make significant progress at providing a long term, sustainable solution to PD. Public release and commercial sale of the first 5 *PdR1* selections (as green-growing bench grafts) is on track for Spring 2020. Alternative strong sources of PD resistance have been identified and advanced in the breeding program. The first stacking of multiple PD resistance sources guided by marker-assisted selection is complete and evaluation is underway. That said, it is important to keep in mind the long term nature of this work. To date crosses made in 2015 have only fruited once; those made in 2016 will fruit for first time this year; those made in 2017 will fruit in 2019 and those made this year will not fruit until 2020. There is a lot of promising material in the pipeline, but it will take time to see it to commercial release.