SUMMARY FINAL REPORT FOR CDFA AGREEMENT NUMBER 18-0389-000-SA

PROJECT TITLE: Breeding Pierce's disease resistant winegrapes.

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REPORTING PERIOD: July 2018 to June 2019

BRIEF BACKGROUND

We use 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 18 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 *PdR1* resistant scion selections and three rootstocks have been sent to Foundation Plant Services (FPS) for certification. Wines have been made from this generation for seven vintages and have been well received in industry professional tastings. In the current grant period the first 3 scion selections that employ both *PdR1* and *PdR2* resistance were delivered to FPS. We have tested over three hundred seventy 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.

Objective of Proposed Research: The overall objective of this proposal is to develop lines representing different Pierce's disease (PD) resistance sources with diverse and elite *vinifera* backgrounds, stack different lines for durable field resistance, and continue to evaluate new resistant germplasm to optimize the breeding of PD resistant winegrapes.

1. Identify PD resistant germplasm for breeding and provide support to the companion mapping/genetics project.
   a. Test new accessions primarily collected from the southwestern United States and northern Mexico.
   b. Establish and maintain mapping populations, and evaluate them for PD resistance to support our companion genetics project.
   c. Develop, maintain and evaluate breeding populations from the most promising new sources of resistance.

2. Develop and select advanced lines of PD resistant winegrapes.
   a. Establish resistance lines with different resistance sources through four backcross generations to elite *V. vinifera* cultivars.
   b. Evaluate and select on fruit quality traits.
   c. Complete wine and fruit sensory analysis of advanced selections.

3. Stack (combine) different resistance loci.
   a. Combine multiple resistances by making crosses of BC4 generation with advanced selections containing *PdR1* and validate with marker testing.
   b. Test for PD resistance and high quality fruit and wine.
   c. Field trials, wine tastings and outreach efforts

2018-2019 ACCOMPLISHMENTS

Objective 1 – Identify PD resistant germplasm for breeding and provide support to the companion mapping/genetics project.

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- We found that most all wild accessions from the southwestern United States (SWUS) and Mexico have PD resistance located on chromosome 14 (Ch14), the same region as *PdR1*.
- A limited 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 largely from the southeastern United States (SEUS) with multigenic PD resistance.
- Our effort to map alternative PD resistance genes is now focused on a single resistance source, ANU67, after determining that resistance in b41-13 and T03-16 also resided on LG14. We have developed and are currently screening an ANU67 F1 population to facilitate genetic mapping efforts in that line.
- We continue to screen *Vitis* species accessions from the PD zone with our rapid greenhouse screen to identify promising new sources of resistance.
- We provided 222 greenhouse screen resistance results on that number of unique genotypes. Results were comprised of both ELISA titers and PD phenotypic symptoms.
- Provided statistical analytic support to help identify the genomic region of b41-13 and T03-16 PD resistance.

Objective 2 – Develop and select advanced lines of PD resistant winegrapes.

- The first 3 scion selections that employ both *PdR1* and *PdR2* resistance were delivered to FPS.
- Five 97% *vinifera PdR1b* selections 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 192 field evaluations on new selections at various stages of advancement.
- Twenty-one sets of berry and juice sensory evaluation were performed on 19 of the most advanced selections.
- ETS Laboratories provided 20 sets of detailed grape berry chemical analyses on 15 different *PdR1* genotypes as well as the first three *PdR1* x *PdR2* selections. Analyses included those on color, phenolic profiles, yeast nutrition and mineral composition as well as organic acids, sugars and pH.
- We made 18 different wine lots from 16 different selections that produced 421 bottles for both near and long term sensory analysis.
- Our PD wines were presented at the 2019 Unified Symposium. Wines were also presented in less formal settings to numerous industry groups. In all, settings they have been well received.

Objective 3 – Stack (combine) different resistance loci.

- We first successfully stacked *PdR1* with *PdR2* at the 96% *vinifera* level in spring 2016. Many additional crosses to a more diverse group of elite *vinifera* cultivars were competed in 2017. Greenhouse screening on the first 77 genotypes identified 7 with excellent resistance of which the best 3 were sent to FPS to expedite release.
- Multi-vine plantings for small scale winemaking of the 3 selections sent to FPS were established in Davis this spring.
- Greenhouse testing of the 455 *PdR1* x *PdR2* 96% *vinifera* level selections is ongoing. The first 54 selections from 2017 crosses were completed in April with 24 identified as promising or very promising. Sixty-three more selections will complete testing by the end of June and 95 more are in various stages of testing.
- Screenings for field performance and grape berry sensory evaluation continue this fall.
- We MAS tested 2400 seedlings from 32 different PD x PM crosses made in 2018. Following greenhouse screening for powdery mildew resistance, 722 were planted in the field. *Vinifera* percentages range from 91% to 97%.
- No crosses were made in the spring of 2019.

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 2016 have only fruited once; those made in 2017 will fruit for the first time this year and those made in 2018 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.