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# Exploring the Growth and Cropping Potential of Pierce's Disease Resistant *Vitis vinifera* L. Selections for Enhanced Viticultural Sustainability in Alabama and the Southeast

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## Abstract

Cultivation of *Vitis vinifera* L. grapevines has not been economically feasible in the southeastern U.S. due to the major limiting factor, Pierce's disease (PD), caused by the endemic, xylem-limited bacterium *Xylella fastidiosa.* Heretofore, hybrids of *V. vinifera* x *V. arizonica/candicans* have not been evaluated in the hot and humid subtropical climate of central Alabama. In 2010, an experimental vineyard consisting of three UC Davis developed PD resistant 87.5% *V. vinifera* selections ('U0501-12', 'U0502-10', and 'U0501-12') was planted at the Chilton Research and Extension Center, (CREC), Clanton, AL for the purpose of investigating the survival rate and overall performance of these selections in the southeastern U.S. Preliminary studies in our lab suggest the *V. vinifera* selections responded well to local conditions and were free of PD infection. This report focuses on recent two-year assessment of vegetative growth, cropping potential, and fruit quality of *V. vinifera* advanced selections during the period of vine establishment. Our results suggest 'U0501-12' had the smallest trunk cross-sectional-area in both years. Pruning weights for all selections ranged between 1.7 and 2.0 kg/vine in both study years. Total yield in 2015 was 8.7, 10.7 and 10.9 kg/vine for 'U0501-12', 'U0502-01', and 'U0502-10', respectively. Furthermore, 'U0502-10' consistently had the largest cluster size and lowest cluster number per vine. The PD resistant *V. vinifera* selections demonstrated high cropping potential and plant vigor in both study years, indicating they can sustain viticulture in the southeast while enhancing opportunities for the grape growing industry in the region. Further work to thoroughly characterize the viticultural performance of PD resistant *V. vinifera* selections in Alabama's environment is critical.


Bunch grapes (*Vitis* sp.) represent an economically and culturally important fruit crop with global production increasing from 63 million metric tons in 2003 to over 77 million tons in 2013, representing a 22% increase (FAOSTAT, 2013). In the U.S., production exceeded 8 million metric tons in 2015 (USDA-NASS, 2016). In the southeastern U.S., bunch grape production has been limited by Pierce's disease (PD), caused by an endemic xylem-limited bacterium, *Xylella fastidioa* (Hopkins and Purcell, 2002; Wells et al., 1987). As a result, Alabama's viticulture industry has evolved around the cultivation of PD resistant hybrid bunch grapes (American and French-American) and muscadine grapes (*Muscadinia rotundifolia* Small) (Keller, 2010). Increasing local interest in grape production is evident in the number of bearing acres in Alabama which grew from 215 in 2002 to 426 in 2012, a 198 % increase (USDA-NASS, 2016).

Recent breeding work conducted at the UC Davis identified a single gene, PdR1, responsible for PD resistance in a *V. arizonica/candicans* hybrid selection (b43-17) (Krivanek et al., 2006). Using marker assisted selection, 87.5% *V. vinifera* selections were developed

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after three *V. vinifera* crosses starting with F8909-08, an offspring of a *V. rupestris* (A. de Serres) x b43-17 cross bearing the PdR1b resistance locus (Riaz et al., 2009).

Until recently, *V. vinifera* vines have not been successfully grown in the high PD pressure of Central Alabama. Based on results from the UC Davis breeding program, and the encouraging preliminary results from our lab (Coneva, 2016), it is hypothesized that PD resistant selections should be capable of producing premium quality European wine grapes in the southeastern U.S., where sustainable production of *V. vinifera* grapes has previously been prevented. To accomplish the goal of evaluating the performance and feasibility of producing *V. vinifera* grapes in Alabama, an experimental vineyard consisting of advanced UC Davis developed PD resistant 87.5% *V. vinifera* selections was established. Data were collected to determine their productivity and vigor in a previously unexplored environment of Central Alabama, considered as a high-risk PD zone (Anas et al., 2008).

## Materials and Methods

Three PD resistant *V. vinifera* selections were planted at the Chilton Research and Extension Center near Clanton, AL, USA (32°55'11.6" N, 86°40'25.4" W) on December 9, 2010. Experimental design was a randomized complete block with six blocks and the experimental unit was five plants per selection per block. Experimental vines were grafted on 'Dog Ridge' rootstock and planted in a Dothan fine-loam (kaolinitic, thermic Plinthic Kandiuudults) soil with pH adjusted to 6.2 prior to planting. Vines were spur-pruned and trained to a Vertical Shoot Positioning (VSP) system with three catch wires. Supplemental drip irrigation was provided. Rows were oriented North to South and the planting distance was 2.1 x 3.66 m.

Data were collected to determine the vine vigor and growth characteristics. The traits measured included vine pruning weight and trunk cross-sectional-area (TCSA). Vines were dormant pruned annually in early spring of 2014 and 2015 and prunings were weighed with an Adam CPWplus-35 scale (Adam Equipment Inc, Danbury, CT, USA). TCSA was measured for each vine at 25 cm above the graft union using a digital caliper (Mitutoyo Corporation, Kawasaki, Japan).

Total yield per vine was recorded at harvest for each experimental vine using an Adam CPWplus-35 scale. Vines were harvested by hand. In 2014, soluble solid concentration, expressed as Brix (°), was determined on a 10 berry subsample/vine using a RF-15 hand refractometer (Ade Advanced Optics). Following harvest in 2015, soluble solid content was determined using a digital refractometer (Pal-1 Atago, Co., Tokyo, Japan) at room temperature based on a homogenized 50-berry subsample per vine.

Analysis of variance was performed on all responses using PROC GLIMMIX in SAS version 9.4 (SAS Institute, Cary, NC). The experimental design was randomized complete block. Where residual plots and a significant COVTEST statement using the HOMOGENEITY option indicated heterogeneous variance among treatments, a RANDOM statement with the GROUP option was used to correct heterogeneity.

## Results and Discussion

Dormant pruning conducted in early 2014 revealed 'U0502-01' had significantly greater vigor than 'U0501-12', but both selections had similar vigor compared to 'U0502-10' (Fig. 1). In 2015, vine vigor was lowest for 'U0502-10' based on pruning weights. For both years, all selections' pruning weights exceeded 1.7 kg/vine, indicating vigorous plant growth. Selection 'U0501-12' had the smallest trunks in both years (Fig. 2).

In 2014, the experimental location experienced abnormal wet and cold spring and summer conditions which may have contributed to the development of powdery mildew (*Uncinula necator* (Schwein.) Burrill) infection that potentially impacted grape yields. No powdery mildew infection occurred in

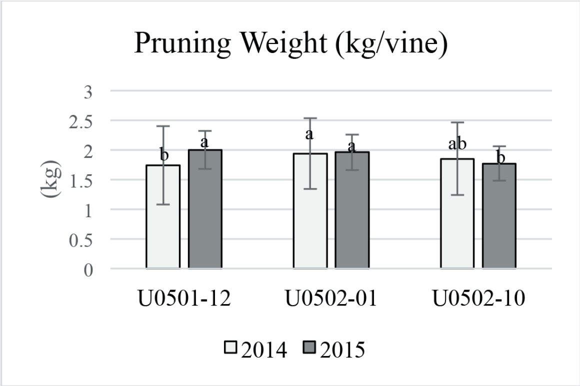


**Figure 1**. Pruning weight of three PD resistant 87.5% *V. vinifera* selections grown at CREC, Clanton, AL in 2014 and 2015. Error bars indicate ± SE of the mean. Least squares means within year with common letters do not differ at the 5% level of significance, by Shaffer-simulated method.

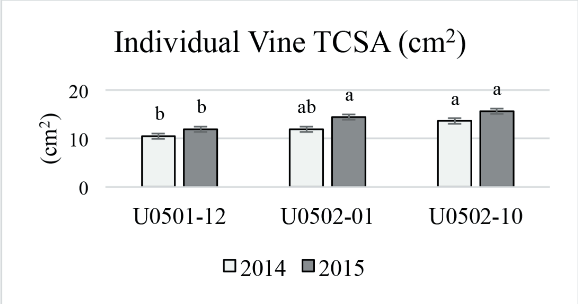


Figure 2. Trunk cross sectional area ($cm^2$) of PD resistant 87.5% *V. vinifera* selections grown at CREC, Clanton, AL in 2014 and 2015. Error bars indicate ± SE of the mean. Least squares means within year with common letters do not differ at the 5% level of significance, by the Shaffer-simulated method.

2015, and yields were higher. In both years, total yield was highest for selections 'U0502-10' and 'U0502-01' (Table 1). Although 'U0501-12' had the lowest yield per vine (8.7 kg/vine) in 2015, when the potential yield per acre was calculated based on planting density, 'U0501-12' crop was equivalent to 11.1 t/ha. The remaining two selections exceeded 13.7 t/ha in 2015.

'U0502-10' produced the largest and fewest clusters per vine in both study years. Selections 'U0501-12' and 'U0502-01' had a similar number of clusters per vine, whereas 'U0501-12' produced the smallest clusters in both years. Average cluster weight was highest for 'U0502-10' in 2015, with clusters weighing 406 g. Similar to their performance in California, Alabama-grown clusters ranked from smallest for 'U0501-12,' to largest for 'U0502-10,' with 'U0502-01' producing intermediate size clusters in both locations (Walker and Tenscher, 2008; Walker and Tenscher, 2009).

To date, PD infection has not been detected in any of the *V. vinifera* grapes tested in the current planting. Overall berry sugar content ranged from 17.0 to 21.9 ° Brix. 'U0502-01' and 'U0502-10' had the lowest sugar content

**Table 1.** Yield characteristics of PD resistant 87.5% *V. vinifera* selections grown at the CREC, Clanton, AL, 2014 and 2015.

| Selection | Total yield (kg/vine) | Cluster number/vine (No.) | Cluster weight (g) | Soluble Solids (%) |
|---|---|---|---|---|
| 2014 | | | | |
| U0501-12 | 2.1 b[z] | 41.5 a | 49.9 c | 21.9 a |
| U0502-01 | 3.4 a | 42.4 a | 80.9 b | 18.9 b |
| U0502-10 | 3.4 a | 25.8 b | 132.1 a | 19.5 b |
| 2015 | | | | |
| U0501-12 | 8.7 b | 45.3 a | 189.2 c | 21.1 a |
| U0502-01 | 10.7 a | 47.8 a | 225.8 b | 19.8 b |
| U0502-10 | 10.9 a | 26.5 b | 406.4 a | 17.0 c |

[z] Least squares means within column and year followed by common letters do not differ at the 5% level of significance by the Shaffer-simulated method.

in 2014 and 2015 respectively. In both years, 'U0501-12' grapes had the highest sugar content.

The successful growth and development of these three selections offered the unique opportunity to examine viticultural characteristics of *V. vinifera* in the high PD pressure environment of central Alabama. The promising preliminary results of our study indicate the potential opportunity for sustainable production of a new, high-value horticultural crop for the southeastern U.S. Increasing our understanding of crop load management, high fruit quality and balanced vine vigor will be of critical importance in future studies aiming to develop proper management techniques to maximize economic and environmental sustainability of *V. vinifera* production in the southeastern U.S.

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