LOOSE CLUSTERED VIGNOLES CLONES REDUCE LATE SEASON FRUIT ROTS

Authors: : Timothy Martinson[1], Peter Cousins[2], Amanda Garris[2], Lance Cadle-Davidson[2], Terry Bates[1] , and Gan-Yuan Zhong[2]

[1]*Cornell University, School of Integrative Plant Science, Cornell AgriTech, Geneva, NY*
[2] *Grape Genetics Research Unit, USDA Agricultural Research Service, Geneva, NY*

*Corresponding author: ganyuan.zhong@usda.gov

Abstract:

Context and purpose of the study

'Vignoles' is an aromatic, white-fruited wine grape variety valued by growers and wineries in the Eastern United States. Vignoles is grown in diverse locations in New York, Missouri, Indiana, Ohio, Pennsylvania, Illinois, Nebraska and Michigan. Consumers recognize and value the variety for its special wine quality. However, Vignoles production is limited by its extremely compact clusters which increase the propensity to *Botrytis cinerea* bunch rot and to sour rot, frequently leading to significant crop losses and decrease in quality. In 2007 the USDA grape genetics research unit used mutation breeding to screen and produce 'loose-clustered' clones that would offer slightly reduced fertility, less compact clusters, and reduced severity of cluster rots. Selections were evaluated at two field locations. Compared to standard vignoles, they reduced cluster rot severity by ~30 to 94%, and reduced cluster weight by 25-33% over 5 growing seasons.

Material and methods

Candidate clones were identified from 2000 vines produced from irradiated budwood by observing cluster compactness and rot susceptibility from 2011-2014. From these, plantings of 18 selections (USDA Agricultural Research Service farm at Cornell Agri-Tech, Geneva, NY) or 8 selections (Cornell Lake Erie Research and Extension Laboratory, Portland, NY) and the industry standard Vignoles (STANDARD) were established. Following establishment, incidence and severity of cluster rots (*Botrytis* and sour rot), cluster compactness, and cluster weight were evaluated over three growing seasons, from 2016-2018 (Geneva, NY) or 2018-2020 (Portland, NY).

Results

At Geneva, NY where 18 accessions + STANDARD were evaluated, Clone, Year, and Year x clone were all significant predictors of cluster rot severity ($P<0.001$). Means separation showed that 17 of 18 clones (2016, dry year), all 18 (2017, wetter) and 14 of 18 (2018, severely wet ripening season) had significantly lower disease severity than the standard clone. Percent reduction of disease severity ranged from 34-69% (2016), 34-71% (2017), and 16-90% (2018). Cluster compactness (weight per cm of rachis length) metrics showed that 9 of 18 (2016), 7 of 18 (2017) and 7 of 18 (2018) were significantly less compact (lower wt/cm of rachis) than the standard Vignoles.

Among the eight accessions planted at Portland, NY, incidence (proportion of clusters with fruit rots) was reduced by 11-88% (2018), 39-81% (2019) and 39-70% (2020) compared standard Vignoles. Severity (% of cluster area with fruit rots) was reduced by 30-94% (2018), 55-92% (2019) and 56-87% (2020), compared to the ~37-42% rot observed in the standard accession. At both sites, disease severity was correlated with cluster compactness at Portland, NY.

Yield and yield components were evaluated in 2019 only. Control vines had 8.6 kg/vine, while two selections (R65V83 and R67V79) averaged 6.2 and 6.8 kg/vine respectively – roughly a~25% reduction in yield. Median cluster weights were 86 g/cluster (Standard Vignoles) versus 54.7 and 58.0 g/cluster in the R65V83 and R67V79 selections – approximately a 33% reduction in cluster weight. These two selections offer a 2 to four-fold reduction in disease severity, potentially offsetting the ~25% reduction in yield and quality losses from *Botrytis* and sour rot infections.

Keywords: Grapevine, Vignoles, mutation breeding, cluster compactness, Botrytis cinerea, bunch rot, sour rot

1. Introduction

'Vignoles' is an interspecific hybrid variety that is valued by growers and wineries in the Eastern United States, and is grown in diverse locations in New York, Missouri, Indiana, Ohio, Pennsylvania, Illinois, Nebraska and Michigan. It produces wines with robust acidity, and apricot, peach, and citrus notes, and is relatively winter hardy (Cousins & Garris 2014). It was produced by French hybridizer J. F. Ravat in 1949, from a cross between Seibel 5455 (Plantet) and Seibel 880 (Foundation Plant services grape registry), and originally known as Ravat51, before being named 'Vignoles' by the Finger Lakes Wine Growers Association in 1970 (Cattell 2014).

Despite its established reputation in Eastern North America, Vignoles production has been limited by its extreme susceptibility to *Botrytis cinerea* and sour rot, which leads to significant crop losses, especially in rainy years (Caldwell-Ewart 2004). Its extremely compact clusters and early bunch closure are associated with botrytis susceptibility (Vail & Marois 1991) and impede fungicide coverage (Hed et al 2009). Berry compression where individual berries touch results in cuticle thinning, and increased opportunity for berry-to-berry spread of infections (Rosenquist & Morrison 1988). Resistance of botrytis to multiple fungicide classes (Hahn 2014, Rupp et al 2015) increasingly limits effectiveness of chemical control.

Several studies have found botrytis incidence and severity to be closely associated with cluster compactness (Vail & Marois 1991,Vail et al 1998, Hed et al 2009). Cultural practices such as early leaf removal (sabbatini & Howell 2010, Intrieri et al 2008), gibberellin applications to lengthen rachises (Hed et al 2015, Hed & Centinari 2021), and delayed shoot tipping (Molitor et al 2015) were shown to reduce botrytis incidence and severity. Wilcox & Zitter (pers communication) were able to reduce botrytis in Pinot noir by artificially thinning fruit clusters. These studies demonstrated effectiveness of integrating cultural methods with botryticides to reduce crop losses.

In 2007, the USDA Grape Genetics Research Unit used mutation breeding (Lapins 1983) to screen and produce 'loose-clustered' clones that would offer slightly reduced fertility, less compact clusters, and reduced severity of cluster rots. Dormant Vignoles two-bud cuttings were exposed to gamma radiation, and grafted to C3309 rootstock, producing ~2330 vines, planted in a vineyard block at the CLEREL laboratory in western NY. By 2010, cluster compactness scores indicated that ~400 had reduced cluster compactness (Cousins & Garris 2014). Subsequent selections were planted at Cornell AgriTech, Geneva NY and later at CLEREL, in Portland NY.

We hypothesized that these 'loose-clustered' selections would consistently reduce the amount of fruit rots compared to the 'Standard clone' in field plantings by normal harvest date. Here we report on results of multi-year evaluations of disease incidence and severity at two sites, cluster compactness of the novel clones, and one year of sensory testing of wines made from a selection of the clones.

2. Material and methods

*Origin of irradiated clones***.** Plant accessions evaluated in two trials were produced in 2007 and 2008 through mutagenesis by exposing dormant Vignoles buds to gamma radiation, as described in Cousins & Garris (2014). The resulting 2336 grafted vines were planted at CLEREL in 2007 and 2008. These vines were rated annually for cluster compactness and bunch rot susceptibility starting in 2011. From this population, several selections of vines with less compact cluster were propagated and planted into replicated blocks at Cornell AgriTech (McCarthy Farm) and the Cornell Lake Erie Research and Extension Laboratory (CLEREL) in Portland, NY

Plantings. Plantings of irradiated selections along with the standard un-irradiated Vignoles were established in two locations. At the McCarthy farm at Cornell Agritech in Geneva NY, 18 irradiated clones and the un-irradiated standard Vignoles propagated and grafted to C3309 rootstock were planted in a completely randomized design. Ten two-vine replicates of the standard Vignoles clone were planted as control vines, along with 3-5 replicates of 18 irradiated accessions. A separate planting of 8 irradiated selections and the

standard Vignoles clone was established in a randomized complete block design at the Cornell Lake Erie Research and Extension Laboratory (CLEREL planting) in Portland New York in 2016. Seven replicates of four vines per replicate were planted.

At both sites, vines were trained to a high bilateral cordon, with two trunks. Standard production practices for hybrid grapevines in NY were used for pruning, management of powdery mildew, downy mildew, and black rot, and insect management, with the exception that no botryticides were applied to the blocks.

Preharvest fruit rot ratings

McCarthy Planting. Evaluations of cluster rot severity were made at the McCarthy site in early to mid September of 2016, 2017, and 2018, 7 to 10 d before harvest. For each vine evaluated, six clusters were examined, and the percentage of cluster volume affected by fruit rots was estimated in increments of 10%. The observer attempted to choose the most injured clusters on each vine, so data was collected on severity, but not on incidence. The rot ratings encompassed both botrytis and the sour rot complex, and no attempt was made to score them separately. For each irradiated clone, 4 to 10 individual vines were sampled, and 20 vines of the standard Vignoles clone were sampled.

CLEREL planting. Incidence and severity of cluster rots was evaluated in 2018, 2019, and 2020. Ten clusters were selected at random at each of three vines per experimental unit, and the percentage of cluster volume affected by fruit rots was estimated to the nearest 10%, except clusters with evident infection on 1-2 berries, which were scored as 2% injury. Because clusters were randomly selected, we were able to use the data to estimate both incidence and severity of cluster rots.

Cluster compactness

At the McCarthy planting, Ten (2016) or four clusters (2017 and 2018) per count vine were harvested, individually weighed, and a sample of 12 berries per count vine were weighed. Rachis length was measured from the first branch to the most distal peduncle of the cluster, and the first primary branch (wing) was measured from the branching point to the distal peduncle. The number of berries per cluster for each vine was calculated by dividing cluster weight by berry weight, and both the number of berries per cm of rachis and G of fruit per cm of rachis was calculated and compared with rot ratings

3. Results and discussion

3.1. *The 'Loose-clustered' vignoles clones dramatically reduced late-season fruit rots at two sites over three growing seasons.*

McCarthy Planting. Combined *botrytis* and fruit rot ratings of 18 accessions and STANDARD in 2016, 2017, and 2018 showed significant reductions in fruit rots in pairwise comparisons. Least square means of disease severity showed 56.6±1.4 % fruit rots in the standard clone, while it ranged from 12.8±2.0 to 40.1±2.0 in the 18 irradiated clones – an overall reduction of 29 to 77% over the three years.

CLEREL Planting: From 2018-2020, the 8 irradiated clones all showed reduced incidence and severity $P<0.01$ compared to the STANDARD clone **(Table 1)**. STANDARD vignoles severity ranged from 37.4 to 41.7%, while it ranged from 3.8 to 10% in the two best selections, representing a range of 73 to 93% reduction in late-season cluster rots.

3.2. *Disease severity was correlated with cluster compactness (cluster weight/cm of rachis), and clusters were significantly smaller in clones selected for further propagation.*

McCarthy. Regressions of disease severity on cluster weight, cluster weight per cm of rachis, and berries per cm of rachis in 2016,2017, and 2018 showed that severity was most closely correlated with cluster weight per cm of rachis. **(Figure 1)**. The standard vignoles clone consistently had the highest fruit rot severity.

CLEREL. Similar trends were seen during the three growing seasons among the eight clones in the planting. In the final year (2020), cluster weights only were tracked **(Figure 2)**. The eight irradiated clones had 5 to 15% cluster rot and 55 to 100 g/cluster, while the STANDARD clone had 37% rot and 128 g/cluster.

3.2. Cluster compactness and disease severity.

McCarthy. Regressions of disease severity on cluster weight, cluster weight per cm of rachis, and berries per cm of rachis in 2016,2017, and 2018 showed that severity was most closely correlated with cluster weight per cm of rachis. (Figure 1). The STANDARD clone consistently had the highest fruit rot severity.

CLEREL. Similar trends were seen during the three growing seasons among the eight clones in the planting. In the final year (2020), cluster weights only were recorded. At CLEREL, disease severity in the STANDARD clone was 37%, while it ranged from 5 to 16% in the eight irradiated clones (Figure 2).

The irradiated clones had smaller clusters, ranging from 55 to 97 grams, compared to 126 grams in the STANDARD clone. **(Figure 2)**.

Two clones, R65V58 and R67V79, combined low levels of rot (8.4 and 8.6% respectively; representing a 77 to 78% reduction in disease) with moderate, but significant reduction in cluster weights (71.2 and 75.0 g/cluster, respectively; representing 40-43% reduction from the STANDARD clone's 126 g cluster weight. These two selections were chosen for further propagation and potential release.

4. Conclusions

Vignoles is an interspecific hybrid variety known for high wine quality attributes, but prone to late-season cluster rots, including *Botrytis* and sour rot. Selected clones produced through mutation breeding greatly reduced the incidence and severity of late-season cluster rots over 3 growing seasons at each of two sites, compared to the standard clone. Rot ratings were correlated with cluster compactness. The cost to achieving this result was a ~40% reduction in cluster weight. Two clones were selected for further propagation and potential release to the industry.

5. Acknowledgments

This study was supported funds from the USDA Grape Germplasm Resources unit of the Agricultural Research Service, and by the Cornell Federal Formula Funds Grants Program, administered by Cornell AgriTech.

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Table 1: Disease severity ratings (% cluster area) of Standard clone and two selections (R67V79 and R65V83) in 2018, 2019, and 2020

Year	Clone	Disease Severity % ±Std Error	p-Value	% reduction
2018	STANDARD	41.7±3.0	-	
	R65V83	5.9±2.9	<.0001	85%
	R67v79	3.8±3.0	<.0001	93%
2019	STANDARD	38.0±1.8	-	
	R67V79	4.1±1.8	<.0001	89%
	R65V83	3.6±1.8	<.0001	91%
2020	STANDARD	37.4±2.01		
	R67V79	10.0±2.01	<.0001	73%
	R65V83	8.4±2.19	<.0001	78%

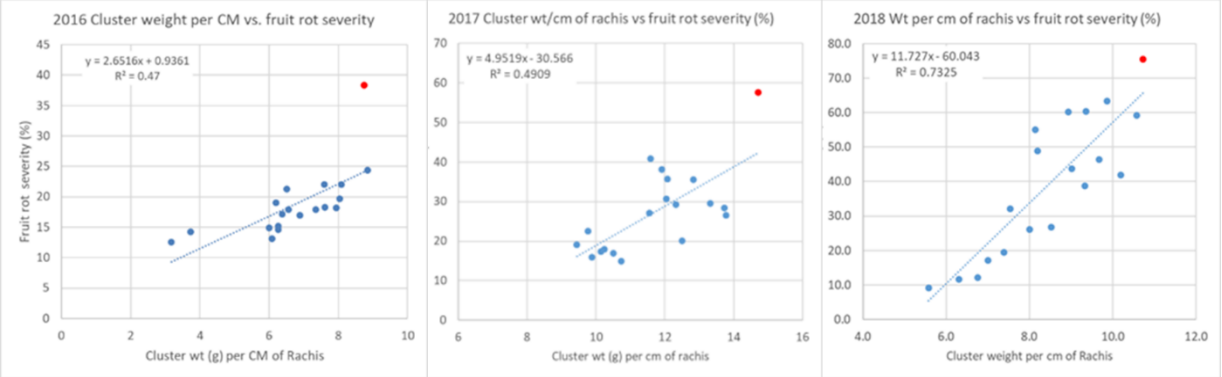

Figure 1. Cluster compactness (cluster weight per cm of rachis) of 18 irradiated vignoles clones vs the standard vignoles clone (red dot) versus disease severity at harvest at the McCarthy planting in 2016, 2017, and 2018.

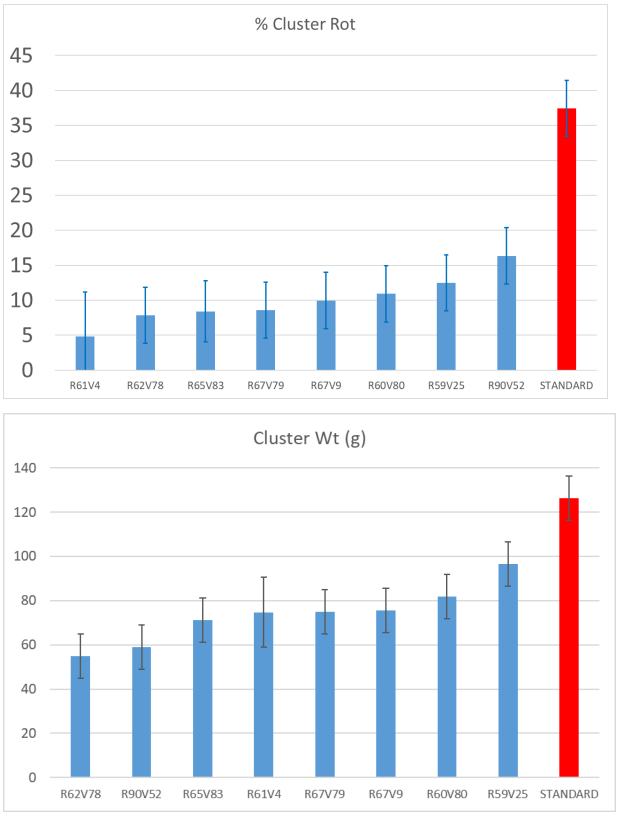

Figure 2. Cluster rot severity (% cluster area ±2SEM) and cluster weight (g ±2SEM) of eight loose-clustered Vignoles clones and STANDARD Vignoles at the CLEREL planting in Portland, NY in 2020.