Research Report for 2019 to the
Lake Erie Regional Grape Program and NY Wine and Grape Foundation
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Breeding and evaluation of new wine grape varieties with improved cold tolerance and disease resistance

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Overall Goals:

Viticulture in the eastern United States is limited by climatic conditions conducive to disease development and cold damage. We seek to breed and evaluate new grapevine cultivars that combine cold hardiness, disease resistance, superior wine quality and regional adaptation.

Objective:

1. Provide eastern winegrowers with varieties of superior wine quality, which are better adapted to our growing conditions. New selections from the Cornell Grape Breeding Program will be screened for cold hardiness and disease resistance. The field performance of new selections from the Cornell program and accessions from other sources will be recorded. The wine aroma and texture profile of new selections is to be comparable to the quality found among vinifera grapes and/or unique and valued by panelists and the wine consumer. Wine flavor/aroma profiles are to be assessed by producing wine samples and characterizing their chemical and sensory properties.

Progress on new grape variety releases to the industry:

Reports indicate that nursery sales of the 2013 wine grape releases, 'Aromella' and 'Arandell', are going extremely well. In 2014, Goose Watch Winery released the first 'Aromella' varietal wine. In 2017, Arbor Hill released its own 'Aromella' varietal. While 'Arandell' is being used in several red wine blends east of the Rockies, the first varietal 'Arandell' wines are being marketed by Vinedo del Alamo winery of Fort Scott, Kansas; Clermont Vineyards, of Germantown, New York, and Briedé Family Vineyards, of Winchester, Virginia. A highly disease-resistant red wine selection (NY06.0514.06) is being propagated for inclusion in regional trials, along with several white wine selections and a red found suitable for rosé wines. Strong interest in the Riesling hybrid, NY81.0315.17, continues and a large scale yeast strain trial will soon conclude.

Wine Sensory Evaluations:

Forty-nine lots of wine (36 white, 13 red) of wine were made from breeding program selections and cultivars in 2019. Brix, pH, titratable acidity, and yeast assimilable nitrogen (YAN) were analyzed at harvest, and musts were chaptalized to 20˚Brix if necessary. Reds were fermented on the skins with yeast strain GRE, and malolactic fermentation induced with LAB culture VP41. Whites were pressed, settled overnight, racked, and inoculated with yeast strain EC1118. One red grape (NY01.0609.01) was processed as a white to produce a rosé style wine. For the third consecutive vintage, sensory impact of commercial yeasts on NY81 wines were evaluated in fifteen of the white fermentations. As in 2017 and 2018, seven yeast strains- R2, DV10, GRE, 71B, Lalvin C, and 58W3- were used in duplicate fermentations, and EC118 in triplicate. All wines are analyzed for pH, titratable acidity, and organic acids (tartrate, malate, lactate, and acetic) via HPLC, and will be screened by a trained sensory panel.

Sensory evaluation of twelve lots (5 white, 7 red) of wines from 2017 had been postponed due to construction in the sensory facility; these were evaluated in early 2019 for liking, flaws, and aroma and flavor characteristics by a sensory panel of researchers and industry members. The highest ranked white wine (6.5 on a 1-9 scale) showed notes of lemon and peach with floral hints. Four small-lot white wines and 19 large lots (10 white, 8 red, 1 rosé) from 2018 were evaluated using the same process. Of these, 13 ranked at or above a liking score of 5, indicating

above average wine quality. As in previous years, the rosé produced with NY01.0609.01 earned the highest average liking, with pleasant aromas of cherry, strawberry, and floral notes.

2019 breeding program analyses of vineyard performance:

Field Data Collection: Observations of vineyard performance in 2019 (including prior years) for program selections and varieties, along with cold hardiness evaluations, disease resistance scores, and wine-related data are summarized in the appendices (Tables 1 to 3)[1].

Comparative vineyard performance data are collected annually (Table 1). Nineteen selections and cultivars were evaluated in second test vineyards with a standard hybrid disease control program in 2019 (Table 1). From the second test vineyard used for the disease resistance program, thirteen selections were harvested in 2019 (Table 2), of which five were harvested for the first time. Additional data are shown for selections harvested in previous seasons. Selections with low relative rankings (e.g. those with poor wine quality, disease susceptibility, overcropping tendency, susceptibility to cold damage) have been discarded each year. Nearly all harvested selections are tested for degree of mid winter bud hardiness each year, and these data are presented in Tables 1 and 2 as estimates of the temperature at which 50% bud kill is expected.

From crosses made in 2005, there was a large group of promising seedlings in the NY05.0403 family. Now in second-test trial plantings, ten selections were initially harvested in 2014 and fruit were fermented for sensory analyses. Of these, only the three most promising were harvested in 2019; the rest were of declining interest due to lack of productivity, low mid winter bud hardiness, and/or wine ratings. These selections, along with other promising second-test selections, are again being tested this winter for the predicted temperature at which 50% primary bud kill would occur. For the seedling family NY05.0403, the range of temperatures at which 50% bud kill would occur was -16 to -19 ^{o}F. The related series, NY03.0207 and NY03.0208, also have strong values for 50% bud kill, between -15 and -17.5 ^{o}F.

Among red wine grapes tested under the standard hybrid disease control program, there are fewer of interest, but some more recent hybrids (with vinifera parents) from crosses made in 2008 may still hold promise. NY02.0101.01 is productive, moderately winter hardy, and disease resistant (under a hybrid spray program), but wine quality has varied.

Summaries of top selections from Geneva – 2nd Test Vineyards:

NY81.0315.17 – Ranks very high for wine quality; the 2009 and 2010 wines were the top-ranked white wines, showing Muscat notes with intense floral, peach and citrus. In 2011, descriptors used included tangerine, grapefruit, apple, pear, honey and floral. In 2017, 2018 and 2019, a large replicated yeast trial was conducted using fruit kindly supply by the FLCC-Cooperative Extension teaching vineyard at Anthony Road Winery. Fruit was subdivided and fermented in duplicate using seven difference yeast strains. Wine evaluations will be taking place soon. Measurements indicate that NY81.0315.17 is 1 to 2 ^{o}F hardier than 'Riesling' (according to temperature of 50% bud kill in mid winter). As a bunch rot resistant alternative to 'Riesling', it will continue to undergo testing in New York and elsewhere. Own-rooted vines are weak and grafting is required. This selection is available for testing via our two cooperating nurseries, Double A Vineyards (Fredonia) and Grafted Grapevine Nursery (Clifton Springs).

A range of other breeding program selections have been chosen for further trials beyond Cornell AgriTech farms, and all available cuttings have been collected for propagation. These include the following:

NY01.0609.01 – This red wine grape produced a very highly ranked and unique wine from vintage 2011, characterized as expressing muscat character with notes of rose and violet. Since 2012, it has been fermented "as a white" to investigate the possibilities of producing a muscat rosé style wine. The color of vintage 2012 was more orange than pink, and some tasters found foxy/cotton candy notes while others described floral, pear, cherry and strawberry notes. The 2013 vintage was also well-liked. Panelists detected some pleasant labrusca notes, along

[1] Tabular reporting of this type of long-term research information has its inherent difficulties. Some breeding selections are tested over a long period of time, while others are discarded after only a few years of testing. Also, as newly produced selections start to fruit, data collection begins and these data are included along with data from selections that have already been tested for multiple years. Since every season is different, accurate comparisons among selections are difficult when the years of data collection differ. However, it is still possible to utilize these tables to understand the basic characteristics of each of these selections: productivity, vine size, winter hardiness, disease resistance, and wine quality. These data help to determine which selections show potential for more advanced, replicated trials.

with cherries, cranberry, strawberry, and currants. Only one taster (of eleven) noted muscat character. Vines are very productive (Table 1), with large clusters and have good resistance to powdery and downy mildews under a hybrid spray program. The predicted temperature for 50% bud kill is -14.4 ^{o}F.

NY03.0207.06 – This white wine selection produces a good canopy with moderate resistance to foliar powdery and downy mildews. Fruit are mostly rot-resistance but some sour rot has been noted in some years. Wines have been highly ranked by tasting panels, with aromas described as melon, pear, spicy and pineapple, while the palate descriptors included good structure and body; and mentions of citrus, pineapple apple and Riesling-like characters. The predicted temperature for 50% bud kill is -17.5 ^{o}F.

NY03.0208.09 – This white wine grape has been described as having citrus, tropical fruit, peach and pear characteristics in both the aroma and palate. It has been very well-liked by tasting panels. Vines have been moderately productive with good resistance to powdery mildew. Bird damage has been a problem and protection (netting) is needed. Some years, rachis necrosis was noted just prior to harvest. The predicted temperature for 50% bud kill is -14.9 ^{o}F

NY04.0303.02 –This is a white wine grape, which produced the top–ranked white wine from vintages 2013 and 2016. Comments included muscat, peach, spicy, tropical fruit, mango, grapefruit, dried apricot, lychee, and passion fruit. The 2016 wine had Sauvignon blanc-like tropical fruit and green notes. These vines are productive and vigorous so far, with good resistance to downy and powdery mildews under a hybrid-type spray program (Table 1). The predicted temperature for 50% bud kill is -15.9 ^{o}F.

Disease Resistance Breeding:

The grape breeding program made 22 crosses in 2019, most targeting combinations of disease resistance with high quality. A central focus of the crossing program was the incorporation of disease resistance sources from pollen shared by cooperators from Germany and Italy. A total of 5,075 seed were produced in 2019, of which 3,243 seeds were stratified for germination.

DNA marker technology, combined with in-season evaluation of disease resistance in a no-spray nursery, is markedly improving the efficiency of disease resistance breeding. DNA markers can be detected in DNA extracted from each seedling, and we are using this technology with the national *Vitis*Gen USDA-NIFA funded projects to accurately predict which seedlings harbor important genes and gene combinations for disease resistance. The correlation with field-observed disease resistance is extremely high.

From seedlings grown in recent years, most underwent DNA-assisted selection for multiple disease resistance genes coding for both downy and powdery mildew resistance. Approximately 90% of all seedlings were discarded prior to nursery planting between 2015-2018. After one season in the nursery, remaining vines were planted to the permanent vineyard sites. In 2019, 43% of seedlings were retained, but labeled according to known desirable genes according to DNA testing results. Resistance to disease will be assessed each season.

Each year, program selections and seedlings grown under no-spray conditions in both nursery and vineyard plantings are evaluated for symptoms of disease. Conditions were less favorable for powdery mildew development between 2017 and 2019, but much more favorable for downy mildew. We rated both diseases on test selections and controls in each of the past three years.

Thousands of seedlings are grown each year, but one group has been noteworthy during the past few seasons. In 2006, crosses were made between selections carrying both the *Run1* gene for powdery mildew resistance and the *Rpv1* gene for downy mildew resistance (from the muscadine grape) and other selections harboring powdery mildew resistance from *Vitis cinerea* and *V. rupestris*. In these populations, unexpectedly high percentages of seedlings were saved in the 2007 nursery since they showed minimal amounts of downy and powdery mildew late into the fall. These were planted to a permanent no-spray vineyard in 2008, and most remained nearly disease-free in subsequent years. Some began to fruit in 2009, and several were immediately propagated and recognized as having potentially good fruit quality combined with unusually high disease resistance. Numerous individuals have already been used as parents for further breeding. It's not unusual to find that many of the *Run1 / Rpv1* seedlings being fermented for the first time do not produce highly ranked wines. However, some show promise with minimal hybrid character. These include the red wine grape NY06.0514.06 and the white wine selection,

NY06.0514.09. NY06.0514.06 has been propagated for further trials beyond Geneva, in cooperation with the NE1720 National Cultivar Trial project.

NY06.0514.06 – a highly disease resistant red wine selection. This selection carries the *Run1 / Rpv1* genes, as well as *Ren2* (for powdery mildew resistance) from *V. cinerea*. Also has excellent resistance to bunch rot, and moderate resistance to black rot. The buds are moderately winter hardy, with expected temperature of 50% bud kill in mid-winter measured to be -15 ^{o}F. Vines are on the small side and grafting on phylloxera-resistant stocks should be tested. Fruit yields seem low (Table 2) due to the use of many clusters for crossing each year. Wine descriptors are as follows: fruity with notes of blackberry, plum, cherry; slightly herbaceous, with green pepper noted; good body and medium tannin; also, some have detected chocolate notes.

Technology transfer:

It is important to us to be able to convey current information about grape varieties to the public. Specific information on recent releases as well as promising elite selections is posted at <*http://www.hort.cornell.edu/reisch/grapegenetics/cultivars.html*>. Bulletins (pdf format) describing Geneva variety releases have also been posted on this web site.

On many occasions we discuss the qualities of new grape varieties with members of the wine industry. We respond to extension phone calls and emails frequently. In many of these communications and at visits to wineries and off-site trials, alternative grape varieties are discussed. Other occasions arise each year where we showcase Cornell wines at industry events. New York State Wine Grape Growers organized a field visit to the breeding program in August, 2017 and another in August 2018. Over 50 growers attended and toured experiment station vineyards and nursery operations at each of these field visits.

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Selected disease resistant seedlings from recent crosses:

Appendix

Impact Statement:
Two new varieties were released in 2013 ('Aromella' and 'Arandell'), and the first commercial wine of 'Aromella' (from Goose Watch) went on sale in 2014, while 'Arandell' varietals reached the marketplace ca. 2016. Three new wine grapes, 'Noiret', 'Corot noir' and 'Valvin Muscat', were released in July 2006, and all are in commercial use. Prior releases such as 'Cayuga White' (1972), 'Chardonel' (1991), 'Traminette' (1996) and 'Geneva Red' (2003) have gained widespread acceptance and account for millions of dollars of wine production annually in New York and in other eastern states.

Publications and presentations resulting from this project:

- Presented a lecture on grapevine breeding (2.5 hr) to two sections of the viticulture class at Finger Lakes Community College. 2.5 hours x 25 students x 2 sections. Geneva, NY, April 16 and 22, 2019. (Reisch)
- Presented on grapevine breeding and genetics to the Viticulture class at the Univ. of Massachusetts, Amherst. (one hour, 20 students, via video connection.) February 8, 2019. (Reisch)
- Recent extension-oriented outputs from "*Vitis*Gen2" include:
- http://www.vitisgen2.org/webinars/
- http://www.vitisgen2.org/home/popular-press/
- Grape Selections from the VitisGen Projects
    -

Our project web site is updated as new information becomes available. See:

http://www.hort.cornell.edu/reisch/grapegenetics/grapeinfo.html

http://www.hort.cornell.edu/reisch/grapegenetics/cultivars.html

http://www.vitisgen2.org

(End of report; See also Appendix Tables 1-3. Detailed data may be obtained by contacting Bruce Reisch <bruce.reisch@cornell.edu>).

Table 1. Summary of vineyard characteristics of breeding selections and varieties under test.

Selections	Years of Data	PM	DM	Yield/ Vine (lb)	Cluster Weight (lb)	Berry Weight (g)	50% Bud Kill (F)	Pruning Wt. (lb)
Reds								
02.0101.01	2010,12-16,18,19	1.8	1.6	18.5	0.24	1.60	-13.5	2.85
08.0702.01	16-19	1.3	1.3	9.8	0.24	1.34	-14.8	3.12
08.0702.02	16-19	1.0	1.3	8.7	0.25	1.03	-11.0	3.76
08.0702.03	17,19	3.8	1.5	13.3	—	1.15	-10.5	—
08.0710.01	16-19	1.0	1.5	13.1	0.29	1.88	-17.9	—
08.0710.02	18	1.0	1.0	10.5	0.47	2.05	-11.3	—
Chambourcin	97-02,06-19	3.9	1.1	18.5	0.42	2.11	-13.7	2.63
Red Pressed as White								
01.0609.01	2009-15,17-19	1.6	1.1	27.9	0.42	2.49	-14.4	3.27
Whites								
03.0207.06	2012-19	1.2	2.0	14.3	0.21	1.24	-17.5	1.98
03.0208.03	10-19	1.4	2.3	12.5	0.23	1.68	-15.9	1.86
03.0208.09	11-18	1.6	2.7	11.9	0.18	1.83	-14.9	2.01
04.0303.02	13-17,19	1.0	1.5	13.5	0.18	2.58	-15.9	4.75
04.0303.04	13-16,18,19	1.3	2.0	14.9	0.21	—	-15.7	2.59
05.0403.01	13-19	1.0	1.6	16.9	0.27	1.92	-16.7	2.91
05.0403.02	13-18	1.0	2.2	7.7	0.09	1.48	-18.4	3.39
05.0403.03	13,14,17-19	1.0	2.0	11.0	0.26	1.69	-16.0	3.97
05.0403.09	13-19	1.3	1.8	12.0	0.28	1.73	-18.9	3.64
08.0721.02	18,19	1.0	1.0	7.6	—	—	—	—
08.0721.03	15,17-19	1.0	1.5	10.5	0.42	1.31	-9.8	—
08.0722.01	17-19	1.0	1.0	3.8	0.32	1.15	-11.0	—
08.0722.02	17-19	1.0	3.0	2.3	0.19	—	-12.4	—

Table 1. Summary of vineyard characteristics of breeding selections and varieties under test.

Cayuga White	10,12-15,18,19	2.8	1.9	25.7	0.42	2.74	-11.3	2.66

Key:

Fruit/Vine (lbs.) converts approximately to tons per acre (at 605 vines/acre) by dividing by 3.

Pruning Weight = average pounds per vine.

50% Bud Kill = predicted temperature (ºF) at which 50% of primary buds would die according to freezing tests run on dormant in mid-winter.

DM Ave. and PM Ave. = Average ratings of foliar downy and powdery mildew severity during severe test years between 2000 Disease Rating System: 1 = 1-3% foliar infection, 2 = 3-12%, 3 = 12-25%, 4 = 25-50%, 5 = >50%.

Pruning weights and 50% bud kill data are not yet complete for the 2019 crop year.

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Table 2. Summary of vineyard characteristics of breeding selections grown under fungicide-free conditions.

Selections	Years of Data	PM	DM	Yield / Vine (lb)	Cluster Weight (lb)	Berry Weight (g)	50% Bud Kill (F)	Pruning Wt. (lb)
Reds								
06.0509.01	2015,17,18	2.5	1.5	9.4	0.24	0.85	-14.9	1.35
06.0514.06	13-19	1.0	1.3	10.0	0.33	1.58	-15.0	1.27
06.0514.07	18,19	2.0	1.0	13.1	—	—	—	—
07.0608.01	14,17-19	2.0	1.3	8.0	0.37	0.94	-18.1	1.59
10.0925.02	19	1.0	1.0	4.8	—	—	—	—
10.0925.03	19	0.0	1.0	21.6	—	—	—	—
Arandell	05-12,14,15,17	2.9	1.8	9.0	0.17	1.13	-12.0	1.53
Whites								
06.0506.02	2013-15,17,19	1.0	1.0	4.5	—	1.59	-14.5	1.30
06.0508.02	17-19	1.0	1.0	8.7	—	1.15	-	3.41
06.0512.04	15,17,19	2.0	1.0	17.7	—	2.48	-9.1	1.18
06.0514.09	15,18,19	2.0	1.0	12.0	0.27	—	—	—
06.0514.12	15,17,19	1.0	1.5	10.8	0.21	0.86	-17.1	-
09.0815.01	19	1.0	1.0	10.4	0.23	—	—	—
10.0934.01	19	1.0	1.0	7.6	0.24	—	—	—
10.0934.02	19	1.0	1.0	7.0	—	—	—	—

Key:

Fruit/Vine (lbs.) converts approximately to tons per acre (at 605 vines/acre) by dividing by 3.

Pruning Weight = average pounds per vine, @ 605 vines/acre.

50% Bud Kill = predicted temperature (ºF) at which 50% of primary buds would die according to freezing tests run on dormant buds in mid-winter.

DM Ave. and PM Ave. = Average ratings of foliar downy and powdery mildew severity during severe test years between 2013 and 2019. Disease Rating System: 1 = 1-3% foliar infection, 2 = 3-12%, 3 = 12-25%, 4 = 25-50%, 5 = >50%.

Pruning weights and 50% bud kill data are not yet complete for the 2019 crop year.

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Table 3. Summary of wine data collected on breeding selections and varieties under test.

Selections	Years of Wine Data	Harv. °Brix	Harv. pH	Harv. T.A. (%)	Wine pH	Wine T.A. (%)	Wine Score
Reds							
02.0101.01	2010, 12-16, 18,19	19.6	3.05	1.00	3.13	0.94	5.02
08.0702.01	16-19	18.8	2.97	1.06	3.19	1.08	5.18
08.0702.02	16-19	20.2	2.79	1.56	2.74	1.96	3.67
08.0710.01	16-19	21.4	2.96	1.06	3.11	1.09	3.24
Chambourcin	97-12, 14-19	20.4	3.01	1.33	3.23	1.01	5.26
08.0702.03	17,19	20.1	2.77	2.16	2.99	1.72	—
Red Pressed as White for Rosé							
01.0609.01	2009-15, 17-19	18.5	3.14	0.99	3.23	1.10	5.35
Whites							
03.0207.06	2012-19	19.4	2.94	1.29	2.86	1.35	5.09
03.0208.03	10-19	20.4	3.02	1.10	2.97	1.16	4.85
03.0208.09	11-18	20.2	2.91	1.10	2.86	1.26	4.99
04.0303.02	13-17, 19	18.4	3.08	1.25	3.05	1.37	5.75
04.0303.04	13-16,18,19	19.8	3.09	0.94	3.17	1.03	5.65
05.0403.01	13-19	20.2	3.01	1.19	2.94	1.14	4.47
05.0403.02	13-18	21.1	3.12	1.03	3.13	1.12	5.20
05.0403.03	13,14, 17-19	20.3	3.08	0.95	3.09	1.01	4.43
05.0403.09	13-19	20.5	2.84	1.63	2.70	1.72	3.88
08.0721.03	15, 17, 18	18.7	3.00	1.07	3.15	1.22	3.52
Cayuga White	96-18	17.5	2.99	1.10	2.98	1.08	4.78
08.0722.01	17-19	19.2	3.06	1.23	3.07	1.33	4.96
08.0722.02	17-19	19.8	3.03	1.42	2.99	1.49	—
08.0721.02	18, 19	19.0	3.02	1.10	3.02	1.25	4.88
Selections from the Disease Resistance Breeding Vineyard							
Reds							
06.0509.01	15, 17, 18	15.7	3.00	1.17	3.14	1.22	4.98
06.0514.06	13-19	19.8	3.12	0.92	3.43	0.86	5.49
07.0608.01	14, 17-19	21.4	2.97	1.41	3.29	1.24	5.00
08.0709.02	19	19.4	2.78	1.93	3.04	1.39	—
10.0925.02	19	19.3	2.92	1.08	3.34	1.19	—
10.0925.03	19	18.5	2.92	1.21	3.17	1.33	—
Arandell	05-12,14-17	19.7	3.28	1.08	3.81	0.76	4.82

Table 3. Summary of wine data collected on breeding selections and varieties under test.

Whites							
06.0506.02	13-15, 17, 19	19.1	2.99	1.40	2.96	1.08	4.99
06.0512.04	15, 17, 19	18.2	2.88	1.23	2.85	1.29	4.14
06.0514.09	15, 18, 19	20.6	3.01	0.97	2.95	0.72	5.17
06.0514.12	15, 17	19.0	2.84	1.54	2.82	1.53	4.43
10.0934.01	19	20.8	2.80	1.40	2.99	1.50	—
10.0934.02	19	21.7	3.11	1.06	3.11	1.19	—

Key: Wine Score = Mean wine panel score, 0-10 scale, 10 is best quality.
Wines from 2019 have not yet been tasted , so Wine Score values reflect averages of 2018 and earlier vintages.

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