Progress Report

Cabernet Franc Clone and Rootstock Selection Suitable for Hudson Valley AVA and Viticultural Techniques for Superior Fruit Quality

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This progress report summarizes accomplishments on two project objectives: (1) to define the most appropriate Cabernet Franc clones and rootstocks for Hudson River appellation based on results obtained through the clone & rootstock trial; and (2) to assess the most successful approach within viticultural methods for controlling methoxypyrazine compounds in Cabernet Franc that cause undesirable herbaceous flavor. With two years of data collection (2017 & 2018) and consistent results, the objective (2) has been completed and thus presented in this report.

Accomplished steps on objective (1): The plot selected for the Cab Franc vineyard was previously used for vine grape variety trial and the removal of that vineyard was carried out during the Fall of 2017. To complete the site preparation 2 t/acre of garden lime were spread and line subsoiling done to a depth of 0.9 m with finished tillage performed shortly before planting in May 2018.

The planting and posting holes were drilled with 10” auger every 3 or 6 feet apart along the rows. Each panel in a row is 24 feet long with 4 plants within the panel. The vineyard consists of 13 rows with South-North orientation and their length ranges between 168 and 264 feet.

Cabernet Franc clone 1, FPS11, FPS13.1 and 623 grafted on 3309C, 101-14, and Riparia Gloire arrived on May 2nd and were stored in a walk-in cooler at 5°C prior the planting. Roots and grafting union were inspected upon arrival and each plant was labeled and bundled up. Twenty-four hours before planting, roots were soaked in cold water. The planting was carried out from May 11th to May 14th with help of 3 technicians. Previously drilled planting holes were filled with water and handful of garden lime was add to each hole. After that, roots were evenly spread out in a hole and buried so the grafting union was under the soil surface. Vines were planted in blocks, so the trial was organized as a Complete Randomized Block Design. A day after planting, 150 lbs of 15-0-30 was spread in the vineyard, which resulted in 24 lbs of N/acre. Additional watering was included depending on soil moisture status.

Bud break occurred approximately 1 to 2 weeks after planting and at the begging of June all vines were shielded with Blue-X growth tubes with bamboo sticks as a support. The vineyard posts were installed during August using a post pounder mounted on a skid-stir. Newly established vineyard was periodically mowed, while herbicides were applied in the rows 3 times during the season. Fungicide sprays against downy and powdery mildew, Phomopsis and black rot were applied with a backpack sprayer in a 2-weeks schedule. Insecticides against mites and Japanese beetles were applied once in the second half of the season.

The anchor rods 40" x 5/8" with a 6" Helix were drilled at 3 feet distance from the end posts and fruiting wire was installed 3 feet above the ground in the beginning of September. Right after that growth tubes were removed allowing the shoots to harden properly. Two shoots per vine were trained along the fruiting wire to form a double cordon. The remaining two sets of removable catching wires were installed during the winter.

Due to a sequence of events with extremely low winter temperature in the Hudson Valley, the newly plated vineyard started a season with 80% bud damage and a few dead vines. For that reason, we had to re-train

survived vines from the base. Vineyard was fertilized in spring with 150 lbs of 15-0-10 NPK formulation. Following a spray schedule recommended by the 2019 Ney York and Pennsylvania Pest Management Guidelines for Grapes, we sprayed on 10 to 14 days interval against downy and powdery mildew, Phomopsis, black rot, Alternaria, anthracnose, and applied herbicides 2 times during the season. Insecticides for Leafhoppers, Phylloxera, Banded Grape Bug, Grape Berry Moth, Leafhoppers, Japanese Beetles, Cutworms were applied based on scouting.

Vines were not harvested since we had to remove all clusters shortly after the fruit set to encourage the new shoot growth. We are expecting to have our first report on fruit composition after the harvest in 2020.

Accomplished steps on objective (2): Widely recommended practice for reduction of MPs in grapes is leaf removal, usually done at fruit set or a couple of weeks later. However, this practice if performed manually is time consuming and labor intensive, and a previously reported study (Scheiner et al., 2012) indicated that vine vigor itself can be of larger importance for IBMP accumulation than leaf removal. Therefore, we tested whether this statement holds the truth for Hudson Valley Cabernet Franc by setting up a trial in three commercial Cabernet Franc vineyards: Whitecliff Vineyard & Winery in Gardiner, Glorie Farm Winery in Marlboro, and Millbrook Winery in Millbrook, NY. In winter 2017, at each site, we randomly selected five blocks of 9 vines and assigned 3 treatments: CP=crop load, LP=leaf pulling and Control to a set of 3 vines per repetition.

Given that at each site vines have been trained to VSP and pruned to 4 canes leaving a couple of spurs for replacement, we increased the crop load in CL vines for one third leaving an extra cane and spur on each side of the cordon. The LP vines were pruned to the basic crop load level leaving 2 canes with 2 spurs per vine as well as Control vines. All vines were pruned and tied with twist ties to a cordon wire in March.

Leaf pulling in Hudson Valley has usually been applied between fruit set and berry pea size manually with the exemption of Millbrook Winery where this operation has been done mechanically. We applied leaf pulling 10 days after full bloom (50% cap fall), manually, removing 5 to 6 leaves from the bottom of shoots. Leaf pulling was performed only on LP vines, while CL and Control vines have not received any leaf pulling during the season.

During the season, experimental vines were subjected to standard vineyard practice including pesticide and herbicide control and shoot toping as the rest of the vines at given location. No irrigation was applied. Each site was visited a couple of times during the season to record growth stages and ensure that the fruiting zone of LP vines were clean and without new laterals.

During the harvest, number of clusters per vine, yield per vine and rot incidence were recorded. Clusters with over 10% of the berries infested with rot were counted as infected. The results showed that leaving additional 1/3 buds per vine did not significantly increase number of clusters per vine, although there was an overall increasing trend of 15% of counted clusters in CL compared to Control or LP. The increment of clusters per vine resulted in overall of 3% increase in yield per vine. We noticed a strong influence of leaf pulling on yield, which was reduced for almost 30%. This decrease came from significantly reduced cluster weight and that was noted at all three sites. The level of leaf removal and timing when it was applied here in our study, were suggested as effective for IBMP reduction in Merlo, without a negative effect on cluster size (Sivilotti et al, 2016). Timing of leaf removal plays key role, affecting the cluster size and studies has confirmed that if it is applied after bloom, at fruit set or later the effect diminishes (Poni et al. 2006, 2008, Intrieri et al. 2008, Lohitnavy et al. 2010, Sabbatini and Howell 2010, Tardaguila et al. 2010, 2012). However, these studies never targeted Cabernet Franc, so we can conclude that this variety is more sensitive to leaf area manipulation at the time of early berry development which may suggest that either less leaf area needs to be removed or the application has to be delayed in order to retain the commercial yield level and cluster size, while at the same time affecting the MPs accumulation in berries.

Bunch rot incidence did not differ among treatments and varied between 0 to 12%, being more influenced by the site than by treatments.

During the harvest a sample of 60 and 100 random berries per treatment was collected in zip-lock bags for MPs analysis and basic fruit chemistry, respectively. Bagged samples were immediately placed on icepacks in coolers and transported to the lab where they were kept in -80C prior the analyses.

Samples for basic fruit chemistry were analyzed in the HVRL using Atago Pocket Refractometer PAL-1 for soluble solids reading. HANNA Instruments HI 84532 Titratable Acidity Minititrator and pH meter was used to measure titratable acidity expressed in g/100mL as tartaric acid and juice pH. Prior the analysis, berry samples in the bags were left at the lab bench to reach room temperature, crashed with hands, and approximately 50 mL of grape juice was collected in centrifuge tubes. Ten mL of juice was used for titration against HI84532-50 low range titrant (sodium hydroxide) until the pH end point at 8.1. The remaining juice was used for soluble solids and pH reading.

At verasion, we saw symptoms of potassium deficiency in whole Cabernet Franc vineyard at Glorie Winery. According to the vineyard owner and manager this problem was noticed in the past and has been mitigated with recommended K fertilization couple of years ago. However, K fertilizer has not been applied since then. Shown deficiency at verasion gradually progressed by the end of the season impairing fruit maturation and resulting in low level of soluble solids (18-19° brix) and higher TA (over 0.72 g/100mL). Overall vines were harvested at 21° brix, with highest level of 24° brix measured in Millbrook vineyard. At this site, we also found significant treatment effect on soluble solids, pH and TA, where LP treatment resulted in higher brix and pH and lower TA comparing to CL treatment.

Pruning weight was unaffected by treatments neither was Ravaz index overall. Looking at the vine balance across the treatments and expressed as percentage of vines being over-cropped, under-cropped or balanced, the general conclusion was that most of the plants only at Glories' site were well balanced. However, the other two vineyards showed disbalance being mostly under-cropped at Millbrook or over-cropped at Whitecliff. Knowing this general status of the vineyards, the positive effect of leaving additional crop load on MPs reduction would be the least probable at Whitechliff and the most probable at Millbrook site.

For MPs analysis, 30 mL of grape juice was collected in glass bottles and kept frozen and cold on dry ice to prevent fermentation while shipped to CCOVI at Brock University, Ontario where the concentration of the 3-isopropyl-2-methoxypyrazine (IPMP), 3-sec-butyl-2-methoxypyrazine (SBMP) and 3-isobutyl-2-methoxypyrazine (IBMP) were analyzed using headspace SPME GC-MS and a stable isotope dilution assay. Although our results showed no significant differences in MPs accumulation induced by treatment application, we noticed an interesting ratio between analyzed MPs. Unlike previously reported, IBMP did not present the most prevalent type of MP in our grape samples (Botezatu et al 2014, Sidhu et al. 2013). Level of IBMP we detected in our berry samples at harvest was twofold lower than previously reported for Cab Franc (Koch et al. 2010, Ryona et al 2008). This discrepancy may come for a different method we used for sample preparation. SBMP, which has been rarely detected in wine and grapes (Legrum et al. 2014, Lei et al. 2017) was found as the predominant form of MP in two vineyards: Glorie and Millbrook; or as equally dominant as IBMP at Whitecliff vineyard. Found concentration of IPMP and SBMP exceeded their sensory detection threshold in water and wine (1-2 ppt) regardless of treatment application. According to Sidhu et al. (2015) the detection threshold for IBMP in water is 1-2 ppm and is higher in wine (10-16 ppt) (Maga 1990). The level of IBMP we measured in grapes was below wine detection threshold (4-5ppm).

The same treatments were repeated in 2018 with only difference in LR treatment, in which, instead of 5 to 6, we removed 4 to 5 leaves at the base of the shoot and moved the defoliation day to 2 weeks after full bloom to avoid the adverse effect this intense level of leaf pulling had on crop load and cluster size. In addition to that, we were limited to use only two sites for the trail, since Whitecliff Vineyard experienced extreme winter frost event during 2018 and lost the entire Cabernet Franc plot.

Unlike the effect LR had on cluster size in 2017, this year results shows no overall effect of LR treatment. Interestingly, we observed an increase in yield and cluster number per vine at Glories' site. Crop load manipulation through winter pruning and more buds per vine did not significantly result in more clusters or higher yield per vine overall. Only at the Glories' site, we noticed an increase of 42% in cluster number and 24% in yield using this technique. Bunch rot incidence did not differ among treatments and was much higher in comparison to the previous season, reaching to approximately 45% of affected clusters in Glorie vineyard alone, due to extremely rainy season.

In the season of 2018, we included the color analysis of the grape juice. Anthocyanins and total phenolics were analyzed using the protocol described by Iland et al. (2003). The absorbances of the extracted color components were read on UV-Vis spectrophotometer (Genesys 150 with a sipper unit, ThermoScientific) at 520 nm and 280 nm and expressed as mg of anthocyanins per g of berry weight and a.u. of total phenolics per g of berry weight.

To prevent damaging effect of bunch rot incidence on fruit quality, grapes were harvested before forecasted rainy period had occurred at brix level of 17.6. Number of clusters and yield was increased with LR only at Glorie's site. This treatment influenced higher Ravaz index at the same location. It's worth mentioning that vines at both locations were under-cropped, probably due to the winter bud damage. Treatment influence on berry size, fruit chemistry and color were not noticed overall. However, looking at specific site, CL and LP significantly reduced berry size in Glorie vineyard. Generally, smaller berries have bigger surface to volume ratio, and thus higher anthocyanins concentration, since anthocyanins are primarily localized in the outer hypodermis or berry skin. This is exactly what we found in LP treatments. Additionally, better light exposure could be as well contribution to the higher anthocyanins content of LP treated vines.

We used CCOVI service again regarding MPs analysis for this year and asked for the protocol to be modified, so we could get MPs extracted from the whole berry and thus obtain maximal level of MPs. In accordance to the previous year, the analysis showed that LR had no effect on concentration of any of 3 tested forms of MPs. The only significant difference was noted in Glorie Vineyard and was a result of CL treatment. With this we can conclude that leaf removal as commonly adopted practice for MPs control might not be efficient as believed and its effectiveness could be strongly influenced by vine balance, location and seasonality.

Detailed data may be obtained by contacting Dana Acimovic at dda42@cornell.edu.

List of significant outreach activities:

The Annual Hudson Valley Cab Franc Coalition Meeting, Benmarl Winery, Marlboro, NY (March 14, 2018). Document and talk delivered to the public: The Research Findings on Viticultural Techniques for MPs Control and Updates on the Cab Franc Vineyard.

The Annual HVRL Industry Meeting, HVRL, Highland, NY (September 7, 2018). Power Point presentation: Introducing New Cab Franc Clone and Rootstock Trial at HVRL.

2019 Hudson Valley Cabernet Franc Barrel + New Release Tasting, Nostrano Vineyards, Milton, NY (May 30, 2019).

Growers and Industry Reporting Session, HVRL, Highland, NY (September 5, 2019). Power Point presentation: Progress Report on New Cab Franc Clone and Rootstock Trial.

2019 CRAVE Conference, Cornell, Plant Science Bldg., Ithaca, NY (December 11, 2019). Power Point presentation: Cabernet Franc Clone and Rootstock Selection Suitable for Hudson River Region AVA and Viticultural Techniques for Superior Fruit Quality.

2019 Apple Forum, HVRL Highland, NY (December 17, 2019). Power Point presentation: Progress Report on New Cab Franc Clone and Rootstock Trial.

The results and information about the project and the progress on Cab Franc Trail can be accessed via HVRL Horticulture – Cornell Blog Service: https://blogs.cornell.edu/hvrlhorticulture/

Impact Statement: The project: 'Cabernet Franc Clone and Rootstock Selection Suitable for Hudson Valley AVA and Viticultural Techniques for Superior Fruit Quality' is intended to support the Hudson Valley Cabernet Franc Coalition in its task to encourage more vineyard plantings of Cabernet Franc in the region. With the complete assessments of clones and rootstocks through this project the Coalition will give complete information and recommendation on the best performing Cab Franc clones for Hudson River Appellation to the potential growers and thus implement its mission.