2019 MGWIC RESEARCH REPORT

PROPOSAL TITLE**: IMPLEMENTATION OF ALTERNATIVE CANOPY MANAGEMENT TECHNIQUES ON THE NW AND SW TO IMPROVE FRUIT TECHNOLOGICAL MATURITY OF GRAPE GROWN IN MICHIGAN**

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1. Use of the financial support from MGWIC

The funding requested of the MGWIC supported (5%) of technical costs, 23 trips at 300 miles each (at MSU rate of $ 0.59 per mile) roundtrip from campus to the experimental vineyards at Lemon Creek Winery (SW) and Loire vineyards (NW). Laboratory analyses and undergraduate support (50%, for 2 months at $ 14.00 per hour). The proposal was also submitted to project GREEEN for matching funds in 2017 but not funded. Preliminary data were presented in 2018 and they will presented in 2019 at state, regional and national meetings.

- VanderWeide J., Ma Z., Frioni T., Murad P. and P. Sabbatini. 2018. Early Season source-sink Modulation in Merlot (Vitis vinifera L.) Enhances Fruit Quality through a Shift in the Flavonoid Metabolome. 43rd Annual ASEV-ES Conference July 9-11, King of Prussia, Pennsylvania, USA.
- VanderWeide J., Ma Z., Sabbatini P., Frioni T. and P. Murad. 2018. Early Source-Sink Modulation in Merlot (Vitis vinifera L.) Enhances Fruit Quality through a Flavonoid Metabolome Shift. 69th Annual ASEV Conference, June 18–21, Portola Hotel & Monterey Conference Center, Monterey, California USA.
- Sabbatini P. Changes in Within-Vine Carbon Partitioning Subjected to Early Basal Leaf Removal. "Forty Years Advancing Fruit Production: Applied Physiology, PGRs, Rootstocks, and Orchard Systems". 24 August 2018, Hagerty Conference Center, Traverse City, Michigan.
- Sabbatini P. 2018. Challenges of Sustainable Viticulture in the Great Lake Region. Inter
- national Symposium New Cultivars for Disease Resistance and Increased Sustainability, August 29th, Community Meeting Room, Leelanau County Government Center, Suttons Bay MI 49682.
- Sabbatini P., Vanderweide J. and P. Murad. 2018.Mechanization of early leaf removal in (Vitis vinifera L.) Pinot Grigio and Merlot. Friday, June 1st, Northwest Michigan Horticulture Research Center (NWMHRC), Traverse City, MI.
- Sabbatini P., Vanderweide J., Murad P., Lemon T. and Lemon J. 2018. Canopy and Cluster Zone Management. MSU Agriculture Innovations Day: Focus on Fruit and Vegetable Technologies; June 28th, Southwest Michigan research hand Extension Center (Benton Harbor).
- Sabbatini P. 2018. Changes in within-shoot carbon portioning in Pinot noir grapevines subjected to early leaf basal leaf removal. Great Lakes Fruit, Vegetable & Farm Market Expo, Grand Rapids (MI), December 4th.

- Sabbatini P., J. Vanderweide. 2018. Early mechanical leaf removal in Merlot.. Great Lakes Fruit, Vegetable & Farm Market Expo, Grand Rapids (MI), December 4th.
- Sabbatini P. 2019. Impact of Early Basal Leaf Removal on Carbon Production and Partitioning in Pinot Noir Grapevines. Northwest Michigan Orchard and Vineyard Show, (Traverse City, MI), January 15-16.

2. Summary objectives of the proposal and results

This extension project aimed to study the effect of innovative mechanized canopy management strategies on grapevines to improve fruit quality at harvest. Few years ago, the owner of the largest vineyard management company in Michigan shared those important concerns with our team that lead to the execution of this extension trial: *"I can't stress enough the importance of mechanizing activities in the vineyard without jeopardizing quality of our industry to going to ever scale beyond a tourist stop. Our costs per acre of management needs to be down around $3,000 or we need to get our yields up around 7-8 tons per acre for vinifera which isn't doable with our growing season. Without solving that issue we can't go head to head on a larger scale with other regions and keep a sense of place by sourcing local fruit. Please let us know how we can help as I see this as one of the largest bottle necks to our industry".*

Canopy management is still poorly used and understood in our industry, and no specific research have been done yet in Michigan to evaluate the impact on fruit technological maturity of timely manipulation of grapevine canopy. Riesling and Merlot were used for this project because being 2 of the most planted white and red grape varieties in Michigan. Extension trial were conducted at the SW and NW of Michigan, in two pivotal venues for outreach activities and summer extension meetings with stakeholders. Several leaf removal treatments were be applied during the season and berry skin characteristics, cluster architecture and basic fruit chemistry parameters, as well as yield data at harvest. Juice from berries collected at harvest were used for chemistry analysis (basic fruit chemistry - Brix, pH, and acidity – plus volatile compounds and volatile acidity). Bunch rot incidence was also measured. Weather data, including daily temperature and daily precipitation, were recorded during the experiment by an automated weather station (MAWN). Standard summer vineyard practices, mowing grass 3 times, sucker cleaning, hedging, no leaf removal and no cluster thinning, were applied. Shoots were trimmed with pruning machine. The extension trial was conducted in a randomized complete block design with one categorical factor, leaf removal at two different timing and by two different methods. Pre-bloom manual leaf removal from six basal leaves and lateral shoots (PB Man, Figure 2.1); pre-bloom mechanical leaf removal (PB Mec, Figure 2.2); after-bloom manual leaf removal from six basal leaves and lateral shoots (AB Man, Figure 2.3); after-bloom mechanical leaf removal (AB Mec, Figure 2.4); and, control without leaf removal treatment (C). Mechanical treatment was

Figure 2.1 Pre-bloom manual leaf removal (PB Man) treatment. Left: before application; Right: after application.

Figure 2.5 Left: whole view of the leaf remover; Right: the machine shattering leaf between two rows.

carried out by a leaf remover Collard E2200F (Collard, Bouzy, France, Figure 2.5). The machine releases relatively low pressure air pulse from two to four nozzles of each rotating wheel, positioned on two axes (40 cm each) per side. Unlike manual leaf removal with detaching each single leaf, the machine reduces the leaf area by shattering the leaf into pieces on approximately 60 to 80 cm of canopy. On the mechanical treatment rows, the tractor ran at 1.6 km/h, pulsing air at 0.8 bar from two nozzles (one positioned for the upper cordon while the other for the lower cordon), rotating at 1650 rpm, thus shattering leaves on that 65 cm of canopy which correspond to the six to eight basal leaves of the shoots both on the upper and lower cordon. Experimental vines were set up in five blocks, three replicate sub-blocks for each treatment. Within each replicate block, nine vines were tagged for experiment with extra two vines as guard vines (one on each block end). In addition, three target vines were randomly selected in each block and three target shoots were randomly tagged in each target vine to keep track for the detailed measurements of daily shoot length, fruit set percentage, cluster parameters, and fruit chemistry. In summary, each treatment had nine experiment vines (including three tagged vines) and 9 tagged shoots. Using the linear regression between the number of visible flowers and the number of actual flowers per cluster, the estimated flower number was calculated; with the linear regression of the number of visible pea-size berries with actual pea-size berries per cluster, the number of pea-size berry was estimated. Fruit set was expressed in two ways: EL-31 fruit-set, the ratio of estimated pea-size berry number to estimated flower number; and EL-38 fruit-set, the ratio of berry number per cluster at harvest to estimated flower number. As shown in Table 3.2, timing of treatment showed obvious effect on fruit set change. Machine did not make significant impact on fruit-set decrease as hand did. All leaf removal treatments did not have impact on TA but PB Man showed the trend of TA reduction. As for grape pH, only pre-bloom treatments significantly increased pH, 3.92 and 3.86 for PB Man and PB Mec respectively, in comparison with C (3.69) (Table 3.3). Pre-bloom leaf removal increased grape total soluble solids by 2.2 ^{0}Brix by PB Mec and 1.1 ^{0}Brix by PB Man, compared with control (20.0 ^{0}Brix). After-bloom leaf removal showed different impact on sugar accumulation as AB Mec slightly increased 0.5 ^{0}Brix while AB Man (19.5 ^{0}Brix) stayed similar to control. Unlike manual leaf removal, mechanically treated vines consistently produced grapes with higher ^{0}Brix. At harvest, sour rot influence was evaluated on each tagged cluster. Similar to sour rot development process, PB Man resulted in the lowest incidence (41 %), severity (10 %), and quantity loss (13.4g in cluster basis and 0.6 kg in vine basis) while the other three treatments had no significant impact on sour rot in comparison with control (incidence: 65%, severity: 19%, cluster quantity loss: 45.8 g, and vine quantity loss: 2.1 kg). Even

Table 3.2 Effect of leaf removal treatment on the estimated flower number, estimated pea-size berry number, harvest berry number, fruit-set percentage at different phenological stages (EL-31, EL-38, Eichhorn and Lorenz, 1977).

Treatment[1]	Estimated flower number[2]	Estimated pea-size berry number	Harvest berry number	EL-31 fruit-set (%)	EL-38 fruit-set (%)
PB Man	253 a[3]	124 b	107 cd	50.9 c	43.9 b
PB Mec	186 b	106 b	94 d	61.5 ab	54.6 a
AB Man	274 a	148 a	139 ab	55.2 bc	52.1 ab
AB Mec	250 a	147 a	125 bc	61.9 a	54.7 a
C	284 a	156 a	149 a	57.7 ab	54.6 a

[1] PB Man: pre-bloom manual leaf removal; PB Mec: pre-bloom mechanical leaf removal; AB Man: after-bloom manual leaf removal; AB Mec: after-bloom mechanical leaf removal; C: control, without leaf removal treatment.

[2] Means were based on 54 replicates.

[3] Mean within columns followed by a letter indicates significance by Tuckey's HSD test ($P < 0.05$)

Table 3.3 Leaf removal impact on basic chemistry parameters at harvest.

Treatment[1]	TSS (°Brix)[2]	pH	TA (g/L)
PB Man	21.1[3] ab	3.92 a	5.03
PB Mec	22.2 a	3.86 ab	5.83
AB Man	19.5 b	3.75 bc	4.97
AB Mec	20.5 ab	3.76 abc	5.98
C	20.0 b	3.69 c	5.74

[1] PB Man: pre-bloom manual leaf removal; PB Mec: pre-bloom mechanical leaf removal; AB Man: after-bloom manual leaf removal; AB Mec: after-bloom mechanical leaf removal; C: control, without leaf removal treatment.

[2] Means were based on 54 replicates.

[3] Mean within columns followed by a letter indicates significance by Tuckey's HSD test ($P < 0.05$)

without significant reduction on sour rot damage, AB Man, PB Mec, and AB Mec showed the trend of quantity decreasing sour rot damage. Compared with yield in C (6.2 kg/vine), pre-bloom leaf removal reduced yield per vine, with PB Man slight reduction (0.3 kg/vine) and PB Mec significant decrease (1.4 kg/vine). After-bloom treatments did not have significant impact on yield and only AB Mec (0.5 kg/vine) indicated the trend of yield reduction while AB Man showed no difference. Cluster number per vine was not affected by leaf removal treatment. As for bunch rot management, mechanical treatments had no impact on diminishing sour rot incidence but increased spray efficiency was observed. With leaf residue left on petioles after treatment, pre-bloom mechanically treated vines ended with higher leaf area to yield ratio. In summary, pre-bloom turned out the better timing for leaf removal than after-bloom and machine had shown its potential to replace hand treatment. However, the amount of leaf area removed by machine should be optimized as well. Therefore, field machine calibration needs further research to achieve the match between timing and method.

Two extension meetings during the summer of 2018 were organized at the SW and NW plots to demonstrate the equipment used in this project and explain the results.