Grapevine nutrition and juice quality

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Background and Rationale: Cold-hardy hybrid wine grape cultivars released by the University of Minnesota have become very important to the wine industry in cold-climate regions of North America. Soil and nutrient management practices to maximize yield and wine quality have not yet been determined for these new cultivars. Our objective is to establish nutrient management and diagnostic guidelines for cold-hardy hybrid wine grapes and to determine the relationships between soil and tissue nutrients on one hand, and juice quality on the other.

Treatments:

We selected three cultivars for study:

- Frontenac
- La Crescent
- Marquette

We sampled soil at two depths to determine nutrient concentrations and other characteristics:

- 0 to 8 inches
- 8 to 16 inches

We sampled leaf petioles and blades at three times to determine nutrient concentrations:

- At bloom
- Thirty days after bloom
- At veraison

We determined yield per vine and mean cluster size and collected berry clusters to measure four juice variables:

- Sugar concentration (˚Brix)
- pH
- Titratable acidity (TA)
- Yeast assimilable nitrogen (YAN) concentration

The study was conducted in 17 vineyards in five states:

- Iowa (6 participating vineyards. Co-PI: Diana Cochran, Iowa State University)
- Minnesota (4 participating vineyards. Co-PI: Carl Rosen, University of Minnesota)
- New York (1 participating vineyard. Co-PI: Tim Martinson, Cornell University)
- North Dakota (2 participating vineyards. Co-PI: Harlene Hatterman-Valenti, North Dakota State University)
- South Dakota (4 participating vineyards. Co-PIs: Rhoda Burrows and Anne Fennell, South Dakota State University)

Methods:

In the springs of 2012 and 2015, from each replicate, soil cores were collected at depths of 0-8 and 8-16 inches, dried, and sent to Agvise Laboratories (Benson, MN) for analysis.

In 2012, 2013, and 2015, leaves were collected at bloom, 30 days after bloom, and at veraison (when grapes begin to develop their mature color). The leaves were separated into petioles and blades, dried, and sent to Agvise Laboratories for nutrient analysis.

In all three years, yield per vine and mean cluster size were determined for a sample of vines at the harvest time determined by the grower. At the same time, a sample of grape clusters was collected to be analyzed for ˚Brix, pH, TA, and YAN.

Analysis of data collected in 2015 is ongoing, and results of the complete study will not be presented until the 2015 data have been incorporated into the analyses. Preliminary results, including only data from 2012 and 2013, are presented.

For each year's data, regression analyses were performed for each juice chemistry variable as a function of each soil, tissue, and yield variable. Results for whole leaves closely paralleled the results for leaf blades and are not discussed.

The relationships were evaluated with and without apparent outliers (based on subjective evaluation of scatterplots) to eliminate relationships attributable only to outliers and detect relationships masked by them. Relationships that were apparent in the full dataset and not due to outliers were given more weight than those that were only apparent after outliers were removed, while relationships that were clearly attributable to outliers were ignored.

Relationships were evaluated both in Excel (by fitting linear trendlines to scatterplots) and in SAS 9.4 (using Pearson correlations). Results presented here were statistically significant at $\alpha = 0.05$ and met one of the following criteria:

1. The relationship was strong ($r \geq 0.4$) and had no outliers, or
2. There were apparent outliers, but the relationship was strong ($r \geq 0.4$) without them.

In addition to meeting one of these criteria, a relationship is only presented if:

3. The relationship was consistent across at least two cultivars within a sampling time or at least two sampling times within a cultivar, within a single year, and
4. The relationship met these criteria for the same sampling time and cultivar in both 2012 and 2013.

Results:

- Though there were significant relationships between multiple independent factors and juice ˚Brix in each year, no factor was related to ˚Brix in both years.
- Juice pH increased with increasing soil N for La Crescent in both years and Frontenac in 2012. It also increased with La Crescent midseason petiole N in both years.
- Juice pH increased with soil and tissue K for Frontenac in both years; with soil K and veraison tissue K in both years for La Crescent; and with soil K in 2012 for Marquette.

- Juice pH decreased with increasing soil sandiness and increased with increasing soil siltiness for La Crescent and Marquette in both years, and with increasing siltiness for Frontenac in 2013. It also increased with soil clay content for Marquette in 2012.
- Juice pH decreased with increasing cluster size in Marquette in both years and in La Crescent in 2012.
- Soil Mg was negatively related to TA in both years in Marquette, and the same was true for Frontenac and La Crescent in 2013. Soil base saturation with Mg was negatively related to TA in both years for Frontenac, and in 2012 for La Crescent.
- Juice TA was higher in sandier soils in 2012 for La Crescent and in both years for Marquette. A weaker trend toward higher TA in sandier soils was also seen in Frontenac vineyards in 2013.
- Juice TA was positively related to blade S at bloom for Marquette in both seasons.
- YAN increased with increasing soil N in both seasons for Frontenac, in 2012 for Marquette, and in 2013 for La Crescent. The same was true for Tissue N in both seasons for Frontenac and La Crescent and in 2013 for Marquette.
- YAN was positively related to midseason blade P in both years for Frontenac, but it was negatively related to veraison petiole P for the same cultivar in 2012. YAN was also negatively related to midseason petiole P and veraison blade and petiole P for La Crescent in both years.
- In Frontenac, YAN increased with increasing midseason blade and petiole S in both years, with bloom petiole S and veraison blade S in 2012, and with soil S in 2013. The same positive relationship was seen in bloom blades and petioles and midseason blades in La Crescent in 2013 and with midseason blades in Marquette in 2013. However, YAN was negatively related to midseason blade S in Marquette in 2012.
- In Frontenac, midseason blade Ca was negatively related to YAN in both years, with midseason petiole calcium in 2012, and with bloom blade and petiole calcium and veraison blade calcium in 2013. The same was seen for midseason petiole Ca in 2012 and veraison blade Ca in 2013 for La Crescent.
- Frontenac and La Crescent YAN increased with increasing soil organic matter content in both seasons. However, Marquette YAN decreased with increasing soil organic matter in 2013.

What the results mean:

- Sandier soils tend to yield juice with lower pH and higher TA than siltier soils, especially for La Crescent and Marquette vines.
- Especially in Frontenac, high soil and tissue K may increase juice pH. (There were also indications that high soil and tissue K may decrease juice TA, but the relationships were generally weaker.)
- High soil and tissue N concentrations generally result in high juice YAN concentrations. They may also produce higher juice pH.
- High soil organic matter promotes high juice YAN in Frontenac and La Crescent, but has, if anything, the opposite effect in Marquette.
- Juice sugar concentration did not respond consistently to any soil or tissue variable, and may be affected more by climate and vine training decisions than by nutrient management or soil characteristics.