Grapevine Nutrition

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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. Practices based on traditional varieties may not be ideal because they are based on research conducted in other climates and with different genetic backgrounds.

Traditionally, fertilization needs are determined based on petiole nutrient concentrations. However, petioles do not always provide the best measure of nutrient status. Blade or whole-leaf samples may serve better in some contexts, and may be more informative for cold-climate cultivars than petiole samples.

Our objective is to establish nutrient management guidelines for cold-hardy hybrid wine grapes and to determine the relationships between soil and tissue nutrients on the 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

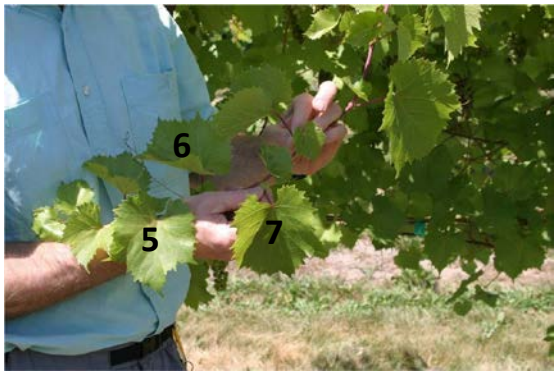
We determined yield per vine and collected berry clusters to measure four juice variables:

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

Methods: The study was conducted in 15 sites in five states: North Dakota (2 sites), South Dakota (3 sites), Minnesota (4 sites), Iowa (5 sites), and New York (1 site). For each cultivar at each site, three replicates of 15 – 16 consecutive vines were selected.

In the spring of 2012, from each replicate, eight soil cores were collected at each depth from within 3 to 4 feet of the vine trunks. The eight cores were bulked, mixed, dried, and sent to Agvise Laboratories (Benson, MN) for analysis.

In 2012 and 2013, 25 to 30 leaves from each replicate were collected at bloom, 30 days after, and at veraison. To collect the youngest mature leaves, we selected the leaf opposite the basal flower cluster at bloom and the 5th, 6th, or 7th fully-expanded leaf from an unpruned shoot tip at the other two times. The leaves were separated into petioles and blades, which were bulked, dried, weighed, ground, and sent to Agvise Laboratories for nutrient analysis.



Yield per vine was determined for a subset of the vines in each replicate at the harvest time determined by the grower. At the same time, a sample of at least five clusters was collected from each replicate and sent to the University of Minnesota Horticultural Research Center for analysis. The sample for each replicate was crushed, and the juice was analyzed for ˚Brix, YAN, pH, and TA.

Because juice variables have not been determined for all sites for the 2013 season, only 2012 results have been evaluated. Pearson correlation (CORR procedure in SAS 9.3) was used to test for significant relationships between soil and tissue variables and juice quality characteristics.

For each correlation, a corresponding scatter plot was visually evaluated to determine whether significant relationships were attributable to outliers and, conversely, whether outliers masked otherwise significant relationships. A relationship between a soil or tissue variable and a juice variable was selected for further evaluation if it met one of the following criteria:

1. The relationship was not due to apparent outliers, $P < 0.05$, and $r > 0.4000$.
2. The relationship was partially due to apparent outliers, but $r > 0.4000$ without them.
3. The relationship did not meet criterion 1 with apparent outliers, but $r > 0.6000$ without them.

In addition, we present only those soil and tissue variables that:

4. had consistent relationships to a given juice variable across at least two cultivars within a sampling time or at least two sampling times within a cultivar.

Results:

Tables 1-4 present the direction (+ or -) of each relationship meeting one of the first three criteria (above), for each soil or tissue variable meeting the fourth criterion.

Table 1. Directions of correlation for leaf tissue variables significantly correlated with juice sugar concentration (˚Brix).

Cultivar	Predictor	Bloom		Bloom + 30		Veraison	
		Blade	Pet.	Blade	Pet.	Blade	Pet.
Frontenac	S	-					
La Crescent	S	-		-	-		
Marquette	Fe	-	-		-		-

Table 2. Directions of correlation for soil and leaf tissue variables significantly correlated with juice YAN.

Cultivar	Predictor	Soil	Bloom		Bloom + 30		Veraison	
		8-16"	Blade	Pet.	Blade	Pet.	Blade	Pet.
Frontenac	N	+	+		+	+	+	
	S		+	+		+		
La Crescent	N				+	+		
Marquette	N		+	+	+	+		+
	S				+			

Table 3. Directions of correlation for soil and leaf tissue variables significantly correlated with juice pH.

Cultivar	Predictor	Soil		Bloom		Bloom + 30		Veraison	
		0-8"	8-16"	Blade	Pet.	Blade	Pet.	Blade	Pet.
Frontenac	K			+	+	+	+	+	+
	B						+		
La Crescent	K							+	+
	Sand	-	-						
Marquette	B					+	+		
	Sand	-	-						

Table 4. Directions of correlation for soil and leaf tissue variables significantly correlated with juice TA.

Cultivar	Predictor	Soil		Bloom		Bloom + 30		Veraison	
		0-8"	8-16"	Blade	Pet.	Blade	Pet.	Blade	Pet.
Frontenac	N			-					
	B			-	-			-	-
	Cu			+					
La Crescent	N				+	+	+		
	S					+	+		
	Cu					+	+		
	Ca						-		
	Sand	+	+						
Marquette	N	+	+	+	+	+	+	+	+
	S			+		+			
	B						-	-	
	Fe			-	-			-	-
	Cu	-	-			+	+	+	+
	Ca	-				-	-	-	-
	Sand	+	+						

What the results mean:

While these results are preliminary, the following observations are noteworthy:

- High N concentrations in leaf tissues imply high YAN concentrations in juice.
- For Frontenac and La Crescent, juice pH increased with tissue K concentration.
- In La Crescent and Marquette, coarse-textured soils promoted lower pH and higher TA in juice.
- Juice TA often increased with tissue Cu concentration.
- In Marquette (and, less so, La Crescent) juice TA decreased as tissue Ca concentration increased.