Sampling Guide for Nutrient Assessment of Irrigated Vineyards in the Inland Pacific Northwest

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Sampling Guide for Nutrient Assessment of Irrigated Vineyards in the Inland Pacific Northwest

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Introduction

Nutrient analysis of various tissues in perennial fruit crops such as wine grapes is an important way to determine the need for fertilizer that is critical for quality production. Under-fertilization can adversely affect grape production sustainability and lead to vine decline and ultimately death. Over-fertilization can result in an overly vigorous canopy, increased disease pressure, and poor fruit quality. Because soil samples are of limited use when accessing the annual nutrient needs of an established vineyard, we recommend collecting whole leaf (blade plus petiole) samples annually in conjunction with occasional (every 3–5 years) soil samples to develop the most effective fertilizer plan for wine grapes (Figure 1).

Pacific Northwest vineyards are primarily either drip or sprinkler-irrigated, which can confound soil sample results. Regulated deficit irrigation stresses the whole vine and is commonly practiced in the Pacific Northwest to improve grape quality (Evans et al. 1993). Drip irrigation systems, particularly when regulated deficit irrigation is practiced, pose challenges in terms of where to collect and how to interpret soil samples because of the variability in moisture, root activity, and nutrient concentrations that result from emitters. Consequently, nutrient assessments of drip-irrigated vineyards need to rely on tissue samples more than sprinkler-irrigated vineyards. (Refer to Dow et al. [1983] for guidelines on soil test values for irrigated grapes.)

Field fertilizer trials combined with our survey work conducted since 1999 in irrigated inland Pacific Northwest vineyards indicate that whole grape leaf nutrient concentrations at veraison are stable for an extended period of time and therefore easier to interpret than leaf samples taken at bloom where changes occur almost daily. Vine leaves collected from a large cross section of the region's vineyards were divided into blades and petioles and analyzed separately (Davenport et al. 2011).

Although petioles are used for grape plant tissue testing and making fertilizer recommendations in the northeastern United States and California, our research shows that petiole analysis results over-recommend N fertilizer in the irrigated Pacific Northwest. For example, less than 10% of wine grape petioles were in the "adequate" range for nitrate nitrogen (NO_3-N) at both bloom and veraison (when grape ripening begins, with sampling between 30% and 50% veraison) compared to California standards for grapes (Fig. 2; Christensen 1969, 1984), which is the standard currently used by analytical labs in the Pacific Northwest. Thus, petiole samples at bloom for wine grapes are likely to indicate that increased N is needed when it is not, thus leading to potential over-fertilization and an overly vigorous

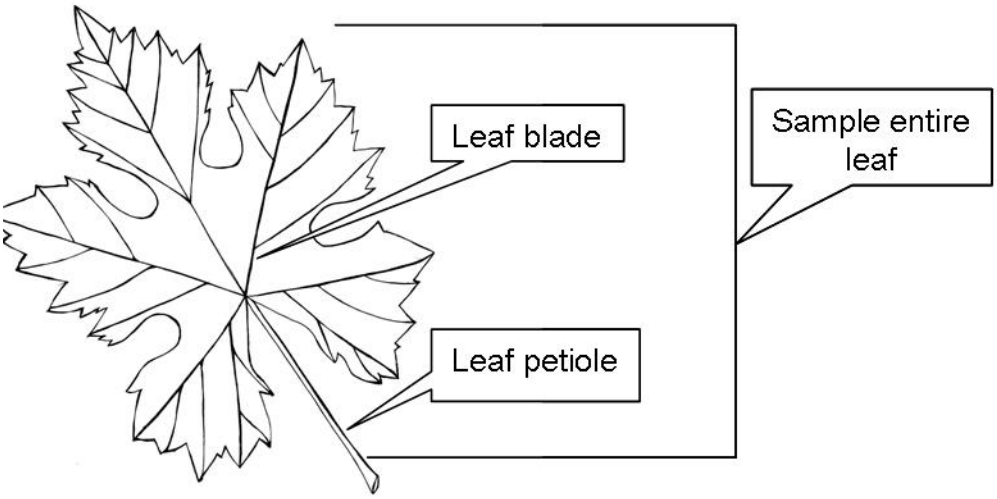

Figure 1. Whole grape leaf needed for tissue nutrient sampling.

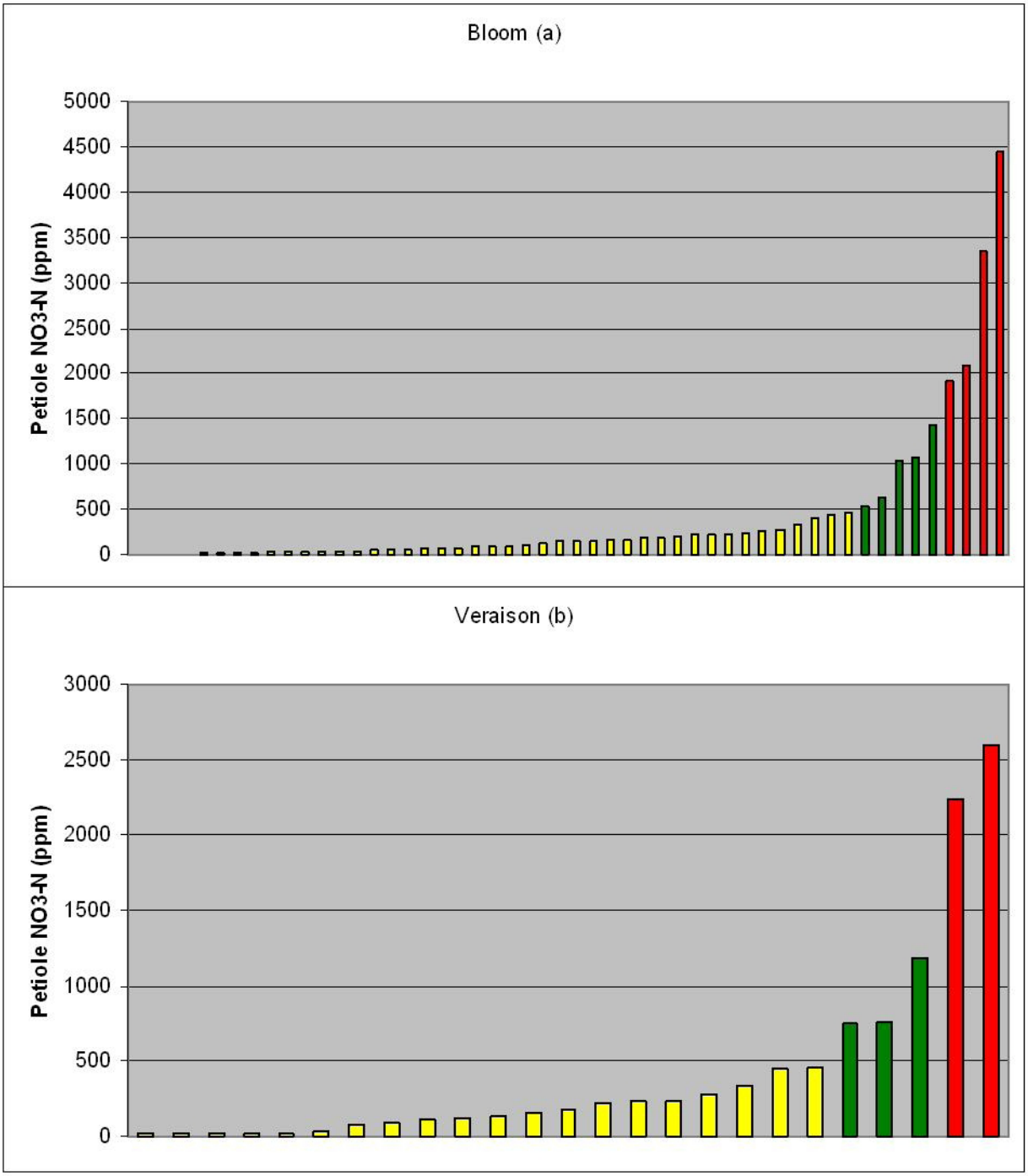

Figure 2. Grape petiole nitrate nitrogen (NO_3-N) concentrations in WA, ID, and OR irrigated wine grapes at a) bloom and b) veraison. Bars are coded in yellow, green, and red for tissue ranges below adequate, adequate, and above adequate according to Christensen (1969, 1984).

canopy and reduction in fruit quality. These regional differences are likely due to the arid climate in the irrigated inland Pacific Northwest which yields 6–12 inches of precipitation a year and leads to very dry soil conditions throughout the growing season, as shown by Davenport et al. (2008).

Vineyard Tissue Nutrient Sampling

The guidelines here cover whole leaf samples taken at bloom and veraison because both yield meaningful results when used together (Table 1).

Table 1. When, where, and how to extract grape leaves for nutrient analysis.

Sampling Time	Leaf Position (Figure 3)	Method
Bloom (30–60%)	Leaf opposite basal cluster of a primary shoot	• 50–100 leaves (target of 25 leaves per acre) • Random collection from both canopy and sides
Veraison (40–60%)	Fifth leaf (If the vineyard has been hedged, use untrimmed canes.)	

Unlike with grape petioles, the time of day does not influence whole leaf or leaf blade tissue nutrient concentrations, so samples can be collected at your convenience. Take leaf samples in a random pattern in the vineyard using predetermined sampling points such as row or vine number. Using designated points helps prevent sampler biases during collection and eliminates some field variation in the results. Another approach is to use a GPS with pre-set waypoints to direct sampling locations.

Ensure that both sides of the canopy are evenly sampled. Skip at least the first 3 vines in any row being sampled when at a row edge. Include an entire vineyard block and a minimum of 50 leaves for blocks 2 acres or less and 25 leaves per acre for all larger blocks. Focus on vines that adequately represent the block. Reserve vines that are overly vigorous or lack vigor for a separate analysis. Similarly, sample cultivars separately if there is more than one in a block.

Although bloom leaf nutrient levels are less temporally stable than those from leaf samples collected and analyzed at veraison, bloom tissue sampling can be used to confirm any nutrient values outside the range of the previous year's veraison results. Bloom tissue samples should be collected between 30% and 60% bloom. Whole leaf samples should be collected between 40% and 60% veraison. Choose the youngest, most fully expanded leaf from shoots with bunches of grapes.

Once a sample has been collected, place it in a paper bag of suitable size and label it with the date your sample was collected, the block it was collected from, and the grape variety. Send your sample to a testing lab in your growing area for analysis, preferably one familiar with grape production practices (see Washington State Pest Management Resource Service 2009).

Interpretation

When the laboratory sends your leaf analysis, it may or may not come with an interpretation. Regardless, the results should be compared to Table 2. When a nutrient is outside of the "normal" range, a decision has to be made:

- Do I ignore it and wait to see if it is an anomaly?
- Do I change my fertilization program to try and correct it?

Due to the perennial nature of grape crops, adjustments should be modest and vine vigor and crop load need to be taken into consideration. For example, if a leaf sample analysis from a veraison sample is low for N

Figure 3. Grape vine shoot at bloom (left) and veraison (right) with appropriate leaf for sampling circled. (Please note that the three smallest leaves appear flat in this illustration, whereas on the actual shoot they would be curled in towards the shoot tip.)

Table 2. Critical ranges for whole grape leaf samples used for tissue analysis[*].*

Nutrient[**]	Bloom	Veraison	
	Juice and Wine grapes	Juice grapes	Wine grapes
N (nitrogen %)	2.50–3.50	2.10–3.00	2.25–3.25
P (phosphorus %)	0.15–0.45	0.15–0.45	0.12–0.30
K (potassium %)	0.75–1.50	0.50–1.00	
Ca (calcium %)	1.00–3.00	1.00–3.00	
Mg (manganese %)	0.25–0.50	0.25–0.50	
B (boron ppm)	30–100	30–100	
Zn (zinc ppm)	25–100	15–50	
Fe (iron ppm)[***]	> 75	> 75	
Cu (copper ppm)	6–20	6–20	
Mn (manganese ppm)	30–100	30–100	

[*]Excessive concentration of plant nutrients, particularly micronutrients, can be toxic to vines. If tissue nutrient concentrations are significantly higher or lower than these values, contact an Extension specialist to help you review your results.
[**]Molybdenum (Mo) is rarely found to be deficient or excessive in grape, and nickel (Ni) or cobalt (Co) are not established as truly essential in grape.
[***]Iron (Fe) concentrations can exceed 75 ppm without being problematic for plants; no upper limit has been found for this nutrient in inland Pacific Northwest grapes.

but the vine is vigorous and the crop load moderate to low, it is likely that the below-normal leaf N value is a result of vigorous canopy growth. Thus, N fertilizer applications should be reduced and a tissue sample collected at bloom the following year to monitor plant nutritional status.

Another consideration when adding or reducing fertilizers is that some nutrient concentrations are difficult to change with a single fertilizer adjustment. It may take several years of corrective action for some nutrients to affect desired results. Other nutrient responses can be immediate. For example, Figure 4 shows how one boron application can last for several years, while Figure 5 demonstrates that tissue manganese levels are more likely linked to soil pH than fertilization practices.

Monitoring

Annual sampling at the same growth stage should be graphed to determine the effectiveness of fertilizer adjustments and identify long-term trends. Such tracking will help you keep from overreacting to any individual leaf analysis. Variability between years can be caused by climatic differences, vine growth, and fruit load. Records of growth and yield in conjunction with leaf analysis are better for making long-term nutrient management decisions than leaf tissue analysis alone.

Conclusion

When leaf nutrient levels are outside the critical range (Table 2), it often means that an adjustment to your fertilizer management program is needed. In general, a low concentration of a nutrient means that you should increase your fertilizer additions of this nutrient, and a high concentration means that you should reduce them. However, make certain you use a tissue test in conjunction with the physical appearance of your vines. If the vines are very stunted and tissue nutrient levels are high, it could be due to insufficient water at a critical growth period. If the vines are overly vigorous and the tissue levels are low, it likely means that an excess of one nutrient (usually N) has spurred growth and the concentrations of other nutrients may be "diluted" across the entire canopy. Regardless, when adjusting your fertilizer management plans, only make small changes over time. With perennial fruit crops, over-adjustment can lead to negative long-term consequences (e.g., excessive canopy growth with excessive N) which may take years to correct.

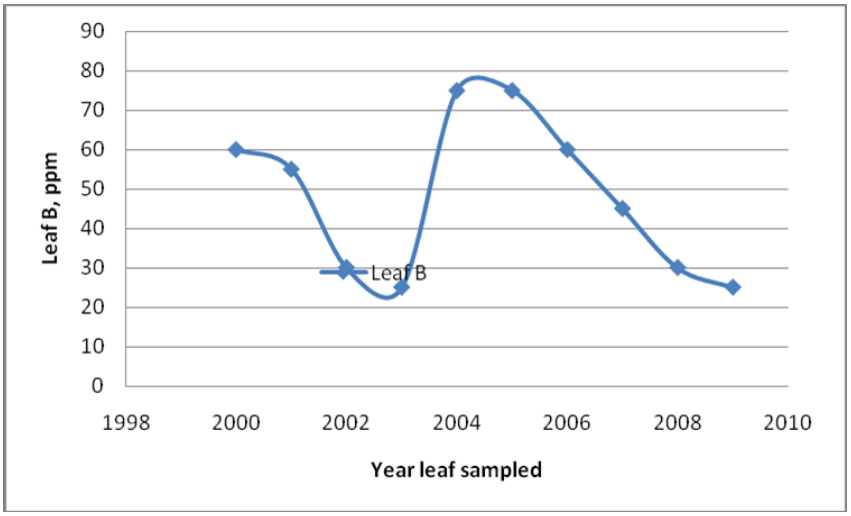

Figure 4. Leaf boron levels in an annual monitoring program. The vineyard was fertilized with boron in 2003 and 2008.

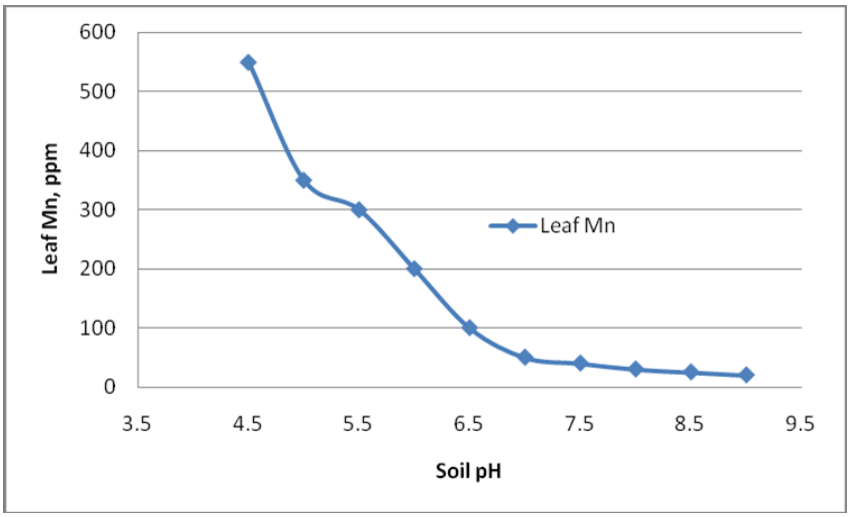

Figure 5. Theoretical leaf manganese levels influenced by soil pH irrespective of soil Mn levels.

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