Vine Nutrition

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&

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Iowa State University

The Northern Grapes Project Webinar Series
March 12, 2013
General Topics

- Soil testing and basic nutrient management for vineyards **before** planting
- Petiole analysis - how and when to use it
- Interpretations – nutrient management based on petiole analysis
Determining the Need for Fertilizer

• Vine vigor
• Visual symptoms
  – Yield and quality already affected
• Soil testing
• Petiole analysis
# Essential Plant Nutrients

14 nutrients derived from the soil and/or fertilizer

<table>
<thead>
<tr>
<th>Macronutrients</th>
<th>Micronutrients</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary</strong></td>
<td>Zn – Zinc</td>
</tr>
<tr>
<td>N – Nitrogen</td>
<td>B – Boron</td>
</tr>
<tr>
<td>P – Phosphorus</td>
<td>Fe – Iron</td>
</tr>
<tr>
<td>K – Potassium</td>
<td>Mn – Manganese</td>
</tr>
<tr>
<td><strong>Secondary</strong></td>
<td>Cu – Copper</td>
</tr>
<tr>
<td>S – Sulfur</td>
<td>Mo – Molybdenum</td>
</tr>
<tr>
<td>Mg – Magnesium</td>
<td>Ni – Nickel</td>
</tr>
<tr>
<td>Ca – Calcium</td>
<td>Cl – Chlorine</td>
</tr>
</tbody>
</table>

[USDA and NIFA logos]
Soil vs. Petiole Analysis

**Soil**

**Pre-plant:**
- Adjust pH, bring P & K to optimum.
- Not an accurate test for many nutrients.

**2nd year & beyond:**
- Monitor pH.
- Basis for K rate if petiole analysis indicates a short supply.

**Petiole**

**1st year:**
- Not accurate
- Reflects growing conditions in the nursery.

**2nd year & beyond:**
- Accurate measure of most essential nutrients.
- Sampling time is important.
- Annual analysis allows for fine-tuning of the fertilizer program, & correcting shortages before they become a problem.
Availability of Essential Mineral Nutrients

- Composition of the soil parent material
- Soil pH
- Soil Texture
  - Soil weathering / leaching
  - Internal drainage characteristics of the soil
- Soil organic matter content
- Competition between nutrients for uptake by the plant
- Previous fertilizer history
Soil Testing

• Soil test before planting

• Test every 4 to 5 years after planting…
  – or when a problem is suspected

• Supplements petiole testing in established vineyards

Don’t Guess ..??..??
..??..??.
...

Soil Test !!!!!
Soil Testing

• pH, P, and K
  – Soil tests very well calibrated for adjusting these properties

• Ca, Mg, Zn, B, S
  – Soil tests also useful for detecting deficiencies (or excesses) of these nutrients

• Organic Matter
  – Used to adjust N rates
Soil Sampling

• Collect representative samples
  – Soil tests are only as accurate as the samples you submit
  – Sampling is often the weakest link in a soil testing program
Sampling Guidelines

• Divide fields into uniform areas
  – Soil type, slope, crop history, previous lime, fertilizer, manure applications
  – < 20 acres for a single sample
  – < 2-3 acres on uneven land

• Collect 15-20 soil cores per sample
  – Random, zig-zag pattern across the field
Soil Sampling

- Sample to a depth of 0 to 8”
- A second sample, 8 to 16” can also be submitted
- Thoroughly mix sub-samples in a clean, plastic container
  - Submit about a pint of composite sample to testing lab
- If soil is wet
  - Air dry
  - Oven dry at <97° F
**FARM/FIELD CROPS and COMMERCIAL HORTICULTURAL CROPS**

SOIL SAMPLE INFORMATION SHEET

**LOCATION REFERENCE**

Name: Pine Hill Vineyard

Address: 123 Needle Lane

City, State, Zip: Big Lake, MN 55309

Check for $ 48 enclosed

**MAIL REPORT TO:**

Name: __________________________

Address: _______________________

City, State, Zip: _______________________

**Sample Identification**

<table>
<thead>
<tr>
<th>Laboratory Number</th>
<th>Field or Sample No. or Letter</th>
<th>Check if Injured</th>
<th>Crop Grown Before Last</th>
<th>Crop Grown Last</th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>57</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>57</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

**Proposed Crops**

<table>
<thead>
<tr>
<th>Crop Grown</th>
<th>Crop History</th>
<th>Proposed Crops</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Check Tests Requested**

<table>
<thead>
<tr>
<th>Nitrate</th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>$500</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Recommendations available for these crops**

**LEGUMES**

- Alfalfa
- Red Clover

**MISCELLANEOUS**

- Hairy Vetch
- White Clover

**CORN**

- Maize
- Sweet Corn

**VEGETABLES**

- Carrots
- Lettuce
- Cabbage

**VEGETABLES (continued)**

- Carrots
- Lettuce
- Cabbage

**FRUITS**

- Apples
- Blueberries
- Grapes

**NURSERY - FIELD STOCK**

- Suggested from Regular Sowable Salts, Nitrates. For sampling instructions, please see nursery farm M-9505-60.
# SOIL TEST REPORT

**FARMER DOE**  
**ROUTE 1**  
**ANYWHERE MN 55000**

**Client Copy**  
Department of Soil, Water, and Climate  
Minnesota Extension Service  
Agricultural Experiment Station

**Page 1**  
**Report No. 9**  
**Laboratory No. 146999**  
**Date Received 03/08/2005**  
**Date Reported 03/20/2005**

## INTERPRETATION OF SOIL TEST RESULTS

<table>
<thead>
<tr>
<th>Soil Texture Code:</th>
<th>P</th>
<th>K</th>
<th>Z</th>
<th>Very Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>C (coarse):</td>
<td>P</td>
<td>K</td>
<td>Z</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>P</td>
<td>K</td>
<td>Z</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>P</td>
<td>K</td>
<td>Z</td>
<td></td>
</tr>
<tr>
<td>M (medium):</td>
<td>P</td>
<td>K</td>
<td>Z</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>P</td>
<td>K</td>
<td>Z</td>
<td></td>
</tr>
<tr>
<td>F (fine):</td>
<td>P</td>
<td>K</td>
<td>Z</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>P</td>
<td>K</td>
<td>Z</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>P</td>
<td>K</td>
<td>Z</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>P</td>
<td>K</td>
<td>Z</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>P</td>
<td>K</td>
<td>Z</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>P</td>
<td>K</td>
<td>Z</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>P</td>
<td>K</td>
<td>Z</td>
<td></td>
</tr>
</tbody>
</table>

## SOIL TEST RESULTS

<table>
<thead>
<tr>
<th>Sample/Field Number</th>
<th>Estimated Soil Texture</th>
<th>Organic Matter %</th>
<th>Soluble Salts, mmhos/cm</th>
<th>pH</th>
<th>Buffer Index</th>
<th>Nitrate NO3-N ppm</th>
<th>Olsen Phosphorus ppm P</th>
<th>Bray's Phosphorus ppm P</th>
<th>Potassium ppm K</th>
<th>Sulfur SO4-S ppm</th>
<th>Zinc ppm</th>
<th>Iron ppm</th>
<th>Manganese ppm</th>
<th>Copper ppm</th>
<th>Boron ppm</th>
<th>Calcium ppm</th>
<th>Magnesium ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
<td>3.0</td>
<td>5.5</td>
<td>6.5</td>
<td>30</td>
<td>85</td>
<td>0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## RECOMMENDATIONS

**Crop Before Last: Grapes; Last Crop: Grapes**

### Crop and Yield Goal

<table>
<thead>
<tr>
<th>Crop and Yield Goal</th>
<th>Method</th>
<th>Lime #ENP/A</th>
<th>N Ib/A</th>
<th>P2O5 Ib/A</th>
<th>K2O Ib/A</th>
<th>S Ib/A</th>
<th>Zn Ib/A</th>
<th>Fe Ib/A</th>
<th>Mn Ib/A</th>
<th>Cu Ib/A</th>
<th>B Ib/A</th>
<th>Ca Ib/A</th>
<th>Mg Ib/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grapes</td>
<td>Broadcast</td>
<td>2500</td>
<td>30</td>
<td>50</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Row/Drill</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Comments: 3,18,24,50,53,64**

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**USDA**  
**NIFA**

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**NORTHERN GRAPES PROJECT**
# Pre-Plant Soil Testing Sufficiency Ranges

<table>
<thead>
<tr>
<th>Test</th>
<th><strong>OSU</strong>*</th>
<th><strong>ISU</strong></th>
<th><strong>U of MN</strong></th>
<th><strong>NRAES-145</strong>**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil pH</td>
<td>5.5 - 6.5</td>
<td>6.0 - 6.5</td>
<td>6.0 to 7.0</td>
<td>**</td>
</tr>
<tr>
<td>Phosphorus (P)</td>
<td>20 - 50 ppm</td>
<td>&gt; 30 ppm</td>
<td>&gt; 25 ppm</td>
<td>20 - 50 ppm</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>125 - 150 ppm</td>
<td>&gt; 150 ppm</td>
<td>&gt; 160 ppm</td>
<td>75 - 100 ppm</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>100 - 125 ppm</td>
<td>100 - 125 ppm</td>
<td>~ 100 ppm</td>
<td>100 - 250 ppm</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>4 - 5 ppm</td>
<td>3 - 4 ppm</td>
<td>&gt; 1 ppm</td>
<td>2 ppm</td>
</tr>
<tr>
<td>Organic matter</td>
<td>2 - 3 %</td>
<td>2 - 3 (4) %</td>
<td>- -</td>
<td>3 - 5 %</td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>- -</td>
<td>- -</td>
<td>&gt; 600 ppm</td>
<td>500 - 2000 ppm</td>
</tr>
<tr>
<td>Boron (B)</td>
<td>.75 - 1.0 ppm</td>
<td>- -</td>
<td>&gt; 1 ppm</td>
<td>0.2 - 2.0 ppm</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>- -</td>
<td>- -</td>
<td>&gt; 6 ppm</td>
<td>20 ppm</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>- -</td>
<td>- -</td>
<td>&gt; 0.2 ppm</td>
<td>0.5 ppm</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
<td>20 ppm</td>
</tr>
<tr>
<td>Sulfur (S)</td>
<td>- -</td>
<td>&gt; 7 ppm</td>
<td>&gt; 7 ppm</td>
<td>- -</td>
</tr>
</tbody>
</table>

  & Midwest Grape Production Guide (OSU Ext Bull. 919)


Soil pH: **
- 5.0 *V. Labrusca*
- 6.0 hybrids
- 6.5 *V. vinifera*
Soil pH

- Ideal pH range for grapes: 6.0 to 7.0

- Low pH easily modified before planting; high pH is often a problem – particularly with high carbonates

- Difficult to change after planting
Soil pH

• Microbial activity

• Nutrient availability

Mineral soils
Modifying Soil pH

• Lime recommended if pH <6.0
  – Rate based on buffer pH

• Lime also adds Ca and Mg
  – Dolomitic lime contains Mg

• Incorporate lime 8 to 10 inches
  – Apply one year before planting

• Acidification of high pH soils is difficult and can be expensive
Iron Chlorosis
Lowering Soil pH Before Planting a Vineyard

• **Soil pH between 6.5 to 7.0**
  • Do nothing? (labrusca types vs interspecific hybrids)
  • Apply sulfur to lower the pH to 6.5 or 6.0 or
  • Take other measures to lower the soil pH
    • Acidifying forms of N fertilizer

• **Soil pH 7.0 to 7.5**
  • Apply sulfur to lower the pH to 6.5 or 6.0 and
  • Take other measures to lower the soil pH
    • Acidifying forms of N fertilizer

• **Soil pH above 7.5**
  • Apply sulfur to lower the pH to 6.5 or 6.0 if free of carbonates
  • If carbonates present - Not recommended due to cost
    • Use soil applied iron chelates if chlorosis is a problem

<table>
<thead>
<tr>
<th>N Source (1 lb)</th>
<th>neutralized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonium sulfate</td>
<td>5.4</td>
</tr>
<tr>
<td>Urea</td>
<td>1.8</td>
</tr>
<tr>
<td>Manure, compost, etc</td>
<td>variable</td>
</tr>
</tbody>
</table>

**Acidifying sources:**
- Elemental S (1x)
- Aluminum sulfate (6x)
- Ferrous sulfate (8x)
Sulfur Required to Lower the Soil pH to 6.5

For a Carbonate-free Soil

Clay soil, High OM

Sandy soil, Low OM
Fizz Test for Calcareous Soils*

Applying a few drops of household vinegar to a soil sample and listen and observe for bubbling.

<table>
<thead>
<tr>
<th>Fizz test result</th>
<th>Estimated carbonates present (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>0</td>
</tr>
<tr>
<td>Heard (barely audible)</td>
<td>0 – 1</td>
</tr>
<tr>
<td>Slight (few bubbles)</td>
<td>1 – 2</td>
</tr>
<tr>
<td>Moderate (several bubbles)</td>
<td>2 – 3</td>
</tr>
<tr>
<td>Vigorous (many bubbles)</td>
<td>&gt; 3</td>
</tr>
</tbody>
</table>

Fertilizer Additions

(Before Planting)

• Base P and K needs on a soil test
  – Also Mg, Zn, and B

• Very difficult to correct P and K deficiencies after vines are planted

• Broadcast and incorporate to a depth of 8 to 10 inches
## Preplant Phosphorus Recommendations

<table>
<thead>
<tr>
<th>Relative Soil Test P</th>
<th>Amount of Phosphate to Apply, lb P$_2$O$_5$/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Low</td>
<td>150</td>
</tr>
<tr>
<td>Low</td>
<td>125</td>
</tr>
<tr>
<td>Medium</td>
<td>100</td>
</tr>
<tr>
<td>High</td>
<td>75</td>
</tr>
<tr>
<td>Very High</td>
<td>25</td>
</tr>
</tbody>
</table>
## Preplant Potassium Recommendations

<table>
<thead>
<tr>
<th>Relative Soil Test K</th>
<th>Amount of Potash to Apply, lb K₂O/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Low</td>
<td>250</td>
</tr>
<tr>
<td>Low</td>
<td>200</td>
</tr>
<tr>
<td>Medium</td>
<td>150</td>
</tr>
<tr>
<td>High</td>
<td>100</td>
</tr>
<tr>
<td>Very High</td>
<td>0</td>
</tr>
</tbody>
</table>
# Potassium Stratification

<table>
<thead>
<tr>
<th>Soil Depth (inches)</th>
<th>K Level (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-3</td>
<td>250</td>
</tr>
<tr>
<td>3-8</td>
<td>95</td>
</tr>
</tbody>
</table>
Preplant Magnesium Recommendations

<table>
<thead>
<tr>
<th>Relative Soil Test Mg</th>
<th>Amount of Magnesium to Apply, lb Mg/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>100</td>
</tr>
<tr>
<td>Medium</td>
<td>50</td>
</tr>
<tr>
<td>High</td>
<td>0</td>
</tr>
</tbody>
</table>
Soil Organic Matter Content:

Nitrogen Released from Organic Matter

Need to adjust N fertilization practices based on the organic matter content of the soil.
N Fertilizer Recommendations
(Non-Bearing Vines 1st or 2nd year)

• General N recommendations:
  – 0-20 lb N/ac – high OM soils (>4.6%)
  – 20-30 lb N/ac – medium OM soils (3.1-4.5%)
  – 30-50 lb N/ac – low OM soils (<3.1%)

• Account for N from manure, compost, legume cover crops

• Apply inorganic N sources after planting
  – Split applications on sandy soils
Tissue (petiole) Analysis

- Most reliable method of determining nutrient needs of established vines (start first year of fruiting or earlier)
- Submit samples on a yearly basis
- Compare to established sufficiency/deficiency ranges
- Some experience needed for interpretation
  - Adjust for site-specific factors
Critical Nutrient Level & Sufficiency Range

The diagram illustrates the relationship between the percent maximum growth and the nitrogen (N) content as a percentage of the plant dry weight. The x-axis represents N as a percentage of the plant dry weight, while the y-axis shows the percent maximum growth. The graph delineates different stages:

- **Deficient**: The growth is significantly reduced when the N content is very low.
- **Adequate**: The growth is optimal within this range.
- **Luxury**: Growth remains high but starts to decline when the N content is excessively high.
- **Toxic**: Excessive N results in toxicity and decline in growth.

The **Sufficiency Range** is the middle ground where the growth is neither deficient nor excessive.
Tissue Analysis
Factors Affecting Nutrient Levels

• Crop load
• Cultivar/rootstock
• Cultural practices
• Insect and disease incidence
• Growing conditions (weather)
Recommended Times to Sample

• **Full bloom**
  – Mid to late June

• **Early veraison**
  – Mid-July to mid-August

• The mid-July to mid-August sampling date generally provides more accurate assessments of vine nutrition.
# Normal Nutrient Ranges for Grapes
Based on Petiole Analysis

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>At Bloom (for American hybrids) *</th>
<th>Mid-July to Mid-Aug.**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen (N)</td>
<td>1.6 to 2.8 %</td>
<td>0.9 to 1.3 %</td>
</tr>
<tr>
<td>Phosphorous (P)</td>
<td>0.20 to 0.60 % ?</td>
<td>0.16 to 0.29 %</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>? 1.50 to 5.00 % ?</td>
<td>1.50 to 2.50 % ?</td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>0.40 to 2.50 % ?</td>
<td>1.20 to 1.80 %</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>0.13 to 0.40 %</td>
<td>0.26 to 0.45 %</td>
</tr>
<tr>
<td>Sulfur (S)</td>
<td>No data (&gt;0.1%)</td>
<td>No data (&gt;0.1%)</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>18 to 100 ppm</td>
<td>31 to 150 ppm</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>40 to 180 ppm</td>
<td>31 to 50 (200) ppm</td>
</tr>
<tr>
<td>Boron (B)</td>
<td>25 to 50 ppm</td>
<td>25 to 50 ppm</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>5 to 10 ppm</td>
<td>5 to 15 ppm</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>20 to 100 ppm</td>
<td>30 to 50 ppm</td>
</tr>
<tr>
<td>Molybdenum (Mo)</td>
<td>0.2 to 0.4 ppm</td>
<td>0.3 to 1.5 ppm</td>
</tr>
</tbody>
</table>


## Normal Nutrient Ranges for Grapes
### Based on Petiole Analysis

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>NRAES 145*</th>
<th>At Bloom</th>
<th>70-100 Days After Bloom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen (N)</td>
<td>1.2 to 2.2 %</td>
<td></td>
<td>0.8 to 1.2 %</td>
</tr>
<tr>
<td>Phosphorous (P)</td>
<td>0.17 to 0.30 %</td>
<td></td>
<td>0.14 to 0.30 %</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>1.5 to 2.5 %</td>
<td></td>
<td>1.20 to 2.00 %</td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>1.0 to 3.0 % ?</td>
<td></td>
<td>1.0 to 2.0 %</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>0.3 to 0.5 %</td>
<td></td>
<td>0.35 to 0.75 % ?</td>
</tr>
<tr>
<td>Sulfur (S)</td>
<td>No data</td>
<td></td>
<td>No data</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>25 to 1,000 ppm ?</td>
<td></td>
<td>25 to 1,500 ppm ?</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>20 ppm</td>
<td></td>
<td>30 to 100 ppm</td>
</tr>
<tr>
<td>Boron (B)</td>
<td>25 to 50 ppm</td>
<td></td>
<td>25 to 50 ppm</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>5 to 15 ppm</td>
<td></td>
<td>5 to 15 ppm</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>30 to 60 ppm</td>
<td></td>
<td>30 to 60 ppm</td>
</tr>
<tr>
<td>Molybdenum (Mo)</td>
<td>.5 ppm</td>
<td></td>
<td>.5 ppm</td>
</tr>
</tbody>
</table>

Collecting a Petiole Sample

• Collect at the same time each year!
• Do not mix cultivars into one sample!
• If a planting is located on more than one soil type, collect separate samples for each soil type.
• If a planting received different fertilizer applications, separate samples should be collected.
• A sample should consist of 100 petioles, or 150-200 for cultivars with small petioles.
Collecting a Petiole Sample

- Collect petioles randomly from representative vines in the designated sampling area.
- Collect petioles from fruit bearing shoots.
  - **Full bloom:** Petiole opposite first cluster.
  - **Mid-summer:** Most recently fully expanded leaf.
- Collect no more than one petiole per shoot.
- Avoid sampling from abnormal, weak or unhealthy vines unless they will be sampled and submitted separately.
- Choose leaves free from insect, disease or mechanical injury.
Full Bloom vs Mid-Summer

Opposite of the first cluster. Most recently fully expanded leaf.

Figures adapted from: Grapevine Nutrition and Fertilization in the San Joaquin Valley. 1978 Univ. of California publ. 4087
Cleaning the Sample?

Best to allow nature to take care of by collecting after a heavy rain.

If the samples are dirty, or if foliar nutrients were recently applied:

- Rinse the sample in a mild detergent solution followed by 2 distilled or de-ionized water rinses.
- Wash while the leaves / petioles are still fresh.
- After rinsing, pat sample dry with clean paper towels.
- The whole procedure should be completed within a minute.
Preparing a Petiole Sample

• Remove the leaf blades.
  – DO NOT use a metal utensil.

• Place the petioles in an unused paper bag, or bag provided by the Lab.

• On the bag, Identify the sample:
  – Your name & address
  – Crop & cultivar
  – Field / sample number

• Map & identify each sampling area for your future reference.

• Submit the sample.
Trouble-shooting

• If you are trying to diagnose specific symptoms, send in two samples of 75 to 100 petioles:
  – One set from vines showing the symptoms.
  – Another set from vines not showing symptoms.

• This can be done at any time of the growing season.
Interpreting a Petiole Analysis

Submit the sample to a Lab for analysis

- Most Labs will provide an interpretation of the results.
  - Make sure the Lab used the sufficiency ranges for the time you sampled.
  - If you have doubts, send the results to your Extension Specialist to look over the interpretation.
Interpreting a Petiole Analysis

Petiole analysis is not an exact science.

• Can tell if you need to apply more or less of a nutrient.
• The more information available, the better.
• Annual testing allows you to fine-tune your fertilizer program.

To assist, additional information suggested:

– The vigor & health of the vines.
– Soil type, texture and internal drainage classification.
– Previous soil test results.
– Production potential for current and previous season.
– Current and past fertilizer program.
– Spray materials applied prior to collecting the sample.
  • Micro-nutrient containing fungicides
  • Foliar nutrient sprays
Normal Nutrient Ranges for Grape Petioles
Mid-July to Mid-August (early veraison) Sampling

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Deficient</th>
<th>Below Normal</th>
<th>Normal</th>
<th>Above Normal</th>
<th>Excessive</th>
</tr>
</thead>
<tbody>
<tr>
<td>N (%)</td>
<td>0.30 - 0.70</td>
<td>0.70 - 0.90</td>
<td>0.90 - 1.30</td>
<td>1.40 - 2.00</td>
<td>&gt;2.10</td>
</tr>
<tr>
<td>P (%)</td>
<td>&gt;0.12</td>
<td>0.13 - 0.15</td>
<td>0.16 - 0.29</td>
<td>0.30 - 0.50</td>
<td>&gt;0.51</td>
</tr>
<tr>
<td>K (%)</td>
<td>0.50 - 1.00</td>
<td>1.10 - 1.40</td>
<td>1.50 - 2.50</td>
<td>2.60 - 4.50</td>
<td>&gt;4.60</td>
</tr>
<tr>
<td>Ca (%)</td>
<td>0.50 - 0.80</td>
<td>0.80 - 1.10</td>
<td>1.20 - 1.80</td>
<td>1.90 - 3.00</td>
<td>&gt;3.10</td>
</tr>
<tr>
<td>Mg (%)</td>
<td>&gt;0.14</td>
<td>0.15 - 0.25</td>
<td>0.26 - 0.45</td>
<td>0.46 - 0.80</td>
<td>&gt;0.81</td>
</tr>
<tr>
<td>S (%)</td>
<td>No data</td>
<td>No data</td>
<td>&gt;0.10</td>
<td>No data</td>
<td>No data</td>
</tr>
<tr>
<td>Mn (ppm)</td>
<td>10 - 24</td>
<td>25 - 30</td>
<td>31 - 150</td>
<td>150 - 700</td>
<td>&gt;700</td>
</tr>
<tr>
<td>Fe (ppm)</td>
<td>10 - 20</td>
<td>21 - 30</td>
<td>31 - 100</td>
<td>101 - 200</td>
<td>&gt;200</td>
</tr>
<tr>
<td>B (ppm)</td>
<td>14 - 19</td>
<td>20 - 25</td>
<td>25 - 50</td>
<td>51 - 100</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Cu (ppm)</td>
<td>0 - 2</td>
<td>3 - 4</td>
<td>5 - 15</td>
<td>15 - 30</td>
<td>&gt;31</td>
</tr>
<tr>
<td>Zn (ppm)</td>
<td>0 - 15</td>
<td>16 - 29</td>
<td>30 - 50</td>
<td>51 - 80</td>
<td>&gt;80</td>
</tr>
<tr>
<td>Mo (ppm)</td>
<td>0.3 - 1.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What if petiole analysis shows a need for a nutrient?

How much should be applied?
When should it be applied?
How often should it be applied?
How should it be applied? (soil vs foliar)

Factors that need to be considered:

- Mobility of the nutrient.
- Soil texture / cation exchange capacity.
- Soil pH as it affects nutrient availability/solubility.
- Soil organic matter content.
Nitrogen (N)
(OSU: 0.9 – 1.3 %)
(NRAES: 0.8 – 1.2% )

Nitrogen Fertilizer Recommendations*
Based on Petiole Analysis (mid-July to mid-August)

<table>
<thead>
<tr>
<th>Petiole N (0.9 – 1.3%)</th>
<th>N Fertilizer to Apply (lbs actual N / A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 1.5</td>
<td>0</td>
</tr>
<tr>
<td>1.3 – 1.5</td>
<td>20</td>
</tr>
<tr>
<td>0.9 – 1.3</td>
<td>30</td>
</tr>
<tr>
<td>&lt; 0.9</td>
<td>40 - 50</td>
</tr>
</tbody>
</table>

* Dr. Carl Rosen, Univ. of Minnesota

Other concerns: petiole K & Zn content
What form of nitrogen should be used?

**Nitrogen Fertilizers:**

- **Nitrate forms - NO$_3$**:
  - Raise the soil pH.
  - Readily available to plants.
  - Very subject to leaching.

- **Urea - CO(NH$_2$)$_2$**:
  - Little change in the soil pH.
  - Taken up as urea, or converted to NH$_4$-N then to NO$_3$-N.
  - Will volatilize under warming temperatures when surface applied.
  - Will volatilize when surface applied on higher pH soils.

- **Ammonium forms – NH$_4$**:
  - Lower the soil pH,
  - Slowly available, must convert to NO$_3$-N to be taken up by vines.
  - Requires soil temperatures above 50$^\circ$ F to convert to NO$_3$-N.
  - Can be tied up on soil particles.
    - Less prone to leaching.
Applying Nitrogen

How much could be leached out of the root zone?

• Sandy soils are more prone to leaching.
  – Consider split N applications – half pre-bud break & the other half ~ 4-6 weeks after bud break.
  – With trickle irrigation, apply multiple applications spread out from bud break to about early-July.

Using Complete fertilizers (13-13-13)?

• Only if there is a need for each of the nutrients.
  – Expensive
  – Immobility of P and K.
  – Risk of K-induced Mg deficiency on sandy soils.
Phosphorous (P)
(OSU: 0.16 – 0.29 %)
(NRAES: 0.14 – 0.30%)

- Practically immobile in the soil.
  - Pre-plant soil analysis & amend before planting.
- Generally not a problem.
  - Plants often do well on low P soils.
    - Unavailable ↔ Exchangeable ↔ Available P in the soil.
    - Soil mycorrhizal organisms aid in making P available.
- Can be a problem on sandy, low CEC soils.
  - Apply manure in the fall as an N source.
    - N (1-3%), P (0.3-3.2%), K (.5-2.9%); OM (30-74%)
  - Winery pomace (dried).
    - N (1-2%), P (~1.5%), K (.5-1.0%); OM (80%)
  - Apply ammonium mono phosphate (11-52-0) as a N source.
  - Apply P as a foliar application (refer to labels).
Potassium (K)
(OSU: 1.50 – 2.50 %)
(NRAES: 1.20 – 2.00%)

Moves very slowly in the soil.
• For perennial crops, high rates of K are needed to move the K down into the root zone.
• If petiole analysis shows a need for K.

<table>
<thead>
<tr>
<th>Petiole K (1.5 – 2.5%)</th>
<th>K Fertilizer to Apply (lbs K₂O / A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 2.0</td>
<td>0</td>
</tr>
<tr>
<td>1.5 – 2.0</td>
<td>100 – 200</td>
</tr>
<tr>
<td>1.0 – 1.5</td>
<td>200 – 300</td>
</tr>
<tr>
<td>&lt; 1.0</td>
<td>300 - 400</td>
</tr>
</tbody>
</table>

* Dr. Carl Rosen, Univ. of Minnesota
Potassium Management

Soil K applications:
• Apply when the need has been identified:
  – Potassium chloride (0-0-62)
  – Potassium sulfate (0-0-50)
  – Potassium magnesium sulfate, Sul-Po-Mag (0-0-22 + 22% S, 11% Mg)
• Apply in the spring:
  – Potassium nitrate (13-0-44) as a source of N

Foliar K applications:
• Often needed in addition to soil applications to correct deficiencies for the first year or two.
• Begin applying early in the season:
  – Potassium nitrate (44% K, 13% N) &
  – Potassium sulfate (53% K, 18% S)
    • Apply at 6 to 10 lb / 100 gallons (1 to 3 applications/season).
  – Vigor-K™ (20% K) follow label directions
  – Nutri-K® (15% K) follow label directions

Apply a straw mulch under the vines.
Magnesium (Mg)
(OSU: 0.26 – 0.45 %)
(NRAES: 0.35 – 0.75 %)

Can be a problem on sandy soils, particularly when K has been over applied.

- If the soil pH is low (acid), apply dolomitic lime to raise the pH to 6.0 or 6.5.
- If the soil pH is in the optimal range, apply:
  - 50 to 100 lb magnesium oxide (MgO) /A.
  - 300 to 600 lb Epson salt (MgSO₄) /A.
- Foliar applications of Epson salt at 10 lb/100 gal.
  - Apply as 2 post-bloom applications.

Excessive Mg can be a problem on some calcareous soils.

- Inhibits K uptake.
Boron (B)
(25 – 50 ppm)

Can be low in many Midwest & high pH soils

• B is involved in fruit set.
  – Improves the rate of pollen tube growth and thereby improves fertilization of the flowers.

• If there is a need for B.
  – 4 to 6 lbs B / A as a soil application.
  – Pre- and post-bloom foliar applications of Solubor (20% B) at a rate of 2 to 4 lbs/A per application.
    • First application at about the 3-inch stage of shoot growth.
    • Post bloom application, if needed.
    • Tight vs loose clustered variety?
Manganese (Mn)
(OSU: 31 – 150 ppm)
(NRAES: 25 – 1,500 ppm)

Can be low on sandy and high pH soils.

• If Mn is low.
  – Include a Mn-containing fungicide in your early season disease control program.
    • mancozeb (Dithane M-45, Maneb, Penncozeb)
      – Contains 16% Mn.
      – 66 day pre-harvest interval.
    – Apply a chelated form of Mn as a foliar spray (refer to label).

Can be excessive (> 700 ppm) on low pH soils.

• Apply lime to raise the soil pH.
Zinc (Zn)
(OSU: 30 – 50 ppm)
(NRAES: 30 – 60 ppm)

Can be low on sandy, high pH, eroded, terraced or leveled soils.

• If Zn is low:
  – Soil application of zinc sulfate (36% Zn) to bring the available Zn up to 6-8 lb/A.
  – Include a Zn-containing fungicide in your early season disease control program.
    • mancozeb (Dithane M-45, Maneb, Penncozeb)
      – Contains 2% Zn.
      – 66 day pre-harvest interval.
    • Ziram
      – Contains 16% Zn.
      – 21 day pre-harvest interval.
  – Apply a chelated form of Zn as a foliar spray (refer to label).
Iron (Fe)
(OSU: 31 – 50 (200) ppm)
(NRAES: 30 – 100 ppm)

Can be low on high pH soils (> 7.4) and some sandy soils.

• If Fe is low.
  – Apply Fe chelate as a foliar spray at a rate of 1-2 lb/A. per application.
    • Start early and repeat every 10-20 days (refer to label).
  – Take measures to lower the soil pH.
Summary of Vineyard Fertilizer Management

• **Pre-plant:**
  – Soil Test: pH, P, K, Mg, Zn, CEC, O.M.
  – Amend soil as needed and incorporate.

• **After planting:** Apply some N (~.5 oz actual N/vine), to get vines off to a good start.

• **Non-bearing years:** Apply N based on the soil’s organic matter content.

• **When production begins:**
  – Begin petiole analysis on an annual basis.
  – Adjust N fertilizer rates based on test results and vine vigor.
  – Apply other nutrients as needed based on petiole analysis results.

• **DO NOT apply any nutrients unless there is a need!**

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