Fertilization Practices for Bearing Vineyards

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Presented at the
Iowa Wine Growers Conference
January 29, 2005
Vineyard Management

Vine Growth

Fruit Production

Maintaining a Balance

“30 Plus 10 Rule”
or
“20 Plus 10 Rule”

Pruning
Fertilization

Nitrogen (N) & other essential nutrients

IOWA STATE UNIVERSITY
University Extension
In Developing a Fertilizer Program for a Vineyard

Need to know & understand your soil.

• Begins before planting.
  – Optimizing the soil pH for Grapes (5.5 to 6.5).
  – Amending to optimize the level of major nutrients.
  – Understanding its internal drainage characteristic.

• After planting – adjusting your program based on:
  – Soil’s fertility level (O.M. content) & vineyard needs.
  – Cultivar characteristics (vigor, cold hardiness).
  – Cropping potential.

No two sites are alike.
## Essential Mineral Nutrients

<table>
<thead>
<tr>
<th>Macro Elements:</th>
<th>Micro Elements:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen (N)</td>
<td>Manganese (Mn)</td>
</tr>
<tr>
<td>Phosphorous (P)</td>
<td>Iron (Fe)</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>Boron (B)</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>Copper (Cu)</td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>Zinc (Zn)</td>
</tr>
<tr>
<td>Sulfur (S)</td>
<td>Molybdenum (Mo)</td>
</tr>
</tbody>
</table>

- Grapes have a high demand for N & K, and respond well to Zn.
- Many Iowa soils are low in P, and very high in Mg.
- Mn and B can be low in Iowa soils.
Nutrient Availability & Uptake
The availability of essential mineral nutrients is dependent on:

• Composition of the soil parent material.
• Soil pH
• Soil weathering / leaching (texture)
• Competition between nutrients for uptake by the plant.
• Soil organic matter content.
• Previous fertilizer history.
• Composition of the soil parent material:
  Soil Phosphorous (P)

From soil samples submitted to the ISU Soil Testing Lab for grapes.
Composition of the soil parent material: Soil Potassium (K)

From soil samples submitted to the ISU Soil Testing Lab for grapes.
Composition of the soil parent material:

Soil Zinc (Zn)

From soil samples submitted to the ISU Soil Testing Lab for grapes.
Soil pH

Nutrient Availability as Influenced by Soil pH

- Nitrogen (N)
- Phosphorous (P)
- Potassium (K)
- Calcium (Ca)
- Magnesium (Mg)
- Sulfur (S)
- Iron (Fe)
- Manganese (Mn)
- Boron (B)
- Copper (Cu)
- Zinc (Zn)
- Molybdenum (Mo)
Changes in Nutrient Concentrations due to soil pH

From soil samples submitted to the ISU Soil Testing Lab for grapes.
Soil weathering / leaching:
Nutrient Mobility in the Soil

Very Mobile
- Nitrogen (N)
- Sulfur (S)
- Boron (B)
- Manganese (Mn)
- Zinc (Zn)
- Iron (Fe)

Very Immobile
- Copper (Cu)
- Molybdenum (Mo)
- Magnesium (Mg)
- Potassium (K)
- Calcium (Ca)
- Phosphorous (P)

Because of very low mobility, it is important to do a pre-plant soil test and optimize P, Ca (lime/pH) & K before planting when they can be tilled in.
• Competition between nutrients for uptake:

• Competition between nutrients for uptake:

**Suppression:**
- \( \text{Mg} \rightarrow \text{K, Ca, Mn} \)
- \( \text{Ca} \rightarrow \text{K, Mg} \)
- \( \text{K} \rightarrow \text{N, Ca, B} \)
- \( \text{N} \rightarrow \text{Fe, Cu} \)
- \( \text{NH}_4^-\text{N} \rightarrow \text{K, Ca, Mg} \)
- \( \text{NO}_3^-\text{N} \rightarrow \text{P, S} \)
- \( \text{P} \rightarrow \text{Zn, Ca} \)
- \( \text{S} \rightarrow \text{B, Mo, Fe} \)
- \( \text{Cu} \rightarrow \text{Zn} \)
- \( \text{Zn} \rightarrow \text{Fe} \)
- \( \text{B, Cu, Mn, Fe compete} \)

**Enhancement:**
- \( \text{NO}_3^-\text{N} \rightarrow \text{Ca} \)
- \( \text{P} \rightarrow \text{Mo} \)
- \( \text{K} \rightarrow \text{Fe} \)
- \( \text{S} \rightarrow \text{N} \)
- \( \text{B} \rightarrow \text{Ca} \)
Soil organic matter content:
Nitrogen Released from Organic Matter

Need to adjust N fertilization practices based on the organic matter content of your soil.
Darker the color, higher the organic matter content.
Soil Organic Matter

From soil samples submitted to the ISU Soil Testing Lab for grapes.
Determining the Need for Fertilizer

• **Visual:**
  Plant vigor – A “shot in the dark”
  Should be adjusting pruning to plant vigor – practicing the “30 Plus 10 Rule” or “20 Plus 10 Rule” to maintain a balance between vine growth and fruiting.
  Deficiency symptoms – Generally too late

• **Soil testing:**
  Suitable for pre-plant testing.
  Only good for some nutrients.

• **Petiole Analysis:**
  Reliable after first growing season.
  Measures what plants are able to take up.
Desirable Soil Test Ranges for Grapes

<table>
<thead>
<tr>
<th>Test</th>
<th>Bul. 861*</th>
<th>ISU</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>5.5 to 6.5</td>
<td>6.0 to 6.5</td>
</tr>
<tr>
<td>Organic matter</td>
<td>2 to 3 %</td>
<td>2 to 3 (4) %</td>
</tr>
<tr>
<td>Phosphorous (P)</td>
<td>20 to 50 ppm</td>
<td>&gt; 30 ppm</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>125 to 150 ppm</td>
<td>&gt; 150 ppm</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>100 to 125 ppm</td>
<td>- -</td>
</tr>
<tr>
<td>Boron (B)</td>
<td>.75 to 1.0 ppm</td>
<td>- -</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>4 to 5 ppm</td>
<td>4 to 5 ppm</td>
</tr>
</tbody>
</table>

* Midwest Small Fruit Pest Management Handbook
Pre-plant Soil Test

- Test for: pH, P, K, Zn, O.M.
- Separate sample for each soil type.
- Separate samples for different cropping histories.
- Submit samples collected from 2 depths:
  - 0 to 6 inch, or 0 to 8 inch depth.
  - 6 to 12 inch, or 8 or 16 inch depth.
- For samples sent to the ISU Soil Testing Lab, indicate on submission form that the results be sent to me for interpretation.
Soil vs Petiole Analysis

**Soil**

**Pre-plant:**
- Adjust pH, bring P, K & Zn 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.
# Normal Nutrient Ranges for Grapes

Based on Petiole Analysis

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>At Full Bloom</th>
<th>Mid-July to Mid-August</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><em>No data (&gt; 0.1 %)</em></td>
<td><em>No data (&gt; 0.1 %)</em></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 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>

The mid-July to mid-August sampling time is preferred.
Annual Growth Cycle of a Grapevine

Changes in growth are occurring rapidly

Bloom

Growth changes have slowed down

Sampling Time

From: Winkler, General Viticulture
At Full Bloom

Petioles to be sampled can be poorly developed.
Changes in Nutrient Concentrations Occur During the Growing Season

**Increase**
- Calcium (Ca)
- Magnesium (Mg)
- Boron (B)
- Iron (Fe)
- Manganese (Mn)

**Decrease**
- Nitrogen (N)
- Phosphorous (P)
- Potassium (K)
- Sulfur (S)
- Copper (Cu)
- Zinc (Zn)

The concentration of nutrients in the leaves/petioles, change during the growing season. This is particularly evident for N & K.
Changes in Nutrient Concentrations during the Growing Season

### At Full Bloom vs Mid-Summer

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>At Full Bloom</th>
<th>Mid July to Mid Aug.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal Range</td>
<td>Variance Within</td>
</tr>
<tr>
<td>N (%)</td>
<td>1.60 – 2.80</td>
<td>1.20</td>
</tr>
<tr>
<td>P (%)</td>
<td>0.20 – 0.60</td>
<td>0.40</td>
</tr>
<tr>
<td>K (%)</td>
<td>1.50 – 5.00</td>
<td>3.50</td>
</tr>
<tr>
<td>Ca (%)</td>
<td>0.40 – 2.50</td>
<td>2.10</td>
</tr>
<tr>
<td>Mg (%)</td>
<td>0.13 – 0.40</td>
<td>0.27</td>
</tr>
<tr>
<td>Zn (ppm)</td>
<td>20 - 100</td>
<td>80</td>
</tr>
</tbody>
</table>

Variance within the normal range is much less during the mid-July to mid-August sampling period, and provides for a more reliable interpretation.
Rules to follow when collecting a Petiole Sample

1. Do not mix cultivars into one sample!

2. If a planting is located on more than one soil type, collect separate samples for each soil type.

3. If a planting received different fertilizer applications, separate samples should be collected.

4. A sample should consist of 100 leaves / petioles, or 150-200 for cultivars with small petioles (Foch).
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   a. Collect petioles randomly from representative plants in the designated sampling area.
   b. Collect petioles from fruit bearing shoots.
      • **Full bloom:** Petiole opposite first cluster.
      • **Mid-summer:** Most recently fully expanded leaf.
   c. Collect no more than one petiole per shoot.
   d. Avoid sampling from abnormal, weak or unhealthy vines unless they will be sampled and submitted separately.
   e. Choose leaves free from insect, disease or mechanical injury.
**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 deionized 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 in less than a minute.
After Collecting a Petiole Sample

• Remove the leaf blades.
• 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.
Other information that will assist in the interpretation of the results

- The vigor & health of the vines.
- Production potential for current and previous season.
- Current and past fertilizer program.
  - Petiole analysis only tells how much the vines are obtaining.
  - Recommendation would be to either increase, decrease or maintain current program.
- Spray materials applied prior to collecting the sample (foliar applied nutrients or nutrient-containing pesticides).
Commercial Plant & Soil Analysis Labs

- A & L Laboratories  Atlantic, IA  Ph: 712-243-6933
- Belmond, Labs, Inc.  Belmond, IA  Ph: 641-444-3384
- Minnesota Valley Testing Laboratories  Nevada, IA  Ph: 515-382-5486 or 800-362-0855
- Key Agricultural Services, Inc.  Macomb, IL  Ph: 309-833-1313
- Soil Tech, Inc.  Arlington, IL  Ph: 815-638-2522
- Harris Laboratories  Lincoln, NE  Ph: 402-476-2811
- Midwest Laboratories, Inc.  Omaha, NE  Ph: 402-334-7770

Call the Labs ahead of sampling to determine if they have special instructions.
Interpreting a Petiole Analysis

Most Labs will provide an interpretation of the results, but I have observed errors.

- Send me the results & I will do an interpretation.

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  Dept. of Horticulture
  Ames, IA 50011

- To assist, provide all the additional information suggested:
  - The vigor & health of the vines.
  - Production potential for current and previous season.
  - Current and past fertilizer program.
  - Spray materials applied prior to collecting the sample.
Interpreting a Petiole Analysis

The interpretation will determine the status of the nutrients, and provide a recommendation if needed.

<table>
<thead>
<tr>
<th>Status</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Def.</strong></td>
<td>Deficient, corrective measures are necessary.</td>
</tr>
<tr>
<td><strong>Low</strong></td>
<td>Below the normal range, but not deficient. Plants will probably respond to treatment.</td>
</tr>
<tr>
<td><strong>Nor-L</strong></td>
<td>Low end of the normal range; plants may respond to treatment.</td>
</tr>
<tr>
<td><strong>Norm.</strong></td>
<td>Within the normal range for good plant growth; continue with current practice.</td>
</tr>
<tr>
<td><strong>Nor-H</strong></td>
<td>High end of the normal range; if being applied, cut back on the rate.</td>
</tr>
<tr>
<td><strong>High</strong></td>
<td>Above normal range, may interfere with the uptake or other nutrients; if being applied, cut back on the rate or discontinue applications.</td>
</tr>
<tr>
<td><strong>Exc.</strong></td>
<td>Well above the normal range, Probably will interfere with the uptake or other nutrients; if being applied, cut back on the rate or discontinue applications.</td>
</tr>
</tbody>
</table>
Summary of Grape Nutrient Management

• Pre-plant Soil Test: pH, P, K, Zn, O.M.
• Amend soil as needed and incorporate as deep & as uniformly as possible.
• Apply a low rate of N after planting, and in 2\textsuperscript{nd} year. (40-50 lb N / A - .4 to .6 oz N applied around each vine, remained broadcast applied. Adjust based on soil organic matter content.)
• Begin petiole analysis during the 2\textsuperscript{nd} year, and adjust N fertilizer rates based on test results and vine vigor (prunings removed).
• Apply other nutrients as needed based on petiole analysis results.