Mineral Nutrition for Muscadine Grapes

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Importance of Nutrition

- Plants need essential elements to survive, produce high quality fruit
- Photosynthesis, cell wall growth, fruit set all depend upon optimum levels of nutrients

- Pre-plant analysis: What can the soil provide?
  - Amendments based on analysis since some elements are easier to fix before planting
Impact of pH on Nutrients

- Soil pH is important
- pH affects nutrient availability
  - Some nutrients more available in soil or solution
- Areas with significant rainfall have lower soil pH
  - Due to leaching of Ca$^{2+}$, Mg$^{2+}$, K$^+$ and Na$^+$
  - Replaced with H$^+$
Impact of pH on Nutrients

**The thicker the bar, the more available the nutrient**
Soil pH Adjustments

- Acidic soils must be adjusted before planting
- Rate of pH change:
  - Dolomitic lime (contains Mg) - Slow
  - Ground limestone - Slow
  - Pelletized limestone – Fast
- Use combination of materials to sustain effect

Irrigation Water pH

- Solutions for high pH water?
  - Acidify the water source
  - Monitor soil pH
  - Apply fertilizers with sulfur to bring pH down
Required Elements

- Macronutrients –
  - Needed in large quantities
  - Reported in % on plant tissue analysis

- Micronutrients
  - Needed in much smaller quantities
  - Reported in parts per million (ppm)
    - Ppm = mg/L
  - Easy to go from deficiency to toxicity with improper application
Nitrogen

- Important in making amino acids & proteins, DNA and RNA, and chlorophyll
- Deficiency affects older leaves first
  - Yellowing, small leaves
- Excessive nitrogen promotes vigor and can leach into groundwater
  - Increased pressure by environmental groups
    - EPA Numeric Nutrient Criteria in Florida
      - Sets numeric limit on P and N in bodies of water
Phosphorus

- Important in cells that transfer energy
  - ATP and ADP – “molecular unit of currency”
  - Need to transfer electrons to make things happen
- Deficiency symptoms:
  - Dark green stems, smaller leaves
- Not often observed in muscadine production
- Doesn’t move readily in the soil
Potassium

- Enzyme activation, translocation of sugars
- Deficiency symptoms:
  - Red in leaf margins
  - Corrected with potassium chloride
  - Timing of application
    - Early in season better than late
- Not common in muscadine production
Blackleaf Disorder

- Thought to be K deficiency
  - Growers responded by putting on excess K
- Research indicated it was due to UV-B damage and water stress
- Check vine nutrient status
Calcium

- Important in cell wall and structure
- Deficiency symptoms:
  - Yellowing between veins and in margins
  - Cupping of leaves
- Calcium supplied in sufficient amounts when lime applied for pH adjustment
Magnesium

- Important in chlorophyll
- Most common deficiency in muscadines
- Deficiency symptoms:
  - Chlorosis, veins stay green
  - Older, basal leaves first, then young leaves
  - Since new growth is priority, Mg gets shuttled to terminal growth
- High Ca, K conditions can also cause Mg deficiency
Magnesium Deficiency

- Alleviating deficiency
  - Epsom salts (magnesium sulfate - \( \text{MgSO}_4 \cdot 7\text{H}_2\text{O} \))
    - Sprayed onto vine through foliar spray
    - Also better than dolomitic lime when applied to soil
    - When soil pH > 6.0, apply at 100 lbs/acre to correct deficiency
  - Dolomitic lime
    - Soil applied when trying to raise pH
    - **only correct major deficiencies – minor Mg deficiencies are normal for SE U. S.**
Sulfur

- Important in two amino acids and other plant molecules
- No reported research on sulfur deficiencies in muscadines
  - Often applied in fungicide program
  - Complete fertilizer + micros

https://www.msu.edu/~janoudi/deficiency.htm
Micronutrients – Boron

- Important in fruit set
  - Pollen tube growth & fertilization
  - Results in “hens and chicks”

- Deficiency symptoms:
  - Dark brown areas near shoot tip, tendrils die back
  - Zig-zag shoot growth, “witches broom” growth
  - Young leaves show chlorosis

- Foliar micronutrient sprays alleviate symptoms
Boron

- To correct deficiency:
  - Borax (10%)
    - 5 lbs/acre every 2 years
  - Solubor (20%)
    - 1 lb/100 gallons annually

- Toxicity can occur quickly – be careful with B applications
Zinc

- Chlorosis on young leaves
- If soil pH is 5.0 – 7.0, deficiency not a problem
- Zinc levels & type of N
  - Ammonium nitrate
  - Ammonium sulfate
Iron

- Important in chlorophyll
- Deficiency symptoms:
  - Chlorosis in young leaves and shoot tip
  - Not easy to correct, but can use chelated iron
    - Expensive and doesn’t provide immediate relief
    - Easy to cause leaf burn
- Not often observed in muscadine production
Copper, Manganese, Molybdenum

- Components of several enzymes, synthesis of chlorophyll and metabolism
- Deficiencies not often observed
- Foliar micronutrient spray contains adequate amounts
Sampling for Nutrition Analysis

- Annual tests should be conducted to monitor nutrition program
- Problem vines
  - Take samples from productive vines as well
- Where to sample?
  - Muscadines – leaf blade
  - Bunch grapes – whole leaf, incl. petiole
Sampling for Nutrition Analysis

- When to sample?
  - Bloom
    - Can be indicator to adjust for upcoming season
    - Fluctuates daily
    - Take leaf opposite fruit bunch, randomized throughout the plot
  - Veraison
    - More stable nutrition levels
    - Use to amend soils for next season
    - Take fifth leaf from shoot tip (count leaves that are fully expanded)
Leaf Position for Sampling

http://cru.cahe.wsu.edu/CEPublications/PNW622/PNW622.pdf
## Nutrient Ranges for Muscadine

<table>
<thead>
<tr>
<th>Element</th>
<th>Deficient</th>
<th>Sufficient</th>
<th>Excessive</th>
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<tbody>
<tr>
<td>N (%)</td>
<td>1.65</td>
<td>1.65-2.15</td>
<td>&gt;2.15</td>
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<td>P (%)</td>
<td>0.12</td>
<td>0.12-0.18</td>
<td>&gt;0.18</td>
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<td>K (%)</td>
<td>0.80</td>
<td>0.80-1.20</td>
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<td>Ca (%)</td>
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<td>0.70-1.10</td>
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<td>Mg (%)</td>
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<td>0.15-0.25</td>
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<tr>
<td>B (ppm)</td>
<td>&lt;15</td>
<td>15-25</td>
<td>&gt;25</td>
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<tr>
<td>Cu (ppm)</td>
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<td>Fe (ppm)</td>
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<td>60-120</td>
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<tr>
<td>Mn (ppm)</td>
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<td>60-150</td>
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<td>Mo (ppm)</td>
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<td>0.15-0.35</td>
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<tr>
<td>Zn (ppm)</td>
<td>&lt;18</td>
<td>18-35</td>
<td>&gt;35</td>
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Current Recommendations

- **Year 1 - Establishment**
  - Apply after growth begins (spring)
    - Transpiration will “pull” up water and nutrients
    - Use complete fertilizer
      - 10-10-10 or similar
      - 4-8 oz/vine (0.25-0.5 lb) around vine
      - Do not apply within 12 inches of vine trunk
    - 2nd application of 2-4 oz (~0.25 lb) in June – midsummer
    - Total: 13-23 lb N/acre
      - Vine density of 182 vines/acre
Current Recommendations

- **Year 2**
  - Increase amount of fertilizer
    - Apply after growth begins in spring
    - Complete fertilizer
      - 10-10-10 or similar
      - 8-16 oz (0.5 - 1lb) per vine
      - Additional N application (0.25 lb/vine) recommended in early June
    - Widen circle of band to accommodate larger root system
  - Total N applied: 34 lb N/acre
  - Total shoot growth = ~36 inches
Current Recommendations

- Year 3
  - Complete fertilizer applied in spring
    - 10-10-10 or similar
      - 2 lb/vine
    - Additional application of complete fertilizer in early summer
      - 0.25 – 1 lb/vine
  - Can band or broadcast throughout vineyard
  - Total: 40-50 lb N/acre
  - Total shoot growth = ~36 inches
Current Recommendations

- **Year 4**
  - Complete fertilizer applied in spring
    - 10-10-10 or similar
      - 2 lb/vine (400 lb/acre)
    - Additional application of complete fertilizer in early summer
      - 1 lb/vine (200 lb/acre)
  - Can band or broadcast throughout vineyard
  - **Total:** 40-75 lb N/acre
  - **Total shoot growth = ~36 inches**
Improving Soil Health

- Cover crops can improve organic matter content
  - Legumes serve to add nitrogen to soil via mineralization
    - Symbiotic bacteria in nodules
    - Breakdown depends on temperature
    - Coordinate with vine growth needs
  - Grasses can tie up nitrogen
Cover Crops in Vineyards

- Can reduce vine vigor
  - Planted under vines
  - Research from Virginia Tech (T. Wolf)

http://www.arec.vaes.vt.edu/elson-h-smith/grapes/viticulture/research/ground-cover.html
Evaporation

Courtesy of M. Keller, WSU
Trying New Techniques

- Research cover crop varieties
- Biopesticides, etc.

- Choose two rows of vines
  - Skip row between treatments
  - Apply treatment to row 1
    - Cover crop on either side of row
  - Apply control or standard to row 3

- Compare vine growth, yield, fruit quality, disease incidence
Summary

- Nutrients have specific roles in plant growth
  - An imbalance can have major or minor consequences
- Diagnostic tool in tissue analysis
  - Be aware of over applying nutrients and environmental consequences
- Need additional nutrition research
- Do research in your own vineyard!