Overview of Elderberry Nutrition in Missouri

Patrick Byers
Regional Horticulture Specialist
Southwest Region- MU Extension
ByersPL@missouri.edu

Introduction

• There is much that we don’t know with precision regarding elderberry nutritional management.
• Models developed for other crops may be useful

Understanding Cations

• Cation exchange capacity –
  – the total amount of negative charge a soil has to attract cations
  – What are cations?
    » Positively charged nutrients – potassium (K), magnesium (Mg), calcium (Ca), and ammonium (NH4)
  – What determines CEC?
    » the amount of clay
    » organic matter
    » soil pH
  – Soils with higher CEC levels have greater plant nutrient holding capacity

Introduction

• The essential elements
  – Elderberries, like other crops, require adequate supplies of all essential plant nutrients for optimum growth and yield
  – Most soils contain adequate or near-adequate quantities of all nutrients.
  – Nitrogen, phosphorous, potassium, and magnesium are the nutrients most likely to limit production in the Midwest.

Understanding the supply of essential elements

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Understanding Cations

<table>
<thead>
<tr>
<th>Textural Class</th>
<th>CEC (cmol./kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>3 to 5</td>
</tr>
<tr>
<td>Loam</td>
<td>10 to 15</td>
</tr>
<tr>
<td>Silt Loam</td>
<td>15 to 25</td>
</tr>
<tr>
<td>Clay and Clay Loams</td>
<td>20 to 50</td>
</tr>
<tr>
<td>Organic Soils</td>
<td>50 to 100</td>
</tr>
</tbody>
</table>

*Base saturation*
- the fraction of the CEC that is satisfied by Ca, Mg, K, and Na
- related to soil pH
- higher pH generally means higher base saturation, improved soil fertility

**Soil pH**
- slightly acidic soils (5.5-7.0) generally have better nutrient balance for plant growth
- why maintain soil pH at optimum level?
  - Improved base saturation
  - High amounts of Fe and Al precipitate P out of the soil solution, making P unavailable at low or high pH
  - Aluminum toxicity can result in low pH soils – reduced root growth
  - Beneficial soil organisms inhibited in acidic soils
  - Availability of micronutrients increases at low soil pH
    - Direct toxicity symptoms
    - Deficiencies of other elements – see above

**Nutrient Anions and Organic Matter**

- Phosphorus availability
- Organic matter
AVOIDANCE AND CORRECTION OF NUTRIENT DEFICIENCIES

Soil Analysis

- Detailed soil analysis must be made prior to elderberry establishment, and at intervals during the life of the planting
  - soil pH
  - soil nutrient content
- Collect and submit a representative sample
- Submit top 8 inches and second 8 inches separately

Soil Analysis

- Recommended soil test results (Missouri) – based on grape and blackberry
  - soil pH – 5.5 to 6.5
  - soil organic matter – 2-3%
  - phosphorus – 40-80 lbs/A = medium
  - potassium – 110-220 lbs/A = medium
  - magnesium – 200-250 lb/A = medium

Soil Analysis

- Adjusting soil pH with liming materials
  - extremely important to do this before establishment
  - very difficult to change soil pH in all but the top few inches of soil once plants are planted
  - lime is most effective if incorporated deeply and thoroughly

Soil Analysis

- liming existing plantings
  - monitor soil pH with regular soil testing
  - remember problems with limited effectiveness of surface lime applications; consider routine applications of high quality lime
  - rescue applications – if soil pH has dropped below 5.5
    - broadcast recommended rate and chisel plow 8-10 inches deep
    - do alternate row middles in alternate years to minimize the effects of root damage
    - do in late winter and cultivate prior to bud break

Plant Tissue Analysis

- Reveals the concentration of elements in tissue
- To be meaningful, analysis must entail:
  - standardized tissue sample procedure
  - accurate and precise analytical methods
  - standard references to compare diagnostic sample values
  - means of interpreting diagnostic data and making fertilizer recommendations
- Useful for:
  - Routine nutrient status evaluation
  - Troubleshooting suspected nutrient problems
Elderberry Plant Tissue Analysis

Materials and Methods

- Study conducted at two sites
  - MSU State Fruit Experiment Station
  - MU Southwest Center
- 3 cultivars(selections)
  - ‘Bob Gordon’
  - ‘Adams 2’
  - ‘Netzer’

- Two types of tissue collected
  - Leaves from new shoots that arise from crown
  - Leaves from shoots that arise from old shoots
- Three collection times
  - After spring flush
  - At bloom time
  - At harvest time

- Fully expanded leaves collected from mid shoot; each sample consisted of 25 leaves
- Leaves dried, ground, and analyzed for nutrient content
- Nutrients analyzed: N, P, K, Ca, Mg, Zn, Fe, Mn, Cu, and B
Results

• N, P, Fe, Zn, and Mn were highest during the spring flush collection period
• Cu was highest at anthesis
• Ca, Mg, and B were highest at fruit ripening
• As a general trend, the elements N, P, K, Fe, Zn, and Mn were at higher levels early in the season (spring flush to anthesis), while the elements Ca, Mg, and B were higher later in the season.

Discussion

• How do we evaluate a fertility program?
  – plant appearance
  – plant growth
  – productivity
• What about foliar analysis?
  – measuring actual elemental uptake by the plant
  – predicting elemental disorders in advance of visible symptoms
  – diagnosing visible elemental disorders

Discussion

• Leaf elemental content measurements are made at times during the growth cycle when these elements are at maximum or stable levels
• A tissue type is selected that consistently contains high elemental levels

Discussion

• Based on this study:
  – Foliar collection times following spring growth flush for N, P, K, Fe, Zn, and Mn
  – Foliar collection times at fruit ripening for Ca, Mg, and B
  – Sample leaves from new shoots originating at the crown
• For troubleshooting, collect samples at any time

Plant Tissue Analysis

Estimated elderberry petiole nutrient sufficiency levels

<table>
<thead>
<tr>
<th>Macronutrients</th>
<th>%</th>
<th>Micronutrients</th>
<th>mg kg⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>4.47</td>
<td>Iron</td>
<td>71</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>0.39</td>
<td>Manganese</td>
<td>147</td>
</tr>
<tr>
<td>Potassium</td>
<td>2.82</td>
<td>Boron</td>
<td>63</td>
</tr>
<tr>
<td>Calcium</td>
<td>1.60</td>
<td>Copper</td>
<td>8</td>
</tr>
<tr>
<td>Magnesium</td>
<td>0.80</td>
<td>Zinc</td>
<td>24</td>
</tr>
</tbody>
</table>
Plant Tissue Analysis

Grape petiole nutrient sufficiency levels

<table>
<thead>
<tr>
<th>Macronutrients</th>
<th>%</th>
<th>Micronutrients</th>
<th>ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>1.70-3.00</td>
<td>Iron</td>
<td>40-100</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>0.15-0.50</td>
<td>Manganese</td>
<td>30-150</td>
</tr>
<tr>
<td>Potassium</td>
<td>1.50-2.00</td>
<td>Boron</td>
<td>30-100</td>
</tr>
<tr>
<td>Calcium</td>
<td>1.30-3.00</td>
<td>Copper</td>
<td>5-50</td>
</tr>
<tr>
<td>Magnesium</td>
<td>0.30-1.50</td>
<td>Zinc</td>
<td>25-100</td>
</tr>
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Source: MU Soil and Plant Testing Laboratory

Visual observations

• How to diagnose problems – examine the pattern of the problem
  – within the planting
  – pattern on a given plant
  – pattern on a particular leaf

Visual observations

• Symptoms of nutritional disorders
  – poor leaf color
  – poor fruit set
  – weak growth
  – delayed fruit maturity
  – excessive vigor

• Watch out for other factors – disease/insect problems, herbicide damage, water stress, overcropping

SELECTING AND APPLYING FERTILIZERS

Choosing a fertilizer

• Analysis of fertilizer
• Acid forming fertilizers
• Cost per unit of nutrient
• Dry and liquid fertilizers
• Organic fertilizers

When to apply a fertilizer

• Nitrogen containing fertilizers
  – During periods of active uptake (based on grape)
    • Bloom to 6 weeks post-bloom
    • Can split the application
    • Post harvest applications useful to address current season problems
  – Annual rate – 60-80 lb/acre (based on blackberry)
• Phosphorus, potassium, other nutrients – anytime
Other considerations

- Apply fertilizers over the root system
  - Sodded row middles – band under plants
  - Clean cultivation – broadcast over floor

- Foliar applications (no experience)
  - generally short term correction of problems
  - Use soluble forms
  - Use caution when mixing with pesticides

Any Questions?

Patrick Byers
MU Extension
2400 S. Scenic Avenue
Springfield, MO 65807
417-881-8909
byerspl@missouri.edu