Goals of Talk

- Overall goal is not to provide a comprehensive review on nutrient management in berries, but to remind everyone about:
  - Key concepts
  - Available resources
Nutrient Management: Key Questions for Consideration

- When developing a nutrient management plan, ask:
  - What are the requirements for nutrients?
  - What is presently available in my soils?
  - What factors will influence uptake and mobility?
  - When are the nutrients needed by the plant?
  - How much of each nutrient is needed?
  - What are sources of various nutrients?
  - Is my current nutrient management plan working?
Plant Nutrients – A Quick Review

- A nutrient is **essential** if it is needed for a plant to grow properly (and be productive)
- **Macronutrients** – needed in large quantities
- **Micronutrients** – needed in small quantities

- Nutrients differ in their **mobility** within the plant
  - **Mobile** - N, P, K, Mg, and Cl
    - Move in phloem (system that transports plant sugars)
    - Symptoms of deficiency first seen on *older* leaves
  - **Immobile** – Ca, B, S, Fe, Mn, Cu, and Zn
    - Move in xylem (system that transports water)
    - Symptoms of deficiency seen on *newer* leaves
Nutrient Removal – Focus on N

- Nutrients are removed from harvested fruit, prunings, and leaves
- Removed nutrients should be replenished
- **Blueberry**
  - 1.3 to 2.7 lbs N removed per ton of fruit
  - 14 lbs N removed per acre of prunings
- **Raspberry**
  - 3.5 lbs N removed per ton of fruit
  - 17.3 lbs N removed per acre of prunings

Source: Rempel and Strik, 2004
# Rates of Nitrogen Application (lb N/acre)

**Blueberry:**

<table>
<thead>
<tr>
<th>Year</th>
<th>Fertigation</th>
<th>Granular Fertilizers**</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>90*</td>
<td>25 – 40†</td>
</tr>
<tr>
<td>2</td>
<td>90</td>
<td>40 – 50†</td>
</tr>
<tr>
<td>3</td>
<td>60</td>
<td>50 – 60</td>
</tr>
<tr>
<td>4</td>
<td>70</td>
<td>55 – 65</td>
</tr>
<tr>
<td>5</td>
<td>75</td>
<td>65 – 75</td>
</tr>
<tr>
<td>6</td>
<td>85</td>
<td>80 – 100</td>
</tr>
<tr>
<td>7</td>
<td>95</td>
<td>90 – 120</td>
</tr>
<tr>
<td>8+</td>
<td>100 – 150</td>
<td>100 – 140</td>
</tr>
</tbody>
</table>

*Based on Strik and Bryla (2015).

**Modified from Hart et al. (2006) for field w/out surface mulch and assumes in-row spacing of 2.5 to 3 ft. **If sawdust mulch is used, add 25 lbs N/acre during years when mulch is reapplied.** Split into 1/3rd years (April, May, and June).

†Assumes application by hand.
Raspberry:
- Recommended N-fertilization
  - Establishment years: 30-50 lbs N/acre
  - Establishment: 50-80 lbs N/acre
  - Split applications

Source: Kowalenko, 1994; Rempel et al., 2004
Nitrate vs. Ammonium

Adapted to med/high soil pH
Nitrate ($NO_3^-$) feeder

Adapted to low soil pH
Ammonium ($NH_4^+$) feeder
Nutrient Types – A Quick Review

Types:
- Dry/granular vs. liquid
- Soil vs. foliar applied
- Organic vs. synthetic
- If organic, is it animal vs. plant based?

- Should consider nutrient type when developing a nutrient management plan
- Caution - Nutrient content in organic sources varies among batches and years; testing recommended
Caution Using Composts in Blueberry

- Animal-based composts tend to be high in salt content, electrical conductivity (EC), and pH*
- Goal is to keep compost pH < 6 (acidification may be required)


<table>
<thead>
<tr>
<th>Source</th>
<th>Sample no.</th>
<th>pH</th>
<th>Electrical conductivity (EC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dairy</td>
<td>9</td>
<td>7.6</td>
<td>6.1</td>
</tr>
<tr>
<td>Horse</td>
<td>5</td>
<td>7.8</td>
<td>3.3</td>
</tr>
<tr>
<td>Yard</td>
<td>5</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Leaf</td>
<td>2</td>
<td>7.4</td>
<td>2.2</td>
</tr>
<tr>
<td>Mint</td>
<td>2</td>
<td>7.7</td>
<td>11.6</td>
</tr>
<tr>
<td>On-farm</td>
<td>5</td>
<td>6.8</td>
<td>6</td>
</tr>
<tr>
<td>Other organics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peat</td>
<td>1</td>
<td>4.8</td>
<td>0.7</td>
</tr>
<tr>
<td>Sawdust</td>
<td>1</td>
<td>5.2</td>
<td>0.4</td>
</tr>
</tbody>
</table>
Assessing Nutrients Preplant – Recommended Soil Sufficiency Levels*

**Blueberry**

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Range (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphorus (Bray P)</td>
<td>25-40</td>
</tr>
<tr>
<td>Phosphorus (Olsen)</td>
<td>10-20</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>100-150</td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>1,000</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>60</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>20-60</td>
</tr>
<tr>
<td>Boron (B)</td>
<td>0.5-1.0</td>
</tr>
</tbody>
</table>

*Repurposed from Strik and Bryla, 2015.

**NOTE**
- Target pH is 4.5 to 5.5
- Not advised to use soil tests to predict nitrogen availability
### Assessing Nutrients Preplant – Recommended Soil Sufficiency Levels*

#### Raspberry

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Range (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphorus (Bray P)</td>
<td>20-40</td>
</tr>
<tr>
<td>Phosphorus (Olsen)</td>
<td>10-20</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>150-350</td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>1,000</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>120</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>20-60</td>
</tr>
<tr>
<td>Boron (B)</td>
<td>0.5-1.0</td>
</tr>
</tbody>
</table>

**NOTE**
- Target pH is 5.6 to 6.5
- Not advised to use soil tests to predict nitrogen availability

Source: EM- 8903-E
Assessing Nutrients – Post-Harvest Soil Testing

- Post-harvest soil nitrate (NO₃) testing recommended for **manured cropping systems**
- Important tool for N management
- Measures the quantity of plant-available N present in the NO₃ form in the surface foot of soil in the late summer/early fall (i.e, *not utilized by crop*)
- **Purpose:**
  - Quantifies **balance** between N supply from manure and other sources and crop N demand
  - Identifies **imbalances** in N supply among fields
  - Identifies fields that **may respond to changes** in nutrient management
  - See EM 8832-E for details
Assessing Nutrients – Tissue Sampling

Guidelines:
- Sample at the correct time
- Collect the right tissue; most recent, fully expanded leaves from:
  - Blueberry - shoots subtending clusters
  - Raspberry - primocanes, about 12 inches from the apex
- Sample problematic plants separately and compare
- Sample cultivars separately
Guidelines (continued):

- Contact the lab you plan to use first to learn of special procedures
- Don’t wash leaves!
- Note that fungicides, foliar nutrients, and dust can influence results
- Pair results with observations, notes, and records when adjusting or maintaining a nutrient management plan
## Recommended Leaf Tissue Sufficiency Levels in Blueberry*

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Current standards for Northern Highbush</th>
<th>Revised standards for Northern Highbush</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen (%N)</td>
<td>1.76 – 2</td>
<td>1.76 – 2</td>
</tr>
<tr>
<td>Phosphorus (%P)</td>
<td>0.11 – 0.4</td>
<td>0.10 – 0.20</td>
</tr>
<tr>
<td>Potassium (%K)</td>
<td>0.41 – 0.7</td>
<td>0.40 – 0.65</td>
</tr>
<tr>
<td>Calcium (%Ca)</td>
<td>0.41 – 0.8</td>
<td>0.45 – 0.85</td>
</tr>
<tr>
<td>Magnesium (%Mg)</td>
<td>0.13 – 0.25</td>
<td>0.13 – 0.25</td>
</tr>
<tr>
<td>Sulfur (%S)</td>
<td>0.11 – 0.16</td>
<td>0.11 – 0.16</td>
</tr>
<tr>
<td>Manganese (ppm Mn)</td>
<td>31 – 350</td>
<td>31 – 350</td>
</tr>
<tr>
<td>Boron (ppm B)</td>
<td>30 – 80</td>
<td>30 – 80</td>
</tr>
<tr>
<td>Iron (ppm Fe)</td>
<td>60 – 200</td>
<td>60 – 200</td>
</tr>
<tr>
<td>Zinc (ppm Zn)</td>
<td>8 – 30</td>
<td>8 – 30</td>
</tr>
<tr>
<td>Copper (ppm Cu)</td>
<td>5 – 15</td>
<td>3 to 10</td>
</tr>
<tr>
<td>Aluminum (Al)</td>
<td>NA</td>
<td>40 – 160</td>
</tr>
</tbody>
</table>

*Strik and Bryla (2015) and Strik and Vance (2015); samples collected late July to early Aug.
# Recommended Leaf Tissue Sufficiency Levels in Raspberry*

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Current standards for Raspberry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen (%N)</td>
<td>2.3-3.0</td>
</tr>
<tr>
<td>Phosphorus (%P)</td>
<td>0.19–4.5</td>
</tr>
<tr>
<td>Potassium (%K)</td>
<td>1.3-2.0</td>
</tr>
<tr>
<td>Calcium (%Ca)</td>
<td>0.6-2.0</td>
</tr>
<tr>
<td>Magnesium (%Mg)</td>
<td>0.3-0.6</td>
</tr>
<tr>
<td>Sulfur (%S)</td>
<td>0.1-0.20</td>
</tr>
<tr>
<td>Manganese (ppm Mn)</td>
<td>50-300</td>
</tr>
<tr>
<td>Iron (ppm Fe)</td>
<td>60-250</td>
</tr>
<tr>
<td>Boron (ppm B)</td>
<td>30-70</td>
</tr>
<tr>
<td>Copper (ppm Cu)</td>
<td>6-20</td>
</tr>
<tr>
<td>Zinc (ppm Zn)</td>
<td>15-50</td>
</tr>
</tbody>
</table>

Source: EM- 8903-E
Summary – Tools and Techniques to Monitor Your Nutrient Program

- Keep good records
- **Soil testing** – sample every 2-4 years, unless there are problems or specific concerns
- **Tissue testing** – test annually and compare results to standards and records
- Pair records of soil and tissue tests with in-field observations and experiences
- Seek out **resources** if you have questions
Canberries

J. Hart, B. Steik, and H. Reepel

Several types of canberries are produced commercially in Oregon, including summer-bearing and prunecan-
tting red raspberries, black raspberries (blackcap), and
blueberries. This publication addresses nutrient assess-
ment and application for canberries produced in western
Oregon.

In this area, canberries typically are planted on Albro,
Jerr, Newberg, Willamette, Woodburn, or Sams soils.
Spacing usually is 2.5 x 4 ft for raspberries and 4 to 6 ft
x 10 ft for blueberries. Recommendations in this pub-
lication are based on research and experience with canberry
production in this region.

The use of fertilizer should be part of a complete man-
agement package. Nutrient application influences yield,
fruit quality, fruit maturity, and trained plant vigor.
Management practices—such as selection of certified
plants to pre- and postharvest irrigation—must be performed in
an appropriate and timely manner so that plants can benefit
from applied nutrients.

Nutrient application is not a substitute for timely
irrigation, late harvest, or failure to control insects, dis-
eases, weeds, or weeds. Soil properties, such as low pH
and/ or poor drainage, can be significant limiting factors in
obtaining high berry yields. Increasing fertilizer rates or
adding nutrients already in adequate supply will not cor-
rect these limiting factors.

Growers, with the assistance of county extension
faculty and field representatives, should consider: nutrient
needs of each field. Logically, collection and analysis of soil
and tissue samples are important in determining the need
for nutrient applications.

To assist with interpretation of soil and tissue analysis
data, keep records of weather, disease problems, nutri-
tent application rates, and timing. Observations of annual
growth (tree number, diameter, height, flower bud length,
yield, leaf color, and fruit quality (amount of red and
droplets on the berries) are also helpful in determining nutrient
needs.

The goal of fertilization for any high-value crop is to
remove limitations to yield and quality by supplying the
crop with ample nutrition in advance of demand. Nutrient
applications should be based on soil and plant analyses and
grower experience. Consider potential returns from your
fertilizer investment, as well as environmental steward-
ship and governmental regulations. A fertilizer application
should be "biologically sound and produce a measurable
change in plant growth or nutrient status. The biological
change caused by a fertilizer application is expected to
increase fruit yield or quality and produce a return on your
investment.

Canberry plants require chemical elements from air,
water, and soil to ensure adequate vegetative growth and
fruit production. When levels of these nutrients in the
plant are low, growth and yield may be affected. Severely
reduced nutrient supply can lead to visible nutrient defi-
cency symptoms such as leaf discoloration and distortion
(Figures 1 and 2). Routine collection and analysis of tissue
samples are important in determining nutrient needs.
Post-harvest Soil Nitrate Testing
for Manured Cropping Systems
West of the Cascades
D.M. Sullivan and C.G. Cogger

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What's in this publication?
This publication describes the use of post-harvest soil nitrate testing as a tool for assessment of nitrogen (N) management in manured cropping systems west of the Cascade Mountains in Oregon, Washington, and south coastal British Columbia.
The first section of this publication gives general information on the test and is designed for use by growers and dairy operators. This section gives a brief introduction to soil sampling, but does not provide all of the technical details. The focus is on how to use the post-harvest test to improve nutrient management. This section describes:
- What the post-harvest test measures
- How to collect soil samples
- Units used in soil nitrate testing
- How to interpret soil nitrate test results for grass and silage corn crops

In addition, background information explains the rationale for the test:
- How to use the post-harvest test as a management tool (page 3)
- Crop and soil response to excess plant-available N (page 4)

Dan M. Sullivan, Extension soil scientist, Oregon State University, and Craig G. Cogger, Extension soil scientist, Washington State University.

EM-8832-E
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