Fertilizer Management for Hop

Hop Production for the Craft Brew Industry
8th Annual Seminar, 2/25/17
Amherst, WI

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Soil Fertility/Nutrient Management Specialists
Situation

• Current UW guidelines for hop based upon old (1990) UW guidelines and more recent data from Pacific North West

Goal

• Collect preliminary data on crop nutrient removal and soil test levels to determine if A2809 needs to be updated
What did we do?

- Sampled at two locations
  - Waterloo
    - McHenry silt loam
    - pH = 6.5
    - OM = 2.6%
  - Rosholt
    - Graycalm loamy sand/Alban loam
    - pH = 5.7
    - OM = 1.5%
Plant Sampling

• Sampled above ground biomass and partitioned between cones and leaves/bines just prior to harvest
  • Collected 2 bines for each sample
  • Took 3 samples (replicates) for each variety

• Waterloo
  • Chinook
  • Sterling

• Rosholt
  • Sterling
  • Centennial
  • Willamette
Soil sampling

• Collected soil samples within 1’, and 3’ and 6’ from row for each variety
  • One 1 composite sample per variety per distance
  • 0-6” and 0-12” depth
Soil sampling results
Soil test P results

Waterloo soil test P declines as distance from row increases.
Soil test K results

**Rosholt**

Soil Test K, ppm

Distance from row, feet

**Waterloo**

Soil Test K, ppm

Distance from row, feet

Cen. 12"  Cen. 6"  Ster. 12"  Ster. 6"  Will. 12"  Will. 6"

Cen. 12"  Cen. 6"  Ster. 12"  Ster. 6"  Will. 12"  Will. 6"

No consistent effect of distance from row on soil test K at Rosholt.

Very limited sampling. Need to sample more to determine if/how general soil sampling guidelines should be modified for hop.
Yield
Yield

Cone Yield (fresh weight)

- ~ 6400 lb/ac average

Cone Yield (adjusted 10% moisture)

- ~ 1500 lb/ac average

- Fresh cone yield varied widely, from ~ 3859-9720 lbs/acre
- Differences are expected between our estimates and actual machine harvesting or hand-picking.
- Estimated yields are comparable to varietal yields reported in PNW.
Yield Estimates and PNW Yields

<table>
<thead>
<tr>
<th>Variety</th>
<th>WI(^1)</th>
<th>Idaho(^2)</th>
<th>Oregon(^2)</th>
<th>Washington(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sterling</td>
<td>1135 (2)</td>
<td>NA</td>
<td>1626</td>
<td>NA</td>
</tr>
<tr>
<td>Chinook</td>
<td>2299 (1)</td>
<td>1712/418</td>
<td>1675/107</td>
<td>1420/1415</td>
</tr>
<tr>
<td>Centennial</td>
<td>1229 (1)</td>
<td>NA</td>
<td>1235/723</td>
<td>1355/4359</td>
</tr>
<tr>
<td>Willamette</td>
<td>1611 (1)</td>
<td>NA</td>
<td>1573/883</td>
<td>1277/728</td>
</tr>
</tbody>
</table>

\(^1\) Estimated cone yield per acre adjusted to 10% moisture. Number of measurements shown in parentheses.

\(^2\) Cone yield per acre and acres reported, 2016 National Hop Report, USDA, NASS.
Biomass Yield

Average whole-plant DM yield = 5160 lb/ac

• Cones averaged 31% of total DM removed.
Nutrient Removal
Nitrogen

Redline indicates N recommendation, based on soil organic matter level.

Total N removed in corn silage can vary from 130 to 240 lb N/a.
Amount of N applied should NOT equal crop removal.

Soil supplies a lot of N on most of our soils!

This principal applies to all WI crops.
Nitrogen application guidelines

• Oregon State University research:
  • 10% of total N uptake by early June
  • N uptake increases rapidly in mid June & total N uptake is almost complete by early July
  • Split apply N on sandy soils
  • Initial N application should be made in April or May
  • 2\textsuperscript{nd} application approx. when vines meet wire

180 lb N/a if 2.0 to 9.9% OM
200 lb N/a if <2.0% OM
✓ Reduce rates by 50 lb N/a if residues are returned
Petiole nitrate test

• Oregon State Univ. guidelines to determine if additional N is needed in June.
  • Collect 40 petioles from recent fully developed leaves at eye level and composite into one sample
  • 5,000 to 9,000 ppm is adequate
    • No yield gain from additional N if petiole nitrate was in this range

• When using petiole nitrate test, apply about 70% of recommended N in April/May
  • If test indicated additional N is needed, apply remainder of recommended rate in June prior to increased demand
Relationship between soil test P & K and nutrient recommendations

<table>
<thead>
<tr>
<th>Soil Test Category</th>
<th>Nutrient Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Low</td>
<td>Crop Removal +</td>
</tr>
<tr>
<td>Low</td>
<td>Crop Removal</td>
</tr>
<tr>
<td>Optimum</td>
<td>½ Crop Removal</td>
</tr>
<tr>
<td>High</td>
<td>¼ Crop Removal</td>
</tr>
<tr>
<td>Very High</td>
<td></td>
</tr>
<tr>
<td>Excessively High</td>
<td></td>
</tr>
</tbody>
</table>
Phosphorus

Average whole plant removal (both sites) = 35.0 lb P2O5/ac

- Bine removal averaged 21 lbs P₂O₅ per acre.
- Current A2809 recommendation at optimum soil test level approximated P removal.
- More samples needed to verify relationship between soil test level and P₂O₅ recommendation.
## Phosphorus

<table>
<thead>
<tr>
<th>Soil Group</th>
<th>Very Low</th>
<th>Low</th>
<th>Optimum</th>
<th>High</th>
<th>Excessively High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loamy</td>
<td>&lt;10</td>
<td>10-15</td>
<td>16-20</td>
<td>21-30</td>
<td>&gt;30</td>
</tr>
<tr>
<td>Sandy, Organic</td>
<td>&lt;12</td>
<td>12-22</td>
<td>23-32</td>
<td>33-42</td>
<td>&gt;42</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Soil test P ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
</tr>
<tr>
<td>60</td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>15</td>
</tr>
<tr>
<td>0</td>
</tr>
</tbody>
</table>
Average whole plant removal (both sites) = 97.4 lb K2O/ac

- Bine removal averaged 63 lbs K₂O per acre.
- Current A2809 recommendation at optimum soil test level approximated K removal.
- More samples needed to verify relationship between soil test level and K₂O recommendation.
# Potassium

<table>
<thead>
<tr>
<th>Soil Group</th>
<th>Soil Test Category</th>
<th>Very Low</th>
<th>Low</th>
<th>Optimum</th>
<th>High</th>
<th>Excessively High</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Soil test K ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loamy</td>
<td>70-100</td>
<td>101-130</td>
<td>131-160</td>
<td>161-190</td>
<td>&gt;190</td>
<td></td>
</tr>
<tr>
<td>Sandy, Organic</td>
<td>45-65</td>
<td>66-90</td>
<td>91-130</td>
<td>--</td>
<td>&gt;130</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>lb K₂O/a to apply</th>
<th>130</th>
<th>100</th>
<th>50</th>
<th>25</th>
<th>0</th>
</tr>
</thead>
</table>
Sulfur & Zinc

Total S Removed at Harvest

- W-Sterling
- W-Chinook
- R-Sterling
- R-Centennial
- R-Willamette

Total Zn Removed at Harvest

- W-Sterling
- W-Chinook
- R-Sterling
- R-Centennial
- R-Willamette

Soil OM supplies S

Very small quantities of Zn are removed
Plant analysis for sulfur & micronutrients

- Soil tests for S and micros are not as reliable as soil tests for P, K, pH.

- Plant analysis can be used to evaluate crop. Exercise caution.
  - Best used as a comparison – good vs. poor
  - Will vary with variety in a field
  - Will vary between fields within a variety
  - Adequate ranges vary between growing regions

- Collect samples from 30+ newest mature leaves

### Plant Analysis Interpretation

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Sufficiency Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>N, %</td>
<td>2.5 - 3.5</td>
</tr>
<tr>
<td>P, %</td>
<td>0.35 - 0.6</td>
</tr>
<tr>
<td>K, %</td>
<td>2.8 - 3.5</td>
</tr>
<tr>
<td>Ca, %</td>
<td>1 - 2.5</td>
</tr>
<tr>
<td>Mg, %</td>
<td>0.3 - 0.6</td>
</tr>
<tr>
<td>S, %</td>
<td>0.18 - 0.3</td>
</tr>
<tr>
<td>Zn, ppm</td>
<td>35 - 80</td>
</tr>
<tr>
<td>B, ppm</td>
<td>25 - 70</td>
</tr>
<tr>
<td>Mn, ppm</td>
<td>30 - 100</td>
</tr>
<tr>
<td>Fe, ppm</td>
<td>35.4 - 151</td>
</tr>
<tr>
<td>Cu, ppm</td>
<td>6 - 12</td>
</tr>
</tbody>
</table>
Summary of Preliminary Data

• WI Hop yield estimates varied widely, but averages were comparable to yields in the PNW.

• Average P and K removal at harvest approximated recommendations at optimum soil test levels published in A2809.

• Current N recommendations may be a little high.

• Further data is needed to verify relationship between soil and/or plant tissue testing and current nutrient recommendations for Hop.

• Studying spatial variability of soil test levels could suggest a better soil sampling scheme.
Questions?

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A good nutrient management program starts with soil sampling

• Collect a sample of soil that represents your field
  • Take soil samples to 6-inch depth
  • Composite 10 to 20 cores from a 5-acre (or less) area to make one sample
    • Smaller sampling areas may be more appropriate depending on your operation
  • Sample once every 4 years at a minimum (every other year OK)
  • Ideally, collect samples at the same time of year

• Get the sample tested at a WI DATCP certified lab
  • http://uwlab.soils.wisc.edu

• Estimate the nutrients needed for crop production using test results
Nutrient crediting

• Credit nutrients from organic sources (manure, compost, etc) or if vines/leaves are returned to hop yard
  • Preliminary data indicate ~20 lbs P$_2$O$_5$ and 60 lbs K$_2$O/acre are potentially recyclable with bines.
  • Recommendations are for total amount of nutrients applied, not just commercial fertilizer

• Failure to credit organic sources can result in excess N and P and negative impacts on surface and groundwater quality
pH and liming

• *Proper soil pH is the cornerstone to a good fertility program*

• Minimum pH is 6.0

• Apply lime & incorporate before planting

• Pelletized lime must be applied at the same rates as ag lime to be effective!

<table>
<thead>
<tr>
<th>Soil pH</th>
<th>6.3</th>
<th>6.4</th>
<th>6.5</th>
<th>6.6</th>
<th>6.7</th>
<th>6.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tons/a of 60-69 grade lime to apply</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.4</td>
<td>4.5</td>
<td>3.7</td>
<td>3.0</td>
<td>2.2</td>
<td>2.0</td>
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<tr>
<td>5.5</td>
<td>4.1</td>
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<td>2.6</td>
<td>2.0</td>
<td>2.0</td>
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<tr>
<td>5.6</td>
<td>3.7</td>
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<td>2.2</td>
<td>2.0</td>
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<tr>
<td>5.7</td>
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</tr>
<tr>
<td>5.8</td>
<td>3.0</td>
<td>2.2</td>
<td>2.0</td>
<td>2.0</td>
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<td>2.0</td>
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