DEVELOPING A SUSTAINABLE NUTRIENT MANAGEMENT PLAN

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PLANT NUTRIENT REQUIREMENTS

- Essential macro and micronutrients

General recommendations for hops

<table>
<thead>
<tr>
<th>Stage</th>
<th>N</th>
<th>P</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>At planting</td>
<td>0-75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>At maturity</td>
<td>100-150</td>
<td>20-30</td>
<td>80-150</td>
</tr>
</tbody>
</table>

* lbs/acre recommended rates for hops in the PNW

Only gets you in the ballpark!
FACTORS AFFECTING FERTILITY MANAGEMENT

- Soil type
- Soil test results
- Environmental conditions
- Age and productivity of the hop plant
- Hop variety
- Fertilizer type
CONSEQUENCES OF OVER-APPLICATION

- Excessive vegetative growth
- Nutrient imbalances
- Increased pest susceptibility
- Reduced cone quality

Aphids
CONSEQUENCES OF OVER-APPLICATION

Average Pounds Per Acre

- < 0.2
- 0.2 - 1.9
- 2 - 2.4
- Greater than 95% Federal at risk
- All no exceed in the 7 crease of
  makes require zero
- N/A: 7 geop boundaries

* Cyrus, Sedge, Wheat, Cotton, Barley, Tobacco and Rice, using average yield over 1992 to 1994
OUTLINE

- Soils 101
- Understanding fertility needs and fertility sources
- Soil and plant tissue testing
- Sample hop fertility management plan
SITE CHARACTERISTICS

- Hops must be grown in well-drained soil
- “Deep, well-drained sandy loam soils”
SOIL TEXTURE

- Proportion of sand, silt, and clay in your soil
- Influences physical, chemical and biological properties
- Function of the soils parent material
- Virtually unchangeable expect through erosion
- Important for soil test interpretation
SOIL TAXONOMY

- Natural Resource Conservation Service (NRCS) web soil survey
- Phase name (ie. Tifton loamy sand)
  - series name (Tifton) – lowest level of classification, usually local
  - texture

http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm
SOIL STRUCTURE (OR TILTH)

- Arrangement of soil particiles in to aggregates
- **Aggregates**: groups of soil particles cohering to each other, sometimes in clusters
- Affects plant growth and potential for soil erosion
- *Can be improved by adding soil organic matter, and reducing soil traffic*
SOIL ORGANIC MATTER

*Feed the soil to feed the plant*

- The soils “nutrient bank account”
  ~ 10-20 lbs N/ac for each % SOM
- Retains soluble nutrients
- Improves soil physical structure
- Food source for soil biota
- ~ 2.2 tons/ac needed annually for maintenance
SOIL PH

- Measure of acidity or alkalinity of the soil
- Key factor regulating nutrient availability
  - too low → Mn becomes toxic
  - too high → Zn is not available
- Optimal range for hops 6.0-6.5
- Increase pH by adding lime or wood ash
- Decrease pH by adding sulfur
UNDERSTANDING FERTILITY NEEDS AND DIFFERENT FERTILITY SOURCES
NITROGEN

- Most difficult nutrient to manage
- N budgets used to estimate fertility rate
- Based on plant uptake and all available N sources
- Application timing is key to optimize uptake, and avoid negative environmental impacts
NITROGEN

- General recommendation at full production
  -100 to 150 lbs/A (takes ~ 4 years to get to full production)

- Timing \( \rightarrow \) just before crop needs it
  - mid-May to mid-June (do not apply after July)
  - pre-sidedress nitrate test (2-4 weeks before rapid uptake)
  - split applications recommendation

- Fertigation
PHOSPHOROUS

- Hops do not require high levels of P to obtain good yields
  - 20 to 30 lbs/acre recommended at full production
- P needs are small relative to N and K
  - avoid over-application
- At optimum soil P (11 to 20 ppm for silt loams, and 23 to 32 ppm for sands) – apply 30 lbs to replace P removed at harvest
POTASSIUM

- General recommendation at full production - 80 to 150 lbs/ac
- Higher rates are needed on soils with higher clay and organic matter content
- Split applications recommended on light textured soils

<table>
<thead>
<tr>
<th>Soil test K (ppm)</th>
<th>Application on a sand soil</th>
<th>Application on a silt-loam soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-90</td>
<td>80-150</td>
<td>100-150</td>
</tr>
<tr>
<td>90-125</td>
<td>optimum 40-60</td>
<td>80-100</td>
</tr>
<tr>
<td>125-200</td>
<td>0-20</td>
<td>optimum 40-60</td>
</tr>
<tr>
<td>200+</td>
<td>do not apply</td>
<td>0-20</td>
</tr>
</tbody>
</table>
OTHER FERTILITY NEEDS

- **Boron**
  - delayed shoot emergence/lots of buds on crown
  - small, distorted, chlorotic leaves/shortened internodes
  - soil tests
    - <1.5 ppm apply 1-1.5 lbs per acre
    - >1.5 no need to apply (*toxic is excess*)

- **Zinc**
  - chlorotic, cupped leaves/long and weak shoots
  - acidic, sandy with low organic matter or high soil P
CONVENTIONAL OR INORGANIC FERTILIZERS

- Generally considered to be 100% available for crop uptake
- Wide variety of different sources and concentrations (call your local county extension educator for advice)
- Know your fertilizer and target for each nutrient
  - example: 10 lbs N, 10 lbs K, 10 lbs/100 lbs of fertilizer
    - 150 lbs N → apply 1500 lbs of 10-10-10 fertilizer
    = 150 lbs P!!
ORGANIC FERTILIZERS

- Only a fraction of total nutrients will be available during the first year
- Rate depends on carbon:nitrogen ratio and environmental conditions
- Wide variability among sources
  - raw manure (yr. 1 50-60%)
  - compost (yr. 1 10-15%)
- Commercially available sources
  - $5 to $187 per pound N

<table>
<thead>
<tr>
<th>Amendment</th>
<th>N</th>
<th>P₂O₅</th>
<th>K₂O</th>
<th>Relative availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa Meal</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>med-slow</td>
</tr>
<tr>
<td>Blood Meal</td>
<td>12-15</td>
<td>1.5</td>
<td>0.6</td>
<td>med-rapid</td>
</tr>
<tr>
<td>Bonemeal</td>
<td>0.7-4.0</td>
<td>11-34</td>
<td>0</td>
<td>slow-med</td>
</tr>
<tr>
<td>Feather Meal</td>
<td>10-15</td>
<td>0</td>
<td>0</td>
<td>slow-med</td>
</tr>
<tr>
<td>Fish Emulsion</td>
<td>3-5</td>
<td>2</td>
<td>2</td>
<td>med-rapid</td>
</tr>
<tr>
<td>Kelp</td>
<td>0.9</td>
<td>0.5</td>
<td>1-4</td>
<td>slow</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>7</td>
<td>2</td>
<td>1</td>
<td>med-rapid</td>
</tr>
</tbody>
</table>
SOIL AND PETIOLE TESTS
SOIL TESTS

- Sample at the same time each year and use the same lab every year
- Collect representative samples around hop plants
  - same soil type/management practices/crop yield
  - avoid irregular areas
  - collect multiple cores and pool for analyses
    - 10-20 cores per 5-10 acre field
- Follow recommendations of your soil testing lab for depth and transport conditions
PETIOLE TESTS

- Collect sample when bines reach ½ way up the trellis
- Collect mature leaves, 5-6’ high from the ground, pool 30-50 petioles per variety/representative area
- Compare results with previous years/problem areas
- General nitrate recommendations
  - **Low**: 0-6000 ppm
  - **Normal**: 6000-10000 ppm
  - **Plenty**: 10000+ ppm
    - *Depends on variety* →
    - Handheld nitrate meters

<table>
<thead>
<tr>
<th>Variety</th>
<th>Optimal range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cascade</td>
<td>9000-12000 ppm</td>
</tr>
<tr>
<td>Nugget</td>
<td>8000-16000 ppm</td>
</tr>
<tr>
<td>Centennial</td>
<td>5000-13000 ppm</td>
</tr>
<tr>
<td>Mt. Hood</td>
<td>6000-10000 ppm</td>
</tr>
</tbody>
</table>
**VISUAL SYMPTOMS OF DEFICIENCY**

- **Nitrogen deficiency**  
  Small, pale green, becoming yellow, petiole red tints

- **Potassium deficiency**  
  Small, bluish green, may be slightly chlorotic near margin, brown scorch at margins

- **Magnesium deficiency**  
  Striking marginal and intervenal chlorosis and necrosis (high pH soil)

*Symptoms will appear first on older leaves first*  
*Symptoms appear in young leave first*
RECORD KEEPING

- When did the plants emerge?
- When did you train/harvest?
- What was the rainfall and temperature conditions?
- Nutrient deficiency symptoms?
- Pest problems?
- Problematic areas in the field?
- Soil and petiole test results
- Yield and hop cone quality

"Oh, so you do keep track of where you bury things."
SAMPLE FERTILITY MANAGEMENT PLAN
Purdue Meigs Hop Yard

- **Cascade**
  - 2015 (Year 2)
    - 50% of total yield expected
    - 740 lbs dry hops/acre
    - Petiole nitrate test results → 11963 ppm
  - 2016 (Year 3)
    - 75% total of total yield expected
    - ~1110 to 1390 lbs dry hops/acre
2016 FERTILITY MANAGEMENT PLAN

- **Drummer silt loam**
- **Fall soil test results**

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>%OM</th>
<th>P1</th>
<th>P2</th>
<th>K</th>
<th>Mg</th>
<th>Ca</th>
<th>%K</th>
<th>%Mg</th>
<th>%Ca</th>
<th>%H</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.7</td>
<td>2.6 M</td>
<td>23 H</td>
<td>33 M</td>
<td>141 H</td>
<td>279 VH</td>
<td>1757 H</td>
<td>3.1</td>
<td>20.2</td>
<td>76.7</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

- **Nitrogen target rate** (75% of 150 lbs/A ~ 112.5 lbs/A)
  - Soil organic matter (~10-20 lbs N/A for each % SOM)
  - 2.6% X 15 lbs = **39 lbs N/A**
  - N fertilizer needed (112.5 - 39 = 73.5 lbs/A) → mid-May 36.7 lbs., Jun 1 - 18.4 lbs., Jun 15 - 18.4

- **Phosphorous target rate**
  - 75% of 30 lbs/A = 22.5 lbs/A → optimum soil test level, so target application **22.5 lbs/A**

- **Potassium target rate**
  - 75% of 60 lbs/A = 45 lbs/A → optimum soil test level, so target application **45 lbs/A**