Fertilizers and nutrient management for hops

Diane Brown, Michigan State University Extension

10-5-5 Guaranteed Analysis

- Ammoniacal Nitrogen: 4.5%
- Nitric Nitrogen: 0.5%
- Organic Nitrogen (derived from urea): 5.0%
- Total Nitrogen: 10%
- Phosphoric Acid (Available, derived from superphosphate): 5.0%
- Potash (Water soluble from Potassium sulfate): 5.0%
Pre-plant nutrient management for hops

- Soil test!
- Correct major issues before planting
- pH 6.2 to 6.5
- Lime season before if necessary
- Make sure all nutrients in optimum range
# Soil pH and Nutrient Availability

## Table 1. Soil pH and Interpretation

<table>
<thead>
<tr>
<th></th>
<th>5.0</th>
<th>5.5</th>
<th>6.0</th>
<th>6.5</th>
<th>7.0</th>
<th>7.5</th>
<th>8.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acid</td>
<td>Strongly Acid</td>
<td>Medium Acid</td>
<td>Slightly Acid</td>
<td>Slightly Acid</td>
<td>Neutral</td>
<td>Mildly Alkaline</td>
<td>Moderately Alkaline</td>
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</table>

Best Range for Most Crops
Why pH matters

• soil pH affects the abundance of microorganisms.
• Bacteria are generally more prevalent in alkaline soils and fungi dominate in acidic soils.
• This is important because microbes are responsible for the cycling of nutrients.
• The most diverse and numerous populations are found in near-neutral soils
The Influence of Soil pH on Nutrient Availability

<table>
<thead>
<tr>
<th>RANGE OF ACIDITY</th>
<th>RANGE OF ALKALINITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>NITROGEN</td>
<td></td>
</tr>
<tr>
<td>PHOSPHORUS</td>
<td></td>
</tr>
<tr>
<td>POTASSIUM</td>
<td></td>
</tr>
<tr>
<td>SULFUR</td>
<td></td>
</tr>
<tr>
<td>CALCIUM</td>
<td></td>
</tr>
<tr>
<td>MAGNESIUM</td>
<td></td>
</tr>
<tr>
<td>IRON</td>
<td></td>
</tr>
<tr>
<td>MANGANESE</td>
<td></td>
</tr>
<tr>
<td>BORON</td>
<td></td>
</tr>
<tr>
<td>COPPER &amp; ZINC</td>
<td></td>
</tr>
<tr>
<td>MOLYBDENUM</td>
<td></td>
</tr>
</tbody>
</table>
Adjusting Soil pH

- Easiest pre-plant
- Soils will progressively acidify with normal farming practices
- Low pH- use lime
- dolomitic lime also adds Ca and Mg
- Low pH- aluminum toxicity and P deficiency
Liming the Hopyard

- Add in fall
- Add prior to planting of yard if possible
- Mix into soil will react faster
fertility

• Test the soil annually
• around 100 pounds of nitrogen per acre (lb N/acre) are removed on average during hop harvest.
• typical first-year N rates are 75 lb N/ acre; in subsequent years, 100 to 150 lb N/acre.
• Low phosphorus requirements- 20-30 lb P/A
• Potassium- 80-150 lb/A
Effect of fertilizers on soil pH

• Ammonium (NH4+) or ammonium forming fertilizers (ex. urea) will cause a decrease in soil pH over time.

• Nitrate (NO3-) sources carrying a basic cation should be less acid-forming than NH4+ fertilizers.

• The presence of Ca, Mg, K, and Na in the fertilizer will slightly increase or cause no change in soil pH.

• Elemental sulfur, ammonium sulfate, and compounds such as iron can reduce the soil pH
Nutrient Sources

- Bines and leaves returned to field *use caution*
- Composts
- Animal manure
- Organic Bagged Fertilizers
- Synthetic Fertilizers
Reading a fertilizer label- what’s in a bag?

• Product or brand name
• N-P-K grade %(by weight) of the three major nutrients in a fertilizer.
• Guarantees for Total Nitrogen (N), Available Phosphate (P2O5) and Soluble Potash (K2O)
  Example: 12-15-24 means 12% nitrogen, 15% available phosphate, and 24% soluble potash
• Net weight
• Guaranteed analysis
Guaranteed analysis

<table>
<thead>
<tr>
<th>Element</th>
<th>Agricultural Fertilizers (percent)</th>
<th>Specialty Fertilizers (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium (Ca)</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>1.00</td>
<td>0.50</td>
</tr>
<tr>
<td>Sulfur (S)</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Boron (B)</td>
<td>0.125</td>
<td>0.02</td>
</tr>
<tr>
<td>Chlorine</td>
<td>-</td>
<td>0.10</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>0.05 (chelate 0.10)</td>
<td>0.50</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Molybdenum (Mo)</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>0.50 (chelate 0.125)</td>
<td>0.50</td>
</tr>
</tbody>
</table>
Fertilizer and nutrients

• Organic or conventional?
• organic- can be difficult to supply nitrogen requirements
• USDA national organic program:
  • [http://www.ams.usda.gov/AM Sv1.0/nop](http://www.ams.usda.gov/AM Sv1.0/nop)
• Template for organic USDA certification:
Fertilizer and nutrients

- USDA national organic program:
  - http://www.ams.usda.gov/AMSv1.0/nop
- OMRI approved fertilizers:
  - http://www.omri.org/simple-opl-search/results/fertilizer
Organic Fertilizers

- Manures, composts, worm castings
- Often high in phosphorus
- Have them tested
- Commercially prepared bulk sources available
Organic Fertilizers- what’s acceptable

- Naturally occurring fertilizers or amendments

<table>
<thead>
<tr>
<th>Mined or Mineral Sources</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>lime - carbonate, not hydrated or burnt</td>
<td></td>
</tr>
<tr>
<td>gypsum - calcium sulfate</td>
<td></td>
</tr>
<tr>
<td>rock phosphate - calcium phosphate</td>
<td></td>
</tr>
<tr>
<td>greensand - potassium (0-0-7)</td>
<td></td>
</tr>
<tr>
<td>potassium sulfate (0-0-50)</td>
<td></td>
</tr>
<tr>
<td>potassium magnesium sulfate (0-0-21)</td>
<td></td>
</tr>
<tr>
<td>basalt rock powder</td>
<td></td>
</tr>
<tr>
<td>granite rock powder (5-10% K₂O)</td>
<td></td>
</tr>
</tbody>
</table>
Organic Fertilizers - what’s acceptable

• Naturally occurring fertilizers or amendments

<table>
<thead>
<tr>
<th>Animal Derived Sources</th>
<th>Material</th>
<th>Release time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>bone meal (6-12-0)</td>
<td>1-4 mo.</td>
</tr>
<tr>
<td></td>
<td>blood meal (12-0-0)</td>
<td>1- 4 mo.</td>
</tr>
<tr>
<td></td>
<td>fish emulsion (5-2-2) adds micronutrients</td>
<td>1-4 mo.</td>
</tr>
<tr>
<td></td>
<td>fish meal (10-6-2)</td>
<td>1-4 mo.</td>
</tr>
<tr>
<td></td>
<td>feather meal varies- N content 7- 12%</td>
<td>1-4 mo.</td>
</tr>
<tr>
<td></td>
<td>manure - many types</td>
<td>4+ mo.</td>
</tr>
<tr>
<td></td>
<td>3 to 5 ft³ per year</td>
<td></td>
</tr>
<tr>
<td></td>
<td>worm castings</td>
<td></td>
</tr>
</tbody>
</table>
Organic Fertilizers—what’s acceptable

- Naturally occurring fertilizers or amendments

<table>
<thead>
<tr>
<th>Plant Derived Sources</th>
<th>Release time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Material</strong></td>
<td></td>
</tr>
<tr>
<td>alfalfa meal (3-0.5-3)</td>
<td>1-4 mo.</td>
</tr>
<tr>
<td>soybean meal (6-1.4-2)</td>
<td>1-4 mo.</td>
</tr>
<tr>
<td>cotton seed meal (6-2-2)</td>
<td>1-4 mo.</td>
</tr>
<tr>
<td>kelp meal (negligible- for trace elements)</td>
<td>4+ mo.</td>
</tr>
<tr>
<td>Kelp powder (1-0-4)</td>
<td>immed. – 1 mo</td>
</tr>
<tr>
<td>wood ash (liming action)</td>
<td>~1/2 the liming value of ag lime</td>
</tr>
<tr>
<td>composts (typ. 1.5-3.5% N, 0.5-1% P, 1-2% K) watch salts!</td>
<td>Very slow</td>
</tr>
</tbody>
</table>
Approximate nutrient content of manure

<table>
<thead>
<tr>
<th>type</th>
<th>with bedding</th>
<th>N</th>
<th>P</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy cattle</td>
<td>with bedding</td>
<td>0.5%</td>
<td>0.2%</td>
<td>0.5%</td>
</tr>
<tr>
<td></td>
<td>without bedding</td>
<td>0.5%</td>
<td>0.2%</td>
<td>0.5%</td>
</tr>
<tr>
<td>Horse</td>
<td>with bedding</td>
<td>0.7%</td>
<td>0.2%</td>
<td>0.7%</td>
</tr>
<tr>
<td>Poultry</td>
<td>with litter</td>
<td>2.8%</td>
<td>2.3%</td>
<td>1.7%</td>
</tr>
<tr>
<td></td>
<td>without litter</td>
<td>1.7%</td>
<td>2.4%</td>
<td>1.7%</td>
</tr>
</tbody>
</table>

Approximately 30-50% of N available in the first year

Non-composted manure- 120 day pre-harvest interval

http://msue.anr.msu.edu/news/fall_manure_application_tips
Want to make your own compost?

- **Compost production and use** - John Biernbaum and Andy Fogiel, Department of Horticulture, Michigan State University
- [www.safs.msu.edu/soilecology/pdfs/Combined%20Compost05.doc](http://www.safs.msu.edu/soilecology/pdfs/Combined%20Compost05.doc)
Synthetic Fertilizers

- Nitrogen sources
- Urea- 46-0-0- converts to NH+ in 2-3 d
  - coated ureas- sulfur coated, CoRoN, Nutralene, N-Sure
- Ammonium nitrate 33-0-0
- Ammonium sulfate- 21-0-0 highly acidifying
- Calcium nitrate 16-0-0
- Potassium nitrate 13-0-44 low salt index
Synthetic Fertilizers

Common Phosphorus sources
• Triple superphosphate 0-46-0
• Diammonium phosphate 18-46-0
• Monoammonium phosphate 11-48-0
Synthetic Fertilizers

Common potassium sources

• potassium chloride 0-0-60 or 0-0-62  **not recommended**
• Potassium sulfate 0-0-50
• Potassium magnesium sulfate 0-0-22
  Mg-11.2%, S-22.7%
• Potassium nitrate 13-0-44
• ! Excessive potassium can lead to Mg deficiency
Hop Requirements

VARIES SLIGHTLY BY VARIETY

• 3% Nitrogen
• 2% Potassium
• 0.50% Phosphorus

• Other important nutrients
  – Boron
  – Zinc
Hops Nitrogen requirements

• 60 to 150 lbs of actual N per acre
• Apply in late May to mid June
• Base rate of application on yields
• Also consider soil type
  – Levels of organic matter-
  – 20 lb N / % OM / Ac / Yr

hop N requirement- (N from manure + returned bines, + cover crops) = fertilizer N to apply
First Year Hop Requirements

PRODUCE 1750 LBS DM/acre

- 3.0% Nitrogen = 55 Lbs
- 2.0% Potassium = 35 Lbs
- 0.50% Phosphorus = 9 lbs
Hop Requirements

PRODUCE 5000 LBS DM/acre
- 3.0% Nitrogen = 150 Lbs
- 2.0% Potassium = 100 Lbs
- 0.50% Phosphorus = 25 lbs

CONES 1/3 to 1/2 of DM/acre
- 3.0% Nitrogen = 75 Lbs
- 2.0% Potassium = 50 Lbs
- 0.50% Phosphorus = 12.5 lbs
Yields?

You Should Know Cone Yields

1000 lbs dry cones per acre

30 to 50% of total weight

2000 to 3000 lbs total

60 to 90 lbs of N removed
Phosphorus

- Phosphorus (0 to 80 lbs/acre)
- Will depend on Al levels in soil and pH
- Will depend on soil test levels

Watch excessive P levels in soils - ZN deficiency
Potassium

- Potassium (0 to 160 lbs/acre)
- Will depend on soil type
- Will depend on yield
- Also depends on soil levels

**For potash**

<table>
<thead>
<tr>
<th>Category</th>
<th>Low</th>
<th>Medium</th>
<th>Optimum</th>
<th>High</th>
<th>V. High</th>
</tr>
</thead>
<tbody>
<tr>
<td>K (ppm)</td>
<td>0–50</td>
<td>51–100</td>
<td>101–130</td>
<td>131–160</td>
<td>&gt;160</td>
</tr>
<tr>
<td>K to apply</td>
<td>120–150</td>
<td>80–120</td>
<td>60–80</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Boron

• Boron deficiency in hops
• Symptoms
  – Delayed emergence of shoots
  – Small, distorted, chlorotic leaves
  – Shortened internodes
  – Lots of buds on the crown at ground level

Photos: Compendium of hop diseases
Boron

• Boron deficiency in hops-Based on soil test results
• $< 1.5$ ppm apply 1.0-1.5 lb/A
• $> 1.5$ ppm no need to apply
• Can be toxic if applied in excess!
Zinc

- Deficiency symptoms-
  - Chlorotic leaves
  - Long shoots with very small, cupped, with deeply cut lobes
  - Weak lateral and bine growth,
  - Acid, sandy soils low in organic matter neutral to alkaline soils or high in P

Photos: Compendium of hop diseases
Zinc

• Foliar application of zinc sulfate (0.15-0.18%).
• or If Zinc is low add 2 to 4 lbs per acre
• Will need to put through irrigation or blend with other fertilizer
Information sources:

Heather Darby, University of Vermont, Building a Hop Industry In New England, powerpoint presentation, August, 2013


Using composts in the home garden, Colorado Master Gardener Note#243 http://www.ext.colostate.edu/mg/gardennotes/243.html

Organic fertilizers, Colorado Master Gardener Note #234 http://www.ext.colostate.edu/mg/gardennotes/234.html

Michigan State University Soil and Plant Nutrient Laboratory http://www.spnl.msu.edu/
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