Malting Barley Nutrient Management

Bill Verbeten
Cornell Cooperative Extension
NWNY Dairy, Livestock, & Field Crops Team
Take Home Points

- Barley is not tolerant of acidic soils.
- Nitrogen management is critical for yield, CP content, & kernel plumpness.
- Phosphorus is key to winter barley establishment & survival.
- Potassium is vital to overall plant health, grain fill, & disease resistance.
- Sulfur response is likely, but application is not recommended for distilling grains.

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pH for Malting Barley

- Lime to at least pH 6.3

- Barley cannot tolerate low pH like some other small grains
Sampling Soil

- Take 2-3 samples per acre up to 10-15 acres for each sample.

- Sample different soil types/drainage areas separately.

- Regularly sample fields every 3-4 years at the same time of the year.

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Sampling Soil

- pH & K vary throughout the growing season. Kentucky
Correcting Soil pH

- Liming & fertilizer recommendations on soil test report.

- No yield or quality responses to changing base saturation ratios of Ca, Mg, & K.

- Increasing pH (up to 7.0) increases nutrient availability.

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Crop Removal of Nutrients

Source: Reference Sufficiency Ranges for Plant Analysis in the Southern US

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Malting Barley Nutrient Removal

- 100 bu of grain & 2.5 tons of straw/A removes

- **N** 100 lb./A
- **P$_2$O$_5$** 40 lb./A
- **K$_2$O** 80 lb./A
- **S** 14 lb./A
- **Zn** 0.22 lb./A

Franze & Gerwing 1997. University of Nebraska

- Typical yields are 70-80 bu/A for winter barley & 50-60 bu/A spring barley.

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Malting Barley Fertility

- Goal: healthy, disease-free, high-yielding grain with CP 9-12% DM.
Malting Barley Yield from N

- **Oregon State**
  - ~1 to 1.5 lb N/bu

- **Montana**

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CP & Nitrogen

- CP increases as soil N+ fertilizer increases

- **Oregon State**

- ~0.5%-1.5% CP for 50 lb./A

- **Montana**

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Kernel Plumpness & N

- More N will decrease kernel plumpness

- Montana

- Oregon State

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Malting Barley & Nitrogen

- Between **70-100 lb./A** nitrogen from all sources will likely achieve reasonable yields, protein, & plumpness.

- Need to **account for all nitrogen contributions**- soil OM, manure, legumes
<table>
<thead>
<tr>
<th>Soil Mgt. Group</th>
<th>Crop</th>
<th>Nitrogen (N)</th>
<th>Phosphorus (P$_2$O$_5$)</th>
<th>Potassium (K$_2$O)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Manure</td>
<td>Manure</td>
<td>Very Low</td>
<td>Low</td>
</tr>
<tr>
<td>I</td>
<td>Winter barley</td>
<td>40–60</td>
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Nitrogen Mineralization

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## Tiller Counts

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Sand</th>
<th>Silt</th>
<th>Loam</th>
<th>Clay</th>
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<tbody>
<tr>
<td>Tillers/plant</td>
<td>N to apply lb./A</td>
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<tr>
<td>1-3</td>
<td>36</td>
<td>45</td>
<td>45-62</td>
<td>53-71</td>
</tr>
<tr>
<td>4-6</td>
<td>22</td>
<td>31</td>
<td>31-45</td>
<td>40-53</td>
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<tr>
<td>6+</td>
<td>13</td>
<td>22</td>
<td>27-36</td>
<td>36-45</td>
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</tbody>
</table>

Getreide anbauen wie die Profis: Bestände aufbauen, führen, schützen.

Growing grains like the professionals: Establishing stands, directing, & protecting

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Nitrogen

- Organic Sources:
  - Manure
  - Hay or legume credit?
  - Organic fertilizer ~5-10 lb./100 lb. of product
  - Chilean nitrate, NaNO₃ 16-0-0

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Nitrogen

- Conventional Sources:
  - Urea, UAN, AMS, etc.
  - Enhance efficiency products

- Apply early, not late

- Apply with stream bars
Bottom line:

- Most malting barley fields will need **10-60 lb./A of nitrogen applied**.
- Apply 10-20 lb./A at fall planting, remainder early spring at green up.
- **70-100 lb./A of nitrogen from all sources** should meet yield & quality goals.

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Phosphorus

- P placement and amount critical for small grain establishment, winter survival, & yield.

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Phosphorus

- Place P with the barley seed, band, or work P fertilizer into ground prior to planting

- `0.3-0.35 lb. P₂O₅ removed/bu

- Keep pH 6.2-7.0
  - Max P available
## Modified Table 5.5.1. Fertilizers for small grains

<table>
<thead>
<tr>
<th>Soil Mgt. Group</th>
<th>Crop</th>
<th>Fertilizer Nutrients to be Added (lb./A)</th>
<th>No Manure</th>
<th>Manure</th>
<th>Soil Test Levels&lt;sup&gt;3&lt;/sup&gt;</th>
<th>Soil Test Levels&lt;sup&gt;3&lt;/sup&gt;</th>
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<tr>
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<td>Nitrogen (N)</td>
<td>No</td>
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</tbody>
</table>
Phosphorus

- Organic Sources
- Manure/Compost
  - Apply in fall
- Organic fertilizer
  - ~0-5 lb./100 lb. of product
- Rock Phosphate & bone meal?
  - Low availability 10-20%
  - P Not available ≥7.0
  - More P available <6.0

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Phosphorus

- Conventional Sources
  - Superphosphate, MAP, DAP—highly available P
  - Made from rock phosphate treated with strong acid.

- Can easily apply with seed at planting.

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Potassium

- Deficiencies can lead to
  - Poor root growth
  - Restricted leaf development
  - Fewer grains per head
  - Smaller grain size affecting both yield & quality
  - More vulnerable to drought, frost and waterlogging as well as pests and diseases.

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Barley Diseases

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<td></td>
</tr>
</tbody>
</table>

\(^1\) Bill Verbeten Cornell Cooperative Extension
Potassium

- Organic Sources:
  - $K_2SO_4$
    - 50 lb. $K_2O + 17$ lb. $S$
  - K-Mag
    - 22 lb. $K_2O$
  - Manure
  - Organic fertilizer
    - ~0-5 lb. / 100 lb.

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Potassium

- Conventional Sources: KCl
  - Cl\(^{-}\) is universal present
    - in soils (~100 ppm or 200 lb/acre)
    - In manure 5-10 lb./ton
  - Cl\(^{-}\) rapidly leaches from the soil
  - Cl\(^{-}\) doesn’t not decrease biological activity

- Chlорine gas (Cl\(_2\)) does not occur naturally.

- KCl does have a higher salt index than other fertilizers and should be limited in furrow with seed.

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Barley & Chlorine

- Low sensitivity—tolerate up to 4% DM, some other crops sensitive to 0.5 to 2.0% DM.

- Slight yield increases out west where soil tests are low.

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Sulfur

- Barley may respond to 10-20 lb./A.
- Don’t apply on grain for distilling.
Calcium & Magnesium

- Soils supply high rates of these nutrients (and Potassium).
- Regular liming with dolomitic limestone replaces removal rates
- 5 tons DM of grass only removes 150 lb./ac of Ca and 30 lb./acre of Mg.
- Some crops may respond to foliar Mg if tissue tests are low.

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Manganese

- pH >6.5 & low soil levels, Delaware

- Corn starter N acidified soil, made Mn available on 30 in. centers

- Standard N stunted between rows, foliar Mn rescued.

- Broadcast 30 lb./A Mn pre-plant or foliar apply 1-2 lb./A at V5.
Boron, Zinc, Copper

- Response is most likely
  - on sandy soils
  - muck soils
  - no history of manure
  - extreme soil pH (<5.0 & >7.0)

- Response to foliar spray possible.

- 5 tons DM of grass only removes about
  - 0.4-0.5 lb./A Boron
  - 0.2-0.30 lb./A Zinc

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Tissue Sampling Timing

- More samples taken than soil samples to account for variability, usually 30+ plants/field
- Sample from “good” and “bad” areas separately
- Samples need to be air-dried in a paper bag prior to shipping
Tissue Sampling Timing

- Needs to be at *proper plant growth stage*

- May be *too late to correct* if sampled at a later growth stage.

- *Soil sampling* is often done at the *same time* for comparison

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Methods-Tissue Sampling

- **Small Grains**
  - Sample 25-35 areas of field

- **Prior to Stem Elongation**
  - All the above ground tissue
  - 50-75 plants

- **Prior to Heading**
  - Top 4 leaf blades with leaf collar visible
  - 30-40 plants
Methods-Tissue Sampling

- Small Grains
  - Response common for **N, S, Mg, Cu, Zn, & possibility Mn.**
Nutrient Tissue Levels in Small Grains

<table>
<thead>
<tr>
<th></th>
<th>N %</th>
<th>P %</th>
<th>K %</th>
<th>Ca %</th>
<th>Mg %</th>
<th>S %</th>
<th>B ppm</th>
<th>Zn ppm</th>
<th>Cu ppm</th>
<th>Mn ppm</th>
<th>Fe ppm</th>
<th>Mo ppm</th>
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<tbody>
<tr>
<td>1</td>
<td>2.0-2.7</td>
<td>0.1-0.5</td>
<td>1.0-3.0</td>
<td>1.0</td>
<td>0.15-1.0</td>
<td>N/A</td>
<td>3-40</td>
<td>10-70</td>
<td>3-10</td>
<td>15-200</td>
<td>25-300</td>
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<td>2</td>
<td>4.0-5.0</td>
<td>0.2-0.5</td>
<td>2.5-5.0</td>
<td>0.2-1.0</td>
<td>0.14-1.0</td>
<td>0.15-0.65</td>
<td>1.5-4.0</td>
<td>18-70</td>
<td>4.5-15</td>
<td>20-150</td>
<td>30-200</td>
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<td>3</td>
<td>4.0-5.0</td>
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<td>30-200</td>
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<td>4</td>
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<td>15-70</td>
<td>5-25</td>
<td>25-100</td>
<td>50-150</td>
<td>N/A</td>
</tr>
</tbody>
</table>

1: *Ontario*: Prior to flowering sample four upper leaves and flag leaf. Critical to normal concentrations listed.
2: *Kentucky*: Seedling (before jointing) sample whole plant. Sufficiency range listed.
3: *Kentucky*: Flowering, sample flag leaf only. Sufficiency range listed.
4: *Oklahoma*: Seedling stage sample whole plant. Prior to heading sample four uppermost leaves. Sufficiency levels listed (seedling stage-prior to heading).

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Take Home Points

- Barley is not tolerant of acidic soils.
- Nitrogen management is critical for yield, CP content, & kernel plumpness.
- Phosphorus is key to winter barley establishment & survival.
- Potassium is vital to overall plant health, grain fill, & disease resistance.
- Sulfur response is likely, but application is not recommended for distilling grains.

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Questions?
How Lime Works

\[ \text{Acid Soil} \quad \begin{align*}
H^+ + CaCO_3 & \quad (\text{Calcium Carbonate}) \\
Al^{3+} & \quad \text{Exchange} \\
Ca^{2+} & \quad \text{Neutral Soil}
\end{align*} \]

\[ \text{Step 1} \]

\[ \text{Neutralization} \quad \begin{align*}
+ H^+ + Al^{3+} + HCO_3^{2-} & \\
Al(OH)_3 + CO_2 + H_2O & \quad \text{Neutral Compounds}
\end{align*} \]
## Liming Materials

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Chemical Formula</th>
<th>CCE</th>
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<tbody>
<tr>
<td>Calcitic Limestone</td>
<td>CaCO₃</td>
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<tr>
<td></td>
<td>MgCO₃</td>
<td>119</td>
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<tr>
<td>Burned Lime, Quick Lime</td>
<td>CaO</td>
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<tr>
<td>Hyrdated Lime, Slack Lime</td>
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<td>Dolomitic Limestone</td>
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<td>CaSiO₃</td>
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<tr>
<td>Wood Ash</td>
<td>Variable</td>
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</tr>
</tbody>
</table>

- Increases mesh size only increases speed of the reaction (only use 20 to 100 mm mesh lime)
Yearly Soil Variation

- pH

- K

Kentucky

- P

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