Commercial Fertilizer and Lime Management

Patricia Steinhilber
Department of Environmental Science and Technology
Ag Nutrient Management Program
University of Maryland
Where we’re going in this unit...

- review terminology
- list some common fertilizer materials
- define some common application methods
- convert from oxide form to elemental form
- calculate fertilizer rates from nutrient recommendation
- list common liming materials and their characteristics
What is a fertilizer?

• a compound that contains at least 1 plant nutrient
  – ammonium nitrate (NH$_4$NO$_3$)
  – potassium nitrate (KNO$_3$)

• no fertilizer materials are 100% of any nutrient! other elements exist with the nutrient in the fertilizer compound.

• pure N is an inert gas, pure elemental P would ignite when exposed to the atmosphere, pure elemental K burns when it contacts water
Where do N, P and K in fertilizers originate?

• N originates from the atmosphere

• P originates from rock phosphates

• K originates from K-bearing minerals, usually chlorides or sulfates
World P Deposits
How do we describe the nutrient content of fertilizers?

This bag contains:
5% nitrogen--10% phosphate--15% potash
or
2.5 lbs. nitrogen
5 lbs. phosphate
7.5 lbs. potash
The fertilizer guarantee

- % nitrogen (total)
- % phosphate, $P_2O_5$ (citrate-soluble)
- % potash, $K_2O$ (soluble)

- $P_2O_5 \times 0.44 = P$
- $P \times 2.27 = P_2O_5$
- $K_2O \times 0.83 = K$
- $K \times 1.20 = K_2O$
# Common N fertilizers

<table>
<thead>
<tr>
<th>Material</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>ammonia</td>
<td>82-0-0</td>
</tr>
<tr>
<td>ammonium nitrate</td>
<td>34-0-0</td>
</tr>
<tr>
<td>urea</td>
<td>46-0-0</td>
</tr>
<tr>
<td>ammonium sulfate</td>
<td>21-0-0</td>
</tr>
<tr>
<td>UAN (urea+ammonium nitrate)</td>
<td>28-0-0, 30-0-0 and 32-0-0</td>
</tr>
</tbody>
</table>
Is the efficiency of all N fertilizers the same?

• No!

• ammonium-bearing fertilizers or fertilizers that are converted to ammonium (urea)

• volatilization losses possible

• surface application only
Adjustments (in SFM-1)

• for corn, increase N rate by
  – 15-20% if UAN is surface-broadcast at planting
  – 5-10% if sidedress UAN is dribbled on the surface
  – 25% for sidedress surface-applied urea
## Less Common N Fertilizers

<table>
<thead>
<tr>
<th>Fertilizer</th>
<th>NPK Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>sulfur-coated urea (SCU)</td>
<td>40-0-0</td>
</tr>
<tr>
<td>ureaform</td>
<td>38-0-0</td>
</tr>
<tr>
<td>methylene urea</td>
<td>28-0-0</td>
</tr>
<tr>
<td>isobutylidene diurea (IBDU)</td>
<td>30-0-0</td>
</tr>
</tbody>
</table>
# Common P Fertilizers

<table>
<thead>
<tr>
<th>Material</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>superphosphate</td>
<td>0-18-0</td>
</tr>
<tr>
<td>triple superphosphate</td>
<td>0-46-0</td>
</tr>
<tr>
<td>monoammonium phosphate (MAP)</td>
<td>11-48-0</td>
</tr>
<tr>
<td>diammonium phosphate (DAP)</td>
<td>18-46-0</td>
</tr>
<tr>
<td>ammonium polyphosphate</td>
<td>10-34-0</td>
</tr>
</tbody>
</table>
## Common K Fertilizers

<table>
<thead>
<tr>
<th>Material</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>muriate of potash</td>
<td>0-0-60</td>
</tr>
<tr>
<td>sulfate of potash</td>
<td>0-0-50</td>
</tr>
<tr>
<td>potassium-magnesium sulfate</td>
<td>0-0-22-22S-11Mg</td>
</tr>
<tr>
<td>potassium nitrate</td>
<td>13-0-44</td>
</tr>
</tbody>
</table>
Types of Fertilizer Materials

• solid
  – **granular** – materials are mixed in a liquid state and then dried to produce granules
  – **bulk blend** - produced by the mechanical mixing of granular fertilizers

• fluid
  – **solutions** (clear liquids)
  – **suspensions** (slurries)
Bulk-Blended Fertilizers

• small local units often serving a limited area

• 19-19-19 (380 lbs N, P$_2$O$_5$, K$_2$O per ton)
  – urea (502 lbs/ton)
  – DAP (826 lbs/ton)
  – muriate of potash (633 lbs/ton)
  – filler or make-weight material (39 lbs/ton)

• In blended, dry fertilizers, fillers are used to make mixtures which meet the fertilizer guarantee.
So, what’s the rest of the stuff in the fertilizer bag?

What makes up the rest of the 100%

- Muriate of potash is actually potassium chloride (KCl). Pure potassium chloride is 52% K and 48% chlorine.
Is there filler?

protein, fat, water, seasonings, oatmeal or breadcrumbs

Is there filler?

XYZ Fertilizer Company
0-0-60

KCl muriate of potash

Is there filler?
Some application terminology…

- broadcast
- top-dress
- side-dress
- starter
- fertigation
- incorporation
- injection
Calculating the Quantity of Commercial Fertilizer Required to Meet a Nutrient Recommendation

• recommendation in nutrient management plan
  – 90 lb/A of potash (K\textsubscript{2}O) on soybean field
• no P or N recommended
• preferred product - muriate of potash (0-0-60)
• How much muriate of potash per acre should be applied?
Relevant Information Needed and Ultimate Question

- What is the recommendation?
- What is the preferred fertilizer product?
- What is the nutrient content in the preferred product?
- Calculate amount of preferred fertilizer product to apply
Calculating Quantity of Fertilizer to Meet a Nutrient Recommendation

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>recommended quantity of nutrient</td>
<td>90 lb/acre</td>
</tr>
<tr>
<td>% nutrient in preferred product</td>
<td>60%</td>
</tr>
<tr>
<td>nutrient content in preferred product (decimal fraction)</td>
<td>0.60</td>
</tr>
<tr>
<td>quantity of preferred product required</td>
<td>90/0.60 = 150</td>
</tr>
</tbody>
</table>
Review Question

• Sixty (60) pounds of $\text{P}_2\text{O}_5$ are equivalent to how many pounds of P?
  A) 12
  B) 26
  C) 36
  D) 60
Review Question #2

- A producer wants to apply 60 lbs N/acre to his orchard grass pasture. If he uses ammonium sulfate (21-0-0), how much material should be applied per acre?

A) 60
B) 200
C) 285
D) 350
Enhanced Efficiency Fertilizers
21st Century Products

• designed to increase the quantity of nutrient actually taken up by crop

• various mechanisms
  – addition of nitrification inhibitors
  – addition of urease inhibitors
  – coated with a reactive material that reduced fixation
  – enveloped by a semi-permeable membrane that slows down movement of nutrient into soil
Urease Inhibitors

- urea $\underset{\text{urease}}{\rightarrow}$ ammonia + carbon dioxide
- urease inhibitors (UIs) temporarily block the action of urease
- may block urea conversion until rain moves urea into the soil
- not effective all years - depends upon weather
- never effective in conventional till or when urea is banded
Reduce the Rate of Nutrient Release

- protect nutrients with a physical barrier
  - ESN®, Environmentally Smart Nitrogen
  - a polymer-coated urea
  - diffusion of urea is temperature controlled

## Info on Common Liming Materials

<table>
<thead>
<tr>
<th>Liming Material</th>
<th>Formula</th>
<th>Calcium Carbonate Equivalent (CCE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>calcitic limestone</td>
<td>CaCO₃</td>
<td>100</td>
</tr>
<tr>
<td>dolomitic limestone</td>
<td>(Ca,Mg)CO₃</td>
<td>109</td>
</tr>
<tr>
<td>burnt lime (calcium oxide)</td>
<td>CaO</td>
<td>179</td>
</tr>
<tr>
<td>slaked lime (calcium hydroxide)</td>
<td>Ca(OH)₂</td>
<td>135</td>
</tr>
</tbody>
</table>
# Info on Common Liming Materials

<table>
<thead>
<tr>
<th>Liming Material</th>
<th>Formula</th>
<th>Calcium Carbonate Equivalent (CCE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>calcitic limestone</td>
<td>CaCO$_3$</td>
<td>100</td>
</tr>
<tr>
<td>dolomitic limestone</td>
<td>(Ca,Mg)CO$_3$</td>
<td>109</td>
</tr>
<tr>
<td>burnt lime (calcium oxide)</td>
<td>CaO</td>
<td>179</td>
</tr>
<tr>
<td>slaked lime (calcium hydroxide)</td>
<td>Ca(OH)$_2$</td>
<td>135</td>
</tr>
</tbody>
</table>

1 T limestone = 0.9 T dolomitic limestone = 0.55 T burnt lime = 0.75 T slaked lime
## Info on Common Liming Materials

<table>
<thead>
<tr>
<th>Liming Material</th>
<th>Formula</th>
<th>Solubility grams/L</th>
<th>H&amp;S</th>
</tr>
</thead>
<tbody>
<tr>
<td>calcitic limestone</td>
<td>CaCO₃</td>
<td>0.014</td>
<td></td>
</tr>
<tr>
<td>dolomitic limestone</td>
<td>(Ca,Mg)CO₃</td>
<td>0.0024 (~6x)</td>
<td></td>
</tr>
<tr>
<td>calcium oxide</td>
<td>CaO</td>
<td>soluble &amp; reactive *</td>
<td>very caustic</td>
</tr>
<tr>
<td>calcium hydroxide</td>
<td>Ca(OH)₂</td>
<td>1.9 (&gt;100x)</td>
<td>caustic</td>
</tr>
</tbody>
</table>

*exothermic when added to water*
Particle Size is Also Important and Regulated

Maryland’s lime law requires labeling % passing 20, 60 and 100 mesh screens
What are Soil Amendments or Conditioners?

- definition: materials with no nutrient claim but which enhance plant growth or improve the physical or chemical conditions of a soil

- if they contain nutrients, must be integrated into NM plan

- examples: chicken processing waste, vegetable processing waste, whey, etc.
Questions?