Nutrient Management

Chapter 16
p. 669-739

Things to Know
• Goals of fertilizer use
• General concept of plant nutrient needs
• Fertilizer grades (e.g., 10-10-10)
• Fertilizer characteristics
• Application methods for fertilizers

Goals of Fertilizer Usage
• Increase yields
• Reduce cost per unit of production
• Improve plant quality
• Disease reduction
• Yields and production costs are most important

Fertilizer Use Concerns
• Reliance on off-farm inputs
• Contamination of water resources by N & P
• Soil acidification
• Some believe that the use of inorganic fertilizers does not promote plant and soil health

Fertilizer Nutrient Needs

<table>
<thead>
<tr>
<th>Crop</th>
<th>Yield</th>
<th>N</th>
<th>P</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>bu A⁻¹</td>
<td>lbs A⁻¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>150</td>
<td>220</td>
<td>80</td>
<td>195</td>
</tr>
<tr>
<td>Soybeans</td>
<td>40</td>
<td>145</td>
<td>40</td>
<td>75</td>
</tr>
<tr>
<td>Banana</td>
<td>1,200 plants</td>
<td>400</td>
<td>400</td>
<td>1,500</td>
</tr>
</tbody>
</table>

Nutrient Balance in Soil
• Soil tests give estimate of P and K fertilizer needs
• Most soil N comes from organic matter mineralization; except for legumes, fertilizer N is always recommended
• Fertilizer recommendations are base on plant needs (P & K) or yield goals (N)
• Soil test results are given as low, medium, high, and very high
• Fertilizers is applied to achieve a high soil test
The Soil Test

- A soil test is a mechanism of predicting the need for fertilizer; **NOT** nutrient availability
- Calibrated soil testing procedures are those methods of extracting soil that have been shown to predict a positive crop response to added fertilizer
- Soil tests for P & K have been around for decades
- Tests for Ca & Mg are now offered, as are tests for Zn, Mn, Cu, Fe, B, S, and NO₃⁻

Soil Test Extractant by State

<table>
<thead>
<tr>
<th>Extractant</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mehlich 1</td>
<td>0.05M HCl + 0.0125M H₂SO₄</td>
</tr>
<tr>
<td></td>
<td>AL, FL, GA, SC, TN, VA</td>
</tr>
<tr>
<td>Mehlich 3</td>
<td>0.2M HCl, 0.25M NH₄NO₃, 0.013M NH₄Cl, 0.015M NH₄F, 0.001M EDTA</td>
</tr>
<tr>
<td></td>
<td>AR, KY, NC, OK</td>
</tr>
<tr>
<td>Lancaster</td>
<td>0.05M HCl followed by pH 4 1.58M acetic-0.187M malic-0.125M malonic-0.037M NH₄F-0.01M AlCl₃</td>
</tr>
<tr>
<td></td>
<td>AL, MS</td>
</tr>
<tr>
<td>Bray</td>
<td>0.1M HCl + 0.03M NH₄F</td>
</tr>
<tr>
<td>Morgan</td>
<td>pH 4.2 1.4M NH₄OAc, 1M HCl, 0.025M EDTA</td>
</tr>
<tr>
<td></td>
<td>TX</td>
</tr>
</tbody>
</table>

Soil Test Results

- Low: < 75% of the crop yield potential is expected without the addition of the nutrient; yield increase to added nutrient is expected
- Medium: 75 to 100% of the crop yield potential is expected without the addition of the nutrient; yield increase to added nutrient is expected
- High: Yield increase to added nutrient is not expected; the soil can supply the entire crop nutrient requirement
- Very high: Yield increase to added nutrient is not expected; the soil can supply much more than the entire crop nutrient requirement

Soil Test Recommendations (lbs A⁻¹)

<table>
<thead>
<tr>
<th>Crop</th>
<th>N</th>
<th>P₂O₅</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Test Rating</td>
<td>L</td>
<td>M</td>
</tr>
<tr>
<td>Corn</td>
<td>210↑</td>
<td>160</td>
</tr>
<tr>
<td>Cotton</td>
<td>30-80</td>
<td>90</td>
</tr>
<tr>
<td>Soybean</td>
<td>0</td>
<td>40</td>
</tr>
</tbody>
</table>

† 175 to 200 bushel per acre yield goal

Nutrient Balance in Soil

- Low
- Hidden Hunger
- Critical Range
- Sufficiency & luxury consumption range
- Toxic Range
Fertilizer Grade

• What is the fertilizer analysis?

Mustang Fertilizer
5-20-20

= 5% N
20% P₂O₅ = 8.72% P
20% K₂O = 16.6% K

Calculations

• % P₂O₅ → % P

\[ \frac{1.0 \% P_2O_5}{100 \ g} = \frac{2 \times 30.974 \ gP}{141.945 \ gP_2O_5} = \frac{0.436 \ gP}{100 \ g} = 0.436 \% P \]

So, % P = 0.436 × % P₂O₅

P₂O₅ = 2.29 × % P

For % K₂O → % K: % K = 0.83 × % K₂O

% K₂O = 1.20 × % K

Calculation

• Your recommendation calls for 150 lbs N per acre. How many lbs of ammonium nitrate do you need? \( NH_4NO_3 = 34-0-0 \)

\[ \frac{lbs \ NH_4NO_3}{acre} = \frac{150 \ lbs \ N}{acre} \times \frac{100 \ lbs \ NH_4NO_3}{34 \ lbs \ N} = \frac{441 \ lbs \ NH_4NO_3}{acre} \]

N Fertilizer Materials

• Ammonium Nitrate \( (NH_4NO_3; 33-0-0) \)
• Anhydrous ammonia (gas) \( (NH_3; 82-0-0) \)
• Urea \( [(NH_2)_2CO; 46-0-0] \)
• Ammonium sulfate \( [(NH_4)_2SO_4; 21-0-0] \)
• Organic sources (1 -12 %N)
  – Dairy manure: ~2.4 %N
  – Swine manures: ~2.1 %N
  – Poultry litter: ~4.4 %N
  – Sewage sludge: ~4.5 to 6 %N
  – Fish and bone meals: ~10 to 12 %N

P Fertilizer Materials

• Rock phosphate (~ 0-(8 to 18)-0): apatite
• Superphosphate (0-21-0): Ca(H₂PO₄)₂ + gypsum
• Triple Superphosphate (0-48-0): Ca(H₂PO₄)₂
• Diammonium phosphate (DAP; 18-46-0): \( (NH_4)_2HPO_4 \)
• Monoammonium phosphate (MAP; 11-48-0): \( NH_4H_2PO_4 \)

K Fertilizer Materials

• Potassium chloride \( (KCl; 0-0-60) \)
  – Muriate of potash
• Potassium sulfate \( (K_2SO_4; 0-0-50) \)
  – Sulfate of potash
• Potassium nitrate \( (KNO_3; 13-0-44) \)
Fertilizer Characteristics

• Soluble salts
  – Over application of fertilizers can cause soil salinity problems, especially in sub-humid, semi-arid regions
  – Cl⁻, SO₄²⁻, and NO₃⁻ salts are "salty"
  – H₃PO₄²⁻ salts are less of a problem
• Acidity
  – Ammonium-N is acidifying

Theoretical Lime Requirements for N Materials

• Ammonium sulfate = 5.4 kg CaCO₃ per kg N
• Anhydrous Ammonia = 1.8
• Ammonium chloride = 5.3
• Ammonium nitrate = 1.8
• Organic sources = 0.5 to 1.5

Nutrient Mobility & Availability

• Phosphates
• Potassium
• Nitrogen

Fertilizer Application Methods

• Starters
  – Small amount banded near seed at planting
  – Usually 2” below and to the side of seed
• Broadcast
  – Uniform spreading on soil surface

Fertilizer Application Methods

• Deep banding
  – Majority of fertilizer at depth of 6 - 8”
  – Usually placed 12 - 30 inches apart, preplant
  – NH₃ applied this way, some strip tillage with P & K
• Injection
  – Tube penetrates soil and liquid fertilizer applied through openings
Fertilizer Application Methods

- Split applications
  - 2 or more trips to apply total amount
  - Often much more efficient, especially for N
- Side-dressing, top-dressing
  - Addition of fertilizers after crop has emerged
  - Surface or shallow soil band of fertilizer applied
  - Usually part of a split application

Fertilizer Use Efficiency

- Nitrogen: 30 - 70% of added is taken up
- P: 5 - 30%
- K: 50-80%
- Amount depends on fertilizer management, weather, plant growth

Fertilizer Application Methods

- Fertigation
  - Application of nutrients to soil in irrigation water
- Foliar applications
  - Best for small amounts: 1 to 10 kg ha⁻¹
  - Micronutrients typical; e.g., Fe-chelates
  - If concentration too high, leaf damage will occur
Some General Management Tips

- Avoid single large addition of N or K, especially on sandy soils
- Avoid surface application of ammonium fertilizers on alkaline soils
- Don’t use nitrate fertilizers on poorly drained soils
- Avoid cycles of aerated-nonaerated states with N fertilizers

Some General Management Tips

- Band P fertilizers on high P-fixing soils
- Avoid placing large amounts of N and K too near seed (< 2 inches) to avoid burning
- Avoid use of N fertilizers with legume crops
- Give credit for manures, sludges, other organic N before adding inorganic
- Test soils often and follow recommendations!

Fertilizer Economics

- \( \text{Cost of Fertilization} \)
- \( \text{Increasing Pollution Potential} \) →

Site-Specific Management

- **Mean Mehlich-1**
  - P = 32 mg kg\(^{-1}\)
  - K = 100 mg kg\(^{-1}\)

- **Mean Yield**
  - 1585 lbs A\(^{-1}\)

Total Cotton Yield, lbs/A