Nitrogen Availability and Your Crops

Julia Gaskin
Sustainable Agriculture Coordinator
University of Georgia

Steven Beltram
Balsam Gardens, Asheville, NC

Goal is Healthy Soil

- Good tilth
- Good biological activity
- Enough nutrients for healthy plants and good yields
- Good water storage and drainage
- Low disease and pest pressure
- Low amounts of chemicals harmful to plants environment
- Able to bounce back from disturbance
Feed the Plant

- Plant/animal residues
- Soluble N, P
- Soil organic matter + microbes
- Mineral reservoirs
- Gas Losses
- Leaching Losses

Feed the Soil

- Soluble fertilizers
- Plant/animal residues/rock phosphate
- Soil organic matter + microbes
- Soluble N, P, K
- Mineral reservoirs
- Gas Losses
- Leaching Losses

Adapted from Drinkwater and Snapp 2007

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**Fertility**

The ability of the soil to supply nutrients needed for plant growth.

Recognize:
- physical, biological, and chemical components
- these are interrelated.
Key Factors for Healthy Soils

- pH
- Soil organic matter
- Management effects on soil tilth and nutrient release

pH and Nutrient Availability

Target is usually 6.0 to 6.5 (near neutral)

At these pHs phosphorus and micronutrients most available

Low pH (<5.5) – aluminum toxicity

At high pH also decreased availability

Exception molybdenum – important for legumes
Organic Matter & Fertility

Energy source for microbial life. Base of the food chain

Every 1% SOM release about 10 to 20 lbs/acre of N over growing season

Soil Management

2 compacted layers
Nitrogen Cycle

Effect of Temperature

Optimal temps for:
- mineralization 68 – 95°F
- nitrification 67 – 87°F

Lower temps for:
- mineralization 41°F less than 20% of 77°F
- nitrification 41°F
Effect of Moisture

Aerobic microbial activity generally from 30-50% of soil pore space

A Brief Aside...... Tillage

- Increases oxygen
- Increases decomposition
- Increases erosion
- Changes community of soil critters
- Breaks soil aggregates
- Increases erosion
- Disrupts soil pores
- Increases decomposition
- Changes water relations
- Changes community of soil critters
- Relocates nutrients
Tillage

• Minimize tillage to maintain soil organic matter
• Strategic tillage to provide burst of nutrients

Tillage Options

• Waiting for things to dry in spring
• Subsoiling and chisel plowing
• Try not to use rotovator when possible – just finishing disc or perfecta if possible
• Mulch!
• Don’t bring up subsoil with turning plow
• OG no till?
Effect of Fertilizer Quality

- C to N ratio - N mineralization or immobilization by soil microbes
  - < 25 net mineralization
  - > 25 net immobilization
- Feedstock
  - Bloodmeal – undigested cells
  - Soybean meal – N in proteins
- Processing
  - Compost – decomposed or digested organic matter
  - Raw manure

Nitrogen Mineralized over 100 Days Optimal Conditions

Data courtesy of Dr. Kate Cassity, UGA
Rate of N Release

Data courtesy of Dr. Kate Cassity, UGA

Effect of Fertilizer Quality

<table>
<thead>
<tr>
<th>Fertilizer</th>
<th>Inorganic N</th>
<th>Total N</th>
<th>Organic N</th>
<th>C:N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compost</td>
<td>0.05</td>
<td>2</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Blood meal</td>
<td>1</td>
<td>14</td>
<td>13</td>
<td>3.81</td>
</tr>
<tr>
<td>Feather meal</td>
<td>0.1</td>
<td>15</td>
<td>14.9</td>
<td>3.59</td>
</tr>
<tr>
<td>Fish meal</td>
<td>1</td>
<td>11</td>
<td>10</td>
<td>3.98</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>0.03</td>
<td>7</td>
<td>7</td>
<td>6.67</td>
</tr>
<tr>
<td>Pelleted poultry</td>
<td>0.9</td>
<td>7</td>
<td>6.1</td>
<td>5.89</td>
</tr>
</tbody>
</table>

Data courtesy of Dr. Kate Cassity, UGA
Putting it Together

• Compost
  – Already stabilized, does not contribute much N
  – Useful to build stable soil organic matter and add microbial life

• Blood meal
  – Mineralizes very quickly and has large amount of inorganic N
  – Useful in cooler soils and high N demanding plants
    • Spring broccoli transplants
  – Might not want to use with slow growing direct seeded crops
Putting It All Together

• Feather meal
  – Mineralizes quickly under good conditions but doesn’t have inorganic N
  – Useful in spring and summer when soil temperatures are high
  – Most useful for transplants

Soluble Fertilizers

• Liquid Fertilizers (Usually fish based)
  – Good for soil and microbial activity
  – Easy to fertigate or foliar feed
  – Low index and expensive per unit of N
• Chilean Nitrate
  – Controversial and not permitted in Canada and EU
  – USDA NOP – 20% rule historic
  – Inorganic N
  – Easy to fertigate and relatively cheap
  – Tissue sample shows deficiency late in season
  – Very early in spring when biological activity is low
Compare Prices

- Find out the cost of the actual units of N
- Example:
  - 3% N means 1.5# of actual N in a 50% bag
  - $15/bag = $10/# of N

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**Guaranteed Analysis**

<table>
<thead>
<tr>
<th>Total Nitrogen (N)</th>
<th>5.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0% Water Soluble Nitrogen</td>
<td>4.0%</td>
</tr>
<tr>
<td>Available Phosphate (P2O5)</td>
<td>4.0%</td>
</tr>
<tr>
<td>Soluble Potash (K2O)</td>
<td>3.0%</td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>9.0%</td>
</tr>
</tbody>
</table>

**Plant Nutrients Derived From:** Fauxly Manure

*4.0% slowly available nitrogen from poultry manure

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**5-4-3**

AG. ORGANIC WITH 9% CALCIUM

**Coverage:**

For turf, flowers & trees – Apply at the first sign of spread. Growth, apply as needed, every 4-6 weeks throughout the growing season. See specific use rates below.

**Turf:**

For 1 lb. of Nitrogen, apply at a full rate of 20 lbs. per 1,000 sq. ft. One bag of 5-4-3 will cover 2,300 sq. ft. or 5,000 sq. ft. at a half rate.

**Landscape Application:**

Similar – Tightly apply or lightly spread into the soil surface at 5 lbs. per 1,000 sq. ft.

**Flowers:**

Apply 3 lbs. per 1,000 sq. ft. Later in the growing season, a second application can be made.

**Vegetables:**

Apply the rate of 30 pounds per 1,000 sq. ft. or 1.5 cups per 100 sq. ft. Reapply as needed. Site specific at half the rate for watered after planting.

**Net Weight:** 50 lb. (22.7 kg)

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**Harmony In Tune With Nature**

**Approved by:**

OMRI Listed

Listed by the
Organic Materials Review Institute
for use in organic production.
Whether you grow 100% organically or conventionally, MicroSTARt 60 fertilizers are the perfect fit for your nutrient management program.

- High Humic Acid Value – up to 6%!
- Extremely Low Salt Index – less osmotic pressure, better nutrient uptake
- Significant Slow Release WIN Value
- Pasteurized, Pathogen Free, Weed Free
- Listed for UNRESTRICTED use in organic crop production by the Organic Materials Review Institute (OMRI) and National Organic Program (NOP) Compliant
- Safe to apply around people and pets
- Micro-element package includes Magnesium, Iron, Sulfur, Manganese, Copper, Zinc, Calcium for improved cell structure
- Consistent Quality and Nutrient Values of 3-2-3 NPK
- Improves Soil Performance, Moisture Retention and Tillth
- Less than 12% Moisture Content
- Encourages Microbial Activity and Cation Exchange while Repressing Leaching

Typical Nutrient Analysis

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>3.80%</td>
</tr>
<tr>
<td>Insoluble N</td>
<td>2.10%</td>
</tr>
<tr>
<td>Soluble N</td>
<td>1.70%</td>
</tr>
<tr>
<td>Phosphorus (P2O5)</td>
<td>2.20%</td>
</tr>
<tr>
<td>Potassium (K2O)</td>
<td>3.50%</td>
</tr>
<tr>
<td>Calcium</td>
<td>2.00%</td>
</tr>
<tr>
<td>Sulfur</td>
<td>0.76%</td>
</tr>
<tr>
<td>Magnesium</td>
<td>0.50%</td>
</tr>
<tr>
<td>Copper</td>
<td>0.05%</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.05%</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.05%</td>
</tr>
<tr>
<td>Iron</td>
<td>0.13%</td>
</tr>
<tr>
<td>Humic Acid</td>
<td>5.40%</td>
</tr>
</tbody>
</table>

Perdue AgriRecycle, LLC
Call Today! 1.888.268.2988 or visit www.PerdueAgriRecycle.com
Effect of Manure Quality

<table>
<thead>
<tr>
<th></th>
<th>Fresh Dairy</th>
<th>Broiler Litter</th>
<th>Stable Manure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen (lbs/ton)</td>
<td>10</td>
<td>68</td>
<td>14</td>
</tr>
<tr>
<td>Available N</td>
<td>2.3</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>Phosphorus (P₂O₅)</td>
<td>7</td>
<td>69</td>
<td>4</td>
</tr>
<tr>
<td>Potassium (K₂O)</td>
<td>8</td>
<td>46</td>
<td>14</td>
</tr>
<tr>
<td>C:N Ratio</td>
<td>19</td>
<td>14</td>
<td>30</td>
</tr>
</tbody>
</table>

Putting It Together - Manures

- Similar approach to fertilizers
- Remember waiting periods before harvest
  - 90 days if crop doesn’t touch soil
  - 120 days if it does
- Maybe best use with cover crops
- Watch phosphorus overload
- Watch for herbicide carryover
- How to apply for early spring crops – pollution/leaching risk for fall application
Nitrogen Fixing Cover Crops

- N production from legumes can vary from 40-200 lbs+ of total N per acre
  - Affected by: plant stand, soil pH, nodulation, and soil moisture
- Available N during first year is usually 30-60% the total N in the plant
  - 30 - 40% when just left on the surface
  - 50 to 60% when incorporated

Nitrogen in Cover Crop Residues

<table>
<thead>
<tr>
<th>Winter Legumes</th>
<th>Lbs Total N / Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>100-250</td>
</tr>
<tr>
<td>Crimson Clover</td>
<td>50-160</td>
</tr>
<tr>
<td>Austrian Winter Pea</td>
<td>40-175</td>
</tr>
<tr>
<td>White Clover</td>
<td>75-140</td>
</tr>
<tr>
<td>Hairy Vetch</td>
<td>45-200</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Summer Legumes</th>
<th>Lbs Total N / Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cowpeas</td>
<td>40-100</td>
</tr>
<tr>
<td>Soybean</td>
<td>35-80</td>
</tr>
<tr>
<td>Sunn Hemp</td>
<td>20-280</td>
</tr>
</tbody>
</table>

Reeves, 1994; Mansoor et al, 1997; Schomberg et al. 2007
Gaskin unpublished data
Effect of Cover Crop Quality

- C:N ratio
  - < 25 net mineralization
  - > 25 net immobilization
- Carbohydrates increase rate of decomposition
- Lignin, tannins and polyphenols slow the rate of decomposition

Cover crop growth stage very important!

March 29, 2017
Black-seeded oats/crimson clover at boot/bud stage

May 19, 2017
Rye, oats, triticale, oats, winter peas, vetch, crimson clover at soft dough/past bloom stage
Growth Stage and C:N

Plant Available N with Growth Stage

Caution – High biomass cereal grain cover crops can immobilize N

Biomass – 15,800 lbs/ac
Cover crop N – 1.06%
C:N = 38

Total N = 168 lbs/ac
0% available

Yields only 38% of county average

Grain/Legume Mixtures

Grain is tall; legume spreads underneath for weed suppression
Slows N release

Recommended rates
2/3 legume to 1/3 grain
½ legume to ½ grain

Growing conditions influence which species dominate.

High N favor grains
Low N favors legumes
Timing of Release

Nitrogen uptake by corn

Days After Placing in the Field

% of Original N Remaining

On Surface

Incorporated

Quemada et al., 1997. Wilson & Hargrove, 1986

Problematic for Farmers

- How much N can I expect?
- When will it be released?
- Is it profitable?
- To replace 60 lbs N/ac
  - Cowpeas = $61/ac
  - Feathermeal (13-0-0) = $355/ac
  - 34-0-0 = $77/ac
To Predict N Need

Minimum data set:
- Biomass
- N concentration in cover crop

Better data set:
- Cover crop quality
- Soil moisture and temperature
- Initial soil conditions

Calculator Outputs
New Extension Bulletins

Challenges of Cover Cropping

- Challenging to provide N for early spring plantings
- High land values make it difficult to take land out of production long enough to maximize cover crop production – either fallow year or no double cropping
- Difficult to mechanically incorporate large amounts of residue
Putting It Together – Cover Crops

• If using cover crops for N source
  – Legumes fix N
    • Most N released within a month of termination
    • Transplant can take better advantage of this

Putting It Together – Cover Crops

• If using cover crops for N source
  – Grains and brassicas good N scavengers
    • Note: Winterkilled radishes release N very rapidly
    • Brassicas - Think about crop rotation and disease bridges
  – Grain legume mixtures slow N release
Putting It Together – Cover Crops

- For maximum N,
  - Maximize legume biomass
  - Timely planting (Asheville probably 1st of Sept)
  - Fresh, correct inoculant
  - Legume kill mid-bloom
  - Grains before boot
- Don’t incorporate too deeply (top 6 inches)
Get Fertilizer Right for the Crop

- Figure out how many actual units of N you need to add in input form for optimal crop production and health
- Don’t over-do it or get it out at the wrong time
- Aphids
- Too much vegetative growth on fruiting crops
- Pollution
- Fertigation schedule in printout- made for conventional production but helpful in understanding timing

Fertilization Strategies

- Depends on:
  - Crops to be grown
  - Fertilizer costs
  - Building or maintenance phase
  - Soil texture – sandy, sandy loam, sandy clay loam, etc.
- Get your soil tested!
How Do I Know?

• Soil tests!
• Many labs, many different types of tests
• Pick a lab and stay with it
• Try to sample same time
• Use test to look at long term trends

Building Phase

New or transitioning growers need to build SOM, phosphorus and potash levels

Need manure based fertilizers

Can take 3 to 5 years
Soils in Building Phase

Soil organic matter:

<1.5% in Coastal Plain,
<2.5% in Piedmont, Ridge & Valley, Mountains

Soil test indices in low or medium range for:

Phosphorus ($P_2O_5$),
Potassium ($K_2O$),
Calcium,
Magnesium,
Zinc,
Manganese

Maintenance Phase

Use of cover crops for fertility becomes more important

Doesn’t imply there is no need for animal based fertilizers
Take Home Messages

- MANY factors affect N
- Mineralization much slower at low soil temperatures or very dry soils
  - N may be in soil but not plant available
- Rely more on manure based fertilizers when building soil, move to cover crops when maintaining
- Think about synchronizing N mineralization with plant need
- Use a variety of N sources

A Couple of References

- *Building Soils for Better Crops* – free pdf at SARE Learning Center
- Sustainable Ag Webpage at UGA – www.sustainagga.org
- NCSU Extension
- *Managing Cover Crops Profitably* – free pdf at SARE Learning Center
- OSU – Organic Fertilizer and Cover Crop Calculator
The University of Georgia
College of Agricultural and Environmental Sciences
Sustainable Agriculture Program