Managing Soil Fertility in Organic Systems

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Overview

• Calculating fertilizer rates
• Match Soil Amendments to crop needs
  – What can be used?
  – Economics

Fertilizer Analyses?

• What is the analysis?

\[
\text{Organic Fertilizer} = \frac{5 \text{% N}}{20 \text{% } P_2O_5} = \frac{8.75 \text{% P}}{20 \text{% } K_2O} = 16.5 \text{% K}
\]

• Convert to lbs per 50 lb bag or per ton

What Soil Amendments Can Be Used?**

• Aquatic plant extracts
• Elemental sulfur
• Humic acids
• Magnesium sulfate (Gypsum) – mined only
• Micronutrients - nitrates or chlorides are not allowed
• Soluble boron products
• Sulfates, carbonates, oxides, or silicates of zinc, copper, iron, manganese, molybdenum, selenium, and cobalt.

** USDA National Organic Program

Fertilizer Analyses?

• 5% N = \frac{5\%}{100} \times 50 \text{ lb} = 2.5 \text{ lb} / 50 \text{ lb bag} = 100 \text{ lb per ton}
• 20% P_2O_5 = 10 \text{ lb} / 50 \text{ lb bag} = 400 \text{ lb per ton}
• 20% K_2O = 10 \text{ lb} / 50 \text{ lb bag} = 400 \text{ lb per ton}

What Soil Amendments Can Be Used?**

• Liquid fish products — can be pH adjusted with sulfuric, citric or phosphoric acid
• Potassium chloride — derived from a mined source
• Sodium nitrate (Chilean Nitrate) — no more than 20% of the crop's total nitrogen requirement

** USDA National Organic Program
Sources of Nitrogen
- Manure
- Cover Crops
- Plant Products
- Animal Byproducts
- Seaweeds
- Mined nitrate (Chilean Nitrate)

Nitrogen: Manure
- Content depends on animal type, age, feed and manure management
- Losses of ammonia (NH₃) from volatilization ~ typically 50% if surface applied, less if incorporated
- Broiler litter – most common source in TN
  - 60 lbs total N per ton (also P₂O₅ and K₂O)
- Dairy manure – depends on how much water is mixed, expensive to transport
- Beef manure

Nitrogen: Cover Crops
- Leguminous cover crops fix atmospheric nitrogen
- Amount of N depends on the plant species, the stage of growth, soil factors, and the effectiveness of the rhizobial association
- 50 to 200 lbs N per acre possible
  - How much is available to plant?
  - How quickly does it decompose?

Nitrogen: Plant Products
- Alfalfa meal (4% N)
- Cottonseed meal (6% N), West Tennessee
- Corn gluten (9% N), Tate & Lyle, Loudon
- Soybean meal (7% N)
  - Some weed inhibition reported
- Check other nutrients
  - Soybean meal (7% N; 2% P₂O₅; 1% K₂O)

Nitrogen: Animal Byproducts
- Blood Meal (derived from slaughterhouse waste, usually cattle), dried powdered blood contains approximately 12% N
- Guano: Seabird guano (8 to 12% N)
- Feather Meal: (14 to 16% N)
- Fish Meal and Fish Emulsion: Fish meal (10 to 14% N); fish emulsion (2 to 5% N)

Nitrogen: Seaweed
- Usually derived from kelp species (Ascophyllum)
- Dried kelp ~ 1% N and 2% K
Nitrogen: Mined

- Chilean Nitrate – mined in Chile and Peru
- Sodium nitrate (NaNO₃, 16% N)

Note: In the U.S.A., the use of NaNO₃ is limited to no more than 20% of the crop N requirement.

Sources of Phosphorus

- Manures and compost
- Rock phosphate
- Phosphatic clays
- Bone meal
- Guano

Phosphorus: Manure

- Content depends on animal type, age, feed and manure management
- Broiler litter – most common source in TN
  - 40-60 lbs total P₂O₅ per ton (also N and K₂O)
  - More concentrated with age
- Dairy manure – depends on how much water is mixed
- Beef manure

Phosphorus: Rock Phosphate

- Apatite (calcium phosphate mineral)
- Sedimentary or igneous - widely varying mineralogy, texture, and chemical properties
- Total vs. citrate soluble P
- Florida, North Carolina, Idaho, Tennessee
- Influence of soil pH is dissolution

Phosphorus: Phosphatic Clays

- Calphos®
  - A soft, phosphatic clay originating in Florida
  - Contains a 17% total P₂O₅, with 3% available P₂O₅
  - Available in a finely ground, powder-like form or granular form
- Tennessee Brown Rock Phosphate
  - 8.7% citrate sol. P₂O₅; 2.4% K₂O
  - Note: TN Dept. Ag. ~ 3.5%
  - Calcium Silicate Corporation, Columbia, (Tel: 931-381-1859)

Phosphorus: Bone Meal

- Prepared by grinding animal bones
- Primary P mineral in bone material is “calcium-deficient hydroxyapatite” - more soluble than rock phosphate
- Bones gleaned from Napoleonic battlefields in Europe in 19th Century
- Fish used by the Native Americans?
Phosphorus: Guano

- Mined from aged deposits of bird or bat excrement in low rainfall environments.
- Struvite (magnesium ammonium phosphate) can be a major P mineral found in guano, dissolving slowly in soil.
- Limited supply and high cost of guano generally restricts its use to small-scale applications.

Sources of Potassium

- Manures and compost
- Greensand
- Langbeinite (Potassium-magnesium sulfate)
- Potassium Sulfate
- Rock Powders
- Sylvinitite (Potassium Chloride)
- Wood ash

Potassium: Manure

- Content depends on animal type, age, feed and manure management
- Found as K+ cation
- Broiler litter – most common source in TN
  - 40 to 60 lbs K₂O per ton (also N and P₂O₅)
  - More concentrated with age
- Dairy manure – depends on how much water is mixed
- Beef manure

Potassium: Greensand

- Sandy rock or sediment containing a high percentage of the green mineral glauconite
- Up to 5% K
- Very slow K release rate (soluble K is generally <0.1% of the total K present) – too slow to provide any significant nutritional benefit to plants at realistic application rates?
- Deposits in AR and TX - only active mine in NJ

Potassium: Langbeinite

- Potassium-magnesium sulfate (K₂SO₄•MgSO₄)
- Contains 18% K, 11% Mg, and 22% S
- Allowed as a nutrient if used raw, crushed form without any further refinement or purification.
- The major source underground deposits in NM

Potassium: Potassium sulfate

- Must be derived from natural sources
- Typically contains approximately 40% K and 17% S
- Most K₂SO₄ in USA from the Great Salt Lake in Utah
- May not undergo further processing or purification after mining or evaporation, other than crushing and sieving
- Product is not allowed in some European countries without special permission from the certifying agency
Potassium: Rock Powders
- Mined rocks, including ballast, biotite, mica, feldspars, granite and greensand allowed without restriction
- Lot of variability in the K release rate from different mineral sources
- Some unsuitable as K sources due to their limited solubility and their heavy and bulky nature

Potassium: Seaweed
- Sea water ~ 0.4 g K/L
- Seaweed ~ up to several % K
- Harvested seaweed biomass can be used directly as a K source (readily soluble, typically < 2% K), or the soluble K may be extracted

Potassium: Sylvinitite
- Potassium Chloride (KCl) is restricted unless it is from a mined source (such as sylvinitite) and undergoes no further processing
- Unprocessed sylvinitite ~ 17% K
- Must be applied in a manner that minimizes Cl accumulation in the soil
- Should only be used after consultation with the certifying Agency
- The Canadian GSB has included KCl on the "Permitted Substances List" for organic food production systems.

Potassium: Wood Ash
- Ash (from hardwood trees) is one of the earliest sources of K for building soil fertility
- An alkaline material, pH 9 to 13, effective lime equivalence 8 and 90% of commercial limestone
- Typical wood ash ~ 0% N, 1% P, and 4% K
- Use of ash from manures, biosolids, coal, and some substances is prohibited for organic production
- Check with the certifying organization before applying!

Economics of Soil Amendment Selection
- Commercial fertilizer
  - N ~ $1.00 per lb
  - P₂O₅ ~ $0.80 per lb
  - K₂O ~ $0.80 per lb
- How much do organic nutrients cost?
  - Bulk or bagged??

2009 Prices**
- Blood meal (12-0-0) $6.25 per lb N
- Feather meal (13-0-0) $4.92 per lb N
- Chilean nitrate (13-0-0) $4.91 per lb N
- Bone meal (1-13-0) $4.91 per lb P₂O₅
- ID Rock P (0-3-0) $9.83 per lb P₂O₅
- Greensand (0-0-7.5) $3.33 per lb K₂O

** From Seven Springs Farm, VA
http://www.7springsfarm.com/catalog.html
Broiler Litter in Tennessee

- Excretion by broilers*
  - 12,000 tons nitrogen
  - 8,000 tons phosphorus (as P$_2$O$_5$)
  - 8,000 tons potassium (as K$_2$O)

- How many tons litter?
  - Estimated 150 to 200,000 tons

- “Typical” nutrient content:
  - 60 lbs N : 50 lbs P$_2$O$_5$ : 50 lbs K$_2$O
  - Approximately a 3 : 2.5 : 2.5 fertilizer

- $40 per ton = $0.25 per lb NPK
- $100 per ton = $0.64 per lb NPK

*Based on ASAE Manure Production Characteristics; *ASAE D384.2 March 2005

Summary

- Don’t guess soil test!
- Don’t guess have your organic amendments analyzed!
- Match soil amendments with UT soil test recommendations
- Do not over-apply nutrients