Soils, Fertilizers, and Soil Test

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What You Don’t See Is As Important As What You Do.
What is Soil?

• Soil is one of the three major natural resources, alongside air and water. It is one of the marvelous products of nature and without which there would be no life.

• Soil is made up of three main components – minerals that come from rocks below or nearby, organic matter which is the remains of plants and animals that use the soil, and the living organisms that reside in the soil.
What is Soil?

• The proportion of each of these is important in determining the type of soil that is present. But other factors such as climate, vegetation, time, the surrounding terrain, and even human activities (e.g. farming, grazing, gardening etc.), are also important in influencing how soil is formed and the types of soil that occur in a particular landscape.
What is Soil?

• Soil can form from the rocks below, or from rocks a very long distance away - perhaps being carried by wind or water. The glaciers of the last ice age acted as giant bulldozers pushing truly huge amounts of soil along as they grew and dropping the soil as they melted.
Soil Facts

• Soil makes up the outermost layer of our planet.
• Topsoil is the most productive soil layer.
• Soil has varying amounts of organic matter (living and dead organisms), minerals, and nutrients.
• Five tons of topsoil spread over an acre is only as thick as a dime.
Soil Facts

• Natural processes can take more than 500 years to form one inch of topsoil.
• Soil scientists have identified over 70,000 kinds of soil in the United States.
• Soil is formed from rocks and decaying plants and animals.
• An average soil sample is 45 percent minerals, 25 percent water, 25 percent air, and five percent organic matter.
Soil Facts

• Different-sized mineral particles, such as sand, silt, and clay, give soil its texture.
• Fungi and bacteria help break down organic matter in the soil.
• Plant roots and lichens break up rocks which become part of new soil.
• Roots loosen the soil, allowing oxygen to penetrate. This benefits animals living in the soil.
Soil Facts

• Roots hold soil together and help prevent erosion.
• Five to 10 tons of animal life can live in an acre of soil.
• Earthworms digest organic matter, recycle nutrients, and make the surface soil richer.
Soil Facts

• Rodents take seeds and other plant materials into underground burrows, where this material eventually decays and becomes part of the soil.

• Animals dig burrows which help aerate the soil.
Media VS Soil

• Media is a sterile mixture of organic and mineral matter that provides a matrix for plants to grow.

• Soil is a living community.
Soil Texture

Relative Size Comparison of Soil Particles

**Barrel**
**Sand**
(feels gritty)
(2.00 - 0.05 mm, USDA)
(2.00 - 0.02 mm, ISSS)

**Plate**
**Silt**
(feels floury)
(0.05 - 0.002 mm, USDA) (0.02 - 0.002 mm, ISSS)

**Coin**
**Clay**
(feels sticky)
(< 0.002 mm, USDA) (< 0.002 mm, ISSS)
Soil Structure

**Granular**: Resembles cookie crumbs and is usually less than 0.5 cm in diameter. Commonly found in surface horizons where roots have been growing.

**Blocky**: Irregular blocks that are usually 1.5 - 5.0 cm in diameter.

**Prismatic**: Vertical columns of soil that might be a number of cm long. Usually found in lower horizons.

**Columnar**: Vertical columns of soil that have a salt "cap" at the top. Found in soils of arid climates.

**Platy**: Thin, flat plates of soil that lie horizontally. Usually found in compacted soil.

**Single Grained**: Soil is broken into individual particles that do not stick together. Always accompanies a loose consistence. Commonly found in sandy soils.

**Massive**: Soil has no visible structure, is hard to break apart and appears in very large clods.
Granular

Blocky

Prismatic

Columnar

Platy

Massive

Single grained
Soil Consistency

**Loose**
You have trouble picking out a single ped and the structure falls apart before you handle it.*

* Soils with "single grained" structure always have loose consistence.

**Friable**
The ped breaks with a small amount of pressure.

**Firm**
The ped breaks when you apply a good amount of pressure and dents your fingers before it breaks.
Soil Diversity
Healthy Soils = Healthy Plants

Tomato roots, 100 days with varying soil amendments

Control Soil  Chemical NPK  Raw Manure  Composted Manure

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Soil Health Schematic

- Soil quality
  (The sum of biological, physical and chemical properties)

- Management influences

- Soil condition

- Sunlight, rain and air

- Specific benchmark condition of "healthy"

- Comparison

- Soil health
Soil Profile
Soil Horizons
Soil Depth Makes A Difference
Texture And Strength Make A Difference
Soil Preparation

• Liming (adjust soil pH)
• Tilling
  – Aeration
  – Infiltration of water
  – Weed control
• Organic matter
  – Composts, manures, leaf mold, sawdust
Soil Tillage

Intensive tillage

Long term no-till

Network of biopores

Ontario Ministry of Ag and Food
Benefits Of Tillage

• **Soil conditioning**—the modification of soil structure to favor agronomic processes such as soil–seed contact, root proliferation, water infiltration, and soil warming.

• **Weed and pest suppression**—direct termination or disruption of weed and pest life cycles.
Benefits of Tillage

• **Residue management**—movement, orientation, or sizing of residues to minimize the negative effects of crop or cover crop residues and promote beneficial effects.

• **Incorporation and mixing**—placement or redistribution of substances such as fertilizers, manures, seeds, and residues, sometimes from a less favorable location to a more favorable spatial distribution.
Benefits of Tillage

• **Segregation**—consolidation of rocks, root clumps, soil crumb sizes, and so forth.

• **Land forming**—changing the shape of the soil surface; the simplest variant is probably leveling; ridging, roughening and furrowing are also examples.

• **Stimulation of nutrient release**—achieved by aeration and mixing; note this can be a disbenefit when not synchronized with crop uptake.
Negative Effects of Tillage

• Compaction of soil below the depth of tillage (formation of a tillage pan).

• Crusting of soil when soil pulverization is followed by rain, stimulating weed seed germination and inhibiting crop emergence.

• Increased susceptibility to water and wind erosion associated with residue removal and soil loosening.
Negative Effects of Tillage

- **Accelerated decomposition** of organic matter, which is undesirable from a long-term perspective;
- **Cost** of equipment purchase and operation;
- **Energy cost** of tillage operations;
- **Labor and temporal obligations**.
- **Alteration of the soil foodweb**, shifting populations away from larger, longer-lived organisms to smaller, shorter-lived organisms.
Raised Beds

• Beds Help Problem Areas
  – Raised beds are planting areas where the soil is several inches higher than that of the natural grade.

• Raised beds can help where gardening space is limited

• Raised beds can be framed with wood, bricks, or cement blocks

• Raised beds should be no wider than 4 feet
Soil Chemistry Makes A Difference

- Soil Organic Matter
- pH
- NPK
- Micronutrients
- Soil Enzymes
  - Urease
What is Organic Matter?

Soil organic matter is the fraction of the soil that consists of plant or animal tissue in various stages of breakdown (decomposition). Most of our productive agricultural soils have between 3 and 6% organic matter.
Components of Soil Organic Matter

- Plant residues and living microbial biomass.
- Active soil organic matter also referred to as detritus.
- Stable soil organic matter, often referred to as humus.
Benefits of Organic Matter

- Nutrient Supply  Organic matter is a reservoir of nutrients that can be released to the soil. Each percent of organic matter in the soil releases 20 to 30 pounds of nitrogen, 4.5 to 6.6 pounds of $P_2O_5$, and 2 to 3 pounds of sulfur per year. The nutrient release occurs predominantly in the spring and summer, so summer crops benefit more from organic-matter mineralization than winter crops.
Benefits of Organic Matter

• Water-Holding Capacity  Organic matter behaves somewhat like a sponge, with the ability to absorb and hold up to 90 percent of its weight in water. A great advantage of the water-holding capacity of organic matter is that the matter will release most of the water that it absorbs to plants. In contrast, clay holds great quantities of water, but much of it is unavailable to plants.
Benefits of Organic Matter

• Soil Structure Aggregation  Organic matter causes soil to clump and form soil aggregates, which improves soil structure. With better soil structure, permeability (infiltration of water through the soil) improves, in turn improving the soil's ability to take up and hold water.
Benefits of Organic Matter

• Erosion Prevention  This property of organic matter is not widely known. Data used in the universal soil loss equation indicate that increasing soil organic matter from 1 to 3 percent can reduce erosion 20 to 33 percent because of increased water infiltration and stable soil aggregate formation caused by organic matter.
pH

- Indicates acidity or alkalinity.
- On a logarithmic scale of 0-14 with 7 being neutral.
- < 7 acid
- > 7 alkaline
- Soils generally range from 4.25 to 8.2.
- It is the single most important parameter next to water in the determining plant vigor.
Soil pH - what is it?

- measure of the acidity or alkalinity of a soil
- concentration of hydrogen ions (H+) in the soil solution

Increasing acidity  NEUTRAL  Increasing alkalinity

Ideal pH for plant growth

Battery acid  Beer  pH Water 1:5  Soap sol’n  Caustic soda
pH

- Battery acid
- Lemon juice
- Pure rain (H₂O in equilibrium with atmospheric CO₂)
- Freshly distilled water
- Seawater
- Baking soda (NaHCO₃ solution)
- Household ammonia (NH₃)
- Household bleach (NaClO solution)
- Household lye (NaOH solution)
- Gastric fluid
- Carbonated beverages
- Vinegar
- Orange juice
- Beer
- Coffee
- Egg yolks
- Milk
- Blood
- Milk of magnesia (Mg(OH)₂) solution
pH Effect On Nutrient Availability

The Influence of Soil pH on Nutrient Availability

<table>
<thead>
<tr>
<th>RANGE OF ACIDITY</th>
<th>RANGE OF ALKALINITY</th>
</tr>
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<tbody>
<tr>
<td>NITROGEN</td>
<td></td>
</tr>
<tr>
<td>PHOSPHORUS</td>
<td></td>
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<tr>
<td>POTASSIUM</td>
<td></td>
</tr>
<tr>
<td>SULFUR</td>
<td></td>
</tr>
<tr>
<td>CALCIUM</td>
<td></td>
</tr>
<tr>
<td>MAGNESIUM</td>
<td></td>
</tr>
<tr>
<td>IRON</td>
<td></td>
</tr>
<tr>
<td>MANGANESE</td>
<td></td>
</tr>
<tr>
<td>BORON</td>
<td></td>
</tr>
<tr>
<td>COPPER &amp; ZINC</td>
<td></td>
</tr>
<tr>
<td>MOLYBDENUM</td>
<td></td>
</tr>
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</table>
### Vegetable Tolerance to Acid Soils

<table>
<thead>
<tr>
<th>Slightly tolerant</th>
<th>Moderately tolerant</th>
<th>Very tolerant</th>
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<tbody>
<tr>
<td>(pH 6.8 to 6.0)</td>
<td>(pH 6.8 to 5.5)</td>
<td>(pH 6.8 to 5.0)</td>
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<tr>
<td>Asparagus</td>
<td>Bean</td>
<td>Irish Potatoes</td>
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<tr>
<td>Beets</td>
<td>Brussells Sprouts</td>
<td>Sweetpotatoes</td>
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<tr>
<td>Broccoli</td>
<td>Carrots</td>
<td>Watermelons</td>
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<tr>
<td>Cauliflower</td>
<td>Collards</td>
<td></td>
</tr>
<tr>
<td>Chinese Cabbage</td>
<td>Corn</td>
<td></td>
</tr>
<tr>
<td>Lettuce</td>
<td>Cucumbers</td>
<td></td>
</tr>
<tr>
<td>Muskmelons</td>
<td>Eggplant</td>
<td></td>
</tr>
<tr>
<td>New Zealand Spinach</td>
<td>English Peas</td>
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<tr>
<td>Okra</td>
<td>Garlic</td>
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<tr>
<td>Onions</td>
<td>Kale</td>
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</tr>
<tr>
<td>Peanuts</td>
<td>Kohlrabi</td>
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<tr>
<td>Spinach</td>
<td>Lima Bean</td>
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<tr>
<td>Swiss Chard</td>
<td>Parsley</td>
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<tr>
<td></td>
<td>Peppers</td>
<td></td>
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<tr>
<td></td>
<td>Pumpkins</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Radishes</td>
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<td></td>
<td>Rutabagas</td>
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<td>Soybeans</td>
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<td>Squash</td>
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<tr>
<td></td>
<td>Sunflowers</td>
<td></td>
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<tr>
<td></td>
<td>Tomatoes</td>
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<td></td>
<td>Turnips</td>
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# Macronutrients Essential To Plant Growth

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<tr>
<th>Element</th>
<th>Cationic</th>
<th>Anionic</th>
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<tr>
<td>Nitrogen</td>
<td>NH$_4^+$</td>
<td>NO$_2^-$, NO$_3^-$</td>
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<tr>
<td>Phosphorus</td>
<td>-</td>
<td>HPO$_4^{2-}$, H$_2$PO$_3^-$, polyphosphates</td>
</tr>
<tr>
<td>Potassium</td>
<td>K$^+$</td>
<td>-</td>
</tr>
<tr>
<td>Calcium</td>
<td>Ca$^{+2}$</td>
<td>-</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Mg$^{+2}$</td>
<td>-</td>
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</table>
## Micronutrients Essential To Plant Health

<table>
<thead>
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<th>Element</th>
<th>Cationic</th>
<th>Anionic</th>
<th>Other</th>
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</thead>
<tbody>
<tr>
<td>Iron</td>
<td>Fe$^{+2}$</td>
<td>-</td>
<td>organic-</td>
</tr>
<tr>
<td>chelated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manganese</td>
<td>Mn$^{+2}$</td>
<td>-</td>
<td>organic-</td>
</tr>
<tr>
<td>chelated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper</td>
<td>Cu$^{+2}$</td>
<td>-</td>
<td>organic-</td>
</tr>
<tr>
<td>chelated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zinc</td>
<td>Zn$^{+2}$</td>
<td>-</td>
<td>organic-</td>
</tr>
<tr>
<td>chelated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molybdenum</td>
<td>-</td>
<td>MoO$_4^-$</td>
<td>-</td>
</tr>
<tr>
<td>Boron</td>
<td>-</td>
<td>B(OH)$_4^-$, H$_3$BO$_3$</td>
<td>-</td>
</tr>
<tr>
<td>Chlorine</td>
<td>-</td>
<td>Cl$^-$</td>
<td>-</td>
</tr>
<tr>
<td>Nickel</td>
<td>Ni$^{+2}$</td>
<td>-</td>
<td>-</td>
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</table>
# Minerals Essential For Animal Health

<table>
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<tr>
<th>Element</th>
<th>Cationic</th>
<th>Anionic</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cobalt</td>
<td>Co$^{+2}$</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Selenium</td>
<td>-</td>
<td>SeO$_4^{-2}$, SeO$_3^{-2}$, Se$^{-2}$</td>
<td>organic</td>
</tr>
<tr>
<td>Sodium</td>
<td>Na$^+$</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Facts About Nutrient Uptake

• Uptake is generally in mineral form.
• Uptake is a function of transpiration.
• Water enters through new roots.
• Uptake into cells is mediated.
• Microbes get first shot.
Law of Limiting Factors
Plant Consumption

Concentration of any particular mineral impacts overall plant growth.

- Macroelements-broad
- Microelements-narrow

Growth

Mineral Concentration

- Deficient
- Adequate
- Luxury consumption
- Toxic
Nitrogen

When plants are established, being careful to keep all fertilizer off plant leaves.
Nitrogen in Plants

• Nitrogen is a part of all living cells and is a necessary part of all proteins, enzymes and metabolic processes involved in the synthesis and transfer of energy.
• Nitrogen is a part of chlorophyll, the green pigment of the plant that is responsible for photosynthesis.
• Helps plants with rapid growth, increasing seed and fruit production and improving the quality of leaf and forage crops.
• Nitrogen often comes from fertilizer application and from the air (legumes get their N from the atmosphere, water or rainfall contributes very little nitrogen)
Phosphorus
Phosphorus

• Like nitrogen, phosphorus (P) is an essential part of the process of photosynthesis.
• Involved in the formation of all oils, sugars, starches, etc.
• Helps with the transformation of solar energy into chemical energy; proper plant maturation; withstanding stress.
• Effects rapid growth.
• Encourages blooming and root growth.
• Phosphorus often comes from fertilizer, bone meal, and superphosphate.
Phosphorus Cycle

The Phosphorus Cycle

- Animal manures and biosolids
- Plant residues
- Crop harvest
- Atmospheric deposition
- Mineral fertilizers
- Runoff and erosion
- Primary minerals (apatite)
- Soil solution phosphorus: $\text{HPO}_4^{2-}$, $\text{H}_2\text{PO}_4^-$
- Leaching (usually minor)
- Mineral surfaces (clays, Fe and Al oxides, carbonates)
- Secondary compounds (Ca, Fe, Mn, Al, P)

http://phsgirard.org/Biology/Ecology/PhosphorusCycle.jpg
Potassium
Potassium

- Potassium is absorbed by plants in larger amounts than any other mineral element except nitrogen and, in some cases, calcium.
- Helps in the building of protein, photosynthesis, fruit quality and reduction of diseases.
- Potassium is supplied to plants by soil minerals, organic materials, and fertilizer.
Potassium Cycle

http://www.ipipotash.org/en/image/present/aspcwdb/fig5.gif
Calcium
Calcium in Plants

• Calcium, an essential part of plant cell wall structure, provides for normal transport and retention of other elements as well as strength in the plant. It is also thought to counteract the effect of alkali salts and organic acids within a plant.

• Sources of calcium are dolomitic lime, gypsum, and superphosphate.
Magnesium
Magnesium in Plants

• Magnesium is part of the chlorophyll in all green plants and essential for photosynthesis. It also helps activate many plant enzymes needed for growth.
• Soil minerals, organic material, fertilizers, and dolomitic limestone are sources of magnesium for plants.
Sulphur

Figure 8. Sulfur-deficient plants (left) and normal plants (right).
Sulphur in Plants

- Essential plant food for production of protein.
- Promotes activity and development of enzymes and vitamins.
- Helps in chlorophyll formation.
- Improves root growth and seed production.
- Helps with vigorous plant growth and resistance to cold.
- Sulfur may be supplied to the soil from rainwater. It is also added in some fertilizers as an impurity, especially the lower grade fertilizers. The use of gypsum also increases soil sulfur levels.
Iron
Iron in Plants

• Essential for formation of chlorophyll.
• Sources of iron are the soil, iron sulfate, iron chelate.
Manganese
Manganese in Plants

• Functions with enzyme systems involved in breakdown of carbohydrates, and nitrogen metabolism.

• Soil is a source of manganese.
Copper
Copper in the Plant

• Important for reproductive growth.
• Aids in root metabolism and helps in the utilization of proteins.
• Immobile in the plant.
Zinc
Zinc in the Plant

- Essential for the transformation of carbohydrates.
- Regulates consumption of sugars.
- Part of the enzyme systems which regulate plant growth.
- Sources of zinc are soil, zinc oxide, zinc sulfate, zinc chelate.
Molybdenum
Molybdenum in the Plant

• Helps in the use of nitrogen
• Soil is a source of molybdenum.
Boron in the Plant

- Helps in the use of nutrients and regulates other nutrients.
- Aids production of sugar and carbohydrates.
- Essential for seed and fruit development.
- Sources of boron are organic matter and borax
Chlorine

Chloride deficiency in Durum Wheat. A=No Cl, B=30 mmol Cl/pot
Chlorine in the Plant

- Aids plant metabolism.
- Chloride is found in the soil.
Nickel

A  Ni-deficient (left row).

B  Ni-sufficient (right row).
Nickel in the Plant

• Important component in nitrogen metabolism.
• Functions in plant growth and development.
• Lowest concentration of any nutrient.
• Most recently discovered micronutrient.
• Leaf tip necrosis and mouse’s ear.
• Foliar sprays or composted sludge are good sources of nickel.
Soluble Salts or Salinity

• Too Much Cations and Anions
• Creates Drought Stress
• Causes Plants to Burn
• Fertilizer on Leaves
• Toxic Levels of Elements
Soluble Salts or Salinity

• Avoid using fresh manure.
• Use moderation and caution when adding other soil amendments with high salt concentrations.
• Do not over fertilize. Apply only the recommend label rate of fertilizers and water fertilizer off of foliage.
• Keep de-icing materials on walkways.
Soluble Salts or Salinity

• Discontinue the use of all fertilizer until the salt levels returns to an acceptable balance that is determined by testing.
• Be certain there is adequate drainage to help move salts out of the root zone.
• Flush the soil with as much water as you can for several days. Apply water slowly so it will infiltrate into the soil and does not runoff taking topsoil with it.
• If your soil has a lot of clay and is low in calcium, apply gypsum at a rate of 10 pounds per 100 square feet and water in. Then in 6 weeks have the soluble salt level tested again. Repeat if subsequent soluble salt test is high (strongly saline).
• Determine the cause of the high salt levels and if you can avoid this situation in the future.
Fertilizers
Remember

• First number is % elemental nitrogen.
• Second number is % phosphate ($P_2O_5$)
  – 43.6% P
• Third number is % potash ($K_2O$)
  – 83% K
• Australia uses a fourth number for sulphur.
## Fertilizer

### Examples of Manufactured Fertilizers

<table>
<thead>
<tr>
<th>Product</th>
<th>Nitrogen %</th>
<th>Phosphate %</th>
<th>Potash %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonium nitrate</td>
<td>34</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ammonium sulfate</td>
<td>21</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Urea</td>
<td>48</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ammoniated super-phosphate</td>
<td>3-6</td>
<td>48-53</td>
<td>0</td>
</tr>
<tr>
<td>Di-ammonium phosphate</td>
<td>11</td>
<td>48</td>
<td>0</td>
</tr>
<tr>
<td>Mono-ammonium phosphate</td>
<td>11</td>
<td>48</td>
<td>0</td>
</tr>
<tr>
<td>Super-phosphate</td>
<td>0</td>
<td>18-50</td>
<td>0</td>
</tr>
<tr>
<td>Triple super phosphate</td>
<td>0</td>
<td>46</td>
<td>0</td>
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<tr>
<td>Potassium chloride</td>
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<td>60</td>
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<tr>
<td>Potassium nitrate</td>
<td>13</td>
<td>0</td>
<td>44</td>
</tr>
<tr>
<td>Potassium sulfate</td>
<td>0</td>
<td>0</td>
<td>50</td>
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<tr>
<td>Potassium-magnesium sulfate</td>
<td>0</td>
<td>0</td>
<td>22</td>
</tr>
</tbody>
</table>
“Organic” Fertilizers

- **Greensand** -- An organic fertilizer which is a good source of iron, potassium, and trace minerals. Mined from ancient seabeds.
- **Fish Emulsion** -- A concentrated organic fertilizer made from fish or fish by-products. Combine it with seaweed will make an excellent fertilizer. NPK approx. 4-1-1 to 7-2-2.
- **Aragonite**
  
  location for aragonite is Molina de Aragón (Guadalajara, Spain), 25 km outside Aragon. It exists naturally in the shells of chiton and other mollusks. Contains 94-97% calcium carbonate. When users apply dolomitic limestone to sweeten the soil, it gives high levels of magnesium that tie up other nutrients. Using Aragonite for a couple seasons will restore the balance. It works by conditioning the soil and lowers acidity of soil. Can also be used to keep moles, mice, chipmunks and squirrels off newly planted bulbs. Apply only based on results of a soil test.
- **Soybean Meal** is a high-nitrogen fertilizer. To get the best price, search for it at animal feed-supply stores. Greenhouse research showed that soybean meal can prevent the germination of small seeds. Soybean Meal is 7% Nitrogen, 2% Phosphorus and 1% Potassium. Application rate: 4 pounds per 100 square feet. Soybean meal fertilizer is a high protein feed that when broken down by microbes provides natural organic nitrogen. It provides a soluble form of phosphorous. Like alfalfa meal, it is particularly beneficial to nitrogen-loving plants, such as roses.
- **Epsom Salts** -- Hydrated magnesium sulfate, used as a fast acting source of magnesium and sulfur. These are elements that are needed in the soil. Excellent organic fertilizer.
- **Coffee Grounds**-- People are finding that a long tossed substance is rich in nitrogen and can be used in the garden and compost piles. Check with your local coffee shop for a steady supply of grounds.
- **Cocoa Meal Shell Mulch**-- WARNING FOR PETS. Cocoa Meal contains three percent nitrogen, four percent total phosphate, and three percent potash. Application rates are normally two hundred to two hundred fifty pounds per acre, due to caffeine content. Cocoa meal is best used as an component in a fertilizer mix than as a direct amendment.
Organic Fertilizer

- **Seaweed**—A saltwater plant, when grounded, will stimulate root growth and has over 60 trace minerals needed by plants. This organic fertilizer when combined with fish emulsion will make the best complete fertilizer.

- **Chilean Nitrate of Soda**, also known as Natural Nitrate of Soda, is a highly soluble, quick acting granular fertilizer that is 16 percent nitrogen. It is also high in sodium so do not use it on arid soils where salt buildup is likely or on plants that are sensitive to salt. Chilean nitrate is mined from a desert in northern Chile, most likely the only known deposit of this mineral salt. It should not be depended upon as the only source of nitrogen. Applying this nitrate mixed with an organic amendment like cocoa meal, peanut meal or compost will add to the efficiency of both products.

- **Azomite**—(0-0-2.5, 5% Calcium)
  A natural, odorless, volcanic mineral rich in trace elements.
  May be used with potting soil, indoor plants, gardens, and mix in with compost and your favorite organic fertilizer. Apply to gardens at 1 pound per 10 square feet, houseplants you want to use 1 teaspoon in water every 3 months.

- **Molasses**—A food for microorganisms in the soil, also contains trace minerals, sulfur and potash. Molasses plays a very important part of the complete organic program.

- **Humates**—A source of humic acid(organic lawn fertilizer) and trace minerals and is the end result of a successful compost. A broken down form of organic matter. Smells like the forest floor decayed leaves.

- **Lava Sand**—Ground up Lava, loaded with trace minerals, water holding ability, and is a much needed energy soil amendment.

- **Lime**—Will adjust the pH of the soil(reduces acidity), contains calcium which keeps magnesium low.
Organic Fertilizers

- **Crab Meal** (5-2-0.5)
  Considered a soil additive which is a by-product of the crab industry. Once they are kiln dried they are ground up into the meal. Adds life to soil by providing food for microorganisms, especially a protein called chitin. Chitin provides not only slow-release nitrogen but also suppresses pest nematode activity. General usage is anywhere plants grow and to add to compost piles.
  Apply:
  - vegetables--5 pounds per 50 foot row.
  - ornamental trees--4 pounds per tree
  - ornamental shrubs--3/4 pounds per bush.
  - tomatoes and peppers--6 ounces per plant
  - house plants--2 to 4 ounces per pot, depending on size of plant.

- **Sul-po-mag** -- Natural fertilizer. A source of 22% sulfur, 22% potash, and 11% magnesium right here in 5 and 50 pounds-

- **Zinc** -- Traces of this mineral show up in organic fertilizers. Too much of this mineral is toxic---do a soil test first.

- **Sustane**(composted turkey manure)-- A very fast acting 100% organic fertilizers- NPK 5-2-4. From real **turkeys**

- **Gypsum** -- An excellent source of micronutrients sulfur and calcium. Used in clay soils because of its draining capabilities and provides aeration.

- **Earthworm Castings**--Organic fertilizer high in useful minerals and bacteria. The n-p-k is high and has over 60 trace minerals, almost an ideal additive to soil. Made from worms digesting organic matter and excretes the castings. *Avoid* chemical fertilizers which contain ammonium sulfate that is toxic to earthworms. Get all the [Earthworm Castings](#) you need.

- **Cottonseed Meal**-- Made from **cotton** seed freed from its hulls. Cotton crops are the most sprayed crop with chemical herbicides and pesticides. Best if composted 1st to rid toxic chemicals. Use in compost pile. 6-1-1--Ground from cottonseeds which is a natural fertilizer considered by many to be the second best source of nitrogen after blood meal. Is a slow release fertilizer and adds acidity to the soil.
Organic Fertilizers

- **Corn Gluten Meal**-- A natural fertilizer and pre-emergent herbicide. Will keep weeds down if applied at the right time of year and is made from corn.

- **Compost**-- Considered the best organic fertilizer because it is high in microorganisms, humic acid, enzymes, vitamins, and humus. We should make our own. But if you cannot make it try this [50LB Compost Cow Manure](#).

- **Bat Guano**--Made from bat excretions, a natural fertilizer, all purpose fertilizer containing nitrogen and lots of trace minerals.

- **Blood Meal**-- is a dried blood material that is a very good source of nitrogen of around 13%. The organisms in the soil turn it into available nitrogen for plants. Lettuce and corn will benefit greatly. Will aid the compost pile. can be used as top dressing or mix with water and used as a liquid fertilizer. A slow release source of calcium and phosphorus used to increase phosphorus levels. Can be recommended for bulbs and most vegetables. Excellent plant food.

- **Bone Meal** (steamed) 1-13-0--Is the best source of phosphorus and also contains calcium and some trace minerals. Because of its slow release it is a safe fertilizer especially when potting new or young plants. Perfect for bulbs and good for lowering transplant shock. Promotes healthy root systems. Contains growth regulators and a good source of nitrogen and phosphorus, mostly used around roses. Excellent plant food.

- **Alfalfa Meal**--A very good organic fertilizer for plants and soil. A plant food growth regulator, high in vitamins and minerals. 3-2-2--a green manure crop made from alfalfa which contains a plant growth regulator hormone. It jumpstarts millions of microbes that will then activate soil organisms that convert the surrounding nutrients into an available form to plants. Roses especially love it but acts as a soil amendment for all plants. Can be added to compost pile to boost the breakdown of carbon rich materials. Use as a top dressing and water in, apply dry at 10 pounds per 1,000 square feet.

- **Kelp Meal**-- Made from dried seaweed. Is a good source of copper and boron. Rich in plant food growth hormones. a natural source of chelated trace elements that increases health of the soil and plants. Use as an additive to organic fertilizers at 10 pounds per 1000 square feet.
Organic Fertilizers

- **Manure** -- Should be composted before using because of nitrogen and ammonia can burn plants. Is rich in nitrogen and can be obtained from many different animals, even horses.
- **Cover Crops** -- They are leguminous plants like clover and grains like rye and oats. Planted as a green manure.
- **Rock Phosphate** -- A dry organic fertilizer used to boost phosphorus levels. Slow to dissolve in water so will last for a long time. NPK 0-25-0. An excellent natural source of phosphorus, calcium and many essential trace elements. It works to build phosphate fertility, increase root activity in transplants and seedlings. Improves the soil and quality of the crops. Will not burn roots. Apply 2 pounds for trees and shrub transplants.
- **Potash** -- Overall describes material containing potassium. It is potassium carbonate from wood ashes.
- **Soybean Meal** -- A legume made into a organic fertilizer and used for it's nitrogen. NPK 7-1-2.
- **Feather Meal** (12-0-0)--feathers are ground up into a meal. Nitrogen is released over a long period of time. Use with other organic fertilizers as a slow release source of nitrogen.
- **Fermented Salmon (Coast of Maine)** (1.4 - 0.2 - 0.2) made from fermented salmon with a pungent smell, pine oil will cover this smell. consists of many nutrients and organic compounds that are immediately available to the plant. Naturally rich in oils and fatty acids when fermented that stimulate germination, root growth, foliage growth, product yield and stress recovery. not a fish emulsion. works to deter wildlife like deer and insects like aphids. recently found to act as a fungicide. use with any plant. apply as you would any other foliar spray or spray fertilizer.
- **Granite meal** --made from soft granite into a rock powder. A source of potassium to help produce sugar and starch for the plants. Its job is to provide trace mineral content where the soil has been overworked and lacking in trace minerals. Apply 75 pounds per 1000 square feet.
- **Leather Meal** --made as a by-product during tanning process. An source of organic, slow-release nitrogen to be added to organic fertilizers mixes.
- **Soft Rock Phosphate (aka Colloidal Rock Phosphate)** --A soft, natural colloidal clay formation that gives up its nutrient slowly enough to last for years without leaching or fixing. Unlike other phosphates, it contains colloidal clay that can bind sandy soils and add to their nutrient holding capacity. Apply 25 pounds per 1000 square feet or a fistful with transplants.
- **Sulfate of Potash** 0-0-52--natural potash that is 51% soluble. Second only to nitrogen in amount needed for plants. It can be applied as a supplement or mixed with other materials. You do need an accurate soil test first.
Lime

• Used to decrease acidity
• Ingredients
  – Calcium carbonate (CaCO$_3$)
  – Magnesium carbonate (MgCo$_3$)
  – Calcium oxide (CaO)
  – Magnesium oxide (MgO)
• Do not use hydrated lime!
  – Exposure risk
Gypsum

- Lower soil pH
- Calcium sulfate dihydrate - \( \text{CaSO}_4 \cdot 2\text{H}_2\text{O} \)
Soil Test

• Free!
• Sample by management unit
• Background
  – What is the crop?
    • Be specific
  – Lime history
Soil Test Results

• Nutrient Availability Index
  – Nitrogen is not routinely analyzed.
    • Poor correlation
    • Recommendations based on research

• Soil Properties
  – Soil EC as requested
  – Soil ECEC
  – Organic matter as requested
  – Soil Texture
  – Estimated Base Saturation
Soil Test Results

• Fertilizer Recommendations
  – Lawn and Garden Crops
    • Lbs/1000 ft$^2$
  – Pastures and Agronomic Crops
    • Lbs/acre
    • 43,560 ft$^2$/ac
  – Crop Notes
Cover Crops

- Add organic matter to the soil
- May add nitrogen
- Improves soil strength and structure
- Improves permeability
- May be competitive with crops
- Allelopathic to crops
Mulches

• Prevents weeds
• Conserves water
• Adds organic matter
Mulches

- Plastic
- Straw
- Leaves
- Sawdust
- Wood Chips
- Pine Bark