University of Idaho
College of Agriculture

Cooperative Extension System
Agricultural Experiment Station

Current Information Series No. 863

Fertilizer Primer

Terminology, Calculations and Application

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Chemical fertilizers, when properly used, provide a satisfactory source of plant nutrients and can increase the yield and quality of crops when applied to nutrient-deficient soils. Other materials such as manure, sewage sludge and industrial wastes also can satisfy the nutrient needs of crops. In many situations, factors such as accessibility and transportation costs result in chemical fertilizers providing the most economic means of improving soil fertility.

The purpose of this publication is to define terminology commonly associated with fertilizers and their use. In addition, this publication shows how to translate fertilizer recommendations into actual pounds of fertilizer per unit area and provides general guidelines for fertilizer application.

Terminology

Plant Nutrient

Any of the elements classified as essential to plant growth excluding carbon (C), hydrogen (H) and oxygen (O) and including the macronutrients nitrogen (N), phosphorus (P), potassium (K), sulfur (S), calcium (Ca) and magnesium (Mg) and the micronutrients boron (B), chlorine (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo) and zinc (Zn). In the United States, "plant nutrient" is used interchangeably with "fertilizer nutrient."

Fertilizer Nutrient

Any plant nutrient. The term is used only in the United States.

Fertilizer

Any substance that is added to the soil or sprayed on plants to supply one or more plant nutrients.

Fertilizer Material

Any substance that contains one or more plant nutrients.

Fertilizer Carrier

The fertilizer material containing the essential plant nutrients [e.g., potassium chloride (KCl) is a carrier of potassium].

Fertilizer Intermediate

A manufactured fertilizer such as ammonia (NH_3), phosphoric acid (H_3PO_4) or nongranular ammonium phosphate [$(NH_4)_3PO_4$] that is intended for further processing. These intermediates can also be used directly as fertilizers.

Straight Fertilizer

A fertilizer containing only one nutrient. Examples include urea, which contains only nitrogen, and triple superphosphate, which contains only phosphorus.

Mixed Fertilizer

A fertilizer that contains two or more of the three macronutrients N, P and K. Several types of mixed fertilizers are available. This definition does not apply outside the United States.

Complete Fertilizer

A fertilizer that contains all three major macronutrients — N, P and K.

Filler

An inert material added to mixed fertilizers to finish out the weight requirements in a given quantity of material (the weight basis is usually a ton). Fillers are rarely used today because of the transportation and other costs to ship, store and handle material that has no plant nutrient value.

Fertilizer Grade

The minimum content of plant nutrient elements guaranteed by the manufacturer, expressed in terms of the percent by weight of total N, available P (expressed as P_2O_5) and available K (expressed as K_2O). The grade is always listed in this order: N, P_2O_5, K_2O. A fertilizer containing 10 percent N, 8 percent P_2O_5 and 15 percent K_2O would have a grade of 10-8-15.

Fertilizers often contain macronutrients other than N, P and K such as sulfur (S) and magnesium (Mg) or micronutrients such as boron (B), zinc (Zn) and molybdenum (Mo). Like nitrogen, these nutrients are listed on the fertilizer label on an elemental basis. Sometimes such nutrients are included in the fertilizer grade. For example, a 15-5-10-8S fertilizer contains 15 percent N, 5 percent P_2O_5, 10 percent K_2O and 8 percent S. Similarly, a fertilizer with a grade of 10-0-2-6Mg contains 10 percent N, no P, 2 percent K_2O and 6 percent Mg.

High Analysis Fertilizer

Fertilizers containing relatively large amounts of nutrients. A fertilizer with a grade of 10-20-20 would have a high analysis compared with a fertilizer with a grade of 4-8-9. High analysis fertilizers usually provide nutrients at comparatively lower costs per pound of plant nutrient than low analysis fertilizers because of lower transportation, storage and application costs per pound of plant nutrient.

Fertilizer Ratio

The smallest whole number relationship among N, P_2O_5 and K_2O.

A fertilizer with a grade of 5-10-10 has a 1-2-2 ratio.
A fertilizer with a grade of 3-9-6 has a 1-3-2 ratio.
A fertilizer with a grade of 17-3-7 has a 17-3-7 ratio.

Unit of Fertilizer

1. Officially, an amount of fertilizer material that contains 20 pounds of nutrient.
2. In Idaho, common usage of "units per acre" is actually pounds of plant nutrient per acre. One unit is equivalent to 1 pound. Thus, three fertilizer units of N equals 3 pounds of N.

Forms of Commercial Fertilizers

Granular Fertilizer

A fertilizer in the form of particles sized between an upper and lower limit or between two screen sizes. Granular fertilizers usually range from 1 to 4 mm in diameter and are often more closely sized.

Fertilizer Crystals

Fertilizers in crystal form, usually of large enough size to be classified as granular fertilizers.

Prilled Fertilizer

A type of granular fertilizer that is nearly spherical. Prills are made by solidifying free-falling droplets in air or a fluid medium.

Coated Fertilizer

A granular fertilizer that has been coated with a thin layer of some substance such as clay or plastic to prevent caking or to control dissolution rate.

Nongranular (Powdered) Fertilizer

Fertilizer containing fine particles, usually with some upper diameter limit such as 3 mm but no lower limit.

Conditioned Fertilizer

Fertilizer treated with an additive to improve physical condition or prevent caking. The conditioning agent may be applied as a coating or incorporated into the product.

Bulk Fertilizer

An unpackaged or unbagged fertilizer.

Bulk-Blend (Blended) Fertilizer

A fertilizer containing two or more granular fertilizers, preferably of similar size, mixed and handled unbagged.

Solid Fertilizers

Granules, prills and powders.

Liquid (Fluid) Fertilizers

Fertilizers wholly or partially in solution, including clear liquids, liquids containing solids in suspension and anhydrous ammonia. Anhydrous ammonia sometimes is referred to as a gaseous fertilizer. While under pressure it is a liquid, but when released from the containing vessel, it instantly becomes gaseous.

Suspension Fertilizer

Liquid (fluid) fertilizers containing solids held in suspension by a small amount of special clay. The solids may be water-soluble materials in a saturated solution, water-insoluble materials or both.

Solution Fertilizer

Liquid fertilizers without undissolved solids.

Slow-Release Fertilizer

Fertilizers that release nutrients slowly, providing them over a relatively long period. These materials commonly are used in potting mixtures and turf management. Slow-release fertilizers can reduce plant toxicity hazards (see salt index under "Other Concepts") by slowing the release of nutrients into the soil water. Slow-release fertilizers are usually comparatively expensive. Commercially available slow-release fertilizers include urea formaldehyde, sulfur-coated urea and plastic-coated fertilizers. Other materials that release nutrients at relatively slow rates include organic fertilizers such as blood meal, tankage (dried animal residues usually freed from the fat and gelatin), sewage sludge and manure.

Organic Fertilizer

A fertilizer consisting of harvested organic materials or wastes. Common organic fertilizers include bird guano, poultry and animal manures of all types and municipal sewage sludges.

Chelate

A micronutrient fertilizer material. Chelated micronutrient fertilizers are often more available to plants than micronutrient salts; however, their relatively high cost limits their use to the highest-value crops.

Specific Fertilizers

Superphosphate

A product made by treating phosphate rock with an acid. Single superphosphate (SSP) is also known as ordinary superphosphate (OSP) or normal superphosphate (NSP). This material normally contains between 16 and 22 percent P_2O_5. Triple superphosphate (TSP), also known as concentrated superphosphate (CSP), contains between 42 and 46 percent P_2O_5.

Nitrophosphate (Nitric Phosphate)

A fertilizer containing N and P made by a process that includes a chemical reaction between nitric acid and phosphate rock.

Muriate of Potash

Commonly known as potassium chloride (KCl). Muriate means the product contains chloride.

Sulfate of Potash

Commonly known as potassium sulfate (K_2SO_4). Sulfate of potash is usually more expensive than muriate of potash.

Solution 32

Refers to a liquid nitrogen fertilizer that contains 32 percent N. Its grade is 32-0-0. Similarly, a material called Solution 28 is a liquid nitrogen fertilizer containing 28 percent N with a grade of 28-0-0. Liquid nitrogen fertilizers generally vary in N concentration between 19 and 40 percent.

Rock Phosphate

The mined ore of phosphorus. It undergoes chemical treatment to produce plant-available P fertilizers. When rock phosphate itself is used as a fertilizer, poor uptake of phosphorus into plants often occurs.

Application of Fertilizers

Fertilizer Application

Any process used to apply fertilizer in or on the soil.

Basal (Preplant) Application

Fertilizer application before establishment of a crop (preplant) to provide for part or all of its needs during the growing season. The fertilizer may be applied before plowing, before planting or during planting or transplanting.

Topdress Application

Application by broadcasting fertilizer over the soil surface after planting.

Broadcast Incorporated

Refers to fertilizer uniformly applied to the soil surface and then incorporated (mixed into) the soil with a tillage implement.

Band Application

Application of nutrients below, above, to one side or to both sides of the seed or seedlings.

Pop-Up (Starter) Application

Application of small amounts of nutrients in direct contact with the seed at planting.

Sidedress Application

A surface or subsurface band application after the crop is planted.

Foliar Application

Application of liquid fertilizer to the above-ground foliage.

Rates of Application of Fertilizer Materials

Recommended fertilizer application rates in current University of Idaho fertilizer guides are expressed in terms of pounds per acre (lb/acre) of N, P_2O_5, K_2O and S. To convert these recommendations to lb/acre of an actual fertilizer material, use the following formula:

$$\frac{\text{lb nutrient recommended/acre} \times 100}{\text{\% nutrient in fertilizer material}} = \text{lb fertilizer needed/acre.}$$

Example 1:

To supply 120 lb/acre of N using ammonium nitrate (34-0-0):

$$\frac{120 \times 100}{34} = 353 \text{ lb/acre of 34-0-0.}$$

Example 2:

To supply 120 lb/acre of N using urea (45-0-0) and 40 lb/acre of P_2O_5 using triple superphosphate (0-44-0):

$$\text{For N, } \frac{120 \times 100}{45} = 267 \text{ lb/acre of 45-0-0.}$$

$$\text{For P, } \frac{40 \times 100}{44} = 91 \text{ lb/acre of 0-44-0.}$$

Gardens and Lawns

To convert pounds per acre (lb/acre) to pounds per 100 square feet (lb/100 sq ft) multiply by $\frac{1}{400}$, and to convert to pounds per 1,000 square feet multiply by $\frac{1}{40}$. Thus, a fertilizer application of 400 lb/acre would equal 1 lb/100 sq ft. In Example 1, a rate of 353 lb/acre of 34-0-0 would equal 0.9 lb/100 sq ft. In Example 2, the conversions would be 0.67 lb urea/100 sq ft and 0.22 lb 0-44-0/100 sq ft.

Fertilizer Application Tips

Fertilizers should be applied uniformly and accurately to avoid uneven plant growth, increase fertilizer effectiveness and reduce risks to the environment. Band applications should be uniformly and accurately placed. It is important to use the recommended method of fertilizer application for these reasons:

1. Some nutrients such as P are fairly immobile in soil and should be mixed into the soil or placed or banded close to the rooting zone. For more information on fertilizer placement see University of Idaho CIS 757, *Fertilizer Placement*.
2. Fertilizers can damage plants if banded too close to seeds or roots at rates in excess of those suggested. Fertilizers containing B should never be banded but should be applied evenly to the fertilized area and mixed into the soil.
3. N can be lost into the atmosphere as gaseous N_2, N_2O or NH_3 when some N fertilizer materials are applied in irrigation water, left on the surface of alkaline soils or applied to standing water.

Dilute solutions of fertilizers are sometimes applied as foliar sprays. This practice is used most frequently for the application of micronutrients and used sometimes when a quick response is required. Large amounts of nutrients cannot be applied using foliar sprays.

Some fertilizers can be applied effectively with sprinkler irrigation, especially the highly soluble N fertilizers. The less-soluble fertilizers and fertilizers that may precipitate (come out of solution) with high-calcium irrigation water may present special problems such as clogged pipes and reduced availability of plant nutrients. Fertilizer application to surface irrigation waters is extremely inefficient and should not be used.

Other Concepts

Acidity from Fertilizers

Some fertilizer materials, such as N fertilizers that contain ammonium (NH_4) or urea, produce acid when they react with the soil. The continuous use of these acidifying fertilizers over a period of years can appreciably lower the pH of soil, especially in the fertilizer bands. When these acid bands are located close to the plant root, damage can occur. The acidifying effect of fertilizers can be neutralized by applying lime.

Some fertilizers, for example calcium nitrate ($CaNO_3$), have the opposite effect on soil. They raise the soil pH. Some fertilizers such as urea initially raise the pH of the soil, but their long-term effect is to increase soil acidity.

Salt Index

Fertilizers increase the concentration of salt in the soil, which can harm plants. The incorrect application of fertilizer can create salt concentrations that are toxic to plants. The salt index is a measure of a fertilizer's capacity to elevate the salt level of the soil, usually expressed as salt index per pound of plant nutrients. Fertilizers with high salt indexes have a higher plant-toxicity potential than fertilizers with lower salt indexes. Salt toxicity is likely to be more serious in soils with low moisture contents, in coarse-textured, sandy soils or where fertilizer is banded close to seeds or plants.

Soil Amendments

Soil amendments are materials used to alter the pH or physical properties of soil. Examples of amendments are lime used to reduce soil acidity, elemental sulfur and aluminum sulfate used to increase soil acidity, and gypsum and elemental sulfur used to improve the physical condition of alkali soil.

Liming materials are soil amendments used to increase acid soil pH and supply calcium and magnesium. The most commonly used material is ground limestone rock ($CaCO_3$). For additional information on liming materials, consult University of Idaho CIS 787, *Liming Materials*.

Need More Information?

If you need more information about fertilizers consult University of Idaho Bulletin 686, *Fertilizer Questions*, or contact the Extension agricultural agent in your county.

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1,500, April 1990

35 cents per copy