

CMG GardenNotes #232

## Understanding Fertilizers

---

Outline: Fertilizer or soil amendment? page 1  
What's in a fertilizer? page 2  
    Analysis or grade, page 2  
    Ratio, page 2  
    Formulation, page 2  
Nitrogen applications, page 4  
Phosphate and potash applications, page 5  
Specialty fertilizers, page 7

---

Fertility is only part of the soil management process. Colorado soils are naturally low in organic matter. To maximize productivity, our soils also need routine applications of organic matter to improve soil tilth. For flower and vegetable gardens, it is desirable to raise the soil organic content, over time, to 4-5%.

Manufactured fertilizers are popular with gardeners because they are readily available, inexpensive, easy to apply, and generally provide a quick release of nutrients for plant growth. Application rates depend on the nutrient need of the soil and the percent of nutrients in the specific fertilizer. **In products containing multiple nutrients, the application rate is always based on the nitrogen content.**

### Fertilizer or Soil Amendment?

By legal definition, the term *fertilizer* refers to a soil amendment that guarantees the minimum percentages of nutrients (at least the minimum percentage of nitrogen, phosphate, and potash).

An *organic fertilizer* refers to a soil amendment derived from natural sources that guarantees, at least, the minimum percentages of nitrogen, phosphate, and potash. Examples include plant and animal by-products, rock powders, seaweed, inoculants, and conditioners. These are often available at garden centers and through horticultural supply companies.

These should not be confused with substances approved for use with the *USDA National Organic Program (NOP)*. The USDA NOP, with its "USDA Organic" label, allows for the use of only certain substances. The Organic Materials Review Institute ([www.omri.org](http://www.omri.org)) and the Washington Department of Agriculture (WSDA) (<http://agr.wa.gov/>) review and approve brand name products made with

ingredients from the “national list” for use in certified organic production. If a fertilizer is not OMRI or WSDA approved, it may still be allowed for organic production but has not been reviewed and deemed suitable for use in certified production. To learn more about which inputs are allowed and which are prohibited refer to <http://www.ams.usda.gov/about-ams/programs-offices/national-organic-program>

Many of the organic fertilizers listed here will meet NOP standards (based on the National List). Growers participating in the NOP should consult with their certifier to ensure compliance for organic certification.

The term *soil amendment* refers to any material mixed into a soil. *Mulch* refers to a material placed on the soil surface. In Colorado, soil amendments contain no legal claims about nutrient content or other helpful (or harmful) effects they will have on the soil and plant growth. In Colorado, the term *compost* is also unregulated, and could refer to any soil amendment regardless of active microorganism activity.

Many gardeners apply *organic soil amendments*, such as compost or manure, which most often do not meet the legal requirements as a “fertilizer” but add small amounts of nutrients.

## What is in a Fertilizer?

### Analysis or Grade

By law, all products *sold as fertilizer* require uniform labeling guaranteeing the minimum percentage of nutrients. The three-number combination (fertilizer *grade* or *analysis*) on the product identifies percentages of nitrogen (N), phosphate ( $P_2O_5$ ), and potash ( $K_2O$ ), respectively. For example, a 20-10-5 fertilizer contains 20% nitrogen, 10% phosphate, and 5% potash.

Note: **Phosphorus, P**, is a primary nutrient in plant growth. The word **phosphate,  $P_2O_5$** , refers to the ionic compound containing two atoms of phosphorus with five atoms of oxygen. The *phosphorus* content of fertilizers is measured in percent *phosphate*.

Note: **Potassium, K**, is a primary nutrient in plant growth. The word **potash,  $K_2O$** , refers to the ionic compound containing two atoms of potassium with one atom of oxygen. The *potassium* content of fertilizers is measured in percent *potash*.

The product may also identify other nutrients, such as sulfur, iron, and zinc, if the manufacturer wants to guarantee the amount. This may be done by placing a fourth number on the product label and identifying what nutrient was added in the ingredients.

### Ratio

Fertilizer *ratio* indicates a comparative proportion of nitrogen to phosphate to potash. For example, a 15-10-5 fertilizer has a ratio of 3-2-1, and an 8-12-4 fertilizer has a ratio of 2-3-1. **Fertilizer recommendations from a soil test are given in ratios.**

When shopping for a fertilizer, select a product with a ratio somewhat similar to that desired. For example, if a soil test recommended a 2-1-0 ratio, the ideal fertilizer would be something like 8-4-0, 10-5-0 or 20-10-0. However, if you cannot find that exact fertilizer, an 8-4-2 would be similar. If a garden soil test calls for a 1-0-0 ratio, a 21-0-0 or 24-2-2 fertilizer would be similar.

## Formulation

The *formulation* tells what specific kinds of fertilizer are in the product. Table 1 gives examples of manufactured fertilizers that could be mixed to derive any specific analysis, ratio, or brand name.

**Table 1. Examples of Manufactured Fertilizers**

Product	N%	P <sub>2</sub> O <sub>5</sub> %	K <sub>2</sub> O%
Ammonium nitrate	34	0	0
Ammonium sulfate	21	0	0
Urea	48	0	0
Ammoniated super-phosphate	3-6	48-53	0
Di-ammonium phosphate	11	48	0
Mono-ammonium phosphate	11	48	0
Super-phosphate	0	18-50	0
Triple super phosphate	0	46	0
Potassium chloride	0	0	60
Potassium nitrate	13	0	44
Potassium sulfate	0	0	50
Potassium-magnesium sulfate	0	0	22

What else is in the fertilizer? In a manufactured fertilizer, the grade does not add up to 100% because the fertilizer also contains other elements like carbon, hydrogen, oxygen, sulfur, iron, zinc, etc. For example, ammonium nitrate (NH<sub>4</sub><sup>+</sup> NO<sub>3</sub><sup>-</sup>) has a grade of 34-0-0 with 34% of the content from nitrogen and 66% from hydrogen and oxygen. Ammonium sulfate (NH<sub>4</sub><sup>+</sup> SO<sub>4</sub><sup>-</sup>) has a grade of 21-0-0 with 21% from the nitrogen and 79% from the hydrogen, sulfur and oxygen.

*Time release* or *slow release* fertilizers contain coatings or are otherwise formulated to release the nutrients over a period of time as water, heat, and/or microorganisms break down the material. [Table 2]

**Table 2. Examples of Quickly and Slowly Available Nitrogen**

<p><b>Quickly available nitrogen</b></p> <ul style="list-style-type: none"> <li>○ Lasts 4-6 weeks</li> </ul>	<p>Ammonium sulfate Ammonium nitrate Calcium nitrate Potassium nitrate Urea</p>
<p><b>Slowly available nitrogen</b></p> <ul style="list-style-type: none"> <li>○ Available over weeks to months</li> <li>○ Regulated by solubility or microorganism activity</li> </ul>	<p>Resin-coated urea Sulfur-coated urea Isobutylidene diurea (IBDU) Methylene urea Urea formaldehyde Manure Poultry wastes Blood meal</p>

---

In an “organic” type fertilizer, the base is decomposed or processed plant and/or animal by-products. For example, fish emulsion is ground and processed non-edible fish or fish scraps. Its nutrient content would be around 8-4-2, with 8% from nitrogen, 4% from phosphate, and 2% from potash.

Some manufactured and “organic” fertilizers contain fillers, which are used to prevent caking, control dust, derive the desired grade, or to facilitate ease of application.

*Complete fertilizer* is a term used to identify fertilizers that contains nitrogen, phosphorus, and potassium. In the national home garden trade, most fertilizers are complete. However, in Colorado many gardens do not need phosphorus or potassium. It is advisable to avoid heavy applications of phosphate and potash when unneeded as they contribute to soil salts.

## Nitrogen Applications

Nitrogen is the nutrient needed in largest quantities as a fertilizer. Nitrogen is annually applied by manufactured fertilizer, organic fertilizers, and/or organic soil amendments. **Application rates are critical, because too much or too little directly affect crop growth.**

**Application rate is based on the soil organic content.** As the organic content increases, nitrogen will be slowly *mineralized* (released) by the activity of soil microorganisms. Standard application rates for gardens are given in Table 3.

Nitrogen fertilizer can be broadcast and watered in, or broadcast and tilled into the top few inches of soil. It can be banded 3-4 inches to the side of the seed row. Do not place the fertilizer in the seed row or root injury may occur.

For additional information on fertilizers refer to the *CMG GardenNotes* #234, Organic Fertilizers, and #711, Vegetable Garden: Soil Management and Fertilization.

**Table 3. Nitrogen Fertilizer Application Rates for Home Gardens**

	Soil Organic Content		
	Typical garden soil low in organic matter (0-1% organic matter)	Moderate level of organic matter (2-3% organic matter)	High level of organic matter (4-5% organic matter)
<b>Nitrogen needed</b>	<b>0.2 lb. actual N per 100 square feet</b>	<b>0.1 lb actual N per 100 square feet</b>	<b>0</b>
<b><u>Fertilizer to apply</u></b>			
Ammonium sulfate 21-0-0	1 lb. fertilizer per 100 square feet (approximately. 2 cups)	0.5 lb. fertilizer per 100 square feet (approximately. 1 cup)	0
<b>OR</b>			
Ammonium nitrate 34-0-0	0.6 lb. fertilizer per 100 sq. ft. (approximately 1 1/3 cups)	0.3 lb. fertilizer per 100 sq. ft (approximately 2/3 cup)	0
<b>OR</b>			
Urea, 45-0-0	0.4 lb. fertilizer per 100 sq. ft. (approximately. 1 cup)	0.2 lb. fertilizer per 100 sq. ft (approximately 1/2 cup)	0

## Phosphate and Potash Applications

**A soil test is the best method to determine the need for phosphate and potash.** When a fertilizer contains a combination of nitrogen with phosphate and/or potash, the application rate is always based on the nitrogen percentage, because nitrogen levels are most critical to plant growth. Phosphate and potash fertilizers are best applied in the spring or fall when they can be tilled into the soil.

### Phosphorus

**Phosphorus may be present in high concentrations, however, it may not be in a plant available form.** With annual applications of compost or manure, phosphorus levels will likely be adequate. Deficiencies are most likely to occur in new gardens where the organic matter content is low and in soils with a high pH (7.8 to 8.3).

Excessive phosphorus fertilizer can aggravate iron and zinc deficiencies and increase soil salt content.

Where phosphate levels are believed to be low, the standard application rate without a soil test is 1/4 to 1 pound triple super phosphate (0-46-0) or ammonium phosphate (18-46-0) per 100 square feet.

When a phosphate fertilizer is applied to a soil, the phosphorus is quickly immobilized in the soil profile. It typically moves only about an inch. Therefore, it needs to be tilled into the rooting zone to be most effective.

## Phosphorus and Water Quality

In surface water, low phosphorus levels limit the growth of algae and water weeds. However, when the phosphorus content of surface water increases, algae and water weeds often grow unchecked, a process called *eutrophication*. This significant decrease in water quality is a major problem related to manure management in production agriculture and the handling of yard wastes from the landscape environment.

Popular press articles often incorrectly point to phosphorus-containing lawn and garden fertilizers as the major source of phosphate water pollution. Actually, phosphate fertilizers are rather immobile when applied at correct rates to lawn and garden soils.

However, high rates of manure applied year after year will build soil phosphorus content where leaching becomes a water quality problem. In sandy soils coupled with high rainfall/irrigation, excessive application rates of organic or manufactured fertilizers may also lead to water quality concerns.

The primary source of water polluting phosphorus in the landscape environment is the mowing, sweeping or blowing of lawn clipping and leaves onto the gutter and street. When mowing, mow in a direction to blow the clippings onto the lawn rather than onto the sidewalk or street. Also sweep any grass on the sidewalk/driveway onto the grass. Avoid blowing autumn leaves into the street! [Figure 1]

Figure 1. Grass clippings and leaves mowed or blown into the street are the major source of phosphate pollution from the landscape environment. Mow in a direction to discharge clippings back onto the lawn and not into the street.



Phosphate in fertilizer is immobilized upon contact with soil and is not a source of phosphate pollution when applied to a lawn (or garden) soil. However, fertilizer over-spread onto the sidewalk, driveway, and street moves with surface runoff into local lakes, streams and ponds. Exercise caution when fertilizing to keep the phosphate out of the street.

It is also important to leave an unmowed buffer strip edging all lakes, streams, ponds and wetlands rather than mowing plant residues into the water.

Second to yard waste management, over-spreading fertilizers onto hard surface (sidewalks, driveways and streets) adds to surface water pollution. When applying fertilizer, avoid spreading the fertilizer onto hard surfaces where it will wash into local surface water through the storm sewer system. Sweep any fertilizer that landed on the sidewalk/driveway onto the lawn area.

Another very important source of phosphorus pollution in the landscape setting is soil erosion from new construction sites, unplanted slopes and poorly maintained landscapes. When the soil moves, it takes the soil bound phosphorus with it. For good water quality, sloping ground needs to be planted with year-round plant cover to prevent soil erosion.

## **Potassium**

**Potassium levels are naturally adequate to high in most Colorado soils.** With annual applications of compost or manure, potassium levels will likely be adequate. Deficiencies occasionally occur in new gardens low in organic matter and in sandy soils low in organic matter. A soil test is the best method to determine the need for potassium.

Excessive potash fertilizer can increase soil salt content.

Where potash levels are believed to be low, the standard application rate without a soil test is  $\frac{1}{4}$  to  $\frac{1}{2}$  pound potassium chloride (0-0-60) or potassium sulfate (0-0-50) per 100 square feet.

Movement of potassium in soils is dependent on soil texture. As the clay content increases, movement decreases. For most soils, it is important that applied potash be tilled into the root zone. In sandy soils, potassium could leach down past the root zone.

## Specialty fertilizers

Specialty fertilizers may be preferred for specific purposes. For example, slow release fertilizers are recommended for lawns (see lawn care information for details). **Slow release** or **time release** fertilizers give out small quantities of nutrients over a time period. The release may be controlled by water, temperature, or microbial activity. For trees and shrubs, use only slow release products.

**For planters and hanging baskets**, two popular specialty fertilizers include time release products (e.g., Osmocote) and water solubles (e.g., MiracleGro, Peters, etc.).

Time release fertilizers such as Osmocote are designed for indoor and outdoor potted plants. Each time the soil is watered, a small amount of nutrients are released. Depending on the specific formulation, it would be applied to the soil once every 3 to 9 months. In outdoor pots watered daily, it releases faster, having about half the life span of the product used on indoor plants. Gardeners sometimes see the Osmocote pellets in potted plants and mistake them for insect eggs.

Numerous brands of **water solubles** are popular in the home garden trade, (e.g., MiracleGro, Peters, Schultz Plant Food, Fertilome Root Stimulator, etc.). Water soluble fertilizers are mixed with the irrigation water, typically giving a blue or green color. This can be done in a bucket or hose-on fertilizer applicator. It is important to water the soil with the fertilizer water, not just wet the leaves. (Note: Hose-on fertilizer applicators and hose-on pesticide sprayers are not the same thing. Fertilizer applicators apply a higher volume as the purpose is to water the soil. Pesticide applicators release a lower volume, as wetting the leaf is the objective.) Water solubles are the standard in greenhouse production where the fertilizer is injected into the irrigation water.

**For herbaceous transplants** (flowers and vegetables), water soluble fertilizers are recommended at planting and possibly two and four weeks after planting (depending on soil organic matter content). These are often marketed as *root stimulators*. It is the nitrogen content that promotes growth rather than any hormones or vitamins in the product. In cool springtime soils, the readily available phosphate may also be helpful. Woody plants (trees and shrubs) do not respond to water soluble fertilizer at planting. Always read the label directions to avoid over-fertilization.

---

Authors: David Whiting (CSU Extension, retired), Adrian Card (CSU Extension), Carl Wilson (CSU Extension, retired), and Jean Reeder, Ph.D., (USDA-ARS, retired). Revised by Dan Goldhamer (CSU Extension)

- Colorado Master Gardener *GardenNotes* are available online at [www.cmg.colostate.edu](http://www.cmg.colostate.edu).
- Colorado Master Gardener training is made possible, in part, by a grant from the *Colorado Garden Show, Inc.*
- Colorado State University, U.S. Department of Agriculture and Colorado counties cooperating.
- Extension programs are available to all without discrimination.
- No endorsement of products mentioned is intended nor is criticism implied of products not mentioned.
- Copyright 2002-2016. Colorado State University Extension. All Rights Reserved. *CMG GardenNotes* may be reproduced, without change or additions, for nonprofit educational use.

Revised October 2014, October 2015

