



Fertilizer Types and Calculating Application Rates

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Introduction

Crop production has increased dramatically over the last few decades, much of which has been due to the widespread introduction of chemical fertilizers starting in the mid-1900s. Matching fertilizer application rates to crop needs is an essential component of optimizing crop production. However, different crops in separate fields will require varying rates of the major nutrients – nitrogen (N), phosphate (P_2O_5), and potassium (potash, K_2O) – due to variations in soil types, soil test phosphorus and potassium levels, and nutrient ranges of different crops. Meeting these N- P_2O_5 - K_2O (sometimes abbreviated to N-P-K) requirements without overapplying any of these nutrients is possible by blending various types of fertilizer to give the correct N- P_2O_5 - K_2O ratio. This allows you to apply the correct rate of a particular blended fertilizer. Other considerations such as cost of available fertilizers and crop micronutrient requirements also need to be considered when blending fertilizers.

In addition, particle size compatibility is important for uniform spreading of dry, granular fertilizers. Chemical compatibility of liquid fertilizers is important to prevent precipitation or “salting out” of incompatible materials.

This publication covers the use of inorganic fertilizers, sometimes referred to as commercial or chemical fertilizer, to supply the major crop nutrients N, P_2O_5 , and K_2O . These nutrients can also be provided from organic sources such as manures, but they are covered in a separate publication, *Soil Test Note 5: Fertilizing with Manures*, Virginia Cooperative Extension publication 452-705.

Calculating Nutrient Requirements

The first step in applying the correct rate of fertilizer is calculating crop nutrient requirements. A soil test is the only way to measure how much P_2O_5 and K_2O are available in soils, and soil tests are available through several private and public laboratories. An explanation of how to perform soil tests and interpret results is available at www.soiltest.vt.edu.

Applications of P_2O_5 and K_2O may not be required annually, depending on how much is available in particular soils, and the amount of P_2O_5 and K_2O that is required to meet production goals for the specific crop to be grown. As N is much more mobile in soils and must be applied every year to nonlegumes, N requirements are based on the crop to be grown and the soil type that influences yield goals. These recommendations are generally made in conjunction with soil test reports.

Determining the Quantity of N, P_2O_5 , and K_2O in a Bag of Fertilizer

The concentrations and the reporting of nutrient concentrations in fertilizers are carefully regulated, with ongoing testing of products to verify proper labeling. An analysis that describes the concentrations of plant-available nutrients can be found on every bag of fertilizer. Also, bulk-blended fertilizers must have a certificate showing the guaranteed analysis of the material.

Generally, there are three numbers that describe, in order, the concentrations of N- P_2O_5 - K_2O . For example, a fertilizer bag of diammonium phosphate will have

the numbers 18-46-0 on it, which means it contains a minimum of 18 percent N, 46 percent P_2O_5 , and no K_2O by weight. For liquid fertilizers, you need to know the density of the solution, as the nutrient concentration is based on the weight and not the volume. Liquid fertilizers such as 30-0-0 (urea ammonium nitrate or UAN), are often used as starter fertilizers or for sidedressing corn. The N- P_2O_5 - K_2O numbers do not add up to 100 percent, because fertilizers usually contain filler materials that help granule formation and assist with even product application.

Sometimes the fertilizer label provides additional numbers or additional analysis details if there are secondary or micronutrients such as sulfur, boron, or magnesium in the fertilizer. Table 1 gives the nutrient concentrations in several common fertilizer materials that can be applied directly to crops or used to make blended fertilizers. You may observe slight variations in nutrient concentrations of similar fertilizer products, based on the specific manufacturer.

Blended fertilizers are mixes of these fertilizer materials that are made to vary the N- P_2O_5 - K_2O ratio to meet crop requirements. You can find out what blends are available in your area by calling your local fertilizer suppliers and then matching these to your crop requirements.

Common dry, blended fertilizers available include 20-10-10, 20-20-10, 20-20-0, 0-10-40, and many others. Some, such as 10-10-10 and 19-19-19, contain the

same ratio of N- P_2O_5 - K_2O . It is important to recognize that you would have to apply almost twice as much of the 10-10-10 product to get the same nutrient application as with the 19-19-19 product.

A common liquid fertilizer is urea ammonium nitrate, i.e., 30 percent UAN that weighs 10.86 pounds per gallon and contains 30 percent N by weight.

Selecting Fertilizer Type, Timing, and Method of Applications

Phosphate and K_2O can be land-applied at any time, but normally it is more cost-effective to apply at the same time as N. However, N is more mobile than P_2O_5 and K_2O in the soil and should be applied as closely as possible to the time of crop uptake. Nitrogen in the form of nitrate can be lost from soils via leaching and can be denitrified to N gas in reducing conditions, such as soils saturated with water.

Ammonium (NH_4^+) forms of N are subject to losses through volatilization, especially when surface-applied, but because NH_4^+ has a positive charge, it is retained by soil particles – especially when injected below the soil surface. Substantial amounts of ammonium can also be lost from surface applications of urea, especially during the warm summer months; applications of fertilizer salts, such as ammonium sulfate, at these times, will reduce these losses. If leaching and/or denitrification are known to be concerns, then ammonium forms of N can perform better. One of the main causes of soil acid-

Table 1. Common basic fertilizer materials used for blending and their nutrient contents

Material	Analysis	N (%)	P_2O_5 (%)	K_2O (%)
Ammonium nitrate	33-0-0	33	0	0
Ammonium sulfate*	21-0-0-24S	21	0	0
Diammonium phosphate	18-46-0	18	46	0
Potassium chloride (muriate of potash)	0-0-60	0	0	60
Potassium sulfate**	0-0-50-16S	0	0	50
Potassium magnesium sulfate***	0-0-22-23S-11Mg	0	0	22
Triple super phosphate	0-46-0	0	46	0
Urea	46-0-0	46	0	0

Note: *Ammonium sulfate contains 24% sulfur (S)

**Potassium sulfate contains 16% S

***Potassium magnesium sulfate contains 23% S and 11% magnesium (Mg)

ity is the oxidation of ammonium forms of N to nitrate-N, the main plant-available form, but in most situations there is little practical difference between N forms in fertilizers.

Fertilizer applications can be split to improve N-use efficiency by crops. For example, part of the crop N requirement can be applied as starter fertilizer that can be placed in bands beside seed rows when planting row crops. This helps the first stages of crop growth without applying large rates of N that could be lost before the crop requires it. The rest of the crop N requirement can be applied immediately prior to the time of maximum crop uptake. For corn, this means sidedressing with N when it is about 12 inches tall, as this N is applied immediately before the corn has its highest rate of growth and, therefore, its maximum N uptake.

Example 1: Liquid nitrogen fertilizer for corn

A liquid N fertilizer (30% UAN) is the N source for 500 acres of corn. Calculate the N application rate in gallons per acre and the total tons of fertilizer needed to apply 160 pounds of N per acre to the 500 acres. The fertilizer weighs 10.86 pounds per gallon and contains 30% N by weight. The 30% UAN has 30% N by weight, which means 0.30 pound of N per pound of fertilizer.

Calculation:

$$\text{Lb N/gal of fertilizer solution} = 10.86 \text{ lb/gal} \times 0.30 \text{ lb N/lb of fertilizer} = 3.26 \text{ lb N/gal.}$$

$$\text{Gal of UAN/acre} = 160 \text{ lb N/acre} \div 3.26 \text{ lb N/gal} = 49.1 \text{ gal/acre.}$$

$$\text{Tons for 500 acres} = (49.1 \text{ gal/acre} \times 500 \text{ acres} \times 10.86 \text{ lb/gal}) \div 2000 \text{ lb/ton} = 133.3 \text{ tons.}$$

Example 2: Dry fertilizer for turf application

An 18-0-18 + 3% iron (Fe) fertilizer must be applied to supply 1.0 pound of N per 1,000 square feet of turf. Calculate the rate of fertilizer to apply to obtain the proper N rate and also calculate the amount of Fe that is applied at the rate of application used to supply the needed nitrogen. There is 18% N in 18-0-18 fertilizer = 0.18 pound of N per pound of fertilizer.

Calculation:

$$\text{Rate of fertilizer to apply } 1 \text{ lb N/1,000 sq ft} = 1.0 \text{ lb N} \div 0.18 \text{ lb N/lb of fertilizer} = 5.56 \text{ lb 18-0-18} + 3\% \text{ Fe/1,000 sq ft.}$$

$$\text{Amount of Fe applied} = (5.56 \text{ lb fertilizer/1,000 sq ft}) \times 0.03 = 0.17 \text{ lb Fe/1,000 sq ft.}$$

Example 3: Dry fertilizer application to forage

Granular ammonium sulfate (21-0-0-24S) is being used to supply N for stockpiled fescue.

Calculate the amount of fertilizer that must be applied per acre to supply 60 pound N per acre.

Calculation:

$$60 \text{ lb N/acre} \div 0.21 = 286 \text{ lb ammonium sulfate/acre.}$$

Forages are almost always fertilized by surface broadcasting of granular fertilizers, and they should also be fertilized with N immediately before their maximum periods of growth. For maximum efficiency, this means splitting N applications between spring and late summer/fall for cool season grasses, such as fescue and orchardgrass.

Examples of Calculating Fertilizer Application Rates

In order to calculate a fertilizer application rate, you will need: (1) the N-P₂O₅-K₂O content of the material from the package label, (2) your target rate (normally from a soil test), (3) the total area you will be applying to, and (4) the density of the material if a liquid fertilizer is to be used.