



Basics of Fertilizer Management

Introduction

Proper fertilization is important for crop yield and quality. For the greatest fertilizer nutrient use efficiency, it is important to select the right source, the right method, the right timing, and the right rate of application (the 4Rs framework). In this factsheet, fertilizer sources, application methods, and timing are discussed.

Fertilizer Formulation

Fertility recommendations for the primary macronutrients are given in pounds per acre of plant available nitrogen (N), phosphorus (P₂O₅) and potassium (K₂O). This corresponds to the way fertilizer composition is defined. For example, a fertilizer that is a 10-20-20 means it contains 10% N, 20% P₂O₅ and 20% K₂O. The N and K are water-soluble, and the P is citrate acid soluble, reflecting the fertilizer's content of plant-available nutrients. In addition to the primary macronutrients, fertilizers may contain other nutrients such as sulfur (S), boron (B), and zinc (Zn). If a significant source of a particular nutrient, other than N, P, or K is present in the fertilizer, it is typically labeled as a fourth value in the fertilizer grade. For example, ammonium sulfate is described as 21-0-0-20S. The fertilizer law in New York requires that fertilizer are labeled consistent with their guaranteed minimum nutrient content; so fertilizers with an equal percentage of P, as an example, all contain at least that amount.

Sources of Fertilizer

Fertilizers can be purchased in dry (granular) or liquid form. Dry fertilizers are applied using a broadcast spreader, a planter or drill. When two or more fertilizer sources are mixed, some degree of particle size uniformity of each of the individual sources is essential for uniform placement of the nutrients in the mixture. With the proper equipment, liquid fertilizers are easy to handle. Chemical compatibility of different liquid fertilizers is important when materials are mixed to prevent precipitation in

the mixing tank. See Agronomy Fact Sheet #44 (Nitrogen Fertilizers for Field Crops) and #73 (Phosphorus Fertilizers for Field Crops) for more information on N and P fertilizer sources.

Application Methods

There are several factors to consider when choosing fertilizer application methods. Considerations include: the particular mixture of nutrients needed, the crop, timing of application, available equipment, and planting/tillage practices. Application methods include starter application (banded or popup/furrow), broadcasting, topdressing, sidedressing, or foliar feeding. A description of each of these application methods and their pros and cons for use are described in Table 1.

Table 1: Application method descriptions as well as the pro's and con's of using each application method.

Application method	Characteristics
Banding	
Small amounts of liquid or granular fertilizer is applied in furrows 1-2 inches below and 2-3 inches to the side of seed placement	<ul style="list-style-type: none"> Liquid or dry fertilizer Nutrient uptake efficiency is higher than for broadcast application, allowing for lower rates Runoff risk is low Equipment is standard on many planters Fertilizer placement in vicinity of roots may aid root development Requires precision placement to avoid placement too close to the seed
Furrow/pop-up/starter application	
Application method used alone or combined with banded application. Usually applied in low rates placed directly on or around the seed during planting.	<ul style="list-style-type: none"> Liquid fertilizers are best suited Can be applied in combination with banded fertilizer during planting Only low rates needed Can only be used in low rates to avoid phyto-toxicity
Broadcast	
Spinning of dry granules or spraying of liquid fertilizer onto the soil surface, with or without incorporation of the material	<ul style="list-style-type: none"> Can be done quickly Standard equipment used Depending on the source, it requires rainfall or tillage to move fertilizers to roots Could result in poor application uniformity

Table 1 (continued): Application method descriptions as well as the pro's and con's of using each application method.

Application method	Characteristics
Topdressing	
Spreading or broadcasting of fertilizers in the standing crop, after emergence.	<ul style="list-style-type: none"> • Fast and easy application of fertilizer • Can result in volatilization losses for urea containing sources • Could cause leaf burn • Could result in poor application uniformity
Sidedressing	
Broadcast or banded between or alongside growing plants; this method normally refers to N applied when corn is 6-12 inches tall	<ul style="list-style-type: none"> • N can be applied with a high nutrient use efficiency • Application with drop nozzles can be done faster than injection or knifing • Weather and field conditions can delay or prevent application
Foliar feeding	
Application where liquid fertilizer is applied directly to the leaves, nutrients are in highly available form and can be taken up by the plant rapidly	<ul style="list-style-type: none"> • Easy application • Standard sprayer equipment can be used • Not always practical due to row spacing • Material must be absorbed by leaves before it dries

Timing of Application

Selecting which fertilizer source to use begins with evaluating which nutrients are required for optimal plant growth and at what time during crop growth these nutrients are taken up in the largest amounts.



Figure 1: Sidedress application of urea ammonium nitrate for corn.

Field crops typically take up most of their nutrient requirements during the rapid vegetative growth phase followed by a decline in nutrient uptake as the plants mature. Because of this non-uniform demand, the highest nutrient use efficiencies can be

obtained when application is timed to coincide with the period of greatest nutrient demand. For example, the highest N use efficiencies in corn are typically achieved when a small amount of N is banded as a starter at planting. This is followed by a sidedress application when the corn is 6-12 inches tall (Figure 1), just prior to the rapid vegetative growth phase of the corn. Sidedressing is especially important for N applications to sandy soils in areas of high rainfall where leaching losses can be high or for soils and weather patterns that favor early season denitrification. For such soils, the use of a nitrification inhibitor can help reduce N loss to the environment and hence increase the N use efficiency of the fertilizer. See Agronomy Fact Sheet #45 (Enhanced-Efficiency Nitrogen Sources) for more information on these products.

In Summary

If fertilizer is needed to supplement nutrients already on the farm (manure, cover crops, previous crop residues etc.), it is important to select the right material, and to apply it at the right rate, the right place, and the right time (4Rs). By understanding what each fertilizer offers with respect to nutrient availability, and ease of handling and application, producers are better able to meet the needs of their crops.

Additional Resources

- Nutrient Management Spear Program Agronomy Fact Sheet Series: nmsp.cals.cornell.edu/index.html
- 4Rs of Nutrient Management: <https://www.agronomy.org/files/publications/crops-and-soils/4r-nutrient-management.pdf>

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This fact sheet reflects the current (and past) authors' best effort to interpret a complex body of scientific research, and to translate this into practical management options. Following the guidance provided in this fact sheet does not assure compliance with any applicable law, rule, regulation or standard, or the achievement of particular discharge levels from agricultural land.

For more information



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2012