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Fertilizer Basics for Pasture Production

Nutrients and water are often the limiting factors for plant growth. Soils must provide greater amounts of plant nutrients than would be needed for natural vegetation. In established grazed pastures, a large percentage of nutrients are recycled through the grazing animals and deposited in the form of urine and feces. When pastures are cut for hay, silage, or sod, a significant portion of nutrients are no longer recycled but are removed. Farmers must supply supplemental nutrients to the soils to ensure optimal crop growth. These supplemental nutrients come in many forms including fertilizers, animal manures, green manures, and legumes. Soil testing should be the basis for any fertilizer application. A good soil testing program indicates the current fertility status of the soil and provides sound recommendations for managing fertility to achieve desired production.

Nutrients are expressed on fertilizer labels as nitrogen (N), phosphate (P_2O_5), and potash (K_2O). This is called the oxide form for elemental phosphorus (P), and potassium (K). When non-agricultural people (water management, natural resource, and other regulatory people) talk about phosphorus, they are referencing to elemental phosphorus (P), not phosphate (P_2O_5), this often causes a lack of communication between farmers and regulators. Following are simple conversions between the oxide and elemental forms:

Phosphorus
$P \times 2.3 = P_2O_5$; $P_2O_5 \times .44 = P$ (Note that the amount of P applied is less than ½ of the labeled phosphate)

Potassium
$K \times 1.2 = K_2O$; $K_2O \times .83 = K$

Fertilizer analysis is the weight percent of available nitrogen (N), phosphate (P_2O_5), and potash (K_2O) in the fertilizer. For example, 20-5-10 indicates 20 percent N, 5 percent P_2O_5 (2.2% P), and 10 percent K_2O (8.3% K) by weight.

Straight materials are the basic materials used in fertilizer manufacturing. Many of these materials can be applied directly. Examples include anhydrous ammonia, urea, nitrogen solution, triple superphosphate, ammonium phosphates, and muriate of potash (potassium chloride) all of which can be purchased and applied individually. Compound or mixed fertilizers are made by chemically or physically combining the straight materials.

Fertilizer materials can be solids, liquids, or gases. Each physical form has its own uses and limitations, which provide the basis for selecting the best material for the job. Granulated fertilizer materials are solid, homogenous mixtures of fertilizer materials generally produced in ammoniation granulation plants by combining raw materials such as anhydrous ammonia, phosphoric acid, and potassium chloride. Granulated materials are N-P or N-P-K grades of fertilizer. Each uniform-size fertilizer particle contains all of the nutrients in the grade. For example, each particle in a 20-5-10 granulated fertilizer theoretically contains 20 percent nitrogen, 5 percent phosphate (P_2O_5), and 10 percent potash (K_2O). There is no segregation of the nutrients in handling or spreading granulated materials, and plant roots absorb a complete set of the applied nutrients. Granulated fertilizers generally have good handling properties, with little tendency to cake or dust.

Blended fertilizers are simple physical mixtures of dry fertilizer materials. The ingredients of a blended fertilizer can be straight materials, such as urea or potassium chloride; they can be granulated compound fertilizer materials mixed together; or they can be a combination of the two. In blended fertilizers, the individual particles remain separate in the mixture, and there is a potential for segregation of the nutrients. Blends have the advantage of allowing a very wide range of fertilizer grades that makes it possible to match a fertilizer exactly to a soil test recommendation.

Fluids can be either straight materials, such as nitrogen solutions, or compound fertilizers of various grades. The grade or analysis is given on a weight percent basis, not on a per gallon basis. Thus, to determine the actual plant food content, you must know the weight per gallon of the material. Most fluids weigh between 10 and 12 pounds per gallon. The following example illustrates the calculations:

20 – 20 – 0 weighs 12 pounds per gallon
Therefore one gallon contains:
$12 \times .2 = 2.4$ pounds nitrogen per gallon
$12 \times .2 = 2.4$ pounds phosphate (P_2O_5) per gallon

It takes about 8.33 gallons of this fluid to equal 100 pounds of total fertilizer. For comparing fluids on a price per ton basis, divide the weight per gallon into 2,000 to get the number of gallons per ton. In the above example, the calculation is:

$2000 \div 12 = 167$ gallons per ton

This calculation can be used to compare a liquid priced in dollars per gallon with a solid priced in dollars per ton:

167 x $ per gallon = equivalent price per ton of the same analysis dry fertilizer

Gaseous fertilizer requires some special considerations in handling and use. Anhydrous ammonia is a high nitrogen content gaseous material used both in the manufacture of all other common nitrogen-containing fertilizers and in direct applications to the soil. Anhydrous ammonia is an excellent nitrogen fertilizer, but it must be handled properly. Anhydrous ammonia can cause serious chemical burns and asphyxiation when proper safety precautions are not followed.

Organic materials that are commonly used as fertilizers have many varied properties. Therefore, the physical properties of these materials should be evaluated on an individual basis. Careful attention should be paid to pH when using lime stabilized bio-solids, as over application can raise the pH of the soil to the point that production will be negatively affected.

Since the specific chemical properties of fertilizers also are very complex and varied, a detailed discussion of all their chemical properties is not possible here. However several important chemical properties should be considered in selecting a fertilizer material. These properties are solubility, particle size, soil pH, chemical form, and soluble salts.

Solubility indicates how readily nutrients are dissolved in the soil water and taken up by plants. Since the nitrogen and potassium in fertilizers are essentially completely soluble in water, their solubility is not a major consideration for the common fertilizer sources. Water solubility of the available phosphorus can vary from 0 to 100 percent. Phosphorus must be dissolved in water to be taken up by plants. Most common phosphorus sources (triple superphosphate and the ammonium phosphates) contain highly water soluble forms of phosphorus. There is no apparent difference in agronomic effectiveness when a highly water soluble phosphorus source is applied as a fluid fertilizer or as a dry fertilizer. Materials such as raw rock phosphate have very low water solubility.

Particle size of a fertilizer material can be important for both agronomic and handling reasons. While there is no standard for particle size, most fertilizers are sized to pass through a No. 6 screen but be retained on a No. 18 screen. Particle size is most critical for materials that are used in blended products. Materials of different sizes tend to segregate as the fertilizer is handled and spread. Particle size has been identified as the most important factor in producing a stable, high quality, blended fertilizer.

Soil pH can be changed by the reaction of fertilizer materials. The most important such reaction is the microbial oxidation of ammonium nitrogen to nitrate nitrogen. This occurs regardless of the source of ammonium nitrogen (fertilizer, manure, or organic residues).

Compare materials on the basis of a price per unit of actual plant food. Remember that the maximum return per dollar invested in fertilizer is achieved from the first increment applied to a deficient soil or crop. However, the maximum profit is achieved at a rate of fertilization that produces near maximum yield.

References:

Agronomy Facts 6, Douglas Beegle, Extension Agronomist, Department of Crop and Soil Sciences, Pennsylvania State University