Fertilizers Types, Uses and Characteristics
Michigan State University
Cooperative Extension Service
M.L. Vitosh, Extension Specialist, Crop and Soil Sciences
September 1975
4 pages

COOPERATIVE - MSU AG FACTS - EXTENSION SERVICE

FERTILIZERS

Types, Uses and Characteristics

No. 53 Extension Bulletin E-896 September 1975

BY M. L. VITOSH
Extension Specialist, Crop and Soil Sciences

THERE ARE MANY brands and analyses of fertilizer, but all can be grouped into three classes — liquids, solids and gaseous.

There is nothing magic about the different brands or types of fertilizer; for a particular analysis they often have the same chemical compounds and are used for the same basic purpose — to supplement those plant nutrients in the soil. Usually all that is needed to compare two fertilizers is the amount and the availability of plant nutrients in the material. This information is given on the label or bill of sale and is guaranteed.

FERTILIZER TYPES

Although it is generally agreed that fertilizers come in three physical forms (liquid, solids and gases), there are actually only two classes of fertilizers: liquids and solids. Anhydrous ammonia (NH_3) is a gas, but it is classified as a liquid because it is a liquid under pressure. The term, liquid fertilizer, therefore, applies to anhydrous ammonia, aqua ammonia, nitrogen solutions and liquid mixed fertilizers, including clear liquids, suspensions and slurry type mixtures, which require constant stirring to keep the solids suspended in the liquid.

Liquid fertilizers have recently increased in popularity. In 1974, 25 percent of all fertilizers in the U. S. and 14 percent in Michigan were in the liquid form. Anhydrous ammonia and 28 percent nitrogen solution together accounted for 76 percent of the total liquids sold in Michigan (48,975 tons of NH_3 and 58,393 tons of 28 percent nitrogen solution).

Dry fertilizers (solids) still constitute the major part of the fertilizers sold in Michigan. About 65 percent of the total dry fertilizer is now sold as bulk material, and 35 percent is bagged. The bulk materials are generally less expensive and easier to handle, if large quantities are used.

Crop responses to liquid and dry fertilizers are similar, provided the same amount of plant nutrients are applied and the same placement and water soluble phosphorus materials are compared. Reactions of these materials in soils are identical. When placed in the soil, dry fertilizers will absorb water and will undergo similar chemical reactions to those of liquid fertilizers.

Price per unit of plant nutrients, application costs, ease of handling and customer service are the prime factors to be considered when buying fertilizers.

CHARACTERISTICS AND USES

There are some principles of fertilizer application and properties of fertilizers with which everyone should become familiar. Many liquid and dry fertilizers are being surface-applied with little or no incorporation into the soil. In some situations, surface application may be adequate, while in others, this method is entirely inadequate, resulting in inefficient use of the fertilizer. Regardless of the form in which it is applied, nitrogen is ultimately converted to nitrate, which can be moved downward by rain, but it can also be lost by volitilization. Potassium and especially phosphorus will not move far from the point of placement; therefore plant nutrients that remain near the surface are not readily available when the soil surface gets dry.

The following is a discussion of several of the more commonly used fertilizers. Table 1 contains the chemical analysis of these and other fertilizer materials.

Anhydrous ammonia (82 percent N) is a high-pressure liquid and must be injected into a moist soil at least 6 inches because it becomes a gas once it is released from the tank. The ammonia in the soil will react with water to form the ammonium (NH_4^+) ion, which is held on clay and organic matter. Anhydrous ammonia is generally the cheapest source of nitrogen; however, the method of application is less convenient and requires more power for application than most other liquid or dry materials.

Nitrogen solutions (28 to 32 percent Nitrogen) are increasing in popularity. The most popular, 28 percent N, is a mixture of half urea and half ammonium nitrate in water. It has no ammonia vapor pressure and is generally sprayed or dribbled on the soil surface. The loss of nitrogen from surface application of 28 percent N solution is generally not considered to be too great. Under certain conditions, however, nitrogen loss might be serious. If the conversion of urea in the liquid fertilizer to ammonia takes place on the surface, some ammonia can be lost. The remainder of the ammonia may react with water on the surface to produce an alkaline condition, which also promotes ammonia loss. The most favorable conditions for nitrogen loss from surface-applied urea (solid or liquid) are alkaline or dry soils, warm temperatures and sandy soils with low cation exchange capacities. A rain will move the urea into the soil before it is converted to ammonia, thus reducing nitrogen losses. Nitrogen solutions should not be used for fall application on barren land because one-fourth of the nitrogen is in the nitrate form.

Aqua ammonia (21 percent N) is a liquid under low pressure and must be incorporated to prevent the loss of free ammonia to the atmosphere. It is possible to lose all of the free ammonia if it is not incorporated. Aqua ammonia does have one advantage over anhydrous ammonia in that placement need not be as deep and high-pressure applicators are not required.

Urea (46 percent N) is the most widely used dry nitrogen fertilizer. Once applied to the soil, urea is converted to ammonia which reacts with water to form ammonium within two to three days (faster under warm conditions). Some volatilization of ammonia can occur when urea is surface applied. Early spring topdressing of urea on wheat or pasture is seldom a problem. Topdressing of urea on pastures during summer months, however, should be avoided because of greater ammonia losses.

Ammonium nitrate (33 percent N) is decreasing in popularity because of storage problems and its lower analysis making it more costly. It is an excellent material for many purposes; however, one-half of the nitrogen is in the nitrate form which makes it susceptible to leaching and denitrification losses. Calcium ammonium nitrate is a mixture of ammonium nitrate and crushed limestone. Neither of these materials should be used for fall application.

Ammonium sulfate (21 percent N), although not used extensively because of its lower analysis and higher cost, is an excellent fertilizer for fall application and topdressing of wheat and pastures. All of the nitrogen is in the ammonium form. It is a good material for alkaline soils and can be used to supply sulfur where a deficiency is suspected. It has the disadvantage of being the most acidifying form of nitrogen fertilizer.

Calcium nitrate (16 percent N) contains all of its nitrogen in the nitrate form, which makes it highly susceptible to leaching and denitrification losses. It is used most extensively in the fruit and vegetable industry where a readily available source of nitrate nitrogen is desirable.

Di-ammonium phosphate (18-46-0) is a dry material being used extensively for bulk blending and for direct application where soils do not need potassium or where potassium is broadcast. It has the advantage of being completely water soluble, having a high analysis and often a price advantage. Di-ammonium phosphate has an acid effect upon the soil similar to anhydrous ammonia. Because of the high ammonia content, this material can cause germination injury to seeds if used in direct contact with the seed.

Polyphosphates are relatively new materials and differ slightly from the more common orthophosphates. Nearly all of the liquid fertilizers containing phosphorus are of the polyphosphate type. Polyphosphates are composed of a series of orthophosphate molecules connected by the process of dehydration (removal of water). Commercial ammonium polyphosphates are usually a mixture of ortho- and poly-phosphates. Solutions of ammonium polyphosphate most commonly made are 10-34-0 and 11-37-0. The most common dry polyphosphate is 13-52-0.

Once polyphosphates are in the soil, they gardually convert to orthophosphate by hydrolysis (adding on water). The time required for hydrolysis to occur varies with soil conditions. In some cases 50 percent of the polyphosphate hydrolyzes to orthophosphate within 2 weeks. Under cool, dry conditions the hydrolysis may take longer.

Another property of polyphosphates is their ability to combine with certain micronutrients such as zinc and iron. It is possible to add a small amount of these micronutrients to polyphosphate solutions without precipitation.

Some claims have been made that polyphosphates will make certain unavailable micronutrients in the soil more available for plant uptake. Due to the rather rapid conversion of polyphosphates to orthophosphates in the soil, it is not likely that such complexes would be available for any significant length of time. Research at Kansas State University has shown that micronutrient uptake is not enhanced by polyphosphate materials. The efficiency of polyphosphates is considered to be equal to, but not better than, the orthophosphates with more than 80 percent water solubility.

SLOW RELEASE NITROGEN FERTILIZERS

These materials generally have some special release characteristics which inhibit the nitrogen from being rapidly released or converted to nitrate nitrogen which is subject to leaching or denitrification losses. The higher cost of these materials has, in general, slowed their widespread use.

Table 1 — Primary and Secondary Nutrient Analysis of Some Selected Fertilizer Materials.

Fertilizer Material	Average Percent					
	N	P_2O_5	K_2O	Ca	Mg	S
Ammonium nitrate	33					
Ammonium nitrate limestone (Calcium ammonium nitrate)	21			7	4	
Ammonium phosphate sulfate	16	20				15
Ammonium sulfate	21					24
Anhydrous ammonia	82					
Aqua ammonia	20–25					
Calcium cyanamide	21			38		
Calcium nitrate	16			19		
Calcium sulfate (gypsum)					22	17
Diammonium phosphate	18	46				
Elemental sulfur						50–99
Magnesium sulfate (Epsom salts)					10	13
Manganese sulfate						14–17
Nitrogen solutions	20–50					
Mono ammonium phosphate	11	48				
Phosphoric acid		54				
Potassium chloride (muriate of potash)			60			
Potassium nitrate	13		44			
Potassium magnesium sulfate (sulfate of potash)			22		11	23
Potassium sulfate			50		18	
Rock phosphate		3–8		33		
Sodium nitrate		16				
Sulfuric acid						33
Sulfur coated urea	32					30
Super phosphoric acid		76				
Super phosphate (normal)		20				
Super phosphate (concentrated)		46				
Urea	46					
Urea formaldehyde	38					

Sulfur-coated urea (SCU) is a new product made by coating urea pellets with sulfur, wax and/or other materials. The coating prevents breakdown and rapid release of nitrogen to the soil. The rate of release is generally dependent upon the thickness of the coating and the material used for coating. The exact time of nitrogen release has been a problem. In some situations, release has been too slow, where in others it has been too rapid.

Ureaform is a combination of urea and formaldehyde and generally has a varying degree of water solubility. This material has been used primarily for golf greens and turf where constant release of nitrogen throughout the season is desirable. The rate of release, however, is dependent upon soil temperature and moisture conditions. It has not been used extensively for agricultural purposes primarily because of added costs.

Nitrification inhibitors have been studied for a number of years, but just recently, *N-Serve* (Dow Chemical Co.) has been released for agricultural use. The material is available as urea or anhydrous ammonia treated with a pryridine chemical which inhibits the growth of soil microorganisms responsible for converting ammonium nitrogen to nitrate nitrogen. The principle is to keep the nitrogen in the ammonium form longer and thereby prevent leaching and denitrification losses, thus allowing for application in advance of the cropping season. Some research has shown this material to be helpful under adverse weather conditions. The timing of nitrogen application closer to the actual needs of the crop will generally eliminate the uncertainty of fall or early spring applications of nitrogen, especially on sandy soils.

RELATED PUBLICATIONS

Additional information concerning the primary, secondary and micronutrients can be found in the following publications.

*Bulletin E-550 Fertilizer Recommendations for Michigan Vegetable and Field Crops.

*Bulletin E-486 Secondary and Micronutrients for Vegetable and Field Crops.

*Bulletin E-471 Lime for Michigan Soils.

*Bulletin E-802 Effect of Nitrogen Fertilizer on Corn Yield.

The information in this bulletin is intended for educational purposes only. Mention of trade names or manufacturers implies no endorsement or discrimination by the Michigan State University Cooperative Extension Service.

Cooperative Extension Service Programs are open to all without regard to race, color, creed, or national origin. Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8, and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Gordon E. Guyer, Director, Cooperative Extension Service, Michigan State University, E. Lansing, MI 48824.

Price 5 cents. Single Copy Free

1P-9:75-25M-UP