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Fluid Fertilizers - Liquids and Suspensions

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Fluid fertilizers are increasing in popularity in Michigan. There are many misconceptions about fluid and dry fertilizers being promoted in the fertilizer industry. This bulletin aims to sort out the facts and highlight important differences between fluid and dry fertilizers.

Fluid Fertilizers

A fluid fertilizer contains one or more available plant nutrients. Two types are recognized: liquids in which all ingredients are in solution, and suspensions, which require periodic agitation of the solution to keep certain ingredients from settling out. Liquids may be clear or dark. The color is an indication of the amount of impurities in the liquid. Suspensions contain both soluble and solid fertilizer and usually contain colloidal clay to prevent rapid settling of the solid fertilizers. This allows the formulator to make a higher analysis N-P-K fertilizer.

Fluid-mixed fertilizers, either clear liquids or suspensions, are made by two types of processes, generally known as hot-mix and cold-mix. Traditional cold-mix fertilizers are made by mixing ammonium polyphosphate (10-34-0), nitrogen solutions (28 to 32 percent N) and soluble potash (62 percent K_2O). There is no heat of reaction when these materials are mixed. The hot-mix process often involves the neutralization of orthophosphoric or superphosphoric acid with ammonia to make ammonium polyphosphate and then the addition of other materials to get the desired formulation.

There are essentially two grades of phosphoric acid used in the production of fluid mixes: furnace acid (white) and wet-process acid (green, black or merchant grade). Wet-process phosphoric acid is used most frequently because of its lower cost, but it does contain some impurities, such as iron, aluminum and magnesium. In the process of making ammonium polyphosphate, however, the impurities are sequestered and held in solution, thus eliminating any problems of precipitation or settling out. Furnace acid, which is more costly to produce, is sometimes used to make a higher analysis ammonium polyphosphate (11-37-0). Certain clear liquid mixes are made with 11-37-0 using potassium hydroxide (caustic potash). The additional cost of both furnace acid and potassium hydroxide often makes these mixes two to three times more expensive than comparable fluid fertilizers made from wet-process acid and soluble potassium chloride.

Agronomically, all liquid mixes are equivalent when applied to the soil in equal nutrient amounts, regardless of the process by which they are made or the materials they are made from. It's possible to make slightly higher analysis clear liquid mixes with potassium hydroxide than with potassium chloride, but identical fertilizer grades can be made if potassium chloride is added to a clay-base suspension. Suspensions must be periodically agitated to prevent settling or salting out and therefore should not be stored for long periods of time. Cold temperatures promote settling or salting out. If settling occurs and agitation does not appear to dissolve the crystals, it may be necessary to add additional water and heat the solution.

Advantages

The main advantages of fluid fertilizers are their greater ease of handling and application and the uniformity of analysis. In contrast, blended dry fertilizers can segregate upon handling and application. Micronutrient additions, in particular, can easily segregate in dry, bulk-blended fertilizers. When the fertilizer is applied at low rates, these micronutrient particles may be spaced too far apart for young plants.

Certain pesticides are compatible with liquid fertilizers, making possible "weed and feed" programs, which help reduce field operation expenses. Many liquid fertilizers can be applied in irrigation water, directly on plants *when properly diluted*, and used in transplanting solutions.

Disadvantages

Fluid fertilizers require special storage tanks, pumps and applicator tanks that can greatly increase costs. Salting out in cold weather can also occur. Adding certain secondary and micronutrients, such as magnesium and manganese, may create a sedimentation problem. Using micronutrient chelates and polyphosphate materials can overcome some of the problems.

Complete N-P-K fluid fertilizers, especially those containing micronutrients, usually contain relatively low amounts of plant nutrients compared with dry fertilizers.

Liquid fertilizers made from orthophosphoric acid have a low capacity to hold micronutrients. However, solutions made from polyphosphoric acid, such as 10-34-0, can hold up to 2 percent zinc, 0.2 percent manganese, 1 percent iron and 1.5 percent copper.

Availability to Plants

Nearly all the active ingredients in fluid or dry fertilizers commonly sold are water- or citrate-soluble. Thus, they are equally available for plants. Though the fertilizer salt may be 100 percent water soluble, it may rapidly change to compounds of low water solubility after application to the soil. For example, a liquid fertilizer containing 100,000 ppm of phosphorus will likely test no more than 0.3 ppm in the soil solution after application.

Residues from Dry Fertilizers

Unlike many dry fertilizers, liquid fertilizers seldom show any residues in the soil when band-placed. These residues are not an example of poor recovery for dry fertilizers, but rather are usually conditioners, inert materials, by-products such as gypsum, or impurities. Some of these residues may be calcium, magnesium or sulfur, which are essential plant nutrients for which no claim has been made. If such materials were added to liquid fertilizers, they could cause sedimentation.

Salt Index

All fertilizers can cause injury to plants when applied in excess. Unless diluted with water, most liquids of comparable formulation are as toxic as dry fertilizers. The extent to which fertilizers can burn plants can be easily evaluated by their "salt index," which compares them with an equal weight of sodium nitrate.

Liquid fertilizers made specifically for application to the foliage of plants, to seed or to household plants should have a low salt index value. Double nutrient salts, such as ammonium phosphate and monopotassium phosphate, help keep the salt index down. Additional information about types, uses and characteristics of fertilizer can be found in Michigan State University Extension bulletin E-896.

Table 1: Salt index for some common fertilizers.

Salt	Salt Index*
potassium chloride	116
ammonium nitrate	105
sodium nitrate	100
urea	75
potassium nitrate	74
ammonium sulfate	69
calcium nitrate	65
potassium sulfate	46
diammonium phosphate	34
monoammonium phosphate	30
superphosphate (0-46-0)	10
monopotassium phosphate	8

*From Rader et. al., Soil Sci. 55:201-218.

By the Gallon or by Weight?

Most fluid fertilizer concentrates weigh 10 to 12 pounds per gallon. Therefore, about 9 gallons of liquid are required to provide the same quantities of nutrients as 100 pounds of dry fertilizer of the same formulation. If the dry fertilizer costs $12 per hundred ($240 per ton), the liquid fertilizer of the same formulation shouldn't cost more than $1.33 per gallon. *Fertilizers of the same grade, formulation, placement and rates give nearly identical response, whether liquid or dry.*

Fertilizer with the Seed

Either dry or fluid fertilizers can be applied with the seed at planting time. However, row spacing, soil moisture conditions and type of seed greatly influence the amount that can be applied. If in doubt, do not follow the practice. Dry soil accentuates the problem of seedling injury. For wheat and other small grains planted in moist soil and in 7-inch rows, do not exceed more than 100 pounds of plant nutrients per acre ($N + P_2O_5 + K_2O$). For field corn planted in 30-inch rows, the upper limit is about 15 pounds. Beans, soybeans, cucumber and melons are very sensitive to salt injury. Do not apply fertilizer on or with the seed of these crops.

Some vegetable crops, such as spinach, red beets, tomatoes and onions can benefit from a small amount of a high phosphate fertilizer placed with the seed, especially when the soil is cold. A suggested material is 10-34-0 at 5 to 10 gallons per acre for 12-inch row spacing, or 2 to 3 gallons for 36-inch row spacing. Use the lower rate for sandy soils — they are likely to contain less water. Solutions such as 10-34-0 are usually diluted four or more times with water to help reduce the salt concentration and to give a more uniform application.

Fertilizers on or near the seed are more likely to benefit small seeds than large seeds, such as corn and beans. Consider the salt index value of the various solutions when applying fertilizer on the seed and use only fertilizers with a low salt index.

Liquid Nitrogen Fertilizers

Anhydrous ammonia and certain liquid ammonia solutions need to be injected into the soil to prevent ammonia losses. Water mixtures containing ammonium nitrate and urea (28 to 32 percent N) are popular, competitively priced products that can be rapidly applied broadcast. Follow the recommended practices to prevent urea volatilization, whether you apply

dry or in a liquid solution. Losses are greatest when urea is applied to dry surfaces, the soil temperature is high and the soil pH is above 7. To reduce losses, incorporate or water the urea into the soil or apply into moist soil.

Leaf Feeding

Plant nutrients can be absorbed through the leaves, *but the amount that can be applied without burn is limited!* The minimum nutrient requirements for plants are rather specific, regardless of the method of application. Therefore, foliar feeding should not be expected to supply sufficient major nutrients for plant growth. Conversely, leaf feeding or any other program will not benefit plants if they already have ample amounts of nutrients. For example, ample nutrient levels for corn ear leaves at silking time are about 3 percent nitrogen, 0.3 percent phosphorus and 1.7 percent potassium. Plants will take up additional nutrients but without an increase in yield. We sometimes call this "luxury feeding."

Foliar application of micronutrients, such as manganese, zinc, copper, iron, boron and molybdenum, can be successful because of the small amounts required for normal plant growth. It takes less fertilizer to meet plant needs for micronutrients if fertilizer is applied to the leaves rather than the soil. (See Table 9, MSU Extension bulletin E-486, for the suggested rates and sources of secondary and micronutrients used for leaf application.)

Leaf feeding can be used to good advantage when spray programs are necessary for pest control and the fertilizer material is compatible with the pesticide. The practice of applying only the major plant nutrients (N-P-K) by leaf feeding generally gives poor returns, however, because of the relative high energy and labor costs per unit of plant nutrient applied. Extra field trips also increase soil compaction problems. *Thus, leaf feeding should be considered a supplement to, not a substitute for, the regular soil application of fertilizers.*

Starter Solutions

Fluid fertilizers are often used to make starter solutions for transplants. Fertilizers in solution are readily taken up by the plants. This promotes new growth and better plant survival. Many all-soluble dry fertilizers also can be used in starter solutions. To prevent salting out, use soft or low-lime water. Rain water or distilled water is best for making a concentrated starter solution from dry fertilizer.

The maximum amount of fertilizer in a starter solution will depend upon the carriers. Follow the manufacturer's recommendations. Normally, 5 to 8 pounds of an all-soluble dry fertilizer are added to 100 gallons of water. Concentrated liquid fertilizers such as 10-34-0, 10-20-10, etc., are diluted 100 to 150 times by volume. The starter solution is then applied directly to the transplant at the rate of one-half pint per plant.

In preparing liquid fertilizers from dry fertilizer, you may need to dissolve the fertilizers in hot water. The solubility of various fertilizers varies greatly. (See Table 2 for approximate solubilities for some common fertilizers.)

Table 2: Approximate solubilities of some common fertilizers.

Fertilizer	Parts Soluble in 100 Parts of Cold Water
ammonium nitrate	118
manganese sulfate	105
calcium nitrate	102
urea	78
zinc sulfate	75
sodium nitrate	73
ammonium sulfate	71
magnesium sulfate	71
calcium chloride	60
diammonium phosphate	43
potassium chloride	34
monoammonium phosphate	23
potassium nitrate	13
superphosphate (0-46-0)	4
borax	1

Fertilizers through the Irrigation System

Nitrogation and *fertigation* are terms sometimes used to describe the application of nitrogen or other fertilizer nutrients through an irrigation system. The most common fertilizer applied is a 28 percent nitrogen solution because it is easily obtained and causes few or no problems when added to the water. All soluble dry products, such as urea, ammonium nitrate and potassium nitrate, can be dissolved in water and then metered into the irrigation system. Phosphate materials, anhydrous ammonia and aqua ammonia should not be applied through an irrigation system because of precipitation problems and losses of ammonia into the air during application.

The amount of nitrogen that can be applied through the irrigation system is limited only by the capacity of the injector pump. Even with a high rate of injection, the nitrogen will be so dilute that it will not injure crops. Most situations call for rates of 20 to 50 pounds of nitrogen per acre per application.

Many greenhouse operators and vegetable growers are equipped to apply fertilizer through their watering systems. They generally make up a concentrated solution and dilute it 100 to 300 times with water through an injector. Many strive for a final concentration of about 100 ppm nitrogen in the water. Twenty ounces of 20 percent nitrogen fertilizer added to one gallon of solution and then injected into the water at a ratio of 1 to 200 will make a final solution containing 150 ppm nitrogen.

Nutrients in One Gallon

A gallon of liquid fertilizer weighs about 11 pounds. Thus, a gallon of 5-20-5 analysis has about 1/2 pound of nitrogen, 2 pounds of phosphate

and 1/2 pound of potash. Except possibly for a starter benefit, do not expect wonders from a few gallons per acre. In midseason, rapidly growing crops such as *corn will take up 4 to 7 pounds of plant nutrients per acre daily*. The total nutrient uptake for a 130-bushel corn crop is about 175 pounds of nitrogen, 70 pounds of phosphate and 160 pounds of potash. Some products on the market are recommended at rates of only 1 to 2 quarts of N-P-K fertilizer per acre. Obviously, this is not enough to meet crop needs. A good fertilizer program takes into account the plant nutrient uptake of the crop, the soil test and the expected economic return.

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