08. Slow release N fertilizers – coated fertilizers – types of coating – lac coated-neem cake blended and coal tar coated urea- chemically modified forms-urea formaldehyde, IBDU, CDU

Slow-release fertilizers are excellent alternatives to soluble fertilizers. Because nutrients are released at a slower rate throughout the season, plants are able to take up most of the nutrients without waste by leaching. A slow-release fertilizer is more convenient, since less frequent application is required. Fertilizer burn is not a problem with slow-release fertilizers even at high rates of application; however, it is still important to follow application recommendations. Slow-release fertilizers may be more expensive than soluble types, but their benefits outweigh their disadvantages.

Slow-release fertilizers are generally categorized into one of several groups based on the process by which the nutrients are released. Application rates vary with the different types and brands, with recommendations listed on the fertilizer label.

Pelletized:

One type of slow-release fertilizer consists of relatively insoluble nutrients in pelletized form. As the pellet size is increased, the time it takes for the fertilizer to breakdown by microbial action is also increased. An example of this type is MagAmp, a 7-40-0 fertilizer that is available in a coarse grade lasting two years and a medium grade lasting one year. MagAmp is used commercially for container plants, but is appropriate for use on turf, tree seedlings, ornamentals, vegetables, and flower borders.

Chemically Altered:

A fertilizer may be chemically altered to render a portion of it water insoluble. For instance, urea is chemically modified to make Ureaform (ureaformaldehyde) -- a fertilizer that is 38 percent nitrogen, 70 percent of which is water-insoluble. This percentage is often listed on fertilizer labels as the Percent W.I.N., or the percent of water-insoluble nitrogen. This form of nitrogen is released gradually by microbial activity in the soil. Because microbial activity is greatly affected by soil temperature, pH, aeration, and texture, these variables can affect the release of nitrogen from Ureaform. For example, there will be less fertilizer breakdown in acid soils with poor aeration -- an environment unfavorable to soil microorganisms. Ureaform is used for turfgrass; landscaping; ornamental, horticulture, and greenhouse crops.

IBDU (isobutylidene diurea) is similar to Ureaform, but contains 32 percent nitrogen, 90 percent of which is insoluble. However, IBDU is less dependent on microbial activity than Ureaform. Nitrogen is released when soil moisture is adequate. Breakdown is increased in acid soils. IBDU is used most widely as a lawn fertilizer.

Coated fertilisers

Controlled- or slow-release fertilizers are broadly divided into uncoated and coated products. Uncoated products rely on inherent physical characteristics, such as low solubility, for their slow release. Coated products mostly consist of quick-release N sources surrounded by a barrier that prevents the N from releasing rapidly into the environment. Different mechanisms, but similar (though not identical) end results.

The terms “controlled-release” and “slow-release” can mean different things to different people, but for purposes of this discussion, the two terms are synonymous. Except for a few slow-release K sources, almost all slow-release fertilizers are N sources. They represent a relatively small segment of the total fertilizer industry (3 to 4 percent), but their use is growing faster than soluble (quick-release) materials. This is primarily because they reduce the overall environmental impact of N fertilizers, as now mandated in BMPs.

Coated:

Water-soluble fertilizers may be coated or encapsulated in membranes to slow the release of nutrients. For example, **Osmocote**, a controlled-release fertilizer is composed of a semipermeable membrane surrounding water-soluble nitrogen and other nutrients. Water passes through the membrane, eventually causing enough internal pressure to disrupt the membrane and release the enclosed nutrients. Because the thickness of the coating varies from one pellet, or prill, to another, nutrients are released at different times from separate prills. Release rate of these fertilizers is dependent on temperature, moisture, and thickness of the coating. Osmocote is recommended for turf, floriculture, nursery stock, and high-value row crops.

Another type of coated fertilizer is **sulfur-coated urea** (SCU), which is manufactured by coating hot urea with molten sulfur and sealing with a polyethylene oil or a microcrystalline wax. Nitrogen is released when the sealant is broken or by diffusion through pores in the coating. Thus, the rate of release is dependent on the thickness of the coating or the sealant weight. SCU is broken down by microorganisms, and chemical and mechanical action. The nitrogen in SCU is released more readily in warm temperatures and dry soils. SCU appears to be more effective when applied to the soil surface, rather than mixed into the soil. Any method of application that crushes the granules will increase the release rate to some extent.

SCU is best used where multiple fertilizer applications are normally necessary, such as on sandy soils or in areas of high rainfall or irrigation. SCU is used on grass forages, turf, ornamentals, and strawberries.

Nutricote is characterized by coating nitrate compound fertilizers with a special resin. The duration of nutrient release is controlled by the porosity of the resin coating. A more porous coating results in quicker release. This technology ensures consistency and precision of nutrient release from Nutricote controlled release fertilizers.

When Nutricote is applied to the soil, the water in the soil enters the granule through micropores which dissolves the nutrient elements. The nutrient elements will then be released steadily through the same pores. Most Nutricote granules are 3 to 4 mm in diameter and the nutrient content are NPK: 14-14-14 and NPK: 20-7-10.

Nutricote's release rate is influenced by soil temperature, the higher the soil temperature, the greater the release rate. Absorption of nutrients and water by plants is generally increased with increasing temperature and plant growth will become more vigorous as a result. Nutrient supply through Nutricote nicely matches the physiology of plant response to temperature.

The release rate of Nutricote is not significantly influenced by soil moisture levels nor by soil type or pH. Nutricote does not depend upon microbiological decomposition for its action.

2.Polymer-coated fertilizers

Polymer-coated fertilizers (PCF) represent the most technically advanced state of the art in terms of controlling product longevity and nutrient efficiency. Most PCFs release nutrients by diffusion through a semipermeable polymer membrane, and the release rate can be controlled by varying the composition and thickness of the coating. The type of fertilizer substrate also may influence the rate of N release.

Meister products : Meister products are produced by using thermoplastic resins as coating materials. The coatings are applied to a variety of substrates including urea, diammonium phosphate, potassium sulfate, potassium chloride and ammonium nitrate. Release-controlling agents such as ethylene-vinyl acetate and surfactants are added to the coating to obtain the desired diffusion characteristics, while coating thicknesses remain similar for most products. Release rates can also be altered by blending talc resin into the coating.

Reactive Layer Coating: A relatively new coating technology known as reactive layer coating (RLC) combines two reactive monomers as they are simultaneously applied to the fertilizer substrate. These reactions create an ultra-thin membrane coating, which controls nutrient release by osmotic diffusion. RLC products include coated basic fertilizer materials such as urea, potassium nitrate, potassium sulfate, potassium chloride, ammonium sulfate, ammonium phosphate and iron sulfate, in various particle sizes. Coating weights on urea vary from 1.5 to 15 percent, depending on the release duration desired.

Multicote products: In the production of multicote products, fertilizer granules are heated in a rotating pan and treated with materials that create multiple layers of a fatty acid salt. This is followed by the application of a paraffin topcoat. Coating weights are relatively large compared to other technologies, but this is offset by the comparatively low cost of the coating materials. Substrates include potassium nitrate, urea and triple superphosphate. The various coated components are blended together into different grades.

Coated N Fertilizers;

1.Ureaformaldehyde reaction products

Ureaformaldehyde (UF) reaction products represent one of the oldest controlled-release N technologies, having been first produced in 1936 and commercialized in 1955. Urea and formaldehyde are reacted together to various extents to produce polymer-chain molecules of varying lengths. The more these products are reacted, the longer the chains tend to be. Chain length, in turn, affects release characteristics.

Ureaform is the oldest class of UF reaction products. It is sparingly soluble, and contains at least 35 percent total N, with at least 60 percent of the total N as cold-water-insoluble N (CWIN). Ureaform is composed largely of longer-chained molecules of UF polymers. The unreacted (and, therefore, quick-release) urea N content in UF is usually less than 15 percent of the total N.

Methylene ureas are a class of sparingly soluble products that evolved during the 1960s and 1970s. These products predominantly contain intermediate-chain-length polymers. The total N content of these polymers is 39 to 40 percent, with between 25 and 60 percent of the N present as CWIN. The unreacted urea N content generally is in the range of 15 to 30 percent of the total N.

UF solutions are clear water solutions. They contain only very-low-molecular-weight, water-soluble UF reaction products, plus unreacted urea. Various combinations of the UF solutions are produced. They contain a maximum of 55 percent unreacted urea with the remainder as one or more of methylolureas, methylolurea ethers, MDU, DMTU or triazone.

Isobutylidene diurea (IBDU) : Unlike the reaction of urea and formaldehyde, which forms a distribution of different UF polymer chain lengths, the reaction of urea with isobutyraldehyde forms a single type of molecule. Although similar in chemical structure to methylene diurea (MDU), its physical properties are quite different. IBDU is a white crystalline solid available in fine (0.5 to 1.0 mm), coarse (.7 to 2.5 mm) and chunk (2.0 to 3.0 mm) particle sizes. The product contains a minimum of 30 percent N with 90 percent of the N in water-insoluble form. The typical commercialized product contains about 31 percent N.

Crotonylidene Diurea (CDU) : This slow acting nitrogen compound is formed by reaction with crotonaldehyde or acetaldehyde. Powdered CDU containing 30 percent N has been directly used as a fertilizer. The microbial decomposition of the chemically bound CDU is temperature dependant

Agronomic properties and nutrient release mechanisms of UF materials

The conversion of UF reaction products to plant-available N is a multi-step process, involving dissolution first, and then microbial decomposition. Once in the soil solution, UF reaction products are converted to plant-available N through either microbial decomposition or hydrolysis. Microbial decomposition is the primary mechanism of N release. Environmental factors such as soil temperature, moisture, pH and aeration affect microbial activity and, therefore, the rate of N release.

The rate of N release from UF reaction products is directly affected by polymer chain length. The longer the methylene urea polymer, the longer it takes for the N to become available. For ureaform and methylene urea products, the rate of mineralization is reflected by the CWIN content and its Activity Index. The higher the AI value, the more rapidly the N will become available. It is questionable if the very long methylene urea polymers (HWIN) are effectively used by the plant.

Agronomic properties and nutrient release mechanisms of IBDU: Nitrogen from IBDU becomes available to plants through hydrolysis. In the presence of water, the compound will hydrolyze (break down) to urea and isobutyraldehyde. The rate of hydrolysis is accelerated by low pH and high temperature. Unlike UF polymers that rely on soil microbial populations to make the N available, IBDU is primarily dependent on water as the critical element in N availability. Its low water solubility controls the transport of the product into the soil solution.

Agronomic properties and nutrient release mechanisms of SCU: The mechanism of N release from SCU is by water penetration through micropores and imperfections (i.e., cracks) or incomplete sulfur coverage in the coating. This is followed by a rapid release of the dissolved urea from the core of the particle. When wax sealants are used, a dual release mechanism is created. Microbes in the soil environment must attack the sealant to reveal the imperfections in the sulfur coating. Because microbial activity varies with temperature, the release properties of the wax-sealed SCUs are also temperature dependent.during the cool-season growth period.