Advanced Fertilizers Technologies

Lecture 5

Slow- and Controlled- Release Fertilizers

Prof.Dr.Hayfaa J.Hussein

Dept.of Soil Science and Water Resources

College of Agriculture

University of Basrah/IRAQ

Definitions of slow- and controlled-release fertilizers

Slow- or controlled-release fertilizer: A fertilizer containing a plant nutrient in a form which delays its availability for plant uptake and use after application, or which extends its availability to the plant significantly longer than a reference 'rapidly available nutrient fertilizer' such as ammonium nitrate or urea, ammonium phosphate or potassium chloride. Such delay of initial availability or extended time of continued availability may occur by a variety of mechanisms.

These include controlled water solubility of the material by semi-permeable coatings, occlusion, protein materials, or other chemical forms, by slow hydrolysis of water-soluble low molecular weight compounds, or by other unknown means.

1. **Stabilized nitrogen fertilizer: A fertilizer to which a nitrogen stabilizer has been added. A nitrogen stabilizer is a substance added to a fertilizer which extends the time the nitrogen component of the fertilizer remains in the soil in the urea-N or ammoniacal-N form**.

2. **Nitrification inhibitor: A substance that inhibits the biological oxidation of ammoniacal-N to nitrate-N**.

3. **Urease inhibitor: A substance that inhibits hydrolytic action on urea by the enzyme urease**

There is no difference in expression between slow release fertilizers and Controlled fertilizers. The two expressions are used for fertilizers that reduce the readiness and release of nutrients from them. (Trenkel, 1997)

The fertilizer is called slow release if it meets the following conditions at a temperature of 25°C: -

1. No more than 15% of the nutrient is released in 24 hours

2. No more than 75% of the nutrient is released in 28 days

3. At least 75% of the nutrients are released during the plant's growth period

slow release fertilizer industry

When manufacturing slow-release fertilizers, the following specifications must be taken into account in the manufacturing materials:

1. The materials involved in the manufacture of slow-release fertilizers must be of low solubility by forming chemical structures with high molecular weight and linking the element in the form of complexes, followed by microbiological decomposition.

2. The materials used cover the fertilizer, and in this case they are called "coated fertilizers".

3. The materials used in the manufacture of fertilizers are not quick to dissolve

4. The nutritional component is not the same as a fertilizer coating material when mixed with the material used in manufacturing

5. The materials used in manufacturing must have a small surface area in relation to their volume and be made in the form of granules, capsules or pills.

Advantages/Disadvantages of slow and controlled release fertilizers

Advantages of slow release fertilizer

Slow-release fertilizers offer a number of advantages:

1. It reduces toxicity, especially during the seeding phase, due to the high ionic concentration resulting from dissolving fast-dissolving fertilizers (and sometimes ammonia resulting from dissolving urea fertilizer), which affects plant growth.

2. Due to the reduction of the toxicity of some nutrients and salts, the fertilizer can be added all at once in the case of slow-release fertilizers instead of adding the fertilizer in the form of batches (dose) to the regular fertilizers, which reduces costs, losses and effort.

3. It is possible to grow several crops instead of single cultivation due to the slow release of nutrients, and fertilizer can be added to them at once.

4. Reducing the effects of environmental pollution from nitrogen fertilizers due to the nitrate washing process or loss in the form of ammonia and nitrogen oxides.

Disadvantages of slow release fertilizers

1. There are no standard methods for estimating the amount released and ready-to-go.

2. According to the products of the chemical reaction such as urea-formaldehyde fertilizer, a small part of nitrogen is released slowly into the soil solution.

3. There are some slow-release fertilizers, such as urea coated with sulfur. The element liberated in the beginning is fast, and this rapid release may affect the growth of the crop. Also, the sulfur coated with urea may be so thick that nitrogen is not released from it.

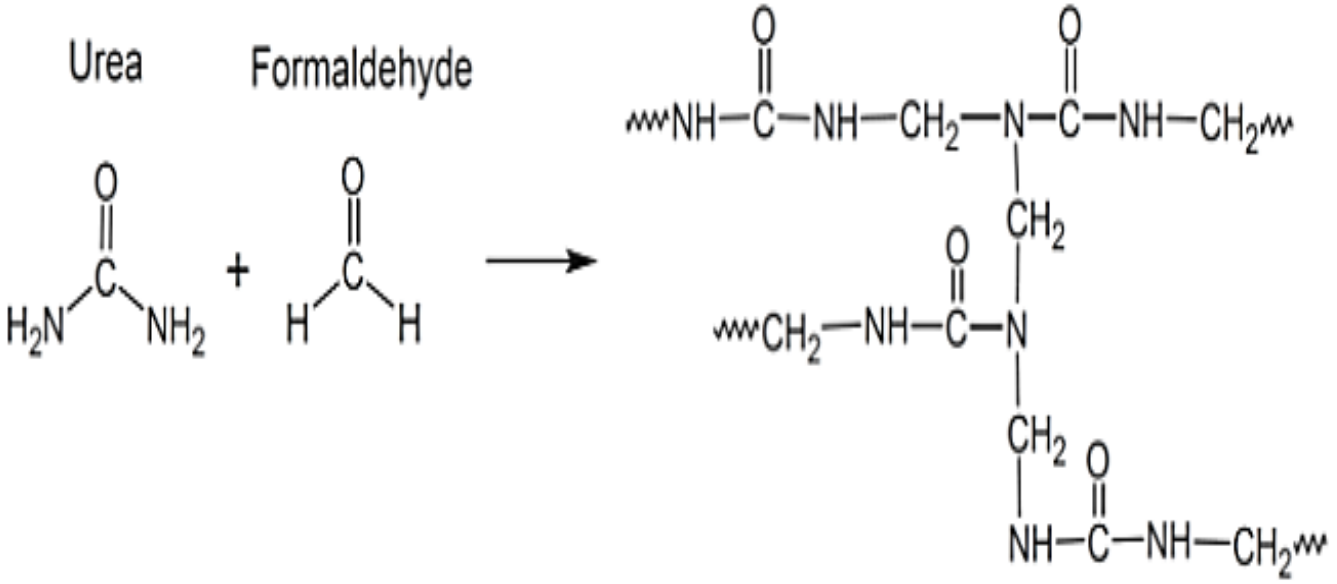
4. The slow release polymeric fertilizers, after the element is released from them, may leave manufactured chemicals that affect plant growth, such as plastic materials coated with fertilizers, which may leave up to more than 50 kg of rubber / hectare / year. We expect within ten years 500 kg of rubber / hectare, which over time becomes part of the components of the soil.

5. The slow-release fertilizer industry is generally more expensive compared to regular fertilizers

Types of Slow Release Fertilizers

1. **Urea formaldehyde**
2. Isobutyldene diurea
3. Sulfur-Coated Urea (SCU)
4. Plastic-Coated Urea
5. Chelated Fertilizers

1.Urea-Formaldehyde (UF) 38% N



Urea-formaldehyde fertilizer is available under different brand names and in different liquid and solid forms. The fertilizer contains 38% nitrogen. The nutrient is contained within long chemical chains that plants cannot absorb. But the presence of soil microorganisms break these chains and release the element into the soil and absorb it by the roots of the plant. The ability of this fertilizer to dissolve in water varies on the ratio of urea to formaldehyde. This fertilizer is added either directly to the soil or mixed with other nitrogen fertilizers according to the needs of the plant and the nature of the soil and environmental conditions.

2.Isobutyldene diurea (IBDU) 32%N

- 31% N
- 90% slow release
- N released by hydrolysis as urea
- Relatively unaffected by
  - Temperature
  - pH
- Particle size important
- Excellent cool season response
- Less effective during heavy rain periods due to rapid release

2.Isobutyldene diurea (IBDU) 32%N

This fertilizer is prepared from the reaction of isobutylidene (liquid) with urea to form a polymer with long chains. This fertilizer contains 32% nitrogen and 90% of the fertilizer is not dissolved in cold water. The release of nitrogen from the compost is a function of the particle size, moisture and soil pH It is generally a slow-dissolving fertilizer.

Sulfur-Coated Urea (SCU)

It is a fertilizer covered with **sulfur.** It is often added with the fertilizer materials that prevent the activity of microbes to reduce the speed of biological decomposition of the sulfur envelope. These fertilizers usually contain 36% nitrogen, 17% sulfur, 3% wax, 0.2% Microbicide, and 1.8% Conditioner.

There are four main reasons why urea fertilizer should be coated with sulfur are: -

1. **Urea contains a high concentration of nitrogen (46%), so covering it with sulfur reduces the nitrogen content to 30-40%.**

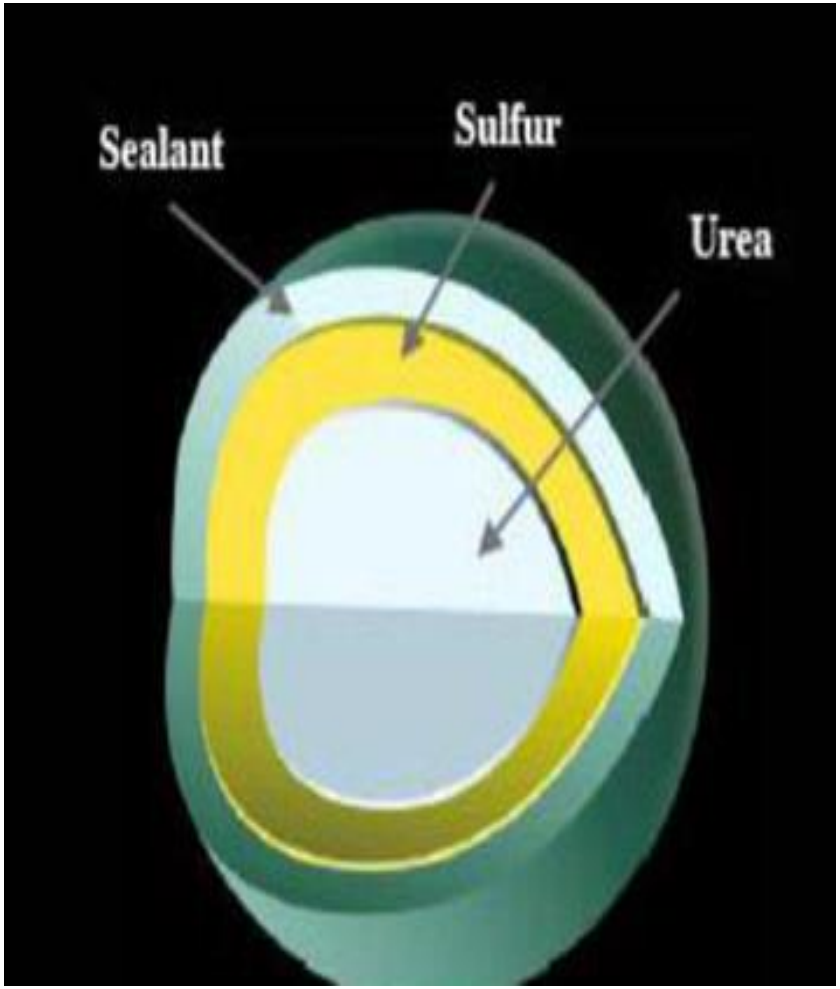
2. **Urea is lost by leaching or volatilization, so coating it with sulfur, which is an impermeable substance, reduces nitrogen loss.**

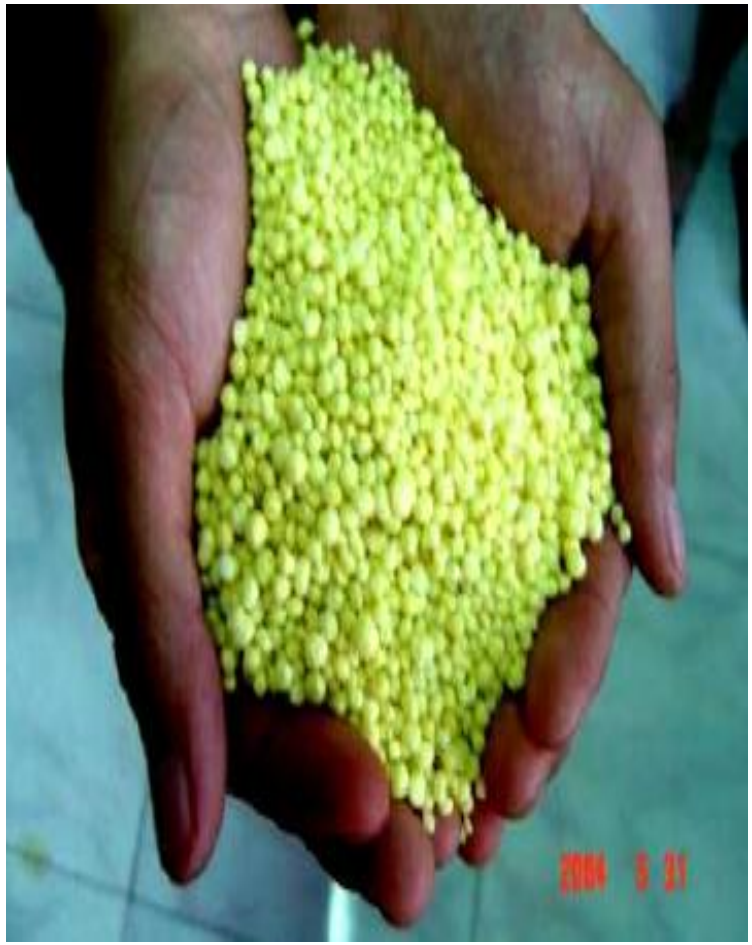
3. **Sulfur is a cheap material**

4. **Sulfur is a plant nutrient**

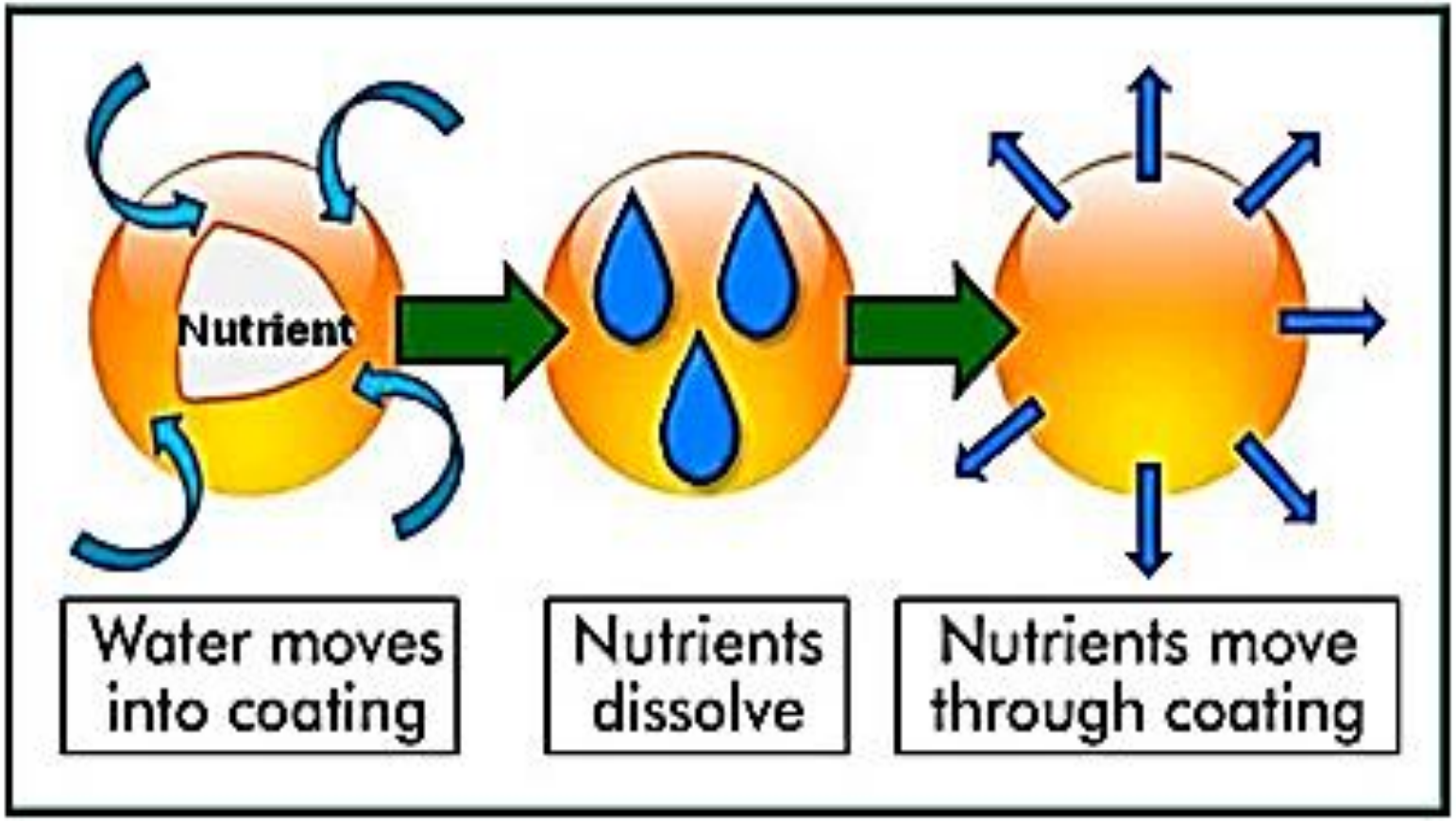
When this fertilizer is added to the soil, a large proportion of nitrogen will become ready for the plant during the first week, due to the lack of complete coverage of urea by sulfur. Then the biological decomposition of the sulfur envelope begins, as moisture reaches the urea and the urea comes out from the small holes that occur in the cover. The rate at which sulfur decomposes depends on soil moisture, temperature, soil organic matter content, soil and other factors. texture,

Sulfur coated urea





Water entry and nutrient release from the coated fertilizer

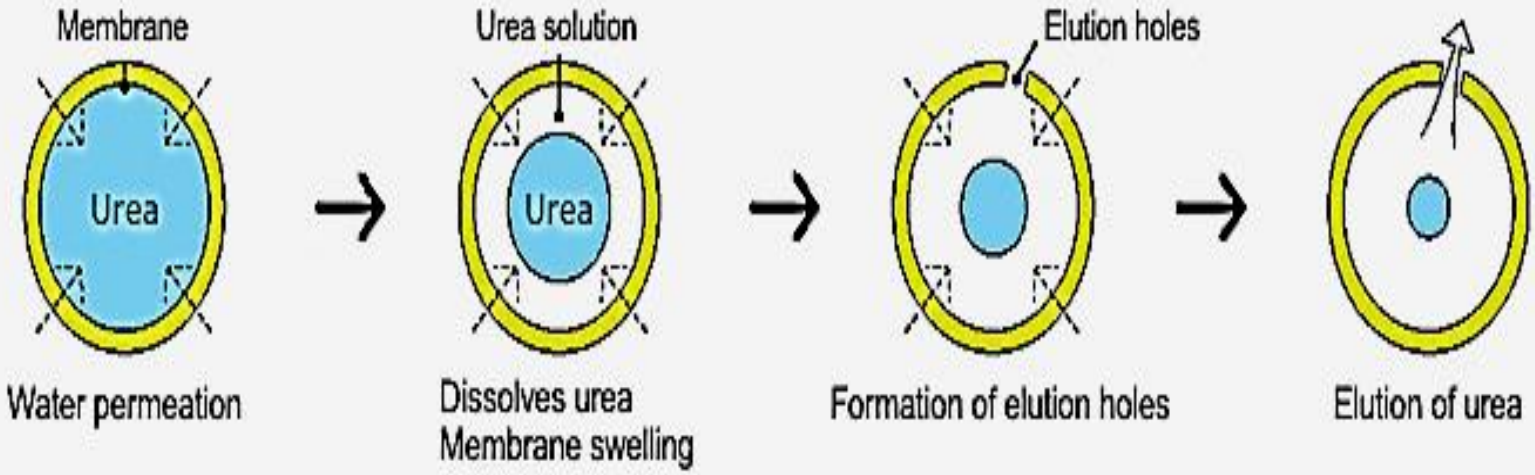


Plastic-Coated Urea

- In recent years, urea covered with plastic has been used from polyvinylchloride or other plastic materials that decompose slowly and release nitrogen from it. The rate of decomposition depends on the thickness of the plastic wrap, bioactivity, and the soil environment.

The process of releasing nutrients from slow-release fertilizers includes the penetration of water into the casing surrounding the fertilizer, then forming a solution of the fertilizer with water, then the liquid exiting through a hole in the fertilizer or cracks on the surface of the cover, as shown in figure below

Water entry and nutrient release from the coated fertilizer



Water passing through the membrane dissolves urea. The membrane swells in the process.

Elution holes are formed as the membrane swells, and elution of urea begins.

Chelated Fertilizers

Wallace (1957) identified the most prominent properties of chelating compounds that can be used in agricultural applications, as follows: -

1. It is not possible to replace the nutrient element in its chelated form easily with other cations prevailing in the solution.

2. The chelating formula possesses stability against the hydration condition

3. The relative resistance of the chelated formula to biodegradation by soil microorganisms

4. The chelated formula is soluble in water

5. The chelated formula does not have the ability to fix in soil

6. The chelated nutrient must be ready for absorption through the root surface or any other location on the plant

7. The chelated formula has no toxic effects within the limits of addition

8. The chelated formula is made in a form that is easy to add to the soil and plants

9. Not to be expensive

Table 1. Common fertilizer ligands.

Abbreviation	Name
CDTA	Cyclohexanediaminepentaacetic acid
CIT	Citric Acid
DTPA	Diethylenetriaminepentaacetic acid
EDDHA	Ethylenediaminediaminedi-o-hydroxyphenylacetic acid
EDTA	Ethylenediamintetraacetic acid
EGTA	Ethylene glycol bis(2-aminoethyl ether) tetraacetic acid
HEDTA	Hydroxyethylenediaminetriacetic acid
NTA	Nitro-triacetic acid
OX	Oxalic acid
PPA	Pyrophosphoric acid
TPA	Triphosphoric acid


THANK YOU
FOR
LISTENING