



UNVEILING THE FUTURE OF FARMING: NANO UREA VS. TRADITIONAL FERTILIZERS

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INTRODUCTION

Nano fertilizers are the new category of fertilizers that comprises nanotechnology in its design and production. Nano-fertilizers are produced by manipulating the materials at a nano-scale at molecular and atomic scale. Due to its nano scale, the materials show different unique properties and improved functioning.

They can be classified based on their action, nutrient composition, and consistency. These categories include controlled release nano-fertilizers, nano-fertilizers for targeted delivery, plant growth-stimulating nano-fertilizers, water and nutrient loss-controlling fertilizers, inorganic and organic nano-fertilizers, hybrid nano-fertilizers, nutrient-loaded nano-fertilizers, and various consistency based nano-fertilizers such as surface coated, synthetic polymer-coated, biological product coated, and nanocarrier based nano-fertilizers.

PREPARATION

Nanotechnology is the production and use of technologies through the alteration of their size and form at the nanoscale. The use of nanostructured materials as fertilizers, also referred to as smart fertilizers, has been made possible by it. In addition, the chemical structure of nano fertilizers may enable effective nutrient uptake, the restoration of soil fertility, ultra-high absorption, increased production, reduced soil toxicity, fewer application frequency, enhanced plant health, and less environmental pollution. Components of nanomaterials include Mn/ZnSe quantum dots, Fe, ZnS core-shell, silica, and gold nanorods etc. The type of crop and the nanoparticles size, composition, concentration, and chemical characteristics all influence how successful they are as nano fertilizers for plant development.

Advantages of Nano fertilizers:

1. Better uptake of nutrients.
2. Ability to control the release of nutrients.
3. Compatible with sustainable agriculture.
4. Reduced fertilizer requirement.
5. Reduced impact on environment in comparison to traditional fertilizers.
6. Improved nutrient efficiency.

Disadvantages of nano-fertilizers:

1. High cost.
2. Public awareness and acceptance.
3. Equipment requirement.
4. Limited knowledge.
5. Nano-particle accumulation risk.
6. Potential risk to environment.
7. Limited framework for regulation.

1. Traditional fertilizers.

A fertilizer is a natural or artificial substance containing the chemical elements that improve growth and productiveness of plants. Fertilizers increase the natural fertility of the soil or replace chemical elements taken from the soil by previous crops.

A. fertilizers.

Organic, or natural, fertilizers come from natural sources, and they comprise a minimum of one essential nutrient to feed plants. Some examples of all-natural plant feed are compost, manure, and rock powders. For plants to be able to assimilate the nutrients in organic fertilizer, soil microbes must first transform the nutrients from an inaccessible form into a bioavailable one. This results in a slower release of nutrients than is typical for inorganic products, as well as enhanced soil quality due to the inclusion of organic matter.

Types of organic fertilizers:

1. Animal based.

- Blood meal is a great source of nitrogen, promoting robust foliage development.
- Bone meal provides plants with calcium and phosphorus, which they need for root growth and flowering.
- Urine contains all the macronutrients, with an average NPK ratio of 11–2–4.
- Fish emulsion and enzymatically digested hydrolyzed liquid fish are both organic liquids that work quickly and are high in macronutrients and trace elements.

- Fish meal is a rich source of nutrients, especially nitrogen and phosphorus.

2. Plant based.

- Ash is an excellent source of potassium and trace elements, which can also treat overly acidic soils.
- Peat maintains a healthy soil pH and is rich in macronutrients and secondary nutrients like magnesium and calcium.
- Compost is a slow-releasing fertilizing product that contains low levels of nitrogen, potassium, and phosphorus and is applied in large quantities.

3. Mineral based.

- Limestone, thanks to its high calcium carbonate content, helps boost the fertility of the soil by improving its chemical properties (for example, reducing acidity).
- Rock phosphate (phosphorite) is a low-priced natural source of slow-releasing soluble phosphorus.

B. Chemical fertilizers.

1. Nitrogenous Fertilizers: Nitrogenous fertilizers are the nitrogen-containing organic substances that supply the nutrition of nitrogen to the plants. They are of four types.

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| i. Nitrate Fertilizers: e.g. Sodium nitrate. | iii. Nitrate and ammonium fertilizers: e.g. Ammonium sulphate. |
| ii. Ammonium Fertilizers: e.g. Ammonium sulphate. | iv. Amide fertilizers: e.g. Urea. |

2. Phosphatic Fertilizers: Phosphatic fertilizers are the phosphorous-containing organic substances that supply the nutrition of phosphorous to the plants.

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| i. Calcium dihydrogen phosphate | iii. Ammonium hydrogen phosphate |
| ii. Ammonium phosphate | |

3. Potassium Fertilizers: Potassium fertilizers are the potassium-containing organic substances that supply the nutrition of potassium to the plants.

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| i. Potassium chloride | ii. Potassium sulphate |
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iii. Potassium nitrate

ADVANTAGES

1. Chemical fertilizers are predictable and reliable.
2. The Fertilizer can be used in poor soil to make it fertile immediately.
3. They add a sufficient amount of nutrients needed by the plant.
4. They contain the three essential nutrients (NPK) needed for plant growth.
5. They are cheaper than organic fertilizers and easy to use.
6. They allow the growth of the same vegetable plants in the same area, eliminating the need for crop rotation.
7. The fertilizers can be custom made to fit the requirements of crop soils, making the perfect planting grounds.

DISADVANTAGES

1. Chemical fertilizers affect micro-organisms living in the soil. The acidity of chemical fertilizers also adversely affects the soil pH and makes it acidic, thereby changing the kinds of microorganisms that can live in the soil. Prolonged use of chemical fertilizers causes an increase in pests and kills the beneficial microbes present in the soil.
2. They are highly soluble in water hence they leach away into groundwater without fully benefiting the plant. Thus fewer nutrients are available for the plant. The leaching away of chemical fertilizers pollutes the water. These chemicals also seep into the subsoil, where they interact with clay, forming impermeable layers called hardpan. Hence, cause compaction of the soil.
3. They encourage plant disease. Fast-release chemical fertilizers have a high nitrogen content compared to slow-release organic fertilizers. When there is an overabundance of nitrogen (N) in relation to phosphate (P), plants are more susceptible to mosaic infections. Too much use of these fertilizers tends to destroy the beneficial microbes present in the soil.
4. While the fertilizers help a plant to grow, they do not do much for the soil. When chemical fertilizers are used for a prolonged duration, the soil gets damaged

as the trace nutrients are not replenished in the soil.

5. Excess nitrogen used in crop fertilization can contribute to the release of greenhouse gases such as carbon dioxide and nitrous oxide into the atmosphere. This effect is caused by using a greater amount of

chemical fertilizer than the plants can readily absorb.

6. There is an increasing concern that continuous use of chemical fertilizers on soil depletes the soil of essential nutrients. As a result, the food produced in these soils has less vitamin and mineral content.

Comparison between nano-fertilizers and traditional fertilizers:

1. Composition.

Traditional fertilizers contain essential nutrients like Nitrogen, Potassium and Phosphorous in liquid, granulated or powder form.

Meanwhile, nano-fertilizers contain nano particles of either organic or inorganic origins depending upon its formulation.

2. Efficiency in nutrient uptake.

Design of nano fertilizers is drastically improves the efficiency in nutrient uptake by increasing the area of contact between nutrients and roots of the plants. The nutrient absorption rate is improved due to larger surface area of nano-fertilizers.

Meanwhile, in case of traditional-fertilizers there are some limitations regarding nutrient solubility and lower efficiency as compared to nano-fertilizers, resulting in excess nutrient loss.

3. Nutrient release:

Nano fertilizers can be engineered to control the release of nutrients slowly and efficiently over time as per the requirement. It established a sustainable supply of nutrients while reducing the application frequency.

Whereas, in case of traditional fertilizers, they release the nutrients immediately which makes them more susceptible to leaching and volatilization.

4. Knowledge and adaptation.

Traditional fertilizers are being used from decades and have a long history of usage and thorough research with applied practices, making most of the farmers and scientists familiar with application methods and usage.

Meanwhile, nano-fertilizers being the new technology involves less research, usage and applied practices in comparison and may require more promotion to get accepted by the farmers.

5. Cost and availability.

Traditional fertilizers are widely available and are more affordable by farmers as compared to nano fertilizers. The nano-

technology used in the manufacturing process results in its high price.

6. Customization in nutrient release.

One of the major advantages of nano fertilizers is the customization property. The nano-fertilizers can be customized on

the basis of a specific crop, soil type, nutrient availability etc.

7. Effect on environment.

The traditional fertilizers can cause damage to environment when used carelessly. The leached-out nutrients get added to the ground water causing water pollution damaging the aquatic ecosystem.

Meanwhile with controlled nutrient release in nano-fertilizers, this risk can be reduced to a great impact. But the nano particles accumulating in the soil may cause potential damage to the soil health and other factors.

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