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Nutrient Use Efficiency and its Management Techniques

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Introduction

A crucially essential topic in the assessment of agricultural production systems is nutrient use efficiency (NUE). Numerous agricultural soils across the world lack one or more of the nutrients needed to sustain the growth of healthy, productive plants. Efficiency can be described in a variety of ways, but one simple strategy to boost food production is to cover more ground with crops and farm more intensively, which increases yields per unit of land.Various scientists have reported that there are elemental toxicities by Al, Mn, Fe, S, B, Cu, Mo, Cl, Na, and Si around the world.

Nutrient Use Efficiency

Nutrient use efficiency is a critically important concept forevaluating crop production systems and is greatly impacted byfertilizer management as well as soil and plant-waterrelationships.Nutrient use efficiency is defined as the amount of dry matterproduced per unit of nutrient applied or absorbed.

Classification of NUE

Nutrient use efficiency can be expressed several ways.Four agronomic indices commonly used to describe nutrient useefficiency are:

i. Partial factor productivity,
ii. Agronomic efficiency,
iii. Apparent recovery efficiency and
iv. Physiological efficiency

i. Partial factor productivity (PFP)

The ratio of yield under fertilizer N and amount of fertilizer N applied is termed as partial factor productivity. The factor gives answer to the question ‘Is this cropping system productive in comparison to its nitrogen application? The higher value of PFP means more efficient use of nitrogen.

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$$\text{Partial Factor Productivity} = \frac{\text{Yield (kg/ha)}}{\text{N applied (kg/ha)}}$$

ii. Agronomic efficiency (AE)

It is defined as the economic production obtained per unit of nutrient applied. It is calculated by the following equation:

$$\text{AE} = \frac{\text{Grain yield of fertilized crop in kg} - \text{Grain yield of unfertilized crop in kg}}{\text{Quantity of fertilizer applied in kg}}$$

iii. Physiological Efficiency (PE)

It is defined as the biological production obtained per unit of nutrient applied.It demonstrates how a plant may convert the N it receives from fertilizer into economic output. The yield generated per unit of N received by the plant shoots is the subject of this N utilization efficiency (NUE).It is calculated by the following equation:

$$\text{P} = \frac{(\text{Total dry matter yield of fertilized crop in kg}) - (\text{Total dry matter yieldofunfertilized crop in kg})}{(\text{Nutrient uptake by fertilized crop in kg}) - (\text{Nutrient uptake by unfertilized crop inkg})}$$

iv. Apparent Recovery Efficiency (ARE)

One of the more complicated NUE expressions is apparent recovery efficiency (ARE), which is often defined as the difference in nutrient uptake in the plant's above-ground sections between treated and unfertilized crops in relation to the amount of fertilizer applied. Also, It is defined as the quantity ofnutrient absorbed per unit of nutrient applied.

$$\text{ARE} = \frac{(\text{Nutrient uptake by fertilized crop}) - (\text{Nutrient uptake by unfertilized crop})}{(\text{Quantity of fertilizer applied})}$$

Importance of NUE

- To increase the overall performance of cropping systems.
- Providing economically optimum nourishment to the crop.
- Minimizing nutrient losses from the field and
- Supporting agricultural system sustainability through contributions to soil fertility or other soil quality components.
- NUE is a critically important concept for evaluating crop production systems and can be greatly impacted by fertilizer management as well as soil and plant- water relationships.
- NUE indicates the potential for nutrient losses to the environment from cropping systems to meet the increasing societal demand for food, fiber and fuel.

Current scenario of NUE

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The Nutrient Use Efficiency has achieved constancy after the green revolution and now the trend is not at all increasing. Besides, there is a huge demand to increase the NUE since the population is increasing with each passing year and there is no scope of increasing the land under agricultural cultivation.

Nutrient Use Efficiency of different nutrients (Meena et al., 2017)

Nutrient	Efficiency	Cause of low efficiency
Nitrogen	30-50 %	Immobilization,volatilization, denitrification, leaching
Phosphorus	15-20%	Fixation in soils Al - P, Fe -P, Ca-P
Potassium	70-80%	Fixation in clay lattices
Sulphur	8-10%	Immobilization, Leaching with water
Micro-nutrients (Zn, Fe, Cu, Mn, B)	1-2%	Fixation in soil

Techniques to increase nutrient use efficiency (NUE)

1. Fertigation

Application of fertilizer through micro irrigation water. The technique was first started in Israel. In some ways, fertilization is similar to spoon-feeding plants. Along with a micro irrigation system, it guarantees nutrient availability to the root zone of the plant. It leads to saving the fertilizers by about 30%. The method also ensures precise application and uniform distribution of fertilizers.

2. Nanotechnology

Nanotechnology is defined as "design, characterization, production and application of structure, devices and systems controlling shape, size and composition at the nano- scale."Nano materials are defined as materials that have a single unit, with size between 1 nanometer (nm) and 100 nm.The term "nano-fertilizer" refers to nutrient-rich nano particles that may quickly reach a target in the rhizosphere or be sprayed onto foliage, directly give vital nutrients for plant development, and have improved nutrient use efficiency. The nano-fertilizers can achieve up to3-fold increase in NUE than in conventional methods. It is also advantageous and can result in 80-100 times less requirement of chemical fertilizers.

3. Nutrient Briquettes

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The briquettes are an unique fertilizer concept that differs from traditional fertilizers in that the fertilizer is made into a briquette that is around the size of one's fingertip (or 2.75 g), as opposed to the more popular granular, prill-sized fertilizers or liquid fertilizers. Briquettes are applied to the soil in a special way called banding, where they are placed below the soil's surface between planted rows. Surface applied urea is said to lose up to 35% of its nitrogen, whereas buried briquettes only lose around 4% of it, which is a significant gain in nitrogen use efficiency.

4. Seed priming

The controlled hydration approach known as "seed priming" involves soaking seeds in water or a solution with a low osmotic potential to the point when germination-related metabolic processes start to take place in the seeds but dramatic emergence does not.The method helps in better establishment of crop, increase in uptake and yields and hence improving the NUE.

5. Different methods to increase Nitrogen Use Efficiency

Various strategies for improving nitrogen use efficiency are:

- Site Specific Nitrogen Management
- Integrated Nitrogen Management
- Use of Slow-release fertilizers
- Improvement in method of N application

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