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Nano Urea vs. Conventional Urea: Assessing the Better Option for Sustainable Agriculture

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This article evaluates the comparative advantages of nano urea over conventional urea as nitrogen fertilizers for sustainable agriculture. Nano urea, a novel nanotechnology-based fertilizer, offers benefits such as higher nutrient use efficiency, reduced environmental impact, and improved crop yields compared to traditional urea. However, challenges such as limited availability, higher costs, safety concerns, and insufficient long-term research hinder its widespread adoption. The article emphasizes the need for continued research and development to overcome these barriers and highlights the potential of nano urea to contribute significantly to sustainable farming practices and global food security.

Introduction

Urea is the most widely used nitrogenous fertilizer in agriculture due to its high nitrogen content and cost-effectiveness. It plays a vital role in promoting plant growth and improving crop yield by supplying essential nitrogen, which is a key nutrient for photosynthesis and protein synthesis. When applied to soil, urea undergoes hydrolysis to release ammonium, which plants can readily absorb. However, conventional urea use can lead to nitrogen losses through volatilization, leaching, and denitrification, which not only reduces fertilizer efficiency but also contributes to environmental pollution. Increasing population and climate change have intensified the demand for food production, highlighting the necessity for more sustainable agricultural practices. Additionally, the use of synthetic fertilizers has negatively impacted both the environment and human health. Therefore, optimizing urea application methods and exploring innovative formulations are crucial for sustainable agricultural practices.

A recent innovation gaining attention as a promising solution in agriculture is nano urea, a novel form of nitrogen fertilizer that offers potential benefits for sustainable farming. Compared to conventional urea, nano urea provides enhanced solubility and improved efficiency. This article will explore the comparative effectiveness of nano urea and conventional urea in enhancing nitrogen use efficiency and promoting sustainable agricultural practices. It will also assess their impacts on crop productivity and environmental sustainability.

Conventional Urea

Urea is the most commonly used solid nitrogen fertilizer worldwide, essential for supplying plants with necessary nitrogen for growth. It is manufactured by reacting ammonia gas with carbon dioxide under high temperature and pressure conditions. Containing 46% nitrogen, urea is cost-effective and quickly converts to a form readily absorbed by plants, making it efficient for transport and use. It readily dissolves in water, allowing for application through

irrigation or foliar sprays. Urea's flexibility enables it to be used in various ways, including as a starter fertilizer, broadcast, top-dressing, or as part of dry and liquid fertilizer blends.

Nano Urea

Nano urea is a novel agricultural product developed using nanotechnology, featuring particles sized between 20 and 50 nm, which results in a much greater surface area compared to traditional urea prills (Raliya et al. 2017; Mahapatra et al. 2022). It contains 4% nitrogen with particle sizes below 100 nm and has an estimated shelf life of around two years (Madhavi et al. 2022). Nano urea enhances nitrogen uptake efficiency by plants due to its smaller particle size, allowing better absorption and reduced nutrient losses. Additionally, its use can lower the overall fertilizer requirement, contributing to more sustainable and eco-friendly agricultural practices.

Table 1: Properties of IFFCO Nano Urea (Jangir et al., 2021)

Properties	Nano Urea	Conventional Urea
Invention	2021	1823
Particle size	32 nm	1 mm
Use efficiency	85-90 %	30-40 %
Price	240 /-	266.5/-
Storage	Less storage space	Large Area
Pollution	No	Yes
Effect on soil	Enhance soil health	Soil Acidification
Availability in plant	Throughout the life cycle	3-4 days
Intake medium	Direct through leaves	Through roots
Method of use	Spray	Top-dressing

Harmful Impacts of Conventional Urea

- Only 30–50% of the nitrogen in urea is effectively absorbed by crops; the rest is lost, leading to contamination of soil and nearby water sources.
- Low nitrogen use efficiency and losses through volatilization release nitrous oxide into the atmosphere, a potent greenhouse gas contributes to air pollution and global warming.
- Excess urea also causes ammonia emissions, soil acidification, and eutrophication of water bodies.
- The unused portion of urea results in environmental degradation and negatively affects long-term soil fertility and health.
- Over-application or wastage of urea can delay crop maturity, reduce productivity, and compromise overall crop performance.
- Plants grown under such conditions often become weaker, less nutritious, and more vulnerable to pests and diseases.

Why is Nano Urea suitable for Sustainable Agriculture?

- Reduced fertilizer requirements:** Nano urea usage can substantially reduce the quantity of fertilizer required for crop production. Its higher solubility promotes more efficient nutrient absorption by plants, the slower release rate of nano urea means that the nitrogen is released over a longer period, which reduces the need for frequent applications of fertilizer.
- Reduced environmental pollution:** Utilizing nano urea can greatly decrease pollution associated with conventional fertilizers. Its controlled nitrogen release helps prevent nutrient leaching into water sources, which can cause eutrophication and other environmental issues. Furthermore, enhanced nutrient absorption by plants reduces the overall fertilizer demand, minimizing the chance of excess nutrients contaminating the environment.
- Cost efficiency and Improves farmers income:** Nano urea can lower fertilizer expenses by reducing the total amount required.

- d) **Enhanced crop productivity:** Nano urea has demonstrated the ability to boost crop yields, especially in situations where conventional fertilizers fall short. This improvement is attributed to better nutrient absorption by plants and the increased mobility of nano urea particles in the soil. The controlled release of nitrogen ensures a consistent nutrient supply throughout the growing period, promoting healthier growth and higher yields.
- e) **Improved soil health:** Applying nano urea can contribute to better soil health by providing a gradual and controlled release of nitrogen. This steady nutrient supply helps improve soil structure, boosts microbial activity, and enhances the soil's ability to retain nutrients.

Challenges to the Adoption of Nano urea

- a) **Limited research:** The long-term impacts of nano urea on soil health and crop development remain inadequately studied. Since this technology is still in its early stages, most existing research has been carried out under controlled laboratory settings. Consequently, further investigations are necessary to assess how nano urea performs under diverse field conditions, including various soil types and climatic environments.
- b) **Health and environmental safety concerns:** Questions remain regarding the safety of nano urea for both human health and the environment. Some research indicates that exposure to nanoparticles through inhalation or ingestion may pose health risks. Furthermore, the full environmental effects of nanoparticles are still not well understood, highlighting the need for additional studies to thoroughly assess the safety of nano urea.
- c) **Limited availability:** Nano urea is not yet broadly accessible in the market. At present, only a small number of manufacturers produce nano urea, and its distribution is confined to specific areas. This limited availability poses challenges for farmers in obtaining and utilizing nano urea.

Conclusion

Nano urea holds great promise as a sustainable fertilizer in agriculture due to its enhanced nutrient use efficiency, lower environmental footprint, and ability to boost crop yields, making it a viable alternative to traditional urea. Nevertheless, there are several challenges to its adoption, including its high cost, limited research on its long-term effects, safety concerns, and limited availability. Overcoming these barriers will necessitate greater investment in research and development. Despite these challenges, nano urea is an emerging technology with the potential to contribute significantly to global food security and environmental sustainability.

References

1. Raliya R, Saharan V, Dimkpa C, Biswas P. (2017). Nanofertilizer for precision and sustainable agriculture: current state and future perspectives. *Journal of agricultural and food chemistry*, **66(26)**:6487-503.
2. Mahapatra DM, Satapathy KC, Panda B. (2022). Biofertilizers and nanofertilizers for sustainable agriculture: Phyco prospects and challenges. *Science of the total environment*, **803**:149990.
3. Jangir, N., Suman, Saxena, S., Yadav, S., and Nishikant. (2021). Nano Urea: environment friendly and better substitute for urea. *Just Agriculture*, **2**, 34-37.
4. Avaneesh Kumar, Hardev Ram, Sandeep Kumar, Rakesh Kumar, Arvind Yadav, Ananya Gairola, Vipin Kumar, and Tanu Sharma. (2023). A Comprehensive Review of Nano-Urea vs. Conventional Urea. *International Journal of Plant & Soil Science*. **35(23)**:32-40.
5. Pooja, L.R., Kumar, S., Singh, R., and Prasad, S. (2023) Nanostructured Urea Fertilizer (Nano Urea): A Promising Approach to Sustainable Agriculture. *Food and Scientific Reports*, **4(5)**: 84-91.
6. Nabanita De and Tanmoy Das. (2024). Nano urea and its Superiority Over urea as Fertilizer Elaborating some Applications. *International Journal of Scientific Research in Science and Technology*. **11(4)**:368-386.