

## Nano Urea A Source of Sustainable Agriculture

Aditya Shri<sup>1</sup>, Kumari Madhumala<sup>2</sup>, Suman Kumari<sup>3</sup>, Kumari Punam Sinha<sup>4</sup> and Karanjev Kumar<sup>5</sup>

<sup>1</sup>Department of Agronomy, BAU, Sabour, Bihar

<sup>2</sup>Dept. of Horticulture (Fruit Science), Veer Kunwar Singh College of Agriculture, Dumraon, Buxar, Bihar

<sup>3</sup>Subject Matter Specialist, Araria

<sup>4</sup>Seed Science & Technology, UBKV, Pundibari, Cooch Behar, West Bengal

<sup>5</sup>Dept. of Horticulture (Fruit Science), Dr.Kalam Agricultural College, Kishanganj

### SUMMARY

In order to meet the rising demands for food production, conventional chemical fertilizers, most notably urea, have been used for a long time worldwide. Concerns about nitrate leaching, global warming, ozone layer depletion, and groundwater pollution have been brought up by the use of conventional urea. With the increasing global population and the decreasing amount of arable land, there is a growing demand for chemical fertilizers, especially nitrogen. Urea production, which accounts for a significant portion of global nitrogen fertilizer demand, leads to environmental issues like greenhouse gas emissions and pollution. Researchers recommend using energy-efficient fertilisers to reduce urea demand and address related issues. Nano-fertilizers, which are distinguished by their nano-dimensions and slow-release properties, present a promising solution. They are efficient nutrient carriers, reducing losses from leaching and emissions. The Indian Farmers Fertiliser Cooperative (IFFCO) created nano-urea, which is unique in that it has particles the size of nanometers, a longer shelf life, and a smaller environmental impact. Adoption of it could contribute to improved soil health, decreased use of agrochemicals, and sustainable agriculture. Higher efficiency, less of an impact on the environment, regulated nutrient supply, and financial advantages are revealed when comparing nano-urea to conventional urea. With its breakthroughs in nanotechnology, Nano-urea is able to revolutionise crop nutrition while encouraging environmental preservation, sustainability, and higher farmer profits.

### INTRODUCTION

Around the world, conventional chemical fertilizers are used to increase agricultural yields in response to the expanding populations demand for food. However, widespread and excessive use during the post-green revolution era raised concerns about the environment. With the growing world population and decrease availability of arable land, there is an increased need for chemical fertilizers, especially nitrogen. Urea accounted for 76.5% of the world's nitrogen fertilizer demand in 2019–20, which was 107.4 million tonnes. Even though urea is widely used, its production adds to various environmental issues such as greenhouse gas emissions, excessive use of water and electricity, and possible pollution. Researchers suggest using energy-efficient fertilizers to lower the demand for urea in order to address these problems. Conventional fertilizers, such as urea, have low efficiency (just over 30–35%), which can have negative effects on the environment if applied excessively to meet crop nutrient requirements. Environmental pollution is caused by nutrient losses from gaseous emissions (NH<sub>3</sub> and N<sub>2</sub>O) or leaching (NO<sub>3</sub>). As a result, stakeholders look for alternate sources of nutrients, with nanofertilizers emerging as potentially revolutionary tools for agriculture. Nano-fertilizers are efficient nutrient carriers with a high surface area to volume ratio, reducing losses through leaching and emissions. This Nano fertilizer has been developed indigenously, for the first time in the world at IFFCO - Nano Biotechnology Research Centre (NBRC) Kalol, Gujarat through a proprietary patented technology. Nano Urea is a source of nitrogen, an essential nutrient for plant growth and development. Nitrogen is essential in amino acids, enzymes, genetic materials, photosynthetic pigments, and energy transfer compounds in plants. Nitrogen content in healthy plants varies from 1.5 to 4%. Nano-urea can promote sustainable agriculture by reducing agrochemical use, minimising pollution, and improving soil health. Nano-fertilizers have the potential to transform agricultural systems by increasing profitability and income for farmers. To achieve sustainable agriculture and reduce environmental impact, adopting energy-efficient fertilisers like nano-fertilizers is crucial. These innovations show potential for reducing environmental impact and meeting global food demands.

**Nano-Urea:** Nano-urea, is an innovative agricultural input based on nanotechnology, offers a particle size of 20 to 50 nm, has smaller particles (20-50 nm) and a larger surface area than traditional urea fertilizer. Nano fertilisers

are designed to meet the nutritional needs of specific crops. The nano form of traditional Agri-inputs enables the site-specific and controlled release of active substances, reducing excess run-off and preventing eutrophication and residual contamination. Nanoparticles improve nutrient usage efficiency and reduce environmental costs by reducing salt build-up in soil, requiring less quantity. These factors will improve crop nutrition and seasoning quality. Promote faster plant growth and development by preventing disease and enhancing plant stability with deeply rooted, anti-bending crops. Because of this, these nutrient formulations can guarantee a controlled and prolonged release of nutrients, making them viable substitutes for conventional fertilisers. But it's important to keep in mind that there might be some significant limitations on the widespread application of nano fertilisers in agriculture. It is necessary to look into the toxicity and biocompatibility of nano fertilisers.

### Three Major Classes of Nano-Fertilizers

- Nano-scale based fertilizer (nanoparticles which contain nutrients),
- Nano-scale based additives (traditional fertilizers with nanoscale additives), and
- Nano-scale based coating (traditional fertilizers coated or loaded with nanoparticles)

### Comparison with Conventional Urea

Comparing nano-urea to conventional urea is essential for assessing its potential as a fertiliser. Understanding the properties and performance differences is crucial given the widespread use of conventional urea in agriculture.

**Higher Efficiency:** Liquid nano urea has a higher efficiency of up to 85% compared to conventional urea, which only achieves 25-30%. Nanotechnology enables the production of small particles with high surface-to-mass ratios, resulting in remarkable performance. This enables accurate and controlled nutrient delivery to crops, unlike traditional urea, which often results in losses due to evaporation or gas emissions.

**Less Environmental Effect:** Liquid nano urea not only proves cost-effective but also presents an environmentally friendly crop nutrition solution. Reduced application compared to conventional urea improves crop nutrient efficiency and reduces soil, water, and air pollution. Conventional urea has a nutrient recovery rate of 30-50%, with the remainder lost due to runoff, leaching, and volatilization, leading to environmental issues. Nano urea liquid addresses concerns by reducing nitrogen losses and increasing nutrient utilization offering a more sustainable and eco-friendly approach to crop nutrition with potential positive implications for environmental conservation.

**Controlled and Targeted Supply Of Nutrient:** Nano-structured fertilisers, with sizes ranging from 1 to 100 nm, have higher reactivity and water solubility due to increased surface area. By reducing the risk of overdosing, these fertilizers contribute to agricultural sustainability, minimizing application frequency and production costs. Spraying liquid nano-urea directly on leaves allows for targeted nutrient absorption through stomata, providing crops with optimal nutrition. Nanoparticles can target specific plant parts and release nutrients in a controlled manner, reducing waste and minimizing environmental impact for efficient and sustainable crop nutrition.

**Economical:** A 500 ml bottle of Nano-urea costs ₹225, which is 10% less than conventional urea, and is equivalent to a 45 kg bag. Farmers can save money by using subsidy-free liquid nano urea instead of subsidised ₹242 bags of urea. IFFCO's extensive trials show that nano-urea can replace up to 50% of urea granules, potentially reducing fertiliser imports. This reduces government subsidies while also lowering costs for transportation, storage, and nitrogen fertiliser usage.

### Improves Plant Nutrition:

- It has been found effective and efficient for plant nutrition which increases the production with improved nutritional quality.
- It will boost a balanced nutrition program by reducing the excess use of urea application in the soil and will make the crops stronger, healthier and protect them from lodging effect.
- Lodging is the bending over of the stems near ground level of grain crops, which makes them very difficult to harvest, and can dramatically reduce yield.

**Improves Environment**

It will also have a huge positive impact on the quality of underground water, a very significant reduction in global warming with an impact on climate change and sustainable development.

**Increase Farmers' Income**

It is easy on the pocket of farmers and will be effective in increasing farmers' income. It will also significantly bring down the most of logistics and warehousing.

**Features of Nano Urea**

- Nano urea contains nanoscale particles of ( $10^{-9}$ ).
- Average physical size of Nano Urea particles is in the range of 10 -50 nm.
- Nano Urea contains 4 % nitrogen by weight in its Nano liquid form.
- Nitrogen present in Nano Urea effectively meets the crop nitrogen requirement for better growth.
- Nano urea has better nitrogen use efficiency than conventional urea.
- Nano Urea is suitable for application of nitrogen requirement for most of the crops.

**Benefits of Nano Urea**

- Reduces the requirement of conventional urea by 50% or more.
- Required less and produces more: Efficacy of one bottle of Nano urea (500 ml) is equivalent to one bag of urea.
- Environment friendly product, can improve soil, air and water quality thus, helps in addressing the concerns of Global Warming and in meeting the UN SDGs.
- Cheaper than conventional urea.
- Reduce input cost to farmers, leads to increase in farmers' income.
- Improves crop productivity, soil health and nutritional quality of produce.
- Nano urea is developed to replace conventional urea and it can curtail the requirement of the same by at least 50 per cent. It contains 40.000 ppm of nitrogen in a 500 ml bottle, which is equivalent to the impact of nitrogen nutrient provided by one bag of conventional urea means 50 kg.
- To test its efficacy, around 11,000 farmer field trials were undertaken on more than 94 crops across India and results showed an average 8 per cent increase in crop yields.
- The new nano urea liquid will increase the production of crops with improved nutritional quality.
- Cheaper than conventional urea, the new product is also expected to reduce the environmental pollution caused by the granular form, by reducing its excessive application that exacerbates soil, water and air pollution with climate change problems.
- The size of one nano urea liquid particle is 30 nm and compared to the conventional granular urea it has about 10,000 times more surface area to volume size.
- Due to the ultra-small size and surface properties, the nano urea liquid gets absorbed by plants more effectively when sprayed on their leave.

**Limitation of Nanofertilizer**

- Nanomaterial phytotoxicity is an issue since different plants respond differently to various nanomaterials in a dose-dependent manner.
- Nanomaterials are very reactive because of their minute size with the enhanced surface area, so this raises safety concerns for farm workers because they may be xenobiotic to the body.
- Some studies have reported the phytotoxic effect of nanoparticles in plants, depending on species, dose and application method and their type.

**CONCLUSION**

Nano-urea is an indigenous fertilizer manufactured by IFFCO, and its promotion can help reduce the financial burden associated with conventional urea imports. Additionally, nano urea helps in reducing the environmental footprint by minimizing nutrient loss through leaching and gaseous emissions, which were causing environmental pollution and climate change. This new form of urea would be advantageous for the agriculture sector, as it enables farmers to achieve comparable yields at a reduced cost of fertilizers Nano urea is an

environmentally sustainable option for farmers, promoting smart agriculture and contributing to climate change mitigation.

**REFERENCES**

Kumar, A., Ram, H., Kumar, S., Kumar, R., Yadav, A., Gairola, A., ... & Sharma, T. (2023). A Comprehensive Review of Nano-Urea vs. Conventional Urea. *International Journal of Plant & Soil Science*, 35(23), 32-40.

Kumar, R., Singh, R. K., Panda, A., & Singh, S. K. (2021). Nano urea: an efficient tool for precision agriculture and sustainability. *Vigyan Varta*, 2(9), 72-74.