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Effect of Nano urea on productivity of different cereal crops: A review

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Abstract
Nano urea supports new integrative venture into farming and feed sciences by gathering skill and construction. It promises meaningful offering to land research, that can bring about new paths for answering many land questions. Nano urea have potential uses in farming plan, namely., less as contaminants, regulated transmittal of fertilizers, minerals can comprise Nano artists information and binding of soil construction. Usually, nitrogen content in an athletic plant ranges from 1.5 to 4%. Foliar request of Nano Urea at detracting crop tumours stages of a plant efficiently fulfils allure nitrogen necessity and increases the adeptness of manure leads to taller crop output and status distinguished to common urea.

Keywords: nano, urea, farming, land, crop, plant, nitrogen, new, content, athletic

Introduction

Modern agriculture is heavily supported by use of high rates of chemical fertilizers, which contribute over 40 % to our agriculture production (Stewart and Roberts, 2012). 25% nitrogen use efficiency because most of the nitrogen in it is vaporized or lost as a gas (Danu *et al*.,2022) [5]. Nitrogen is a crucial component of amino acids, enzymes, genetic information (DNA-RNA), photosynthetic pigments (chlorophyll), and energy transfer components (ATP-ADP) in plants. A healthy crop nutritionally requires about 2-5 % of nitrogen of its dry weight in its foliage tissues to maintain its physiological process (Torres-Olivar *et al*.,2014) [5]. Among the nitrogenous fertilizers, the most used fertilizer used in India is urea. Researchers have concentrated their research on the usage of urea as the principal fertilizer, as the losses of nitrogen due to premature decomposition of urea before its uptake are very high (Kottegada *et al.,* 2017) [7]. Cereals are the staple food for majority of the population hence more cereals per unit area is the demand of today's faster increasing global population. Basic nutrient for most of the crop growth is nitrogen. Urea is the foremost nitrogen based straight fertilizer having 46% of nitrogen in the form of amide with critical relative humidity of 72 and equivalent acidity 80. But it is costly, bulky and overuse of this fertilizer in soil leads to alter the natural composition of soil hence lowering the fertility as well as the productivity of the soil.

Cereals belong to the family Poaceae and crops included in this family are Rice, Wheat, Maize, Sorghum, Barley etc. As they belong to same family physiological activities of these crops are approximately same hence the consequence of application of fertilizers are same. Requirement of nitrogen is high for the cereal crops as they are heavy feeder. The application of conventional fertilizers like urea results in increase the loss of nitrogen nutrient in terms of leaching, volatilization, denitrification etc. But if nano-urea is applied at specific growth stages to this family leads to tremendous increase in growth and yield. Nano-urea is slow releasing, biodegradable nitrogen formulation which enter to the plant by means of stomatal opening of plants so absorption of nutrient without significant loss leads to increase nitrogen use efficiency. Simply efficiency means output per applied input here we apply Nano-urea as the input and the output is in terms of economic yield.

Nano Urea

Liquid (Nano) urea is a nutrient to provide nitrogen to plants as an alternative to conventional urea. It is urea in the form of a nanoparticle. Recently, the Indian Farmers Fertilizer Cooperative Limited (IFFCO) introduced the world's first Nano Urea Liquid for farmers across the world. Founded in 1967 IFFCO was one of the biggest Indian cooperative societies. Nano Urea was developed to replace conventional urea. And it can limit the usage of conventional urea up to 50% as stated by IFFCO. A lot of nitrogen is also either leached down or washed away during irrigation. The efficiency of Liquid Nano Urea can be as high as 85-90 %. Nano Urea is sprayed on the leaves of plants and can be absorbed by plants (Rajan *et al*.,2014) [17]. It will provide a targeted supply of nutrients to crops, as they are absorbed by the stomata and pores found on the epidermis of leaves (Malhotra and Srivastav, 2015) [10]. According to the findings, urea produced from nanohybrids with a 1:6 hydroxyapatite to urea ratio released urea 12 times more slowly than pure urea. Furthermore, the nanohybrid contained almost the same amount of accessible nitrogen as pure urea (Nair *et al.,* 2010) [16]. Nitrogen fertilizer fortified with nano porous zeolite could be used as an alternative strategy to improve the nitrogen use efficiency in crop production systems (Manikandan and Subramanian 2014) [11]. Replacement of traditional fertilizer by nano fertilizer is beneficial as upon application, it releases nutrients into the soil steadily and in a controlled way, thus preventing the water pollution (Naderi and Danesh-Shahraki 2013; Moaveni and Kheiri, 2011) [13, 14]. To improve the nutrient use efficiency, nano-based slow-release or controlled-

release fertilizers have the tremendous potential. Nano fertilizer may regulate the release of nutrients and deliver the correct quantity of nutrients required by the crops in suitable proportion and promote productivity while ensuring environmental safety (De Rosa *et al*. 2010) [6] The use of nano fertilizer not only causes increased use efficiency of the elements but also reduces the toxicity generated due to over-application in the soil as well as reduces the split application of fertilizers (Naderi and Danesh-Shahraki 2013) [15].

Application of Nano Urea

Liquid Nano urea as foliar sprayed on leaves Nano Urea easily enters through stomata and other openings and is assimilated by the plant cells. It is easily distributed through phloem from source to sink inside the plant as per its need. Unutilized nitrogen is stored in the plant vacuole and is slowly released for proper growth and development of plant. These "nano-urea" have high surface area, sorption capacity, and controlled-release kinetics to targeted sites attributing them as smart delivery system. However, being an infant technology, the ethical and safety issues surrounding the use of nanoparticles in plant productivity are limitless and must be carefully evaluated before adapting.

Mode of Action of Nano Urea

1. When liquid formulation of nano urea is sprayed on leaves initially these ultra-small particles of nano urea get absorbed easily and enters through stomata, hydathodes and other openings.It is easily distributed through vascular tissue phloem from source to sink (leaves to assimilatory parts) inside the plant as per need.
2. Translocated nitrogen is metabolically assimilated as proteins, amino acids, nucleic acids etc. as per the plant's requirement.
3. As controlled delivery system of ultra-nano particles facilitates unutilized nitrogen is stored in the plant vacuole and is slowly released during life cycle of plant for its proper growth and development.

Advantages of Nano Urea

- Nano Urea is applied @ 1250 ml ha-1 at initial growth stage and before flowering, when sprayed on leaves initially it gets absorbed easily and enters through stomata and other pores
- It is translocated and metabolically assimilated as proteins, amino acids etc. as per the plant's need. Reduces the amounts of traditional urea needed by half or more. Produces more with fewer resources: One bottle of Nano Urea (500 ml) has the same efficacy as one bag of urea.
- Environmentally friendly product that can improve soil, air, and water quality, so assisting in addressing global warming issues and reaching UN SDGs (United Nations Sustainable Development Goals)
- It's less costly than traditional urea. Farmers' input costs are reduced, resulting in increased income. Increases crop output, soil health and produce nutritional quality.

Table 1: Differences between liquid nano urea and conventional urea

Characteristics	Nano urea	Conventional urea
Year of Invention	2021	1823
Technology	Nano- technology	Conventional method
Particle size	32 nm	1 mm
Use efficiency (%)	85-90	30-40
Price (Rs.)	240/- per bottle (500 ml)	266.50/- per bag (45 kg)
Storage area requirement	Very less area	Very high area
Pollution	No	Air, water and soil
Vaporization	No	Yes
Soil residual	No	Yes
Effect on soil	Enhance quality	Acidifies soil
Availability in plant	Throughout the life cycle	3-4 days
Effect on crop maturity	Maturity on time	Early maturity
Intake medium	Direct through leaves	Through roots
Method of use	Only for foliar spray	Soil application as basal and top dressing and foliar spray

Impact of Nano Urea on Growth and Yield of different Cereal crops.

Foliar spray of Nano Urea at knee stage and tasselling stage could be an ideal technological alternative to achieve sustainability in irrigated maize (SAMUI *et al*.,2021) and significantly increased the plant height, dry matter accumulation, chlorophyll content, nitrogen content, phosphorus content and potassium content in grain and straw of pearl millet (Sharma *et al*.,2022) [22]. Panicle initiation and booting stage recorded a significantly higher number of productive tillers plant of pearl millet with the use of foliar spray of nano urea (Arya *et al*., 2022) [2].

Foliar nitrogen application through Nano-N resulted in notably greater plant heights in Oats (Rajesh *et al*., 2023) [18] and as well in foliar application of chemically synthesized nano N was found optimum for sweet corn. (Rajesh *et al*., 2021) [18].

Liquid nano urea as foliar spray with Bio Organic fertilizer has the more plant height, a greater number of productive tillers, greater yield and higher B:C ratio in rice (Saud *et al*., 2022) [22].

Intercropping groundnut with maize and using Liquid N nano fertilizer as well with N mineral fertilizers recorded the highest values. The pattern of maize and groundnut intercrop fertilized with nano fertilizer N as well as mineral

fertilizer N of the recommended for maize were more economically beneficial to farmer (Karamity *et al*., 2020) [1].

Nano urea applied at tillering and pre-flowering stage was found superior in terms of growth, yield parameters and yield of finger millet (Samanta *et al*.,2022) [19].

Spraying Liquid Nano-Urea recorded significantly highest N,P and K content in grain and straw over control and foliar application of Nano - Urea in pearl millet under clay loam soils at Jaipur (Sharma *et al*., 2022) [22].

The application of N via Nano Urea resulted in highest plant height, number of tillers, leaf area index and dry matter accumulation in Rice (Midde *et al.*,2022) [12].

The experimental trials were conducted in different District of States in India on station through IFFCO proved that with the application of liquid Nano urea, the quantity of conventional urea to meet recommended dose of nitrogen can be reduced to half. The findings of the said study are mentioned in the following table.

Table 2: Effect of foliar application of nano urea–liquid (nano N) on different crops in "on-station' trials across India

S.No.	Location/State	Crop	Season	Yield in RDF plot (t ha)	Yield in 50% N - 1 + and nano N and nano N (t ha)$^{-1}$
1.	Telangana	Maize	Kharif/Summer 2019-20	6.63	6.75
2.	Raichur, Karnataka	Maize	Kharif/Summer 2019-20	5.08	5.83
3.	Raichur, Karnataka	Maize	Kharif 2020-21	4.74	4.94
4.	Bengaluru, Karnataka	Maize	Kharif 2020-21	8.31	9.14
5.	Shimoga, Karnataka	Paddy	Kharif/Summer 2019-20 & 2020-21	2.78	3.16
6.	Jorhat, Assam	Rice	Kharif 2020-21	4.26	5.30
7.	Bengaluru, Karnataka	Rice	Kharif 2020-21	5.26	5.42
8.	Anand, Gujarat	Wheat	Rabi 2019-20 & 2020-21	4.70	4.82
9.	Ranchi, Jharkhand	Wheat	Rabi 2019-20	3.43	4.22
10.	Udaipur, Rajasthan	Wheat	Rabi 2019-20	4.42	5.31
11.	Jaipur, Rajasthan	Wheat	Rabi 2019-20	4.82	5.55
12.	Ayodhya, Uttar Pradesh	Wheat	Rabi 2019-20	3.20	3.94
13.	Lucknow, Uttar Pradesh	Barely	Rabi 2019-20	4.80	5.19

Conclusion

Science and scientific endeavours are a continuous process and significant efforts go in the process from concept to translation stage. Nano fertilizers are novel in the way that they provide immense opportunity in terms of addressing the challenges being faced by intensive agriculture practices currently underway which are ultimately harming the soil, air and water in the long run. It is therefore prudent that nano fertilizers like nano urea are holistically viewed in perspective of declining nutrient use efficiency (NUE) of chemical fertilizers and alternative solutions that need to be made available to farmers.

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