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NK Suthar
 Department of Agronomy,
 CPCA, SDAU,
 Sardarkrushinagar, Gujarat,
 India

CK Desai
 Assistant Research Scientist,
 Dry Farming Research
 Station, SDAU, Radhanpur,
 Gujarat, India

JS Desai
 Department of Agronomy,
 CPCA, SDAU,
 Sardarkrushinagar, Gujarat,
 India

Nano urea: A review paper

NK Suthar, CK Desai and JS Desai

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Abstract

Among mineral nutrients, nitrogen is the first and foremost nutrient required for plants as it is a vital role in structural constituent of many proteins, enzymes, chlorophyll, Rubisco, nucleic acids and some hormones as well as plays a significant role during the vegetative growth of crops thus N fertilization is an essential agronomic management practices to enhance the crop productivity. Nano urea is a unique source of nitrogen containing 4 per cent nitrogen in only 500 ml of bottle having particle size 30-50 nm. It has emerged as a novel fertilizer for targeted and precise application of nitrogen. Nano urea is a source of nitrogen (containing 4% N), a major essential nutrient required for better growth and development of crops. IFFCO nano urea liquid which having shelf life around 2 years, based on nanotechnology, effectively fulfils crop nitrogen requirement when sprayed at critical crop growth stages.

Keywords: Nano urea, nitrogen, foliar spray, nutrient

Introduction

Nitrogen is deficient in most of the Indian soils particularly in the light textured ones, which is one of the basic plant nutrients. Nitrogen is involved in the formation of proteins, nucleic acids, growth hormones, vitamins and also an integral part of chlorophyll. An adequate supply of nitrogen is associated with vigorous vegetative growth and dark green colour. Urea is widely used nitrogenous fertilizer in the country because of its high N content (46% N) as well as cheapest source of N but main drawback of urea is burden on government in the form of giving subsidy (nearly ₹ 3,700 per bag) and also having another drawback like volatilization. Excess use of urea resulted more susceptibility of plant to disease and insect infestation and delayed maturity of the crop which indirectly reduce production too. With an increasing population and race for more production per unit area we are losing the sustainability and fertility of the soil. Due to the huge application of fertilizer since a long period of time, the motherly earth is now full of stresses and lost its ability to produce per unit input. The world with a huge increasing population and continuously degradation of land by various way, facing a huge hazard in the field of agriculture. The new technology is required to increase the efficiency of input for the huge population. Now keep mind to apply input preciously to reduce the stress in environment by increasing the efficiency of the inputs with various new technologies and research. Indian Farmers Fertilizer Cooperative Organization (IFFCO) always works for the farmers since 1967. IFFCO contributes about 21.3% to the total N and 32.1% to the total P₂O₅ produced in the country.

Nano is word come from the Greek language having meaning dwarf. It is a billionth of the metre (10⁻⁹ m). It has smaller size and higher surface to volume ratio having particle size ranging between 1 to 100 nm. Nano fertilizer are growing in agriculture because of it boost up the crop yield, increase nutrient use efficiency and also reduce the use of chemical fertilizer usage that directly or indirectly sustain our environment via acceptable, viable and equitable.

This technology has enabled to build the “smart fertilizer”, which is able to enhance the efficiency of nutrients use and reduce the cost of environment protection. The use of nano-fertilizers causes an increase in plant nutritional efficiency, reduces their toxicity to soil organisms, as well as reduces the effects of potential stress due to over application of fertilization and reduces amounts of fertilizers used. Post effect of nano fertilizer application in soil showed better pH, moisture, EC and available nitrogen under nano fertilizer treatment than the conventional fertilizer.

Corresponding Author:
NK Suthar
 Department of Agronomy,
 CPCA, SDAU,
 Sardarkrushinagar, Gujarat,
 India

Urea molecules are converted into NO_x and this compound emitted into atmosphere, around 1 kg of NO_x equivalent to 298 kg of CO₂. Urea granules fertilizer efficiency is only 30-50% and storage life is only 6-8 months. On the other hand, nano urea fertilizer eliminates the NO_x by this way it reduce environment pollution. Liquid fertilizer (Nano urea), storage lifespan is 2 year and having efficiency of 80%. Nano urea is a potential component of 4 R (Right source, Right rate, Right time and Right place).

IFFCO has established Nano Biotechnology Research Centre (NBRC) at Kalol, Gandhinagar, Gujarat on 3rd November, 2019 and subsequently prepared Nano-Urea liquid for the farmers, having production capacity of 1.5 lakh bottle per day. After 11,000 of vigorous trials with ICAR, State Agricultural Universities and KVK's IFFCO nano-urea liquid showed its efficiency and got included in FCO list. India's largest fertilizer co-operative IFFCO has begun the mass production of nano urea invented by 33 year old Indian scientist Ramesh Raliya.

Nano urea is a source of nitrogen (containing 4% N), a major essential nutrient required for better growth and development of crops. IFFCO nano urea liquid which having shelf life around 2 years, based on nanotechnology, effectively fulfils crop nitrogen requirement when sprayed at critical crop growth stages. It is used in place of conventional urea and other nitrogenous fertilizers for better environment, soil health and farmers profitability. (IFFCO, Kalol)

Nano Urea is a long-term solution for farmers who want Smart agriculture with climate change: -

- Suitable particle size of 20-50 nm
- Higher surface area (10,000 times that of a 1 mm urea prill)
- Number of particles (55,000 nitrogen particles over 1 mm urea prill)

As a result, Nano urea boosts crop availability by more than 80%, resulting in increased nutrient-use efficiency.

The science behind Nano Urea

In the Nano Urea (Liquid), 4 per cent nanoscale nitrogen particles are present. Nanoscale nitrogen particles are smaller (30-50 nm) and have greater surface area and particles per unit area than traditional urea. Because nano urea solutions can easily penetrate the plant's cell wall, they result in more effective nitrogen absorption, higher physiological growth and grain production when sprayed via foliar (Kumar *et al.*, 2021)^[5].

Application instruction

1. Shake well the bottle before the use.

2. Use flat fan or cut nozzles for spraying on the leaves.
3. Spray during morning or evening hours avoiding dew.
4. If rain occurs within 12 hours of the spray of nano urea, it is advised to repeat the spray.
5. Nano urea can easily be mixed with bio-stimulants, 100% water-soluble fertilizers and agrochemicals. It is always advised to go for a jar best before mixing and spraying for compatibility.
6. For better result nano urea should be used within 2 years from the date of its manufacturing.

Precaution

- Nano urea is safe for user, safe for flora and fauna and is non-toxic, however, it is recommended to use a face mask and gloves while spraying on the crop.
- Store in a dry place avoiding high temperature and keep away from the reach of children and pets.

Mode of application possible for nano urea

1. Through drone
2. Through knapsack sprayer

Advantages

1. It's Cheaper than conventional urea.
2. Increased crop yields; because, Nano Urea particles are easily available to crops due to their small size and high surface area to volume ratio.
3. Increased photosynthesis in leaves, as well as an increase in root biomass and the number of effective tillers per branches which resulted in higher crop yields (according to field trial average 8% increase)
4. Nano Urea increases farmer's revenue by lowering input costs, increasing crop yields and improving crop quality.
5. It is environment friendly; because its production is energy and resource friendly and it reduces the amount of bulk urea used as well as the associated volatilization, leaching and run-off losses.
6. Crops grown using nano urea are completely safe to eat. In terms of protein and nutrient content, the nutritional quality of harvested produce is superior.
7. Reduction in chemical fertilizer usage.
8. One bottle of IFFCO nano urea (500 ml) has the ability to replace at least one bag of traditional urea due to its increased use efficiency.
9. It is easy to store and transport. Farmers can easily carry bottles of Nano Urea over bulkier Urea bags, which have a substantial influence on warehousing costs.

Review of literature

Table 1: Effect nano urea on growth, yield attributes and yield

Sr.	Result	Reported By
1.	Plant height, fresh weight and dry weight of sage plant was significantly increase with application of nano urea + biofertilizer	Hegab <i>et al.</i> (2018) ^[4]
2.	With application of FFP (50% N) + 1 spray of nano urea + 1 spray of nano-Zn + 1 spray of nano-Cu @ 4 ml/L recorded higher yield, response over FFP and per cent increase over FFP in wheat and check pea	Kumar <i>et al.</i> (2020) ^[6]
3.	Application of nano urea can reduce the chemical load of convection urea (at least by 50%) with increasing average yield (11.8%)	Anonymous (2021) ^[1]
4.	With application of FFP (50% N) + 2 spray of nano urea @ 4 ml/L recorded higher yield and per cent increase over FFP in various crops like wheat, mustard, potato	Anonymous (2021) ^[1]
5.	Grain per earhead, biomass and yield were found significantly higher with application of 75% RDN + 2 spray of nano urea at tillering and jointing stage in wheat	Anonymous (2021) ^[1]
6.	Plant height, leaf area, girth of stem, weight of 100 kernel, weight of cob and yield of maize crop were found significantly higher with application of 50% N, 100% PK + 2 sprays of nano urea (4 ml/L) mixed with Sagarika (2 ml/L)	Kumar <i>et al.</i> (2021) ^[5]

7.	Application of N ₆₆ PK + nano urea 0.4% gave significantly the highest plant height, shoot length and shoot weight of rice	Velmurugan <i>et al.</i> (2021) ^[14]
8.	50% RDN as basal + 0.5% Nano-urea FS @ P.I and booting stage in pearl millet crop gave significantly higher productive tillers per plant, earhead length, earhead girth, no. of grain per earhead, test weight, grain yield and stover yield	Arya <i>et al.</i> (2022) ^[2]
9.	Plant height, no. of tillers per plant, LAI, no. of panicles per square metre, grain yield and straw yield were found significantly the highest with application of 50% RDN through urea + 50% N through nano urea in rice	Midde <i>et al.</i> (2022) ^[8]
10.	Application of 75% of RDN + 2 foliar sprays of nano urea after transplanting and at panicle initiation stage gave significantly higher no. of panicles per square metre, total no. of grain per panicle, grain yield and straw yield of rice. Nutrient uptake (NPK) was also found significantly with above including treatment	Sahu <i>et al.</i> (2022) ^[10]
11.	With application of 100% RDN + FSNU @ 4 ml/L at knee height and tasseling stage gave significantly higher plant height, dry matter accumulation, length of cob, cob per plant, grain yield, stover yield and biological yield of maize	Samui <i>et al.</i> (2022) ^[11]
12.	2 sprays of nano urea at 4 ml/L at 30 and 45 DAS of pearl millet gave significantly the highest plant height and dry matter accumulation	Sharma <i>et al.</i> (2022) ^[12]
13.	Significantly higher number of siliquae per plant, seed and stover yield were registered with application of 100% RDN through NCU (50% basal dose + 50% at 35 DAS) and it was at par with 100% basal RDN through NCU + 4 ml/litre two spray of nano urea at 30 and 45 DAS.	Damor (2023) ^[3]
14.	Significantly the higher plant height was recorded at 60 DAS and at harvest with application of 100% basal RDN through NCU + 4 ml/litre two spray of nano urea at 25 and 45 DAS. Significantly higher number of effective tillers, grain and straw yield were recorded with the application of 100% RDN through NCU (50% as basal dose + 50% at CRI stage) which was remained at par with 100% basal RDN through NCU + 4 ml/litre two spray of nano urea at 25 and 45 DAS in wheat.	Suthar (2023) ^[13]

Table 2: Effect of nano urea on quality of crop

Sr.	Result	Reported By
1.	Significantly higher oil yield of <i>Borago officinalis</i> L and Significantly the highest Chlorophyll content and NPK content of pearl millet were found with the nano urea application	Mahmoodi <i>et al.</i> (2018) ^[7] and Sharma <i>et al.</i> (2022) ^[12]

Table 3: Effect of nano urea on soil health

Sr.	Observation	Reported By
1.	Nitrogen (ammonical and NH ₄ + N + NO ₃) release pattern of nano urea is superior over convectional urea in both submerge as well as upland condition	Priyantha <i>et al.</i> (2016) ^[9]
2.	Application of nano urea along with biofertilizer gave significantly the highest available NPK content in soil, total microbial populations, <i>Azotobacter</i> and enzymatic activities	Hegab <i>et al.</i> (2018) ^[4]

Table 4: Effect of nano urea on economics

Sr.	Result	Reported By
1.	Farmer Fertilizer practices (50% N) + 1 spray of nano urea + 1 spray of nano-Zn + 1 spray of nano-Cu @ 4 ml/L application in various crops gave higher economics in the term of net return over other treatment	Kumar <i>et al.</i> (2020) ^[6]
2.	In wheat, mustard and potato application of Farmer Fertilizer Practices (50% N) + 2 Nano urea spray @ 4 ml/L gave higher net return over farmer fertilizer application	Anonymous (2021) ^[1]
3.	B:C ratio was found higher in maize by application of 50% N, 100% PK + 2 sprays of nano urea (4 ml/l) mixed with Sagarika (2 ml/l)	Kumar <i>et al.</i> (2021) ^[5]
4.	Maximum net realization and BCR was secured with application of 100% RDN through NCU (50% basal dose + 50% at 35 DAS) followed by 100% basal RDN through NCU + 4 ml/litre two spray of nano urea at 30 and 45 DAS.	Damor (2023) ^[3]
5.	Maximum net realization and benefit cost ratio of wheat were recorded under 100% RDN through NCU (50% as basal dose + 50% at CRI stage) followed by 100% basal RDN through NCU + 4 ml/litre two spray of nano urea at 25 and 45 DAS.	Suthar (2023) ^[13]

Conclusion

From the foregoing discussion it can be concluded that nano urea had positive effect on crop growth and yield, It may become one of the best option of urea by which we can reduce the subsidy burden on the government as well as soil pollution.

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