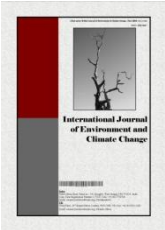

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Nano Fertilizer on Sustainable Agriculture- A Review

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

With an increment of population day by day the agriculture sector is facing a big issue with the production and the economics of production as well. In this scenario adoption of more efficient tools which could mitigate the drawbacks and led the agriculture in a sustainable way is the need of the hour. The application of nanotechnology in agriculture and forestry will help the environment to retain its biodiversity [1]. Nano fertilizers are synthesized or modified form of traditional fertilizers, fertilizers bulk materials or extracted from different vegetative or reproductive parts of the plant by different chemical, physical, mechanical or biological methods with the help of nanotechnology used to improve soil fertility, productivity and quality of agricultural produces [2].
In this particular scenario adoption of labour saving and well advanced technologies is badly needed. This could be mitigated by a eco-friendly technology of Nano-science [3]. Nano fertilizers can control nutrient release and give the proper amount of nutrients to crops in the right proportions, boosting yield while maintaining environmental safety [4]. A report by Dwairi [5] proposed that urea-impregnated zeolite may be utilised as a slow-release fertiliser, releasing nitrogen slowly and steadily from Nano zeolite. Zinc is one of the commonly deficient micronutrient in soil [6]. Chlorophyll formation, fertilisation, pollen function, and auxin synthesis all need zinc-containing nanomaterials. Zn is one of the elements that defend plants from drought conditions. [7]. A research by Raliya and Tarafdar in 2013 [8] showed that zinc oxide, Nano Particles were shown to improve chlorophyll content, protein synthesis, rhizospheric microbial activity, acid phosphatase, alkaline phosphatase, and phytase activity in a cluster bean rhizosphere. Copper has

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characteristics of first transported to shoot and then re translocated into root [9]. An experiment on moong bean (*Vigna radiata*) and wheat revealed that nano copper could penetrate cell membrane and conglomerate thereafter. Moong bean was found to be more sensitive regarding the toxicity of nano copper than wheat [10], (Rico et al. 2011)

Keywords: Nanofertilizer; nutrient; production; technology.

ABBREVIATIONS

IFFCO: Indian Farmers Fertilizer Cooperative Limited
FCO : Fertilizer Control Order

1. INTRODUCTION

In today's world, agriculture is facing a bunch of problems. In one hand the population is increasing with a demand of huge supply of foods; on the other hand, input use efficiency is decreasing, food and land quality is degrading with a subsequent environmental misbalance. In this scenario adoption of more efficient tools which could mitigate the drawbacks and led the agriculture in a sustainable way is the need of the hour. Nanotechnology is nothing but the study of science, engineering, and technology at the Nano scale, which is measured in manometers. Many people believe that current technologies will meet the world's expanding food demand while also providing a slew of environmental, health, and economic benefits [11]. Nanofertilizers are one of the highly engineered input discovered and proved to be sound in the field of agriculture [12]. In the meantime, nanotechnology has established itself as an integrative technology and a pioneer in solving challenges and filling gaps in agricultural sciences and related businesses. Nanotechnology has numerous applications in agricultural product production, processing, storage, packaging, and transportation. The application of nanotechnology in agriculture and forestry will help the environment to retain its biodiversity [1]. IFFCO has introduced Nano-Urea in India which has been approved and listed in FCO. After a thorough research they have also concluded its benefits over the conventional processes. Nano-fertilizers, pesticides, and herbicides may be helpful instruments in agriculture to solve these difficulties in crop production. As Nano-materials have a greater penetration capacity, they can help with nutrition control. Capacity, surface area, and usage efficiency are all factors that help to keep leftovers out of the environment. As a result, these agriculturally useful nanoparticles developed using nanotechnology may be used across the value chain of the whole agriculture production system. Nanotechnology is also reducing the application and transportation cost due to small size and more efficiency. Thus, it is reducing the cost of cultivation as a whole. This article examines the effects of Nano fertilizers (Nano N, Nano Zn, and Nano Cu) as well boosting nutrient usage efficiency, crop production, and produce quality based on the research done by the various researchers around the globe.

2. ADVANTAGES OF NANO OVER CONVENTIONAL FERTILIZER

Nano fertilizers are synthesized or modified form of traditional fertilizers, fertilizers bulk materials or extracted from different vegetative or reproductive parts of the plant by different chemical, physical, mechanical or biological methods with the help of nanotechnology used to improve soil fertility, productivity and quality of agricultural produces [2]. Due to more availability of nano nutrient to the plant it prevent from disease, nutrient deficiency and other biotic and abiotic stress which indicates that Nano fertilizers enhance overall health of the plant. Fig. 1 shows that the different positive wings of advantages of nano fertilizer.

3. EFFECTS OF DIFFERENT TYPES OF NANO-FERTILIZER

In a future world with less resource and increased population agriculture is the most important way out the feed all the stomach [14]. In this particular scenario adoption of labour saving and well advanced technologies is badly needed. This could be mitigated by an eco-friendly technology of Nano-science [3]. Nano fertilizers can control nutrient release and give the proper amount of nutrients to crops in the right proportions, boosting yield while maintaining environmental safety [4].

In general the use efficiency of the major nutrient is substantially low. A report suggests 40–70 % Nitrogen, 80–90 % of Phosphorus, and 50–90 %

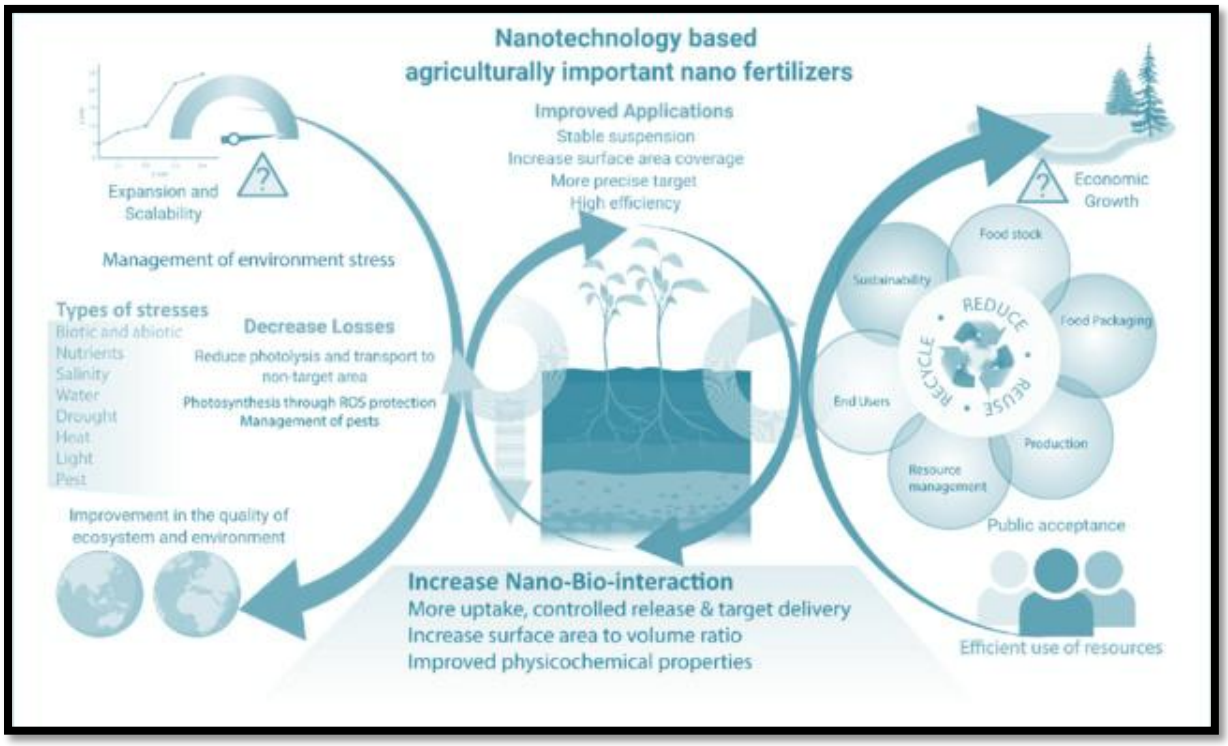

Fig. 1. Wings of Nano Fertilizers advantages
(Origin: Mittal et al, 2020) [13]

of Potassium of applied fertilizers is lost in the environment and responsible for significant economic losses (Saigusa 2000, Solanki , 2015) [15]. NUE increased up to 45 % was reported by Nano fertilizer the control Rahale [16].

The increased surface area of Nano-fertilizers due to the smaller particle size provides more sites to support different metabolic reactions in the plant system, resulting in the production of more photosynthets. Reactivity of the Nano fertilizer is too high due to small size and high surface area and for the same reason it could easily penetrates in the plant system and get into action quickly. The sizes of the Nano particles are lesser than the pore size of plant and roots. Thus it can easily enter within the plant systems. Fertilizers encapsulated in nanoparticles should increase nutrient availability and absorption by crop plants Surface particle energy is a function of the size of the particles. As their size is decreasing in the surface: volume ration is increasing rapidly and a rapid penetration in the plant system is taking place [17]. Particle size less than100 nm may be used as fertilizer for efficient and eco-friendly nutrient management to reduce environment pollution. Secretion of root exudates in nutrient stress condition could be good indication for applying Nano-nutrients [18].

A report by Dwairi [5] proposed that urea-impregnated zeolite may be utilised as a slow-release fertiliser, releasing nitrogen slowly and steadily from Nano zeolite.

The beneficial impact of zinc oxide nanoparticles on tomato plants suggests that they might be used as a future Nano fertilizer. Plants have been shown to be unaffected by NPs at small quantities, but they are capable of triggering particular cellular and morphological responses. For example, TiO_2 nanoparticles (0.25–4%) can boost photosynthesis and nutrient absorption in spinach, allowing the plants to develop more quickly [19], (Klaine et al. 2008).

Zinc is one of the commonly deficient micronutrient in soil [6]. Chlorophyll formation, fertilisation, pollen function, and auxin synthesis all need zinc-containing nanomaterials. Zn is one of the elements that defend plants from drought conditions [7]. ZnO NPs were shown to improve chlorophyll content and protein synthesis, rhizospheric microbial activity, acid phosphatase, alkaline phosphatase, and phytase activity in a

cluster bean rhizosphere by Raliya and Tarafdar (2013).

Cu has characteristics of first transported to shoot and then re translocated into root [9]. An experiment on moong bean (*Vigna radiata*) and wheat revealed that Copper nano particle penetrates the cell more easily and get accumulated [10] (Rico et al., 2011).

4. CONCLUSION

In a very critical situation globally we will be facing food scarcity to feed out upcoming emerging populations. Proper efficient technology is thus is the utmost important thing in the context of agriculture. Nano technology has popped out of the brilliant research of the scientists' as an innovative way to serve the agriculture of our country in terms of fertilizer use efficiency and production in a eco-friendly way. Several research at several points throughout the globe suggestion a positive vive for a sustainable performance of Nano Fertilizer in the upcoming days. Though further research is also needed for a strong comment. Nano Nitrogen has proved its role on its field. Though, substantial trial and research till needed for Nano copper and Nano zinc. With the all observation we must say the agriculture will be illuminated by the bright rays of Nano Fertilizer efficiencies in the days to come.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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