Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 03, Issue: 01 (JAN-FEB, 2023)
Available online at http://www.agriarticles.com
©Agri Articles, ISSN: 2582-9882

Nanomaterials as New Generation Fertilizer for Crops

(*Priyancka Arora)
Department of Biotechnology, Faculty of Engineering and Technology, Rama University, G.T., Road, Kanpur 209217, Uttar Pradesh, India
*Corresponding Author's email: priyanckaa@hotmail.com

Nanomaterials (NMs) are a wide variety of materials from 1 to 100 nanometers of particulate matter composed of carbon, metal, metal oxides or organic matter. Tiwari et al., 2012 noted that nanomaterials can be 0D, 1D, 2D or 3D depending on their overall form. Nanomaterials (NMs) exhibit unique physical and chemical properties such as surface area, pore depth, morphology of particles, and reactivity. In fact, copper, zinc, titanium, gold, magnesium, alginate and silver form dissimilar metallic nanomaterials. "Magic bullets" is an alternative name to NMs because of their challenging agricultural uses. A 20 nm gold (Au), platinum (Pt), silver (Ag) and palladium (Pd) NMs showed characteristic colors and characteristics with variation in size and shape that can be used in applications of bioimaging. NMs activity is plainly highly influenced by chemical and physical characteristics of the surrounding environment. Comprehension of the NMs resulting in soil is incredibly difficult considering the broad continuum of potential interactions and the rigorous necessity of effective particle sensing systems for environmental matrices. Most definitely, the initial properties of NMs leave to be transformed by contacts with soil components both biotic and abiotic, and those modifications later affect NMs stability, aggregation, instrumentality, and biota availability. Tolaymat et al. (2010), observed that e.g. Ag NM became more mobile in what the authors defined as "poor polar soils," and greatly impacted the long-term transport capacity of the NMs.

Applications of NMs: The growth of genetically modified crops (GMCs), iNMut animal processing, biocides and precision farming systems has possibly been encouraged by advanced research and development of nanomaterials in agricultural use. Improvements in the development of superior plants associated with a variety of economical applications via nanotechnology. ENs applications both inspire plant germination earlier and enhance plant production.

Positive effect of NMs on crops: Crop germination, growth and increase crops productivity due to the positive effects of nanomaterial exposure. Nanomaterials can alter plant chlorophyll and carotene, increase plant protein levels, improve plant photosynthesis rates, encourage growth, increase soil fertility and decrease plant toxicity and availability of heavy metals. The effects of NM vary according to plant species and type of NM. Positive impacts of NM exposure to metal / metal oxide on crop growth and/or pathogen inhibition are shown. Antimicrobial activity involves probably destroying crop diseases in particles such as Ag, ZnO, Mg, Si, and TiO2. Silver NMs show microorganisms strongly inhibitory activity.

Nanomaterials used in Germination of Seeds, Growth of Crops and Quality Enrichment: Germination of seeds is a sensitive form in the plant's life cycle which helps seeds to develop, survive, and dynamic population. But seed growth is largely influenced by various parameters including environmental conditions, inheritable feature, availability of moisture and soil fertility. A large number of studies have revealed that nanomaterial application has positive effects on plant growth as well as production. Seed germination of various crop species, including tomato, corn, soybean, barley, wheat , rice, peanut and garlic, is positively influences by multi-walled carbon nanotubes (MWCNTs). Disfani et al., 2017 also derive nanomaterials from Fe / SiO2 that have substantial potential to enhance the germination of seeds in barley and corn. Nanomaterials have the capacity to penetrate the seed coat and increase the ability to absorb and use water, as revealed in few studies, stimulating the enzymatic system and eventually enhancing the growth and development of seedlings.

Increase crop growth and positive effects on plant development due to nanomaterials such as TiO2, MWCNTs, FeO, ZnO, ZnFeCu-oxide, and hydroxyl completeness in several crop species including soybean, wheat, peanut, mungbean, onion, potato, tomato, spinach, and mustard. Gao et al. (2011) fullerenes also originated from the fact that seed coverings containing Fullerol not only increase the number of fruits, size and final yield by up to 128%. The exact mechanism behind the promotion of plant growth and enriched quality is still not clear, but the potential of nanomaterials to absorb more nutrients and water can be explained at least in part, which in turn helps to increase the strength of root systems with increased enzymatic activity. El-Feky et al. (2013) noted that nanomaterial utility has a performance in plant growth. Increased spinach growth was also studied upon exposure to NM TiO2; the authors conjectured that under nitrogen deficiencies in sunlight, nano-TiO2 directly decreased atmospheric nitrogen to ammonia, thus supporting the growth of plants.

Tarafdar et al. did biosynthesize NM Zn. They exposed ZnO salt solution to a *Rhizoctonia bataticola* filtrate, which had been a cell-free filtrate. Then, the effect of revised of foliar bulk and NM Zn on pearl millet grown in soil (*Pennisetum americanum*) was compared. Expressively, the root area, shoot length, dry biomass, chlorophyll content, grain yield, and soluble leaf protein have increased steadily with the use of NM Zn. A number of primary enzymes and their activities were also found to increase and strengthen, including phytase, alkaline phosphatase, acid phosphatase, and dehydrogenase.

NM Interactions with Plants: Application of various techniques such as microscopy and spectroscopy to detect and imagine NMs in biological samples that were published for review, which shows developments in the field of studying ENM loads and biota deliveries. The NM load can be transferred to better levels of the food chain and also consumed by humans when adsorbed via consumption plants or internalized to them. Translocation to roots may occur in combination with the photosynthesis products via phloem transport. In roots, NMs can also be internalized in soil or hydroponic media with water and nutrients, with the growth medium, pH, cation interchange capacity, root exudate, and mycorrhizal fungi being extremely moderated by outward factors. The Casparian strip, which requires cellular plasmodesmata to carry symplastic transport to reach the xylem and phloem, may be limited to take-up, translocation to leaves. NM uptake is highly dependent for root and foliar exposures on plant species and transpiration rate and NM size, chemical configuration, surface functionality, ages and constancy.

Nonfertilizer: Nonfertilizer are nutrient carriers of nano-dimensions ranging from 30 to 40 nm, capable with transporting nutrient-rich ions because of their high surface area and of gradually and steadily discharging in proportion to demand of crop noted by Subramanian et al., 2015. Micronutrient fertilizers are often released quickly, which can cause major nutrient losses, thereby reducing their effectiveness and increasing the crop production cost. GO sheets use as modern carriers for filling plant micronutrients with large potential and their use for constant and gradual release of advanced fertilizers. Here we investigated the behavior of these new graphene-based micronutrient fertilizers by assessing their loading capability and solvent release and soil and plant quality.

Importance of nano-fertilizers in plant nutrition:

- High solubility and stability
- High efficiency
- Unblocked release time
- Improved targeted work with effective concentration
- A lesser amount of eco-toxicity
- Safe, easy mode of transfer and removal

They increase nutrient use efficiency (NUE), ion passage in soil-plant system and act as exciting agents for plant growth and activate metabolic procedures in plants. Compared with conventional fertilizers, nano-fertilizers increase the nutrient production and improve plant nutrition. Any product that is made with nanoparticles or uses nanotechnology to improve nutrient efficacy called as nonfertilizer.

Nonfertilizer have been classified in three parts:

A) Fertilizer nanoscale (nanoparticles containing nutrient)

B) Nanoscale additives (traditional fertilizers with additives made from nanoscale)

C) Nanoscale coating (traditional nanoparticular coated or activated fertilizers)

Importance of Micronutrient Nonfertilizer: Zinc, iron, manganese, and copper have been yield-limiting factors and are partly responsible for nutritionally poor. These are added to the N, P, and K fertilizers at low concentrations as soluble salts for crop uptake. Micronutrients commonly provide enough nutrients in these composite fertilizers and cause slight environmental risks. Plant availability of the applied micronutrients, however, can transform low. When fertilizer micronutrients are applied to the soil, the analytical elements react quickly to shape chemical precipitates, or interact with clay colloids and soil organo-mineral matrix, rendering them inaccessible during crop growth for coordinated plant uptake. The cultivation efficiency of fertilizer-micronutrient (MUE) is therefore small, < 5 percent. Because of leaching in high rainfall areas, they get significantly lost. Nanomaterials containing micronutrients could potentially enhance plant growth by supplying the nutrients. Nonfertilizer are used as 'smart distribution devices' to boost the formulation of fertilizers by reducing nutrient release and hyperbolic absorption into plant cells.

Uptake, translocation and fate of nonfertilizer in plants: Nano-fertilizers absorption in plants is a rising area of interest in research. The uptake, translocation, and accumulation depend on the plant species, age, growth environment, and physicochemical properties, functionalization, stability, and nanomaterial delivery mode depends on the uptake, translocation, and accumulation. Nanomaterial entry due to the cell wall depends on the diameter of the cell wall's pore (5–20 nm). Navarro et al., 2008 described that nanomaterial or nanomaterial mixtures with a diameter below the pore size of the plant cell wall can effectively penetrate the plasma membrane via the cell wall. Nair et al., several experiments have addressed with the incorporation of nanomaterial into plant cells through binding aquaporin, ion channels, or endocytosis to carrier protein. Nanomaterials can also be transported into the plant by forming complexes with membrane transporters or root exudates.