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Nano-fertilizers

Effective supply of Nutrients

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Introduction:

In this present era, nanotechnology has wider applications in the field of plant science and agriculture. Recent advances in nanotechnology have paved many ways for massive production of nano-particles of relevant metals, for development of improved fertilizer formulations leading towards enhanced uptake in plant cells and by reducing nutrient loss. Nanotechnology is a modern approach towards the increase of agricultural production with improved quality, financial stability, eco friendly technology and biological support.

Eco-friendly technology has acquired its relevance in advanced agricultural applications as a substitute to conventional fertilizers and pesticides. Nanotechnology has many advantages over traditional agriculture. Therefore, advanced research is highly required for development of nanoparticles in agriculture. Generally, the size of nano-particles ranges from 1 to 100 nm. The different physicochemical properties of these Nano-Particles have made them suitable for the development of different nanofertilizers and nano-pesticides thereby elevating the metabolic activity of biofactors (Reda et al., 2021).

Nano-fertilizers are relevant for the reduction of the application of inorganic fertilizers thereby reducing their adverse effects to the environment. Nano-fertilizers deliver most nutrients in a nano form, thereby leading towards enhanced growth of plants and their production (Dimkpa and Bindraban, 2016). On the basis of nutrient availability of plants, nano-fertilizers can be categorized into 3 types viz. nano-particulate fertilizers, macro nano-fertilizers and micro nano-fertilizers (Chhipa and Joshi, 2016).

Nano-fertilizers, being highly reactive, enhance the nutrient use efficiency by penetrating the epidermis thereby allowing gradual release and targeted distribution. The significant properties of nano-fertilizers can be summarized to be through providing required nutrients for increasing

growth of plants by soil and foliar applications. Besides, nano-fertilizers are inexpensive and sustainable sources for plant nutrition. They are reported to have improved efficiency of fertilization. They are eco-friendly in nature. Besides, nano-fertilizers are efficient sources for eradication of water pollution and hence can be recommended as important future plant nutrient alternatives.

Nano-Fertilizers and their Enhanced Potential

Nano fertilizers regulate nutrient availability in crops by covering required nutrients with nanoparticles thereby promoting slow or controlled delivery of the nutrients to plants. This mechanism of slow delivery can be an additional advantage for farmers as they can enhance the crop yield through the prolonged nutrient delivery to plants. Application of nano fertilizers involves reduction of total costs of input through minimizing the overall transportation and application costs (Fan *et al*., 2014). Another additional advantage of nano-fertilizers is their mechanism of synthesis being dependent upon the nutrient requirement of the concerned crop (Kah *et al*., 2018).

Nano Fertilizers Over Traditional Fertilizers

Nano-fertilizers have additional advantages over conventional fertilizers because of their more economical, non-toxic and eco-friendly nature. They are more efficient in improving the crops both qualitatively as well as quantitatively in comparison to the traditional fertilizers. Besides, they are also reported to improve the nutrient use efficiency (NUE) as well as minimize environmental protection cost (Naderi et al., 2012). They also promote development of abiotic and biotic stress resistance, lodging tolerance, improved plant stability as well as better rooting systems among the crops (Tarafdar et al., 2012). Nanofertilizers provide optimal nutrition to the crops.

Nano Fertilizers and their Application

NUE is facilitated through nano-fertilization:

Reduced particle size promotes higher penetration of nano-particles from the surface of application to the plants. This is basically due to the reduced particle size and number of particles per unit area. (Liscano *et al*., 2000).

Improved growth parameters through nano-fertilization:

Nano-fertilization promotes improved growth parameters including rate of formation of chlorophyll, rate of photosynthesis, production of dry matter resulting in enhanced overall growth of plants. (Mahajan *et al*., 2013). Different morphological parameters including root and shoot length have been reported to be higher in comparison to the control due to application of nano-fertilizers.

Besides, yield attributing characters like seeds per panicle has been improved by the application of nano- Potassium and Iron fertilizer (Farajzadeh *et al*., 2009; Nadi *et al*., 2013).

Methods of Delivery of Nano-Fertilizers in the Plant System

1. In Vitro Methods:

a. Aeroponics: This technology involves the spraying of nutrient solution continuously to the roots of plants suspended in air.

b. Hydroponics: This technique is also referred to as “solution culture” as plants are grown in soilless media especially in nutrient solution.

2. In Vivo Methods:

a. Soil Application: Nutrient supplementation using chemical and organic fertilizers is basically done through soil application. This is dependent upon many factors including

longevity of fertilizer in soil, texture of soil, the salinity of soil and sensitivity of plants to salts, pH of amendment and salt content. (Taiz and Zeiger, 2010).

b. Foliar Application: This method includes the direct application of liquid fertilizers to the leaves or foliar parts of plants. Generally, trace elements are supplied through this method. (Taiz and Zeiger, 2010).

Comparative study of Conventional fertilizers and Nano-fertilizers:

S.N.	Characteristics	Conventional Fertilization	Nano-fertilization
1.	Nutrient Use Efficiency (NUE)	This has reduced efficiency.	Nano-fertilization enhances fertilizer efficiency and uptake ability of the soil macro & micro nutrients thereby saving fertilizer application.
2.	Mineral micronutrients dispersion and solubility	Minimum or lesser bioavailability to plants because of larger particle size and lesser solubility in soil.	Nano-fertilization may improve mineral solubility and its dispersion of soil. They also minimize absorption and nutrient fixation in soil thereby improving the bioavailability.
3.	Rate of fertilizer loss	Maximum loss of nutrients due to leaching and drainage.	Nano-fertilization leads to reduced fertilizer loss by leaching.
4.	Mode of release of nutrients	Uncontrolled release of fertilizers results in toxicity and destruction of ecological balance of soil.	The encapsulation or coating of the nutrients in envelopes by semi-permeable membranes which promote controlled release rate and pattern.
5.	Nutrient release duration	Instant release of nutrients to plants with maximum loss in the form of insoluble salts.	Nano-fertilization leads to prolonged release of nutrients to soil.

Conclusions

Nano fertilizers play a significant role in the agriculture sector for the achievement of increased productivity and abiotic stress resistance. However, in spite of extraordinary results of nano fertilizers in the Agricultural Sciences, so far, there has been less focus towards marketability. An organized and precise quantitative assessment with regard to possible effects towards health, environmental concerns and safe nanomaterial disposal could lead to efficient fertilizer utilization. Biologically synthesized nanoparticles-based fertilizers and nano biofertilizers should be further explored as a promising technology for the improvement of yields towards achievement of sustainability.

References:

1. Chhipa, H. and Joshi, P., 2016. Nanofertilizers, nanopesticides and nanosensors in agriculture. In *Nanoscience in Food and Agriculture* 1 (pp. 247-282). Springer, Cham.

2. Dimkpa, C.O. and Bindraban, P.S., 2016. Fortification of micronutrients

for efficient agronomic production: a review. *Agronomy for Sustainable Development*, 36(1), p.7.

3. Fan, S., 2014, August. Ending hunger and undernutrition by 2025: The role of horticultural value chains. In XXIX *International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): Plenary* 1126 (pp. 9-20).
4. Farajzadeh Memari Tabrizi, E., Yarnia, M., Khorshidi, M.B. and Ahmadzadeh, V., 2009. Effects of micronutrients and their application method on yield, crop growth rate (CGR) and net assimilation rate (NAR) of corn cv. Jeta. *International journal of food, agriculture and environment* 7(2), pp.611-615.
5. Kah, M., Kookana, R.S., Gogos, A. and Bucheli, T.D., 2018. A critical evaluation of nanopesticides and nanofertilizers against their conventional analogues. *Nature nanotechnology*, 13(8), pp.677-684.
6. Liscano, J.F., Wilson, C.E., Norman-Jr, R.J. and Slaton, N.A., 2000. *Zinc availability to rice from seven granular fertilizers* (Vol. 963). Arkansas Agricultural Experiment Station.
7. Mahajan, P., Shailesh, K., Dhoke, R.K. and Anand, K., 2013. Effect of nanoparticles suspension on the growth of mung (Vignaradiata) seedlings by foliar spray method. *Nanotechnology*, 3, pp.4052-4081.
8. Naderi M. R. and Abedi A. (2012) *J. Nanotech*., 11(1), 18-26.
9. Nadi, E., Aynehband, A. and Mojaddam, M., 2013. Effect of nano-iron chelate fertilizer on grain yield, protein percent and chlorophyll content of Faba bean (*Viciafaba* L.). *International Journal of Biosciences*, 3(9), pp.267-272.
10. Reda, F.M., El-Saadony, M.T., El-Rayes, T.K., Attia, A.I., El-Sayed, S.A., Ahmed, S.Y., Madkour, M. and Alagawany, M., 2021. Use of biological nano zinc as a feed additive in quail nutrition: biosynthesis, antimicrobial activity and its effect on growth, feed utilisation, blood metabolites and intestinal microbiota. *Italian Journal of Animal Science*, 20(1), pp.324-335.
11. Taiz, L. and Zeiger, E., 2010. *Plant physiology*., 5th edn (Sinauer Associates: Sunderland, MA, USA).
12. Tarafdar J. C., Raliya R. and Tathore I. (2012a) *Journal of Bionanoscience*, 6, pp.84-89.