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A REVIEW ON EFFECT OF NANO-PHOSPHORUS ON CROPS

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Introduction

Nano-Fertilizers are the new way to increase Nutrients use efficiency in crop production (Singh, et al., 2017). Nano-fertilizers have emerged as a promising alternative that ensures high crop production and soil restoration. These 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 (Brunnert *et al.*, 2006). These are the important tools in agriculture to improve crop growth, yield and quality parameters with increasing nutrient use efficiency, reducing wastage of fertilizers and cost of cultivation. These are very effective for precise nutrient management in precision agriculture with matching the crop growth stage for nutrient and may provide nutrient throughout the crop growth period (Liu and Lal, 2015). These increase crop growth up to optimum concentrations, further increase in concentration may inhibit the crop growth due to the toxicity of nutrient. These provide more surface area for different metabolic reactions in the plant which increase rate of photosynthesis and produce more dry matter and yield of the crop. It also protects plant from different biotic and abiotic stresses (Singh *et al.*, 2017). The unique properties of nanoparticles, such as high sorption capacity, the increased surface to volume ratio, and controlled-release kinetics to targeted sites, make them a potential plant growth enhancer. Because of these characteristic features, nano-structured fertilizers can be used as a smart delivery system of nutrients to the plant. In nano-fertilizers, nutrients are released very slowly in comparison to conventional fertilizers. This approach improves nutritional management, i.e., increasing the nutrient-use efficiency and decreasing nutrient leaching into groundwater. These are specifically designed to release active ingredients in response to biological demands and environmental stress. It is found that nano-fertilizers increase agricultural productivity by improving photosynthetic activity, seedling growth, rate of seed germination, nitrogen metabolism, and carbohydrate and protein synthesis.

Application of one bottle of nano-fertiliser can effectively replace at least one bag of conventional fertiliser. When sprayed on leaves, nano-fertiliser easily enters through stomata and other openings and is assimilated by the plant cells. Zeolite based nano-fertilizers release nutrient slowly to the crop plant and thus increase nutrient availability to the crop throughout the growth period by preventing nutrient loss through denitrification, volatilization, leaching and fixation in the soil especially NO_3-N and NH_4-N (Joseph and Morrisson, 2006).

It is easily distributed through the 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 the plant. Small size (20-50 nm) increases its availability to crop by more than 80% (IFFCO,2017). It effectively fulfils crop nutrient requirement, increases leaf photosynthesis, root biomass, effective tillers & branches. It enhances Farmer's income by an increase in crop productivity and reduction in input cost. Because of higher efficiency, it can reduce the requirement of conventional Urea by 50 % or more. Farmers can easily store or handle one bottle (500 ml) of nano-fertiliser. It helps to conserve soil, air and water quality.

Effects of nano-phosphorus on crops:

Singh *et al.*, (2012) reported that Nano hydroxyl appetite (nHA) application produced 5.9 g soybean seeds per plant, compared to 4.9 g per plant under regular P treatment, and merely 1.1 and 0.6 g soybean per plant respectively for the controls without P application.

Significant increase in yields has been observed due to foliar application of nano particles as fertilizer. It was shown that 640 mg/ ha foliar application (40 ppm concentration) of nano phosphorous gave 80 kg ha-1 P equivalent yield of cluster bean and pearl millet under arid environment. Fertilizers encapsulated in nanoparticles will increase the uptake of nutrients (Tarafdar *et al.*, 2012a)

Kumar *et al.*, (2014) studied the effect of gypsum and rock phosphate nano-fertilizers tagged with urea applied at the rate of 3 kg ha-1 on wheat and reported that nano-materials and fertilisers significantly increased tillers m^{-2}, days to 50% flowering, dry matter accumulation, physiological maturity, and harvest maturity compared to control and other treatments.

Liu & Lal (2014) reported that increase in maximum seed yield per plant (20.4%), biomass productions were enhanced by 18.2% (above-ground) and 41.2% (below-ground) with nano-hydroxy apatite(nHA) treatment compared to regular P fertilizer (Ca(H2PO4)2).

Liu & Lal (2014) studied the effect of phosphorus fertilizer on soybean in the form of synthetic apatite nanoparticle and reported that maximum height of the plants (121 cm, ,32.6% higher) under nano-hydroxy apatite (nHA) treatment compared to regular P fertilizer (Ca(H2PO4)2) treatment. However, result also showed that apatite nanoparticles as an alternate P fertilizer to enhance agronomical yield and reduce risks of water eutrophication.

Ruiqiang and Rattan (2014) conducted a greenhouse experiment at School of Environment and Natural resources, Ohio State University, Ohio to assess the fertilizing effect of synthetic apatite nanoparticles on soyabean (Glycine max). The data showed that application of the nanoparticles increased the growth rate and seed yield by 32.6 and 20.4 percent, respectively, when compared to other soyabean treated with conventional P fertilizer [Ca(H2PO4)2]. Also, biomass productions were enhanced by 18.2 percent (above ground) and 41.2 percent below ground. Using apatite nanoparticles as a new class of P fertilizer can potentially enhance agronomical yield and reduce risks of water eutrophication.

Hussien *et al*., (2015) reported the interaction effect of nano-fertilizer and drought through some growth stages of cotton plants indicated that application of nano-P at@ 0.5 g/L promoted best nutrients uptake under missing of irrigation at budding stage whereas nano-P fertilizer@ 1.0 g/L depicted the enhanced nutrients uptake under missing of irrigation at flowering stage.

Magda and Hussein (2015) obtained that application of nano phosphorus showed positive effect on corn weight alone as well as in combination with Beauveria bassiana.

Rajonee *et al*., (2017) studied the effect of four different fertilizer treatment (T_1 = control, T_2 = conventional phosphorus fertilizer T_3 = nano phosphorus fertilizer and T_4 = nano potassic fertilizer) on release of phosphorus under incubation for 30 days at field capacity moisture conditions. The experiment carried out in silty clay soil at Department of Soil and Environmental Sciences, University of Barisal, Bangladesh. Among the different treatments, the release of phosphorus from different sources were decreased with increasing time. The P was higher from nano fertilizer than the conventional one. The release of higher amount of phosphorous by nano fertilizer treated soil due to incorporation of KH_2PO_4 into zeolite and a smaller fixation of the nano-P at low pH.

Swetha Kumari *et al*., (2017) explored the effect of bio and nano P fertilizer and reported bio phosphorus proved superior or equivalent to nano phosphorus gave the greatest values for yield and yield parameters.

Upadhyaya *et al*., (2017) recorded the impact of calcium phosphate nano particles on rice plant and resulted the length of roots increased 3.4% and 6% at 10mg/l of calcium phosphate nano particles whereas 1% decrease in root length with 50mg/l of calcium phosphate nano particles showing the toxicity at higher concentration. Also, 8%, 7% increase in root fresh mass and 8%, 18%, 10% increase in shoot fresh mass was observed with 10,20 and 50mg/l concentration.

Dhansil *et al*., (2018) carried out experiment at College of Agriculture, JAU, Junagadh on pearl millet and reported that significantly increased protein content (10.67%), grain nitrogen, phosphorus and potassium (1.71, 0.44 and 1.63 per cent) straw nitrogen, phosphorus and potassium (0.75, 0.25 and 0.69 per cent) and total nitrogen, phosphorus and potassium uptake (1.96, 0.57 and 1.84 g pot-1) respectively was observed when treated under T4 treatment i.e. @ 2.5 times reduction of recommended dose of phosphate through nano phosphatic fertilizer.

Hagab *et al*., (2018) conducted a field experiment at Baloza Research Station of the Desert Research Center, North Sinai, Egypt, to study the effect of applying 50, 75 and 100% of the recommended rates of nano-zeolite phosphorus (20.9% P2O5), zeolite phosphorus (8% P2O5), and the ordinary superphosphate fertilizer (15.5% P2O5) to yield components, nutrients content, uptake by straw, seeds of peanut crop (Giza 6 cultivar), and the level of available nutrients in the sandy soil. Application of nano-zeolite phosphorus resulted in the highest values of yield components including 1.89, 3.48, 1.46-ton fed^{-1} and 53.2 % for pod, straw, seeds crop and oil content, respectively. The study indicated that the well-organized use of fertilizers can be enhanced through using nano sources, so the pollution hazard can be reduced.

Choudhary *et al*. (2018) examined for nano phosphorus as managerial input in legume based inter-cropping and resulted significant increase in plant height, dry matter production (1326.1gm^{-2} and LAI (3.21) in 50% recommended dose of phosphorus with 40% nano phosphorus. Also, 30% more nutrient mobilization and greater nodulation was noticed in rhizosphere in legume with foliar spray of nano phosphorus. With respect to phosphorus management practice, maximum grain yield (1162 kg/ha) and straw yield (5148 kg/ha) of pigeon pea, black gram and maize were recorded with 50% RDP + 40 ppm nano-P followed by 100% RDP and 40 ppm nano-P .

A two-season field investigation was conducted at The Experimental Farm of RRTC, Egypt, during 2018 and 2019 to examine the impact of nano phosphatic fertilizer utilization on the performance of four Egyptian rice varieties. The selected tested varieties were Sakha106, Sakha107, Giza177, and Giza179. The phosphorus fertilizer treatments included superphosphate (15% P2O5) as a soil application, nano-phosphorus as a foliar application, superphosphate as a foliar application and control (distilled water). Superphosphate was incorporated into the soil at the rate of 36 kg ha-1 for the first treatment. Nano-phosphorus (1%) and superphosphate (2%) were sprayed at 35 and 45 days after transplanting (DAT) for the second and third treatments. The application of phosphorus fertilizers increased the number of tillers per m2, the number of branches per panicle, filled grains number per panicle, 1000-grain weight (g), grain yield (t ha-1) and straw yield (t ha-1) for al tested rice varieties. Superphosphate soil application and a foliar application of nano phosphorus to Giza 179 surpassed the other plural in terms of grain and straw yields in both seasons. Application of phosphorus as superphosphate or nano-phosphorus enhanced grain quality characteristics as well as nitrogen and phosphorus content in milled grains. (Sorour *et al*.,2020).

Conclusion

Nano fertilizers are advantageous over conventional fertilizers as they increase soil fertility yield and quality parameters of the crop, they are nontoxic and less harmful to environment and humans, they minimize cost and maximize profit. Nano particles increase nutrients use efficiency and minimizing the costs of environment protection (Naderi *et al*.,2012). Improvement in the nutritional content of crops and the quality of the taste. Enhance plants growth by resisting diseases and improving stability of the plants by anti-bending and deeper rooting of crops. (Tarafdar *et al*.,2012) also suggested that balanced fertilization to the crop plant may be achieved through nanotechnology.