

Nanotechnology: An Emerging Technology in Agriculture

**Nirmal Singh* and Axay
Bhuker**

Department of Seed Science and
Technology
CCS HAU, Hisar Haryana-
125004



*Corresponding Author

Nirmal Singh*

E-mail: nirmalsingh@hau.ac.in

Article History

Received: 29. 10.2020

Revised: 10. 11.2020

Accepted: 19. 11.2020

INTRODUCTION

Agriculture is backbone of economy of every country and each individual is dependent on it directly or indirectly to fulfil daily needs. Population in world is increasing exponentially so food demand is also increasing with time. To ensure food security, different techniques are being used to increase agricultural production like use of synthetic fertilizers and pesticides, high yielding varieties and hybrids. Traditional techniques have some limitations and are not enough to achieve targeted agricultural production. There is need of new technologies that should be eco-friendly and should increase production by using minimum natural resources. Nanotechnology is emerging technology which have been used in different sectors like medical, textile, engineering, security, biotechnology, defence, energy and communication. Despite having potential to change fate of agriculture, application of nanotechnology is still limited in agriculture. Nanotechnology is science that deals with synthesis and application of nanoparticles. Nanoparticles are materials that have minimum one dimension under 100nm. Nanoparticles could have positive/negative/no-effects on crop growth. There are different methods to use nanoparticles in agriculture sectors which are mentioned in this article.

Use of nanoparticles for seed treatment: Seed is key input agriculture that decides productivity of crops. Seed treatment with nanoparticles could be done by direct exposure of seeds to nanoparticles or by nano priming of seeds. Nano particles has both positive and negative effects on germination and seedling vigour. Proper seed germination and high seedling vigour ensures higher grain production. Different type of nanoparticles like metal-based nanoparticles, carbon-based nanoparticles, nano composites etc. have been used for seed treatment.

Seed treatment with nanoparticles increases water and nutrient uptake that helps in higher germination and in raising healthy seedlings. There are many examples of increased seed germination of different crops like wheat, maize, rice, tomato, groundnut etc. due to seed treatment with nanoparticles. Increased defence mechanism and enzymatic activity of seeds was also observed due to application of nanoparticles. Silica nanoparticles has increased seed germination and yield of tomato and rice. Seed treatment with manganese nanoparticles improved nitrogen uptake in *Vigna radiata*. Germination percentage of soybean seeds was increased by the treatment of seeds with iron, cobalt and copper nano crystalline powder

Nanofertilizers: Conventional chemical fertilizers are required in large quantity due to low fertilizer use efficiency. Chemical fertilizers are also responsible for environmental and soil pollution. There is need of replacement of chemical fertilizers with something which should be required in less quantity and eco-friendly. Nano fertilizers are best possible replacement for chemical fertilizers because fertilizer use efficiency of nano fertilizers is nearly three times of chemical fertilizers and release time of nutrients is also prolonged in nano fertilizers comparatively. Urea releases nutrient up to 12 days but nano fertilizers releases nutrients up to 50 days. Nano composites are also potential fertilizers. Soil pollution is also decreased due to use of nano fertilizers. Soil application of ferric oxide nanoparticles promoted growth of groundnut.

Nanoinsecticides and nanopesticides: Higher use of insecticides and pesticides favours

insects and diseases infestation. Smaller size of nanoparticles is beneficial in making them highly active, compared to conventional insecticide or pesticide. Several metallic nanoparticles, such as silver, gold and iron are widely used for insect and pest control. Quantum dots are extensively used to monitor plant pathogens and advantageous microbes. Antimicrobial property of nanoparticles like zinc and silver could reduce use of pesticides.

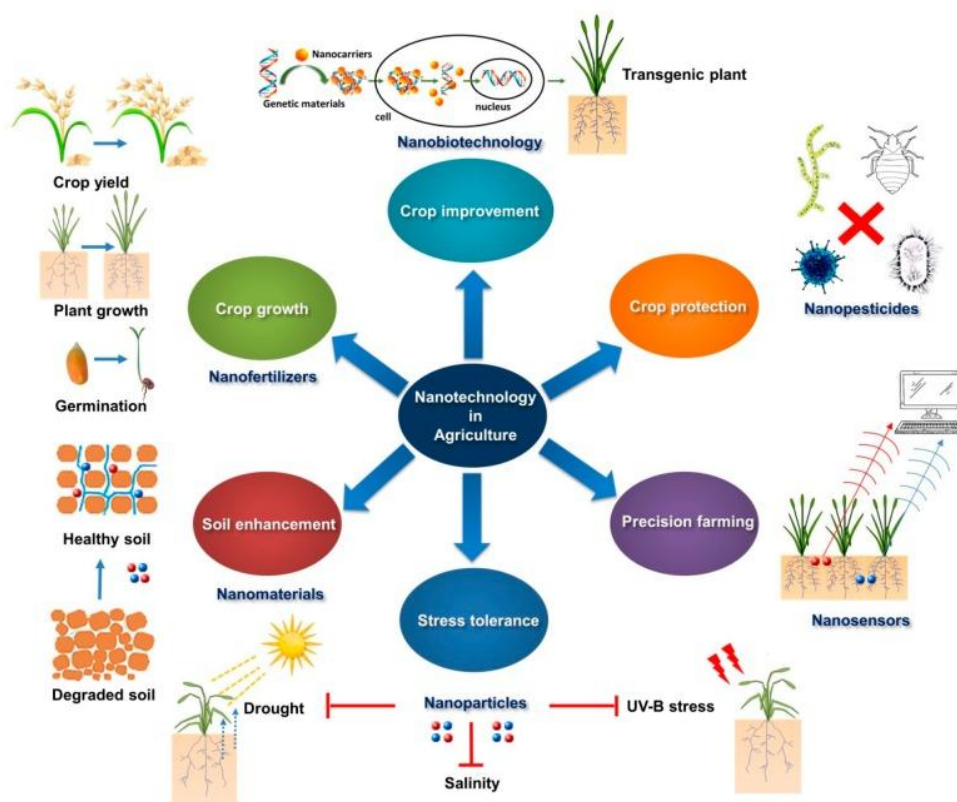
Precision farming application: Proper use of natural resources in agriculture is need of hour. Excessive use of agricultural inputs causes environmental pollution and is responsible for higher cost of production. Various nano sensors are developed with help of nanoparticles to know exact demand of nutrients and water of agricultural crops. Wireless nano sensors network (WNSN) obtains data about soil temperature, soil moisture, nutrient status of crops and soil. These nano sensors could be used for deciding exact time of sowing and harvesting of crops according to availability of soil moisture and temperature.

Nanotechnology in the development of plant breeds: Nanoparticles has gained attention in plant breeding due to their ability to change genetic make-up of crops. Nano particles could be used for develop photo-insensitive crops varieties which could be produced throughout year. Silica nanoparticles were used for transferring DNA into tobacco plant, whereas gold nanoparticles were used for the capping of targeted gene to avoid gene leaching at non-targeted site of plant. Scientists have altered the purple colour of leaves and stem of rice variety “Khao Kam” to green colour via nanotechnology.

Conventional agriculture vs Nanotechnology-mediated agriculture:

Factors	Conventional agriculture	Nanotechnology-mediated agriculture
Production	Low	High
Nutrition status	Low	High
Nutrient uptake	Low	High
Input dose	High	Low
Input use efficiency	Low	High
Effective time of treatments	Short	Long
Incidence of diseases	High	Low
Nutrition status in yield	Low	High

Stress tolerance ability	Low	High
Effect on soil health	Negative	Positive
Soil microbial activity	Low	High
Use of natural resources	High	Low
Energy demand	High	Low
Wastage of resources	High	Low
Effect towards environment	Eco-unfriendly	Eco-friendly
Production of harmful greenhouse gases	High	Low



CONCLUSION

Nanotechnology is an emerging science that has gained significant interest among scientists to be included in several agricultural applications and could be used more in the future for sustainable agriculture.

REFERENCES

Swaminathan, M. S., & Bhavani, R.V. (2013). Food production & availability- Essential prerequisites for sustainable food security. *The Indian Journal of Medical Research* 138(3), 383.

Chen, H., & Yada, R. (2011). Nanotechnologies in agriculture: new tools for sustainable development. *Trends in Food Science and Technology* 22(11), 585-594.

Scott, N., & Chen, H. (2013). Nanoscale science and engineering for agriculture and food systems. *Industrial Biotechnology* 9(1), 17-18.

Lyons, K., Scrinis, G., & Whelan, J. (2018). Nanotechnology, agriculture, and food. In: *Nanotechnology and global sustainability*. CRC Press, pp 146-169.