

## **Perspective of Nanotechnology in Precision Agriculture**

**Dr. Prafull Kumar<sup>1</sup>**

<sup>1</sup> Department of Agriculture, Sanskriti University, Mathura Uttar Pradesh-281401, India

Corresponding author:

**Dr. Prafull Kumar**

Department of Agriculture, Sanskriti University, Mathura Uttar Pradesh-281401, India.

### **Abstract**

It has been considered that nanotechnology is a multidisciplinary field of research. Various researches in this field has been carried out to increase the levels of production of agriculture. The inexperienced evolution ended in blind utilization of insecticides and several type of chemical fertilizer that precipitated the nutrient value of the soil and have led to soil biodiversity reduction. Use of these fertilizers and pesticides is also a main reason for the enhanced level of resistance in pests and pathogens. Nanoparticles enhanced cloth transport to plant as well as higher levels of biosensor for accuracy agriculture are promising by nanotechnology. Nano encapsulated conventional fertilizer, pesticide and herbicide allows in measured as well as constant discharge of nutrient and agrochemical which results in accurate quantity to the plant life. Kits are being developed with the help of nanotechnology. These kits based on the plants are enhanced and have the capacity to detect the viral disease prior to the infection. Current study discusses the potential and useful advantages of nanotechnology in accurate agriculture.

**Keywords:** Agriculture, Biosensors, Fertilizer, Nanoparticle, Nutrient.

### **Introduction**

Lots of technological fields are incorporated in the nanotechnology, fields like Chemistry, physics, medicine technology. Application of nanotechnology have a lot of potential in various field but it has a significant effect in the field of agriculture. This technology involves very small or in other words nanoparticles which have variant dimensions but within the limit of 100nm or even less than this[1]. These nanomaterials can be applied to protect the plant, nutrients as well as control of farming strategies because of fine dimensions, precise optical property and high surface to quantity ratio[2].

Several type of material are used to form the nanoparticle such as steel oxide, magnates, semiconductors, quantum dot, lipid, polymer, dendrimer as well as emulsion[3]. Nanoparticle made chitosan are used in farming for seed remedy as well as it enables the crops to fight against the infections caused by the fungi. Every plant have different uptake efficiencies, metabolic function and the effect of these particles at the boom. The quantity of these nano sized particles are responsible for various affects like boom as well as germination of the plants[4].

Many chemical strategies are to be had for production of nanoparticle, that utilizes poisonous chemical substances which increases the want of application of environmental caring, green and organic ways. Scientists are searching ahead for numerous organic body like virus, fungus, better flora, actinomycete and bacteria for the production of nanoparticle as they have the ability to reduce the salts of nanoparticles. Numerous organic resources were utilized for the production of these particles and are utilized in the accurate agriculture[5]. Few examples of nano-particles are zinc-oxide nanoparticle, silver nanoparticle, titanium dioxide nanoparticle.

#### *1. Silver nanoparticle:*

These contain an excessive surface location in addition to portion of floor atom; as an end results include excessive effects against microbes as compared to the silver in bulk[6]. Properties against microbes of silver nanoparticle is being utilized in opposition to a wide variety of human being pathogen[7]. Nevertheless, the

complete capacity remains to be investigated for crops safety. Therefore, there may be an increasing importance to make use of antimicrobials assets of silver's nanoparticle for the control of diseases in plants[8]. Silver's nanoparticle had been experimented as pesticide to lessen the trouble of pest from plants. Silver's nanoparticle may be produced from bodily, chemically and organic techniques. Requiring the necessity of intense environment and poisonous chemical substances in bodily as well as chemical techniques, natural strategies are extensively utilized. One step production and eco-friendly, Several researcher have produced silver's nanoparticle from various assets (plant life, microorganism, fungus etc.). The silver nanoparticle are being utilized to cast off dangerous microorganisms in plants

### 2. Zinc-oxide nanoparticle:

Yield of farms in alkaline soil containing calcium carbonates are adversely affected by the deficiency of zinc.[9]. The soil with calcium carbonates are a chief resource of farming in the Mediterranean environment. The parameter which restrict the accessibility of zinc to plant life is calcium. Zinc-oxide nanoparticle may be produced via chemicals or organic techniques. Since chemicals techniques need poisonous chemical compounds, organic techniques are gaining the popularity. Production of zinc-oxide nanoparticle with the help of flora is price efficient and green. Extracts from plant's leaves are being utilized normally for the production of nanoparticles of zinc-oxide. For production of zinc-oxide nanoparticle, suitable attention of whichever zinc sulphate heptahydrates or dehydrates is solubilised in H<sub>2</sub>O. Extracts of plant's leaves are being made in the solvent like ethanol, methanol or water. By blending plant's extracts and zinc sulphate heptahydrates or dehydrates answer at favoured pH, zinc-oxide nanoparticle are produced.

### 3. TiO<sub>2</sub> (Titanium dioxide) nanoparticle:

Resistance to corrosion, strong, shiny are some properties related to titanium. Dioxide of titanium is an important picture-catalyst which can be to utilize to produce the pigment [10]. Titanium stimulate manufacturing of extra carbohydrate, hopeful increase and photosynthesis price in flowers[11]. Titanium dioxides have proven image catalytic pastime for dreadful conditions of pests[12]. Photo catalyst belongings of titanium dioxides have programs in plant's fortification as it doesn't shape poisonous and hazardous compound consequently own exquisite pathogen's disinfection effectiveness. Researchers are looking to enhance the phyto pathogenic disinfection effectiveness of titanium dioxides samll-films with the aid of dye doping and different suitable strategies.

## APPLICATION OF NANOTECHNOLOGY IN PRECISION FARMING

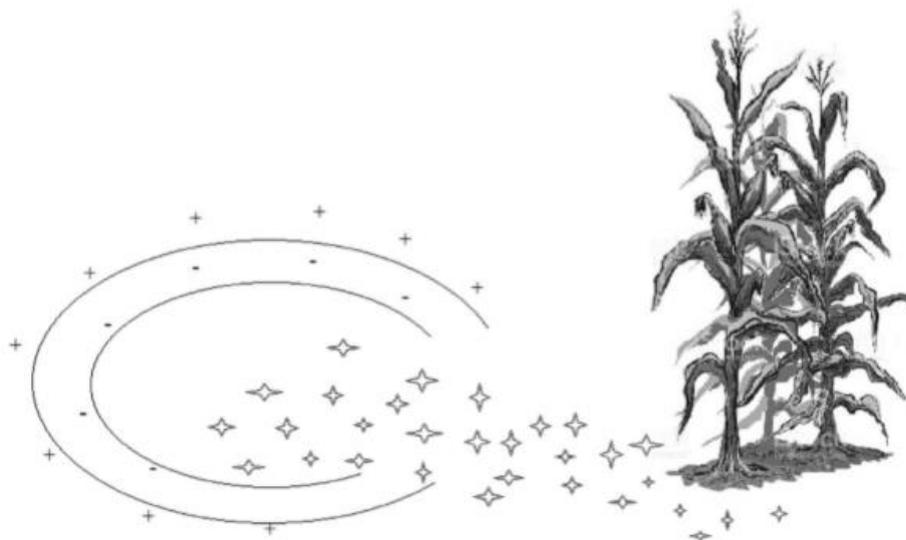
The field of nano technology finds wide variety of applications in the area of agriculture leading to various benefits in agriculture. The applications are illustrated in Figure 1 and discussed as follows:



Figure 1: Application of Nanotechnology in Agriculture

### *1. Delivery of fertilizer:*

Huge quantities of fertilizers in the shape of salts of ammonia, urea, and nitrates or phosphate's compound has elevated production of foodstuff, however they've numerous dangerous effect on the advantageous soils micro flora. Fertilizer runs-off and are not utilized by the crops which further leads to the waste of money as well as is one of the cause of pollution. Fertilizer lined in nanomaterial may remedy this dilemma. Nanomaterial has capacity contribution in sluggish discharge of fertilizer as nanoparticle grasp the fabric greater sturdily on the crop because of superior surfaces anxiety of nanoparticle as compared to traditional surface. In addition, Nano coatings offer floor safety for large particle. Illustration of shipping of insecticide/fungicide/nutrient from Nano coating is proven in Figure 2.



**Figure 2: Controlled release of Pesticides**

### *2. Chemical's fertilizer:*

The utilization of nitrogen's fertilizers within the shape of urea have accelerated various (29%) following the inexperienced growth generation in India. Improved foodstuff manufacture thru extra nitrogen's utility is chargeable for 80 percent of the growth in atmosphere N<sub>2</sub>O that cause multiplied atmosphere temperature and accordingly contribute to worldwide temperature growth[13]. Chemical's fertilizer such as single superphosphates (SSPs), diammonium phosphates (DAPs) and urea are utilized in farming to fulfil the deficiency of P, K and N within the soils. A good amount of those fertilizer are misplaced as runs off. It has been calculated that approximately 40–70 percent of N, 80–90 percent of p, and 50–70 percent of K of the carried out fertilizer is misplaced to surroundings or might be engrossed by means of plants functional cause exchequer discharge to the country as well as causing the environment pollution.

A current-day technique leads to the utilization of Nano covered urea or different chemical's fertilizer. The constancy of the Nano coating reduce the tempo of suspension of the fertilizers plus allow gradual, constant launch of lined fertilizers that is greater effectively engrossed by means of plant's root. Lately, the usage of sluggish launch fertilizer have come to be a novel technique to keep fertilizers utilization with the intention to reduce environment pollutants. Fertilizer through sulphur's Nano coating are helpful as gradual discharge fertilizer due to the fact sulphur content are helpful particularly for sulphur scarcity soil.

### *3. Bio fertilizers:*

Bio fertilizers are existing, advantageous microorganism like fungal mycorrhizae, Rhizobiums, Azotobacterias, Azospirillums and blue green algae[14]. Microorganism change natural remember into uncomplicated compound which offer important nutrient to flora, enhances soil's productiveness, preserve the

soil's biodiversity and boom crop's production. The preparing, storing and process of software are crucial to the success of bio fertilizers software[15]. Drawback in practice are quick shelflife, temperature's sensitiveness and garage parchedness troubles. Possible programs of polymeric's nanoparticle for covering of bio fertilizer arrangements to give in formulation which are proof against parchedness are being used. Oil and water emulsions is among the technique for storing and distributing microorganism thru fluid formulation.

#### *4. Micro nutrient supplies:*

It is a finely recognized information that micronutrient such as mg, cu, boron, Fe, molybdenum, Zn etc. be vital for the increase as well as improvement. A massive enhancement of crop's yield by green revolution in addition with novel agriculture strategies have regularly reduced the micronutrient of soils like Zn, molybdenum and Fe. Foliar applications of micronutrient be able to improve up take with the aid of the leaf. Nano technology may be utilized to form the supply of micronutrient to flora. Nano-formulation of micronutrient may be dispersed on flora or may be taken by the soils via root to improve soil's fitness as well as vigour[16]. Launch of behaviour of Inaphthylacetic acids (an essential plant's boom hormones) from chitosan's nanoparticle have been examined at diverse pHs and temperatures. The formula turned into discovered to contain possible ability for the gradual launch of agrochemical together with hormone[17].

Diverse nanoparticle had been experienced to give suitable levels of micronutrient in flowers. Iron scarcity is a common hassle in flora rising particularly in increased pH and calcium soil. Foliar software of compound of iron by the technologies of Nano particles perhaps a way out to the hassle. Consequence of Dispersion of oxides of iron nanoparticle on the reaction of wheat increase, capitulate and first-rate have been measured. The concentration of iron's Nano oxides answer are being utilized in 5 stages.

#### *5. Nano fungicides:*

Fungal sicknesses among crops motive essential failure to the manufacture. Even though here are some of fungicide accessible for sale, whose utility cause unfavourable effect to flora additionally. Nano technology may take part in a extremely vital function in fixing these problems. Nanoparticle has been experimented as compounds against fungus in opposition to pathogen fungus. Antifungal's interest of nanoparticle of zinc's oxides (36–46 nm), silver's (20–eighty nm) and titanium dioxide's (86–a hundred nm) have checked in opposition to *Macrophomina phaseolina*. The better antifungal's effects turned into practical in silver's nanoparticle at decrease concentration than zinc oxide's and titanium dioxide's nanoparticle.

Nanosilica (21–41 nm) used ahainst maize is observed for resistances in opposition to phytopathogen, *Fusariumoxysporums* and *Aspergillus-niger* in contrast to the silica in bulk. Nano silica-dealt with plants represented a better appearance of phenolic's compound in amassed extract of leaves and a small appearance of pressure reactive enzyme in opposition to those fungi. These effects confirmed important advanced resistances in maize in dealt by nano silica as compared to the volume in term of disorder indexes and expressions of overall phenol, phenylalanine ammonia's lyases, peroxidases and polyphenol oxidases, at 9.99 and 14.99 kg/ha. So silica's nanoparticle may be utilized as an substitute robust anti fungal negotiator in opposition to phyto pathogens[18].

Artificial agrochemical had distorted the look of farming, however it have additionally enhanced novel project in shape of pest's resistances. Nanoparticle had a brilliant guarantee for managing and controlling of insect's pests of current farming. Anti-Insect hobby of garlics crucial oils towards *Triboliumcastaneum* have been elevated via the means of polyethylene's glycol covered nanoparticle. With the help of this method the managing effectiveness towards fully developed *TriboliumCastaneum* changed into measured to eighty% that changed into most probably because of the gradual as well as constant discharge of the lively component by the nanoparticle.

Application of diverse styles of nanoparticle like silver's nanoparticle, aluminium oxide's, zinc oxide's and titanium dioxide's nanoparticle within the management of rice weevil and grasserie's disorder in silkworms had

been studied[19]. Das experimented the transformations of Bombyxmorinucleopolyhedrovirus by using lipophilically lined silica's nanoparticles, alumina's nanoparticle within the hexagonally closely stacked  $\alpha$  structures and aspartated capped gold's nanoparticles in B.Mori mobile lines the use of cytopathic effects in addition to plaques reducing assay. A restrained polyhedra roughen were located for alumina's nanoparticle, and zero roughen changed into observed for gold's nanoparticle. When the leaf of Mulberry treated by ethanol solution of water repellent alumino silicate's nanoparticles, a significantly reduces the viral's weight changed into report[20].

#### *6. Nano herbicides:*

Weed is the major burden in farming and reduces the production of the crop to a massive amount with the aid of the usage of the vitamins which in any other case was accessible to the crop's flowers. Eliminating weed through traditional method not time effective. Some herbicide are accessible in the market. These herbicides reduces the weed in the farms, but additionally costs negative effect to crop's flora. These herbicides are also responsible for polluting the soil as well as reducing the fertility of the soil. Nano herbicides could be of essential importance in eliminating weed from crop in an environmental friendly path, devoid of any detrimental residue in soils and surroundings. Encapsulation of herbicides in polymeric nanoparticles too consequences in environment protection[21].

Uneven utilization of herbicide for wide length of instances leave residue in soils, that reason damages to subsequent plants. Nonstop utilization of identical herbicides for consistent duration purpose weed resistances towards similar herbicides. Efficiency of nanozerovalent iron (nano ZVI) have been measured to dechlorinate herbicides atrazine (2-chloro-4ethylamino-6-isopropylamino-1, 3, 5-triazine) from water and soils contaminated by atrazine. Goal sensitive herbicide-loaded nanomaterials have been produced for distribution into weed root. Such molecule enter the root of the weed, transmit to cell which, with the glycolysis, block metabolic processes.

### **BIOSENSOR IN PRECISION FARMING**

Accuracy agriculture have been prior favoured aim to maximise production from vegetation whereas reducing the need of fertilizer, insecticides, herbicide, etc. thru observing environment variable and implimenting cantered actions. Accuracy agriculture uses computer, sensor, international satellite's position structures and far flung sense gadgets to calculate exceptionally local environment condition as well as helping in figuring out whether vegetation are developing at utmost effectiveness or exactly figuring out the character and position of troubles. Eventually, accuracy agriculture with the help of clever sensor will permit improved yield in farming through supplying precise statistics hence supporting farmer to take higher decision.

### **CONCLUSION**

In precision farming, nanotechnology has demonstrated tremendous promise. It is simple to synthesise nanoparticles with special characteristics from varied biochemical resources and can be introduced to farming. Plant extracts (leaf, flowers, branches, roots) from a diversity of plants were utilised appropriately in the nanomaterials from natural amendments. In a step-green synthesis method, biomolecules present in seed extract convert metal ions to nanoparticles. This novice synthesis approach is environmentally sustainable, simple to perform, can be completed with no need for specialised instruments at ambient temperature and can be quickly sized or adjusted in compliance with the requirements.

In this system the diverse water soluble plant metabolite (such as Alkaloid, phenolic compound, terpenoid) and co-enzyme are condensed to nanoparticle. The nano technology on the basis of transport of nanoparticle have provided potential outcomes for plants disorder resistances, more advantageous plant's development as well as nutrients through website specific release of fertilizer and vital nutrient with the aid of managed launch formulation of nanoparticle. Nano encapsulation may also enhance herbicides utility by means of offering improved penetrations as well as permitting the sluggish and constant discharge of the vigorous substance.

Therefore nano technology can offer inexperienced, well-organized as well as green approach for insects pest control in farming. The superior nanotechnology tools and technique may enhance the means; farming is observed and have the hopeful prospect in the imminent time of machines in agriculture. Nanoparticle has an amazing prospective as 'magic bullet' overloaded by herbicide, fungicide, nutrient, fertilizer or nucleic acids and focused on particular tissue of plant to discharge the price to preferred a element of plants to acquire the favoured outcomes. Advancement in biotechnology and the quick and greater unique analysis gear by means of Nano materials has a first-rate and hopeful prospect for the cutting-edge farming practice like accurate release of vitamins and fertilizer and disease identification at near the beginning phase.

## REFERENCES

1. M. Auffan, J. Rose, J. Y. Bottero, G. V. Lowry, J. P. Jolivet, and M. R. Wiesner, "Towards a definition of inorganic nanoparticles from an environmental, health and safety perspective," *Nature Nanotechnology*. 2009.
2. V. Ghormade, M. V. Deshpande, and K. M. Paknikar, "Perspectives for nano-biotechnology enabled protection and nutrition of plants," *Biotechnology Advances*. 2011.
3. "Polymer Applications in Agriculture," *Biokemistri*, 2011.
4. L. Zheng, F. Hong, S. Lu, and C. Liu, "Effect of nano-TiO<sub>2</sub> on strength of naturally aged seeds and growth of spinach," *Biol. Trace Elem. Res.*, 2005.
5. B. Pooja, S. D. Joginder, and K. G. Suresh, "Biogenesis of nanoparticles: A review," *African J. Biotechnol.*, 2014.
6. K. H. Cho, J. E. Park, T. Osaka, and S. G. Park, "The study of antimicrobial activity and preservative effects of nanosilver ingredient," in *Electrochimica Acta*, 2005.
7. P. Prakash, P. Gnanaprakasam, R. Emmanuel, S. Arokiyaraj, and M. Saravanan, "Green synthesis of silver nanoparticles from leaf extract of *Mimusops elengi*, Linn. for enhanced antibacterial activity against multi drug resistant clinical isolates," *Colloids Surfaces B Biointerfaces*, 2013.
8. S. Mishra, B. R. Singh, A. Singh, C. Keswani, A. H. Naqvi, and H. B. Singh, "Biofabricated silver nanoparticles act as a strong fungicide against *Bipolaris sorokiniana* causing spot blotch disease in wheat," *PLoS One*, 2014.
9. P. N. Takkar and C. D. Walker, "The Distribution and Correction of Zinc Deficiency," in *Zinc in Soils and Plants*, 1993.
10. S. Mizrahy and D. Peer, "Polysaccharides as building blocks for nanotherapeutics," *Chemical Society Reviews*. 2012.
11. M. V. Khodakovskaya and M. H. Lahiani, "Nanoparticles and Plants: From Toxicity to Activation of Growth," in *Handbook of Nanotoxicology, Nanomedicine and Stem Cell Use in Toxicology*, 2014.
12. M. Pelaez et al., "A review on the visible light active titanium dioxide photocatalysts for environmental applications," *Applied Catalysis B: Environmental*. 2012.
13. S. Park et al., "Trends and seasonal cycles in the isotopic composition of nitrous oxide since 1940," *Nat. Geosci.*, 2012.
14. S. C. Wu, Z. H. Cao, Z. G. Li, K. C. Cheung, and M. H. Wong, "Effects of biofertilizer containing N-fixers, P and K solubilizers and AM fungi on maize growth: A greenhouse trial," *Geoderma*, 2005.

15. M. N. Jha and A. N. Prasad, "Efficacy of new inexpensive cyanobacterial biofertilizer including its shelf-life," *World J. Microbiol. Biotechnol.*, 2006.
16. S. F. Peteu, F. Oancea, O. A. Siciua, F. Constantinescu, and F. Dinu, "Responsive polymers for crop protection," *Polymers*. 2010.
17. S. Tao, R. Pang, C. Chen, X. Ren, and S. Hu, "Synthesis, characterization and slow release properties of O-naphthylacetyl chitosan," *Carbohydr. Polym.*, 2012.
18. N. Patel, P. Desai, N. Patel, A. Jha, and H. K. Gautam, "Review Article Agronanotechnology for Plant Fungal Disease Management : A Review," *Int. J. Curr. Microbiol. Appl. Sci.*, 2014.
19. A. Goswami, I. Roy, S. Sengupta, and N. Debnath, "Novel applications of solid and liquid formulations of nanoparticles against insect pests and pathogens," in *Thin Solid Films*, 2010.
20. S. Das, A. Bhattacharya, N. Debnath, A. Datta, and A. Goswami, "Nanoparticle-induced morphological transition of Bombyx mori nucleopolyhedrovirus: A novel method to treat silkworm grasserie disease," *Appl. Microbiol. Biotechnol.*, 2013.
21. S. Kumar, G. Bhanjana, A. Sharma, Sarita, M. C. Sidhu, and N. Dilbaghi, "Herbicide loaded carboxymethyl cellulose nanocapsules as potential carrier in agrinanotechnology," *Sci. Adv. Mater.*, 2015.