

A Review: Applications of Nanotechnology in Plant Growth and Crop Protection

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ABSTRACT

In the time of environmental change, worldwide agrarian frameworks are confronting various, remarkable difficulties. To accomplish food security, progressed nano-designing is a helpful instrument for boosting crop creation and guaranteeing maintainability. Nanotechnology assists with improving horticultural creation by expanding the proficiency of data sources and limiting pertinent misfortunes. Nanomaterials offer a more extensive explicit surface region to manures and pesticides. Furthermore, nanomaterials as interesting transporters of agrochemicals encourage the site-focused on controlled conveyance of supplements with expanded harvest insurance. Because of their immediate and proposed applications in the exact administration and control of information sources (manures, pesticides, herbicides), Nano tools, for example, Nano biosensors, uphold the advancement of innovative agrarian ranches. The joining of science and nanotechnology into Nano sensors has enormously expanded their capability to detect and distinguish the ecological conditions or weaknesses. In this audit, we sum up late endeavors at imaginative employments of nanotechnologies in horticulture that may assist with fulfilling the rising need for food and ecological maintainability.

Keywords: nanotechnology, Nanoagrochemicals, Nanosensors, Nanobionics, Sustainable agriculture, Food security.

INTRODUCTION

To address the expanding difficulties of maintainable creation and food security, huge mechanical progressions and advancements have been made lately in the field of horticulture (Dwivedi et al., 2016; Kou et al., 2014; & Xiao et al., 2013). Such nonstop agrarian advancements are critical to fulfill the expanding food need of detonating worldwide populace through the employments of regular and manufactured assets. Specifically,

nanotechnology can possibly give compelling answers for the different agribusiness related issues. To overcome any barrier between mass materials and nuclear or sub-atomic constructions, nanoparticles give an incredible logical interest. Throughout the most recent twenty years, a lot of exploration has been done on nanotechnology underlining its various applications in agribusiness areas (Lv et al., 2018, & Chen et al., 2016).

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Manure application assumes a critical part in expanding the agrarian creation; be that as it may, the unnecessary utilizations of composts irreversibly modify the substance nature of soil, further decreasing the accessible zone for crop creation. Maintainable farming involves a base utilization of agrochemicals that can at last secure the climate and ration various species from termination. Remarkably, nanomaterials upgrade the profitability of yields by expanding the effectiveness of rural contributions to encourage site-focused on controlled conveyance of supplements, consequently guaranteeing the negligible utilization of agri-inputs. For sure, the help of nanotechnology in plant security items has dramatically expanded, which may guarantee expanded harvest yield. Also, the significant worry in farming creation is to empower quickened variation of plants to reformist environmental change factors, for example, outrageous temperatures, water insufficiency, saltiness, alkalinity and natural contamination with poisonous metals without undermining existing touchy biological systems (Prasad et al., 2017). Moreover, the turn of events and abuse of nanosensors in exactness cultivating, to gauge and screen crop development, soil conditions, illnesses, uses and infiltration of agrochemicals and ecological contamination have significantly improved the human control of soil and plant health, quality control and security affirmation contributing a lot to reasonable farming and natural frameworks (Chen et al., 2016). Nanomaterial designing is the forefront track of exploration that underpins the advancement of cutting edge rural fields by offering a more extensive explicit surface territory urgent for the supportable improvement of horticulture frameworks (Panpatte et al., 2016). Accordingly, nanotechnology can lessen the vulnerability, yet in addition facilitate the administration techniques of horticultural creation as an option in contrast to customary advances. In numerous cases, agro-nanotech advancements offer transient techno-fixes to the issues looked in current mechanical farming. The current audit sums up the

utilizations of nanotechnology in farming, which may guarantee the maintainability of agribusiness and climate.

Nano-Farming: A new pattern of farming system

Nanoparticle designing is one of the most recent mechanical advancements that show one of a kind focused on qualities with raised strength. The term 'nanotechnology' was first instituted by Norio Taniguchi, an educator at Tokyo University of Science, in 1974 (Khan et al., 2014). Albeit, the term 'nanotechnology' has for quite some time been presented in different controls, the possibility that nanoparticles (NPs) could be of interest in horticultural improvement is a new mechanical advancement, is as yet under reformist advancement (Gogos et al., 2012). Ongoing progressions in the manufacture of nanomaterials of various sizes and shapes have yielded their wide exhibit of utilizations in medication, ecological science, agribusiness and food handling. Since forever, farming has consistently profited by these developments (He et al., 2018). In continuation, as farming appearances various and extraordinary difficulties, for example, diminished harvest yield because of biotic and abiotic stresses, including supplement lack and natural contamination, the rise of nanotechnology has offered promising applications for exactness agribusiness (Figure 1). The term accuracy horticulture or cultivating has arisen lately, which means the advancement of remote systems administration and scaling down of the sensors for observing, evaluating, and controlling rural practices. All the more explicitly, it is identified with the site-explicit harvest the executives with a wide exhibit of pre-and after creation parts of agribusiness, going from green yields to handle crops (Dwivedi et al., 2016). Ongoing progressions in tissue designing and designed nanomaterials-based focused on conveyance of CRISPR (bunched consistently interspaced short palindromic repeats)/Cas (CRISPR-related protein) mRNA, and sgRNA for the hereditary adjustment (GM) of yields is an imperative logical accomplishment (Ran et al.,

2017). Further, nanotechnology gives superb answers for an expanding number of natural difficulties. For instance, the advancement of Nano sensors has broad possibilities for the perception of ecological pressure and improving the fighting possibilities of plants against sicknesses (Afsharinejad et al., 2016).

In this way, such persistent upgrades in nanotechnology with extraordinary inclination on the distinguishing proof of issues and advancement of cooperative methodologies for manageable agrarian development can possibly give wide social and impartial advantages.

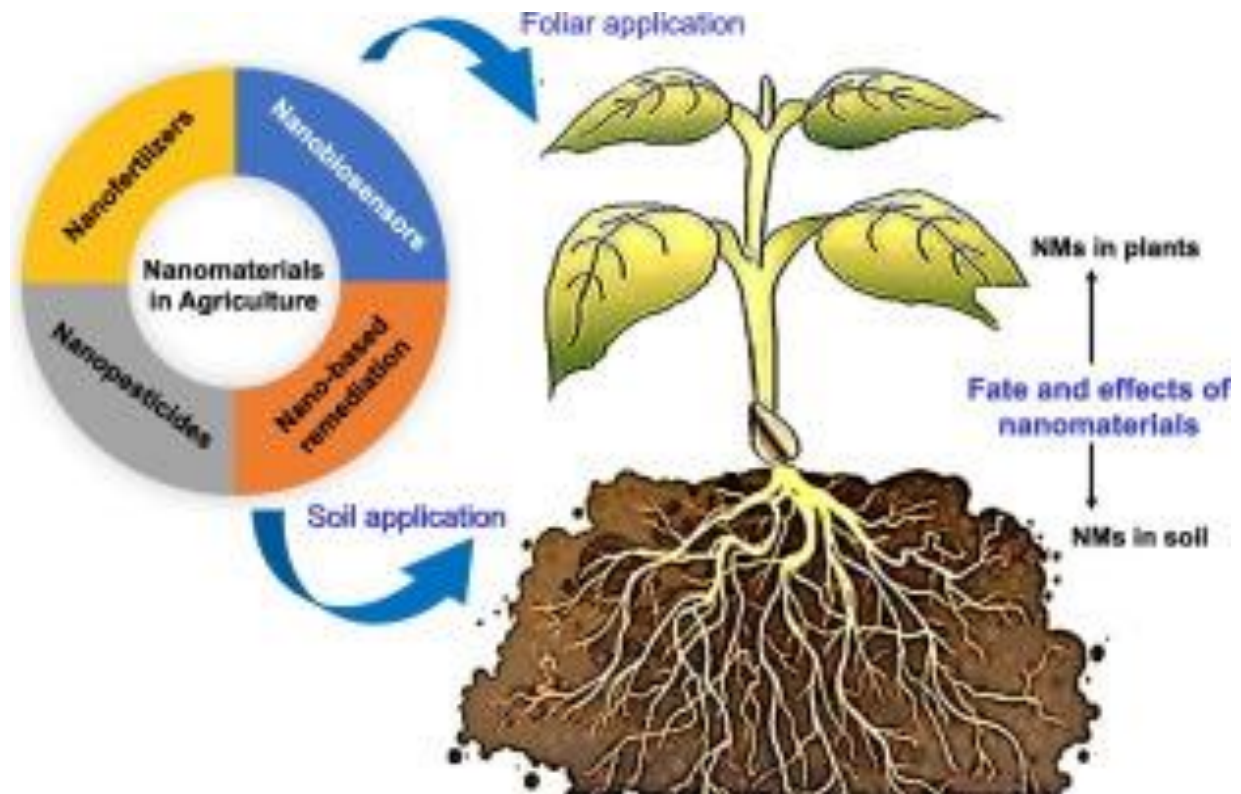


Figure 1: Applications of nanotechnology in agriculture. Controlled releases nanofertilizers improve crop growth, production and productivity.

Nanoparticles for sustainable agriculture

Nanotechnology is considered as one of the vital advances in the twenty-first century that vows to progress conventional rural practices and offer economical improvement by improving the administration and protection strategies with diminished misuse of farming information sources (Kwak et al., 2017). The conveyance frameworks of agrochemicals and natural atoms including transport of DNA particles or oligonucleotides into the plant cells are significant parts of feasible horticultural creation just as exactness cultivating (Joga et al., 2016). In customary strategies, agrochemicals are for the most part applied to crops by splashing and additionally communicating. Thus, an extremely low number of agrochemicals arrives at the

objective destinations of yields, which is much underneath the base viable focus needed for effective plant development. The misfortunes are because of draining of synthetics, debasement by photolysis, hydrolysis and furthermore by microbial corruption (Nair et al., 2010). For example, on account of the use of manure, more accentuation ought to be made of the bioavailability of supplements because of the chelation impacts of soil, corruption by microorganisms, dissipation, and over-application, hydrolysis, and run-off issues. On account of pesticide applications, the viability improvement with splash float the board is to be centered around. To guarantee eco-accommodating horticultural practices, the new progression of nanotechnology-based union of moderate or controlled delivery

manures, pesticides and herbicides has, along these lines, gotten an additional consideration in agribusiness cultivating. With the progression of time, nanotechnology has bit by bit moved from the lab-based trial preliminaries to useful applications. The point of controlled conveyance strategies is to deliver estimated measure of vital and adequate amounts of agrochemicals throughout some undefined time frame and to acquire the full organic competency with limiting the misfortune and unsafe impacts (Shojaei et al., 2019).

Nano fertilizers for healthy and protected crops

All in all, the supplementation of the fundamental supplements (component treatment) is inescapable for improving yield profitability and soil richness (Li et al., 2018). In any case, the exact compost the executives is considered as perhaps the main requirements for practical horticultural advancement (Davarpanah et al., 2016). Nonetheless, food is a crucial basic liberty. Worldwide food security is under genuine test across the world. Food security is compromised somewhat because of the impediment of accessible regular assets. It has been foreseen that current total populace (seven billion) will increment over the long haul and stretch around nine billion by 2050. To take care of the expanding populace, around 60–100% more food will be required. To fulfill the expanded food need, escalated cultivating is being polished which in the long run prompts an endless loop of depletion of soil richness and decay of rural yields. It has been assessed that roughly 40% of the world's horticultural land has truly been debased, prompting a serious misfortune in soil richness because of such escalated cultivating rehearses (Kale et al., 2016). Thusly, a colossal measure of manures is utilized to improve soil fruitfulness and harvest profitability. It has likewise been unequivocally seen that 33% of yield profitability is credited to composts and the lay relies upon use efficiencies of other horticultural sources of info. In any case, the supplement use efficiencies of traditional

manures scarcely surpass 30–40%. For instance, the supplement use productivity of customary manures, for example, for nitrogen (N) 30–35%, phosphorus (P) 18–20%, and potassium (K) 35–40% stayed consistent for as long as quite a few years (Subramanian et al., 2015). Also, the supplement use effectiveness of customary manures that are applied straightforwardly into the dirt, or showered on the leaves, to a great extent relies upon the last convergence of the composts arriving at the objective locales. In evident sense, a low sum, which is much beneath the base wanted focus, arrives at the focused available because of filtering loss of synthetics, float, overflow, hydrolysis, vanishing, photolytic or even microbial corruption. As outcomes, the rehashed utilization of abundance measure of manures unfavorably influences the inborn supplement balance of the dirt. Adjacent to these, water conditions have genuinely been defiled because of draining of harmful materials into waterways and water supplies, which likewise causes the tainting of drinking water. It has been accounted for that in mid-970, just 27 kg NPK ha⁻¹ was needed to create one ton of grain, while in 2008 it raised to 109 kg of NPK ha⁻¹ to accomplish a similar degree of creation. As per the International Fertilizer Industry Association (IFIA), world manure utilization has been expanding strongly and the world interest was projected to arrive at 192.8 Mt constantly 2016–2017 (Heffer et al., 2012). Among these a lot of traditional manures, a significant bit of the synthetic substances stay in the dirt or may go into the other natural compartments, bringing about extreme ecological contamination that can influence the typical development of greenery.

As a promising interdisciplinary exploration field, nanotechnology has excited its monstrosity in horticulture. Notwithstanding macronutrients, micronutrients like manganese, boron, copper, iron, chlorine, molybdenum, zinc likewise assume a necessary part in consistent increment of yield profitability. Nonetheless, various components, for example, soil pH

(alkalinity or acidic condition), invigorate their lacks in harvest creation with broad cultivating practice. The lack of micronutrients diminishes the profitability of yields, yet in addition influences human wellbeing through the utilization of micronutrient-insufficient nourishments. For example, iron insufficiency causes sickness, development hindrance, regenerative medical issues and even diminished psychological and actual execution in people. Conversely, the supplementation of nanoformulated or nano ensnared micronutrients for the moderate or controlled arrival of supplements would invigorate the take-up cycle by plants, advance the development and profitability of yields, and add to keeping up soil wellbeing too (Pleteu et al., 2010). For instance, in zinc insufficient soil, utilization of nano zinc oxide at low dosages emphatically impacts the development and physiological reactions, for example, shoot and root stretching, the new dry weight and photosynthesis in many plant species contrasted with the control. Kale et al. likewise demonstrated that use of zinc oxide nanoparticles with other manure in zinc inadequate soil, advances supplement use proficiency as well as expands grain efficiency by 91% contrasted with the control, while conventional mass ZnSO₄ builds profitability by 31% contrasted with the control.

CONCLUSIONS

In the field of agribusiness, nanotechnology has been utilized to uplift the yield creation with quality enhancement by improving cultivating frameworks as schematically appeared in Figure 4. The rise of designed nanomaterials and their activities inside the edge of manageable horticulture have changed world farming campaign drastically by curiosity, quick development and hugeness to meet the projection of worldwide food interest. In practical farming, the security of the climate from contamination is the urgent objective for exchange, and nanomaterials give an affirmation of better administration and protection of contributions to plant creation. The capability of nanomaterials energizes

another green unrest with diminished cultivating chances. In any case, there are as yet immense holes in our insight into the take-up limit, allowable breaking point and the ecotoxicity of various nanomaterials [9,150]. Along these lines, further examination is direly expected to unwind the conduct and destiny of changed agribusiness inputs and their connection with biomacromolecules present in living frameworks and conditions.

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