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Impact of Nanotechnology on Tuber Crops: One Step Forward for Crop Improvement

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Abstract

Numerous challenges in agriculture might perhaps be solved through nanotechnology. Applications based on nanotechnology have been used in the agriculture sector for several years. In addition to addressing reduced environmental harm and crop loss, it is highly beneficial in improving crops in many ways. Although tuber crops are currently underused, there are relatively few nanotechnologies used in this field. As a result, this study highlights the applications of nanotechnology in agriculture, as well as its significance for improving tuber crop yields.

Introduction

In recent years various technology and innovations have been addressed to overcome food sustainability in production and its security. This type of innovation in the field of agriculture is meant to surpass the increasing demand for food globally by utilizing both natural and synthetic sources. Among these, nanotechnology has emerged as a potential solution to multiple agricultural-related problems. Over the past few decades, nanotechnology-based various applications have been employed in the agricultural segment. Using fertilizer in the agricultural field to improve crop production, however excessive use of fertilizer can lead to change in the chemical ecology of the soil. Again, the use of various chemicals also leads to environmental pollution and damage to many helpful organisms. To overcome these barriers, nanotechnology has played an important role to enhance crop production by creating a path for site-targeted nutrient-delivered systems to slow down the use of various Agri inputs (Prasad *et al.*, 2017).

When it comes to crop production, there are certain things like stability, protection of the plants, salinity, temperature, humidity, pollutant, *etc.* are major concerns. But nanotechnology has been developed as an ultimate solution where nano-biosensors made the task easy for the farmers in such a way that measures and monitors the growth of crops, condition of the soil, and status of diseases. Precisely nanotechnology has improved the needs of humans in the case of the agricultural area employing plant health, its safety measurement with the quality of the crops. It not only diminishes the uncertainty in farming but also can be an alternate remedy for conventional methods. Although the applications of nanotechnology have been successfully employed in various agro-crops still this technology is unrevealed for tuber crops as there have been few implementations on these crops which need to be explored to a large extent. This study covers various applications of nanotechnology in the field of agriculture and its prospects for tuber crops.

Nano-Farming: A New Era Solution

Nanotechnology has unique characteristics and emerged with elevated strength in various disciplines but the interest in nanotechnology to apply in the field of agricultural development is still under progression. Emerging of various challenges in agricultural field such as reduction in yield of crop due to biotic and abiotic stresses, depletion in essential nutrients, pollution in soil, where nanotechnology evolved as a promising remedy in agricultural sector demonstrated in figure 1. Utility of Nanosensors (Lv et al., 2018) towards environmental stress and plant health; whereas, Nano fertilizers for the better growth of crops, Nanopesticides as replacement of conventional chemicals to reduce soil pollution.

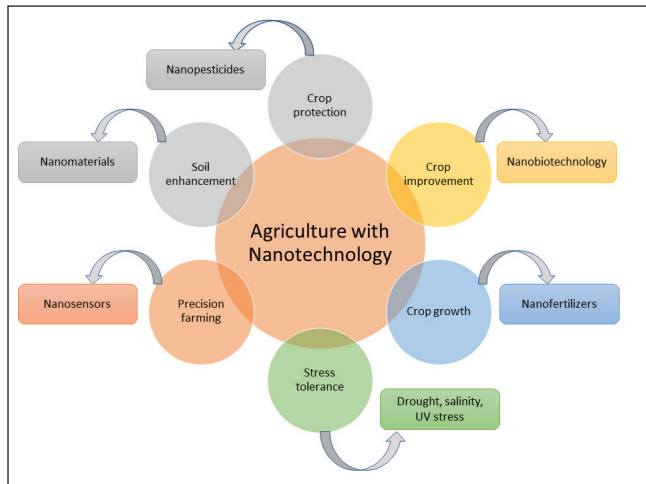


Figure 1: Application of Nanotechnology in Agriculture

Smart Transportation System based on Nanotechnology

The conventional method of spreading agrochemicals to the crops resulted in reaching inadequate amounts to the target sites of crops and the application of these pesticides degrades many microorganisms and the fertility of soil gradually decreases. Nanotechnology emerged as an eco-friendly practice in agriculture due to its controlled and slow release of agro-inputs to the target sites. This technology aims toward the actual and sufficient amount of agro-inputs to be released over a certain period without much loss and harm. Nanoparticles are having a large surface area and they can easily attach to surfaces so that they are incorporated with the agrochemicals sometimes like small capsules through several mechanisms. One of the examples is grapheme-oxide films are used for the capsulation of potassium nitrate for fertilizer release which turns out to be very low cost. Effects on crops after the introduction of Nanoparticles were presented in tabular form below.

Table 1: Effect of Nanoparticles in different Agro-crops

Nanopar-ticles	Concentration	Plant	Effect
Ag-NPs	50 ppm	Potato	Improved growth and yield quality.
Ag-NPs	50 ppm	Wheat	Growth improvement and heat stress tolerance.
ZnO-NPs	1000 ppm	Peanut	The high growth rate in stem and root.
SiO ₂ -NPs	2.5 mM L ⁻¹	Rice	Decrease in heavy metal toxicity and increase.
CuO	150-340 g mL ⁻¹	Tomato	Disease control.
MgO	7-10 g mL ⁻¹	Tomato	Disease control.
Ag-NPs	50 mg L ⁻¹	Cowpea	Enhanced growth biomass of root.
Fe ₂ O ₃ -NPs	0.5-75 g L ⁻¹	Soybean	Improved yield and quality.

Nano-fertilizer: Alternate Hazardous

Nutrients are the main source for improved growth rates in plants in addition to soil fertility. Though all living beings depend upon food and it's a fundamental right of every human being. Due to the huge demand for food, it's now a global challenge to fulfill the need. For which intensive farming has been carried out to increase yield rate which again using of different chemical fertilizers leads to decrease soil fertility and damage to different microorganisms. Using such chemicals by spraying methods does not cover the target site many times and increases the toxicity of soil and again leaching of toxic substances with soil underwater flow into water resources becoming polluted. But nanotechnology has changed the whole way of food production in agriculture with limited sources. The best use of Nano fertilizer in Agri crops is to decrease the deficiency of micro and macronutrients required by the crops. It is helpful for direct accumulation by the crops which prevent unwanted loss and interaction with soil, microorganism, or any external environment (Gogos et al., 2012).

Conclusion

Nanotechnology has been in a process of alternate sources of conventional methods by making remarkable progress in the agricultural field. It is very helpful in crop improvement in various ways in addition to taking care of less damage to the environment and crop loss. However, there are very few applications of nanotechnology

in the case of tuber crops which are still underutilized. These tuber crops are a very good source of nutrients and can be helpful in the fulfillment of food demand by their maximum consumption. Here, nanotechnology may be way helpful in improving quality tuber crop production and be beneficial for the farmer by good quality yield at low cost.

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