Role of Nanotechnology in Agriculture

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***Abstract*— In recent years there is a vast improvement in the crop cultivation, production, post harvesting and application of fertilizers. There is a big technological advancements in the field of agriculture namely drip irrigation, remote monitoring of moisture status. In addition to these Nanotechnology improves the production of crops with less adverse effects on humans and environment. Nanotechnology has many techniques which plays a key role right from sowing the seed to packaging and selling the crop. We can say that Nanotechnology is a boon to modern agriculture.**

Keywords*— *Nanotechnology, Agriculture, Crops

I. INTRODUCTION

Agriculture has been in practice for about 10,000 years. Agriculture is based on the domestication of plants and keeping the domestic animals for food which is the primary basic need of humans. But nowadays agriculture has been commercialized. To increase the number of crops, many advanced technologies and chemicals are used. Sometimes the quantity of crops is increased but has adverse effects on humans and the environment. Nanotechnology helps to increase the number of crops along with secured human health and protects the environment. In the process of agriculture, Nanotechnology plays a vital role in every stage of cultivation. The various techniques are explained below in detail.

II. NANO SENSORS

Generally, sensors are used to detect the change in input (i.e., changes in the environment.) and gives information to the microcontroller which changes the output correspondingly. Nano sensors are used to give information about nanoparticles to the macroscopic world. This nano sensor technique is used in the field of agriculture too. Compared with normal sensors and their shortcomings, Nano sensors have several advantages, such as high sensitivity, near real-time detection, low cost, etc., [1]. Nano sensors in agriculture are used to detect various parameters such as pesticide residue, the humidity of the soil, crop pest identification, and nutrient requirement. If there is excessive usage of chemicals to save crops, there may be adverse effects on human health and the environment. To balance all the requirements in correct proportion Nano sensors are used.

III. CONVENTIONAL FERTILIZERS

Fertilizers are substances that are supplied to the crops to increase fertility and productivity. They provide essential nutrients to plant growth. Plants require nutrients for their growth. The nutrients which are required in low concentration such as Fe, Cu, Zn, Mn, B, Mo, Na, and Cl are called micronutrients. Nutrients like N, P, K, Mg, Ca, S, and Si which are required in high concentration are called macronutrients. [2] The application of conventional fertilizers takes place either by spraying or broadcasting. [2] This results in very less concentration reaching the crop due to leaching, runoff and evaporation. It is estimated that hardly 30-35 %, 18-20% and 35-40% of N, P, and K reaches the crop respectively. [3] The bulk fertilizers are not only results in economic losses but also causes harm to the environment. To overcome the disadvantages, Nano fertilizers prompts to be an alternative to Nano fertilizers.

IV. NANO FERTILIZERS

Nano fertilizers works on the principle of Nano encapsulation. The plant nutrients are encapsulated into Nano materials. A thin coating of nanomaterial is employed on the plant nutrients and is delivered in the form on Nano sized emulsion. [3] The Nano fertilizers are synthesized by two approaches. They are top-down (physical) or bottom up (chemical) approach. [4] The top down approach in which

macro or micro material is transformed into Nano scale. The bottom up approach implies that the atomic material is transformed into Nano scale. The targeted nutrients such as NH_4^+, K^+, Ca^{2+}, and $Mg2^+$ are loaded as cationic nutrients and other nutrients like NO_3^- and PO_2^- are loaded as anionic nutrients. [3] Number of studies have shown that Nano fertilizers have positive effects on plant growth. Graphene oxide films, a carbon based Nano material prolongs the process of potassium nitrate release. [5].Porous Nano materials such as clay or chitosan reduces the loss of nitrogen significantly by demand based release. [6] The main advantage of Nano fertilizer is that it releases nutrients slowly and steadily for more than 30 days. It improves nutrients efficiency with slow or controlled release. It regulates the availability of nutrients in crops. Reduced size and cost of transportation and field application is reduced.

V. PESTICIDES

Pesticides are compounds or substances that are used to kill pests which causes harm to the crops. It includes herbicides, insecticides, and nematicides and so on. In India production of pesticides started in the year 1952. Now, India stands as the second largest manufacturer of pesticides in Asia after China. [8] However some of the chemicals in pesticides poses a potential risk to humans and environment. One such example is Organochlorine (OC) compounds that causes pollution in every life form on the earth. [12] The harmful chemicals can also enter the human body through inhalation or penetration through the skin. It has direct impact on humans and food commodities. Pesticides also causes surface water contamination when it reaches surface water through runoff from treated plants and soil. [9] Hence an alternate approach like Nano pesticides are required.

VI. NANO PESTICIDES

Nano pesticides are tiny molecules which are constituents of pest control derivatives. [11] They are preferred due to their small size, permeability, biodegradability, reduced losses, more efficient application, stiffness and higher surface area when compared to conventional bulk pesticides. Nano pesticides are delivered by nanoemulsions, nanoencapsulates, nanocontainers or nanocages. The factors deciding the efficiency of Nano pesticides are chemical structures, water solubility, volatility and stability. Some of the research that proves Nano pesticides are better than conventional pesticides are summarized here.

Gold nanoparticles when conjugated with Ferbam, a non-systematic pesticide, and sprayed on the upper surface of the tea leaves penetrates more rapidly when compared with commercial Ferbam. [13] When comparing with bulk counterparts, nanoindoxacarb has shown better stability and protection under normal and UV light. [11] When released from the matrix of the carrier the dispersion of the payload depends on the size range and colloidal particles. For conventional form, the chemistry principle 'like-dissolves-like' is followed. In case of nanoform it will be simply dissolved after contact with water. Hence the two factors dispersion and solubility favors the selection of nanoform over bulk conventional pesticides. [10] Nanomaterial can also be used for the removal of pesticides. Compared to conventional catalysis technologies, use of metal nanoparticles has several advantages such as high surface area and more adsorbent atoms per unit mass. [7]

VII. NANO FUNGICIDES

According to an analysis worldwide insect caused an estimated 14% loss, plant diseases cause a 13% loss, and weeds a 13% loss. The value of plant disease loss was calculated to be about 2,000 billion dollars per year [14]. The use and development of nanotechnology in fungicides are in nascent stages. For example, an eco-friendly fungicide is under development that makes use of nanomaterial to liberate its pathogen killing properties only when it is inside the respective targeted fungal pathogen [15]. Nano fungicides can be considered as next-generation fungicides with eco-friendly in nature. The combined anti-microbial effect of inorganic NPs with bioorganic pesticides in the field of plant protection, let singly demonstrated a synergistic effect [16]. Nano fungicides can be used not only for the benefit of agriculture but also for food security.

CONCLUSION

In recent years nanotechnology is making significant contributions to many fields of study. However the current public views on nanotechnology in the development of agricultural industry are mixed. The agro Nano tech products are still facing issues in reaching the market due to lack of awareness and poor communication. Unclear technical benefits and

legislative uncertainties have become a hindrance for introducing nano technology to a traditional industry such as agriculture. Nevertheless nanotechnology has a promising start in agriculture and more research works are required in the future to support this theory.

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