Short Communication

Role Of Nanosensors In Agriculture Sciences

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ABSTRACT
Agriculture provides food for humans in a straight line and in a roundabout way. As planet inhabitants are rising; it's obligatory to use contemporary technology such as biological tools and nanotechnology in agriculture sciences. In the present study, we have explored the utility of nanotechnology in crop growing sciences.

KEYWORDS: Nano Sensors; Agriculture; NCR; Nano Technology.

1. INTRODUCTION

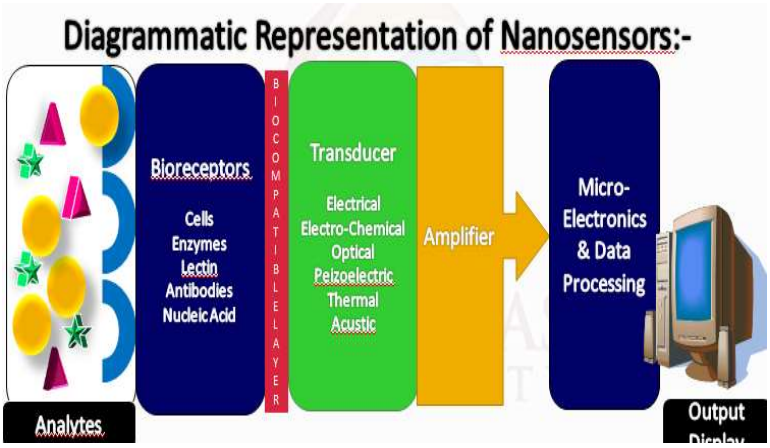
The nanotechnology is definite as it's linking to equipment, system, and process which function at a level of 100 nm or a smaller amount. Nanotechnology has a lot of applications in all stages of produce, dispensation, store, covering, and transportation of cultivation crops. Nanotechnology will transform cultivation and foodstuff manufacturing by modernization new technique such as Precision farming technique, ornamental the ability of flora to attract nutrients, more competent and under fire use of inputs, sickness discovery and manage the disease, endure ecological pressure and efficient system for meting out, storage space and wrapping, etc. A microscale tool capable of measure and detect the visible quantity are measured as Nanosensors.

I. The Research Centre of Advanced Bionics of the National Institute of Advanced Industrial Science and Technology of Japan developed the world's first nanosensor in 2004 to analyze the viable incidence of soil diseases [1].
II. Diagnosing soil with the help of this nanosensor was dependent on the precept of evaluating the beneficial and destructive activity of microbes of soil.

Nanosensor works on the basis of three main components:

I. **PROBE:** Any biological elements which are sensitive enough to fetch the signals springing out from the analytes and have the ability to transfer these signals further to the transducer are called Probes.
II. **TRANSDUCER:** Transducers are the components that can estimate the differences arising from the outcome of the Probes and can convert them into an acceptable form.
a. It contains electrodes for electrochemical signals, piezoelectric crystals for mass, Optrodes for optical signals, and Thermistors for measuring temperature differences.
III. **DETECTOR:** Detectors catch the signals transferred from the Transducers and forward them to the microelectronics and data processor for analyzing the data, storing it and further processing it to give outputs.

As the signals transferred are electrical thus it first amplifies the signals to improve their efficiency and then examines them for further data processing.



Source: https://www.researchgate.net/publication/318176669_Nanosensors_Frontiers_in_Precision_Agriculture.

2. CHARACTERISTICS OF NANOSENSORS

I. Nanosensors have nanoparticles that increase the surface area for reaction and thus are more efficient in fetching signals from the analytes.

a. Any material that is made up of Nanoparticles has a large surface area in comparison to the material of bigger particles of the same volume.

b. It meant that when the radius of the Carbon spheres present in nano-materials is decreased, the surface area to volume ratio of that material increases thus increasing the area of reaction.

II. A lot of miniature devices termed nanodevices which are able to detect and process the signals of analytes have the special characteristic of detecting temperature differences, electrical conductivity, and optical signals which makes them more sensitive and reduces the response period.

III. Nanosensors are much better than conventional biosensors as they are small and handy.

IV. Nanosensors are also useful in keeping a check on agricultural pollutants that are hazardous to human health. They use SWCNT i.e., Single Wall Carbon Nanotubes which are graphene layers and require metal catalysts for their synthesis. They can easily detect the availability of gases like NH_4, NO_2, and SO_2, etc. when they cross a certain limitation and thus help in detecting pollutants of agriculture.

V. Minute wireless like MEMS i.e., Micro electro-mechanical Sensors can assist in controlling pollution as they are very sensitive to temperature, light, vibration, and noise and thus improves the efficiency of nanosensors.

VI. At regular storage conditions, they are safe and stable.

VII. Their analytes are very specific as they catch only a particular change for which they are assigned and ignore the other changes making the nanosensors work precisely.

VIII. The traditional detection methods require more time in providing the results whereas the nanosensors provide the results on time.

3. NANOSENSORS APPLICATIONS IN AGRICULTURE

Nanosensors are located in the entire cultivated field and are connected with the Global Positioning System (GPS) for getting on-time data and concise evaluation of the crop field. The data collected from the field are transferred to the Ground Centre Station for analyzing, processing, and storing for future uses. After data processing, the results are shown on the basis of the present situation of the field such as whether the field requires any fertilizer application or pest control or irrigation, etc.

Nanosensors can be used in agriculture for various purposes such as to detect the temperature of the soil, for identifying pest and diseases in the soil, for analyzing the nutrient required by the crops, for evaluating the quality of irrigation water, etc. as these nanosensors are specific to their detecting range and highly sensitive thus contributing to smart agriculture.

3.1. NANOSENSORS CAN ALERT FOR WATER SHORTAGE IN PLANTS

A group of researchers mentioned that the growth of a plant is affected due to a shortage of water in the soil which reduces the photosynthetic activity of leaves [2]. This may cause wilting of plant leaves. Thus, engineers of the Massachusetts Institute of Technology (MIT) have developed a printable sensor that can be printed on plant leaves and can detect the water shortage in plants. The MIT researchers have built a sensor using ink composed of carbon nanotubes that can conduct electricity, passed into a solution of Sodium dodecyl sulfate. This ink has no adverse effect on stomata functioning and can be easily printed on the pores of the stomata connected with the electric circuit. When the stomata remain closed, the circuit is complete and unbroken. It will conduct the electricity which can be measured by connecting a multimeter to the circuit but when the stomata open, the circuit is broken and the electricity is not conducted. In this way, the opening and closing of stomata can be measured very accurately which can help in detecting the water stress in the Plants helping farmers to manage farming during dry and drought conditions.

3.2. TO MONITOR SOIL CONDITION

Monitoring and improving soil conditions are the primary aspects of Smart agriculture. It was identified that the Potassium Niobate ($KNbO_3$) nanofiber has a better exterior part to size relation which can logic the moisture by display the conductance's logarithmic-linear dependence behavior with the humidity as the conductance increases with the increase in humidity [3].

3.3. TO IDENTIFY DISEASES and PESTS

A group of scientists demonstrated that by keeping a check on the plant growth and its response to the stresses around it [3]. Nanosensors can help to identify the diseases and pests' incidences in the field. There are several stress hormones like Jasmonica acid, salicylic acid, etc., which mediates the physiological changes to which plants respond. Thus, a team of researchers formed a unique gold electrode nanosensor embedded with copper nanoparticles which were capable of identifying the fungus infestation in oilseeds by scanning the level of salicylic acid [4].

3.4. USE OF CARBON NANOTUBES CAN WARN FOR PLANT STRESS

MIT researchers have developed a technique of using a sensor to detect plant stresses either due to injury or infection etc. Plants when faces any stress conditions, communicates via sending hydrogen peroxide signals which enables the cells and tissues of leaves to generate elements that can heal or can fix the damage caused in the plant leaves. The MIT engineers with the help Lipid Exchange Envelope Penetration method inserted the carbon Nanotube sensors into the plant leaves. When the plant leaves face any injury, they secrete Hydrogen Peroxide as a stress signal along with which the nearby cells produce Calcium which facilitates the other cells to produce secondary metabolites to repair the injuries [5].

3.5. TO IDENTIFY PENETRATION OF AGROCHEMICALS AND PESTICIDE RESIDUE DETECTION

Nanosensors assist in an easy and affordable technology to detect the availability of pesticides in agriculture which can act as a pollutant.

a. GOLD NANOPARTICLES: Fang *et al*. [5] based on upconversion nanoparticles or Gold nanoparticles formed a multi-functional platform having glutathione for identifying the activity of acetylcholinesterase and Cadmium toxicity in the soil and water in the field.

b. PHOTOSYSTEM II BIOSENSOR: Nanosensors containing photosystem II have the ability to bind with the pesticides keeping a check over the chemical pollutants in the field.

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AUTHOR CONTRIBUTIONS

All the authors have actively participated in the preparation of the manuscript and discussion of all topics related to this viewpoint manuscript.

CONFLICT OF INTEREST

There is no conflicting interest.

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