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Implications of Nano biosensors in Agriculture

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Nanotechnology has emerged as a boon to the society with immense potential in varied area of research and our day to-day life. The application of nanotechnology for the advancement of biosensor leads to an efficient nano biosensor with miniature structure as compared to conventional biosensors. Nano biosensors can be effectively used for sensing a wide variety of fertilizers, herbicide, pesticide, insecticide, pathogens, moisture, and soil pH. Taken together, proper and controlled use of nano biosensor can support sustainable agriculture for enhancing crop productivity.

Introduction

Accessibility of net land and water-resources for agriculture is rapidly declining, causing huge loss in agricultural output. Besides, the ever-increasing concentration of herbicides, pesticides and heavy metals in agricultural land is alarming. These issues can only be dealt efficiently with the aid and continuous flow of new technologies into this sector. Presently, nanotechnology is visualized as a rapidly evolving field with high potential to revolutionize agricultural and food systems. It is viewed as a potential tool to enhance the quality of the agriculturally based products and natural resource. It may boost rural economy by promoting sustainable agriculture, facilitating farm costs reduction and up lift product-values.

Nano Biosensors

Nano biosensor is a modified version of a biosensor which may be defined as a compact analytical device/ unit incorporating a biological or biologically derived sensitized element linked to a physico-chemical transducer. In the year 1967, the first biosensor was invented which led to the development of several modified biosensors. Interestingly, since early 20th century the concept of biosensors existed but their uses were limited only in laboratories and with advent of sciences several modern biosensors were designed. Overall, there are three so-called "generations" of biosensors; first generation biosensors operate on electrical response, second generation biosensors functions involving specific "mediators" between the reaction and the transducer for generating improved response, and in third generation biosensors the reaction itself causes the response and no product or mediator diffusion is directly involved.

Characteristics for Ideal Nano biosensors

- Highly specific for the purpose of the analyses i.e., a sensor must be able to distinguish between analyte and any "other" material.
- Stable under normal storage conditions.
- Specific interaction between analytes should be independent of any physical parameters such as stirring, pH and temperature.
- Reaction time should be minimal.
- The responses obtained should be accurate, precise, reproducible and linear over the useful analytical range and also be free from electrical noise.

- The nano biosensor must be tiny, biocompatible, nontoxic and non-antigenic.
- Should be cheap, portable and capable of being used by semi-skilled operators.

Constituents of Nano biosensors

A typical nano biosensor comprises of 3 components;

1) The biologically sensitized elements (probe) including receptors, enzymes, antibodies, nucleic acids, molecular imprints, lectins, tissue, microorganisms, organelles etc., which are either a biologically derived material or bio-mimic component that receives signals from the analytes (sample) of interest and transmits it to transducer. And such nano-receptor may play a vital role in the development of future nano biosensors.
2) The transducer acts as an interface, measuring the physical change that occurs with the reaction at the bioreceptor/sensitive biological element then transforming that energy into measurable electrical output.
3) The detector element traps the signals from the transducer, which are then passed to a microprocessor where they are amplified and analysed; the data is then transferred to user friendly output and displayed/stored.

Advantages of Nano biosensors over Conventional Biosensors

- These sensors are ultra-sensitive and can detect single virus particles or even ultra-low concentrations of a substance that could be potentially harmful.
- Nano biosensors work at atomic scale with highest efficiency.
- Nano biosensors also have increased surface to volume ratio.

Disadvantages of Nano biosensors.

- Nano biosensors are very sensitive and error prone.
- Nano biosensors are still under infancy stage.

Role of Nano biosensor in Agriculture

Presently, nanomaterial-based biosensors exhibit fascinating prospects over traditional biosensors. Nano biosensors have marked advantages such as enhanced detection sensitivity/specificity and possess great potential for its applications in different fields including environmental and bioprocess control, quality control of food, agriculture, bio defence, and, particularly, medical applications. But here we are concerned with the role of nano biosensor in agriculture and agro -products. Some of the potential applications of nano biosensors are listed below:

As Diagnostic Tool for Soil Quality and Disease Assessment: Nano sensors may be used to diagnose soil disease (caused by infecting soil micro-organisms, such as viruses, bacteria, and fungi) via the quantitative measurement of differential oxygen consumption in the respiration (relative activity) of “good microbes” and “bad microbes” in the soil. The measurement proceeds through the following steps: two sensors impregnated with “good microbes” and “bad microbes” respectively, are immersed in a suspension of soil sample in buffer solution and the oxygen consumption data by two microbes were detected. By comparing two data, we can easily decide which microbe favours the soil. Apart from that, we can also predict whether or not soil disease is ready to break out in the tested soil beforehand. So, it is to be emphasized that the biosensor offers an innovative technique of diagnosing soil condition based on semi-quantitative approach.

As a Device to Detect Contaminants and Other Molecules: Several nano biosensors are designed to detect contaminants, pests, nutrient content, and plant stress due to drought, temperature, or pressure. They may also potentially helpful for farmers to enhance competence by applying inputs only when necessary.

Smart Delivery Systems: Nano based smart delivery systems and nano biosensors have a significant role in the utilization of natural resources like soil nutrients, water and other

organic compounds. Farm managers can detect the crop pests and identify the stress (for example drought) by satellite photographing of fields through global positioning systems and nanomaterials. If crop pests and drought are identified, pesticide applications and irrigation levels will be modified automatically. Encapsulated fertilizers have capabilities to release the fertilizer slowly and according to need, that leads to minimize the fertilizer use and environmental pollution.

Conclusion

Nano biosensors have great sensitivity. They are simple to use and needs less sample material. They are portable and have faster detection rates. Nano biosensors increased the surface to volume ratio and are capable of measuring more variables. They consist of multi analyte and works at atomic scale with highest efficiency. But nano biosensors are still under infancy stage and lacks nanoscale quantification. Nano biosensors are needed for advanced and efficient agricultural system with economical use of resources, accurate detection of stress and good post-harvest care.