The use of nanotechnology in the agriculture

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Abstract.   Nanotechnology is considered the most important technological advancement in recent years, and it is utilized in all industries due to its potential applications. Almost all of the industries (food, agriculture, medicine, automotive, information and communication technologies, energy, textile, construction, etc.) reorganize their future in the light of nanotechnological developments. As the most important source of income of countries, the agriculture industry increases the use of nanotechnology products gradually as a solution to the problems encountered. Reducing the use of agricultural inputs (pesticides, herbicides, fertilizers, etc.) by increasing their efficiency utilizing nano-carriers, detecting the environmental conditions and development of the crops in the field simultaneously by making use of nanosensors, reducing the sample volume and the amount of analyte used thanks to nanoarrays, effective treatment of water resources through nano-filters, accelerating the development of crops by using nanoparticles are the prominent nanotechnological applications in the agriculture industry. This review presents information on the benefits of the recent developments in nanotechnology applications in the agriculture industry.

Keywords: agriculture; nanobiotechnology; nano-fertilizers; nano-pesticides; nanobiosensors

1. Introduction

The nano- prefix was derived from a Greek word "nannos", meaning "dwarf", and refers to one billionth of a physical dimension. The nanometer term corresponds to one billionth of a meter (1 nm=10^{-9} m) (Navrotsky *et al*. 2000, Huang *et al.* 2007). The term nanotechnology is a science on the manipulation and engineering of nano-scale materials up to 1-100 nm in size (Dudo *et al.* 2011, Ehsani *et al.* 2012). The focus is on the nanotechnology, among the recent technological developments. Nanotechnology has a wide range of applications used in agriculture, medicine, chemistry, physics, food industry, energy, telecommunications, textiles, electronics, sporting goods, construction industry, energy and automotive industry etc. (Qureshi *et al.* 2009, Bradlay *et al.* 2011, Zambrano-Zaragoza *et al.* 2011, Rai and Ingle 2012, Fakruddin *et al.* 2012, Ditta *et al.* 2015).

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