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Nanotechnology in Crop Science

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Due to advancement in nanotechnology, Nano-Engineered Materials (NEMs) are getting more common in our daily life and the production, number and significance of commercial applications of nanomaterials mostly called as nanoparticles (NPs) are growing very fast in the last decades. The number of consumer products is over 1800 and has increased by 521% from 2006 to 2011. On the other hand, it is estimated that the global market for nanotechnology industry will grow to US$ 75.8 billion by 2020 [1,2]. According to the National Nanotechnology Initiative (NNI), nanomaterial is an ingredient containing particles with at least one dimension that approximately measures 1–100 nm (NNI, 2006) [3]. The customized NPs are used in very different areas related to human life such as fabrics, medicine, food, engineering, dye and cosmetic chemistry and other areas. At this point, the common question is becoming important that weather NPs are toxic or not, especially in an aquatic ecosystem and weather safe for human and ecosystems health [4]. Understanding the impacts of nanomaterial exposure in ecosystems is important to protect the environment from increased NP pollution. Many studies showed that some NPs may be toxic to aquatic and terrestrial animals and may have health risks for human while some NPs are not toxic [5-7].

Although agricultural chemicals are developed through rigorous regulations to function with solidity and minimal impact on human and wildlife health, critical anxieties have been occurred about their health risks in ecosystems, food and drinking water [8]. Nowadays, the activities of most suitable and environmentally friendly crop applications, that are less dependent on agricultural chemicals, are becoming important. On the other hand, the improvement of new generation pesticides with novel modes of action and the development of safer formulations and novel application methods such as microcapsule formulations may reduce the adverse effects of pesticides and fertilizers. Therefore, nanotechnology applications may help to reach these objectives. Various regulations and policies around the world, governing the chemical industry of crop science, prohibited use of many pesticides in agriculture due to their risks on non-target organisms. In this sense, NEMs may provide safe and effective solutions for new generation pesticides and fertilizers instead of old-style applications.

The US EPA has developed short and long term strategies to implement the policy on agricultural safety. Especially, the strategies addressed for developing lower risk pesticides for human and environment health in which the overall registration process, improvement of information for users and more informed choices in the marketplace for storage, transportation, mixing and usage, are streamlined. Due to this approach, new products may have important potential to enhance the quality and production of crops in various fields and may help safe agricultural products and protection environmental health.

Researchers are now in search of new productive materials in agricultural activities. Nanotechnology may a be new source for agricultural improvements instead of synthetic chemicals and biotechnology applications, widely used in crop production [9]. The European Food Safety Authority, [10] has recently published a report, revealing that two objectives in the study about an inventory of current and potential future applications of nanotechnology in the agri/feed/food sector; and reviewed the regulation of nanomaterials in the EU as well as in non-EU countries. The use of nanomaterial in agriculture may reduce the amount of sprayed chemicals, minimize nutrient losses in germination and growth, increase yields of crops and provide cheaper nutrient management. In the recent years, nanotechnology based materials are being tested using liposomal nano capsules, emulgators and particles for pesticide and fertilizer applications [11,12]. In the near future, nano-sized xylem vessels, lignocellulosic materials, clay nanotubes (halloysite) with safe environmental characteristics may act as carriers of pesticides, high photocatalytic capacity oxidizing nanoparticles such as TiO2, ZnO, SnO2 and nanocapsullated fertilizers may be used in the market instead of traditional products.

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