Chapter 10

Environmentally Friendly Slow Release Nano-Chemicals in Agriculture: A Synoptic Review

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ABSTRACT

Agriculture is important for people all over the world in order to obtain food to sustain the ever-growing population. However, the current practices for obtaining more and more food has several environmental challenges. Hence, new environmentally friendly fertilizers, herbicides, and pesticides have been developed that enhance crop yield by facilitating maximum nutrient uptake by the application of nanotechnology that will help in promoting sustainable agriculture by the slow or controlled release fertilizers. This slow discharge encourages improved delivery of nutrients to the plants that further speeds up early germination, fast growth, and high nutritional level. The current study is aimed to review nano-chemicals used in agriculture that have been developed by the researchers all over the world.

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INTRODUCTION

Agricultural is a backbone to economy of most countries and currently feeding to the entire human race and has no alternative till date. However, it has various challenges both at national and international level. In one hand, agricultural products has to meet various challenges to ever growing population with same limited resources of land and water. Due to this, most of the chemical fertilizers are being used to enhance the productivity of crops (Liu and Lal, 2015). The efficiency of most fertilizers, especially the nitrogen forms, is reduced greatly due to the volatilization and leaching of nutrients. This has not only caused decline in land quality but 40 to 75% leaching losses were reported, they contribute less towards plant growth and more towards environmental issues (Trenkel, 2010) that may various health concerns directly and indirectly not only to humans but a great damage to other organisms (Rodriguez, 2004). The economic loss due to the use of fertilizers can’t be ignored at the same time. This is can’t be seen as a healthy sign for the developing countries that are continuously struggling for economic development. Hence, there is an urgent need to develop new environmental friendly fertilizers that can increase the yield of crops and manage the environment.

It is reported that application of nanotechnology may assist in promoting sustainable agriculture by slow or controlled release of fertilizers, herbicides and pesticides (Rai, Acharya, & Dey, 2012; Mura, Seddaiu, Bacchini, Roggero, & Greppi, 2013; Baruah & Dutta, 2009). Research in the direction has been already started by various organizations all over the world by making nanoparticles or nano-composites that will help in plant growth either by direct uptake or by slow release of nutrients (Naderi & Shahraki, 2013). Out of 16 nutrients 13 nutrients are present in soil and are being taken by plants from soil ecosystem by slight modifications and it is argued that nano-fertilizers can help in provision of these essential nutrients to the soil by slow release to enhance delivery of nutrients to the plants that will further enhance early germination, fast growth and high nutritional level (Hamid, Mohamad, Hing, Dimin, Azam, Hassan, Mustaq & Ahmad, 2013).

The barrier to inhibit the “burst effect” of fertilizers is generally used to prepare slow-release fertilizers by physically encapsulating the soluble fertilizers with hydrophobic inorganic and/or organic materials. Among those coating materials, The insoluble inorganic materials such as sulfur used to be attractive candidates are the coating materials that aids in retarding the release of nutrients from fertilizers and promote additional functions like secondary plant nutrients and agents that neutralize soil alkalinity as well (Tsai, 1986). The different types of polymers were widely tested as coating materials, however, some developed cracks and pores like sulfur film formed on the surface of fertilizer granules (Bao et al., 2015), and some were also susceptible to microorganisms (Azeem, Kushaari, Man, Basit, & Thanh,
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