

Chapter 24

Application of Nanocompounds for Sustainable Agriculture System

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ABSTRACT

Agriculture is one of the major determining forces for the economy of India. The burgeoning population also puts more pressure of the agriculture system. To meet the requirement for future population with little arable land and limited agricultural production, doubling of crop yields is required. Development of such production systems which depend on renewable resources is an urgent requirement for sustainable agriculture. New technologies are also required to be tested and tried for the improvement of the crop production system. Nanotechnology in agriculture system is the recent hope to make sustainable agriculture a success. A high proportion of the atoms in a nanoparticle are present on the surface of a nanoparticle which accounts for higher reactivity compared with particles of macrosize. On the other side, toxicity is also a considerable concern, but using nontoxic nanoparticles like nanozeolite, nanochitosan, and nanoclay is safe. These nanocompounds show advantages in crop production without harming the soil system.

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INTRODUCTION

Agriculture is a science of food production utilizing the capabilities of plants to convert inorganic form of energy into organic matter which supports the plants for same. To meet the requirement for future population with little arable land and limited agricultural production, doubling of crop yields is required. Development of such production systems which depend on renewable resources is urgent requirement for sustainable agriculture (Cassman, 1999). Conservation and enhancement of soil quality and health is mandatory to preserve agriculture for upcoming generations.

Soil quality can be described as the cumulative effect of chemical, physical and biological properties which help in supporting productivity and environmental quality (Gugino *et al.*, 2009). The soil acting as a major interface between agriculture and environment determines survivability and extinction for most land-based life (Doran *et al.*, 1996). Assessment of soil quality or health is invaluable for determining the sustainability of agriculture systems (Karlen *et al.*, 1997). Although contribution of soil in plant productivity is widely recognized but it significantly effects water and air quality.

NANOTECHNOLOGY

Nanotechnology is a new and fast-developing industry which influences economy, society and environment. It is the science of understanding and functioning of matter at dimensions of about 0.2–100 nm. The unique physical properties of nanocompound support their wider applications in various fields. Matter at nanoscale level show extraordinary properties which are not shown by their bulk counterparts. A high proportion of the atoms in a nanoparticle are present on the surface of a nanoparticle (Maurice and Hochella, 2008), which accounts for higher reactivity compared with particles of macroscale. Nanoparticles may have different surface compositions, types and densities and reactivity than their bulk counterparts (Hochella *et al.*, 2008).

The present study deals with the impact and assessment of three natural nanocompounds (i.e. Nanozeolite, nanoclay, and nanochitosan) on soil health including enzyme and microbial system. Nano clay polymers have potential application in agriculture due to their unique properties like cation exchange capacity, surface area, ion adsorption, complexation, and many more. Functions of clay would multiply if they are converted to nanoscale.

Zeolite is composed of complicated silicate mineral with spacious pores within its crystal structure which makes it different from other silicate minerals. Zeolite is a crystalline substance with a structure having a framework of connected tetrahedra, each of which consists of four oxygen atoms surrounding a cation. Zeolites are classified on the basis of their crystal structure, morphological characteristics, chemical composition, natural occurrence, pore diameter etc. (Coombs *et al.*, 1997). The Si:Al ratio is an important property of zeolites. The Si:Al ratio is inversely proportional to cation content, but directly proportional to thermal stability.

The cationic interchange ability of zeolite is 2-3 folds higher than the other types of minerals found in soil. Zeolites are the potential adsorbents because of their microporous structure (Kamarudin *et al.*, 2003). Out of forty naturally occurring zeolites, the most recognized ones are clinoptilolite, chabazite, erionite heulandite, stilbite, mordenite and phillipsite (Polat *et al.*, 2004). Among these, clinoptilolite is frequently used in the agricultural practices for soil amendment (Wehtje *et al.*, 2003). It requires other positively charged accessory cations to become electrically neutral and stable mineral. It can combine

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