Chapter 11
Potential Application of Nanotechnology for Enhancing Crop Yield in an Environmentally Sustainable Crop Protection System

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ABSTRACT

Climate change-induced biotic and abiotic stresses reduced the productivity of agricultural systems. This raised severe concerns about food security in the world. Researchers reported improved agricultural performance using nanotechnology under various stresses. Consequently, it is imperative to explore the potential of nanotechnology against different environmental stresses for a better understanding of researchers and scholars in the field of agriculture. Thus, the authors delve into diverse applications of nanotechnology, i.e., nano fertilizers, nano fungicides, nano herbicides, and nano pesticides, in strengthening the crop production system under different biotic and abiotic stresses globally. Further, the use of nanotechnology in agriculture reduced plant disease risk factors, improved food quality and water use efficiency, decreased environmental pollution, and promoted sustainability while ensuring food security challenges. Thus, the utilization of nanotechnology becomes indispensable for enhancing crop production with a sustainable crop protection system.

INTRODUCTION

Industrial agriculture increased the food production but have developed a serious destruction in agriculture production system in the world (Tsoraeva et al., 2020). Human induced climate change significantly decreased the crop performance due to various abiotic (drought, salt, heat, waterlogging, cold, heavy metal) stresses (Sánchez-Bermúdez et al., 2022). Additionally, crop productivity reduced due to biotic (pathogen, weeds, insect, pest) stresses in field (Del Buono et al., 2023). Plants modify their chemical makeup, biological activities, and physical structure to cope stress conditions (Nardi et al., 2021). This response depends upon crop type, severity and duration of stress (Grey & Brady, 2016; Madani et al., 2019). It is dire need to preserve natural resources while increasing food production to meet food demand (Wani et al., 2024). The current situation demands a persistent solution to the hot issue of food security (Akbari et al., 2022). Sustainable agriculture improves plant physiochemical response to augment growth and development under stress conditions (Verhulst et al., 2010; García-Tejero et al., 2011; Imadi et al., 2016). Research on nanotechnology is fascinating and developing quickly with promising results in numerous fields (Salerno et al., 2008; Purohit et al., 2012; Karkare, 2013). For agriculture, nanotechnology serves to provide nutrients, pesticides, herbicide and insecticides (Bhatt & Sharma, 2018; Shang et al., 2019). Moreover, different