Chapter 9
Biological Control Agents for Pest Management and Advancements in Crop Development

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ABSTRACT

Changing agro-climatic conditions are exacerbating the incidence of various insect pests, posing significant threats to crop productivity for human consumption. Due to the drawbacks associated with conventional chemical approaches, there is a growing interest in employing biological control methods as a secure and economical remedy for pest management challenges. The maximum utilization of biological control in recent years can be attributed due to its long-term ability against and specially for target species. Unlike chemical methods that harm non-target species, pose health risks to humans, and pollute the environment, biological control offers a more targeted and sustainable approach. This chapter aims to explore the major aspects of biological pest control, focusing on various strategies employed for successful pest

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management in farms, greenhouses, gardens, and forests. These strategies include conservation biological control, classical bio-control and control by augmentation the further unleashing of natural enemies via inundation or by inoculation.

INTRODUCTION

Agricultural losses constitute a serious risk to the availability of food and the economic well-being of farmers and traders (Avelino et al., 2015). These losses not only diminish global food availability but also inflict damage on economies and the environment while squandering the natural resources utilized in production processes. The Food and Agriculture Organization estimates that each year, around 1.3 billion tons of food are wasted (Salihoglu et al., 2018). Food wastage, whether quantitative or qualitative, can result from pest attacks, mites, rodents, chemical or compositional changes, and mycotoxins. Various factors contribute to crop losses, including biotic factors (animal pests, diseases, pathogens, and weeds) and abiotic factors (such as water scarcity, salinity, temperature fluctuations, radiation, and nutrient deficiencies). Pest and insect infestations can occur on agricultural land either before harvest (pre-harvest) or after harvest (postharvest), leading to decreased crop quality and hindered production (Savary et al., 2006). Weeds account for 34% of global agricultural potential losses, exceeding losses by animal pests and pathogens worldwide (Benjamin et al., 2024). Pathogens also significantly reduce global crop productivity, causing both direct and indirect losses with varying consequences. Along with weeds and animals, pathogens cause twenty to forty percent of all damages in agricultural productivity (Savary et al., 2012).

The word "biocontrol" has been used for more than a century to combat various pest types, including insects, pests (Pertot et al., 2017) and mosquitoes (Ingabire et al., 2017). (Jäkel et al., 2019). By using natural enemies, biological management provides an efficient and ecologically friendly way to mitigate pests and their impacts. It depends on natural processes like herbivory, parasitism, predation, and other processes, which are frequently enhanced by proactive human management (Brodeur et al., 2013). Over a century of active use of biological control has produced a wealth of historical analysis, including losses and accomplishments. For a variety of reasons, interest in biological control has been rising for decades (Bailey et al., 2009).

Furthermore, protective antagonist actions in food chain, including animal feed processing and significant human medical treatments are also based on the principles of biological control (Jordan et al., 2014; Dedrick et al., 2019). However, these fields may use different nomenclature. Remarkably, the acceptance of pest management as a new standard for the protection of crops worldwide has

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