Progress in Biological Control

P. Narayanasamy

Biological Management of Diseases of Crops

Volume 2: Integration of Biological Control Strategies with Crop Disease Management Systems

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Volume 2: Integration of Biological Control Strategies with Crop Disease Management Systems

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Memory of My Parents for
Their Love and Affection

Progress in Biological Control

Series Preface

Biological control of pests, weeds, and plant and animal diseases utilising their natural antagonists is a well-established and rapidly evolving field of science. Despite its stunning successes world-wide and a steadily growing number of applications, biological control has remained grossly underexploited. Its untapped potential, however, represents the best hope to providing lasting, environmentally sound, and socially acceptable pest management. Such techniques are urgently needed for the control of an increasing number of problem pests affecting agriculture and forestry, and to suppress invasive organisms which threaten natural habitats and global biodiversity.

Based on the positive features of biological control, such as its target specificity and the lack of negative impacts on humans, it is the prime candidate in the search for reducing dependency on chemical pesticides. Replacement of chemical control by biological control – even partially as in many IPM programs – has important positive but so far neglected socio-economic, humanitarian, environmental and ethical implications. Change from chemical to biological control substantially contributes to the conservation of natural resources, and results in a considerable reduction of environmental pollution. It eliminates human exposure to toxic pesticides, improves sustainability of production systems, and enhances biodiversity. Public demand for finding solutions based on biological control is the main driving force in the increasing utilisation of natural enemies for controlling noxious organisms.

This book series is intended to accelerate these developments through exploring the progress made within the various aspects of biological control, and via documenting these advances to the benefit of fellow scientists, students, public officials, policy-makers, and the public at large. Each of the books in this series is expected to provide a comprehensive, authoritative synthesis of the topic, likely to stand the test of time.

Heikki M.T. Hokkanen, Series Editor

Preface

Various crop plants have been domesticated, after careful selection from innumerable wild plant species over several millennia, because of their potential for higher yield and better quality of the produce. Crop production systems have been developed primarily to fulfill philosophic and economic objectives of feeding humans and animals and providing better livelihood for the growers. Microbial plant pathogens continue to be a scourge of mankind from the prehistoric period, as the causative agents of numerous devastating diseases of plants that provide food, feed, fiber and all other materials essentially required for man and animals. Continuous and sustained efforts have been made to minimize the quantitative and qualitative losses of crops due to diseases incited by the microbial plant pathogens – oomycetes, fungi, bacteria, phytoplasmas, viruses and viroids – in different ecosystems. Managing crop diseases through development of cultivars resistant to diseases has been successful only to a limited extent, because of the unavailability of dependable sources of resistance genes for incorporation into susceptible cultivars. Application of chemicals is being practiced for several centuries and selective chemicals with systemic action could provide protection against microbial pathogens for short periods only. Development of resistance in plant pathogens to chemicals, accumulation of chemical residues in grains and food materials and environmental pollution due to indiscriminate use of chemicals, gave negative signals for their continued use for crop protection. Biological management of crop diseases has emerged as an attractive, alternative approach for minimizing the incidence and severity of diseases of crops caused by microbial pathogens.

Biological management of crop diseases involves the utilization of biotic and/or abiotic agents that act through one or more mechanisms to reduce the infection potential of microbial pathogens directly and/or indirectly by activating the host defense systems to reduce the disease incidence and/intensity. The biotic agents include oomycetes, fungi, bacteria and viruses that suppress the development of crop diseases caused by microbial pathogens in various crops. The abiotic agents such as solar energy, heat, ultraviolet light, organic amendments, organic and inorganic compounds and naturally-derived substances of plant and animal origin

also possess the ability to restrict the development of crop pathogens through direct and/indirect effects, as the biotic agents. Although innumerable biotic and abiotic agents have been demonstrated to have high level of biocontrol activity in in vitro assays, very few have been found to have the expected level of biosuppressive activity under field conditions where they have to compete with the pathogens for the available nutrients and niche for survival. In the recent years, due to growing concern and awareness for protecting the environment and the need for providing chemical-free food to the consumers, several formulations based on microbial antagonists and resistance inducers (plant activators) have been commercialized. Consistency in their performance under various agroclimatic zones is one of the major requirements to make the production of biocontrol products as a viable economic industrial venture. The advantages of biocontrol strategies and their limitations are discussed in detail in two volumes of this treatise. The investigations to study the nature and characteristics of the biological control agents are presented in the first volume. The possibilities of integrating different biological strategies with crop disease management systems are highlighted in the second volume.

The information presented in this book represents extensive literature search (over 2,500 citations) and it is aimed to provide a comprehensive knowledge to the upper level undergraduate and graduate students, researchers and teachers associated with teaching courses as a component of biological management of diseases of crops in the Departments of Plant Pathology, Plant Protection, Microbiology, Molecular Biology, Botany, Ecology, Agriculture and Horticulture. Provision of several protocols appended at the end of relevant chapters to assist the researchers in planning their experiments is a unique feature of this book.

Coimbatore, India P. Narayanasamy

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Contents