International Journal of Recent Research and Review, Vol. VI, June 2013
ISSN 2277 – 8322

A Review on Role of Antagonists in Growth, Production and Disease Management of Horticultural Crops

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***Abstract*: The occurrence of host-parasite and microbe-microbe interactions keeps the scientific community interested in the microbial world. Microbes in the same niche compete or battle mostly for resources and space. Therefore, each microbe has a special way of surviving such microbe-microbe conflict (Antagonism). The Greek word 'antagonizesthai' (fight against), which was first used in the nineteenth century, is the source of the word antagonism. The French word "antibiose," which characterises the hostile interactions between bacteria, is where the name "antibiosis" first appeared. The discovery of antagonistic activity therefore causes a paradigm change in the control of human, animal, and plant parasites.**

Utilising disease-fighting microbes for plant health is known as biocontrol. Phytopathogens are currently being controlled commercially using biocontrol chemicals, which have been used successfully to control plant diseases. They are mostly employed to combat illnesses that are transmitted through the soil. This chapter reviews some of the most significant biological control agents that are now being utilised to manage phytopathogenic fungus of several significant crops.

***Keywords*: Biocontrol Agents, Secondary Metabolites, Plant Disease Management, Antibiotics and Defence Mechanisms.**

I. Introduction

After the green revolution, the agricultural sector has grown dramatically. The productivity of different crops is now increased entirely by the use of chemical fertilisers and pesticides in agricultural practices. While these chemical fertilisers have helped crops produce more, they have also had disastrous impacts on the soil's fertility and caused a variety of pests to develop pesticide resistance. Using microbial technology is one of the best methods for achieving sustainable agriculture. It has been shown that plants are vulnerable to a variety of diseases that cause plant death.

Fruits, vegetables, ornamentals, and medicinal plants are all examples of horticultural crops, which are crucial to the world's economy, agriculture, and food security. However, these crops have a number of difficulties, such as pathogen-caused illnesses that can significantly lower yields and quality. Chemical pesticides have traditionally been widely used in the treatment of diseases in horticultural crops. However, excessive pesticide usage has sparked worries about disease resistance, environmental pollution, and threats to human health. A popular and sustainable method of managing diseases while fostering development and output in horticultural crops in recent years has been the use of antagonists as biocontrol agents.

Plant diseases can be suppressed by antagonists, commonly referred to as biocontrol agents, which are naturally occurring bacteria. These microorganisms, which can prevent disease growth and development and enhance plant health, include bacteria, fungus, viruses, and nematodes. A number of advantages of using antagonists in the cultivation of horticultural crops.

Microbial Antagonists' Sources

The majority of the harmful bacteria come from the earth, sea, fruit surfaces, and various plant sections. Additionally, it has been shown that many fermentation products are a source of harmful bacteria and fungus. Numerous studies have demonstrated the efficiency of a wide variety of microbial antagonists in avoiding postharvest fungal infections. For instance, postharvest pathogens can be effectively controlled by lactic acid bacteria (LAB) recovered from various fermentation products.

II. Disease Suppression & Management

Through processes including competition for nutrition and space, parasitism, predation, antibiosis, and induction of plant systemic resistance, antagonists have the power to actively combat plant infections. As an illustration, certain bacteria strains like Bacillus subtilis and Pseudomonas fluorescens generate lytic enzymes or antibiotics that prevent the growth of harmful fungus. Mycoviruses infect and weaken fungal pathogens, whereas a group of fungus called Trichoderma species can parasitize and kill harmful fungi.

a) Prevention and Sanitation: Prevention is the first line of defence against diseases in horticultural crops. The occurrence and spread of illnesses can be considerably decreased by putting into practise sound agricultural practices, such as utilising disease-free seeds or seedlings, practising crop rotation, eliminating contaminated plant debris, and keeping clean field conditions.

b) Resistant Varieties: Plant breeders have developed disease-resistant varieties of horticultural crops, which exhibit natural tolerance or immunity to specific diseases. Planting disease-resistant cultivars is a good way to limit disease occurrence and rely less on chemical treatments.

c) Biological Control: Biocontrol agents, such as beneficial microbes and predators, can be used to suppress plant diseases. Trichoderma species and Bacillus subtilis are two examples of microorganisms that can colonise the root zone and prevent the establishment of harmful fungus by competing with them or by creating antifungal substances. Additionally, predators that can suppress disease-carrying insects include parasitic wasps and predatory mites.

d) Chemical Control: When necessary, chemical control measures can be employed using fungicides or bactericides to manage severe disease outbreaks. However, they should only be used sparingly, using the right application methods, and taking into account things like managing pest resistance, environmental effect, and worker safety.

Growth Promotion

Through a variety of methods, antagonists can promote plant growth and development. Auxins, gibberellins, and cytokinins are a few examples of compounds they produce that can promote plant development. Some antagonists have the ability to solubilize soil nutrients, increasing their availability to plants. Additionally, they can boost root growth, raise plant resistance to abiotic stressors, and increase the efficiency of nutrient uptake, which will promote overall plant health and vigour.

Environmental Sustainability

The concepts of sustainable agriculture are in line with the use of antagonists as biocontrol agents. In comparison to chemical pesticides, antagonists are less hazardous to the environment, human health, and non-target creatures. They can decrease chemical residues in crops, save helpful creatures, and support biodiversity preservation. Additionally, the use of antagonists in disease management helps prevent microorganisms from becoming resistant to pesticides, assuring the long-term efficacy of disease control strategies.

III. Compatibility with Integrated Pest Management (IPM)

Antagonists can be integrated into IPM programmes, which aim to manage pests and diseases using a combination of biological, cultural, physical, and chemical control measures. Growers may lessen their reliance on chemical pesticides, encourage natural pest and disease management, and improve overall crop health and yield by introducing antagonists into IPM methods.

A thorough selection of suitable biocontrol agents, comprehension of their mechanisms of action, and optimisation of application techniques are necessary for the effective use of antagonists in horticultural crops. When selecting antagonists, factors including the target disease, crop species, climatic circumstances, and compatibility with other management methods should be taken into account. The viability and efficiency of biocontrol agents are also dependent on proper formulation, storage, and application methods.

IV. Biocontrol: Present Situation, Issues, and Prospects

For the management of diverse crop illnesses, microbial biocontrol is currently receiving crucial attention. Several biocontrol microorganisms, including bacteria and fungus (Yeast and Trichoderma), are being identified and investigated right now for their ability to combat numerous pathogenic illness that affect plants.

Unfortunately, most biological agents perform well in a laboratory context but poorly in real-world settings. This is most likely explained by the physiological and ecological restrictions on the effectiveness of biocontrol agents. As a remedy for this problem, genetic engineering and other molecular techniques offer a fresh potential for improving the selection and assessment of biocontrol agents. A bioagent's potency can be increased by a variety of methods, including mutation or protoplasm fusion with polyethylene glycol. It is also critically important to produce bioagents in big quantities, understand how they function, and evaluate the environmental factors that promote the quick growth of biocontrol agents.

However, additional exploitation of prospective antagonists with several advantageous qualities should be carried out in tandem with the enhancement of the already recognised microbial biocontrol. Recent developments in bioinformatics and DNA and proteomics-based technologies have created new opportunities for the research of postharvest biocontrol systems. These advancements have made it feasible to comprehend the molecular connections between infections, hosts, and microbial biocontrol agents. In addition, improvements and developments in a variety of "omics" technologies, including metagenomics, transcriptomics, and proteomics, may be more effectively applied for the in-depth clarification of the disease-inhibitory processes of biocontrol.

V. Conclusion & Future Aspects

In conclusion, horticultural crops need an integrated and sustainable strategy to growth, productivity, and disease management. Growers can optimise crop growth, boost production, and guarantee the long-term sustainability of horticultural crop systems by putting excellent agricultural practices into practise, using efficient disease control tactics, and adopting climate-smart procedures. The development of horticulture crop management and the availability of high-quality fruits, vegetables, ornamentals, and medicinal plants worldwide depend on ongoing research, knowledge exchange, and the implementation of novel practices.

In order for horticultural crops to thrive, produce, and manage disease, antagonists are essential. They are useful tools for sustainable agriculture because they may control diseases, encourage plant development, and support environmental sustainability. Farmers may lessen their reliance on chemical pesticides, improve crop health and productivity, and maintain the long-term sustainability of horticultural crop production by utilising the power of these biocontrol agents. The evolution of resilient and sustainable agricultural practices depends on ongoing study, development, and application of antagonists in horticultural crop management.

A significant alternative to chemical pesticides for the management of diseases in many crops is biological control utilising fungal antagonists, which has no detrimental effects on human health or the environment (Khan et al. 2012). It is challenging to discover economic exploitation of fungal antagonists owing to the current surge in interest in biological management of soil-borne illnesses; this may be because of inadequate laboratory infrastructure. However, commercially viable manufacturing methods are of utmost relevance in order to improve the marketing of these antagonistic microfungi as biological control agents.

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