Popular Article

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Biological control in relation to Integrated Disease Management

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1. Integrated disease management (IDM)

Integrated plant disease management can be defined as a decision-based process involving coordinated use of multiple tactics for optimizing the control of pathogen in an ecologically and economically manner. Plant pathologists embraced integrated disease management by applying fundamental information on loss potential and pathogen biology, ecology and epidemiology and applying the basic concepts of plant disease management.

2. Importance of Integrated disease management

Plant diseases are considered an important biotic constraint which leads to significant crop losses worldwide. Over the past few decades application of pesticides was the dominant form of disease control in developed and increasingly in developing countries. However, many problems have been associated with such an approach such as the frequent emergence of fungicide resistance in pathogens and the harmful effects of fungicides to human health and the environment. The concept of "Integrated Disease Management (IDM)" where diseases are managed by integrating biological, cultural, physical and chemical control strategies in a holistic way rather than using a single component strategy proved to be more effective and sustainable.

3. Basic objective of IDM

- Reduce the introduction of disease
- Avoid conditions that are suitable for disease establishment and their spread

4 Components of Integrated Disease Management

4.1 Biological control

Biological control refers to the purposeful utilization of introduced or resident living organisms, other than disease resistant host plants, to suppress the activities and populations of one or more plant pathogens. The term applies to the use of microbial antagonists to suppress diseases. In fields, the organism that suppresses the pest or pathogen is referred to as the biological control agent (BCA).

Principle of biological control

The goal of classical biological control is to

- Find useful natural enemies
- Introduce them into the area of the target pest and
- Permanently establish them so that they will provide continuing pathogen control with the result that the pathogen population decreases in population density, hopefully below the economic injury level

Importance of biological control

The many approaches to biological control can be categorized conventionally into

Regulation of the pathogen population (the classical approach): The biological control directly involved in suppression of growth of the pathogen in its natural environment and destroys the pathogen inoculum and also reduces the aggressiveness of the pathogen.

Exclusionary systems of protection: A living barrier of microorganisms (antagonists) on the plant that deters infection by the pathogen

Systems of self-defense (resistance and immunization): Antagonists indirectly helps in growth and development of the plant through production of different hormones and regulators and also provides nutrients in turn makes plants resistance against the pathogens.

Bio control agents

Bio control agents are used as a core component of integrated disease management system. Fungal bio control agent *Trichoderma* is one of the model microorganism which has faster growth rate and has long retaining capacity in soil. These bio control agents are of enormous value in integrated diseases management for sustainable agriculture where they often replace the need of fungicides. Fungal bio control agents such as *Trichoderma*, *Aspergillus*, *Pencillium*, *Gliocladium etc* have been identified as potential bio control agent and bacterial biocontrol agent *Pseudomonas* spp., *Bacillus* spp. and actinomycete bio control agent *Streptomyces* spp. The mechanisms of bio control agents has given in Fig. 1.

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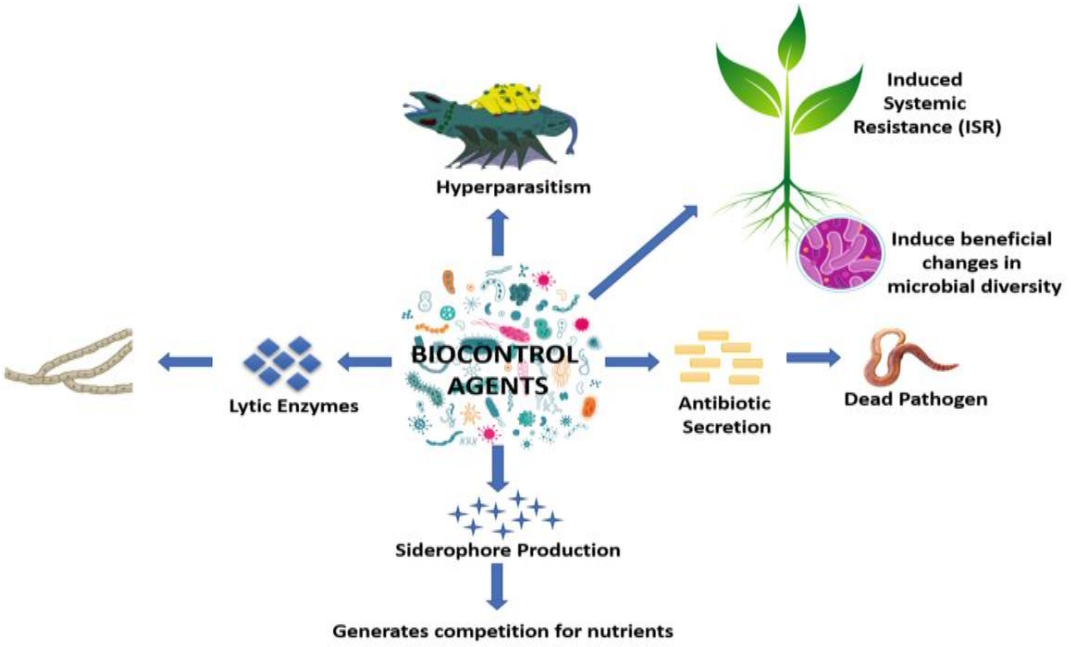

Fig.1.

Mechanism of bio control agents

Application methods of bio control agents in IDM

Seed treatment: The commercial formulations of bio agents are used at 5 g or 10 g for coating the seeds. The seeds after treatment are shade dried and used for sowing.

Seedling dip method: In transplanting crops such as vegetables, the seedlings from nursery are collected and roots are dipped in the solution of bio agents for 15-20 minutes and later transplanted in the main field.

Foliar spray: The solution of bio agents is made and used for spray onto the crop.

Soil application: The bio agents are mixed with FYM and applied to the field before sowing.

Precautionary measures followed while using bio control agents

- Better results can be expected when good quality bio control agents are used.
- Required moisture and organic materials must be present in sufficient quantity for bio control agents.
- No chemical fungicides must be treated to soil, while applying bio control agents in the soil. Do not use it by mixing with chemical fertilizers

Compatibility of bio agents with fungicides

- In the field, a more reliable disease control could rely on combinations of BCAs and fungicides
- Some fungicides perform these activities without distinguishing between harmful pathogens and non-target organisms such as beneficial micro-organisms in soil and living BCAs

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- Fungicides could impact the growth of BCAs or reduce their population size, making the bio control treatment ineffective
- Bactericides: Streptomycin and Agrimycin can be mixed with lead arsenate, Captan, Parathion, Water soluble sulphur, maneb, Stabilized copper and zineb without any harmful effect. But they should not be mixed with Bordeaux mixture and chemicals which have alkaline reaction

Integration of chemical and bio-Integration of chemical and biological control in IDM

Bio-control agents such as *P. fluorescens*, *T. viride*, *T. harzianum*, *B. subtilis*, *P. putida*, *P. cepacia*, *Talaromyces flavus* and *A. radiobacter* strain K 84 *etc*. can be used with integration of chemicals for the effective control of certain diseases. In a different study, on stored apples, a mixture of the biocontrol yeast *Cryptococcus laurentii* and thiabendazole, at 10 per cent of the standard dose, resulted in the highest and longest control of important post-harvest pathogen, *B. cinerea*. The incomplete disease control of *B. megaterium* against *F. oxysporum* on tomato could be improved when combined with a low dose of the fungicide carbendazim in plant-packs (Carbo *et al*., 2019). Combined application of rhizobacteria *P. fluorescens* and a 10-fold reduced dose of benomyl was more effective than treatment with either alone and reduced the disease as much as a full dose of the fungicide alone (Huang *et al*., 2015). In multiple greenhouse trials, the foliar application of *B. subtilis* with azoxystrobin provided the highest yield and the best disease control against powdery mildew (caused by *Podosphaera xanthii*) on zucchini, compared to both treatments alone (Silva *et al*., 2019). A combination of *P. fluorescens*, *M. cicero* and *T. harzianum* with the fungicide Vitavax (carboxin + thiram) provided the highest seed germination, grain yield and the lowest wilt incidence (caused by *F. oxysporum*) in pot and field experiments of chickpea (Dubey *et al*., 2015).

Conclusion

Plant pathogens are among the most important factors that cause serious damages and losses to plants. Harmful impacts of the chemical pesticides on the environment and non-target organisms have clearly been documented. The need for the development of non-chemical alternative strategies to protect plants against plant diseases including fungal pathogens is therefore clear. Biological control using microbial antagonists to manage plant diseases seems to be a promising alternative strategy and have successfully been applied to control some diseases on different plants and crops. Some of the important factors that affect the efficacy of microbial bio-control agents in controlling plant diseases which should carefully be considered include biotic and a biotic factor, method of application, formulation of bio-control microorganisms and timing of application.

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