[Article ID : 01/II/09/0121]

ROLE OF BIOLOGICAL METHODS IN INTEGRATED DISEASE MANAGEMENT

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Abstract
Plant diseases cause the reduction in yield and income. Control measures should be taken to reduce the incidence. Integrated disease management (IDM) plays very important role in reduction of disease inoculum. In recent days, biological control has become one of the important strategy in IDM for control of plant diseases due to harmful effects of fungicide application and also their easy commercial multiplication and economically cheaper compare to other chemical fungicides. However, efficiency of biological methods varies with geographical area, soil texture, clay content, crops, and moisture content. Due to increasing consciousness among the people regarding the residual effects of the chemical used and the beneficial effects of the biological agents, used of biological con troll methods has been becoming very important.

Key words : Bio control agents, suppressive soils, pathogen, disease, antagonism, disease incidence, management,

Introduction
Plant diseases cause more devastation in crop production. All crops are susceptible to diseases caused by many pathogens. According to FAO, losses in production due to diseases are 12% annually. The losses are also increasing due to diversified agricultural practices. Diseases have to be controlled to increase the yield and productivity and ultimately to increase farmer's income. Management of these diseases is a significant component in crop production. Different conventional methods like cultural, physical, biological and chemical methods are important. In recent years, farmers follow chemical control widely rather than other methods due to their quick action provided by low concentration. However, their high cost, excessive use of agrochemicals and residual effects leads to environmental pollution. Knowing its harmful effects, it is high time to search for alternative methods. Among all alternative methods, biological control is gaining popularity due to eco-friendly and economical nature. 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 pathogen. The use of microbial antagonists to reduce diseases as well as the use of host specific pathogen to control weed and insect populations is generally referred as biological control agents (BCA). The main advantage of using BCA is that they are pathogen specific and cause less harm to non-target species. The major biocontrol agents are *Gliocladium virens, Trichoderma harzianum, Trichoderma viridae, Purpureocillium lilacinum, Fusarium oxysporum, Agrobacterium radiobacter* K-84, *Bacillus subtilis, Pseudomonas fluorescens,* etc. Biological control also includes suppressive soils, trap crops (bhendi, marigold, mustard), antagonistic crops, botanicals etc.

Integrated disease management (IDM) is defined as a decision based process involving coordinated use of multiple tactics for optimizing the control of pathogen in an ecologically and economically manner. IDM is majorly based on application of combined strategies and tactics. Biological control play very important role in IDM, in which BCA enhances the root zone microflora, reduce the

pathogen incidence. Even though fungicides are giving results but due to their residual effects, biological methods are used against certain pathogens, BCA is available in cheaper cost and it can easily be multiplied in FYM and soil. Besides, used of bio-control agent will reduce the amount of the use of chemical fungicides for managing the diseases, thereby reducing the residual effect.

Mycelium and resting spores of fungi such as *Pythium, Phytophthora, Rhizoctonia, Sclerotinia,* and *Sclerotium* have been parasitized by fungi which belong to some Chytridiomycetes and Hypomycetes families. The major beneficial microorganisms are *Trichoderma, Pseudomonas, Bacillus, Gliocladium*, etc. Biocontrol agents using antagonistic microorganisms help in practical and economical alternative for management of plant pathogens. The level of disease control by BCA's to the crop is nearly equivalent to fungicide action. These BCA have multiple mode of action with target specific, also control the seed borne diseases and enhance the plant growth. The efficiency and durability of BCA's depends on specific traits of the pathogen such as genetic diversity and ability to evolve in opposite to selection pressure. This was affected by mutation, population genetics, and recombination. Selection pressure clearly depends on extent use of biocontrol agents and also specific mode of action of BCA.

Mechanisms of Biocontrol agents

A proper understanding of concept of mechanism of action of BCA's will improve the consistency of management. There are two types of mechanisms are involved, direct antagonism and indirect antagonism.

Direct antagonism

Hyper parasitism

It is the most direct form antagonism. It involves huge tropical growth of biocontrol agents against pathogen. Mycoparasitism is under the control of enzymes. The two enzymes are chitinase and beta−1, 3 gluconase helps Trichoderma in biological control. A single pathogen can be attacked by multiple hypoparasites e.g. *Ampelomyces quisqualis* and *Gliocladium virens* that can parasitize powdery mildew pathogen. Many fungi show to antagonize and inhibit the numerous fungal pathogens of aerial plant parts. E.g. *Chaetomium* spp. And *Anthelia bombacina* suppress *venturia inaeqalis*. *Darluca filum* parasitizes several rusts, *Ampelomyces quisqualis* parasitize powdery mildew. *Gonatobotrys simplex* and *Nectria inventa* parasitize *Alternaria* species.

Competition

Both pathogens and biocontrol agents are compete for the nutrients and space to get establishment. Usually BCA's compete for nutrients is rare, but, for micronutrients such as iron and manganese in highly oxidized and arable soils. Biocontrol agents have more efficient in production of iron binding ligands called siderophores. This forms a complex called siderophore-fe-complex. This results in less availability of iron for the pathogen leads to less pathogen infection.

Antibiosis

Production of low molecular weight compounds or antibiotic compounds by microorganisms that are directly affect the pathogen. An efficient biocontrol agent produces sufficient qualities of antibiotics reduce the pathogen inoculum density. *Pseudomonas putida* WCS358r strains produce phenazine and 2, 4-diacetyl pholoroglucinol improves capacity to suppress plant diseases in the field. *Bacilluscereus* strain UW85 produces both zwittermycin and kanosamine.

Production of lytic enzymes

Microorganisms secrete and excrete other metabolites that interfere with pathogen metabolic activities. Lytic enzymes can hydrolyze chitin, proteins, cellulose, hemicellulose and DNA. E.g.

control of *Sclerotium rolfsi* by *serratia marcescens mediated* by chitinase expression. Hydrogen cyanide effectively blocks the cytochrome oxidase pathway is high toxic to all aerobic microorganisms.

Indirect antagonism

Induced systemic resistance

It is indirect form of antagonism. Many classes of compounds are released by the *Trichoderma* spp. into the zone of interaction and induce resistance. Induced resistance is one of the mechanism by which the resistance is obtained in the host against pathogens. The defense responses includes thickening of cell wall by lignification, production of phytoalexins, proteins, pathogen related proteins, enzymes stops the spread of disease to other parts of the plant.

Cross protection

An organism which first arrives at an infection site acts directly or indirectly against a pathogen that arrives later. E.g. Symptomless strains of the TMV are used to protect tomatoes from virulent strains of the same virus. Cross protection involves inoculation of young citrus trees and nursery with mild strain of Tristeza virus inoculated trees protected from virulent strain.

Suppressive soils

Many soil borne pathogens such as *Fusarium, Rhizoctonia*, Take-all disease, *Pythium* spp ciolonized well in soil and cause severe diseases and makes the soil conducive for diseases. The soil in which, these soil borne organisms develop less and cause mild disease due to some innate bio-chemical or biological property of the soil is termed as suppressive soils. A number of antagonistic microorganisms have been naturally found in suppressive soils such as *Trichoderma, Pencillium, Pseudomonas, Bacillus*, etc. These microorganisms produce antibiotics, lytic enzymes, competition for food and do not allow pathogen to reach high inoculum density. However, continuous monoculture of crops in conducive soils sometimes leads to suppressive soils after some years. Suppressive soil added to conducive soil also reduces the disease inoculum. The degree of supressiveness depends on soil physical and chemical characteristics like fertility level, biodiversity, soil pH, organic matter, clay content, and population of soil microflora and soil management. The mechanism of suppression is through antibiosis, competition, parasitism and predation. Suppressive soils can be divided to two broad types, natural and induced. Natural supressiveness is correlated with the physical properties of soils and relatively not depends on crop history. In induced supressiveness, it is majorly dependent on agricultural practices. Soils that naturally suppress the development of wilt diseases were identified in various cropping systems in the world. Soil suppressive to Take-all disease of wheat was identified under cropping conditions, that is, monoculture over the years. Avocado root rot caused by *Phytophthora cinnamomi* was controlled due to supressiveness created by highest number of microorganisms with higher nitrogen and calcium content. Suppression of inoculum densities of *Pythium ultimum* was found in finely textured soils.

Antagonistic Plants and botanicals

A few kinds of plant e.g. Asparagus and marigold, are the antagonistic to nematodes because they release substances in the soil that are toxic to several plant parasitic nematodes and fungi. When interplant with nematode susceptible crops, antagonistic plants decreases the number of nematodes in the soil and in the roots of the crops. E.g. sorghum secrets HCN that inhibit *Fusarium* population. Marigold roots secrets alpha-tertinyl which reduces root knot nematode. Mustard produces glucosinolates reduces the incidence of soil borne nematodes. Scales of red onion produces catechol and protocatechuic acid reduces the smudge incidence. A number of botanicals

are used against a number of fungal disease. Commercially used botanicals are neem, garlic, turmeric, eucalyptus, tobacco, lemon grass, etc. The leaf extracts of *Eucalyptus globosus* (5%) and *Azadirchta indica* (5%) exhibits greater antifungal against *Alternaria brassica*e and *Albugo candida*.

Conclusion

Integrated approach of preventive and corrective measures to keep the pathogen from causing significant problems. IDM is a disease control approach which uses all the management strategies to maintain disease pressures below an economic injury. It does not allow a regular application of chemicals, but promotes cultural, physical and biological methods in which regular application of fungicides effect the environment. Practical application of biocontrol agents in the field level are not showing effective results due to constraints such as soil type, soil texture, soil pH, convenience, efficacy, reliability, BCA's shows diversity in different field conditions. Some experiments resulted that biological control has the nearly same efficiency as fungicide application. The combined systematic using of all control methods such as cultural, physical, chemical method and biological methods would be economical and control these diseases effectively. Benefits of IDM in disease control are more than that achieved by individual method.

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