Mechanisms of Biological Control

In natural ecosystems, the natural enemies control the populations of pest species as part of ecological services through different types of biotic interactions (like predation, parasitism, herbivory, competition, antibiosis), and help keep any one species from taking over for very long. The biocontrol agents use these mechanisms to kill or overcome the pests. They either bring about a physiological or biochemical change in the host plant thereby reducing its susceptibility to pest or they kill or inactivate the pest itself. Understanding how the bio control agents work can facilitate optimization of control as well as help to screen for more efficient strains of the agent.

Some important mechanisms behind diverse biological control are:

1. **Predation**: is a a type of negative/ antagonistic biological interaction where one organism, the predator, kills and eats another organism, its prey. Among biocontrol agents, predators are entomophagous insects that feed on more than one prey in their lifetime. Larvae, nymphs and adults of many insect orders can be predators and may feed on all developmental stages of their prey. e.g. predatory lady beetle (*Rodolia cardinalis*) to control cottony cushion scale (*Icerya purchasi*), an insect attacking citrus.
2. **Parasitism**: is another type of negative/antagonistic interaction where one organism (parasite) live on or inside other organism (host) and deprives the host off nutrition.
3. **Parasitoidism**: Parasitoids are parasitic organisms (mostly insects in the orders Diptera and Hymenoptera) that develop in a single host, usually **killing** it. Parasitoids can parasitize all insect developmental stages, from eggs to adults. e.g egg parasite *Trichogramma* for controlling the eggs of various types of moths.
4. **Herbivory**: is another negative interaction where one organism (an animal species) injure the other organism (plant species) by feeding on it and decreasing host biomass. This is mostly used to control weeds.
5. **Competition**: is also another negative interaction, where two organisms compete with each other for nutrients and space.
6. **Antibiosis:** is an antagonistic interaction, in which the antagonist produces substance(s) that could be an antibiotic, lytic enzyme (degrades plant cell wall), volatile substance, or toxin that effectively targets and destroys the pathogen.
7. **Making crop resistant to pest (Genetically engineered).** In this, crop species is modified genetically using genetic engineering. The desired disease resistance gene is incorporated into the genome of crop. e.g. Bt cotton.

Various mechanisms employed by the bio control agents in controlling the plant diseases are broadly classified into:
a) Direct antagonisms
b) Indirect antagonism

Direct Antagonism

Direct antagonism results from the physical contact and / or high degree of selectivity for the pathogens by bio control agent. It includes hyper-parasitism. It is the most considered and the most direct form of antagonism. Hyper-parasitism involves tropic growth of bio control agent towards the target organism, coiling, final attack and dissolution of target pathogens cell wall or

membrane by the activity of enzymes (Tewari, 1996). It is one of the main mechanisms involved in *Trichoderma*. *Trichoderma harzianum* exhibits excellent mycoparasitic activity against *Rhizoctonia solsni* hyphae (Altomare *et al.,* 1999). Mycoparasitism is under the control of enzymes. Harman (2000) reported the involvement of chitinase and β-1, 3 glucanase in the *Trichoderma* mediated biological control. Since enzymes are the products of genes, slight change in the structure of gene can lead to the production of different enzyme. Gupta et al. (1995) reported that a strain of *Trichoderma* deficient in the ability to produce endo chitinase had reduced ability to control *Botrytris cineria* but shows increased ability to control *Rhizoctonia solani.*

Indirect Antagonism

Competition

From the microbial perspective, soils and living plant surfaces are frequently nutrient limited environment. Both the bio control agents and the pathogens compete with one another for the nutrients and space to get established in these environments. This process of competition is considered to be an indirect interaction between the pathogen and the bio control agent whereby the pathogens are excluded by the depletion of food base and by physical occupation of site. e.g. in rhizpsphere the beneficial bacteria colonize the plant roots and inhibit access to plant roots by pathogenic bacteria and fungi.

Antibiosis

Refers to the production of low molecular weight compounds or an antibiotic by micro-organisms that have a direct effect on the growth of plant pathogen. *In situ* production of antibiotics by several different bio control agents has been measured. An efficient bio control agent is one that produces sufficient quantities of antibiotics in the vicinity of the plant pathogen. The production of HCN by certain fluorescent pseudomonads is believed to be involved in the suppression of root pathogens. *Pseudomonas fluorescens* CHA0 produces antibiotics, siderophores and HCN and suppress root pathogens.

Plant Growth Promotion

Bio agents can reduce the disease incidence of crops by increasing their growth at least during the early stages of the life cycle by the way of disease escape. The best example of this is the resistance of damping off of Solanaceous crops with advance of age.

Induced Systemic Host Resistance

Induced resistance is the most indirect form of antagonism. Induced resistance can be local or systemic. Salicylic acid (SA) and non-expressor of pathogenesis-related genes1 (NPR1) are key players in systemic acquired resistance. *Trichoderma harzianum* when inoculated on to roots or on to leaves of grapes also provides control of diseases caused by *Botrytis cineria* on leaves spatially separated from the site of application of the bio control agent.

References:

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