**Biological control**

Microorganisms like fungi naturally present in natural habitats, have been parasitizing plants over millions of years to non-cultivated and cultivated plants. Also they have been interacting with their pathogenic counterparts and have been governing the infection in plants to a minimum level. But this behaviour of controlling one organism by other called biological control.

According to Baker and Cook (1974) biological control is the reduction of inoculums density or disease producing activities of a pathogen or parasite in its active or dormant state, by one or more organisms, accomplished naturally or through manipulation of the environment, host or by mass introduction of one or more anatagonists.

**Natural biological control**

Soils may be classified as conducive and suppressive in respect to development of soil-borne diseases. There are many soil-borne diseases, e.g., root rot disease of many fruit and forest trees vascular wilts, damping off, and take-all of wheat that appear in severe form in certain soils, such soils are called conducive soils. But the same diseases develop much less and cause much milder effect on their host in other soils, such soils are referred to as suppressive soils. The inhospitability of suppressive soils to certain pathogens is such that either the pathogen can not established themselves, or they become established but fail to cause disease, or they become established and initiate disease but diminish in severity with monoculturing of the crop.

Various kinds of antagonistic microorganisms do occur in suppressive solis, the most common pathogen and disease suppression appears caused by fungi (e.g. *Trichoderma*, *Sporidesmium*, *Penicillium*) or by bacteria belonging to genera *Pseudomonous*, *Bacillus* and *Streptomyces*. Such antagonists, through direct parasitizing of the pathogen, through competition for nutrients, or through the toxic/inhibitory chemicals they produce, do not allow the pathogen to reach high enough population to cause severe disease. Thus suppressive soil is an umbrella wherein fungistasis, competitiveness for survival, and variety of interactions between pathogen and host exist.

**Mycoherbicides**

Though viruses, bacteria as well as fungi has been used as herbicides, fungi could be found more suitable for the purpose. Fungal pathogen are attractive biocontrol for weed control in view of their host specificity and ease in production and inoculation in the field where, once established, they will spread on their own. In classical strategy fungi parasitic on a particular weed plant is introduced into a new area in which the pathogen is not known to attack the weed. Mostly rust fungi have been used. These include *puccinia chondrillina* to control rush skeletonweed in Australia, and west U.S., and Phragmidium violaceum to control Eurepaen blackberry in Chile. Recently, however, a new strategy mycoherbicide or inundative strategy, has been developed. In this method the weed plant is repeatedly inoculated with inoculums doses of the pathogenic fungus. Several products of different fungi have been developed and are in use on commercial scale in different parts of world.

**Table Biological control agents being developed for commercial use**

|  |  |  |
| --- | --- | --- |
| **Microorganisms** | **Target organisms** | **Crops** |
| *Bacillus thuringiensis* | Heliothis and other Lepidopteran and Coleopteran paest | Cotton, chickpea, maize, tomato, groundnut etc. |
| *Trichograma parasitoid* | Sugarcane internode borer, bollworms of cotton, stem borer (sorghum) | Sugarcane, cotton, sorghum |
| *Trichoderma* | Macrophomina phaseolina; seed treatment | Groundnut, chickpea, sunflower etc. |
| *Colletotrichum gloeosporioides* | Northern jointvetch |  |
| *Phytophthora palmivora* | Milkweed vine |  |
| *Colletotrichum gloeosporioides* | dodders |  |
| *Colletotrichum coccodes* | Velvet leaf |  |
| *Colletotrichum gloeosporioides* | Round leaved mallow |  |
| *Alternaria cassiae* | Sicklepod |  |

**Myconematicides**

Various studies have been made with fungal nematicides. Classcal nematode-trapping fungi belonging to the genera, *Arthrobotrys, Dactylaria, Dactylella and Monacrosporium* have been studied in trials to control nematode genera Meloidogyne, Heterodera and Rotylenchulus, attacking mostly vegetable crops. These nematodes cause cyst and root knot diseases in these plants. There have been some limitations in the use of classical nematophagous (trap-forming) fungi for the control of these nematodes. It is difficult to manage fungi so that periods of nematode migration and trap formation coincide. Another group of fungi, the soil fungi have been found more ideal nematicides. These are **opportunistic fungi** such as *Vertivillium chlamydosporium, Dactylella oviparasitica* and *Paecilomyces lilacinus* that also attack eggs and young females of cyst and root-knot nematodes. Of these *P. lilacinus* has attracted much attention as it is almost ubiquitous in tropical and subtropical soils.

**Mycoinsecticides**

The greatest commercial impacts of biocontrol agents have been made in the insecticide markets. The most successful biocontrol agent has so far been the insecticidal bacterium, *Bacillus thuringiensis*, whose sales in forestry, agriculture and public health went much higher. Viruses, bacteria and fungi have been used as microbial insecticides.

Fungal insecticides become most common and effective by means of control of insect pests in some countries, chiefly in ex-USSR. Products of the entomogenous fungi have been used for insects of field crops, forest trees as well as horticulture and vegetable crops grown in greenhouse. Several preparations have been produced, formulated and used commercially, chiefly in ex-USSR and developing countries like Brazil, Cuba and Israel. In western world fungal products have not yet been as successful as viral and *B.t.* insecticides. Different kinds of formulations have been developed and applied in different ways to insect pests. Though insect mycoses are caused by members of every class of fungi, most studies on entomogenous fungi have been concerned with species of the genera, *Aschersonia, Beauveria, Metarrhizium, Verticillium, Hirsutella, Coelomomyces and Entomophthora*. Some fungal insecticides are listed below

|  |  |  |
| --- | --- | --- |
| **Sl. No.** | **Insect pest** | **Fungus** |
| 1 | Glasshouse whitefly of many crops | *Aschersonia aleyrodis* |
| 2 | Colorado potato beetle, coding moth Pine caterpillar, green leaf hopper, European corn borer | *Beauveria bassiana* |
| 3 | Rice black bug aphid | *Entomophthora sphaerosperma* |
| 4 | Spittle bug of sugarcane, Coconut pest, Pasture cockchafer, black vine weevil | *Metarrhizium anisopliae* |
| 5 | Aphids and white fly of glasshouse crops | *Verticillium lecanii* |

**Mycofungicides**

Mycofungicides have been promoted for agricultural use because of their ability to control plant diseases and their ability to increase crop production in an environmentally friendly manner. In recent years several mycofungicides have been patented and registered for plant disease control. Several effective mycofungicides have been formulated for commercial production. Formulation of mycofungicides includes wettable powders and granules; these being applied to seeds, seedlings and mature plants. Examples are Ketomium, formulated from *Chaetomium globosum* and *Ch. cupreum*, Promote formulated from *Trichoderma harzianum* and *T. viride*, Soil Gard formulated from *Gliocladium virens*, and Trichodex from *T. harzianum*.

Microbial antagonists can suppress plant diseases and organisms that suppress pathogens can be referred to as biological control agents (BCA). Various fungal species can be used as biological control agents and may provide effective activity against various pathogenic microorganisms. Examples are *Trichoderma harzianum* - a species with biocontrol potential against *Botrytis cineria*, *Fusarium*, *Pythium* and *Rhizoctonia*; *Ampelomyces quisqualis*, - a hyperparasite of powdery mildew; *Chaetomium globosum* and *C. cupreum*, - having biocontrol activity against root rot disease caused by *Fusarium*, *Phytophthora* and *Pythium*; *Gliocladium virens* - effective biocontrol of soil borne pathogens; *Coniothyrium minitans* - a mycoparasite of *Sclerotinia*; and *Fusarium oxysporum* (nonpathogenic species) - having biocontrol potential against *Fusarium oxysporum*. An effective biological control agent should be genetically stable, effective at low concentrations, easy to mass produce in culture on inexpensive media, and be effective against a wide range of pathogens. The fungal biological control agent should also occur in an easily distributed form, be non-toxic to humans, have resistance to pesticides, be compatible with other treatments, and be non-pathogenic against the host plant. Several fungal taxa have been reported to be antagonist against plant pathogens and have been successfully formulated as mycofungicides or biological control products e.g. *Ampelomyces quisqualis, Aspergillus niger, Candida oleophila, Chaetomium cupreum, Ch. globosum, Coniohyrium minitans, Cryptococcus* *albidus, Gliocladium virens, G. catenulatum, Fusarium oxysporum, Phlebiosis gigantean, Pythium oligandrum, Rhodotorula glutinis, Trichoderma harzianum, T. polysporum, T. viride*.