Biological control of diseases and IPM

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Biological control-definition

- According to **De Back** (1964)- “biological control is the action of predators, parasites or pathogens in maintaining another organisms’ population density at a lower average than would occur in their absence”.
- According to **Garrett** (1970)- “any condition under which or practice whereby survival or activity of a pathogen is reduced through the agency of any other living organism (except man himself) with the result that there is a reduction in the incidence of the disease caused by that pathogen is called biological control”.

Mode of action of biological control agents (BCA)

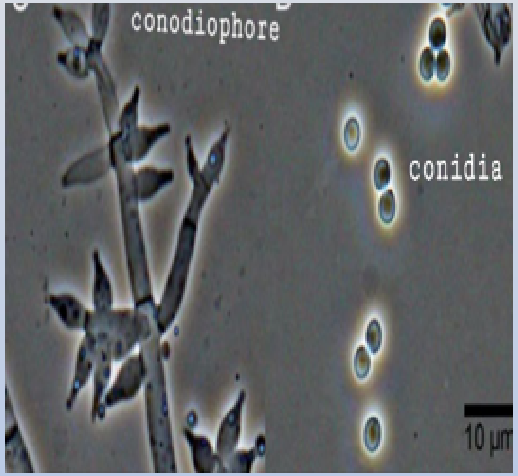
- **Antagonism-** In biological control, antagonism is the central dogma, which occurs routinely in nature. Antagonism is a type of symbiosis (living together of two unlike organisms) in which one organism is harmed by the other either by the latter being parasitic or predatory on former, or through competition for food in short supply, or through secretion of certain toxic substances.

  Antagonism can be divided into 3 broad categories:

- Exploitation (Parasitism or predation)
- Competition
- Antibiosis

Exploitation (parasitism or predation)

- Exploitation is an antagonistic condition where in an organism directly harms other organisms to get benefit out of the harm done to the organism. This phenomenon is operated through parasitism and predation. The two terms basically being same in their effect but different in their mode of operation.
- A parasite develops some sort of etiological relationship with its host and the latter is exploited slowly.
- A Predator physically eliminates prey (host) by directly feeding on it without establishing any etiological relationship. *Trichoderma* species mainly ***Trichoderma harzianum*** is one of the most common mycoparasitic fungi. It has been found to parasaitise mycelia of ***Rhizoctonia*** and ***Sclerotium***. Several yeasts for instance ***Pichia gulliermondii*** also parasitize and inhibit the growth of *Botrytis*, *Penicillium* other plant pathogenic fungi.



Trichoderma

Competition

Ability to compete successfully with a pathogen is an important property of biological control organisms. Often, successful competition occurs at the infection court, preventing the ingress of the pathogen although in some instances, ability of the biological control agent to limit reproduction of the pathogen can also be important. The fungus ***Idriella bolleyi***, controls **take-all disease of wheat caused by *Gaeumannomyces tritici*** by competition for both nutrients and infection sites. It does this by exploiting senescing cortical cells of the plant, which occur naturally early in its growth and rapidly producing spores. These are carried down the root by water and continue its colonization. Many pathogens require iron as an essential mineral nutrient for growth and in some cases iron is required for virulence. Hence, production of a siderophore by a biological control agent may reduce the growth of a pathogen or its ability to attack the host.

Antibiosis

- Antibiosis is that antagonistic condition in which there is suppression of pathogenic microorganisms due to secretion of toxic or inhibitory compounds (antibiotics) by other microorganisms. Such compounds range from hydrogen cyanide (HCN) to enzymes and the microorganisms involved are often species of ***Trichoderma*** and ***Gliocladium*** among fungi and ***Bacillus*** and ***Pseudomonas*** among bacteria. Eg. ***Trichoderma harzianum*** produces two **pyrone** antibiotics to suppress take-all disease of wheat (***Gaeumannomyces tritici***).
- ***Bacillus subtilis*** effectively controls ***Rhizoctonia solani*** in many crops by producing **bacilysin** and **fengymycin**.

Hypovirulence

- Hypovirulence is the phenomenon of reduced virulence of a pathogen strain than normal ones developed as a results of its infection by double-stranded RNA (ds RNA). When a hypovirulent strain was co-inoculated with highly virulent strain of a fungus, the latter became hypovirulent normally by hyphal contact (anastomosis). Some transmissible factors moved from the hypovirulent strain into the more aggressive one. The agent (s) responsible were shown to be cytoplasmic and were subsequently identified as double stranded RNA (ds RNA) molecules.
- The phenomenon of hypovirulence is well established in a number of fungal pathogens. ***Cryphonectria parasitica*** and ***Ceratocystis ulmi*** are the pathogens of chestnut blight and Dutch elm disease respectively. Both harbour double stranded RNA because several different-sized double stranded RNA have been isolated from hypoviral strains of these fungi.

Induction of host resistance

- Disease suppression through the induction of resistance in host is an alternative and quite different mode of action of biological control agents. It has been found during recent years that rhizosphere bacteria (rhizobacteria) applied to seeds or roots induce systemic resistance response expressed against pathogens infecting aerial tissues. For instance, when ***Pseudomonas fluorescence*** was applied to roots of carnation and the stems were inoculated one week later with ***Fusarium oxysporum f.sp. dianthi,*** the vascular wilt causing fungus, the incidence of the disease was reduced as a result of increase in the resistance of the host.

Characteristics of an effective biological control agents (BCA)

An effective biological control agent that results in protection against disease caused by the plant pathogenic organisms must have the following characteristics:

1. BCA must be able to control the pathogen by inhibiting its development, making it vulnerable to other members of the prevailing microflora or killing it.
2. BCA must be able to establish itself at the appropriate location and at a sufficient density to give effective control for air-borne pathogens.

Commercially available BCAs, their trade name and the target

BCA	Trade name	Target
Trichoderma harzianum	F-stop	several soil-bone diseases
Trichoderma harzianum/T.Polysporum	Binab-T	Wood decays, mushroom dry bubble, silverleaf of fruit trees
Pseudomonas fluorescens	Dagger G	*Rhizoctonia* and *Pythium* damping off
Bacillus subtilis	Kodiak, Quantum 4000	Seedling disease

Integrated Pest disease management

- The concept of integrated Disease Control was developed by Stern *et al.*, in 1959. Since then the concept has expanded beyond the original vision to embrace not only chemical and biological control but a wide variety of additional approaches to best suppression. In fact integrated pest management (IPM) is an effective and environmentally sensitive approach to pest management. It takes the advantage of all appropriate pest management options including judicious use of pesticides. Although, some of the principles of integrated pest management are similar to those that applied to organic farming but the latter limits the use of pesticides to those that are produced from natural Sources as opposed to synthetic chemicals.

Farmers practicing IPM follow a four tired approach. The four steps are as follows:

1. **Set action threshold** Before taking any pest control action IPM first sets an action threshold, a point at which pest population or environmental conditions indicate that pest control action must be taken. Sighting a single pest does not always mean Control is needed. The level at which pest will become an economic threat is critical to guide future pest control decisions.
2. **Monitor and identify pest** Not all insects, weeds and other living organisms require control. Many organisms are not at all harmful and some are even beneficial. IPM programs work to monitor for pest and identify them accurately so that appropriate control decisions can be made in conjunction with action threshold.
3. **Prevention** As a first line of pest control, IPM programs work to manage the crop, lawn or indoor space to prevent pest from becoming a threat. In an agricultural crop this may mean using cultural methods such as rotating between different crops, selecting pest-resistant varieties and planting pest-free stock. These control methods can be very effective and cost-efficient. Prevention presents little or no risk to people or the environment.
4. **Control** Once action threshold, monitoring and identification indicate that pest control measures are required and preventive methods are no longer effective. IPM programs then evaluate the proper control method both for its effectiveness and risk. Effective and relatively less risky pest controls are chosen first. These may include highly targeted chemicals, such as pheromones to disrupt pest mating or mechanical control such as trapping or weeding. However, if further monitoring, identification and action thresholds indicate that less risky controls are not working, then additional pest control methods would be employed. These may include targeted spraying of pesticides. Broadcast spraying of non-specific pesticides is the last resort.

IPM system includes following elements:

1. Identification of pests and their natural enemies.

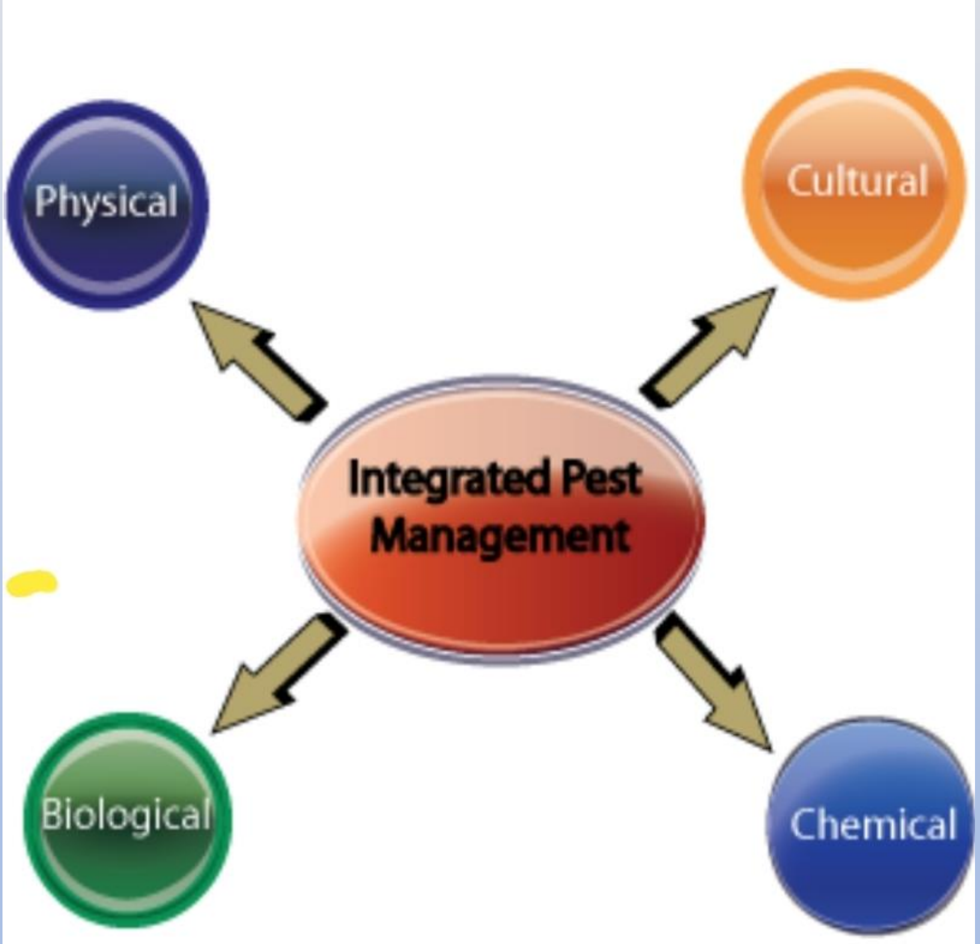
2. Continuous monitoring, sampling and assessment of pests and their natural enemy population.

3. Determining the pest population levels that can be tolerated based on aesthetic, economic and health concerns and setting action threshold where pest populations or environmental conditions warrant remedial action.

4. Preventing pest population through improved sanitation, management of waste, addition of physical barriers and modification of habitats that attract or harbour pests.

5. Relaying on non-toxic, biological, cultural or mechanical pest management methods or on the use of natural control agents, as for as possible.

6. If the use of chemical pesticides is inevitable, preference should be given to the products that are the least harmful to human health and the environment.


Physical
Cultural
Integrated Pest Management
Biological
Chemical

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