Lecture 17: BIOLOGICAL CONTROL - DEFINITION - HISTORY AND DEVELOPMENT - CLASSICAL EXAMPLES - FACTORS GOVERNING BIOLOGICAL CONTROL

Biological control

Definition

The study and utilization of parasitoids, predators and pathogens for the regulation of pest population densities.

Biological control can also be defined as the utilization of natural enemies to reduce the damage caused by noxious organisms to tolerable levels.

Biological control is often shortened to biocontrol.

History and development of biological control and classical examples of biological control

Antient times - In China Pharoah's ant *Monomorium pharaonis* was used to control stored grain pest. Red ant *Oecophylla* spp. used to control foliage feeding caterpillar.

Year 1762 - 'Mynah' bird imported from India to Mauritius to control locust.

1770 - Bamboo runways between citrus trees for ants to control caterpillars.

1888 - **First well planned and successful biological control attempt made**

- During 1888 citrus industry in California (USA) seriously threatened by cottony cushion scale, *Icerya purdian*
- Chemical treatments not known at that time
- Mr. C.V. Riley, a prominent entomologist suggested that the scale inset originated from Australia and natural enemy for the scale from Australia should be introduced into USA
- Mr. Albert Koebele was sent to Australia
- He found a beetle called Vedalia (*Rodolia cardinalis*) attacking and feeding on seeds
- Vedalia beetle (*Rodolia cardinalis*) was imported in November 1888 into USA and allowed on scale infested trees
- Within a year spectacular control of scale insect achieved
- Even till date this beetle controls the scale insect
- After this successful attempt of biological control many such introduction of natural enemies were tried.

1898 - First introduction of natural enemy into India

1898 - A coccinellid beetle, *Cryptolaemus montrouzieri* was imported into India from Australia and released against coffee green scale, *Cocus viridis*. Even today it is effective against mealybugs in South India.

1920 - A parasitoid *Aphelinus mali* introduced from England into India to control Woolly aphid on Apple, *Eriosoma lanigerum*.

1929-31 - *Fodolia cardinalis* imported into India (from USA) to control cottony cushion scale *Icerya purchasi* on Wattle trees.

1958-60 - Parasitoid *Prospatella perniciosus* imported from China

1960 - Parasitoid *Aphytis diaspidis* imported from USA

Both parasitoids used to control Apple Sanjose scale *Quadraspidiotus perniciosus*

1964 - Egg parasitoid *Telenomus* sp. imported from New Guinea to control Castor semilooper *Achaea janata*

1965 - Predator *Platymeris laevicollis* introduced from Zanzibar to control coconut Rhinoceros beetle, *Oryctes rhinoceros*

History, development, classical examples of biocontrol
Till 1988

At global level 384 importations made against 416 species of insect pests. Out of them

164 species (39.4%) - Completely controlled
75 species - Substantially controlled
15 species - Partially controlled

- Regional Station of Commonwealth Institute of Biological Control (CIBC) established at Bangalore in 1957
- Presently Project Directorate of Biological Control (PDBC) Bangalore looks after Biocontrol in India.

Factors affecting biological control

1. Tolerance limit of crop to insect injury - Successful in crops with high tolerance limit
2. Crop value - Successful in crops with high economic value
3. Crop duration - Long duration crops highly suitable
4. Indigenous or Exotic pest - Imported NE more effective against introduced pest
5. If alternate host available for NE, control of target pest is less
6. If unfavourable season occurs, reintroduction of NE required
7. Presence of hyperparasites reduces effectiveness of biocontrol

8. Tritrophic interaction of Plant-Pest-Natural enemy affects success of biocontrol, e.g. *Helicoverpa* parasitization by Trichogramma more in timato than corn
9. Use of pesticides affect natural enemies
10. Selective insecticides (less toxic to NE required)
11. Identical situation for successful control does not occur

Qualities of an effective natural enemy

1. Adaptable to the environmental condition
2. Host specific (or narrow host range)
3. Multiply faster than the host (with high fecundity)
4. Short life cycle and high female : male ratio
5. High host searching capacity
6. Amenable for easy culturing in laboratory
7. Dispersal capacity
8. Free from hyper parasites
9. Synchronise life cycle with host

Three major techniques of biological control

1. Conservation and encouragement of indigenous NE

Defined as actions that preserve and increase NE by environmental manipulation. e.g. Use of selective insecticides, provide alternate host and refugia for NE.

2. Importation or Introduction

Importing or introducing NE into a new locality (mainly to control introduced pests).

3. Augmentation

Propagation (mass culturing) and release of NE to increase its population. Two types,

(i) **Inoculative release**: Control expected from the progeny and subsequent generations only.

(ii) **Inundative release**: NE mass cultured and released to suppress pest directly e.g. *Trichogramma* sp. egg parasitoid, *Chrysoperla carnia* predator

ROLE OF PARASITOIDS AND PREDATORS IN IPM

- Parasitoids and predators may be used in Agriculture and IPM in three ways. They are
  - i) Conservation
  - ii) Introduction
  - iii) Augmentation - (a) Inoculative release, (b) Inundative release

- Since biological control is safe to environment, it should be adopted as an important component of IPM.
- Biological control method can be integrated well with other methods namely cultural, chemical methods and host plant resistance (except use of broad spectrum insecticides)
- Biological control is self propagating and self perpetuating
- Pest resistance to NE is not known
- No harmful effects on humans, livestock and other organisms
- Biological control is virtually permanent
- Biological agents search and kills the target pest

MICROBIAL CONTROL

- It is a branch of biological control
- Defined as control of pests by use of microorganisms like viruses, bacteria, protozoa, fungi, rickettsia and nematodes.

I. VIRUSES

Viruses coming under family *Baculoviridae* cause disease in lepidoptera larvae. Two types of viruses are common.

NPV (Nucleopolyhedro virus) e.g. HaNPV, SlNPV
GV (Granulovirus) e.g. CiGV

Symptoms

Lepidopteran larva become sluggish, pinkish in colour, lose appetite, body becomes fragile and rupture to release polyhedra (virus occlusion bodies). Dead larva hang from top of plant with prolegs attached (Tree top disease or "Wipfelkrankeit")

II. BACTERIA

2 types of bacteria
- Spore forming (Facultative - Crystalliferous)
- Spore forming (Obligate)
- Non spore forming

i. Spore forming (Facultative, Crystelliferous)

The produce spores and also toxin (endotoxin). The endotoxin paralyses gut when ingested e.g. *Bacillus thuringiensis* effective against lepidopteran. Commercial products - Delfin, Dipel, Thuricide

ii. Spore-forming (Obligate)

e.g. *Bacillus popilliae* attacking beetles, produce **'milky disease'**
Commercial product - 'Doom' against 'white grubs'

iii. Non-spore forming

e.g. *Serratia entomophila* on grubs

III. FUNGI

i. Green muscardine fungus - *Metarhizium anisopliae* attack coconut rhinoceros beetle

ii. White muscardine fungus - *Beaveria bassiana* against lepidopteran larvae iii. White halo fungus - *Verticillium lecanii* on coffee green scale.

Other Microbs: Protoza, Nematodes

Limitations of biocontrol technique

- Complete control not achieved - Slow process
- Subsequent pesticide use restricted
- Expensive to culture many NE
- Requires trained man power