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Role of Bio-Agent in Organic Farming

Gaurang Chhangani*, Hemant Swami, Lekha and N.L. Regar
Department of Entomology, Rajasthan College of Agriculture
Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan

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Introduction

Organic Farming is a method of cultivation done in line with nature, which facilitates biodiversity and cost effective method to involve use of Bio-agents (Bio-fertilizers, Bio-Pesticides and Bio-Control Agents). This piece deals with Bio-agents – its types, uses and advantages. These are cost efficient, which helps the farmers. It is so affordable even to the poor farmers and the produce excels in quality compared to the chemically produced ones. As a bonus to the ecosystem and environment, the microbial load is increased, the farmers' friends (insects like spider, earthworm and many beneficial insects) and their food web are protected.

Farming practices rely on methods which combine knowledge of ecology and modern technology with traditional farming practices based on naturally occurring biological processes. In order to minimize the usage of synthetic pesticides, biological pest control methods are used. This method uses other organisms to control insects, mites, weeds and plant diseases which rely on predation, parasitism, and herbivory or some other natural mechanisms, including an active human management role. Biological pest control creates no chemical runoff in waterways or soil pollution. It targets a narrow range of pests, sometimes even a single species and other beneficial insects. As a result, animals remain unharmed. Successfully established biological control species will maintain stable populations for generations without the need for additional investment by humans.

Biological Control Agents

Natural enemies for plant insect pests and diseases are known as biological control agents. They include predators, parasitoids, and pathogens. A predator is an organism that eats another organism (animal, plant, fungi or dead organic matter) while parasitoids have most of their life attached to or within a host organism, with which they have a relationship. It is similar to parasitism but they ultimately sterilize, kill or sometimes consume their hosts.

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Major Characteristics of Insect Parasitoids:

- Host specific and smaller in size.
- Different parasitoids attack different stages of host
- Eggs/ larvae are usually laid in, on, or near the host
- Immatures remain on or in the host; adults are free-living, mobile
- Immatures almost always kill the host.

Common Bio-agents

1. **Ladybird beetles**

They are natural enemies of many insects, especially the aphids and other sap feeders. A single lady beetle may eat as many as 5,000 aphids in its lifetime and common in most habitats.

Adult lady beetles have very characteristic convex, hemispherical to oval shaped bodies that can be yellow, pink, orange, red, or black, and usually are marked with distinct spots. This is a type of warning coloration to discourage other animals that may try to eat them.

Adult females usually lay clusters of eggs on plants in the vicinity of aphids, scales, or mealybug colonies. The alligator-like larvae are also predators. They are spiny and black with bright spots. Although they look dangerous. Some lady beetle species have several generations each year while others have only one.

2. **Lacewing bugs**

Common species of lacewings include two green lacewing species, *Chrysoperla carnea* and *Chrysopa oculata*, and one brown lacewing species, *Hemerobius pacifus*. Lacewing eggs are white and laid singly or in groups on long stalks on the underside of leaves or branches. The brown and green lacewing larvae are very similar except for small

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differences in body shape and the brown lacewing's habit of moving its head from side to side while walking.

There can be upto four generations per year depending on temperature. Lace wings feed on different Insect Pests like Aphids, spider mites, whiteflies, thrips, leafhoppers, scales, mealybugs, psyllids, small caterpillars and insect eggs. Green lacewings are commercially available.

3. Syrphid (Hover) fly larvae

Hover fly larvae are flattened, legless maggots with no distinct head and a tapered body. They are variously coloured (yellow, green to brown). Adults frequently visit flowers over which they hover before landing to feed on nectar and pollen (their only food source). They are often mistaken for bees or wasps which they mimic in colouration.

Hover fly eggs are white, elongate, with fine sculpturing and are visible in aphid colonies. Eggs are laid on aphid infested plant parts. There can be several generations per year depending on the temperature and location. Hover fly maggots attack aphids, scales, thrips and other small soft-bodied insects.

4. Praying mantids

Adults are 5-10 cm long and green, brown or yellow in colour. Mantids have an elongated thorax and grasping forelegs, which they use for holding their prey while eating.

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Mantids have one generation per year and overwinter as eggs in egg cases, which are glued to wood, bark, or other plant material.

Mantids attack many insects including aphids, flies, beetles and feeds on pests as well as beneficial insects. Mantids grasp their prey with spined front legs and hold them while they eat.

5. Parasitic wasps

Parasitic wasps occur in various shapes and sizes and are commonly named according to their family name (for example; Ichneumons, Brachnoids, Chalcids and Trichogramma). They attack various pests *viz*., Aphids, borers, whiteflies, pyrilla and DBM etc. Parasitized aphids (mummies) appear inflated and are often tan or black in colour with hardened, shell-like appearance. Small round exit holes will appear in those from which adult wasps have emerged. Some parasitic wasp larvae may leave their host - such as caterpillars - to make small white cocoons beside the host carcass in which to pupate.

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Trichogramma, *Encarsia formosa* and *Aphidius* parasitoids such as *Aphidius ervi*, *A. colemani*, *A. matricariae* are commercially available. *Trichogramma* is an egg parasitoid which works well against Lepidopteran insect pests and commercially available as Tricho-card. *Encarsia formosa* is used for the control of whiteflies in greenhouses. Aphididius parasitoids are effective against aphids.

Common Microbial Agents

1. *Bacillus*

Bacillus thuringiensis, a naturally soil borne microbe. It makes proteins that are toxic to immature insects (larvae). There are many types of *Bt*. Each targets different insect groups. Target insects include beetles, mosquitoes, black flies, caterpillars, and moths. Currently, *Bt* strains are found in over 180 registered pesticide products. *Bt* products are used on crops and ornamental plants. *Bt* makes toxins that target insect larvae when eaten. In their gut, the toxins are activated. The activated toxin breaks down their gut, and the insects die of infection and starvation. Death can occur within a few hours or weeks. Each type of *Bt* toxin is highly specific to the target insect. For example, the 'kurstaki' type targets caterpillars. The 'isrealensis' type targets immature flies and mosquitoes. Little to no direct toxicity to non-target insects has been observed.

***Bacillus thuringiensis var kurstaki* (Bt-k) C**aterpillars, gypsy moth, cabbage looper, tomato hornworm and other leaf eating caterpillars on trees, shrubs, tomatoes and other vegetables.

***Bacillus thuringiensis var israelensis* (Bt-i)** Mosquito, black fly and fungus gnat larvae.

Bacillus thuringiensis var tenebrionis limited range of leaf-eating beetle species

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Bacillus popilliae Japanese beetle larvae

2. Fungus

The disease caused by fungus are called 'Mycosis'. The important genera are Paecilomyces, Nomuraea, Metarhizium, Hirsutella , Fusarium, Beauveria , Asperigllus, Cordyceps. High humidity is vital for germination of fungal spores and transmission of the pathogen from one insect to another.

The green muscardine fungus, *Metarhizium anisopliae* has been detected from atleast 300 species of insects. It is active against chrysomelid, cucurculionid and scarabaeid beetles. The white muscardine is effective against many important insects like European corn borer, *Ostirinia nubilalis*, codling moth, *Cydia pomonella*, the Japanese beetle, *Popillia japonica*, Colorado potato beetle, *Leptinotarsa decemlineata*, cabbage caterpillar, *Pieris brassicae*, cotton whitefly, *Bemisia tabaci*. *Verticillium lecani* is a common pathogen of scale insects. *Hirsutella thompsonii* is highly virulent to citrus rust mite, *Phylloctruta oleivora*. *Nomuraea rileyi* is pathogenic to noctuids like *Helicoverpa* and *Spodoptera*.

3. Viruses

Viruses in the family Baculoviridae are the best known of all insect viruses. Baculoviruses are infectious by mouth and exhibit efficient horizontal transmission. They replicate rapidly and cause extensive cell and tissue destruction in host cell. In terminal stages of infection, the insect liquefies and thus release polyhedral which can infect other insects upon ingestion.

*Ha*NPV	*Helicoverpa armigera*
*Sl*NPV	*Spodoptera litura*

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*Or*V	*Oryctes rhinoceros*

The infected larva exhibit negative geotropism before succumbing to the virus infection. The dose is measured in Larval equivalents (LE) *i.e.* 6 x 10^9 POBs/ ml.

4. Nematodes

Entomogenous nematodes have various deleterious effects on their host including sterility, reduced fitness, delayed development and rapid mortality. Nematodes in the family Heterorhabditidae and Steinernematidae, have the ability to kill their host within 1-4 days, due to their mutualistic association with bacteria in genus Photorhabdus and Xenorhabdus, respectively. They are obligate pathogens in nature. The only stage that survives outside of a host is the non- feeding third stage infective juvenile (IJ) or Dauer juvenile.

IJ's invade a host through natural opening or thin areas of cuticle and penetrate into host heamocoel. The bacteria propagate and produce substances that rapidly kill the host. The nematodes feed on the bacteria, and go through 1-3 generations. Nematode based biopesticides are currently available for the control of number of Coleopterans (flea beetles, root weevils, root worms) , Dipteran (leaf miners, sciarid flies) and Lepidopteran (cutworms,

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armyworms, peach borer, crown borer, stemborers) on a variety ofcrops. Most of these products are based on *Steinernema carpocapsae*.

5. Protozoa

A majority of highly pathogenic forms occur in the protozoan phylum Apicomplexa and Microspora. The protozoans cause tumor formation, high mortality in nymphs, reduced fecundity and reduction in food intake. *Nosema locustae* against grasshoppers; *Vairimorpha necatrix* infects noctuid pests.

6. Rickettsiae

These are gram negative, obligate intracellular pathogens with typical bacterial cell walls and no flagella. When ingested, they penetrate the insect's midgut wall and replicate in tissues causing lysis. Masses of rickettsia filled vacuoles are released in haemolymph. *Rickettesiella popilliae* infects the Japanese beetle causing 'blue disease ' while *R. melolanthae* infects *Melolanthae melolantha* and other scarabaeid beetles.

7. Actinomyctes

Gram positive bacteria with a mycelial growth habit, producing a large number of secondary metabolites. Avermectins produced by *Streptomyces avermitilis* are being commercially produced as pesticides. Other compounds with insecticidal activity include aureothin produced by *S. Thiolutens*, citromycin by *S. hygroscopicus*, piericidins by *S. mabaraensis* and spinosyns by *Saccharapolyspora spinosa*.

8. Enterobacteriacae

Non spore forming, gram negative, facultative anaerobic, rod shaped bacteria with peritrichous flagella. *Serratia* spp. commonly infect insects species in orthoptera, coleoptera, hymenoptera, lepidoptera and diptera. *Serratia entomophila* offers promise for the control of grubs. An infected grub stops feeding within few days and empties its digestive tract with the midgut developing an amber discoloration. The grub gradually loses weight and dies in 4-6 weeks. Xenorhabdus spp. are mutualistically associated with entomopathogenic nematodes. The nematodes assist the bacteria in penetrating the insect's haemocoel, and the bacteria provide nutrients essential to the nematode.