ROLE OF BIO-AGENTS IN ORGANIC FARMING

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Organic Farming involves use of Bio-agents (Bio-fertilizers, Bio-Pesticides and Bio-Control Agents). 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. 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. 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.

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. Their larvae are also predators. They are spiny and black with bright spots.

2. Lacewing bugs

Common species of lacewings include two green lacewing species, *Chrysoperla carnea* and *Chrysopa oculata*, and one brown lacewing species, *Hemerobius pacificus.* 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 differences in body shape and the brown lacewing's habit of moving its head from side to side while walking. Lace wings feed on different insect pests like aphids, spider mites, whiteflies, thrips, leafhoppers, scales, mealybugs, psyllids, small caterpillars and insect eggs.

3. Syrphid (Hover) Fly Larvae

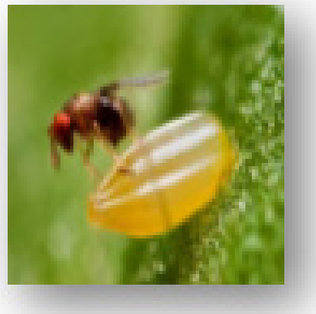
Hover fly larvae are flattened, legless maggots with no distinct head and a tapered body. They are variously colored (yellow, green to brown). Adults frequently visit flowers over which they hover before landing to feed on nectar and pollen (their only food source). They are often mistaken for bees or wasps which they mimic in coloration. Hover fly eggs are white, elongate, with fine sculpturing and are visible in aphid colonies. Eggs are laid on aphid infested plant parts. 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. 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. They attack various pests viz., aphids, borers, whiteflies, pyrilla and DBM etc. Parasitized aphids (mummies) appear inflated and are often tan or black in color 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. *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-cards. *Encarsia formosa* is used for the control of whiteflies in greenhouses. *Aphidius* parasitoids are effective against aphids.



COMMON MICROBIAL AGENTS

1. Bacteria

Bacillus thuringiensis is a natural 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. 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.

2. Fungus

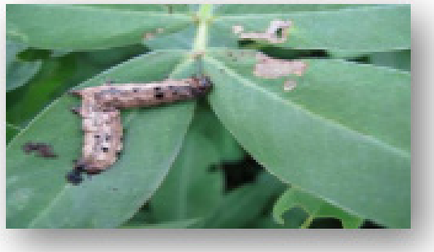
The disease caused by fungus is called 'Mycosis'. The important genera are *Paecilomyces, Nomuraea, Metarhizium, Hirsutella, Fusarium, Beauveria, Aspergillus and Cordyceps*. High humidity is vital for germination of fungal spores and transmission of the pathogen from one insect to another.

The green muscardine fungus, *Metarhizium anisopliae* 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*) and cotton whitefly (*Bemisia tabaci*). *Verticillium lecanii* 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. The infected larva exhibit negative geotropism before succumbing to the virus infection. The dose is measured in Larval Equivalents (LE) i.e. 6x109 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 haemocoel. The bacteria propagate and produce substances that rapidly kill the host. Nematode based biopesticides are currently available for the control of number of coleopteran pests (flea beetles, root weevils, root worms), dipteran pests (leaf miners, sciarid flies) and lepidopteran pests (cutworms, armyworms, peach borer, crown borer, stemborers) on a variety of crops. 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* is effective against grasshoppers and *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. *Rickettsiella popilliae* infects the Japanese beetle causing "blue disease" while *R. melolonthae* infects *Melolontha melolontha* 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. mobaraensis* and spinosyns by *Saccharopolyspora spinosa*.

8. Enterobacteriacae

Non spore forming, gram negative, facultative anaerobic, rod shaped bacteria with peritrichous flagella. *Serratia* spp. commonly infects insect 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. is 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.