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Approaches to the Biological Control of Pest

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Biological control is an environmentally sound and effective means of reducing or mitigating pests and pest effects through the use of natural enemies. It relies on predation, parasitism, herbivory, or other natural mechanisms. Biocontrol (biological control) agents are living organisms that are introduced or supported by humans with the intent to harm invertebrate pests. Biocontrol agents are sometimes called "enemies" because they attack pests. Biocontrol agents include predators, parasitoids, parasites and pathogens of pests. Biological control of pest is the use of pathogens, predator and parasitoid to kills pests by reducing their populations or eliminating them completely from our farms, garden and forest, thereby increasing productivity and safety of the consumers and environments. In recent years, microbial antagonists are used for the control of pest and diseases. Typical example abounds on the Bacillus thuringiensis which are toxic to many species of insects. In addition, Entomopathogenic nematodes in the families *Steinernematidae* and *Heterorhabditidae* have been used to suppress populations of pest in a variety of agro ecosystems, and in several cases their positive effects on crop yield have been shown. Lastly, the advantage of use of microbial control agents include safety for humans, reduction of pesticide residues in food, preservation of other natural enemies, and increased biodiversity in managed ecosystems.

Role of natural enemies of insect's pests

Pest are those species that attack some resource we human beings want to protect, and do it successfully enough to become either economically important or just a major annoyance. They are only a tiny fraction of the insect species around us. Even many of the species we would recognize as important pests only occasionally do significant damage to us or our resources. Natural enemies play an important role in limiting the densities of potential pests. This has been demonstrated repeatedly when pesticides have devastated the natural enemies of potential pests. Insects which were previously of little economic importance often become damaging pests when released from the control of their natural enemies. Conversely, when a non-toxic method is found to control a key pest, the reduced use of pesticides and increased survival of natural enemies frequently reduces the numbers and damage of formerly important secondary pest species.

Releasing of bio control agents

Farmers can release predators, parasites or parasitoids to attack pests. The choice of agent depends on the situation. For example, farmers can choose between generalist predators that attack several types of pests, or specific parasitoids to attack one pest species. Biocontrol is particularly well suited for greenhouse production where pest outbreaks can be severe due to the lack of wild beneficial organisms. Also, the greenhouse itself inhibits dispersal of introduced organisms.

Biocontrol (biological control) agents include:

- **Predators**: organisms that eat pests. Predatory insects are beneficial because they feed directly on other insects like aphids. Common predatory insects include lacewings, ladybugs, and praying mantis. Ladybugs or lady beetles (*Coleomegilla maculata*) have been recognized by many cultures for their predatory behaviors for centuries. Adults of these insect predators are some of the most widely recognized insects in the United States. Adult and larvae feed on large numbers of small, soft-bodied insects such as aphids but they will also eat other small, soft-bodied insect larvae, insect eggs, and mites. Example of predatory insect commonly found in garden is Green lacewing (*Chrysoperla carnea*) the adult, primarily feed on nectar and other fluids, but some species also consumes a few small insects.
- **Parasitoids**: organism's usually parasitic wasps or flies that lay their eggs in the adult bodies, pupae, larvae or eggs of pests. When parasitoids hatch, they consume the pest from the inside out. Many parasitoids start consuming non-essential tissue before attacking the internal organs of the pests; this gives them time to feed before emerging as adults. Examples: Braconid wasps, Chalcid wasps and Tachinid flies
- **Parasites:** organisms that feed on, but generally don't kill, living hosts. Parasitoids are sometimes called parasites. Examples: parasitic mites and parasitic nematodes.
- **Pathogens**: Pathogens are microorganisms including certain bacteria, fungi, nematodes, protozoa, and viruses that can infect and kill the host. Populations of some aphids, caterpillars, mites, and other invertebrate are sometimes drastically reduced by naturally occurring pathogens, usually under conditions such as prolonged high humidity or dense pest populations. In addition to naturally occurring disease outbreaks, some beneficial pathogens are commercially available as biological or microbial pesticides. These include Bacillus thuringiensis or B.t, entomopathogenic nematodes, and granulosis viruses Microorganisms (bacteria, fungi, viruses, protozoa, etc.) that cause disease in pests. Certain pathogens are also parasites. Examples: *Beauveria bassiana* and *Bacillus thuringiensis* (Bt).
- **Entomopathogenic Nematodes:** Nematodes are simple roundworms, colorless, unsegmented, and lacking appendages. They may be free living, predaceous, or parasitic. Many of the parasitic species cause important diseases of plants, animals, and humans. Other species are beneficial in attacking insect pests, mostly sterilizing or otherwise debilitating their hosts. Entomopathogenic nematodes in the families *Steinernematidae* and *Heterorhabditidae* have been used to suppress populations of insect's pest in a variety of agro ecosystems.
- **Entomopathogenic Fungi:** Entomopathogenic fungi act as parasites of insects, these fungi can kill, or seriously disable insect pests. Fungal entomopathogens are important regulators of insect populations with considerable potential as mycopesticides. The ecological function of endophytic fungal remains largely unknown, but some studies have implicated them in plant growth, herbivore resistance, and disease resistance.
- **Baculoviruses:** Baculoviruses are a large group of double-stranded DNA viruses (almost 1000 species have been described); the majority have been isolated from a few insect orders: Lepidoptera, Diptera, Hymenoptera and Coleoptera. Viral genome ranges in size from 80 to 200 kb. Individual baculoviruses usually have a narrow host range limited to a few closely related species. The most widely studied baculovirus is the *Autographa californica Nuclepolyhedron-virus* (AcMNPV). Baculovirus insecticides have been used in a wide range of situations from forests and fields to food stores and greenhouses. Additionally, these viruses are excellent candidates for species-specific, narrow spectrum

insecticidal applications. They have been shown to have no negative impacts on plants, mammals, birds, fish, or even on non-target insects

Biocontrol Agents	Examples
Predators	Ladybugs, dragonflies, lacewings, pirate bugs, rove and ground beetles, aphid midge, centipedes
Parasitoids	*Ichneumonid* wasps, braconid wasps, chalcid wasps, tachinid flies
Nematode	Heterorhabditidae spp. (Figure 1), Mermithidae spp., Rhabditidae spp., Steinernematidae spp.
Bacteria	*Bacillus thuringiensis, Bacillus popillae*
Virus	*Cytoplasmic polyhedrosis* (CPV), *granulosis* (GV), and *entomopox viruses* (EPN)
Fungi	*Metarhizium anisopliae, Beauveria bassiana, Trichoderma viride*

Source: Biological pest control. In: New World Encyclopedia (18).

Using biological control in the field:

- **Conservation of existing natural enemies:** Reducing pesticide use, most natural enemies are highly susceptible to pesticides, and pesticide use is a major limitation to their effectiveness in the field. The original idea that inspired integrated pest management (IPM) was to combine biological and chemical control by reducing pesticide use to the minimum required for economic production, and applying the required pesticides in a manner that is least disruptive to biological control agents. The need for pesticides can be reduced by use of resistant varieties, cultural methods that reduce pest abundance or damage, methods of manipulating pest mating or host-finding behavior, and, in some cases, physical methods of control.
- **Introducing new natural enemies and establishing a permanent population:** This is a process which requires extensive research into the biology of the pest, potential natural enemies and their biology, and the possibility of unintended consequences (e.g. negative effects on native species which are not pests or on other natural enemies of the pest). After suitable natural enemies are found, studied, and collected, they must undergo quarantine to eliminate any pathogens or parasites on the natural enemy population. Then, the natural enemies are carefully released, with attention to proper timing in the enemy and pest life cycles, in a site where the target pest is abundant, and where disturbance of the newly released enemies is minimized.
- **Mass rearing and periodic release, either on a seasonal basis or inundatively:** In some cases, a natural enemy is not able to overwinter successfully, here in the Northeast due to the weather or the lack of suitable hosts or prey. In other cases, such as in greenhouses, all possible habitat for the natural enemy is removed at the end of the season or production cycle. Thus, particularly in annual crops, or in other highly disturbed systems, the natural enemy may need to be reintroduced regularly in order to maintain control of the pest. Seasonal inoculative release of insect parasitoids and predators has been a highly successful strategy for biological control in greenhouses in Europe.

Examples of successful bio control in greenhouses include:

- Herbivorous mites controlled by predatory mites (*Amblyseius* spp., *Galendromus occidentalis, Neoseiulus californicus* and *Phytoseiulus persimilis*), predatory mirids sold under the brand name Mirical (*Macrolophus pygmaeus*) and spider mite destroyers (*Stethorus punctillum*).
- Thrips controlled by cucumeris mite (*Neoseiulus cucumeris*), another predatory mite (*Gaeolaelaps aculeifer*), and the minute pirate bug (Orius) and parasites (*Steinernema*).

- Aphids controlled by various parasitoids (*Aphelinus abdominalis*, *Aphidius colemani* , *Aphidius ervi*, and *Aphidius matricariae*) and predators including aphid midge (*Aphidoletes aphidimyza*), two-spot ladybird (*Adalia bipunctata*), lacewings (*Chrysoperla carnea* and *Chrysoperla ryfilabris*) and convergent lady beetle (*Hippodamia convergens*).
- Whiteflies controlled by the parasitoids, the chalcidoid wasps (*Encarsia formosa*, *Eretmocerus mundus* and *Eretmocerus eremicus*), and by predators including Whitefly lady beetle (*Delphastus catalinae*), Swirski-mite (*Amblyseius swirskii*) and mirids (M. *pygmaeus, M. caliginosus* and tobacco capsid, *Nesidiocoris tenuis*).

Bio Pesticides

Bio pesticides are pesticides made from natural sources, such as microorganisms, plants, animal tissue or minerals. A common example is pyrethrum, which is made from crushed chrysanthemum flowers. (Note pyrethrum is permitted in organic production, unlike its synthetic counterpart, permethrin.) Many plants that provide habitat for predators and parasitoids also have insecticidal or repellent compounds. In addition to intercropping with these plants (e.g., buckwheat, coriander, oregano and clove basil), operators can make crude extracts from their foliage. Spraying these bio pesticides on crops may repel or even harm pests. Microbial bio pesticides may contain viruses, bacteria, fungi or nematodes. Researchers are investigating the control of wireworms by the soil fungus, *Metarhizium brunneum* LRC112, sold as Attracap23. Other species of *Metarhizium* can be used against other pests. To control caterpillars in brassicas, many organic growers use Dipel or other commercial products containing soil bacteria (*Bacillus thuringiensis* var. kurstaki).

Main advantages of bio control

1. Insect or weed pest repression to manageable levels and reduces potential legal hazard of chemical use. Chemical pesticides can cause a wide range of human health problems such as nerve, skin, and eye irritation.
2. Chemical pesticides can spoil agricultural land by affecting beneficial insect species, soil microorganisms, and worms responsible for soil health. Chemicals also disturb plant root and immune systems, and thus reduce concentrations of nitrogen and phosphorous in soil which are essential plant nutrients.
3. Reduces acute and long-term impact of chemical pesticides on human, animals, non-target organisms and the environment. Biocontrol agents are usually very specific and present less danger to environment and water.
4. Protection of biodiversity and restoring natural ecosystems.
5. Chemical residue-free products from farms and natural systems.
6. Potential of permanent reductions of pest organisms.
7. There are usually no phytotoxic effects on young plants.

Conclusion

Biological control of pest is the use of pathogens, predator and parasitoid to kills pests by reducing their populations or eliminating them completely from our farms, garden and forest, thereby increasing productivity and safety of the consumers and environments. In recent years, microbial antagonists are used for the control of pest and diseases. To keep a strong and stable community of biocontrol agents, farmers can provide ‘SNAP’ - Shelter, Nectar, Alternative prey and Pollen throughout the year, including the winter, organisms need shelter, such as untilled areas, mulch, perennial plantings, hedgerows or wild areas. Farmers can concentrate pests by growing trap crops, plants that attract pests. the advantages of use of microbial control agents include safety for humans such as reduction of pesticide residues in food, preservation of other natural enemies, and increased biodiversity in managed ecosystems.