Innovative methods for biological control in greenhouse vegetables: pests and their natural enemies

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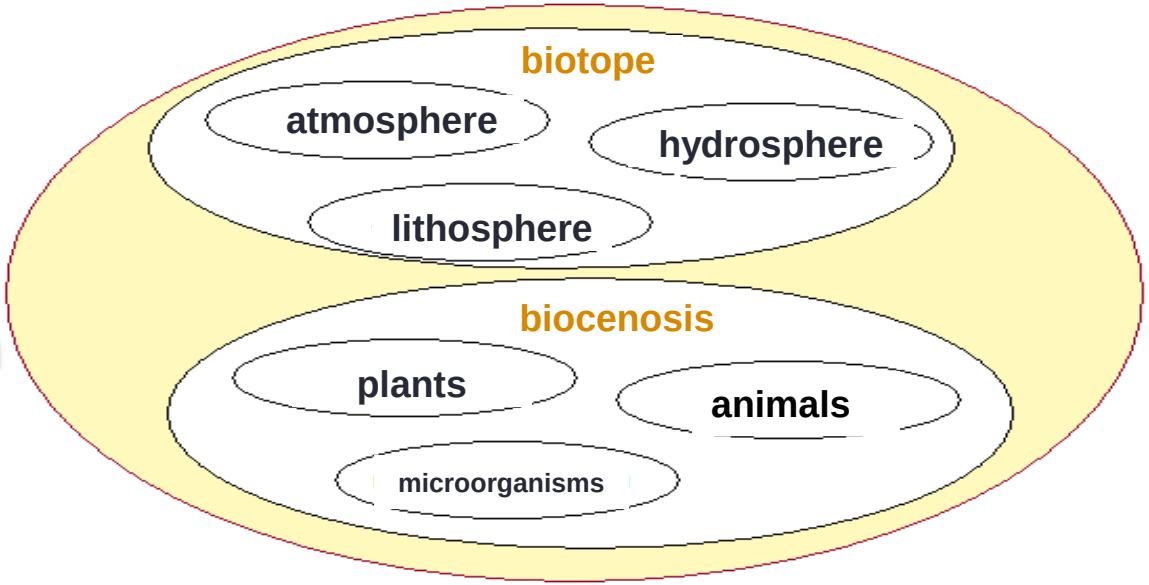


Biocenoses are complex communities that include plant species, animal organisms and microorganisms. The relationships within are complex and they are formed during the ontogenetic and phylogenetic development. Some of these relationships, mostly antagonistic, are the basis of biological control. Bioagents are a component of these communities, part of the biological control system of pests.

Biological control

The biological control uses the natural enemies of the pests which could be parasites, predators and pathogens. Biological control is part of the comprehensive Integrated Pest Management (IPM) program, which includes:

- **monitoring;**
- **use of varieties resistant to pests;**
- **agrarian practices;**
- **compatible plant protection products.**

The protection and use of beneficial species (bioagents) in vegetable agrocenoses in greenhouses is an element of biological systems of growing.

BENEFICIAL species

Why use BIOAGENTS?

ADVANTAGES

- Pests have no resistance to bioagents
- Bioagents are extremely easy to apply
- Bioagents are compatible with organic production

The use of bioagents (beneficials) is an environmentally friendly method of dealing with a pest without having an adverse effect on plants, animals or humans.

The application of bioagents leads to:

- **Obtaining of pesticide-free, quality and healthy vegetables;**
- **Preservation the biological balance in the agrocenoses;**
- **Environmental protection of soils and waters (without residues and harmful emissions).**

Natural enemies of the pest:

Predators

Parasites

Pathogens

fungi bacteria viruses

Macrobioagents

Microbioagents

Predation

Predation is a form of relationship between organisms in which one organism (predator) feeds on the other (victim), which dies in a short period of time. It is:

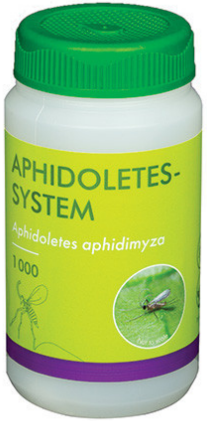
- **fatal - the prey always dies;**
- **non-fatal - the victim remains alive.**

Predation is very common among insects and mites, and has a significant impact on the natural regulation of organisms. Predators are insects and mites that feed on enemies but do not breed in them. They attack more than one enemy during their development into adults. Predators are less specific to the host than parasites and often lay their eggs close to the enemy, so that when they hatch, they have a food source nearby.

PREDATORY INSECTS USED AS PLANT PROTECTION BIOAGENTS

Aphidoletes aphidimyza

Aphidoletes aphidimyza **is a small fly (gall-midge) that is active at night. The females fly to the aphid colonies and lay huge amount of eggs. *Aphidoletes* larvae are active predators that pierce and consume aphids. During its development, a larva feeds on 25 to 70 aphids. The predator multiplies rapidly in a short period of time. *Aphidoletes* is mainly used in mass colonization by aphids. Predator:prey ratio should be between 1:30 and 1:200 depending on aphid species and their density.**




larva

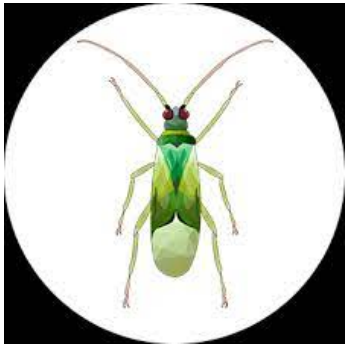
Aphis gossypii

Aphidoletes aphidimyza

Predatory bug

Macrolophus pygmaeus

Predatory bug on whitefly, thrips and tomato borer



The predatory is very active at all stages of development and it can feed and control various pests - whiteflies, thrips and tomato borer. Other food sources are leaf miner flies, spider mites and moth/butterfly eggs. It is found in *Solanaceous* plants - tomato, eggplant, pepper and some ornamentals. The predator survives even when the food is poor.

The cycle of development from egg to adult continues less than a month at 25°C. There are 5 larval stages during which the predators are active as well as adults. *Macrolophus pygmaeus* should be used early, even before the presence of pests, in order to be able to develop well. For this purpose, several imports in small quantities are most suitable. A good strategy is to import the predator when the first flowers appear once in a small dose and then 2 to 3 more introductions every week. The average dose usually varies from 1 to 4 individuals/m^2.

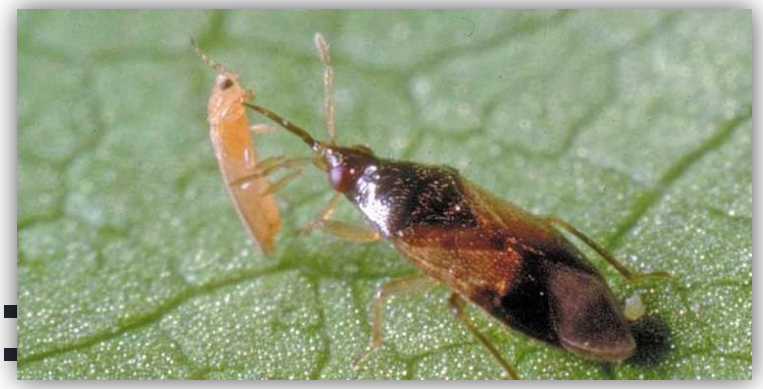
Predatory bug

Nesidiocoris tenuis - predator on whitefly and tomato borer

Nesidiocoris tenuis **is a predator that adapts well to warm climates. It completes its development cycle in about 30 days. Many insects of the family *Miridae* bore plant tissue and can cause damage to the flowers and tomato fruits. This occurs when the predator population is high or the variety is sensitive. Population monitoring is recommended. The predator is available in bottles and the individuals are scattered in vermiculite. To allow the predator to multiply, it must be imported at the beginning of the season, during flowering, before the infestation by pests. 0.5-1.5 individuals/m^2 is the optimal dose.**

Predatory bug

Orius laevigatus - predatory bug on thrips



The bug is a predator during all mobile stages and can actively feed also on other food sources such as mites, aphids and moth eggs. During all stages of its development, it searches for a prey, even in hidden places under the leaves and flowers. At 25°C the development cycle is about 15 days. The bug is available in bottles. It is recommended to make several applications with a total of 2-4 individuals/m^2.

Predatory mite

Amblyseius swirskii

Amblyseius swirskii **is a predator on various small insects and their eggs, on early stages of development of whiteflies and thrips larvae. Its development is quite short, about a week. For biological control against thrips and whiteflies, it is recommended to apply preventively during flowering. It can be used in combination with other bioagents such as, *Orius* spp. and *Eretmocerus eremicus*. The number of imported predators can vary from 50 to 100 individuals/m^2 depending on the environment.**

Predatory mite

Hypoaspis aculeifer

Hypoaspis aculeifer **is a soil mite that feeds on small insects and nematodes. It can perfectly control thrips by attacking pupae in the soil. Studies on this species show that it has a high preference to thrips pupae and feeds 5 times more thrips than any other predatory mite inhabiting the soil. This trait has earned him the name "killer mite". It can also help control other pests inhabiting the soil.**

Hypoaspis miles **and** ***Hypoaspis aculeifer***

Predatory mite

Phytoseiulus persimilis

Phytoseiulus persimilis **is a specialized predator on tetranichid mites (*Tetranychidae*). The predator has a short biological cycle, shorter than that of harmful mites. Its development is very fast and at 20°C it takes 10 days, while under the same conditions the harmful mite needs almost 18 days to reach the adult stage. The predator has a good search ability and is very agile. Available in bottles scattered in vermiculite or sawdust. It is preferable to import before the first signs of an infestation. It can be imported from 5-6 to 20-25 predators/m^2.**

Parasitism

Parasitism is a form of relationship in which one organism (parasite) lives at the expense of another organism (host) for a long period of time and causes its death, exhaustion or sterility. There is a great variety of forms of parasitism. They depend on:

- **the habitat – endoparasitism and ectoparasitism;**
- **type of obligation - obligatory, facultative and accidental;**
- **the number of hosts necessary for its development - monoxene and heteroxene.**

Parasites are insects that lay their eggs in or on the pest, develop in it and kill it. The adult parasite leaves the pest and the cycle continues. They have preference to specific hosts and feed on only one enemy as they develop.

PARASITOID INSECTS USED AS BIOAGENTS FOR PLANT PROTECTION

Encarsia formosa

Encarsia formosa **is a parasite on the greenhouse whitefly (*Trialeurodes vaporariorum*). Adults have a black - yellow body. The female lays her eggs in the whitefly's larvae. The parasitized individual turns black, which is an easy way to determine the activity of the parasite. Upon completion of its development in the host, the adult parasite cuts a round hole and emerges.**

Two to six parasites are imported per square meter per week, depending on the density of the pest. Importation begins early in the season, when the first whiteflies are found. *Encarsia formosa* is available as infested pupae glued to a board or simply as free infested pupae for spreading evenly in the greenhouse.

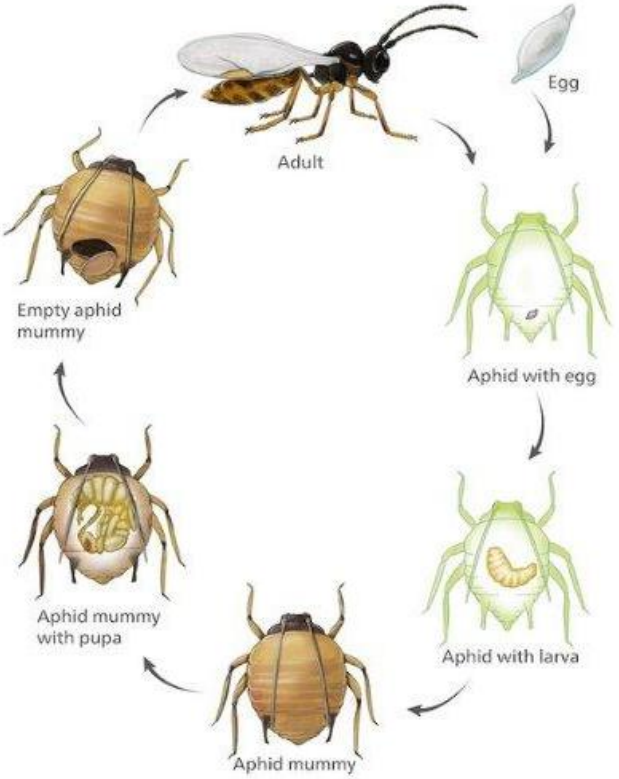
Parasitoid on whiteflies

Eretmocerus eremicus

Eretmocerus eremicus **parasitizes all whitefly species. The adult parasitoid has a yellow body and it is able to control the early stages of development of *Trialeurodes vaporariorum* and *Bemisia tabaci*. The parasitized nymphes have an amber color and are slightly swollen. *E. eremicus* is available in bottles containing pupae from which the parasitoid comes out very quickly. The IPM program includes several repeated introducing with a total amount of 12-20 individuals/m^2 depending on the degree of infestation.**

Parasitic insects

Aphidius spp.



The parasite *Aphidius colemani* is very effective for biological control of aphids, especially *Aphis gossypii* and *Myzus persicae*. The aphid infested with *Aphidius* turns into a brown mummy, from which a new parasite appears in 10 days.

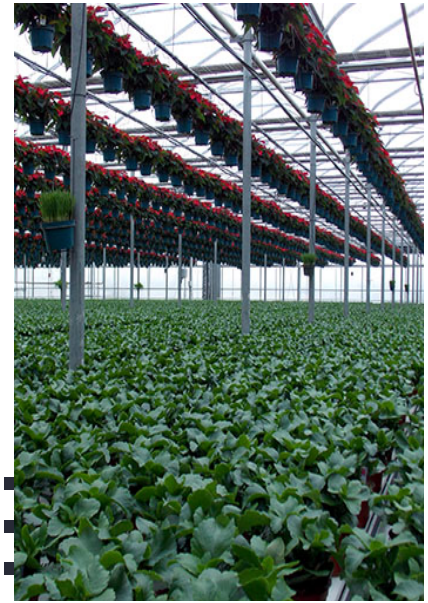
Aphis gossypii

Infested aphids

The development cycle is short, at a temperature of 16-22°C, but its activity decreases at temperatures above 30°C. The total number of imported bioagents can be 10-40 individuals/m^2, distributed in 3-6 times, depending on the degree of infestation. The biological material is delivered as mummies/adults in containers that are easily dispersed. Pre-application is recommended when it is difficult to assess the presence of aphids. Some of the most common species are *Aphidius colemani* and *Aphidius ervi*.

The parasites *Dacnusa sibirica*, *Diglyphus isaea* and *Opius pallipes* are used for biological control of leaf miner flies (*Agromyzidae*). These parasites are native to Europe and may naturally be present in greenhouses.

Banker plants



"Banker plants" are reservoir plants for useful species. They provide alternative food (such as pollen) and/or a host for the cultivation, establishment, conservation and release of bioagents. "Banker plants" are designed so that natural enemies can reproduce and survive on them, even when pest populations are low. The “banker plant” system requires availability of an uncultivated/wild plant, a source of pollen, or a host for the predator/parasitoid. The idea is to establish biological control of the population over the plant and to be able to continue it even when the presence of a host is poor. In this way, the bioagents are ready when the pests arrive at the object of cultivation.

Banker plants

There are many predators and parasitoids that could be used in greenhouses to control pests, but only specific species can be identified and maintained on "banker plants". "Banker plants" can become an economical and long-term, sustainable solution for pest control when they are properly used.

“Banker plants” are used to grow the host (pest), which provides a constant source of food for definite natural enemies to ensure that they continue to reproduce. For aphids these plants are cereals on which colonies of aphid species are maintained. Then the parasites are released to parasitize aphids on "banker plants“; later they are placed along the paths in the greenhouse or used in the production cycle to grow beneficial species.

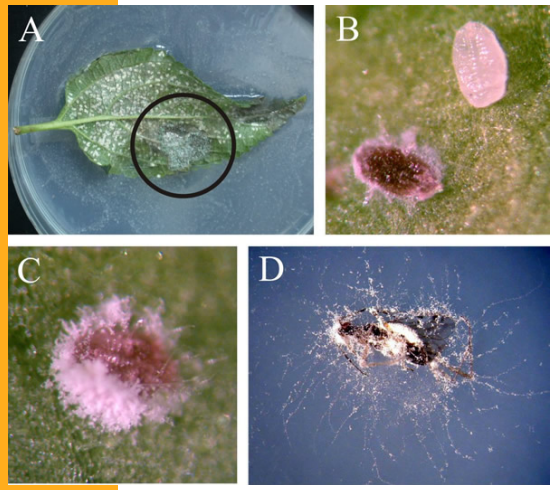
For thrips control the most suitable "banker plant" is the decorative pepper cv. Purple Flash. Its pollen is a proven rich source of food for *Orius*, an important and insatiable predator of thrips. This "banker plant" helps in production of sustainable *Orius* populations.

Banker plant

Common mullein (*Verbascum thapsus*) can be an important plant for growing some predatory bugs, where they can complete their life cycle in the absence of a host by feeding on the plant's nectar.

Micro-bioagents **or so called** ***Microbial insecticides*** **are the agents that cause fatal diseases in pests. They could be viruses, bacteria and fungi. They are the basis of the microbiological method of control – application of microorganisms and products of their vital activity to control the pests.**

At present standardized organic products, easy to use, are available on the market.



***Naturalis* – standardized organic product based on entomopatogenic fungus *Beauveria bassiana* strain ATCC 74040 to control greenhouse whitefly, thrips, mite and aphids. The conidia of the fungus cling to the cuticle of the insects and mites, germinate and penetrate the body of the host, thus covering it completely.**

- **Rapax (a. i. *Bacillus thuringiensis (Bt)* subsp. *kurstaki* strain EG 2348)**
- **Dipel 2X (a.i. *Bacillus thuringiensis* subsp. *kurstaki* strain ABTS 351)**

Highly selective Bt insecticides, which contain bacteria to control the larvae of species of *Lepidoptera* family.

Bt insecticides have a unique mode of action:

- **Immediately deters insects from feeding — death occurs within 1–3 days**
- **Not harmful to bees or beneficial insects making it a great tool for spring feeding caterpillars**
- **Zero pre-harvest interval (PHI) and no re-entry interval (REI), safe for humans**

Helicovex (a. i. *Helicoverpa armigera nucleopolyhedrovirus Hear NVP, DSMZ-BV0003* – 7,5 x 10^{12} viral bodies/liter)


Helicoverpa armigera


Helicoverpa armigera larva treated with Helicovex a biological insecticide

Nucleopolyhedroviruses are bigger and contain mostly several virions.

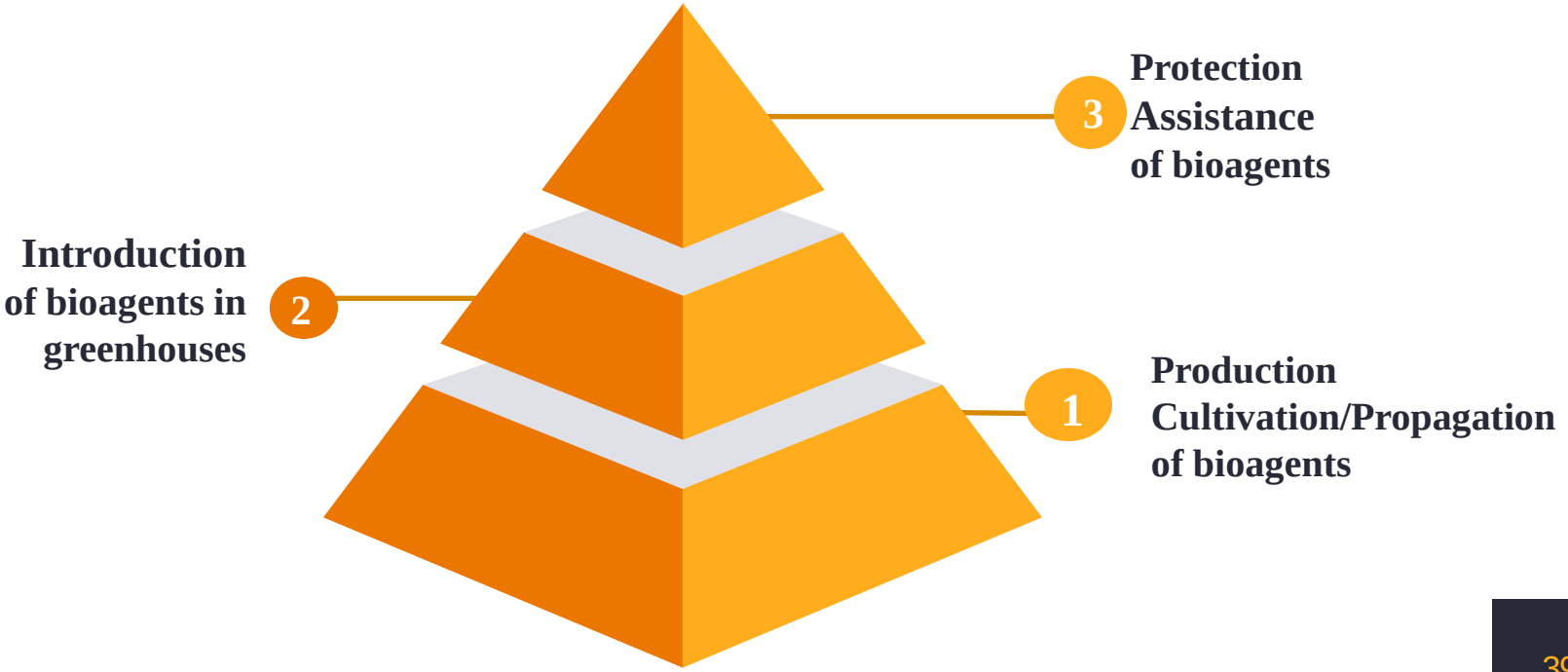
- **Highly effective**
- **Residue-free**
- **Safe for non-target organisms, such as beneficial insects**
- **Selective**
- **Good storage stability**
- **Compatibility with most products**
- **Well suited for conventional and organic production focusing on resistance management and integrated pest control.**

Steinernema feltiae

Steinernema feltiae **is a beneficial nematode that attacks many soil-living insects, such as pupae thrips. Nematodes enter the body of insects through the openings and release a bacterium that kills the host insect.**

Entomopathogenic Nematodes (Steinernematidae) for Biological Control of Soil Pests

Production of bioproducts from vegetable crops in greenhouses through the application of bioagents



GREENHOUSE GIMEL

GIMEL
ORGANIC

БИОзеленчуци с чиста БИОграфия
BIOvegetables with clean BIOgraphy

From idea to practic

GIMEL greenhouses are one of the largest producers of organic vegetables in greenhouses. Gimel Organic brand products are known on the Bulgarian market and in Europe. The company applies modern technologies for growing vegetable crops, produces and introduces bioagents, applies organic products and produces certified organic products from high quality vegetables. The greatest success of the team in the years from 1995 until today is the proof in practice that the idea of organic farming in Bulgaria is possible.

The organic farming sector is one of the fastest developing sectors in the world. The trend is to increase producers and consumers of organic products. The motivation for this varies from concern for our own health to nature protection. Bulgarian organic vegetables are recognizable and preferred by consumers throughout Europe.

BIOLOGICAL SERVICES

http://www.biologicalservices.com.au

Sources

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