The Chemical-Free Way

Ed Bloodnick & Dr. Rémi Naasz

Biological insect suppression in the root zone.

Over the years, various biological controls have been developed and used by commercial growers for control of insects above the soil line. The natural enemies of insect pests are categorized as predators, parasitoids and pathogens. Predators catch and eat their prey, compared to parasitoids that lay their eggs on, in or near their host insect to later feed on them.

Pathogens are insect disease-causing organisms that infect insects causing them to become sick or interfere with their normal processes. While both chemical pesticides and biological controls can "control" insects and "suppress" insects, biologicals offer another option in the grower's tool bag. This is of interest for growers wanting to reduce the amount of chemical pesticide applications and for growers of organic crops. However, biological control of insects below the soil line in the root zone can be a greater challenge, since there are less options available.

Insect-suppressing fungi

Some of the insect-pathogenic fungi that can be used as microbial control agents for potting soils and growing media include *Beauveria, Metarhizium* and *Paecilomyces*. All three genera are naturally occurring and found around the world. All have different species and isolates to suppress different host insects.

For example, *Beauveria bassiana* is a fungus that produces conidia, a non-motile spore of the fungus that penetrates the outer hard cuticle covering of the insect. The fungus develops inside the insect, killing it after a few days. *Beauveria bassiana* controls insects that either live in the root zone or have a stage of development in the root zone, such as thrips, root weevil and some grubs.

Like *Beauveria bassiana, Metarhizium anisopliae* is also a naturally occurring fungus. Once in contact with the body of an insect host, the fungus germinates and the hyphae that emerge penetrate the outer cuticle cover of the insect, developing inside the insect and killing it after a few days. *Metarhizium anisopliae* is a fungus used as a biological insecticide to control fungus gnats, thrips and some types of grubs.

Paecilomyces lilacinus is another fungus that's used as a microbial nematicide to control pathogenic nematodes. It parasitizes adult nematodes and kills eggs, juveniles and adult females of plant parasitic nematodes.

These fungi are effective for control of some root zone insects, as labelled, however, they're not available in preformulated growing media and must be applied by the grower during the crop cycle. These are live organisms and care must be taken for their handling, storage and use for effective insect control. Some must be stored at cool temperatures, and once the package is opened, must be used immediately. Keep in mind that fungi are less robust than bacteria and may have compatibility interaction with certain chemicals that could render them useless. Therefore, growers should contact the specific manufacturer or dealer for specific storage and use recommendations.

Insect-suppressing bacteria

For years, growers have used *Bacillus thuringiensis* (Bt) for the control of caterpillars and worms above the soil line. Bt was first discovered in the early 1900s and commercialized in the mid-1960s. The pathogenic action of this bacterium occurs after ingestion by the insect. Spores and crystalline inclusions containing insecticidal endotoxins interact in the insect midgut, causing disruption of natural cell membrane permeability. This results in gut paralysis and death of the insect within a few hours or weeks, depending on the isolate and insect type.

Early work in the 1990s suggested that maybe other types of *Bacillus* bacteria could suppress certain soil insects. In 2010, Kuhne Heller published the results of their findings at the International Peat Symposium called "Sciarid Fly Larvae in Growing Media—Biological Control Measures." In their research, they evaluated the black fungus gnat *(Bradysia difformis)* and types of pathogenic fungi as sites for selective egg laying and larval feeding on fungal hyphae of *Botrytis cinerea,* Fusarium species and *Phoma betae* in petri dishes.

It was known that black fungus gnats are attracted to and feed on plant pathogenic fungi that cause plant disease. For comparative purposes, they also included two bacterial species, *Bacillus pumilus* and *Pseudomonas flourescens,* to evaluate insect feeding and egg laying. After four days, the pathogenic fungi were completely consumed by adult flies and fungus gnat eggs were present on the petri dish. However, no feeding activity and only a few eggs were observed on the petri dishes with the bacterial strains (*Bacillus pumilus* and *Pseudomonas flourescens*).

Interestingly, PRO-MIX BIOFUNGICIDE+MYCORRHIZAE was introduced to the market more than 10 years ago. This product contains *Bacillus pumilus* PTB180, a type of bacteria that's been

shown to suppress certain insects that have a stage of development in growing media. Over the years, Premier Tech Horticulture received reports from growers indicating reduction of fungus gnats and thrips in their greenhouse crops. PRO-MIX BIOFUNGICIDE+ MYCORRHIZAE is enriched with *Bacillus pumilus* PTB180 bacteria that colonize developing root systems and suppress disease-causing organisms, such as Pythium, Fusarium and Rhizoctonia.

In addition, the *Glomus intraradices* fungi contained in PRO-MIX BIOFUNGICIDE+ MYCORRHIZAE attach to and colonize root systems, working in symbiosis with plants. Endomycorrhizal fungi benefit the host plant by increasing acquisition of water and nutrients (especially phosphorus, copper and zinc) by forming an extensive mycorrhizal hyphal network that attaches to the plant root system. In exchange, the plant provides soluble sugars to the fungus. This symbiotic relationship between fungi and plant results in overall improved plant growth. To further explore this insect suppression observations, a research study was conducted in conjunction with Laval University.

The pioneering laboratory work from Kuhne Heller (2010) mentioned that fungus gnats don't lay their eggs randomly on moist surfaces of growing media. They preferably laid their eggs on hyphae of certain phytopathogenic fungi *(Botrytis cinerea, Fusarium species* and *Phoma betae)* on which their larvae will feed rather than on other fungi or soil bacteria (*B. pumilus*). If the pathogenic fungi are reduced, then the environment is less favorable for fungus gnats, which results in reduction of egg laying and populations.

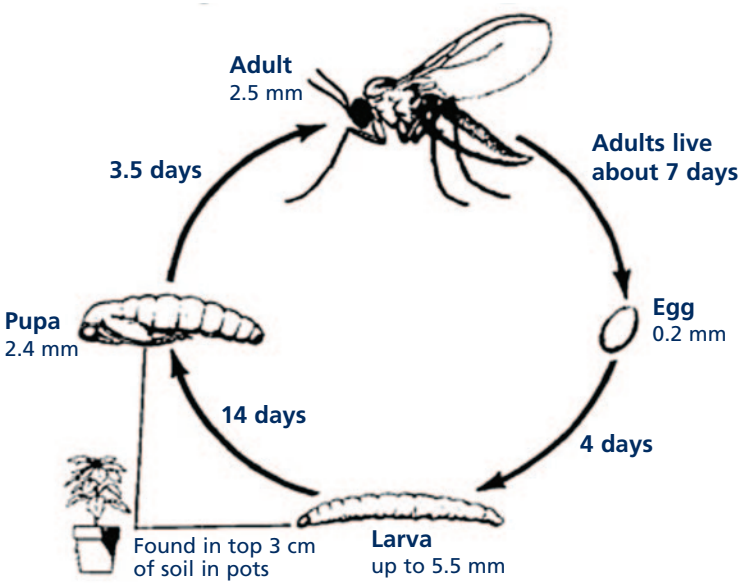
The series of research experiments conducted over several years included several short-term bedding crops and long-term ornamental crops (cyclamen, poinsettia). Research results indicated that PRO-MIX BIOFUNGICIDE+MYCORRHIZAE suppresses both insect pests, fungus gnats and thrips to an average level of 30% and 22%, respectively, during the whole crop-growing period.

We also observed that the diminution of fungus gnat infestation could reach up to 67% for a specific time during plant culture. By reducing the fungal food sources of certain root zone-dwelling insects with *Bacillus pumilus* (PTB180 bacteria), there's an indirect suppressive effect on insect populations. PRO-MIX BIOFUNGICIDE+ MYCORRHIZAE is now labelled to suppress two major pests in greenhouses: fungus gnats that attack root systems and thrips that pupate into the growing medium.

Premier Tech is currently conducting additional research tests to further investigate the potential to reduce other pests with biologicals.

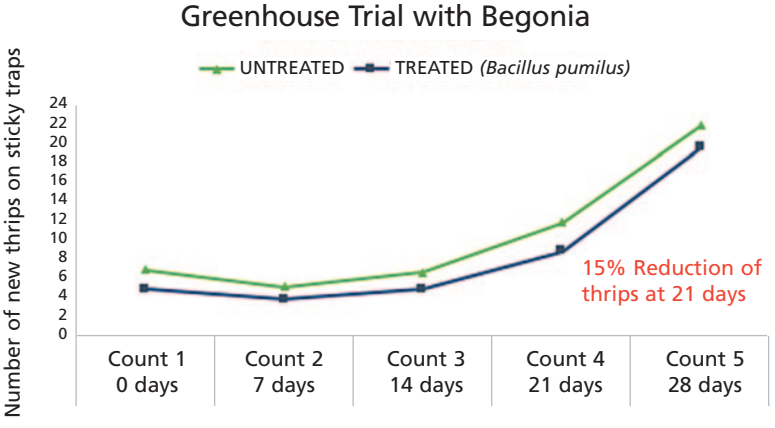
Reference: Kuhne Heller. 2010. "Sciarid fly Larvae in Growing Media …" Proceedings of the International Peat Symposium Peat in Horticulture – *Life in Growing Media – Amsterdam, 11 October 2010 pp. 95-102*

Ed Bloodnick (bloe@premiertech.com) is Director of Grower Services and Dr. Rémi Naasz is IR&D Supervisor (naar@premiertech.com) for Premier Tech Horticulture.



Life cycle of black fungus gnat (*Bradysia difformis*)

Closeup of fungus gnats counts on sticky cards. Untreated growing medium on the left and growing medium treated with *Bacillus pumilus* on the right demonstrating insect suppression. Source: Premier Tech 2017



Comparison of begonia with untreated growing medium and growing medium treated with *Bacillus pumilus* to reduce population of thrips. Source: Premier Tech 2017