Commercially Available* Biological Control Agents for Common Greenhouse Insect Pests

*Commercially available in the United States. Updated November 2015. Bulletin 3299.

MICHIGAN STATE UNIVERSITY | Extension

K-STATE Research and Extension

By: Heidi Wollaeger and Dr. Dave Smitley, Michigan State University Extension and Dr. Raymond Cloyd, Kansas State University

Commercially Available Biological Control Agents for Aphids

Parasitoids

Predators

Aphelinus abdominalis

Parasitic Wasp

- Parasitizes a wide-range of aphid species.
- Can tolerate higher temperatures than most *Aphidius* species.
- Slower to establish than *Aphidius* species.
- Release 2 to 4 adult wasps per 10 square feet weekly or until 80-90% of the aphids are parasitized.

Aphidius colemani

Parasitic Wasp

- Parasitizes smaller aphids such as green peach and melon aphid.
- Can be reared using banker plants (oat or wheat) infested with bird-cherry oat aphid (use a minimum of 4 banker plants per acre).
- May be sold as a mixture with *Aphidius ervi.*
- Release 400 to 2,000 adults per acre.

Aphidius ervi

Parasitic Wasp

- Parasitizes larger aphids such as foxglove and potato aphid.
- May be sold as a mixture with *Aphidius colemani.*
- Release 400 to 2,000 adults per acre.

Aphidius matricariae

Parasitic Wasp

- Parasitizes green peach aphids.
- Active at cooler temperatures (50°F to 85°F; optimum 77°F) than *Aphidius colemani* (Optimum: 86°F).
- Release 400 to 2,000 adults per acre.

Aphidoletes aphidimyza

Predatory Gall Midge

- Larval stages prey on all aphid species encountered in greenhouses.
- Most effective at temperatures between 68 and 80°F and a relative humidity between 70 and 80%.
- Primarily active at night.
- Mainly used against high aphid populations.

Adalia bipunctata

Ladybird Beetle

- Both larvae and adult feed on many different aphid species.
- Used when aphid populations are high.
- Adults typically attempt to leave the greenhouse after release. Therefore, make releases in the evening.
- Release adults every 2 to 3 weeks.

Chrysopa carnea

Green Lacewing

- Larvae feed primarily on aphids but may also feed on mealybugs.
- Can consume up to 425 aphids per week.
- Release 5 to 10 eggs per plant or 1,000 eggs per 200 square feet.

Chrysoperla ryfilabris

Green Lacewing

- Tolerates a higher relative humidity (>75%) than *Chrysopa carnea.*
- Can consume up to 300 aphids per week.
- Release 5 to 10 eggs per plant or 1,000 eggs per 200 square feet.

Hippodamia convergens

Ladybird Beetle

- Feeds on 2,000 aphids during their lifetime.
- Multiple releases are usually required.
- Most effective when aphid numbers are high.
- Adults typically attempt to leave the greenhouse after release. Therefore, make releases in the evening.
- Release adults every 2 to 3 weeks .

***All release rates are benchmarks – they will vary with crop type and infestation level.**

***Photo credits: [1]Koppert Biological Systems, [2]Bugwood.org or [3]Evergreen Growers Supply.**

By: Heidi Wollaeger and Dr. Dave Smitley, Michigan State University Extension, and Dr. Ray Cloyd, Kansas State University

MICHIGAN STATE UNIVERSITY | Extension

K-STATE Research and Extension

MSU is an affirmative-action, equal-opportunity employer. Michigan State University Extension programs and materials are open to all without regard to race, color, national origin, gender, gender identity, religion, age, height, weight, disability, political beliefs, sexual orientation, marital status, family status or veteran status.

Commercially Available Biological Control Agents for Western Flower Thrips

Predators

Beneficial Nematode

Amblyseius swirskii

Predatory Mite

- Feeds on both 1st and 2nd instar larvae.
- Tolerates higher temperatures than *Neoseiulus cucumeris.*
- Will also feed on the eggs and nymphs of whiteflies.
- Feeds on pollen in the absence of prey.
- More expensive than *Neoseiulus cucumeris.*

Neoseiulus (=*Amblyseius*) *cucumeris*

Predatory Mite

- Most widely used predatory mite for western flower thrips.
- Feeds on the 1st instar larvae.
- Make releases early in the crop production cycle.
- Active at temperatures between 70 and 75 ° F; prefers a relative humidity around 65%.

Orius spp.

Minute Pirate Bug

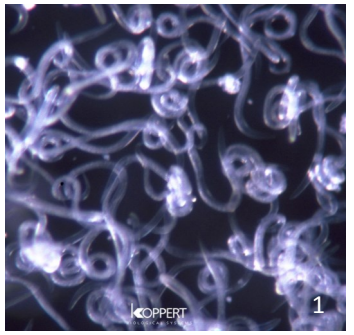
- Feed on larvae and adults of western flower thrips.
- May also feed on aphids and whiteflies.
- Can be used with ornamental pepper plants serving as banker plants (example: 'Purple Flash,' 100 per acre).
- More expensive than using *Neoseiulus cucumeris.*
- Most effective when temperatures are >60° F and day length is >12 hours.
- Release 0.5 to 1 per square foot.

Stratiolaelaps scimitus

Soil-dwelling Predatory Mite

- Adults may kill up to 30 prey, including western flower thrips pupae or fungus gnat larvae, per day.
- Release 1,000 to 2,000 per square foot.

Steinernema feltiae



Beneficial Nematode

- Apply as either a foliar spray or drench to the growing medium. Drench applications target the pupa stage.
- Requires soil temperatures of 50 to 80° F to be effective.
- Apply early in the morning or late in the evening.
- Water crops both before after application to increase efficacy.
- For foliar sprays, apply 50 million per 1,000 square feet.
- Remove screens before making applications.

***All release rates are benchmarks – they will vary with crop type and infestation level.**

***Photo credits: [1]Koppert Biological Systems, [2]Bugwood.org or [3]Evergreen Growers Supply.**

By: Heidi Wollaeger and Dr. Dave Smitley, Michigan State University Extension, and Dr. Ray Cloyd, Kansas State University

MICHIGAN STATE UNIVERSITY | Extension

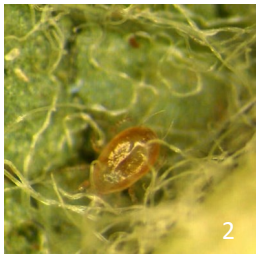
K-STATE Research and Extension

MSU is an affirmative-action, equal-opportunity employer. Michigan State University Extension programs and materials are open to all without regard to race, color, national origin, gender, gender identity, religion, age, height, weight, disability, political beliefs, sexual orientation, marital status, family status or veteran status.

Commercially Available Biological Control Agents for Twospotted Spider Mites

Predators

Amblyseius andersonii



Predatory Mite

- Feeds on alternative prey if twospotted spider mites are absent.
- Active at temperatures between 43 and 46° F.
- Release 10 mites per square foot.

Amblyseius californicus

Predatory Mite

- Slower acting than other predatory mites such as *Phytoseiulus persimilis.*
- More effective at higher temperatures (>80° F) and a lower relative humidity than *Phytoseiulus persimilis.*
- Used for long-term crops under warm, dry conditions.
- Release 10 mites per square foot.

Amblyseius fallacis

Predatory Mite

- Tolerates cooler temperatures than most predatory mites.
- Feeds on pollen in the absence of prey.
- Release 10 mites per square foot.

Feltiella acarisuga

Predatory Gall Midge

- Larvae feed on all life stages of the twospotted spider mite.
- Females lay eggs near colonies of the twospotted spider mite.
- Adults fly around and can spread among a crop.
- Most effective when used in combination with other biological control agents.
- Optimal conditions are 68 to 80° F and a relative humidity >60%.
- Does not perform well when temperatures are >85° F.
- Release 10 adults per square foot.

Galendromus occidentalis

Predatory Mite

- Smaller than *Phytoseiulus persimilis.*
- Most effective at higher temperatures and a relative humidity between 40 and 80%.
- Survives well when twospotted spider mite populations are low.
- Feeds on twospotted spider mite, broad mite and cyclamen mite.
- Release 10 mites per square foot.

Phytoseiulus persimilis

Predatory Mite

- Main predatory mite used against the twospotted spider mite.
- Most effective at temperatures between 70 and 80° F and a relative humidity >60%.
- Does not perform well when temperatures are >85° F.
- At optimal temperatures, develops twice as fast as twospotted spider mite.
- Release 10 mites per square foot.

Stethorus punctillum

Predatory Beetle

- Both larvae and adults feed on all life stages of twospotted spider mites.
- Release 10 adults per square foot.

***All release rates are benchmarks – they will vary with crop type and infestation level.**

***Photo credits: [1]Koppert Biological Systems, [2]Evergreen Growers Supply, [3]Wikimedia Commons or [4]Biobest.**

By: Heidi Wollaeger and Dr. Dave Smitley, Michigan State University Extension, and Dr. Ray Cloyd, Kansas State University

MSU is an affirmative-action, equal-opportunity employer. Michigan State University Extension programs and materials are open to all without regard to race, color, national origin, gender, gender identity, religion, age, height, weight, disability, political beliefs, sexual orientation, marital status, family status or veteran status.

Commercially Available Biological Control Agents for Fungus Gnats

Predators

Dalotia coriaria

Predatory Rove Beetle

- Apply directly onto the surface of the growing medium.
- Larvae and adults are predators and highly mobile.
- Both adults and larvae are very sensitive to light.
- Adults can fly and spread within a greenhouse.
- Release 1 adult per 10 square feet.

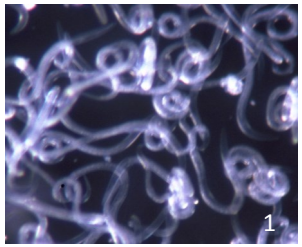
Stratiolaelaps scimitus

Predatory Mite

- Adults may kill 15 to 30 fungus gnat larvae per day.
- Feeds on eggs, larvae and pupae of fungus gnats.
- Apply directly to the growing medium.
- Previously known as *Hypoaspis miles.*
- May be used in combination with *Steinernema feltiae*.
- Release 1,000 to 2,000 mites per square foot.

Beneficial Nematode

Steinernema feltiae



Beneficial Nematode

- May be effective up to 4 weeks.
- Attacks the larval stages of fungus gnats.
- Requires a moist growing medium and growing medium temperature between 50 and 86° F.
- Apply early in the morning or late in the evening.
- Irrigate before and after application.
- Apply 50 million per 1,000 square feet as a drench.

***All release rates are benchmarks -– they will vary with crop type and infestation level.**

***Photo credits: [1]Koppert Biological Systems, [2]Bugwood.org, [3]Evergreen Growers Supply, or used with permission from [4]Kent M. Daane, University of California.**

MSU is an affirmative-action, equal-opportunity employer. Michigan State University Extension programs and materials are open to all without regard to race, color, national origin, gender, gender identity, religion, age, height, weight, disability, political beliefs, sexual orientation, marital status, family status or veteran status.

Commercially Available Biological Control Agents for Mealybugs

Parasitoids

Leptomastix dactylopii

Parasitic Wasp

- Females attack only the 3rd and 4th instars of the citrus mealybug.
- Effective at low mealybug populations.
- Release 5 parasitoid adults per 10 square feet.

Anagyrus pseudococci

Parasitic Wasp

- Attacks both vine and citrus mealybugs.
- Females attack 2nd through 4th instars.
- Optimal temperature is around 86° F.

Predators

Cryptolaemus montrouzieri

Predatory Beetle

- Both larvae and adults feed on all mealybug life stages.
- Not effective at temperatures <50° F.
- Most active under warm, sunny conditions.
- Less effective on tomato and other crops with glandular trichomes (hairs).
- Repeated releases (introductions) are usually required.
- Release 1 to 2 larvae or adults per square foot.

By: Heidi Wollaeger and Dr. Dave Smitley, Michigan State University Extension, and Dr. Ray Cloyd, Kansas State University

MICHIGAN STATE UNIVERSITY | Extension

K-STATE Research and Extension

Commercially Available Biological Control Agents for Whiteflies

Parasitoids

Encarsia formosa

Parasitic Wasp

- Most widely used parasitoid for greenhouse whiteflies.
- Most effective at higher temperatures (>70° F).
- May be ineffective on plants with honeydew (clear, sticky liquid).
- Make releases when greenhouse whitefly populations are low.
- Adult females will host feed on nymphs.
- Release parasitoids every 1 to 2 weeks.
- Release 2 wasps per 15 square feet every 1-2 weeks for preventation.

Eretmocerus eremicus

Parasitic Wasp

- Parasitizes sweet potato and greenhouse whitefly.
- Females prefer laying eggs into 2nd or 3rd nymphal instars.
- Tolerates higher temperatures and does more host-feeding than *Encarsia formosa.*

Predators

Amblyseius swirskii

Predatory Mite

- Feeds on the eggs and nymphs of whiteflies and larvae of western flower thrips.
- May also feed on pollen in the absence of prey.

Delphastus catalinae

Predatory Beetle

- Most effective when whitefly populations are high.
- Can feed on >150 whitefly eggs per day.
- Will not attack parasitized whitefly.
- May be sensitive to pesticide residues.

Dicyphus hesperus

Predatory Mirid Bug

- Feeds on greenhouse whitefly.
- Reared on mullein banker plants: requires a minimum of 8 weeks to establish a sufficient population.

***All release rates are benchmarks – they will vary with crop type and infestation level.**

***Photo credits: [1]Bugwood.org, [2]Evergreen Growers Supply, [3]Wikimedia Commons or [4]Biobest.**

By: Heidi Wollaeger and Dr. Dave Smitley, Michigan State University Extension, and Dr. Ray Cloyd, Kansas State University

MICHIGAN STATE UNIVERSITY | Extension

K-STATE Research and Extension

MSU is an affirmative-action, equal-opportunity employer. Michigan State University Extension programs and materials are open to all without regard to race, color, national origin, gender, gender identity, religion, age, height, weight, disability, political beliefs, sexual orientation, marital status, family status or veteran status.