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COMMERCIALLY AVAILABLE BIOLOGICAL CONTROL AGENTS FOR GREENHOUSE INSECT AND MITE PESTS

Raymond Cloyd, Kansas State University Research and Extension

Sarah Jandricic, Ontario Ministry of Agriculture, Food and Rural Affairs

Heidi Lindberg, Michigan State University Extension

K-STATE Research and Extension

Ontario

MICHIGAN STATE UNIVERSITY | Extension

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COMMERCIALLY AVAILABLE BIOLOGICAL CONTROL AGENTS FOR APHIDS

Parasitoids

Biological Control Agents			Comments	Optimum Temperatures for Activity
 Photo Credit: Koppert Biological Systems	*Aphelinus abdominalis*	Parasitic Wasp	• Parasitizes a wide range of aphid species. • Tolerates higher temperatures than most *Aphidius* species. • Release weekly or until 80 to 90% of the aphids are parasitized. • Aphid mummies are black.	59–95 °F 15–35 °C
 Photo Credit: Bugwood	*Aphidius colemani*	Parasitic Wasp	• Parasitizes green peach and melon aphid. • Rear on banker plants (barley or wheat) infested with the bird-cherry oat aphid. • Sold alone or as a mixture with *Aphidius ervi*. • Release weekly until 80 to 90% of the aphids are parasitized. • Aphid mummies are golden brown. • Place containers near aphid infestations or on banker plants.	59–86 °F 15–30 °C
 Photo Credit: Wikimedia Commons	*Aphidius ervi*	Parasitic Wasp	• Parasitizes foxglove and potato aphid. • Sold alone or as a mixture with *Aphidius colemani*. • Release weekly until 80 to 90% the aphids are parasitized. • Aphid mummies are golden brown. • Mummies may not be present on plants due to foxglove and potato aphids' falling off plants. • Place containers near aphid infestations.	50–86 °F 10–30 °C

Biological Control Agents			Comments	Optimum Temperatures for Activity
 Photo Credit: Biobest Group NV	*Aphidius matricariae*	Parasitic Wasp	• Only parasitizes green peach aphid. • Release weekly until 80 to 90% of the aphids are parasitized. • Aphid mummies are golden brown.	50–83 °F 10–28 °C

Predators

Biological Control Agents			Comments	Optimum Temperatures for Activity
 Photo Credit: Dave Gillespie, Applied Bio-nomics Ltd.	*Anystis baccarum*	Predatory Mite	• Feeds on thrips, aphids, mites, and whiteflies. • Will attack and kill immatures and adults. • All mobile stages are predatory. • Can be used with other biological control agents. • Can be used against foxglove aphid. • Available in Canada with limited availability in the U.S.	50–95 °F 10–35 °C
 Photo Credit: Sarah Jandricic, OMFRA	*Aphidoletes aphidimyza*	Predatory Midge	• Larvae feed on many aphid species. • Primarily active at night. • May be used with other aphid biological control agents.	54–81 °F 12–27 °C
 Photo Credit: Wikimedia Commons  Photo Credit: Bugwood	*Adalia bipunctata*	Ladybird Beetle	• Larvae and adult feed on many aphid species. • Adults typically attempt to leave the greenhouse after release. Therefore, make releases in the evening.	54–95 °F 12–35 °C

Biological Control Agents			Comments	Optimum Temperatures for Activity
 Photo Credit: Bugwood	*Chrysopa carnea*	Green Lacewing	• Larvae feed on many aphid species. • Larvae can consume up to 400 aphids per week. • Adults do not feed on aphids but require nectar from flowering plants as a food source. • Does not disperse well in the greenhouse; therefore, use for localized aphid infestations.	59–82 °F 15–28 °C
 Photo Credit: Bugwood	*Chrysoperla rufilabris*	Green Lacewing	• Larvae feed on many aphid species. • Larvae can consume up to 300 aphids per week. • Tolerates a higher relative humidity (>75%) than *Chrysopa carnea*. • Adults do not feed on aphids but require nectar from flowering plants as a food source. • Does not disperse well in the greenhouse; therefore, use for localized aphid infestations.	59–82 °F 15–28 °C
 Photo Credit: Dave Gillespie, Applied Bio-nomics Ltd.	*Eupeodes americanus*	American Hoverfly	• Larvae are predators of aphids. • Adults lay eggs among aphid colonies. • A nectar source, such as sweet alyssum flowers, needs to be provided. • Can be used with aphid banker plants. • Sold as pupae. • Only available in Canada.	50–77 °F 10–25 °C
 Photo Credit: Bugwood	*Hippodamia convergens*	Ladybird Beetle	• Larvae and adults feed on many aphid species. • Multiple releases are usually required. • Adults commonly attempt to leave the greenhouse after release. Therefore, make releases in the evening.	54–77 °F 12–25 °C

Biological Control Agents			Comments	Optimum Temperatures for Activity
 Photo Credit: Dave Gillespie, Applied Bio-nomics Ltd.	*Micromus variegatus*	Brown Lacewing	• Adults are the primary predator. • One adult can consume up to 100 aphids per day. • Feeds on foxglove aphid. • Does not disperse well in the greenhouse; therefore, use for localized aphid infestations. • Only available in Canada	39–88 °F 4–31 °C

COMMERCIALLY AVAILABLE BIOLOGICAL CONTROL AGENTS FOR WESTERN FLOWER THRIPS

Predators

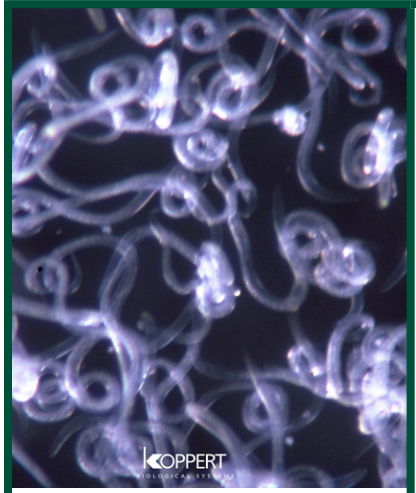
Biological Control Agents			Comments	Optimum Temperatures for Activity
 Photo Credit: Dave Gillespie, Applied Bio-nomics Ltd.	*Anystis baccarum*	Predatory Mite	• Feeds on thrips, aphids, mites, and whiteflies. Will attack and kill immatures and adults. • All mobile life stages are predatory. • Only available as loose product. • Available in Canada with limited availability in the U.S.	50–95 °F 10–35 °C

Biological Control Agents			Comments	Optimum Temperatures for Activity
 Photo Credit: Koppert Biological Systems	*Amblydromalus limonicus*	Predatory Mite	• Feeds on 1st and 2nd instar larvae. • Only available as loose product. • Active at lower temperatures (<60 °F or 15 °C) than other predators. . • Less effective at a relative humidity of <70%. • Feeds on pollen as an alternative food source. • Feeds on whitefly eggs and young nymphs. • More expensive than other predatory mites, but predation rate is higher.	55–86 °F 13–30 °C
 Photo Credit: Biobest Group NV	*Amblyseius degenerans*	Predatory Mite	• Feeds on the 1st and 2nd instar larvae. • Release early in the crop production cycle. • Only available as loose product. • Can be used with other biological control agents. • Effective at lower humidities (<50%). • Feeds on pollen in the absence of prey. • Also feeds on spider mites. • Only available in Canada.	61–77 °F 16–25 °C
 Photo Credit: Biobest Group NV	*Amblyseius swirskii*	Predatory Mite	• Feeds on the 1st and 2nd instar larvae. • Release early in the crop production cycle. • Available as loose product or as slow-release sachets. • Feeds on pollen in the absence of prey. • Tolerates higher temperatures than *Neoseiulus cucumeris*. • More expensive than *Neoseiulus cucumeris.*	64–90 °F 18–32 °C

Biological Control Agents			Comments	Optimum Temperatures for Activity
 Photo Credit: Dave Gillespie, Applied Bio-nomics Ltd.	*Dalotia coriaria (=Atheta)*	Rove Beetle	• Larvae and adults feed on fungus gnat eggs, larvae, and western flower thrips pupae in the growing medium. • Apply onto the growing medium surface. • Adults can fly and spread within a greenhouse. • Can be used with drenches of microbial pesticides and beneficial nematodes. • Sold as adults.	55–77 °F 13–25 °C
 Photo Credit: Dave Gillespie, Applied Bio-nomics Ltd.	*Gaeolaelaps gillespiei*	Predatory Mite	• Adults feed on fungus gnat larvae and western flower thrips pupae in the growing medium. • Release onto the surface of the growing medium. • Can be used in non-peat-based media, such as, rockwool and coconut coir. • Only available in Canada.	57–77 °F 14–25 °C
 Photo Credit: Biobest Group NV	*Neoseiulus (=Amblyseius) cucumeris*	Predatory Mite	• Feeds on the 1st instar larvae. • Release early in the crop production cycle. • Available as loose product or as slow-release sachets. • Less expensive than *Amblyseius swirskii*.	47–86 °F 8–30 °C

Biological Control Agents			Comments	Optimum Temperatures for Activity
 Photo Credit: Bugwood	*Orius insidiosus*	Insidiosus Flower Bug	• Nymphs and adults feed on western flower thrips larvae and adults. • May also feed on aphids and whiteflies. • Use with ornamental pepper banker plants (cultivars: 'Black Pearl' and 'Purple Flash'). • Sold as adults. • Release early in the crop production cycle. • From October to March, *Orius* may not establish in the greenhouse. However, *Orius* can be released from fall through spring.	59–77 °F 15–25 °C
 Photo Credit: Dave Gillespie, Applied Bio-nomics Ltd.	*Stratiolaelaps scimitus (formerly Hyposaspis miles)*	Predatory Mite	• Adults feed on western flower thrips pupae and fungus gnat larvae in the growing medium. • Release onto the surface of the growing medium. • Can be used with drenches of microbial pesticides and beneficial nematodes.	59–86 °F 15–30 °C

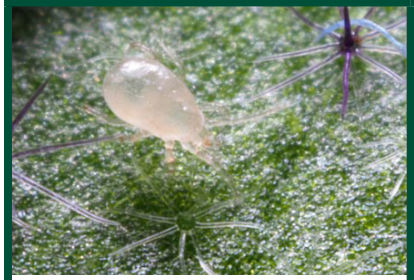
Beneficial Nematodes

Biological Control Agents			Comments	Optimum Temperatures for Activity
 Photo Credit: Koppert Biological Systems	*Heterorhabditis bacteriophora, Steinernema feltiae, Steinernema carpocapsae*	Beneficial Nematodes	• Apply as a drench to the growing medium to target western flower thrips pupae and fungus gnat larvae. • Apply early in the morning or late evening. • Keep the growing medium moist before and after application. Avoid overwatering to prevent washing nematodes out of containers. • Remove screens from equipment before applying and keep container agitated to prevent nematodes from settling. • Begin applications immediately after sticking vegetative cuttings and continue weekly until canopy closure. • Can be used with microbial pesticides when applied as drench applications.	41–95 °F 5–35 °C

COMMERCIALLY AVAILABLE BIOLOGICAL CONTROL AGENTS FOR TWOSPOTTED SPIDER MITE

Predators

Biological Control Agents			Comments	Optimum Temperatures for Activity
 Photo Credit: Dave Gillespie, Applied Bio-nomics Ltd.	*Anystis baccarum*	Predatory Mite	• Feeds on thrips, aphids, mites, and whiteflies. Will attack and kill immatures and adults. • All mobile life stages are predatory. • The life cycle (egg to adult) takes approximately 4 weeks to complete. • Available in Canada with limited availability in the U.S.	50–95 °F 10–35 °C

Biological Control Agents			Comments	Optimum Temperatures for Activity
 Photo Credit: Biobest Group NV	*Amblyseius andersonii*	Predatory Mite	• Feeds on alternative prey in the absence of twospotted spider mites. • Release early in the crop production cycle. • Not active when relative humidity <65%.	43–82 °F 6–28 °C
 Photo Credit: Koppert Biological Systems	*Neoseiulus californicus*	Predatory Mite	• Tolerates higher temperatures (>80 °F or 26 °C) and a lower relative humidity (<60%) than *Phytoseiulus persimilis*. • Use for long-term crops under warm and dry conditions.	50–86 °F 10–30 °C
 Photo Credit: Dave Gillespie, Applied Bio-nomics Ltd.	*Amblyseius fallacis*	Predatory Mite	• Tolerates cooler temperatures (<50 °F or 10 °C) than most predatory mites. • Feeds on pollen in the absence of twospotted spider mites.	48–86 °F 9–30 °C
 Photo Credit: Koppert Biological Systems	*Feltiella acarisuga*	Predatory Midge	• Larvae feed on twospotted spider mite. • Females lay eggs near localized infestations of the twospotted spider mite. • Adults do not feed on twospotted spider mites but fly and spread within a greenhouse. • Can be used with other biological control agents.	55–81 °F 13–27 °C

Biological Control Agents			Comments	Optimum Temperatures for Activity
 Photo Credit: Dave Gillespie, Applied Bio-nomics Ltd.	*Phytoseiulus persimilis*	Predatory Mite	• Primary predatory mite used against the twospotted spider mite. • Develops twice as fast as the twospotted spider mite at optimum temperatures. • Exhibits cannibalistic behavior when twospotted spider mites are absent. Therefore, only release when twospotted spider mites are present. • Active when relative humidity is >60% (and ≈80 °F or 26 °C).	59–81 °F 15–27 °C
 Photo Credit: Dave Gillespie, Applied Bio-nomics Ltd.	*Stethorus punctillum*	Ladybird Beetle	• Larvae and adult feed on all life stages (eggs, larvae, nymphs, and adults) of the twospotted spider mite. • Adults can consume an average of 20 twospotted spider mites per day. • Can be used with other biological control agents.	54–95 °F 12–35 °C

COMMERCIALLY AVAILABLE BIOLOGICAL CONTROL AGENTS FOR FUNGUS GNATS

Predators

Biological Control Agents			Comments	Optimum Temperatures for Activity
 Photo Credit: Dave Gillespie, Applied Bio-nomics Ltd.	*Dalotia coriaria (=Atheta)*	Rove Beetle	• Larvae and adults feed on fungus gnat larvae and western flower thrips pupae. • Apply onto the growing medium surface. • Adults fly and spread within a greenhouse. • Can be used with drenches of microbial pesticides and beneficial nematodes. • Sold as adults.	55–77 °F 13–25 °C

Biological Control Agents			Comments	Optimum Temperatures for Activity
 Photo Credit: Dave Gillespie, Applied Bio-nomics Ltd.	*Stratiolaelaps scimitus (formerly Hyposaspis miles)*	Predatory Mite	• Adults feed on fungus gnat larvae and western flower thrips pupae in the growing medium. • Release onto the surface of the growing medium. • Can be used with drenches of microbial pesticides and beneficial nematodes.	61–86 °F 16–30 °C
 Photo Credit: Dave Gillespie, Applied Bio-nomics Ltd.	*Gaeolaelaps gillespiei*	Predatory Mite	• Adults feed on fungus gnat larvae and western flower thrips pupae in the growing medium. • Release onto the surface of the growing medium. • Can be used in non-peat-based media, such as, rockwool and coconut coir. • Only available in Canada.	57–77 °F 14–25 °C

Beneficial Nematodes

Biological Control Agents			Comments	Optimum Temperatures for Activity
 Photo Credit: Raymond Cloyd	*Steinernema carpocapsae, Steinernema feltiae*	Beneficial Nematodes	• Apply as a drench to the growing medium to target fungus gnat larvae. • Apply early in the morning or late evening. • Keep the growing medium moist before and after application. Avoid overwatering to prevent washing nematodes out of containers. • Remove screens from equipment before applying and keep container agitated to prevent nematodes from settling. • Begin applications immediately after sticking vegetative cuttings and continue weekly until canopy closure. • Can be used with microbial pesticides.	41–95 °F 5–35 °C

COMMERCIALLY AVAILABLE BIOLOGICAL CONTROL AGENTS FOR MEALYBUGS

Biological Control Agents			Comments	Optimum Temperatures for Activity
 Photo Credit: Biobest Group NV	*Cryptolaemus montrouzieri*	Predatory Ladybird Beetle	• Larvae and adults feed on all life stages (eggs, nymphs, and adults) of mealybugs. • Larvae resemble mealybugs in appearance. • Females can lay between 200 and 500 eggs. • Activity decreases at temperatures <50 °F (10 °C). • Attracted to light, so release adults in the evening. • Not effective on tomato and other plants with glandular trichomes (hairs). • Multiple releases are generally required. • Can release larvae and adults at the same time.	61–95 °F 16–35 °C
 Photo Credit: Sarah Jandricic, OMFRA	*Dicyphus hesperus*	Predatory Mirid Bug	• Feeds on aphids, thrips, and mealybugs. • Reared on mullein banker plants. • Release early in the crop production cycle. • Only available in Canada.	59–95 °F 15–35 °C
 Photo Credit: Dave Gillespie, Applied Bio-nomics Ltd.	*Micromus varigaetus*	Predatory Brown Lacewing	• Feeds on aphids and mealybugs. • Release early in the crop production cycle. • Only available in Canada.	39–88 °F 4–31 °C

COMMERCIALLY AVAILABLE BIOLOGICAL CONTROL AGENTS FOR WHITEFLIES

Parasitoids

Biological Control Agents			Comments	Optimum Temperatures for Activity
 Photo Credit: Dave Gillespie, Applied Bio-nomics Ltd.	*Encarsia formosa*	Parasitic Wasp	• Primarily used against the greenhouse whitefly but will parasitize the sweetpotato (*Bemisia*) whitefly. • Females lay eggs in 2nd and 3rd instar nymphs. • Adult females feed on whitefly nymphs. • Active at temperatures >70 °F (21 °C). • Honeydew (sticky, clear liquid) on leaves inhibits ability to locate whiteflies. • Release early in the crop production cycle. • Make releases every 1 to 2 weeks. • Sold alone or in combination with *Eretmocerus eremicus*.	68–77 °F 20–25 °C
 Photo Credit: Raymond Cloyd	*Eretmocerus eremicus*	Parasitic Wasp	• Primarily used against the sweetpotato (*Bemisia*) whitefly. • Females lay eggs in 2nd and 3rd instar nymphs. • Tolerates higher temperatures (>80 °F or 26 °C) than *Encarsia formosa*. • Sold alone or in combination with *Encarsia formosa*.	68–86 °F 20–30 °C

Biological Control Agents			Comments	Optimum Temperatures for Activity
 Photo Credit: Biobest Group NV	*Amblyseius swirskii*	Predatory Mite	• Feeds on whitefly eggs and young nymphs. • Release early in the crop production cycle. • May be used with other whitefly biological control agents. • Feeds on pollen in the absence of prey.	64–90 °F 18–32 °C
 Photo Credit: Koppert Biological Systems	*Amblydromalus limonicus*	Predatory Mite	• Feeds on whitefly eggs and young nymphs. • Feeds on pollen as an alternative food source. • May be used with other whitefly biological control agents. However, do not use with other predatory mites. • Less active at a relative humidity of <70%. • More expensive than other predatory mites but has a higher predation rate.	55–86 °F 13–30 °C
 Photo Credit: Dave Gillespie, Applied Bio-nomics Ltd.	*Delphastus catalinae*	Ladybird Beetle	• Larvae and adult feed on all life stages (eggs, nymphs, and adults) of whiteflies. • Feeds on >150 whitefly eggs per day. • Adults can live up to 65 days. • Will not feed on parasitized whitefly. • Release early in the crop production cycle.	55–95 °F 13–35 °C
 Photo Credit: Sarah Jandricic, OMFRA	*Dicyphus hesperus*	Predatory Mirid Bug	• Feeds on aphids, thrips, mealybugs, and whiteflies. • Usually reared on mullein banker plants. Requires at least 8 weeks to establish sufficient numbers to manage whitefly populations.	59–95 °F 15–35 °C

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