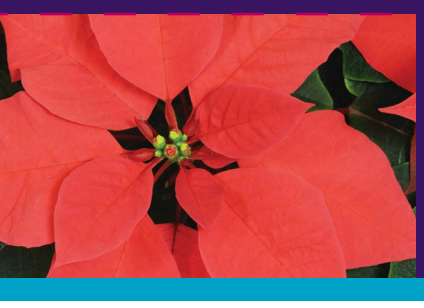
*The use of biological control agents (BCAs) in ornamental crops has been of interest to growers as it has become increasingly difficult to control thrips, the most common pest that affects spring crops, with traditional pesticides alone. BCAs are excellent resistance management tools, and since they can be distributed very early in the crop cycle during propagation, they are excellent for preventing pest populations from establishing.*

# BIOLOGICAL CONTROL STRATEGIES FOR ORNAMENTAL PRODUCTION



# BIOLOGICAL CONTROL STRATEGY FOR POINSETTIA PRODUCTION

Using biological control agents (BCAs) to control pests in poinsettias has been successful for years. There are few pests that affect poinsettias; however, the discovery of the 'Q' Bio-type silver leaf whitefly has increased the use of BCAs because it is more resistant to traditional control products.Working with BCA's improves resistance management and can help increase plant quality. For more information, download the Bioline App from www.biolineapp.com

## BIOLINE BIOLOGICAL CONTROL AGENTS FOR POINSETTIA

| | | | Application Rate | | | |
|---|---|---|---|---|---|---|
| **Pest** | **BCA** | **Product** | **$m^2$** | **sq. ft.** | **Timing** | **Comments** |
| **Whiteflies*** (*Trialeurodes vaporariorum* and/or *Bemisia tabaci*) | *Eretmocerus eremicus* | Eretline | 10 | 1 | Start second week after sticking cuttings or immediately after planting. Repeat weekly. | Optimal introduction method for *Eretmocerus eremicus* is blister packs. *Eretmocerus* is also available on cards. Keep blister packs (cards) out of direct sunlight. |
| | *Amblyseius swirskii* | Swirskiline | 50 | 5 | First introduce on rooted cuttings just before transplant. Second introduction just prior to spacing. | Introduction of *Amblyseius swirskii* is timed to coincide with the maximum foliage cover to ensure the greatest number of mites get onto the plants. |
| | | Swirskiline Stick - mini sachet | 1 sachet for each 10" pot for large poinsettias or for each pot for all stock plants. | | Place sachet at sticking/seeding and again during transplanting into larger pots. | Larger pots that are individually placed need one Swirskiline Stick sachet per pot. |
| **Fungus gnats** (*Bradysia spp*) | *Stratiolaelaps scimitus (Hypoaspis miles)* | Hypoline | 100 | 10 | Apply at sticking and at transplanting. | If applied at rooting stage, second application should be half rate at transplanting. |
| | *Dalotia coriaria (Atheta coriaria)* | Staphyline | 2 | 0.2 | | |
| | *Steinernema feltiae* | Exhibitline Sf | 250,000 | 25,000 | Apply at sticking and repeat twice during rooting stage. Reapply immediately after transplanting. | Correct application is critical for efficacy. Make sure solution is agitated, fine filters are removed and pressure is kept low. |
| **Two-spotted spider mites** (*Tetranychus urticea*) | *Phytoseiulus persimilis* | Phytoline | 6 to 8 | 0.6 to 0.8 | Start when first mites are detected. Repeat weekly for 3 to 4 weeks until *Phytoseiulus* is established and mites are controlled. | Check mite species. *Phytoseiulus* does not work well on Lewis mite. |
| **Lewis mites** (*Eotetranychus lewisi*) | *Amblyseius andersoni* | Anderline | 4 to 6 | 0.4 to 0.6 | Start when first mites are detected. Repeat weekly for 3 to 4 weeks until mites are controlled. | |
| **Thrips** (*Frankliniella occidentalis*) | *Amblyseius swirskii* | Swirskiline | 50 | 5 | First introduce on rooted cuttings just before transplant. Second introduction just prior to spacing. | Western Flower Thrips (WFT) do not reproduce well on poinsettia. Typically WFT will decrease naturally in poinsettia crops. *Echinothrips americanus* can establish on poinsettia and requires a different approach. |
| | | Swirskiline Stick - mini sachet | 1 sachet for each 10" pot for large poinsettias or for each pot for all stock plants. | | Place sachet at sticking/seeding and again during transplanting into larger pots. | Larger pots that are individually placed need one Swirskiline Stick sachet per pot. |
| | *Stratiolaelaps scimitus (Hypoaspis miles)* | Hypoline | 100 | 10 | Apply at sticking and at transplanting. | If applied at rooting stage, second application should be at half rate at transplanting. |
| | *Dalotia coriaria (Atheta coriaria)* | Staphyline | 2 | 0.2 | | |

| Whitefly development relative to temperature | Sweet potato whitefly | | Greenhouse whitefly | |
|---|---|---|---|---|
| | 60°F/16°C | 80°F/27°C | 60°F/16°C | 80°F/27°C |
| Egg | 21 | 6 | 16 | 7 |
| Larvae 1 (L1) | 12 | 4 | 8 | 4 |
| L2 | 9 | 3 | 5 | 2 |
| L3 | 10 | 3 | 5 | 2 |
| L4/pupa | 18 | 6 | 15 | 7 |
| **Total** | **70** | **22** | **49** | **22** |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# BIOLOGICAL CONTROL STRATEGY FOR CHRYSANTHEMUM PRODUCTION

The most common pests that affect chrysanthemum crops are thrips, but spider mites, aphids and leafminers can also be problematic. Incorporating biological control agents (BCAs) into chrysanthemum production has been very successful for the last decade in Europe. However, new developments in biocontrol have increased the use of BCAs in chrysanthemum crops in North America.

## BIOLINE BIOLOGICAL CONTROL AGENTS FOR POTTED CHRYSANTHEMUM

| | | | Application Rate | | | |
|---|---|---|---|---|---|---|
| **Pest** | **BCA** | **Product** | **m²** | **sq. ft.** | **Timing** | **Comments** |
| **Thrips** *(Frankliniella occidentalis)* | *Amblyseius cucumeris* | Amblyline - loose | 100 | 10 | Apply weekly during propagation. | Broadcast evenly or use a battery-operated blower. |
| | | Amblyline Stick-mini sachet | 1 sachet per propagation tray, shuttle tray or Pot. | | Place sachet at sticking/seeding and again during transplanting into pots or hanging baskets. | Place a minimum of 1 Amblyline Stick per 4, 5 or 6-inch shuttle tray. Larger pots that are individually placed need 1 sachet per pot. |
| | *Orius insidiosus* | Oriline | 5 to 10 | 0.5 to 1 | Release in hot spots. | Consider using pepper banker plants. |
| | *Stratiolaelaps scimitus (Hypoaspis miles)* | Hypoline | 100 | 10 | Apply at sticking and at transplanting. | If applied at rooting stage, second application should be half rate at transplanting. |
| | *Dalotia coriaria (Atheta coriaria)* | Staphyline | 2 | 0.2 | | |
| **Two-spotted spider mites** *(Tetranychus urticae)* | *Amblyseius andersoni* | Anderline | 4 to 6 | 0.4 to 0.6 | Release together as mixed application with *Amblyseius cucumeris* in propagation. | |
| | *Phytoseiulus persimilis* | Phytoline | 6 to 8 | 0.6 to 0.8 | Start when first mites are detected. Repeat weekly for 3 to 4 weeks until *Phytoseiulus* is established and mites are controlled. | Early detection improves results. Consider using indicator plants (bush beans). |
| **Fungus gnats** *(Bradysia spp)* | *Stratiolaelaps scimitus (Hypoaspis miles)* | Hypoline | 100 | 10 | Apply at sticking and at transplanting. | If applied at rooting stage, second application should be half rate at transplanting. |
| | *Dalotia coriaria (Atheta coriaria)* | Staphyline | 2 | 0.2 | | |
| | *Steinernema feltiae* | Exhibitline Sf | 250,000 | 25,000 | Apply at sticking and repeat twice during rooting stage. Reapply immediately after transplanting. | Correct application is critical for efficacy. Make sure solution is agitated, fine filters are removed and pressure is kept low. |
| **Leafminers** *(Liriomyza trifolii)* | *Diglyphus isaea* | Digline | 0.25 to 1 | 0.025 to 0.1 | Release weekly for 3 to 4 weeks until sufficient parasitism has been established. | Start releasing at first signs of leafminer (feeding and oviposition spots). |
| **Aphids** *(Aphis gossypii, Myzus persicae, Myzus nicotianae)* | *Aphidius colemani* | Aphiline | 0.25 to 1 | 0.025 to 0.1 | Release weekly and/or use in combination with aphid banker plants. | *Aphidius matricariae* is more aggressive towards *Myzus nicotianae* ('red' aphid). |
| | *Rhopalosiphum padi* | Aphid banker plant | 1 / acre (2.5 / ha) minimum | | Apply every other week. | Initial introduction is 2 per acre. |
| | *Aphidoletes aphidimyza* | Aphidoline | 1 | 0.1 | Release at first signs of aphids. Continue weekly releases until control has been achieved. | |
| | *Chrysoperla spp* | Chrysoline | 10 to 20 | 1 to 2 | Use as hot spot treatment only for quick knock down. | |
| **Caterpillars/ loopers** *(several spp)* | *Bacillus thuringiensis* | For example, DiPel WP biological insecticide | Follow label. | | Apply at first signs. | |

| **Dipping at sticking and/or planting:** | | **per 12 to 15 gallons** | |
|---|---|---|---|
| **Thrips, fungus gnats and others** | *Beauveria bassiana* (strain GHA) - Use WP formulation | See label | Keep solution in agitation. Refresh dipping solution as often as needed. |
| | *Trichoderma harzianum* strain T-22 and *Trichoderma virens* strain G-41 | See label | |
| | Exhibitline Sf biological control agent | 50 million | |

## BIOLINE BIOLOGICAL CONTROL AGENTS FOR SPRING ORNAMENTALS AND HANGING BASKET

| | | | Application Rate | | | |
|---|---|---|---|---|---|---|
| **Pest** | **BCA** | **Product** | **m²** | **sq. ft.** | **Timing** | **Comments** |
| **Western Flower Thrips, Chili Thrips and other species** *(Frankliniella occidentalis, Scirtothrips dorsalis)* In areas where temperatures are consistently >75°F/24°C, replace *Amblyseius cucumeris* with *Amblyseius swirskii.* | *Amblyseius cucumeris* | Amblyline - loose | 100 | 10 | Apply weekly during propagation. | Broadcast evenly or use a battery-operated blower. |
| | | Amblyline Stick - mini sachet | 1 sachet per propagation tray, shuttle tray or hanging basket. | | Place sachet at sticking/seeding and again during transplanting into pots or hanging baskets. | Place a minimum of 1 Amblyline Stick per 4, 5 or 6-inch shuttle tray. Larger pots that are individually placed need 1 sachet per pot. |
| | *Orius insidiosus* | Oriline | 5 to 10 | 0.5 to 1 | Release in hot spots. | Consider using pepper banker plants. Consult with a Bioline specialist. Be aware of diapause until March 1st. |
| | *Stratiolaelaps scimitus (Hypoaspis miles)* | Hypoline | 100 | 10 | Apply at sticking/seeding and at transplanting. | If applied at rooting stage, second application should be half rate at transplanting. |
| | *Dalotia coriaria (Atheta coriaria)* | Staphyline | 2 | 0.2 | | |
| **Fungus gnats and shore flies** *(Bradysia spp., Scatella spp.)* | *Stratiolaelaps scimitus (Hypoaspis miles)* | Hypoline | 100 | 10 | Apply at sticking and at transplanting. | If applied at rooting stage, second application should be half rate at transplanting. |
| | *Dalotia coriaria (Atheta coriaria)* | Staphyline | 2 | 0.2 | | |
| | *Steinernema feltiae and Steinernema carpocapsae* | Exhibitline Sf Exhibitline Sc | 250,000 | 25,000 | Apply at sticking and repeat twice during rooting stage. Reapply immediately after transplanting. | Correct application is critical for efficacy. Make sure solution is agitated, fine filters are removed and pressure is kept low. |
| **Aphids (small spp.): Green peach, black melon, tobacco aphid** *(Aphis gossypii, Myzus persicae, Myzus nicotianae)* | *Aphidius colemani* | Aphiline | 0.25 to 1 | 0.025 to 0.1 | Release weekly and/or use in combination with aphid banker plants. | Ideal release method is Aphiline in blister packs. Hang in shady spot out of intense direct sunlight. |
| | *Rhopalosiphum padi* | Aphid banker plant | 1/acre (2.5/ha) minimum | | Release Aphiline weekly and/or use in combination with aphid banker plants. Initial introduction is 2 banker plants per acre. | |
| | *Aphidoletes aphidimyza* | Aphidoline | 1 | 0.1 | Release at first signs of aphids. Continue weekly releases until control has been achieved**.** | Be aware of diapause between October 15th and March 1st. |
| | *Chrysoperla spp.* | Chrysoline | 10 to 50 | 1 to 5 | Use as hot spot treatment only. Works for quick knock down. | |
| **Aphids (larger spp.): Potato, foxglove aphid** *(Macrosiphum euphorbiae, Aulacorthum solani)* | *Aphidius ervi* | Erviline | 0.25 to 1 | 0.025 to 0.1 | Release weekly before aphids become a problem. | |
| | *Aphidoletes aphidimyza* | Aphidoline | 1 | 0.1 | Release at first signs of aphids. Continue weekly releases until control has been achieved. | Be aware of diapause between October 15th and March 1st. |
| | *Chrysoperla spp.* | Chrysoline | 10 to 50 | 1 to 5 | Use as hot spot treatment only. Works for quick knock down. | |
| **Two-spotted spider mites** *(Tetranychus urticae)* | *Amblyseius andersoni* | Anderline | 4 to 6 | 0.4 to 0.6 | Release in propagation. | Can be a mixed application with *Amblyseius cucumeris* in propagation. |
| | *Phytoseiulus persimilis* | Phytoline | 6 to 8 | 0.6 to 0.8 | Start when first mites are detected. Repeat weekly for 3 to 4 weeks until *Phytoseiulus* is established and mites are controlled. | Early detection improves results. Consider using indicator plants (bush beans). |
| **Leafminers** *(Liriomyza trifolii)* | *Diglyphus isaea* | Digline | 0.25 to 1 | 0.025 to 0.1 | Release weekly for 3 to 4 weeks until sufficient parasitism has been established. | Start releasing at first signs of leafminer (feeding and oviposition spots). |
| **Broad mites** *(Polyphagotarsonemus latus)* | *Amblyseius cucumeris* | Amblyline Stick - mini sachet | 1 sachet per propagation tray, shuttle tray or hanging basket. | | Place sachet at sticking/seeding and again during transplanting into pots or hanging baskets. | Place a minimum of 1 Swirskiline Stick per 4, 5 or 6-inch shuttle tray. Larger pots that are individually placed need 1 sachet per pot. |
| **Sweetpotato, greenhouse whiteflies** *(Trialeurodes vaporariorum and/or Bemisia tabaci)* If *A. swirskii* is released for whitefly, it will also control thrips larva, eliminating the need to release *A. cucumeris. A. swirskii* requires temperatures >68°F/20°C for good performance. | *Amblyseius swirskii* | Swirskiline - loose | 100 | 10 | Apply weekly during propagation. | Broadcast evenly or use a battery-operated blower. |
| | | Swirskiline Stick - mini sachet | 1 sachet per propagation tray, shuttle tray or hanging basket. | | Place sachet at sticking/seeding and again during transplanting into pots or hanging baskets. | Place a minimum of 1 Swirskiline Stick per 4, 5 or 6-inch shuttle tray. Larger pots that are individually placed need 1 sachet per pot. |
| | *Encarsia formosa and Eretmocerus eremicus* | Encarline Mix | 3 to 6 | 0.3 to 0.6 | Start at first signs of whitefly. Continue weekly releases until control has been achieved. | Optimal introduction method for wasps is blister packs. Keep blister packs (cards) out of direct sunlight. Open release flap on the back. |
| **Caterpillars/ loopers** | *Bacillus thuringiensis* | For example, DiPel WP biological insecticide. | Follow label. | | Apply at first signs. | |