



## Biological Control Agents (BCAs): Greenhouse Pepper Insect Management

BCA Insect Control					
Pest	BCA	Rate (Units/m <sup>2</sup> )	Rate (Units/ft <sup>2</sup> )	Release strategy	Application Notes
<b>Thrips</b> Western flower thrips <i>(Frankliniella occidentalis)</i> ; Chili thrips <i>(Scirtothrips dorsalis)</i> ; and other species  Note: <i>A. swirskii</i> can interfere with aphid control by predation on <i>Aphidoletes aphidimyza</i>	<i>Amblyseius cucumeris</i> or <i>A. swirskii</i>	1 sachet per plant at propagation, then 1 sachet per 3 plants		Sachets are preferred release method. For loose broadcasting during propagation, start at germination and repeat weekly.	After planting, hang sachet 6 – 8 inches from the top of every 3 plants. <i>A. cucumeris</i> establishes well on pepper pollen and in most cases 1 introduction after planting is sufficient for establishment.
		100 when loose	10 when loose		
	<i>Orius insidiosus</i>	0.5 – 1	0.05 – 0.1	Release for 4 weeks in a row until establishment is confirmed. Release during longer days (beginning of March). Earlier releases can be done if lights available.	To increase <i>Orius</i> egg laying capacity, <i>Ephestia</i> spp. eggs can be provided as an alternative food source besides pollen from the crop.
	<i>Stratiolaelaps scimitus</i> (= <i>Hypoaspis miles</i> )	100	10	Release first on the organic substrate during propagation and repeat after transplanting to containers with organic material.	Release full rate during propagation. Release half rate after planting if full rate is used during propagation. Both species can be mixed and applied together. (Does not work in Rockwool media.)
	<i>Dalotia</i> (= <i>Atheta</i> ) <i>coriaria</i>	2	0.2		
	<i>Steinernema feltiae</i> (NemaShield)	250K -300K	25K -30K	Apply bi-weekly from the beginning of the crop.	Initiate treatments during the seedling stage. Keep suspension under constant agitation, remove filters and keep low pressure for better results. (Does not work in Rockwool media.)



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<b>Aphids (small species)</b> Cotton/Melon aphid ( <i>Aphis gossypii</i> )	<i>Aphidius colemani</i>	0.25 -1	0.025 -0.1	Release weekly or minimum of 4-5 weekly releases in combination with aphid banker plants.	Mummies typically start to show 2-3 weeks after initial release. With banker plants, do not stop weekly introductions until first mummies are hatching on initial banker plants.
	<i>Aphelinus abdominalis</i>	0.5 - 2	0.05 -0.2	Alternate releases with <i>Aphidius</i> spp.	Release this species when low parasitism is achieved with <i>A. colemani</i> or if hyperparasitism is confirmed on aphid populations.
	<i>Aphidoletes aphidimyza</i> <sup>1</sup>	1	0.1	Weekly releases upon aphid detection. Continue until control has been achieved.	Start at first sign of aphid presence. Diapause occurs between October and early March. <sup>2</sup> Keep carrier lightly humid to ensure <i>A. aphidimyza</i> emergence.
	<i>Chrysoperla</i> spp. larvae	10-50	1-5	Release weekly on hot spots during episodes of high aphid pressure.	Best for quick knock-down effect in hot spots.
	Aphid Banker Plants ( <i>Aphidius colemani</i> + <i>Rhopalosiphum padi</i> )	2.5 plants/ ha or 1 plant/acre		Start banker plant strategy as early as possible before aphids are detected in the crop. Add new banker plants on a bi-weekly basis.	Initial introduction should be 2 times the recommended amount.



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<b>Aphids (large species)</b> Potato aphid <i>(Macrosiphum euphorbiae)</i> ; Foxglove aphid <i>(Aulacorthum solani)</i>	<i>Aphidius ervi</i>	0.25 -1	0.025 -0.1	Release on a weekly basis.	Use <i>A. ervi</i> as a complementary strategy when large aphid species are detected in the crop.
	<i>Aphelinus abdominalis</i>	0.5 - 2	0.05 – 0.2	Alternate releases with <i>Aphidius</i> spp.	Release this species when low parasitism is achieved with <i>A. ervi</i> or if hyper-parasitism is confirmed on aphid populations.
	<i>Aphidoletes aphidimyza</i> <sup>1</sup>	1	0.1	Weekly releases upon aphid detection. Continue until control has been achieved.	Start at first sign of aphid presence. Keep carrier lightly humid to ensure <i>A. aphidimyza</i> emergence. (Be aware of diapause and natural sunset.) <sup>2</sup>
	<i>Chrysoperla</i> spp. larvae	10 - 50	1-5	Release weekly in hot spots during episodes of high aphid pressure.	Best for quick knock-down effect in hot spots.
<b>Two-spotted spider mite</b> <i>(Tetranychus urticae)</i>	<i>Phytoseiulus persimilis</i>	8 - 10	0.8 - 1	Release upon detection of first spider mite spots.	Repeat every week until achieving control.
	<i>Amblyseius (=Neoseiulus) fallacis</i>	4 - 6	0.4 – 0.6	Start releasing from crop propagation stage.	This species is compatible with other spider mites' predators like <i>P. persimilis</i> .
	<i>Amblyseius andersoni</i> / <i>A. californicus</i>			Release with sachets, 1 per 6 plants, or broadcast loose at the start of the crop.	Establishes well on pepper pollen and in most cases 1 introduction is sufficient for establishment.



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<b>Whiteflies</b> Greenhouse Whitefly ( <i>Trialeurodes vaporariorum</i> ); Sweet Potato Whitefly ( <i>Bemisia tabaci</i> )  Note: <i>A.swirskii</i> can interfere with aphid control by predation on <i>Aphidoletes aphidimyza</i> . For whitefly control in peppers the wasps <i>Encarsia formosa</i> and <i>Eretmocerus eremicus</i> will avoid this concern.	<i>Amblyseius swirskii</i>	1 sachet per plant at propagation, then 1 sachet per 3 plants		Sachets are preferred release method. For loose broadcasting during propagation, start at germination and repeat weekly.	Release evenly in the area or apply with a battery-operated blower. <i>A. swirskii</i> will also help control thrips larvae <b>but requires temperatures &gt;68 °F for best results.</b>
		100 when loose	10 when loose		
	<i>Encarsia formosa</i>	3 - 6	0.3 – 0.6	Start releasing after first whiteflies are detected and continue weekly.	Maintain releases every week until achieving control. A combination of both species can be used for better results. Note: <i>Encarsia</i> is not effective for controlling <i>Bemisia tabaci</i> .
	<i>Eretmocerus eremicus</i>				
	<i>Dicyphus hesperus</i>	3-4 per Mullein plant per week for 8 weeks		Introduce Mullein plants at 40 per acre. Apply <i>Ephestia</i> eggs weekly during establishment.	This generalist predator feeds on eggs, larvae and pupae of whitefly. Also feed on aphids, thrips (including <i>Echinothrips americanus</i> ), moth eggs and various species of mites.
<b>Loopers</b> Cabbage looper ( <i>Trichoplusia ni</i> ) and other species  <b>Borers and Caterpillars</b> European corn borer ( <i>Ostrinia nubilalis</i> ); Beet armyworm ( <i>Spodoptera exigua</i> )	<i>Podisus maculiventris</i>	0.05	0.005	Start releases early in the crop.	Keep up weekly introductions to ensure establishment. Concentrate releases on lepidopteran hot spots as this benefits <i>Podisus</i> nymph development.
	<i>Orius insidiosus</i>	Same as for thrips control.			A good establishment of <i>Orius</i> guarantees a good control of both thrips and moth eggs.
	<i>Dicyphus hesperus</i>	Same as for whitefly control.			Only effective in a proactive system with banker plants. Populations need to be established to be effective in feeding on moth eggs (curative releases will not be effective).



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Fungus gnats ( <i>Bradysia</i> spp.); and shore flies ( <i>Scatella</i> spp.)	<i>Stratiolaelaps scimitus</i> (=Hypoaspis miles)	100	10	Release first on the organic substrate during propagation and repeat after planting to other containers containing organic material.	Release full rate during propagation. Release half rate after transplanting if full rate is used during propagation. It may require several introductions in hydroponic crops. Both species can be mixed and applied together.
	<i>Dalotia coriaria</i> (=Atheta coriaria)	2	0.2		
	<i>Steinernema feltiae</i> (NemaShield)	250K -300K	25K – 30K	Apply bi-weekly from the beginning of the crop.	Initiate treatments during the seedling stage. Keep suspension under constant agitation, remove filters and keep low pressure for better results.

### NOTES:

<sup>1</sup> *Aphidoletes aphidimyza* is highly susceptible to the use of any sulfur products; sulfur should be avoided when using this species.

<sup>2</sup> *Aphidoletes* and *Feltiella* both mate at dusk. If lights are utilized in the greenhouse, it is better to allow the natural sunset, and wait to turn on lights later, at 2 or 3 am. To avoid diapause (between October and early March), extend daylength to 12 hours.

Lygus bugs can also be a problem pest in Pepper production. Currently there are no known specific BCA's for controlling this pest. Practical experience has shown that established populations of generalist predators such as *Orius*, *Dicyphus* and *Podisus* will help to maintain this pest problem below threshold levels.

Contact your Biological Control Advisor for additional information.