

Tomato

General Information

Over the last 10 years, tomato production changed in many ways: growing became more intensive to maximize yield and profit. At the same time, efforts were made to minimize inputs and cost. Biological control in greenhouse tomato has kept-up with increased pest pressure due to the intensification while its input cost has remained the same or even decreased. Inter-planting, aggressive de-leafing and lower temperatures in the greenhouse are examples of some profit driven changes that biological control in greenhouse tomato has had to cope with. The most common pests of greenhouse tomato are, in order of importance, whitefly, caterpillars/loopers and spider mite. Occasional pests include thrips, aphid and potato psyllid. Key to a successful program in greenhouse tomato is an integrated approach combining BCA's (biological control agents) as a first line of defence for the most common pests with BCA-compatible pesticides against pests currently not controlled with BCA's. Also important are early preventive introductions of BCA's and a good monitoring system.

Scouting and Monitoring

Scouting needs to be done on a regular and consistent basis (weekly) to monitor pest and BCA populations. Scouting consists of examining sticky cards and plants. An excellent tool for monitoring pest populations is the use of sticky cards. Biobest suggests using 10 yellow sticky cards per hectare (1 card/4000ft²). Identify, count and record the number of pests and BCA's found on cards. All counts (and observations) can be recorded on the Biobest 'Scout-Sheet' or other scouting and monitoring sheets. Some pests do not show up on sticky cards because they do not fly; the two-spotted spider mite is a good example of such a pest. We suggest inspecting a minimum of 20 plants/acre; if any pests and BCA's are found on plants, identify and record observations.

Pests, Biological Control Agents (BCA) & Control Strategy

Whitefly



Tomato is attacked by the greenhouse whitefly (*Trialeurodes vaporariorum*) and by the silverleaf (tobacco/sweet potato) whitefly (*Bemisia argentifolli* or *B. tabaci*). A large whitefly population can affect production both in quantity and quality. As well, there are several devastating viruses that are vectored by whitefly. It is important to identify the whitefly species because BCA's may attack some

whitefly species but not others; therefore, whitefly species present in a greenhouse can impact the choice of the BCA's used (for detailed identification key, consult the 'Whitefly Pest-Info Sheet').

For tomato, we recommend to start introducing BCA's as soon as possible after the beginning of the crop. In case only greenhouse whitefly are present, we recommend weekly preventive introduction of the Encarsia-System and/or of the Eretmocerus-System, which contains the parasitic wasps *Encarsia formosa* and *Eretmocerus eremicus* respectively. These two BCA's can be used individually or in combination and are also available mixed together (50%-50%) in the product Eretmix-System. In regions where silverleaf whitefly is more common, we recommend weekly preventive releases of the Mundus-System, which contains the parasitic wasp *Eretmocerus mundus*. Since *E. mundus* does not attack the greenhouse whitefly, it is therefore to also introduce Encarsia-System, Eretmocerus-System or Eretmix-System. For hot-spots, we recommend additional releases of the appropriate BCA's depending on the whitefly species present. (Introduction rates: Table 1 and 2).

Spider mites



Two-spotted spider mite (*Tetranychus urticae*, TSSM) is a major pest that can defoliate an entire plant. A characteristic of TSSM that makes its control difficult is that TSSM enter diapause (hibernation) in the fall; at that stage, they can easily be recognized by their orange to orange-red colour. Diapausing TSSM walk off plants to hide in the greenhouse structure or in cracks and crevices. As soon as temperatures are favourable (spring), spider mites slowly come out of diapause and move to the

nearest plants. Because diapausing TSSM are difficult to kill with clean-up products, we recommend lowering the TSSM population by using chemical corrections or BCA's before they begin to diapause in the fall. This is important in order to start up the next crop with the lowest mite pressure as possible.

As soon as the first spider mites are discovered, we suggest introducing the Phytoseiulus-T-System, which contains the predatory mite *Phytoseiulus persimilis*, specially bred for tomato plants. *Phytoseiulus persimilis* is the most commonly used and most successful BCA against TSSM. Another tool and excellent BCA that can be used, especially in hotspots, is the Feltiella-System, which contains the predatory midge *Feltiella acarisuga*. For any developing hotspots, a combination of extra Phytoseiulus-T-System and Feltiella-System can be introduced curatively on plants surrounding the hotspot. Because TSSM thrive under dryer and warmer conditions, it is important to closely monitor the balance between the populations of BCA's versus the spider mite. (Introduction rates: Tables 1 and 2)

Thrips



While thrips can sometimes cause significant damage to greenhouse tomato by feeding on plants, the main danger posed by thrips is the chance of virus transmission. For example, Tomato Spotted Wilt Virus (TSWV) is vectored by thrips and is potentially a costly virus if left unchecked. The western flower thrips *Franklinella occidentalis* has supplanted other thrips species to become the most common; however, it is still possible to find other species of thrips like Onion thrips (*Thrips tabaci*) in certain areas. BCA's currently available against thrips are not very effective on tomato plants and thrips control is generally achieved with cultural methods where virus is not a factor or with pesticides where virus is a problem. Please contact your Biobest or distributor's IPM consultant to discuss options.

Aphids



Aphid populations can develop very fast because they give birth to live young (no eggs), which in return start to be reproductive very quickly. The most common aphid species found in greenhouse tomato are the green peach aphid and potato aphid (for detailed identification key, consult the 'Aphid Pest-Info Sheet'). Identification is important because the species of aphid infesting the crop can dictate which BCA is used.

Since aphids can multiply very quickly, the best control strategy is a preventive one. We recommend introducing banker-systems even before aphids are found in the crop; a banker-system consist of barley plants infested with cereal aphids, which can support a population of a BCA but will not attack tomato; in other words, it is an 'in-house rearing system of aphid enemies'. There are two banker-systems available, the Colemani-Banker-System and the Ervi-Banker-System. The Colemani-Banker-System is used with the Aphidius-System, which contains the parasitic wasp *Aphidius colemani* and is effective against small aphids such as the green peach aphid. The Ervi-Banker-System is used with Ervi-System, which contains the parasitic wasp *Aphidius ervi* and is used against large aphids such as potato aphid. In case hotspots develop, we recommend additional introductions of the parasitic wasps mentioned above (depending on the aphid species present) in combination with the Aphidoletes-System, which contains the midge *Aphidoletes aphidimyza*, a generalist predator that can be used against all aphid species. (Introduction rates: Table 1 and 2).

Fungus gnats



Fungus gnats can be a problem at both the propagation of young plants and at the planting stage because they can feed on and damage plant roots as well as vector diseases such as Pythium. Shore flies can be a nuisance but they do not cause direct damage to plants.

We suggest using Hypoaspis-System, which contains the predatory mite *Hypoaspis miles*, as a preventive measure against fungus gnats. One application soon after seeding or at planting is enough to establish a population and obtain control. (Introduction rates: Table 1)

Caterpillars and Loopers

Caterpillars and loopers can be controlled with B.t.k. (*Bacillus thuringiensis* var. *kurstakii*) products or with some pesticides that have no negative effect on the rest of the biological control system and/or BCA's introduced. There are BCA's available commercially for use against caterpillars and loopers; if you are interested in learning more about these BCA's, please contact your Biobest or Biobest distributor's IPM consultant.

Russet Mite and Potato Psyllid

At the moment, there are no BCA's available to control these pests effectively. Therefore, these pests need to be addressed with selective pesticides when infesting the greenhouse. Please contact your Biobest or Biobest distributor's IPM consultant to discuss options.

Impact of pesticides on BCA's

- Pesticides (insecticides, nematicides, fungicides, etc.) can have short or long-term negative effects on one or more stages of the BCA's. Therefore, be careful if or when choosing pesticides to apply while using BCA's.
- If buying plants from an outside source, request a record of the pesticides applied on the plant material you are buying. Some pesticides with long-term residuals can have a negative impact on BCA's for many weeks after their application, even if pesticides were applied before the plant material is brought into your greenhouse. Ask your supplier of plant material to incorporate BCA's as much as possible in his pest management program.
- Effects of pesticides on BCA's are listed in the Biobest's publication "Side Effects Manual" or can be found on Biobest's website (www.biobest.ca);

Additional sources of information

- For detailed information on pests and BCA's mentioned above, consult the corresponding "Pest Info-Sheet" or "Beneficial Info-Sheet", which are all contained on the "Biobest Info-System" CD. To obtain a copy of any info-sheet or of the CD, please contact Biobest directly or a Biobest representative.

Miscellaneous

- Introduction rates of BCA's can be influenced by climate, season and location;
- Always use products as soon as possible after receipt. If storage is unavoidable, keep at recommended temperature (indicated on package) for the shortest amount of time possible;
- Always use products before the expiry date stated on the package;
- For additional information, please contact a Biobest supplier or technical advisor.

Biobest Canada Ltd., 2020 Fox Run Rd.; Leamington, ON, N8H 3V7, Canada. Tel.: (519) 322-2178; Fax (519) 322-1271; E-mail: info@biobest.ca; Website: www.biobest.ca

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Table 1: Preventive introduction of BCA's against tomato pests.

Pest	Product (BCA)	Introduction rate	Timing	Application
Whitefly	Use one of the first two products against greenhouse whitefly; use third product against silverleaf (<i>Bemisia</i> spp.) whitefly.			
	Encarsia-System (<i>Encarsia formosa</i>)	0.3 / ft ²	Weekly	Hang cards on plant
	Eretmocerus-System (<i>Eretmocerus eremicus</i>)	0.3 / ft ²	Weekly	Hang cards on plant
	Mundus-System (<i>Eretmocerus mundus</i>)	0.3 / ft ²	Weekly	Hang cards on plant
Small aphids (green peach)	Use the following two products in combination.			
	Colemani-Banker-System	1 plant / acre	Every month, start immediately after planting	Transplant in hanging basket
	Aphidius -System (<i>Aphidius colemani</i>)	250 /Aphid Banks	Immediately after planting Repeat if needed	Sprinkle on leaf
Large aphids (potato)	Use following two products in combination			
	Ervi-Banker-System	1 plant / acre	Every 2 weeks, start immediately after planting	Transplant in hanging basket
	Ervi-System (<i>Aphidius ervi</i>)	250 /Aphid Banks	Immediately after planting; repeat if needed	Sprinkle on leaf
Fungus gnat	Hypoaspis-System (<i>Hypoaspis miles</i>)	10/ft ² at seeding or 100/slab after planting		Sprinkle on seeding trays or make pile on slab

Table 2: Curative introduction of BCA's against tomato pests.

Pest	Product (BCA)	Introduction rate	Timing	Application
Whitefly	Use at least one of the first two products against greenhouse whitefly; use third product against silverleaf (<i>Bemisia</i> spp.) whitefly			
	Encarsia-System (<i>Encarsia formosa</i>)	0.4 to 0.6 / ft ²	As necessary	Hang cards on plant
	Eretmocerus-System (<i>Eretmocerus eremicus</i>)	0.4 to 0.6 / ft ²	As necessary	Hang cards on plant
	Mundus-System (<i>Eretmocerus mundus</i>)	0.6 to 0.9 / ft ²	As necessary	Hang cards on plant
Spider mite	Use first product; second product is optional			
	Phytoseiulus-System (<i>Phytoseiulus persimilis</i>)	2 / ft ²	At least 3 introduction a week apart, repeat as necessary	Sprinkle on plants in hot spots
	Feltiella-System (<i>Feltiella acarisuga</i>)	250 / acre	At least 2 introductions a week apart	Open package in hot-spots
Aphids	Use first product against small aphids (green peach); use second product against large aphids (potato); third product is optional and can be used against any aphid species			
	Aphidius -System (<i>Aphidius colemani</i>)	0.05 – 0.1 / ft ²	As necessary	Sprinkle on plants in hot spots
	Ervi-System (<i>Aphidius ervi</i>)	0.05 – 0.2 / ft ²	As necessary	Sprinkle on plants in hot spots
	Aphidoletes-System (<i>Aphidoletes aphidimyza</i>)	0.5 - 1 /ft ²	As necessary	Make pile in hot spots