# Biological Control in Organic Integrated Pest Management (IPM) for Cucumbers and Tomatoes

Teagasc
Agriculture and Food Development Authority

GROWING ORGANICS

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This factsheet describes how organic cucumber and tomato growers can use biological control as part of organic integrated pest management (IPM) for commercial protected crops (glasshouses and polytunnels) of organic tomatoes and cucumbers. Information in the factsheet is based on a Growing Organics Monitor Farm Programme funded trial in 2025 with Green Earth Organics, Co. Galway using supplemental release of natural enemies in protected organic cucumbers and tomatoes. The factsheet highlights key biological control options for spider mites, whiteflies and aphids and is not intended as a comprehensive overview of biological control. It is important to seek advice when introducing natural enemies to ensure that the right species are used and that the timing and release methods are appropriate for your specific crop, growing system and pest issues.

# Growing Organics Monitor Farm Programme


*Kenneth Keavey owner of Green Earth Organics.*

The Growing Organics Monitor Farm Programme led by Teagasc and supported by the Department of Agriculture, Food and the Marine (DAFM) focuses on supporting and growing Irish organic production in line with the National Organic Strategy. 12 organic farms have been selected across the country to demonstrate best practice and to improve knowledge exchange and technical advice over a five-year period until 2027. Kenneth Keavey of Green Earth Organics, Co. Galway is one of two organic vegetable growers participating in the programme.

# Action points

Understand the pests associated with the crop being grown, the natural enemies and the biological control agents being introduced.

Crop monitoring and early detection is very important. Carry out regular crop walks to spot signs of pest infestation. Make the most of sticky traps where appropriate, for example, for whiteflies and thrips.

Use a hand lens. Being able to see small insects and mites is key. A 10X hand lens is suitable.

Seek advice when introducing biological control to ensure that the right species are used and that the timing and release methods are appropriate for your specific crop, growing system, for example, closed/semi-closed glasshouse or polytunnel, and pest issues.

Continue crop walks to monitor for establishment of introduced natural enemies and to assess pest levels and biological control efficacy.

*Organic cucumbers*
*Green Earth Organics.*

# Background

In its simplest form, biological control is the reduction or eradication of pest populations by natural enemies, which can either occur naturally or be introduced as commercially available biological control agents. Natural enemies and biological control are fundamental in organic crop production. Regulation (EU) 2018/848 on organic production and the Organic Food and Farming Standards in Ireland allows for the use of natural enemies and biological control to the extent necessary as part of an integrated approach to pest management.

Success with supplemental release of natural enemies does not come easily or cheaply. It can be more labour intensive and relies on the ability of the grower to apply biological control at the correct time under suitable conditions to achieve the best level of pest management. It is important to seek advice when introducing natural enemies to ensure that the right species are used and that the timing and release methods are appropriate for your specific crop, growing system, for example, closed/semi-closed glasshouse or polytunnel, and pest issues.

Most natural enemies require specific environmental conditions, particularly temperature and relative humidity. While many natural enemies will survive sub-optimal conditions, a high level of pest control is unlikely to be achieved after introduction until conditions become more favourable. The well-known predatory mite *Phytoseiulus persimilis*, for example, is most effective at temperatures between 13°C and 27°C. Introducing *Phytoseiulus persimilis* too early or too late in the season (except under heated glass) is ineffective.

*Organic tomatoes*
*Green Earth Organics.*

*Phytoseiulus persimilis* does not perform well under dry, warm conditions i.e. humidity lower than 60%. Many natural enemies prefer a moist environment, relative humidity of 70% or more, but this can often be undesirable or impractical to achieve in a protected cropping situation.

Best results with supplemental release of natural enemies are generally achieved when they are introduced at a low initial level of pest activity, well before the pest population starts to build up. Most growers find that making several successive introductions of natural enemies, either prior to seeing the pest or at a very low levels, is more effective than applying one or two large introductions at a later stage.

Regular weekly crop monitoring is required to get a good idea of the level of pest activity and to determine whether the introduced biological control population is starting to increase in numbers. Good success with biological controls is rarely achieved without crop walking aided with a hand lens and sticky traps where suitable such as for whiteflies and thrips, which helps to pin-point low levels of pest activity, build-up of hot-spots and application of the correct level of natural enemies at the appropriate time.

## Spider mites

*Monitoring spider mites on the underside of a cucumber leaf using a 10X hand lens.*

Two-spotted spider mite (*Tetranychus urticae*) is one of the most common and damaging spider mites in protected crops of cucumber and tomato. Larvae, nymphs and adults cause damage by feeding on plant sap on the underside of leaves, which results in speckling on upper surfaces of leaves and reduced photosynthesis and plant growth. As populations increase, nymphs and adults produce dense webbing.

Adult females are about 0.4-0.6 mm long with an oval body. Their colour can vary from orange, light yellow or light green, to dark green, red, brown, or almost black. Eggs are round and approximately 0.14 mm in diameter, translucent when first laid, turning opaque before hatching. Males are smaller and more active than the females, with a body that is narrower and more pointed at the rear. Colour is very variable from light yellow or orange to dark yellow or brown. The colour of the adults often depends on the crop, for example, on cucumbers they tend to be yellow-brown, on tomatoes red-brown. Both males and females usually have two large black spots, which can vary in both form and size. The red eyes can be seen in all stages.

At temperatures below 12°C, no development occurs but spider mites can increase and spread rapidly during the summer months with temperatures up to 30°C. If plants are heavily infested, mites can move from plant to plant where the crop canopy is in contact, or by falling to the ground and migrating to other plants. They can move to new plants along crop wires or secrete silk threads on which they are dispersed by air currents. Spider mites can also spread either by the movement of infested plant material or on workers' clothing and other objects. Hibernating females (orange-red colour) can overwinter concealed in holes and crevices in the glasshouse or polytunnel structure framework. As soon as conditions are favourable in the spring, the females become active again and resume egg laying. Early detection is critical. Infestation can occur pre-planting, for example, at the propagators or upon delivery. Check and remove infested plants from the batch before planting if necessary. Carry out regular crop walks to spot signs of spider mite infestation. As spider mites do not fly, sticky traps are ineffective for monitoring.

*Spider mites feeding on the underside of a cucumber leaf (left).*
*Spider mite feeding damage causes speckling on upper surfaces of leaves (right).*

# Key natural enemies/biological control agents for spider mites in cucumbers and tomatoes

**Table 1** Key natural enemies/biological control agents for two-spotted spider mite in cucumbers and tomatoes.

| **Pest** | **Natural enemies/biological control** | |
|---|---|---|
| Two-spotted spider mite | *Phytoseiulus persimilis* | Predatory mite |
| | *Neoseiulus californicus* | Predatory mite |
| | *Feltiella acarisuga* | predatory gall midge |

Seek advice when introducing biological control to ensure the right species are used and that the timing and release methods are appropriate for your specific crop, growing system and pest issues.

**Notes**

- *Phytoseiulus persimilis* is highly specialised in targeting two-spotted spider mites and prefer warm humid conditions. Good control will not be achieved if temperatures go below 13°C or if humidity is consistently below 70%. *Phytoseiulus persimilis* populations decline in the absence of spider mites. It may be necessary to reintroduce with the appearance of new populations of spider mites.
- *Neoseiulus californicus* is ineffective in tomato crops due to the trichome density on tomato plants. *Neoseiulus californicus* is more tolerant of higher temperatures and lower humidity than *Phytoseiulus persimilis*. *Neoseiulus californicus* can survive in the crop in the absence of spider mites longer than *Phytoseiulus persimilis*.
- *Feltiella acarisuga* gall midge establish naturally and can also be introduced to control large, concentrated hot-spot spider mite populations.
- The predatory bug *Macrolophus pygmaeus* and the thrips predator *Amblyseius cucumeris* are also capable of controlling spider mites. Care should be taken in some crops, for example certain varieties of tomatoes, that are susceptible to damage from *Macrolophus pygmaeus* feeding on plant sap.

# Whiteflies

Protected crops of tomatoes and cucumbers are liable to attack by whiteflies. One of the most common species is the glasshouse whitefly *Trialeurodes vaporariorum*. Ireland maintains a protected zone against the tobacco whitefly *Bemisia tabac*i. Adult whiteflies and the young found on the underside of upper leaves suck sap from the leaves and when present in large numbers cause a general weakening of growth. In addition, whiteflies produce a sticky excretion (honeydew), which covers the leaves preventing normal function. Honeydew frequently becomes dark brown because of fungal growth (sooty mould) that interferes with photosynthesis and reduces yield and quality. Adults can also transmit several viruses to the crop that can cause distortion, yield loss or crop death.

*Whiteflies in the top of a tomato plant and on the underside of leaves.*

Adult whiteflies are about 1 mm long and snowy white due to a covering of white, mealy wax. They are usually found on the underside of upper leaves and fly readily if disturbed. Oval eggs are white at first but turn brown to black after 2–3 days. Pale green arvae hatch from eggs and lremain active for a few days before going through immobile stages called scales on the underside of leaves until they mature.

Before planting, it is important to ensure that none of the plants are already infested. Carry out regular crop walks to spot signs of infestation early. Monitor with sticky traps and introduce biological control at the first signs of whitefly presence on traps. Mass trapping with sticky traps can help control whiteflies, reducing their population and ability to reproduce. This interrupts the whitefly life cycle and lowers infestation levels. Weeds can carry over whitefly infestations from one crop to the next, particularly in mild winters. Yellow sticky traps in empty glasshouses/polytunnels are effective at removing adult whiteflies.

# Key natural enemies/biological control agents for whiteflies in cucumbers and tomatoes

**Table 2** Key natural enemies/biological control agents for whiteflies in cucumbers and tomatoes.

| **Pest** | **Natural enemies/biological control** | |
|---|---|---|
| Whiteflies | *Encarsia formosa* | Parasitic wasp |
| | *Macrolophus pygmaeus* | Predatory bug |
| | *Amblyseius swirskii* | Predatory mite |

Seek advice when introducing biological control to ensure the right species are used and that the timing and release methods are appropriate for your specific crop, growing system and pest issues.

**Notes**

- The predatory wasp *Encarsia Formosa* is a key biological control solution that specifically targets whiteflies.
- *Macrolophus pygmaeus* applied for whiteflies but also feeds on two-spotted spider mites, aphids and leaf miner larvae. Care should be taken in some crops, for example certain varieties of tomatoes, that are susceptible to damage from *Macrolophus pygmaeus* feeding on plant sap.
- *Amblyseius swirskii* used for whiteflies and thrips. Use of *Amblyseius swirskii* is not recommended in tomatoes as it is hindered by the trichome density on the stems and leaves.

# Aphids

*Aphids feeding on the underside of tomato leaves (left).*
*Aphids moulted white skins in tomatoes visible on the upper surface of leaves (right).*

Aphids are soft bodied, rounded insects that feed on plant sap. Because of their reproductive capacity, many species of aphids cause crop damage and are virus vectors. The first aphids found in a crop are usually scattered. Once the population becomes too large, winged aphids disperse throughout the crop. Several aphid species attack cucumber and tomato crops. The most common species are *Aulacorthum solani*, *Macrosiphum euphorbiae*, *Myzus persicae* and *Aphis gossypii*. Winged adults fly into polytunnels or glasshouses in spring to autumn. First sign of infestation may be white skins (cuticles) on the upper surface of lower leaves and fruit. Aphid feeding on sap can cause stunted, distorted growth and leaf curling. They excrete excess sugars as honeydew on to plants, which encourages the growth of sooty moulds that continues to weaken the plant and blemishes the surface of fruit. Aphids can also transmit various viruses to crops that causes leaf yellowing, mosaic, stunting and malformation.

Aphids have a complex life cycle, with both winged and wingless forms of adults in a variety of colours. When reproduction is asexual, the young aphids are born as developed nymphs. They immediately start to feed on plant sap and grow rapidly. When reproduction is sexual, the aphids lay eggs that overwinter. In glasshouses reproduction also takes place by parthenogenesis, with unfertilised viviparous females continuing to produce new generations of females. Young aphids moult four times before becoming adult. With each moult they shed white skins, which shows their presence in the crop. It is important to carry out regular crop walks to spot signs of aphid infestation early. Aphid skins and honeydew typically mean populations have already increased or are increasing rapidly.

# Key natural enemies/biological control agents for aphids in cucumbers and tomatoes

**Table 3** Key natural enemies/biological control agents for aphids in cucumbers and tomatoes

| **Pest** | **Natural enemies/biological control** | |
|---|---|---|
| Aphids | *Aphidoletes aphidimyza* | Predatory gall midge |
| | *Aphidius colemani* | Parasitic wasp |
| | *Aphidius ervi* | Parasitic wasp |

Seek advice when introducing biological control to ensure the right species are used and that the timing and release methods are appropriate for your specific crop, growing system and pest issues.

**Notes**

- *Aphidius colemani* widely used for *Aphis* and *Myzus* species. *Aphidius ervi* parasitises aphid species that are not parasitised by *Aphidius colemani* including *Aulacorthum solani* and *Macrosiphum euphorbiae*.
- *Aphidoletes aphidimyza* used for many species of aphids.
- Other important natural enemies include the ladybird *Adalia bipunctata*, lacewing *Chrysoperla carnea* and hoverfly *Episyrphus balteatus*.

# Green Earth Organics approach to organic IPM and biological control for organic cucumbers and tomatoes 2025 trial

**Table 4** Green Earth Organics approach to organic IPM and biological control for protected organic cucumbers and tomatoes in 2025 trial.

| **Week number** | |
|---|---|
| 19-20 | Planting date.<br>Weekly crop monitoring. |
| 23 | Spider mites detected/leaf damage.<br>Biological control ordered. |
| 24 | Application 1:<br>Spical Ulti-Mite 100 (*Neoseiulus californicus)* cucumbers only and Spidex Vital 2000 (*Phytoseiulus persimilis)* cucumbers and tomatoes.<br>Horiver Wetstick (sticky traps). |
| 25 | Application 2:<br>Spidex Vital 2000 (*Phytoseiulus persimilis)* cucumbers and tomatoes, weekly crop monitoring continued. |

Seek advice when introducing biological control to ensure the right species are used and that the timing and release methods are appropriate for your specific crop, growing system and pest issues.

**Notes**

- Preventative and curative biological control programmes were planned for key pests of protected crops of organic cucumbers and tomatoes (spider mites, aphids and whiteflies) in the 2025 trial.
- Horiver Wetstick sticky traps were used from week 24 to aid monitoring of flying insect pests including whiteflies, thrips and leaf miners. Traps were attached to wires at a maximum of 30 cm above the crop and adjusted during the season as the crops were growing. Placing traps in-between the plants was avoided to prevent beneficial parasitic wasps from being trapped.
- Biological control was introduced on week number 24 for low levels of spider mites and leaf damage: one application of Spical Ulti-Mite 100 (*Neoseiulus californicus*) in protected cucumbers only at 1 sachet per 2 plants (1 sachet per 1 linear metre), combined with Spidex Vital 2000 (*Phytoseiulus persimilis)* in both protected crops of cucumbers and tomatoes at approximately 10 per $m^2$ per release.
- A second application of Spidex Vital 2000 (*Phytoseiulus persimilis*) was applied to both protected cucumbers and tomatoes on week number 25 at approximately 10 per $m^2$ per release.
- Very good spider mite control was achieved with the applications of Spical Ulti-Mite 100 (*Neoseiulus californicus*) and Spidex Vital 2000 (*Phytoseiulus persimilis*). Supplemental release of natural enemies for aphids and whiteflies was not required in 2025.
- Potassium hydrogen carbonate, approved for use in protected crops of organic cucumbers, applied at 750 g per 100 L for powdery mildew control did not negatively affect predatory mite populations nor biological control efficacy.

**Table 5** Organic IPM biological control costs 2025 trial.

| **Product** | **Unit price* (excl. VAT)** |
|---|---|
| Spical Ulti-Mite 100 (*Neoseiulus californicus)* | €75.20 |
| Spidex Vital 2000 (*Phytoseiulus persimilis*) | €19.92 |
| Horiver Wetstick (yellow 10 × 25 cm) | €7.97 |

*Products supplied by Fruit Hill Farm

# Further information

Malais, M.H. and Ravensberg, W.J. (2003) Knowing and Recognizing: The Biology of Glasshouse Pests and Their Natural Enemies. Reed Business Information, Amsterdam.

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# Photography credits

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