

TUTAVIR® Natural efficacy that is reliable

Winner of the
Bernard Blum
Award 2019 for Novel
Biocontrol Solutions



Technical information

Target pest

Tuta absoluta, common name: Tomato leafminer (TLM)

Crops

Tomato, eggplant, solanaceous species

Formulation

Suspension concentrate containing $> 2 \times 10^{13}$ OB of PhopGV (Phthorimaea operculella granulovirus) per liter.

Standard dosage

50 – 200 ml/ha, every 6 – 8 days

Timing

At hatching of first larvae. Acts by ingestion.

Water volume

200 – 1800 l/ha. Should be adjusted according to crop, leaf area index and spraying equipment in order to ensure full coverage.

Ensure good coverage of the underside of the leaves.

Pre-harvest and re-entry interval (PHI, REI)

Free of residues on fruits and plants. Minimal PHI and REI, defined according to national registration regulations.

Toxicity profile

No maximum residue levels (MRLs) are defined. Contains no chemical ingredients and leaves no residues on the crop. Complies with organic farming. No side effects on non-target organisms and beneficials.

Compatibility

Compatible with most insecticides, fungicides and fertilizers.

A pH level between 5 and 8.5 in the tank mix has to be respected.

Storage

Storage stability: > 2 years at -18 °C, 2 years at 5 °C, 3 months at 20 °C. Avoid temperatures above 35 °C.

Tutavir is an excellent tool for integrated tomato programs in greenhouse as well as outdoor production

- ✓ Highly compatible with other inputs, also pollinators and other beneficials
- ✓ Unique and new mode of action for resistance management
- ✓ Safe for consumer, producer and the environment



Andermatt
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High selectivity and safety

The active substance of Tutavir® is a *Phthorimaea operculella* granulovirus (PhopGV) that was selected from a wild Potato tuber moth (PTM) population. These viruses belong to the family of insect pathogen baculoviruses that occur naturally in lepidopteran species.

Tutavir® causes no phytotoxic symptoms on plants after application. The formulation only contains food grade additives; therefore the use of Tutavir® does not leave any chemical residues, making it suitable for low residue or organic food production.

No maximum residue levels (MRLs) are defined for Tutavir®. The product is free of genetically modified organisms. Baculoviruses are safe and cause no hazards to human health (OECD Consensus paper, 2002).

Compatibility

Tutavir® is compatible with most agricultural chemicals. **A pH level between 5 and 8.5 in the tank mix** with other products has to be respected. Otherwise the protective protein capsule will be destroyed and the active substance inactivated.

Avoid tank mixes with copper products. Spraying of copper a few days before or after a Tutavir® application has no adverse effect.

Rainfastness

Virus particles naturally have lipophilic properties, favoring a strong adherence to the plant surface. Tutavir® is rain resistant as soon as the product has dried on the leaves. No additives are necessary to improve rainfastness.

Use of adjuvants

Tutavir® is available in a ready to use formulation, made with Andermatt Biocontrol's 30 years of experience in formulating baculovirus products. Tutavir® is ready to use. It is thus not necessary to add feeding stimulants.

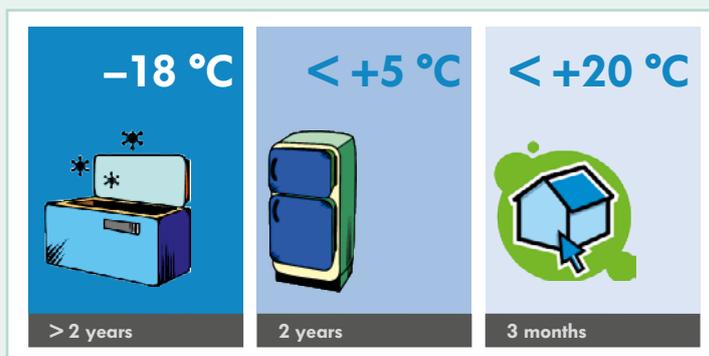
No side effects

Tutavir® preserves natural antagonists due to its specific host range. Aquatic species, birds, beneficial insects, mammals and bees are not affected.

Storage and handling

Avoid temperatures above 35 °C during storage or transport. Temporarily sub-optimal storage conditions during transport or at the end-user may be accepted for a short period of time.

At -18 °C, the product remains liquid and can be immediately used for spraying without unfreezing. Once opened, the bottle can be stored at low temperatures without loss of quality.



Mode of action

Granuloviruses are encapsulated within a protein occlusion body, which protects the virus from destructive environmental influences (e.g. UV radiation). The size of a single virus particle is not bigger than 400 nm.

Young larvae that are actively moving and feeding on leaves, stems or fruits will ingest the virus that was sprayed onto the plant surface. Following ingestion, the virus particles enter the larval midgut, where the protein capsules dissolve due to the high pH level (pH higher than 10). Within 2–4 days, the virus infests most organs of the host and the larva stops feeding. Upon death, the larval body liquefies and releases millions of new virus particles into the environment, infecting other larvae.

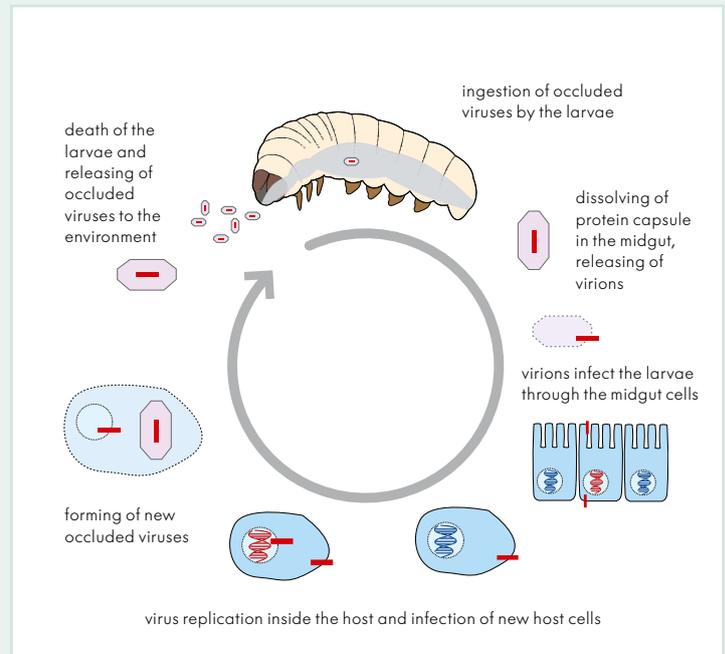
Under laboratory conditions, only 1 ingested virus particle is sufficient to kill a first instar larva.

Later instars (older than L3) are not instantly killed and may therefore cause further damage before getting killed (which is often reflected by superficial or deeper stopped damage in the fruit). The virus infection may also be transferred to the next generation, where it can break out due to weakness or stress and kill the larva, thus providing excellent population control.

Granulovirus (GV)

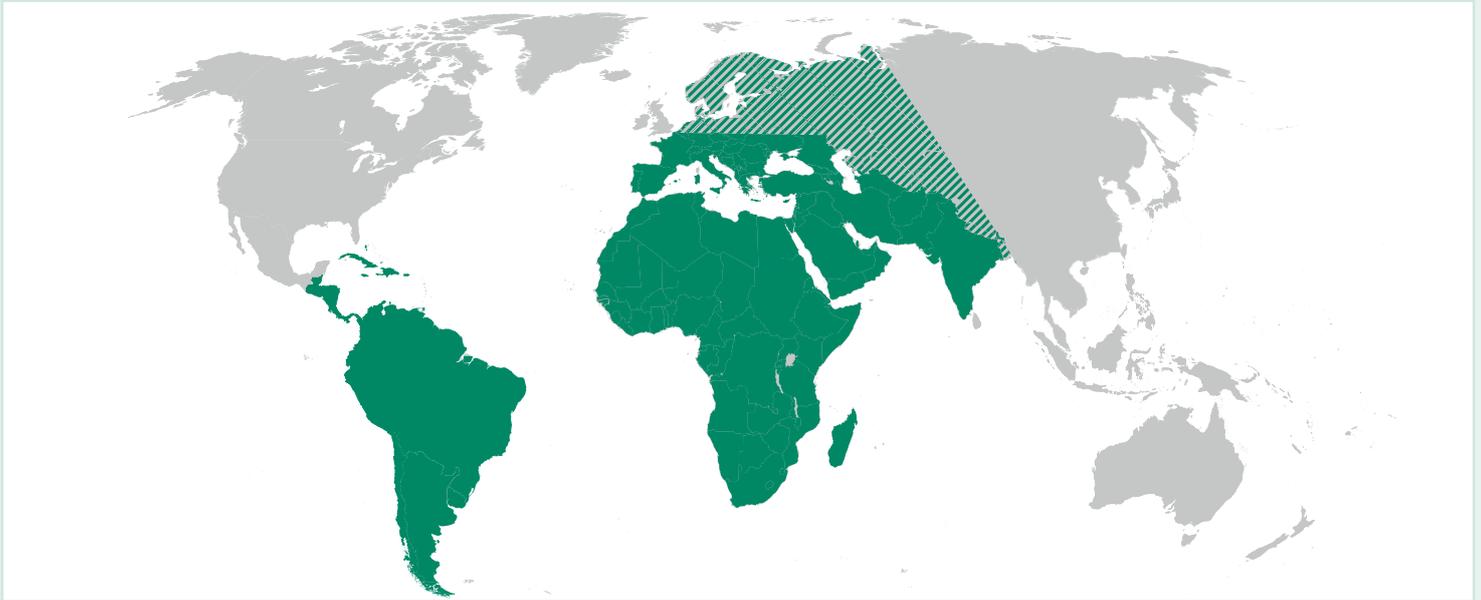


Shape of a granulovirus. The virion (holds viral DNA) is embedded in a protective occlusion body.



Mode of action of a granulovirus. Replication of the virus inside the pest.

Information about the pest



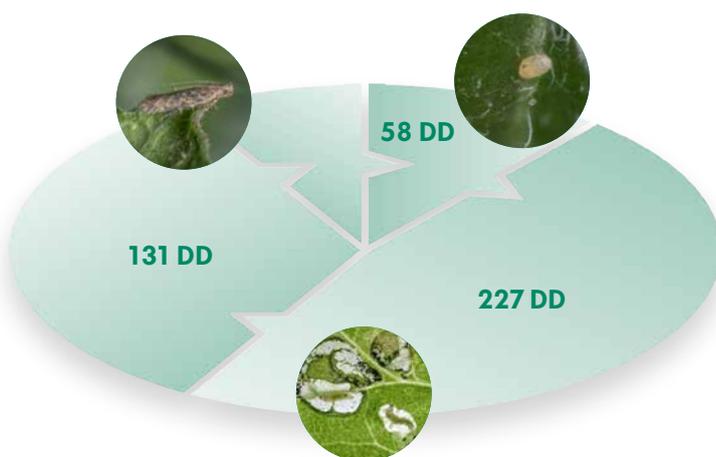
Geographical distribution of *Tuta absoluta*

Tuta absoluta is a very destructive and hard to control pest within its natural habitat. Originating in South America, it was found in Spain in 2006 and has been spreading throughout the Mediterranean region but also continental Europe, the Middle East and Africa. Because of continuous use of pesticides with the same mode of action and missing resistance management, many *Tuta absoluta*

populations are resistant to a wide array of pesticides, both chemical and biological. *Tuta absoluta* is most destructive on tomato, but its host range includes solanaceous species such as eggplant, peppers, tobacco, potato and many more.

After the larvae have fully developed, they pupate in the soil at a depth of up to 10 cm.

Life cycle



$$\text{DD (Degree-day)} = \frac{\text{min.} + \text{max. day temperature}}{2} - \text{min. developmental threshold of pest}$$

The life cycle

- The complete life cycle ranges from 24 days (under best conditions) to 76 days (under poor conditions).

Generations

- Up to 12 annual generations (no diapause)

General information

- Min. developmental threshold: 8 °C
- Max. developmental threshold: 37 °C

Degree days (DD) that are needed to complete each stage of development of *Tuta absoluta* (Kraechmer and Foerster 2015)

A few days after emergence, females lay up to 300 eggs, usually singly or in small clusters on the lower surface of the leaves. Larvae pass through 4 instars. The life cycle is completed within approximately 25 to 30 days at 25 °C. Thus, in suitable climates or

conditions (greenhouse), up to twelve generations per year are possible. The larvae do not undergo diapause if food is abundant and pupae tolerate temperatures of about 0 °C for several days. Pupation takes place in the leaves, the soil or sometimes in cocoons.

Damage pattern

Tuta absoluta larvae prefer feeding on young leaves. They may also feed on stalks, apical buds and undeveloped fruit. The larvae feed singly and enter the leaf where they form mines, feeding on the mesophyll but leaving the epidermis intact. Larvae will also enter stalks, usually at nodes, which leads to great damage. When feeding on fruit, feeding damage often leads to secondary infection with pathogens. Damage can be up to 100% when not properly controlled. *Tuta absoluta* are active during the night and twilight.



General instructions

Tutavir® – application with the right timing

Like all granulovirus products, Tutavir® is not a knock-down product and it will take a few days to kill the larvae due to its mode of action. The granuloviruses, the active ingredient of Tutavir®, are infecting the TLM larvae after ingestion through the midgut. Timing of application is therefore very crucial in order to have good control, even more as TLM larvae are very cryptic and quickly penetrate into the leaves. Start application as soon as the first adult moth has been monitored. Tutavir® is an excellent population control tool. Therefore we recommend focusing the application of Tutavir® already at the beginning of the TLM infestation, so that the population control effect can be carried over the entire crop period.

To ensure good coverage and cover newly grown plant material reapply at least every 6–8 days.

Monitoring of TLM – a tricky thing

Monitoring of the moth flights using pheromone traps helps to record the increase of TLM population and potential infestation with TLM. Trap catches can vary, depending on the pheromone quality, positioning of the traps and also on weather conditions. No or low records of catches in pheromone traps do not definitively correlate with low pest infestation. Often only a low but constant pressure can be recorded without recognizable peaks. In such case information on crop stage together with historical data on the pest development in the specific crops in the area may help to position the right timing of Tutavir® application.

Use in Integrated Pest Management

Tutavir® can successfully be used as part of an Integrated Pest Management (IPM) program, which can also include chemical and cultural practices preventing economic pest damage. IPM principles and practices include field screening and monitoring systems (pheromone traps), correct target pest identification, population monitoring, rotation of insecticides with different modes of action, and treating when target pest populations reach locally determined threshold levels.

Please note: Pheromone traps for TLM monitoring in areas under mating disruption will not work properly. They need to be placed in plots without mating disruption in the neighbourhood.

Use in organic production

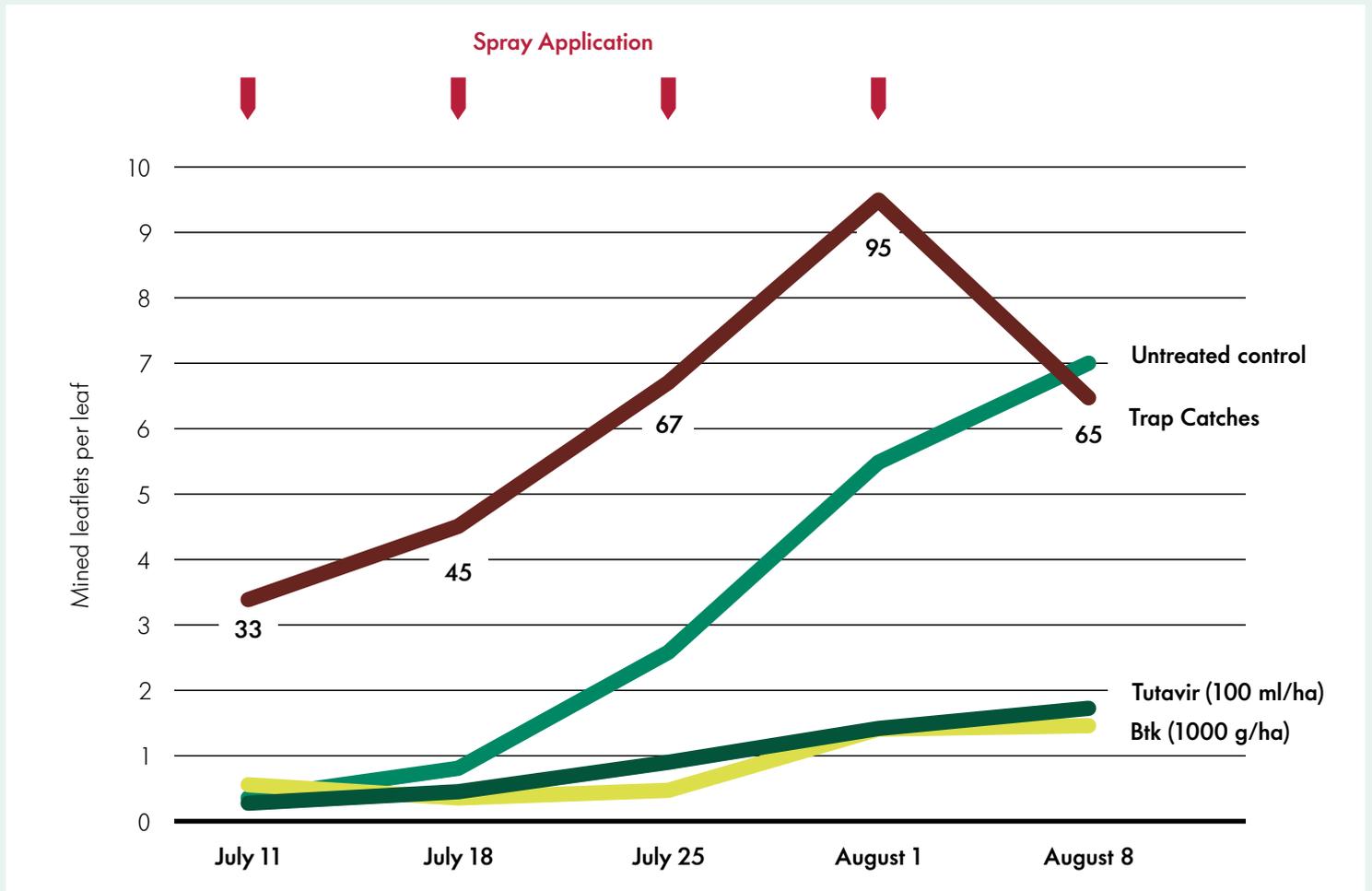
The use of baculoviruses complies with the EU Regulation 834/2007 for organic farming.

Resistance management

Tuta absoluta has developed widespread resistance and cross-resistance to organophosphates, synthetic pyrethroids, diamides and other types of insecticides. To effectively control *Tuta absoluta* and to delay development of resistant populations to new active substances, a spray program including the most efficacious insecticides and alternating modes of action against consecutive pest generations is recommended.

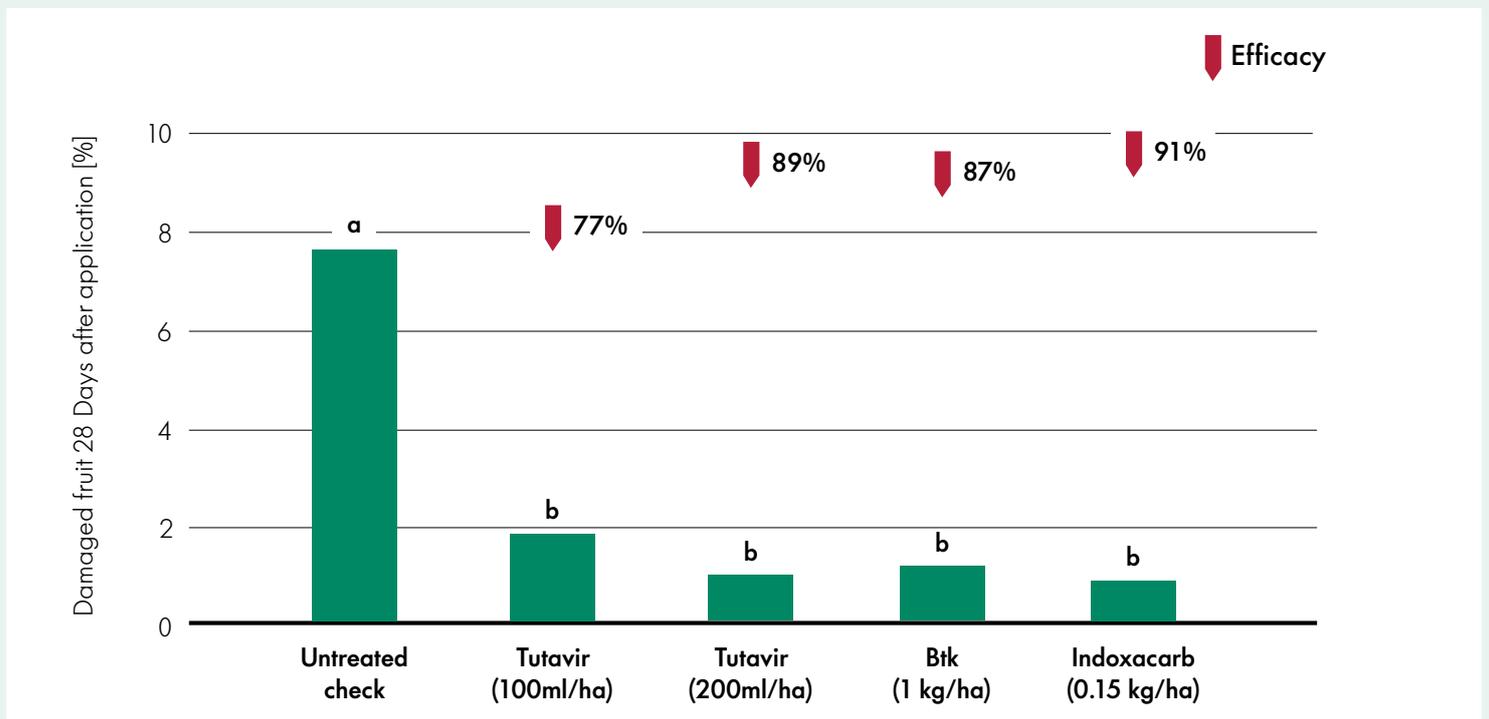
Field trials with Tutavir®

Greenhouse tomato trial, Campania, Italy, 2018



Greenhouse trial on tomato, Sicily, Italy, 2017

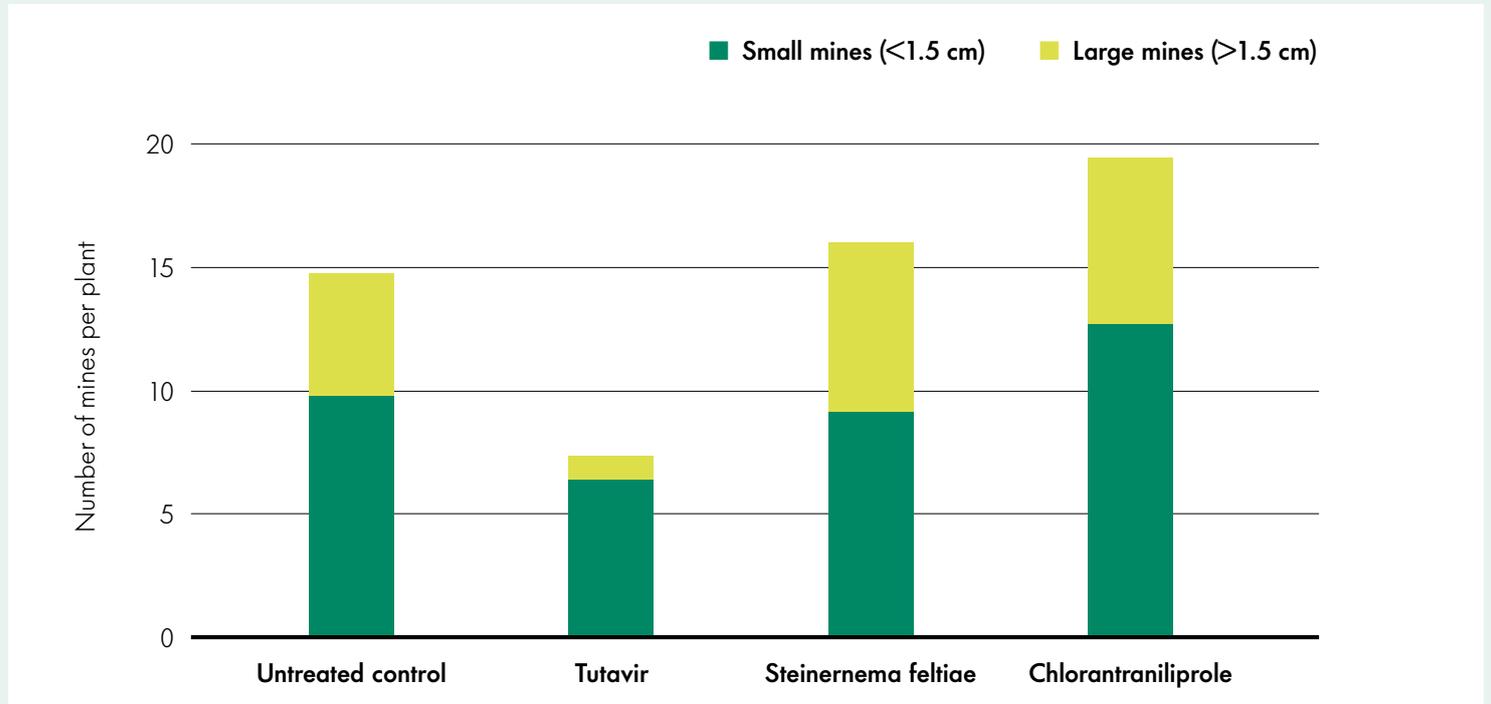
4 applications once a week, assessment 7 days after last application



Field trials with Tutavir®

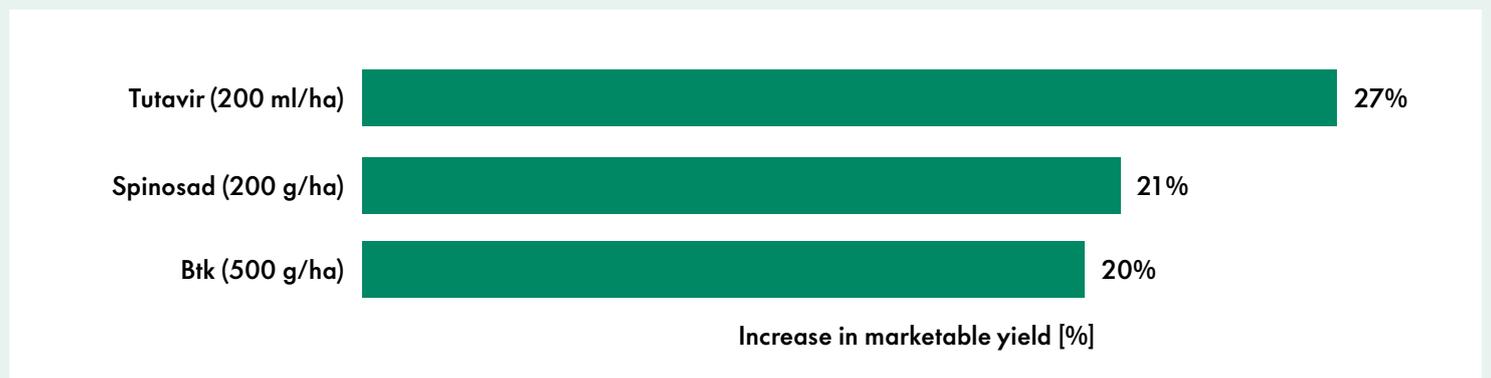
On-farm greenhouse tomato trial, NRW, Germany, 2018

Weekly application, assessment two weeks after 7th application. Decrease in large mines indicates death of larva in the mine.



On-farm greenhouse tomato trial, NRW, Germany, 2018

Six applications, once a week.



TUTAVIR®: Swiss quality

Tutavir® is produced by Andermatt Biocontrol in Switzerland. The company Andermatt Biocontrol is certified according to ISO 9001:2008.

Andermatt Biocontrol is committed to highest quality of its products. Every produced batch of Tutavir® undergoes a systematic bioassay process. The virulence of each batch is tested against the standard reference batch within the Andermatt Biocontrol laboratories. Only batches that fulfil the high quality standards will be released into the market.

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