HELICOVEX® Natural efficacy that is reliable

Technical information

Target pests
Helicoverpa spp. such as *Helicoverpa armigera, Helicoverpa zea, Helicoverpa virescens, Helicoverpa punctigera*. Common names: African cotton bollworm, corn earworm, tomato fruitworm, tobacco bollworm, old world bollworm, among others.

Crops
Soybean, tomato, sweet pepper, corn and sweet corn, beans, lettuce, strawberry, tobacco, fruits, cotton, sorghum, and others.

Formulation
Suspension concentrate containing > 7.5×10^{12} PIB of HearNPV *(Helicoverpa armigera* nucleopolyhedrovirus*)* per liter.

Standard dosage
Depending on crop and infestation 50 to 200 ml/ha

Mode of action
Ingestion

Timing
For optimal results, start applications targeting the beginning of the first moth flight, covering egg laying and the first larval stages (larvae smaller than 7 mm).

Water volume
200 – 1600 l/ha. Volume should be adjusted according to the leaf area index spraying equipment and local practices.

Standard interval between sprays
Generally repeat application at 8 day intervals. This may be adjusted depending on the specific pest control strategy.

Pre-harvest and re-entry interval (PHI, REI)
Leaves no residues. Minimum PHI and REI are defined according to national registration regulations.

Toxicity profile
Product contains no chemical ingredients and complies with organic farming. No chemical residues on the crop. No side effects on mammals, beneficial insects, bees, aquatic organisms and other non-target organisms. No maximum residue levels (MRLs) are defined for Helicovex®.

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
Excellent storage stability: > 2 years at –18 °C, 2 years at 5 °C, 1 month at 25 °C. Avoid temperatures above 40 °C.

Rainfastness
Good rain resistance as soon as product has dried on the leaves.

Andermatt Biocontrol

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High selectivity and safety

The active substance of Helicovex® is a *Helicoverpa armigera nucleopolyhedrovirus* (HearNPV). These viruses belong to the family of baculoviruses and only occur in arthropod species (mainly lepidopteran species). Generally, baculoviruses have a narrow host range and are therfore safe and cause no hazards to human health (OECD 2002). Helicovex® does not cause any phytotoxic symptoms on plants after application. The formulation only contains food grade additives; therefore the use of Helicovex® does not leave any chemical residues on the treated crop, making it suitable for low residue or organic food production. No MRLs are defined for Helicovex®. The product is free of genetically modified organisms.

No side effects

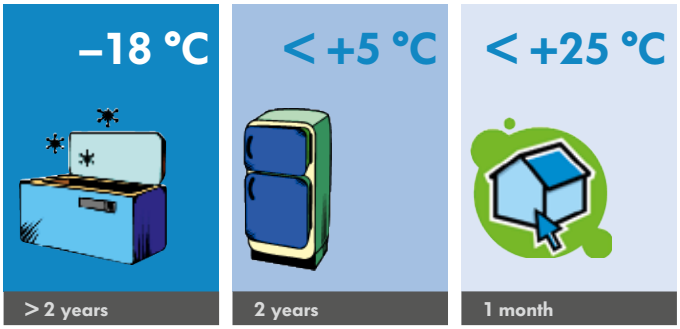
Helicovex® preserves natural antagonists due to its specific host range. Whilst being an effective *Helicoverpa* spp. control tool, aquatic species, birds and mammals are not affected. It is also safe for bees, bumble bees, predatory mites and parasitoids.

Compatibility with other pesticides

Helicovex® is compatible with most agricultural chemicals. Only restriction: **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 Helicovex® application has no adverse effect.

Storage and handling

At –18 °C the product remains liquid and can be used immediately for spraying without unfreezing. Once opened, the bottle can be restored at low temperatures without loss of quality.
Avoid temperatures above 40 °C during storage or transport. Temporarily sub-optimal storage conditions (25 – 40 °C) during transport or at the end-user may be accepted for a few days.



Rainfastness

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

Use of adjuvants

Helicovex® is ready to use. It is thus not necessary to add any feeding stimulants, surfactants/wetting agents or other adjuvants.

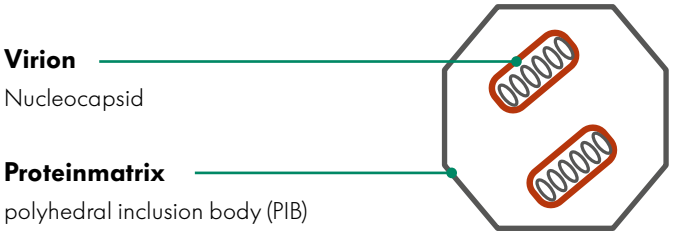
Advantages of Helicovex®

- ✔ Efficient Helicoverpa spp. population and damage control
- ✔ Excellent restistance management tool
- ✔ Non-toxic for beneficials such as mammals or humans (OECD, 2002)
- ✔ No Maximum residue level, min. withholding period and re-entry-interval (MRL, WHP & REI)
- ✔ Applicable in IP and organic
- ✔ High compatibility with other products (insecticides, fungicides and fertilizers)
- ✔ Good storage stability
- ✔ Good rainfastness

Mode of action

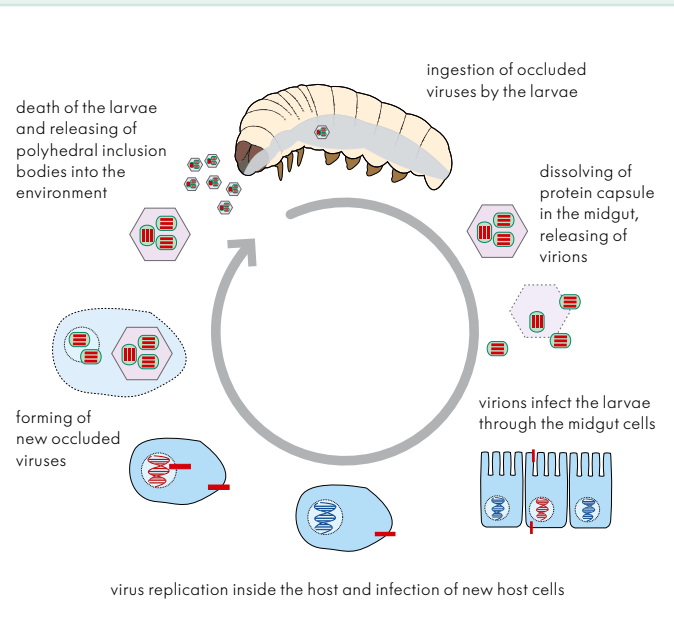
Larva infected by NPV turns black and liquefies before decomposing.

Nucleopolyhedrovirus (NPV)



Young larvae that are actively moving and feeding on the crop 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). The virion is released and infects the midgut cells. The genetic information of the virus is incorporated into the host genome, resulting in the production of new replicate copies of the virus. The host cells get destroyed and the new viruses infect new host cells. Within 2–4 days, the viruses infest most organs of the host and the larva stops feeding. Upon death, the larval body deteriorates and releases millions of new viruses into the environment, infecting other larvae. Under laboratory conditions, only 1 ingested virus particle is sufficient to kill a first instar larva.

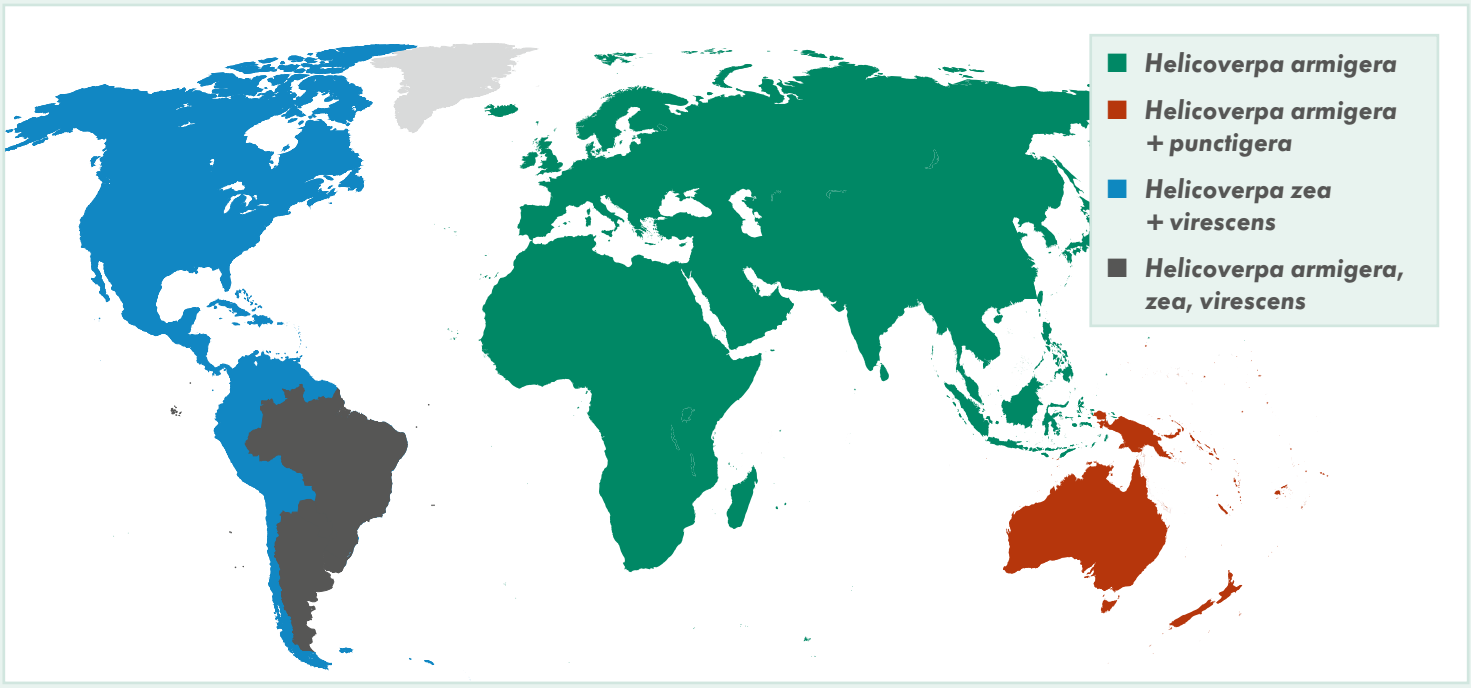
Older larvae (older than L3) are not instantly killed and may therefore cause further damage before getting killed in later larval instars. They can also pass on the virus infection to the next generation, where it may develop due to biotic or abiotic stress.



Information about *Helicoverpa armigera*

The African cotton bollworm is one of the most destructive polyphagous pest species of world-wide economic importance. It can establish itself in regions with tropical climates (i.e. Africa, tropical Asia) and also regions with a cooler temperate climate (i.e. Mediterranean area). In Northern Europe, occasional outbreaks in glasshouses occur.

Due to resistances to a wide range of chemical insecticides such as carbamates, organophosphates and synthetic pyrethroids, *Helicoverpa armigera* is increasingly difficult to control. The migratory behaviour of *Helicoverpa armigera* is also reponsible that resistance can easily spread to other regions.

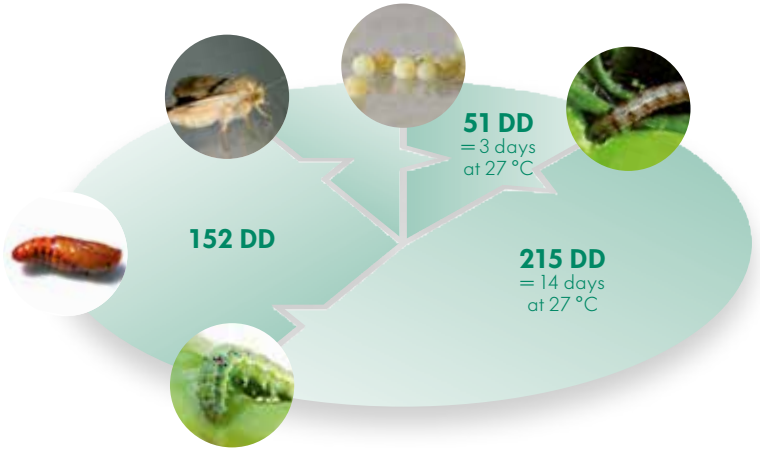


Geographical distribution of *Helicoverpa armigera* (European plant protection organisation EPPO), spring 2015

The most common host plants of which *H. armigera* is a major pest:

- Tomato
- Sweet pepper
- Soybean
- Cotton
- Sorghum
- Corn and sweet corn
- Legumes
- Tobacco
- Okra
- Flax
- Fruits
- Potato
- Wheat, barley
- Ornamentals

Life cycle



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

Developmental thresholds

- Min. 11 °C
- Max. 36 °C
- The developoment time varies in relation to the food source and temperature.

General information

- Undergoes facultative diapause
- 2 to 4 generations per year in Europe
- Up to 11 generations are possible in (sub-) tropical regions
- Up to 3000 eggs per female

Day degrees (DD) that are needed to complete each stage of development of *Helicoverpa armigera* on tomato (Jallow and Matsumura 2001)

Helicoverpa armigera can make 2 to 11 generations depending on climatic conditions. Lifecycle takes 4 to 6 weeks from egg to adult at temperatures from 25 to 28 °C. In regions with cool winters *H. armigera* can undergo a facultative diapause in the soil.
At medium temperatures of 27 °C larvae hatch after about 3 days. The larvae pass through five to six developmental stages (instars) and ultimately reach 30 to 40 mm in length. Development is more rapid at higher temperatures. At temperatures higher than 36 °C the development slows down again. Larval activity and feeding stops when temperatures fall below 11 °C.

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

Main survival strategies of Helicoverpa spp.

Polyphagy
> 200 host plants

High fecundity
1500 – 3000 eggs

High mobility
100 m –> 1000 km

Facultative diapause
Excape unfavourlable conditions

Damage pattern

Early larval instars forage on tender young foliage for 1 – 2 days, and then move to feed on buds, flowers, young pods, bolls, fruits or stems. Older larvae bore into the plant at the base of flower buds, fruits, bolls or maize cobs. The entry holes can promote secondary infection of the damaged tissues, which often leads to rotting and fruit or leaf drop. Adults can migrate over large distances. Migration from early harvested to late crop varieties is common. Adult moths preferably deposit single eggs on buds, flowers, fruits or leafy parts of the plant. Moths live for around 10 days. In this time females lay up to 3000 eggs, mainly at night.

Caption

1. *H. armigera* on corn cob
2. Tomato fruit damage
3. Damage on stalks
4. Entry hole on pepper with secondary infection with fungal disease
5. 6. *H. armigera* mining inside bean pod

General instructions

Weekly monitoring of Helicoverpa activity (by pheromone traps, scouting for larvae/eggs) is essential. If Helicovex® is sprayed at the right timing and under optimal conditions, it can provide up to 90% efficacy. Good coverage of the feeding area is essential, as the larvae need to ingest the virus to get infected. Young infected larvae may survive a few days until they die, but feeding activity will be reduced. Older larvae take a longer time to die. It is therefore essential to apply Helicovex® when larvae are still young and not yet hidden inside fruits, flowers or stems, and their damage is still very small.

Ninety percent of all feeding by Helicoverpa is done by larva from the third instars onwards (8 to 13 mm long). Large Helicoverpa larvae (longer than 24 mm) are the most damaging stage, since larvae consume about 50% of their overall diet in the last instars. This highlights the importance of controlling Helicoverpa larvae while they are still very small.

Application timing and spray intervals

For best crop protection, the first Helicovex® spray is applied right before first egg-hatch and before fruits get attacked. Since the young larvae consume parts of the egg shell during hatching, the larvae can be infected at the earliest possible time point of their development. As viruses are sensitive to UV radiation and horticultural crops have a strong vegetative growth, sprays have to be repeated at intervals of 6 to 8 days of full sunshine to assure a constant coverage during the larval hatching period. Two partly sunny days are equal to one sunny day. If the leaf area is heavily exposed to UV radiation – for example in open field tomato – and pest pressure is high, the shorter interval should be used.

For crops having a high leaf area index, such as cotton, maize or sorghum, treatments should be repeated after every 8 days of full sunshine. Water volume: from 200 – 1600 l/ha.

Spray volumes

Ensuring a good leaf coverage improves the efficacy of the application, yet that the virus particles need to be ingested, application equipment should garantize a good coverage. For spray boom or ground rig applications, application volumen may vary between 200 and 500 and for tree crops up to 1600 l/ha. For aereal applications, water volume shold be at least 30 l/ha.

Application strategies

Use in Integrated Pest Management

Helicovex® can successfully be used as a part of an Integrated Pest Management (IPM) programme, which may include chemical and cultural practices, aimed at 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.

Use in organic production

Helicovex® is a biological insecticide. The use of baculoviruses fully complies with the EU Regulation 834/2007 for organic farming. It can be used as a stand-alone product, in alternation with other biological insecticides or in combination with other cultural practices for the control of *Helicoverpa* spp.

Resistance management

H. armigera has developed widespread resistance to organophosphates, carbamates and pyrethroids. To effectively control *H. armigera* and to delay development of resistant populations to new active substances, a spray programme incorporating the most efficacious insecticides and alternating modes of action against consecutive pest generations is recommended.

Soybean

Application timing

- Target on eggs and first instar larvae
- Normally 1-3 applications are sufficient for achieving a good control

Application rate

- 50 – 200 ml/ha every 6 to 8 days

Tomato, Pepper – Greenhouse

Application timing

- Targeted on eggs and against first instar larvae

Application rate

- 200 ml/ha every 14 days
- 100 ml/ha every 7 days

Cover the whole larval hatching period of the treated generation until harvest.

Tomato, Pepper – Open field

Application timing
- Targeted on eggs and against first instar larvae

Application rate
- 200 ml/ha after every 6 to 8 days
- 100 ml/ha every 6 days

If pest pressure is high and flowers and fruits of the crop are present choose shorter spray intervals at 200 ml/ha. At low pest pressure or during vegetative growth, there is the option to spray 100 ml/ha every 6 days. Cover the whole larval hatching period of the treated generation until harvest.

Sweet corn

Application timing
- As soon as male tassels are visible or as soon as Helicoverpa flight has started. Focus on 1st instar larvae.

Application rate
- 200 ml/ha every 8 sunny days
- From the start of the silking period 50 to 100 ml/ha every 2–7 days, depending on local practices to ensure continuous coverage of the silk.

Combination or alternation with other insecticides or *Trichogramma* spp. to control simultaneous infestation of *Ostrinia nubilalis* (corn borer) is possible.

Green beans

Application timing
- targeted on eggs and first instar larvae
- Normaly 3 applications are sufficient for stopping damages

Application rate
- 200 ml/ha every 6 to 8 days

Target crop stage
Start flowering – first beans

Cotton

Application timing
- Normally between 2 and 4 sprays at full flowering stages (BBCH 65-71).

Application rate
- 200 ml/ha. Due to a negative effect on NPV of a higher pH in cotton leaves, it is recommended to reduce the interval to 6 days or less, if economically justifiable. As larvae enter the pods, timing is crucial.

Sorghum

Application timing

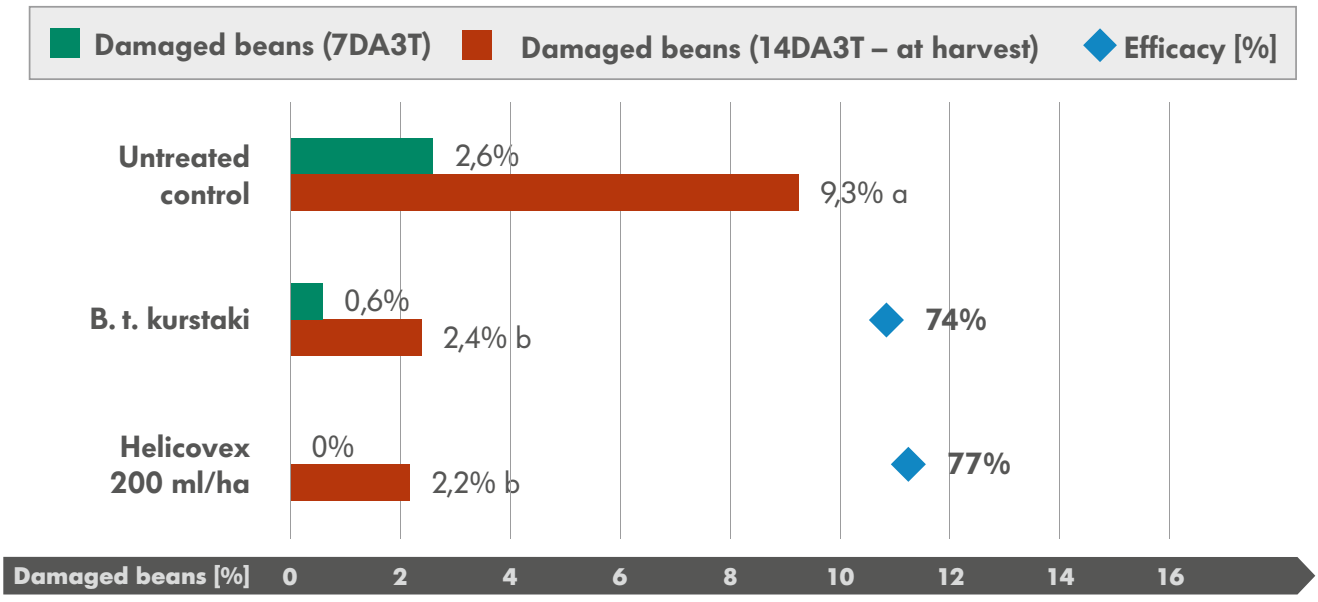
- As soon as 50% of the panicles have reached flowering and the lower anthers turn brownish, targeting L1 - L2 larvae.
- Normally 1 application is sufficent for achieving a good control

Application rate

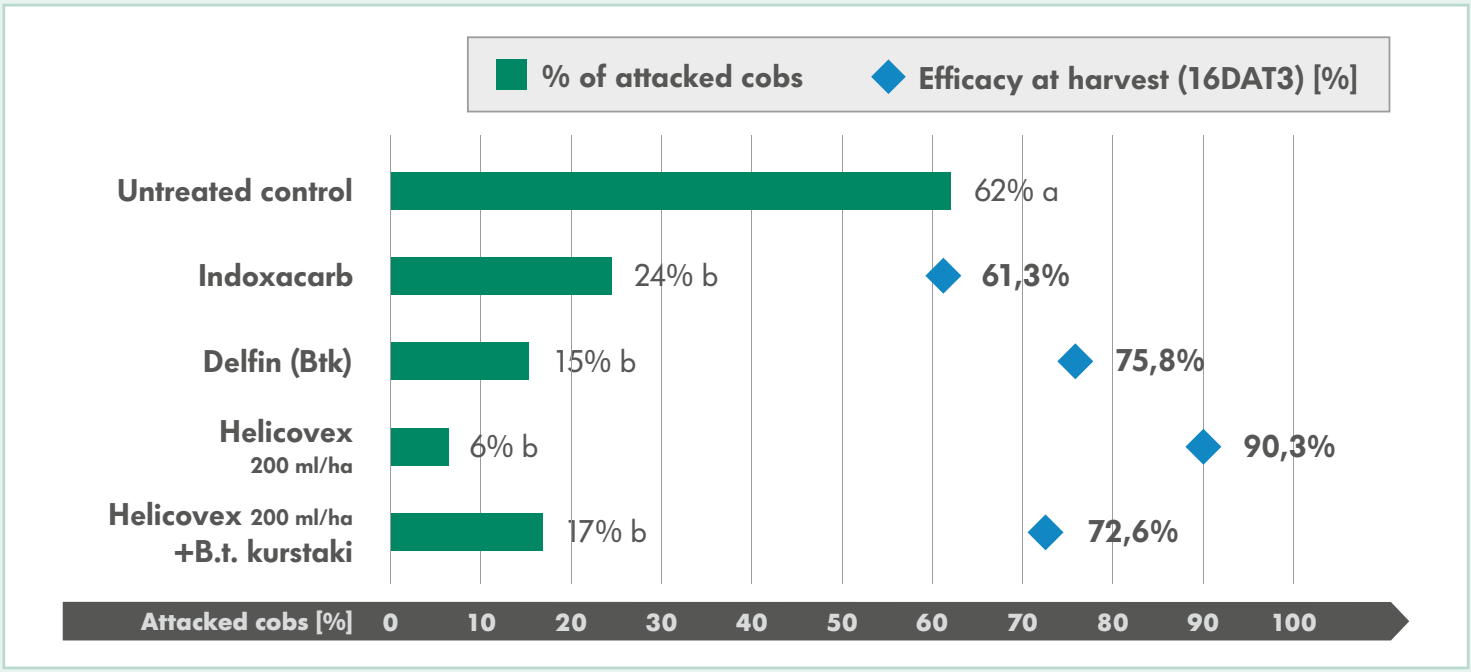
- 50 – 200 ml/ha
- Use higher rate when older larvae are already present

HELICOVEX® efficacy trials

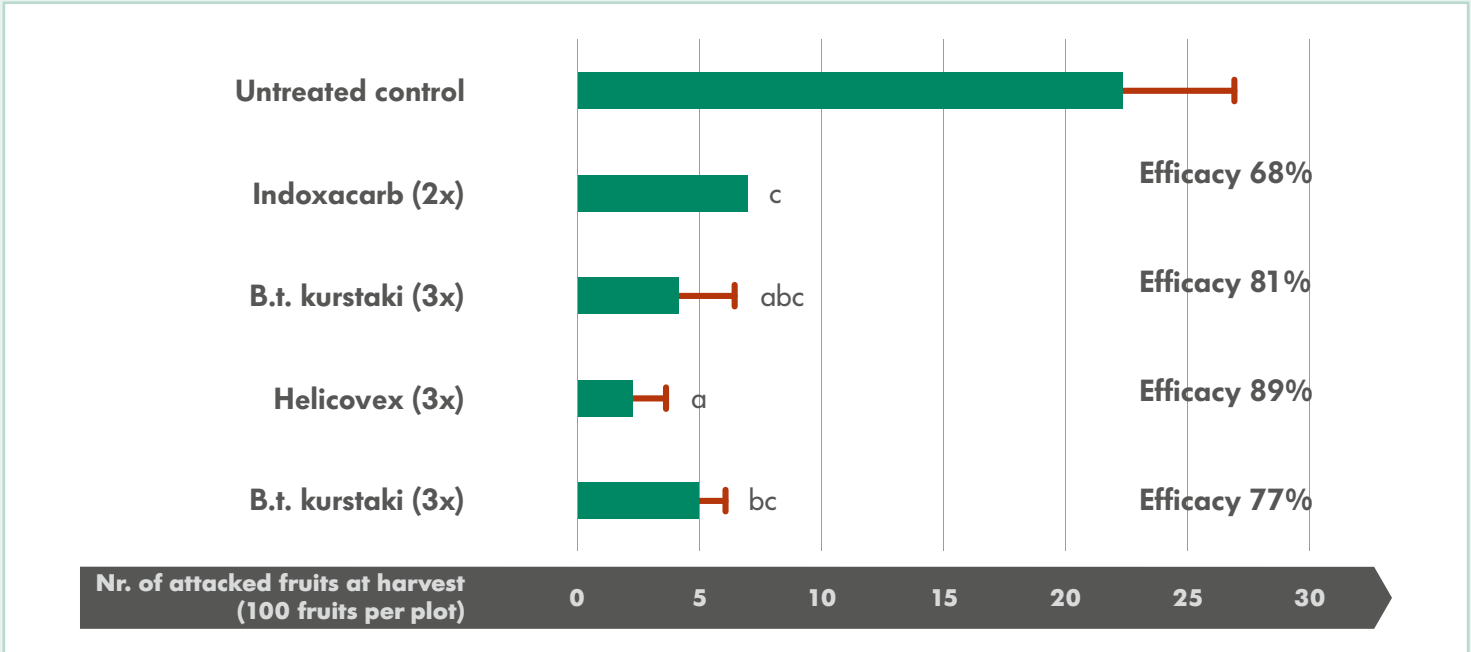
Control of *Helicoverpa armigera* in Green Beans, France 2011
Helicovex®, B.t. kurstaki: 3 applications (7 – 11 days interval)



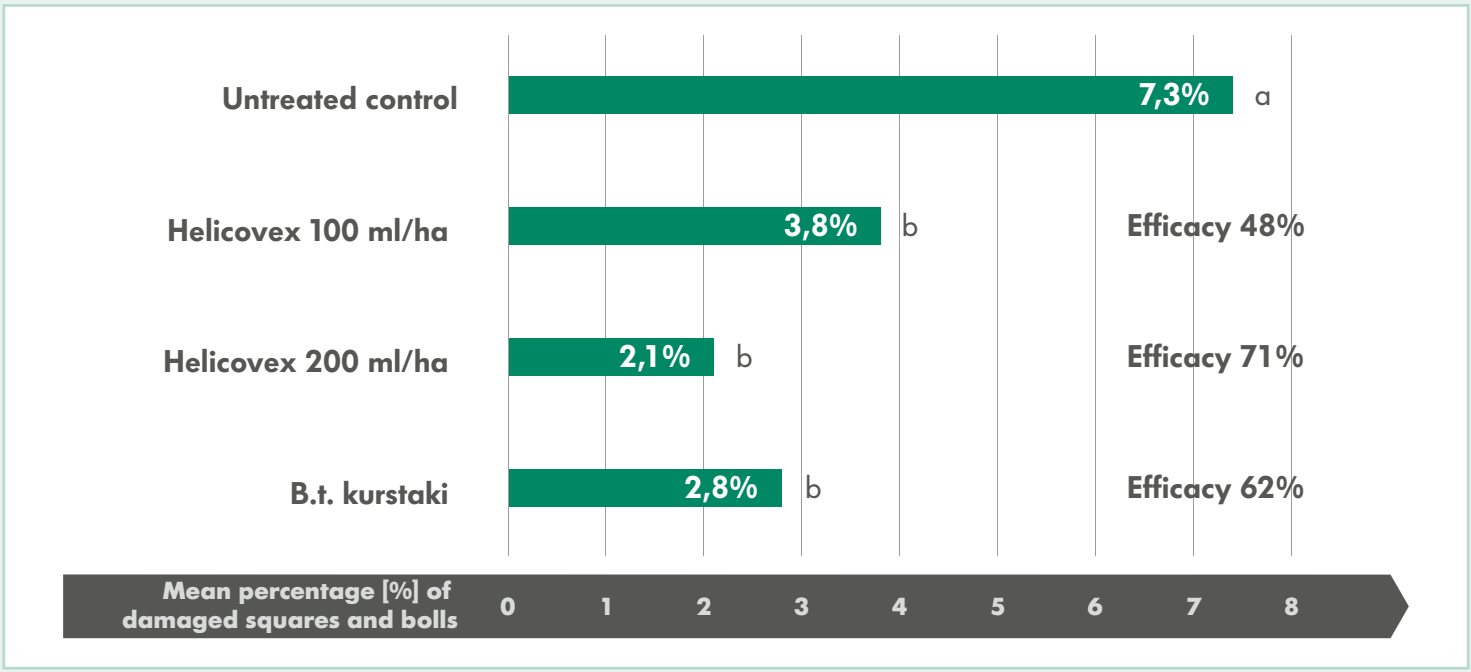
Control of *Helicoverpa armigera* in Sweet Corn, Aquitaine, France 2011
Helicovex®, B.t. kurstaki, Helicovex®/ B.t. kurstaki: 3 applications each (11 and 8 days interval),
Indoxacarb: 2 applications (19 days interval)



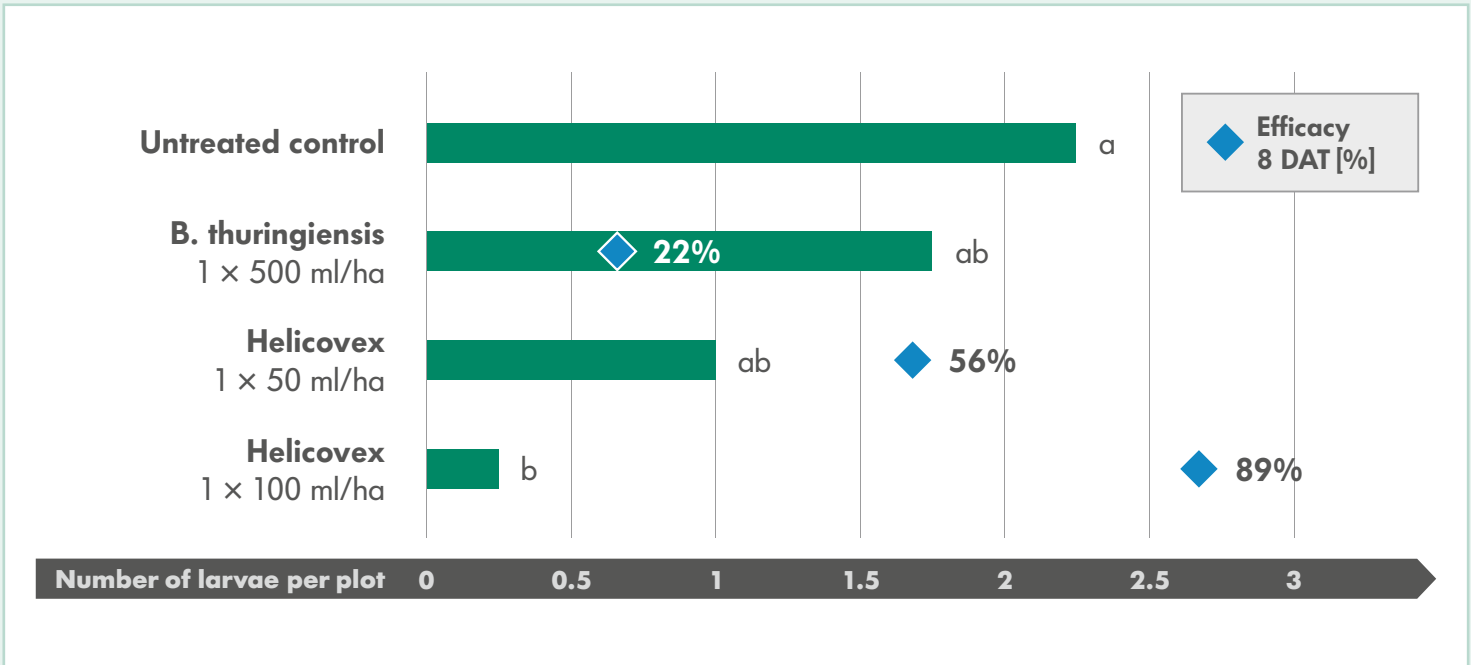
Control of *Helicoverpa armigera* in open field Tomato, Italy 2007
Helicovex®, B.t. kurstaki: 3 applications (8 and 6 day interval), Indoxacarb: 2 applications (14 days interval)



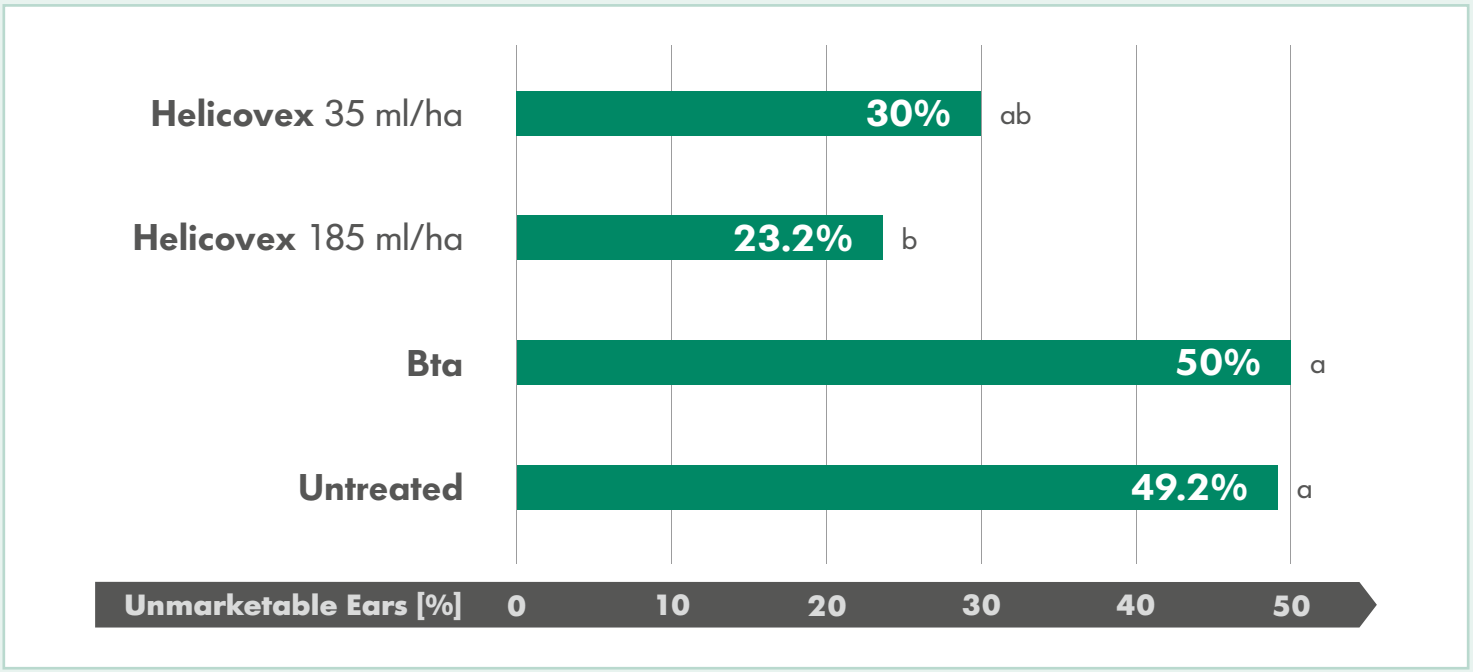
Control of *Helicoverpa armigera* in Cotton, Greece 2012
4 applications (7 – 9 days interval)



Control of Helicoverpa on soybean in Brasil 2014
Efficacy of single application of Helicovex 8 DAT



Control of Helicoverpa on sweet corn, USA 2016
6 applications, 3 day interval



HELICOVEX® Swiss quality

Helicovex® 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 Helicovex® undergoes a systematic bioassay process. The virulence of each batch is tested on cotton bollworm larvae against the standard reference batch within the Andermatt Biocontrol laboratories. Only batches that fulfill the high quality standard criteria will be released into the market.

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