



AGAINST STORAGE DISEASES

JULI 2017

Blossom Protect™ Product User Manual



AGAINST FIRE BLIGHT

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Blossom Protect™

Blossom Protect™ is a biotechnological bactericide and fungicide for the control of fire blight (*Erwinia amylovora*) and storage rots in pome fruit Blossom Protect™ is based on two strains of the species *Aureobasidium pullulans*.

Key benefits of Blossom Protect™

- Highly effective
- Safe for humans and animals, harmless to bees and beneficials
- GMO free
- No residues
- No resistance development, FRAC: not classified
- No preharvest interval
- Well adapted to a wide range of temperature
- Fully biodegradable
- No influence on taste and quality of fruits or processing procedure
- Miscible with many chemicals
- Valuable part in a modern IPM strategy and essential for high value organic production

Composition: *Aureobasidium pullulans* strain
DSM 14940 and DSM 14941, coformulants

Formulation: Wettable granule (WG)

Package: PE-HD can 1.2 kg, 1 kg or 0.4 kg



Fig. 1 Blossom Protect™ packaging

1 *Aureobasidium pullulans*, active substance in Blossom Protect™

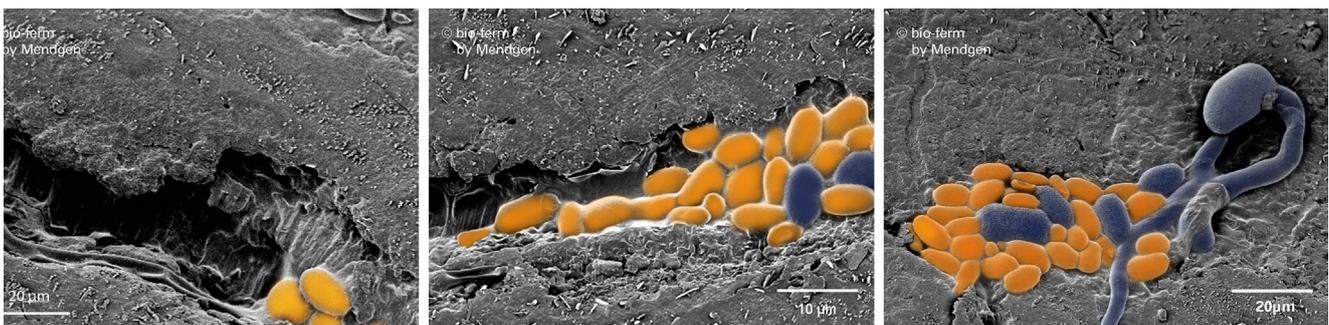
Aureobasidium pullulans is an eu-ascomycete which can build asexual blastospores showing a yeast-like life form. The fungus is well adapted to outdoor conditions, tolerant against drought, insensitive against solar radiation and frugal even under suboptimal nutrient supply. Both strains of *Aureobasidium pullulans* are not genetically modified for our products.

Mode of Action, stable efficacy and absence of resistance

The efficacy of *Aureobasidium pullulans* against different pathogens (e.g. *Erwinia amylovora*, *Botrytis cinerea*, storage pathogens) is based on its antagonistic activity by competing successfully with pathogens for nutrients and space.

Due to the antagonistic mode of action, bio-ferm products control also those pathogens, which are already resistant against chemical substances. As bio-ferm products reduce share of resistance carriers in the population, also the performance of chemical products used subsequently to bio-ferm products, will upgrade.

● *Aureobasidium pullulans*
● *Botrytis cinerea*



1. Microscratches on the plant's surface provide a natural entry point for gray mold (*Botrytis cinerea*). These scratches are colonized immediately after applying the highly effective microorganisms (*Aureobasidium pullulans*).

2. The rapid proliferation of *Aureobasidium pullulans* consumes available nutrients and inhibits the development of *Botrytis*

3. The microscratch is sealed by *Aureobasidium pullulans*, which acts as a natural shield and prevents *Botrytis cinerea* from infecting the plant.

Fig. 2 Scanning electron micrograph: Highly efficient microorganism (*Aureobasidium pullulans*) in competition with *Botrytis cinerea* colonizing a microscratch on the plant surface

2 Blossom Protect™ against fire blight on pome fruits

Fire blight, caused by the bacterial pathogen *Erwinia amylovora*, is one of the most dangerous diseases in pome fruit (apple, pear and quince). The name 'fire blight' refers to the macroscopic appearance of the infected trees, which appear to be burned.

Blossom Protect™ application instructions for use against fire blight

1.5 kg of Blossom Protect™ together with 10.5 kg Buffer Protect in 1000 L water per ha for 2 m canopy height, which results in a concentration of 0.15% (1.5 g/L) Blossom Protect™ and 1.05% (10.5 g/L) Buffer Protect. For trees of higher or lower canopy height, the application rate should be adapted: 0.75 kg/ha Blossom Protect™ and 5.25 kg/ha Buffer Protect per m canopy height.

Low-volume spraying is possible with appropriate nozzles with agitation. The water volume can thereby be reduced to 180 L water per ha for 2 m canopy height, as long as consistent treatment is assured. Keep the application rate of 1.5 kg/ha Blossom Protect™ together with 10.5 kg/ha Buffer Protect.



Fig. 3 Apple blossom infected with fire blight (Pictures: S. Kunz)

Blossom Protect™ application instructions for use against fire blight

- For the application of Blossom Protect™, use the standard spraying equipment
- Clean the tank before using
- Agitate the Blossom Protect™ package before using
- Put the product into the mesh and jet it into the tank with water
Keep the water temperature below 30°C
- Use the tank suspension within 8 hours
- The suspension should be stirred during application
- Thoroughly treat all blossoms when applying the product
- Do not leave leftovers in the tank /The microorganisms in the product can multiply and thus block filters or nozzles

Blossom Protect™ & Buffer Protect should be applied one day before a potential infection day, calculated by a forecast system such as e.g. Maryblyt. If several consecutive days with high infection risk (CDH18 >100%) are predicted, the treatments should be done every second day. If daily maximum temperatures exceed 29°C, daily applications are necessary as blossoms opening in the morning can be infected in the evening of the same day.



Efficacy

Two steps strategy using antagonistic microorganisms:

1. competing for space and nutrients
2. reducing pH-value

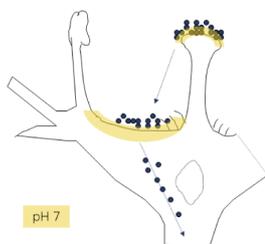
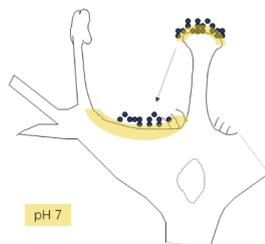
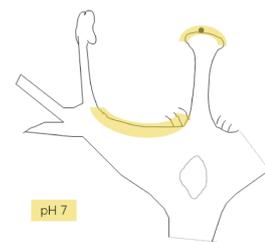
Tip: bio-ferm's Fire Blight Risk Calculator is dedicated specifically to the mode of action of Blossom Protect™. After registration, the use is free of charge: www.bio-ferm.com.

Unprotected blossoms

The fire blight pathogen *Erwinia amylovora* (●) is transferred to the stigma of open blossoms (pH-value ca. 7) by insects.

The fire blight pathogen multiplies quickly on unprotected blossoms at a natural pH-value of 7.

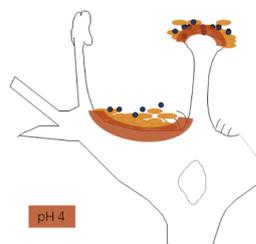
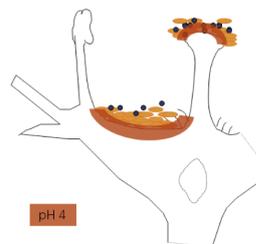
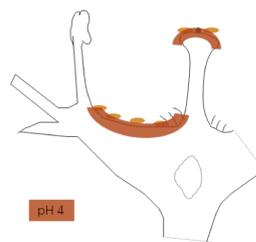
Once the bacterium has been transported to the bottom of the blossom by rain or dew, it uses chemotaxis to swim actively to the nectaries where it infects the blossom at these nectar producing cells.



Blossoms protected by Blossom Protect

Blossom Protect protects two-fold:

1. antagonistic microorganisms (●) colonize the stigma and blossom bottom.
2. pH-value is reduced to around 4 in the blossom.



The lower pH-value and the microorganisms' antagonistic effect inhibit pathogen growth and seal the blossom bottom.

Blossom Protect protects the place of infection (nectaries) from the pathogen, inhibits its growth and disrupts its chemotaxis, making it an effective prevention against the infection of the blossom.

Fig. 4 Schematic illustration of the mode of action of Blossom Protect™

On sensitive cultivars and under certain adverse conditions, Blossom Protect™ can enhance russetting of fruits. Since 2004, bio-ferm performed more than 160 trials in commercial orchards and with trial facilities all over the world. In cultivars, which are not sensitive to russetting, up to 4 treatments can be applied during the flowering period. Those varieties, which are sensitive to russetting should be treated only twice (Table 1). The addition of a skin smoothing product such as AlgoVital or Cutisan reduces the risk of fruit russetting.

Table 1 Classification of apple and pear varieties according to their sensitivity to fruit russet after applications of Blossom Protect™

	Sensitive to russetting	Less sensitive to russetting
Apple	Elstar Rubinette Idared Jonagold Sansa Santana Arlet Discovery Golden Delicious	Boskoop Gala Gloster Goldrush Pinova Shampion Kanzi Topaz Braeburn
Pear	Conference	Abate Fetel

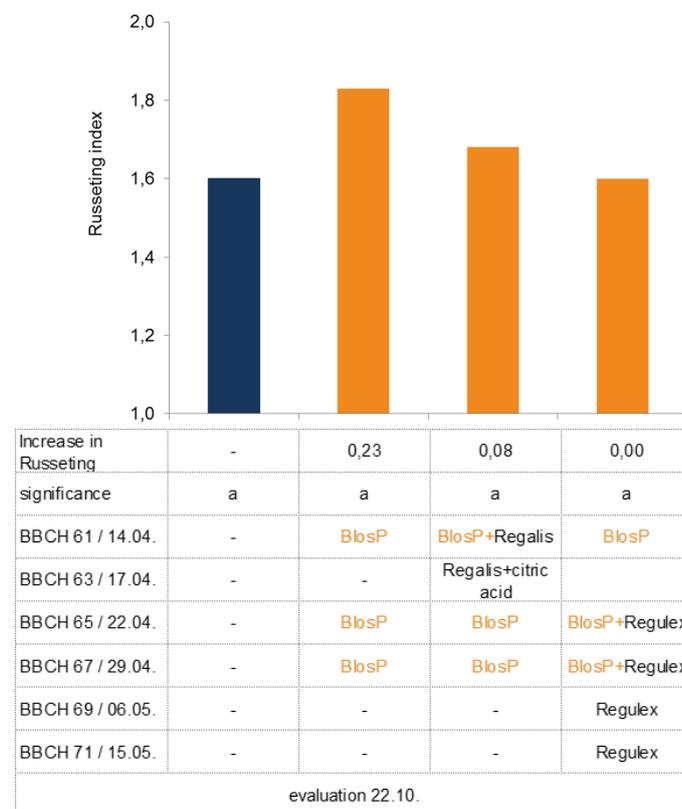


Fig. 5 Russetting index of Golden Delicious in a field trial 2014 in Germany after treatment with Blossom Protect™ & Buffer Protect in several spray strategies. Different letters show significant differences in Tukey's Multiple Comparison Test ($p < 0.05$)

Efficacy results against fire blight in pome fruit

Between 2003 and 2016, Blossom Protect™ + Buffer Protect was tested in 19 field trials in Germany, which resulted in an overall mean efficiency of 78%. Streptomycin containing products (Strepto) were used as reference products in 7 of these trials and resulted in a mean efficiency of 85%. Since 2010, LMA (a.i. potassium-aluminium sulphate) was tested in three trials with a mean efficiency of 69% and was comparable to Myco-Sin. Different formulations of *Bacillus* spp. (Serenade, Amylo X) showed lower efficacies (Figure 6).

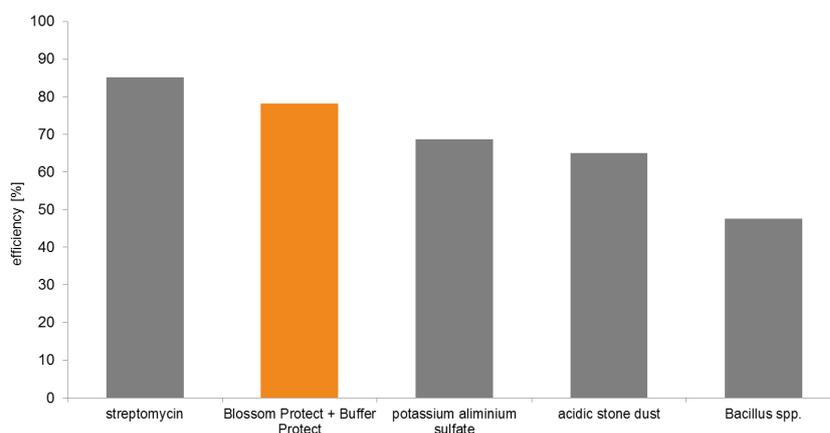


Fig. 6 Sources: Fried A (1997), Obstbau 22(12):598-602. Fried A et. al (2004), Obstbau 29(3):161-164. Kunz S et. al (2004), Ökoobstbau (4): 2-7. Jelkmann W (2006) Jahresbericht der BBA 2005). Kunz S et. al (2006), Ökoobstbau (4): 3-7. Fried A (2007), Obstbau 32(4):204-208. Scheer C et. al (2007), Obstbau 32(4):199-202. Kunz S et. al (2008), 13th Ecofruit (FÖKOe.V., Weinsberg), pp 299-305. Kunz S et. al 14th Ecofruit (FÖKOe.V., Weinsberg), pp 118-125. Kunz S et. al (2011) Acta Horticulturae, 896:431-436. Knaus C & Joseph C (2012), Infodienst Weihenstephan Ausgabe Juli 2012. Kunz S (2012). Obstbau 4/2012(4):217-220. Fried A (2014), Obstbau 3/2014(3):134-136. Fried, A, (2016), pers communication

In the US, Blossom Protect™ + Buffer Protect was compared to the antibiotics streptomycin, oxytetracyclin and kasugamycin as well as to other biologicals. The efficiency of Blossom Protect™ + Buffer Protect was 77% in average of 29 trials and was in between streptomycin and oxytetracyclin and more effective than all the other products tested (Figure 7).

According to American Trial Institutes, Blossom Protect™ + Buffer Protect is the first natural product with high efficacy levels like this.

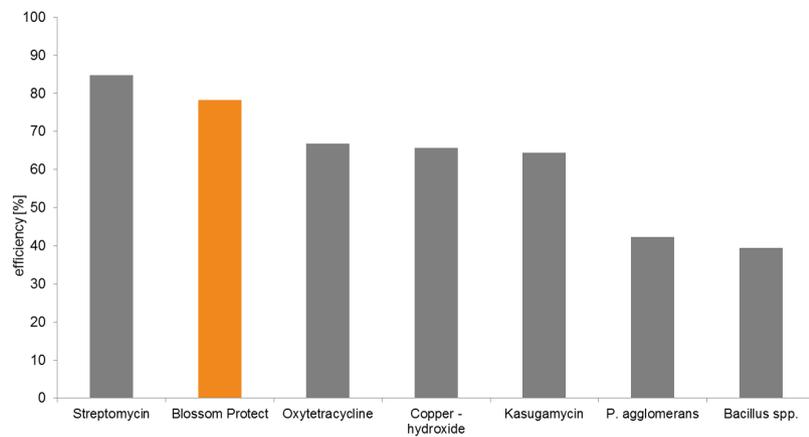


Fig. 7 Efficiency of Blossom Protect™ +Buffer Protect in field trials in the USA between 2008 and 2014 after artificial inoculation of the blossoms of apple or pear. In courtesy of Westbridge Agricultural Products

3 Blossom Protect™ against storage disease on pome fruits

Storage rots generate losses in the range of millions (Germany: 35 to 100 Mio Euro per year). More than 90 species of fungi (Jones and Aldwinckle, 1990) were described as decay pathogens on apples. Main pathogens are *Neofabraea* spp. (syn. *Gloeosporium* spp., *Pezicula* spp), *Monilia fructigena*, *Penicillium expansum*, *Botrytis cinerea*, *Fusarium* spp. and *Nectria galligena* (Figure 8).

In general, our product Botector® which is especially formulated for the use against all kind of fungal diseases, should be used against storage diseases. However, since fire blight occurrence is hard to predict at the beginning of the season, Blossom Protect™ is also registered against storage diseases in pome fruit. This exception allows using up not needed units of Blossom Protect™. All our products do not have a preharvest interval.



Fig. 8 Main storage disease pathogens: Left: *Neofabraea alba* symptom called “*Gloeosporium*”
Centered: *Penicillium* sp., Right: *Botrytis cinerea*

Blossom Protect™ application instructions against storage diseases

- Maximum 5 applications starting 5 weeks before harvest
- Apply Blossom Protect™ preferably before rain events
- Application between the pickings is possible
- For fungicides and fertilizers not compatible to Blossom Protect™, an interval of three days should be kept before and after the application of Blossom Protect™
- For the application of Blossom Protect™ use the standard spraying equipment
- Clean the tank before using
- Agitate the package before using
- Put the product into the mesh and jet it into the tank with water / Keep the water temperature below 25°C / Use the tank suspension within 8 hours
- The suspension should be stirred during application
- Thoroughly treat all fruits when applying the product
- Do not leave leftovers in the tank. The microorganisms in the product can multiply and thus block the nozzles.
- Preharvest applications can be combined with all known storage techniques as cold storage, CA, ULO, DCA, MCP-1 (smart fresh), hot water treatment

1 kg Blossom Protect™ in 1.000 L water per ha and 2 m canopy height (which results in a concentration of 0.1% (1 g/L)). For trees of higher or lower canopy height, the application rate should be adapted: 0.5 kg Blossom Protect™ in 500 L water per ha per m canopy height.

Low-volume spraying is possible with appropriate nozzles and agitation (reduction to 75 L water/ha per m crown height). Keep the application rate and ensure thorough coverage!

Efficacy against storage diseases

Since 2002, several field trials with Blossom Protect™ were carried out in apple and pear in numerous European countries.

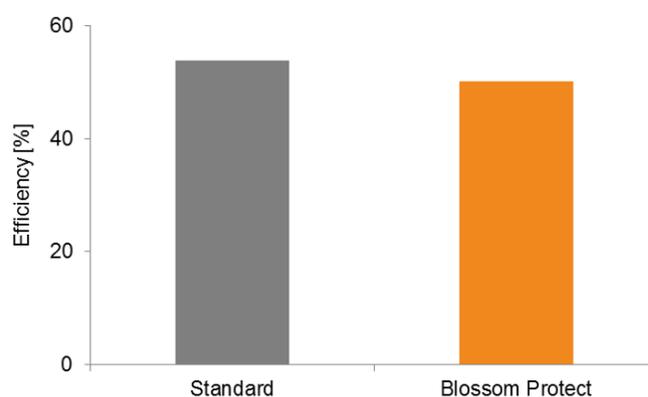


Fig. 9 Average of efficiencies of the chemical standard and Blossom Protect™ in 63 trials in pome fruit in which chemical fungicides were replaced by Blossom Protect™. Trials were done in Europe from 2002 to 2016

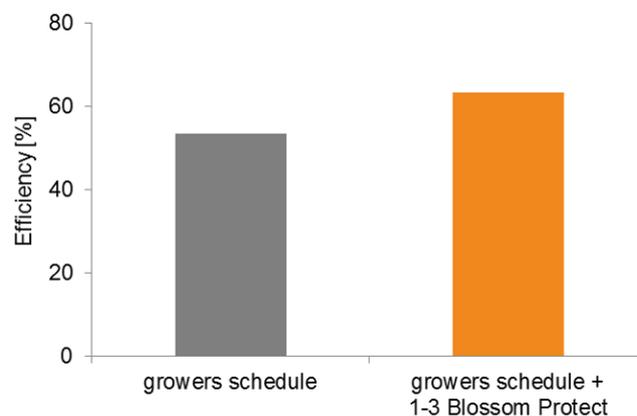


Fig. 10 Average of 14 trials, in which 1-3 Blossom Protect™ treatments were applied in addition to standard chemical fungicides in pome fruit. Trials were done in Europe from 2002 to 2016

4 Compatibility of Blossom Protect™ with other products

During the flowering period of apple treatments against apple scab (*Venturia inaequalis*) might be necessary. Therefore, it has to be considered that the active ingredient of Blossom Protect™, *Aureobasidium pullulans*, is sensitive to many scab fungicides. However, tank mixtures of Blossom Protect™ with wettable sulphur and substances such as anilinopyrimidins (Cyprodinil, Pyrimethanil and Mepanypirim) and several sterolbiosynthesis inhibitors (Penconazol, Fluquinconazol, Flusilazol) are possible. Wherever these substances are still effective against apple scab, they should be preferably used for scab control during the flowering period.

In many growing areas, these substances are no longer effective due to resistance development of the scab fungus and consequently protective contact fungicides are used. A tank mixture of Blossom Protect™ and contact fungicides (Dithianon, Captan, Strobilurin, Dodine, lime sulphur) is not possible. Scab treatments with these substances have to be applied separately from treatments with Blossom Protect™. Lime Sulphur (e.g. Curatio) is used in some regions for so-called stop applications during the germination of the scab fungus. Lime sulphur can be applied whenever needed from 6 hours after Blossom Protect™ applications on. Fungicides not compatible to Blossom Protect™ can be applied the day before or the second day after Blossom Protect™ application.

Copper products should not be used in tank mixture with Buffer Protect due to the phytotoxic effect of copper when applied with acidic pH. In pears, copper products should not be used two days before and two days after Buffer Protect.

Application against storage diseases: For fungicides and fertilizers not compatible to Blossom Protect™, an interval of three days should be kept before and after the application of Blossom Protect™.

5 Storage stability of Blossom Protect™

The bio-ferm products contain living microorganisms, do not store above 25°C!

Storage stability from date of manufacture:

- at room temperature ($\leq 20^{\circ}\text{C}$, 77°F) 18 months,
- at cold temperature ($\leq 8^{\circ}\text{C}$, 46°F) minimum 30 months.

Please note that storage stability is subject to national product registration. Depending on national authority and procedure, different information on shelf life may appear on the label. Please refer to the national product label.

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