

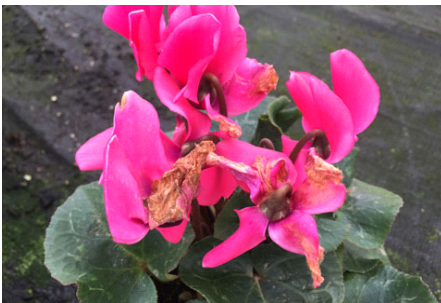
GROWERTALKS

Pest Management

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Bacillus-based Biopesticides

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The first *Bacillus*-based biopesticide we worked on was originally called Rhapsody and is made from *Bacillus subtilis* QRD 713. We probably have more information on using Rhapsody/Cease for control of ornamental diseases than any of the other products created from strains of *Bacillus subtilis* or *B. amyloliquifaciens*.

Pictured: Botrytis blight on cyclamen.

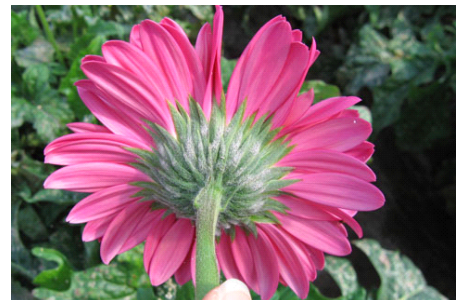
Since OHP brought us Triathlon BA, we've worked on it in a wide variety of trials. Then we started to work on Stargus (Marrone BioInnovations) and most recently a number of newer or experimental products based on other strains of this bacterium.

Some of the products have been registered recently (AmyloShield), while the majority of products registered from this group have been liquid formulations. We're now working on two different formulations, which are wettable powders, and another liquid formulation from Harrell's.

Table 1 lists some of these products, including their exact strain and their manufacturers. Specific strain identification and strict product processes are critical. Each of the products I decided to include has a four-hour REI (except AmyloShield) and is OMRI-listed, making them user-friendly, especially for growers who produce edibles as well as ornamentals.

Pictured: Powdery mildew on gerbera daisy.

Buying a product without a strain identification is a risk. Products that are strain-identified are more likely to produce reliable, consistent results. Just like conventional chemicals like strobilurins or sterol inhibitors are not interchangeable, not all *Bacillus amyloliquifaciens/subtilis* are the same. A large effort has been underway for over 40 years to determine how they work. The *Bacillus* strains in these products share many of the same features.



- Antibiosis is the creation of anti-fungal metabolites. Some are created once the products are applied, but many of the current products are created during production of the product itself (lipopeptides, enzymes, siderophores and salicylates). These products are effective in directly damaging the plant pathogens.

- Competition by growing in the area a pathogen would normally occur crowds them out.

- Induced resistance—many if not all of the effective *Bacillus* products stimulate the plant's defense systems.
 - Production of gibberellins and cytokinins that directly attack the fungal or bacterial pathogen or enhance plant growth.
 - Promoting roots or seed germination can result in the plant outgrowing the damaging effects of soil-borne pathogenic fungi.
 - Promoting plant resistance to toxic metabolites from fungi, increased photosynthesis and delayed senescence.

Trial efficacy summary

Some of these products work better on foliar diseases while others work better on soil-borne diseases. Some work better on bacterial leaf spots than the others. It would be impossible to choose a single product to cover the range of diseases one might encounter in ornamental production.

Table 2 and 3 summarize research trials with these *Bacillus* products on all crops (not just ornamentals). In some cases, the trials were primarily performed on edible crops, especially in Table 3. In others, a large number of trials have been conducted on ornamentals.

Finally, the fact that these are living organisms makes their full benefits dependent on more factors than use of a conventional fungicide or bactericide. It's easier to affect a living organism with pH, salinity, temperature or even storage of the product than a conventional chemical.

Bacillus products can be very effective in a rotation with other biopesticides or conventional products. Some of their effects are based on the natural chemicals they create during their production. You can check manufacturer websites for compatibility of their *Bacillus* product with other effective choices for specific crops or diseases. Read the labels carefully! They usually include critical information on successful use of the product. The blanks indicate no trials that I could find.

In 2023, we performed four trials with AmyloShield: Botrytis blight on pansy, Botrytis blight on cyclamen, powdery mildew on gerbera daisy, and rust on snapdragon. Results are shown in Table 4. Products were applied once before inoculation (all trials) and then again on a weekly interval for powdery mildew and rust trials. Trials were conducted with different conventional standards, as well as Triathlon BA (1%) in each trial.

- Botrytis trials had Astun (17 oz./100 gal.) and the disease rating for both Botrytis trials was the number of infected flowers.
- The powdery mildew trial had Broadform (4 oz./100 gal.) with the disease rating for the powdery mildew trial was the number of powdery mildew colonies.
- The rust trial had Terraguard (4 oz./100 gal.) and disease rating was number of pustules.

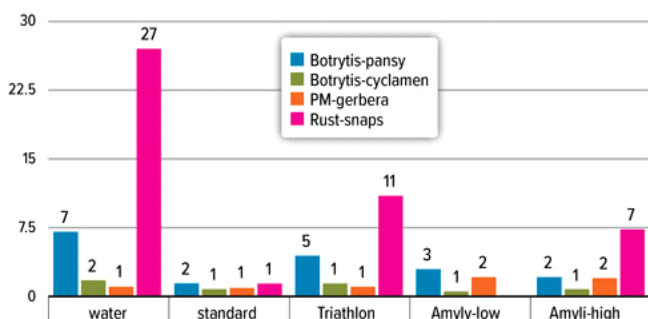


Table 4. Disease severity with AmyloShield, conventional and Bacillus-based (Triathlon BA) standards. Higher bars show more disease.

Disease results showed that both rates of AmyloShield in both Botrytis trials, the powdery mildew trial and the rust trial were as effective as the standard. We did see some phytotoxicity in the gerbera daisy trial. Both rates of AmyloShield caused slight burning on leaves and flowers. This was not seen in any other trial. Check the

product labels for legal use rates, application intervals and targets. Be sure to test all products for safety on your crops under your specific conditions.

Conclusions

Using Bacillus-based organic fungicide/bactericides can be as effective as conventional products for Botrytis, powdery mildew and rust. Many of the organic products currently available, as well as those in development, are proving to be an effective choice either in an organic program or in a conventional program. Even tank-mixtures with copper can work, although why use them together when an effective rotation is less costly?

Early testing with Cease and copper showed its tolerance (resistance) of copper was quite high. Read labels carefully to make sure you don't try to make something work on a disease that the product isn't labeled for. It's always less costly to prevent a problem than to try to correct one. **GT**

Table 1. Some Bacillus products with known strain identification.

Product	Active agent	Manufacturer
AmyloShield (12 hr REI)	<i>Bacillus amyloliquefaciens</i> strain PTA-4838	Mycorrhizal Applications
Cease	<i>Bacillus subtilis</i> QRD 713	BioWorks Inc.
Companion Maxx (Bacillus A)	<i>Bacillus amyloliquefaciens</i> strain ENV503	Harrell's (DHB Biologicals)
Companion	<i>Bacillus subtilis</i> strain GB03	Growth Products
Serenade ASO (Landscape use only)	<i>Bacillus subtilis</i> QRD 713	ENVU (Bayer)
Stargus	<i>Bacillus amyloliquefaciens</i> strain F727	Marrone Bio Innovations
Subtilex NG, Serifel NG	<i>Bacillus subtilis</i> strain MBI 600	BASF Corp.
Taegro 2	<i>Bacillus subtilis</i> var. <i>amyloliquefaciens</i> strain FZB24	Novozymes
Triathlon BA	<i>Bacillus amyloliquefaciens</i> strain D747	OHP (Certis)

Table 2. Trial summary for foliar diseases on all crops.

Product	Alternaria	Bacteria	Botrytis	Cercospora	Colletotrichum	Cylindrocladium	Downy mildew	Powdery mildew	Rust	Sclerotinia
AmyloShield			very good					very good	very good	
Cease	some	good	very good	very good	some		some	good		
Companion		some	none			none	none	some		
Serenade ASO	none	none			some			good		
Stargus	good	good	good	some	excellent		none	very good		good
Taegro 2	none	some					none	very good		
Triathlon BA	good	very good	good	good	none	very good	some	good	good	

Table 3. Trial summary for soil-borne diseases on all crops.

Product	Cylindrocladium crown/root rot	Fusarium crown/root rot, wilt	Phytophthora root rot	Pythium root rot	Rhizoctonia crown/root rot	Sclerotium (So. Blight)	Thielaviopsis (black root rot)
Cease	some	some	some	some	some		
Companion	none	none		some	none		none
Serenade ASO			none				
Stargus	good	good	very good	some	good		
Subtilex				none	very good		none
Taegro 2		some	none	none	none		
Triathlon BA	very good	some		some	good	some	