

GROWERTALKS

Pest Management

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Bacillus-based Biopesticides

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One of the first effective biological control agents that was registered for foliar diseases on ornamentals for disease control was discovered by Agrquest in California in the late 1990s and registered around 2005. It was originally called Rhapsody and is made from *Bacillus subtilis* QRD 713. We worked on it for years when we did trials in Northern California on ornamentals and 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. amyloliquefaciens*. (There's some debate about the naming of these bacteria, so I've listed simply what's on each product's label in Table 1.)

Table 1. Some *Bacillus* products with known strain identification.

Product	Active agent	Manufacturer
Cease	<i>Bacillus subtilis</i> QRD 713	BioWorks Inc.
Companion	<i>Bacillus subtilis</i> strain GB03	Growth Products
Serenade ASO	<i>Bacillus subtilis</i> QRD 713	Bayer
Stargus	<i>Bacillus amyloliquefaciens</i> strain F727	Marrone Bio Innovations
Subtilex 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 (Double Nickel)	<i>Bacillus amyloliquefaciens</i> strain D747	OHP (Certis)

Rhapsody/Cease was one of the first biopesticides that was similar to conventional chemistry with respect to consistent positive results. Others have been registered as well, including the most recent product to enter our market, Stargus (Marrone Bio Innovations). Several others are also under development based on *Bacillus* species.

Table 1 lists some of these products, including their exact strain and manufacturers. Specific strain identification and strict product processes are critical. Each of the products I decided to include has a four-hour REI and is organic, making them user-friendly, especially for growers who produce edibles as well as ornamentals. However, not all *Bacillus amyloliquefaciens/subtilis* are the same. Buying a product with unknown or unidentified strain identification is like buying a pig in a poke—at least use EPA-registered products for reliable, consistent results.

How do these products work?

Are biological control products magic? Do we know the mechanisms that are acting to yield the positive results in disease control? Actually, a large effort has been underway for over 40 years. The *Bacillus* strains in the products I'm reviewing here share many of the same features.



Pictured: Alternaria leaf spot on poinsettia.

Antibiosis is the creation of anti-fungal metabolites. Some are created once the products are deployed (in the potting medium or soil), but most in our current products are made during production of the product itself. These include lipopeptides, enzymes, siderophores and salicylicates.

Competition through colonizing the rhizosphere (area closest to plant roots) also occurs in some cases. The space where a plant pathogen might live and invade the roots can be taken up by the *Bacillus* strain.

Many of, but not all, of the effective *Bacillus* products act on the plant. The defense systems can be activated, including causing production of plant chemistry (like gibberellins and cytokinins) that directly attacks the fungal or bacterial pathogen or enhances plant growth. Growth promotion, especially roots or improved seed germination, can result in the plant outgrowing the damaging effects of soilborne pathogenic fungi. In addition, reduced plant sensitivity to pathogen toxic metabolites, increased photosynthesis and delayed senescence also help control the negative effects of the disease.

Trial efficacy summary

Some of these products work better on foliar diseases (Cease and Triathlon BA), while others work better on soilborne diseases (Stargus). Some work better on bacterial leaf spots (Triathlon BA) than others. It would be hard to choose a single product to cover the range of diseases one might encounter in ornamental production.

Tables 2 and 3 summarize research trials with these *Bacillus* products on all crops. In some cases, the trials were primarily performed on edible crops, especially in Table 3. In others, a fair amount of the data is based on ornamentals. You can see that for some entries there's a wide range of reactions.

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

Product	Alternaria	Bacteria	Botrytis	Cercospora	Colletotrichum (anthracnose)	Downy mildew	Powdery mildew	Rust
Cease	none to good	some to very good	some to good	some to excellent	none to good	none to very good	good to very good	
Companion		none to some	none			none to some	some to good	
Serenade ASO	none	none			none		good	
Stargus	none to very good	none to good	none to very good	very good	excellent		none to excellent	
Taegro	none	none to good				none	good to very good	
Triathlon BA Double Nickel	none to good	very good to excellent	good to excellent	good		none to some	some to very good	none to excellent

Table 3. Trial summary for soilborne diseases on all crops.

Product	Cylindrocladium crown/root rot	Fusarium crown/ root rot, wilt	Phytophthora root rot	Pythium root rot	Rhizoctonia crown/root rot	Sclerotinia	Thielaviopsis (black root rot)
Cease	none to good	none to some	some	none to some	none to some		
Companion	none	none		none to some	none		none to some
Serenade ASO			none				
Stargus	good		none to very good	some	none to good	some to excellent	
Subtilex				none	none to excellent		none
Taegro		some	none	none	none		
Triathlon BA	very good	none to good		some	some to very good		

For instance, Triathlon BA (Double Nickel) has provided some to very good control of powdery mildew in research trials. This could be due to the fact that there are quite a few distinct genera of fungi that cause powdery mildew. Additionally, this work was performed on a variety of plant types under a variety of conditions. Sometimes a single entry rating is due to the fact that only one trial has been performed/reported. In all cases, many different researchers all over the U.S. have done some of the trials. As individuals working on very diverse crops, the trials necessarily would be conducted differently.

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. Thus, some of the negative results could be due to poor storage conditions alone.

Finally, these products can be very effective in a rotation with other biopesticides or conventional products. 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.

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