SERENADE ® SOIL (*BACILLUS SUBTILIS*, STRAIN QST 713): TECHNOLOGY AND PERFORMANCE

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The SERENADE ® SOIL product's active ingredient is *Bacillus subtilis*; strain QST 713. This strain of Bacillus falls within the category of Plant Growth Promoting Rhizobacteria. This class of organisms aggressively colonizes plant roots, bestowing an array of benefits to plants. These benefits may include improved plant growth and induced systemic resistance to plant pathogens. The discussion below will address the known technology behind Serenade Soil and its translation to successful field applications on key crops that often require fumigation.

The active ingredient of Serenade Soil is a patented strain of *Bacillus subtilis*. By microscopy, we showed that QST 713 is a robust root colonizer and protects the root system of many types of plants. The effect can be achieved by way of both seed treatment and soil drench. Colonization sets the stage for interplay between microbe and root. Serenade Soil takes chemical signals from plant roots to produce beneficial chemistry for disease control.

One of the significant characteristics of Serenade Soil is its production of an array of lipopeptides (Iturins, Surfactins, Fengycins). To date, no other commercial strain is known to have such a robust production. Lipopeptides are molecules composed of an amino acid ring with a fatty acid tail. Their structure mimics that of the phospholipids of cell membranes. They suppress pathogenic fungi by disrupting the cell membrane, leading to lysing of the cell. Thus, phospholipids have direct activity on soil borne pathogens; not only through their production in the root zone, but also through their presence in the formulated product. So a soil application of Serenade Soil, like those of synthetic chemistry, provides direct contact control of pathogens in a volume of treated soil. Another well-known property of lipopeptides is their ability to trigger induced systemic resistance. This phenomenon has been displayed with Serenade Soil.

I addition to lipopeptides Serenade Soil produces other chemicals that can aid in disease control and plant health. First, Serenade Soil produces sufficient levels of

the antibiotics Macrolactin, Bacilysin and Difficidin to suppress bacterial pathogens. Second, Serenade Soil produces auxin analogs and 2,3-butanedial that can enhance plant growth and photosynthesis, respectively. The activity of the aforementioned chemistry had been displayed with proof-of-concept studies. The studies appear to effectively exhibit transfer to the field under research and commercial conditions. Examples of the utility of Serenade Soil are discussed below.

Strawberry is an at-risk crop as MeBr is phased out, as no effective drop-ins appear to be on the horizon. Serenade Soil has exhibited utility in strawberry production in research and limited grower trials. Trials have shown Serenade Soil to suppress soil pathogens such as Fusarium, Verticillium and Phytophthora. Improved yields result from applications following In-Line or with multiple applications over the course of the season. Integrated programs with synthetics or other biological may result in Serenade Soil playing a significant role in future strawberry production.

Fruiting vegetables, cucurbits and other vegetable crops suffer from a number of soil borne pathogens. Serenade Soil has exhibited significant suppression of diseases such as Damping Off, *Fusarium, Rhizoctonia, Phytophthora* and *S. rolfsii*, resulting in improved yield and grade of tomatoes. Direct yield improvements have been exhibited in cucurbits due to the suppression of *Phytophthora* and *Pythium*. Serenade Soil improves yields in lettuce due to *Sclerotinia* control. Serenade Soil has made significant commercial inroads in potatoes with in-furrow applications suppressing Rhizoctonia and Phytophthora resulting in measurable improvements in yield and grade.

Root colonization is a critical element for a favorable outcome. In-furrow, at-planting applications have proven effective, as have soil drenches, drip-irrigation and directed sprays. Rate, timing and method of applications must be optimized for each crop. We continue to refine Serenade Soil work in multiple crops. We are also exploring methods of integrating Serenade Soil with synthetic chemistry and other biopesticides to ensure the most favorable outcomes for growers.

Key points on Serenade Soil:

- It is essential to deliver the product to the root zone
- Methods of application are quite flexible
- Compatible with a wide range of pesticides and fertilizers
- Safe to handlers and to non-target organisms (NOP approved)
- Has direct activity on soil borne pathogens