GROWERTALKS

Features

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Seeing Through the Fog

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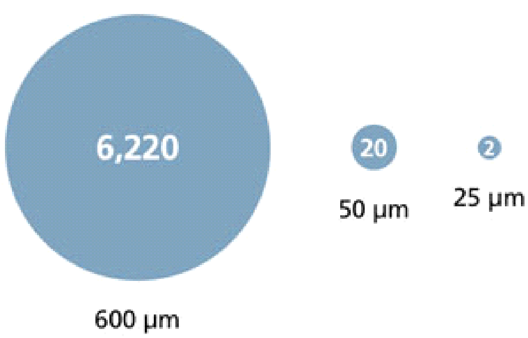
All greenhouse crops are prone to pests and diseases. Canadian growers are faced with two major issues related to their management: widespread pesticide resistance and limited availability of effective chemical pesticides. As a result, the industry has undergone a major transition over the past 10 years and biological control is now successfully implemented on a wide range of crops. While growers in the U.S. have generally had greater access to conventional controls, the efficacy of many products is declining. There's an increasing recognition that greater integration of biological controls into pest management strategies is essential to the industry's future.

Use of biological controls can deliver savings through reduced expenditures on protective gear, pesticide application costs and training. Further, reduced pesticide use will delay resistance in key pests such as thrips, spider mites and whitefly. This strategy also conforms to retail and consumer calls for lower residue levels on plants and fresh produce, and market demand for crops grown using "sustainable" practices.

Success in a biocontrol program is rarely achieved through the use of a single agent. Rather, success is realized through the concurrent use of several biological and cultural strategies within an integrated plant production system. Microbial biopesticides can play an important role in a biologically-based IPM program; they can contribute to the control of several challenging pests and thus strengthen an IPM program in a manner that's compatible with the other natural enemies used within it.

Figure 1. Spray droplet sizes and spores carried in each. Relative droplet diameter and approximate number of spores carried in each (using the recommended spray concentration for Beauveria bassiana [BotaniGard]).



Why consider using a low-volume sprayer?
To be effective, a biopesticide must make contact with the pest or disease it's targeted against. In other words, for foliar pests and diseases, excellent spray coverage is essential to efficacy. Several types of sprayers are available for greenhouse use. Historically, hydraulic sprayers have been the workhorse of the industry, delivering (relatively) high volumes of material via

large spray droplets. However, better coverage is typically achieved when smaller spray droplets are applied and this has seen many growers shift towards the use of low-volume and ultra-low-volume systems, as well as using low-flow nozzles with their hydraulic systems to produce finer droplets.

Low-volume sprayers include high-pressure cold foggers and thermal foggers. Both use very low volumes of spray, delivering small spray droplets that can penetrate crop foliage. Several cold foggers are automated (Figure 1), so that the user doesn't have to remain in the greenhouse during spraying, creating cost-savings through reduced applicator time and eliminating risks of exposure to sprays during application. Kurt Becker of the Dramm Corporation puts it best: "Typically, low-volume application reduces run-off, reduces pesticide usage, reduces labor and exposure and increases efficiency."

While the amount of active ingredient delivered by low-volume sprayers per unit area of greenhouse effectively remains the same as that applied through a high-volume system, it's delivered in a much smaller volume of water (carrier). Low-volume sprayers produce spray droplets that are significantly smaller than those produced by a hydraulic sprayer, but it produces considerably more of these droplets per unit volume of spray. As a result, excellent coverage is achieved through the delivery of a high density of fine spray droplets. Hydraulic sprayers commonly produce spray droplets that are around 600 µm in diameter, targeted low-volume sprayers produce droplets with a diameter of 40-70 µm and ultra-low-volume cold and thermal foggers produce droplets that are 25 µm or less in diameter. The volume of one 600 µm diameter spray droplet will produce approximately 1,728 droplets of 50 µm in diameter and 13,824 droplets that are 25 µm in diameter.

By doing the math, it's easy to see how the surface area that can be covered increases greatly as droplet size decreases. Low-volume spray equipment has been successfully used to apply conventional insecticides, fungicides and nutrients to greenhouse crops.

Why are microbial sprays different?

While the advantages of low-volume spray equipment seem compelling, in general, there's a shortage of information on the relative effectiveness of these sprayers for application of microbial biopesticides, such as BotaniGard, Met52, Cease and Rhapsody. Shouldn't everything be the same? Well …

There are a number of factors to consider that can affect the efficacy of biopesticides applied via a low-volume sprayer. These include the sprayers and the way in which they work, the size of the droplets produced and the nature of the products themselves.

Let’s first consider the products. Fungal biopesticides like BotaniGard (Beauveria bassiana) and Met52 (Metarhizium brunneum) contain conidia (spores) of these fungi; these are the “active ingredients.” They must contact or be picked up by the target pest, germinate and then infect the insect (or mite) to kill it (Figure 2). If the application process adversely impacts the “fitness” of the fungal spore, there will be a direct and negative impact on efficacy. If the process kills the spores, then the spray will have no activity against the pest. Fungal spores aren’t very heat-tolerant and may be affected by high-spray pressure. Even if heat exposure doesn’t kill a spore, germination is usually delayed and slower, and successful insect infection less likely to occur. The spores of Bacillus subtilis (in Cease and Rhapsody) are much more heat-tolerant, so equipment deemed unsuitable for fungi may be appropriate for the application of a bacterial product.

Figure 2. Dramm Autofog, an air-assisted, ultra-low-volume cold fogger

What about the equipment used to make ultra-low-volume sprays—thermal—and cold-foggers? As the name suggests, thermal foggers use heat to generate ultra-fine spray droplets. These aren’t recommended for application of biological and other heat-sensitive materials, as the heat used to generate the droplets is lethal to spores. This leads to the development of “biological” thermal foggers. These foggers use a preliminary injection of water to cool the thermal gases produced after fuel ignition; the active ingredient is injected via a second port at a cooler point further down the resonator and mixes with the water vapor just beyond the end of the exhaust pipe. This mixing takes place at significantly lower temperatures and the active ingredient is only exposed to the moderately high temperature for a fraction of a second.

Cold foggers use high pressure and special nozzles to create fine spray particles. The spray suspension is pumped at high pressure through the nozzle, which separates the liquid suspension into tiny droplets, emerging from the nozzle in a fog or fine mist. While there’s no heat involved in this process, there’s potential for mechanical damage to the spores.

Figure 3. Thrips larva infected with Beauveria bassia

na on mini roses following application of BotaniGard by a cold fogger.

Finally, the size of the droplets produced by the different sprayers may also impact their utility for application of microbials. Can a droplet be too small? The droplets carry the spores from the sprayer to the target—think of a balloon containing ping pong balls and you’ll get the picture. How many spores can you fit into a droplet? Of course, it depends on the size of both. Let’s consider our three droplet sizes again and the number of Beauveria bassiana spores each may carry if the recommended spray concentrations are used (Figure 3). As you would expect, the larger the droplet, the more spores it will contain.

A droplet produced by an ultra-low-volume sprayer will carry far fewer Beauveria spores; given the fact that many droplets may be considerably smaller than 25 µm, then some of them may contain no spores at all. Of course, more spores could fit inside the spray droplets, but to do that would require putting even higher concentrations in the spray tank and there comes a point where you simply cannot increase the concentration any more. For products such as Met52, which contains spores that are about three times larger than those in BotaniGard, then there could be even more "empty" spray droplets, especially when the size falls below 10 µm. There are other physical/environmental factors that can affect the drops in flight and on impact with a leaf or insect; all interact to influence the final coverage and efficacy achieved.

So, does it make sense to use low-volume sprayers for application of spore-based microbials? Like the answers to many things in life, "it depends." Based on our knowledge of the sprayers and the microorganisms, and early results from our trials, some equipment does appear to be better suited to their application. We should have more definitive information on the relative pros and cons of each system later in 2017.

Ultimately, our goal is to define spray methods that can efficiently deliver insect/mite-killing and other beneficial microbes to plants. If we can, then we can manipulate insect behavior to make them better targets … but that's a story for another day! **GT**

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