GROWERTALKS

8/27/2015

Biocontainers 2.0

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Plastic is everywhere in horticulture. Equally widespread is a desire to identify biological-based (bio-based) alternative materials for replacement of petroleum plastics in our industry. Among the most popular targets for alternative materials are the containers used for container-crop production.

While biocontainers aren't a new concept, our goal is to develop biocontainers made from bioplastics that have similar characteristics to the ubiquitous petroleum-plastic container. In the January and February 2014 issues of *GrowerTalks*, we reported on early phases of biocontainer research occurring at Iowa State University. Since then, we've updated our container design and suite of materials for manufacturing, and we've continued our evaluations and grower trials.

Container design and materials

In collaboration with one of our industry partners (VistaTek, LLC), we improved the design of our containers from prototypes to commercial-grade biocontainers. Based on our early biocontainer evaluations and continued development, we made two primary changes: 1) We added a "lip" to the container for improved handling, increased strength and increased head-space for watering; and 2) we added ridges to the bottom of the container to improve drainage and discourage pooling of water.

One of the most interesting aspects of our biocontainers is the assortment of bioplastics and biocomposites that we use to make them. This part of our research is widely applicable and provides opportunities to fulfill different grower needs depending on the formulation used for manufacturing. This phase of biocontainer development tested blends of six main biorenewable components: soy-based bioplastic (soy), polylactic acid (PLA), polyhydroxyalkanoates (PHA), lignin, dried distillers grains with solubles (DDGS) and BioRes (Laurel Biocomposite, LLC). The result was seven different bioplastic composites for evaluation and comparison with conventional petroleum-plastic containers. The formulations, appearance and attributes of the seven commercial-style bioplastic containers and petroleum-plastic control are shown in Figure 1.

We're often asked, "Which one of these is the best?" We've found it difficult to provide a one-size-fits-all answer, when different growers have different priorities, and our containers provide a variety of attributes. Do you want a container that looks, feels and acts just like conventional containers? We have a material that can fill that need, but it won't biodegrade in the landscape. Are you interested in a container that biodegrades and has a "natural" look? We have that container, too, though the durability of the material won't be as great when compared to conventional plastics. What about added functions beyond petroleum plastic? Some of our bioplastic containers provide fertilizer and improve root morphology.

In our quest for the next-generation, sustainable container, there may not be a “holy grail.” Instead, there may be several “righteous cups” made of different materials with unique attributes, strengths and key functions. We’ve found so much variation in the preferences of producers and consumers that we believe the biocontainer market can be segmented, rather than taking a “one-container-suits-all” approach.

Shuttle trays and container integrity

In our previous articles, we reported on the fertilization effect of some of the materials we used. With containers made of formulations that include soy-based bioplastics, macro and micronutrients are released and plants take them up similarly to those from controlled-release or water-soluble fertilizers. One of the drawbacks of the fertilizing pots is that they’re less durable than some bioplastics and become slightly brittle during crop production—drawbacks similar to those of bio-based fiber containers currently on the market. Results with our new commercial-grade biocontainers show that all of the material types meet or exceed the crush strength of petroleum-based pots after 10 weeks of greenhouse production and some of the containers are extremely strong and durable (Figure 1).

A large percentage of annuals produced in 4.5-in. containers are grown in shuttle trays to facilitate transporting and handling of crops. In a shuttle tray, the amount of moisture surrounding the container increases. To better understand how our biocontainers would hold-up to conditions typical of production in shuttle trays, we grew Honeycomb marigold in the eight container types in shuttle trays in a glass-glazed greenhouse for eight weeks (Figure 2). Plants were fertilized with 150 ppm N with each irrigation, and at the end of production, we conducted visual ratings and measured shoot weight.

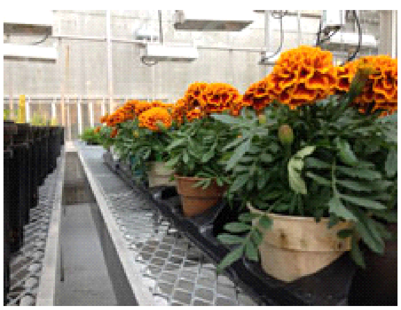

Figure 2. Honeycomb marigolds grown in 4.5-in. containers made with biopolymers and produced in shuttle trays.

Across container types, there were no containers that resulted in unacceptable plant quality. Marigolds grown in containers that included soy bioplastic were larger and darker green than those grown in the other container types, an effect resulting from the additional intrinsic fertilizer supplied by the container walls.

In addition to variation in plant growth, we found that the container strength and integrity differed after production. Containers made from PLA-lignin and Recycled PLA (resin only) were unaffected by the shuttle tray; they were as strong as the day they were placed into the experiment. Alternatively, containers with higher composite filler content, such as PLA-soy (60/40) and PLA-soy-BioRes (50/30/20), had lost some of their integrity and could be broken if they were handled harshly—an issue that should be considered if transportation and handling conditions might be severe.

There’s room for variation in container strength during production, but nobody wants to pick up a container and inadvertently break it during handling. While the strength of all seven biocontainers was sufficient for handling that's reasonably harsh, growers who use shuttle trays may want to select containers made from high-percentage PLA or PHA composites in order to ensure moisture doesn't compromise container integrity throughout production, transport and retail sale. Alternatively, growing crops with less irrigation can reduce the impact of shuttle trays for the less-durable container types and growers who don't use shuttle trays or have minimal shipping and handling could benefit from a wider selection of container options.

The appearance of some biocontainers was also affected by shuttle trays. In some instances, the area of the container that was surrounded by the shuttle tray was discolored when removed after production. Additionally, biocomposites with high filler content exuded or "bled" small amounts of bio-based plasticizers when containers initially absorbed some water, but stopped after a few weeks of production.

We're finding that the response to aesthetic appearance varies among producers and consumers. Some want their biocontainers to look just like conventional containers, while others want their containers to look "eco-friendly" to differentiate them from plastic containers. Dyes can be used to add color to biocontainers, however, consumers looking for eco-friendly containers prefer that all colorants be bio-based or that containers remain their natural color.

Conclusions

One of the primary reasons biocontainers have become popular is their ability to degrade after production. However, biodegradability of a container can impact its integrity during the greenhouse-production phase. Our experiments have shown that use of shuttle trays can affect both the integrity and appearance of bioplastic containers. Biocontainers made of high-percentage PLA or PHA and a lower percentage of composite filler, are highly durable and aren't affected by shuttle trays, but they degrade poorly after use. If you're interested in trying some of these new containers, they're now available through SelfEco: selfeco.com; (651) 342-5195. **GT**

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