GROWERTALKS

Features

12/30/2013

Bioplastics for Greenhouses —Soy What?

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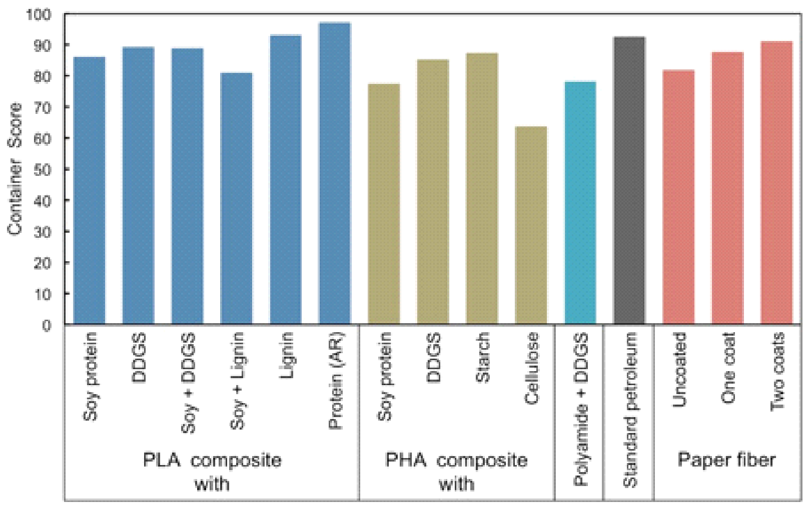

The widespread use of plastics in horticulture has become a hot topic of discussion over the last few years. Questions have risen concerning the environmental impact, low frequency of recycling and negative perceptions of the green industry related to our dependence on single-use plastic containers—with many searching for answers or solutions to the problem of petroleum-based plastic. Biocontainers currently being marketed are made from byproducts or co-products of agriculture and forestry. Many of the current biopots available are made from wood fiber, peat, paper fiber, wheat polymer and rice hulls. Some growers and retailers have adopted these products because they identify a value in producing plants in containers made of bio-renewable materials. However, there's increasing interest in new types of biocontainers; both growers and retailers are interested in alternative containers that function and look like current standard injection-molded petroleum containers. Bioplastics may be part of the solution.

Bioplastics are polymer materials that aren't petroleum based. Rather, bioplastics are biorenewable materials produced from biological products or co-products of biological processes. Some of the more popular bioplastics include compounds such as polylactic acid (PLA) and polyhydroxyalkanoate (PHA). These materials can be used like petroleum polymers for producing injection-molded containers. Additionally, these polymers can be combined with lower-cost bio-renewable materials such as corn stover, dried distillers grains with solubles (DDGS) or lignin to reduce the amount of bioplastic required to make the containers.

The project

In 2011, Iowa State University, the University of Nevada—Reno, the University of Illinois and The Ohio State

University received a USDA Specialty Crops Research Initiative (SCRI) grant to develop new and improved biocontainers for use in ornamental greenhouse and nursery production. The objective of the first phase of the project was to screen numerous bioplastics and biocomposites for use as sustainable materials that could function as well as or better than petroleum plastics for plant containers. The second phase is focused on selecting superior containers and materials that have been refined based on results of our evaluations.

The first phase, completed in 2012, evaluated 34 biorenewable polymers and composites and examined several factors, including: the processability of materials; the performance of prototype containers of each material during greenhouse production; the biodegradation of the materials in soil; and the effect of the degrading materials on garden transplants when the container was removed, crushed by hand and buried near the plant roots. Of the 34 biocontainer prototypes, 20 were injection-molded bioplastics and biocomposites, and 14 were containers made of natural fibers of coconut coir, peat, paper and wood that were dip-coated with one of four bioplastics. The second phase of development is nearing completion and will provide results of evaluations with 12 additional improved materials.

What we've seen

The injection-molded materials that performed well were polymers of soy, PLA and PHA, and composites of PLA and PHA with fillers of DDGS or corn stover. Adding the filler materials to make injection-molded composites improved the bioplastics in three ways.

First, it improved the processability of the bioplastics during injection molding. This will enable manufacturers to produce containers with these bioplastics more easily and will allow them to use existing manufacturing equipment to mold the materials.

Secondly, it increased the rate of biodegradation of used containers compared to the base polymer. By increasing the rate of degradation, biocomposite container materials "return to the earth" more quickly than the bioplastics without fillers.

Lastly, it reduced the cost of the material required to make the containers, without affecting the performance of containers in greenhouse and garden trials. (It goes without saying, both container manufacturers and greenhouse growers will benefit from these results!) While both PLA and PHA are available in commercial formulations, the amount of PLA that is produced and available for manufacturing is much greater than that of PHA and, as a result, PLA is available at a lower price.

One of the best-performing container materials during the first phase of the project was a blended bioplastic of 50% soy polymer and 50% PLA. This soy-PLA material provided a nitrogen-fertilizer effect that improved plant growth and health during greenhouse trials and improved growth and fruit production during garden trials with bioplastic degrading near plant roots. Growing in soy-PLA containers also improved the growth and structure of the plant roots. This added function has potential to reduce root circling, a common problem with plants grown in petroleum-plastic containers, and may improve transplant establishment in the landscape.

However, when containers were made with injection molded soy plastics alone, not blended with another bioplastic, plants and containers both performed poorly during the trials. First, the containers lacked durability and broke down during the production cycle. Secondly, they provided an excessive fertilizer effect that appeared to result in toxicity from excessive nutrient availability. Results of the second phase of evaluations suggest that bioplastic blends of PLA and soy-protein polymers will be top-notch materials for plant containers intended to degrade in soil or compost after use.

In addition to the strong showing by injection-molded bioplastics, fiber containers that received a coating of bio-based polyurethane produced good-sized, healthy plants and maintained container integrity and appearance throughout greenhouse production. However, when plants were grown in fiber containers coated with a different material, such as tung oil, they didn't perform well during the trials. One of the main advantages of using coated fiber containers, as opposed to uncoated ones, is that the plants are able to use water in the substrate more effectively, with less lost through the porous walls of fiber.

Our garden trials demonstrated that transplanting container-grown plants with the container intact on the plant roots slows plant establishment and growth, regardless of the container material. Based on these results, we would advise consumers who purchase plants grown in biodegradable containers to remove the plant from the container before transplanting, break the container into smaller pieces, place it in the planting hole, then install the plant. This will help the consumer enjoy better garden performance of plants grown in biocontainers, while reducing contribution to landfills

Future directions

From the initial phases of our research, we've identified several materials that would be great candidates for use in the greenhouse and nursery industry. Containers molded from PLA blends and composites seem especially promising as biorenewable alternatives to petroleum plastic. Currently two Minnesota companies are working together to bring
these products to market. VistaTek (www.vistatek.com), a manufacturer of injection-molded plastics, is collaborating with Aspen Research (www.aspenresearch.com), a bio-polymer producer, to produce 4.5-in. containers for the green industry that should be available this spring.

As with any change in cultural practices in the greenhouse, growers should perform some trials to see what works for them in their production scheme. For many of the types of biocontainers evaluated in our studies, greenhouse cultural practices would remain unchanged for growers adopting the alternative containers. However, for growers interested in using containers with soy protein in them, you'll have the opportunity to reduce the fertilizer applied to plants growing in those containers—more on that in next month's issue. **GT**

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