GROWERTALKS

Features

1/31/2017

Wood Substrates: The Plant's Perspective

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In November 2016, an article in *GrowerTalks* provided an overview of past and current trends relative to the use of wood components in greenhouse growing media. The overview was in response to the growing national and international trend of using wood products in growing media as an alternative to peat moss, perlite, pine bark or other commonly used materials. In that article, much was discussed about the reasons behind the evolution of wood substrate products. In this article, we wanted to provide a glimpse into some of the many trials that have been conducted and other in-depth scientific projects currently underway at North Carolina State University related to the development and commercialization of wood substrates.

From oranges to apples

There's been a tremendous amount of research conducted on wood substrates and substrate components over the past decade. The data and observations generated from those trials has been the foundation to all that we know today about the uses and potential of these substrate materials. While previous data is valid and has answered many questions (while generating many more), the learning curve for how to properly research, evaluate and characterize these materials has been steep.

As we understand more and more about the physical, chemical, hydrological and biological properties of wood materials, we have to continually evolve how we conduct our substrate research. Based on all that we've learned in the past decade, when conducting trials today we must consider many variables (many of which are potentially confounding) about wood substrate materials before we conduct specific trials to learn more about a specific question.

For example, we cannot design an experiment to understand fertility needs/issues (i.e. nitrogen immobilization) without considering and accounting for pH differences, liming adjustments, porosity variations, water/irrigation management, potential toxicities, etc. of the wood materials being tested compared to whatever control is being used. When these variables are known, considered and minimized as much as possible, we get closer to comparing "apples to apples" as opposed to "apples to oranges" when comparing plant growth and substrate performance.

Anytime data is presented (at trade shows, education sessions, company advertising, marketing

propaganda, etc.) that shows plant growth differences or similarities as it relates to substrate performance or comparison to other products, it's important to keep in mind—and ideally ask the person presenting the data—what the conditions were that the crops were grown under (were all variables the same?), and if the results were obtained from comparing "apples to apples" or "apples to oranges."

All wood isn't created equal

In this article, we'll highlight some general observations and points-of-interest from various trials conducted in 2016 on wood components in greenhouse substrates. Before presenting any results, it's very important for us to "address the elephant in the room" as it relates to research results and findings, and say that based on the large variation that exists in wood materials/components, all data and results aren't "absolute" for everything and can vary based on the type of wood being tested, the method of production (mechanical harvesting of trees and processing of the wood feedstock), type of tree/wood being tested, etc.

With that being said, Lesson #1 is that currently wood is NOT wood is NOT wood when comparing different products/materials. If, however, you as a grower are purchasing wood substrate materials from a manufacturer or distributor, the product SHOULD be consistent in its properties and performance. One of the many advantages and benefits of wood components is that they ARE different and can be manufactured in different ways to create different products with different uses (Figure 1).

Figure 1. Wood substrate components vary in particle size and shape as a result of different manufacturing methods.

One plant growth trial from 2016 evaluated four different wood substrate components to test the variation in product performance when blended with peat moss at rates of 10%, 20%, 30% and 40% (by volume). An 80:20 peat:perlite substrate was used as the control (Figure 2). In this trial, special attention was given so that each wood component was properly blended into the peat moss base. This is important because all wood materials don't blend with peat the same way, therefore, proper blending is very important.

Figure 2. Geranium growth in peat-based substrates containing 10% to 40% wood component additions from four different wood substrate suppliers.

Each substrate blend (four products x four rates = 16 total) also had its pH adjusted individually to a target of 5.8 based on what we know, which is the following: wood materials have higher pH than peat, pHs vary across wood products and pH buffering is different in wood than peat and changes in the blended substrate as the percents of each component changes (increase or decrease). For this particular experiment, all plants were fertilized with 200 ppm nitrogen from a 20-10-20 Peters peatlite special. Special attention was also paid to the irrigation of all plants so that none were over- or under-

watered. Irrigation timing, volume and frequency is a difficult, and often confounding, variable in substrate research and ideally should be managed independently from any other variable being tested or evaluated.

The results from this one trial with geraniums provided interesting data on the variability in plant growth in different wood materials. Wood components from sources 1 and 2 produced plants in all blends (10% to 40% wood) that were equal in size to the control plants grown in a traditional 80:20 peatlite mix. Contrary to those results, wood sources 3 and 4 were, for the most part, smaller in size and overall visual quality at all rates of incorporation (10% to 40%).

Does this mean that wood from sources 3 and 4 are bad? Not necessarily. What this one experiment shows is that there's variability in wood products based on the parameters we chose to grow them under. It's our opinion that, as long as there are no toxicity issues, management strategies can/could be modified to improve the performance of substrates from sources 3 and 4. The differences may be due to the particle size of the wood materials, age, physical properties, etc.

What these results do show is that plant growth isn't always the same and that all wood materials don't perform the same under the same conditions. It also further illustrates, as have dozens of trials over the years, that plants can be grown in substrates containing a significant percentage of wood at the same rate and quality as traditional peatlite substrates. When you factor in potential modifications to fertility, pH and irrigation, it's highly conceivable that substrates with higher percentages of wood can indeed be used successfully. This was shown to be viable years ago, and even today, there are efforts being made to increase the percent of wood used to go over 50%.

Other observations

In other trials from 2016, we continually noticed that as the percent of wood component increases in peat-based mixes, the irrigation and drainage profiles of the substrates change—a topic that no doubt needs much work and further understanding, as this is a critical facet of crop production and management.

Relating to irrigation and water management, anther common observation has been the quickness to wilt of plants grown in substrates containing wood (above ~20%) compared to plants in traditional peatlite mixes (Figure 3). Plant wilting is typically not an issue during production as long as irrigation is managed properly, but what about post-production shelf life of crops? That's an area we at NC State are very interested in and focused on understanding more about. The wilting of plants in wood substrates has been seen many times over the past decade in many crops (woody and herbaceous). The reason for this occurrence likely has to do with water-holding capacity, water release patterns of the wood substrate materials and the propensity for enhanced root growth in substrates containing wood.

Figure 3. Plants grown in substrates containing high percentages of wood components can have different irrigations requirements and dry-down timing. In this photo, the plants on the right have 0% wood fiber additions, the middle row has 20% wood fiber additions and the plants on the left have

40% wood fiber additions.

Lastly, an important point to pay attention to when using substrates containing wood components (especially at higher rates) is the tendency for high pH issues. As previously discussed in this article, the pH of wood coupled with the lower pH buffering capacity of wood means that pH adjustment (lime rates) often have to be adjusted (lowered) accordingly. When lime rates aren't decreased from what's standard practice for peat substrates, pH during crop production can easily rise above 7.0 or 7.5 and become a serious issue especially for pH-sensitive crops like petunia. Much work is currently underway to better understand and address the pH-related issues.

There's currently a great need in our industry for information about the use/adoption of wood substrate materials, and because of that, we as substrate scientists are trying to gather data and answer questions at warp speed to meet the demand of substrate manufacturers and growers.

To put things in perspective, peat has been researched for 50 years and research continues today on its use in horticultural applications. We're barely scratching the surface on knowing all we need to know and understanding all of the potential benefits/issues/possibilities of wood substrates. BUT we now know what the questions are that need to be answered and we know better today how to properly and scientifically generate that information. **GT**

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