Wood Substrates: How Long Can They Go?

Here's a closer look at recent research on the long-term viability of wood when used as a substrate mix.

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Note: This is the second article in a two-part series highlighting observations and research findings on the stability, decomposition, and longevity of soilless substrates containing wood products. Go to ***GreenhouseGrower.com/tag/oct2020*** *or the October 2020 print issue to read the first part of the series.*

Figure 1: **The root balls of plants grown in 100% wood substrates show that wood particles often do not change color even over several months in production.**
Photos: Brian Jackson

Stability is needed, or at least desired, in nearly all aspects of our lives. The same can be said for plants growing outdoors in soil, or certainly plants growing indoors in some type of soilless culture system.

Stability for plants comes in the form of a highly functioning root ball or environment that provides the structural support and critical inputs needed for growth (water, air, nutrition). Plant culture systems that utilize inorganic materials (perlite, pumice, rock/mineral wool, grow stones, baked clay pebbles, etc.) are at an advantage when it comes to stability over time (not decomposing), which can alter the root zone environment in a negative (or less than optimal) way, and an advantage in the potential of being reused or repurposed in future cropping cycles.

However, there are also many benefits that drive the utilization of far greater volumes of organic materials in soilless substrates, namely cost, abundance, availability, sustainability, chemical properties, and biological properties. In this article, we will highlight some of the past and current data from research trials that have monitored and assessed the degradation of one particular organic substrate component — wood.

How Wood Substrates Became Viable

Factors that directly influence the speed and rate of microbial decomposition of organic matter include 1) chemical composition of the material, including percentages of cellulose, hemi-cellulose, and lignin; 2) nutrient availability, primarily nitrogen, for microbes to metabolize in the degradation process; 3) temperature and moisture of the substrate material; and 4) particle size of the organic materials. When thinking of a greenhouse environment, several of these variables are readily present in container substrate systems so these indoor environments can accelerate microbial degradation at a high rate.

One of the reasons wood products have made the cut as a viable and now mainstream component in many substrates is the seemingly acceptable level of structural stability that these materials offer. Not to be confused with sawdust materials, which can and likely will degrade rapidly (depending on species and particle size), the engineered wood components being produced and used today have shown to be suitable for use in substrates for short- and long-term crops.

Based on the advancements made in wood substrate engineering, handling, and formulation, most wood materials do not have any significant or noticeable degradation, and many times there is not even a change in color after being in a container for several weeks to several months (Figure 1, page 24). Color change can and will occur, however, when wood products are processed or blended with other materials like peat or aged bark due to staining/discoloring. If the species, age, particle size, or amendment to wood substrates is not correct, there can be degradation that impacts plant growth. It is for these reasons that numerous trials have been conducted over the past several years with the goal of understanding how, when, and under what conditions wood stability is compromised due to microbial degradation.

It is important to note that in the early years of wood substrate research, these materials were being tested at 100%. The belief was, if we can understand how 100% wood materials behave during crop production, then any lower percentage of wood used with peat or bark would be even easier to manage, and if there was degradation, the rate and severity would be less. Currently, wood inclusion rate is between 20% and 50% for the majority of greenhouse growers. Based on the need to understand stability of substrates with lower percentages of wood, several experiments have been conducted.

Figure 2: **Poinsettias grown in 6½-inch containers for four months retain their stability, as do poinsettias grown in 10-gallon containers for 15 months.**

Trialing in Poinsettias

For greenhouse crops, poinsettias represent a plant with one of the longer production times. For this reason, this plant has been used in numerous studies to test various physical and chemical properties of substrates that contain wood. In the production of poinsettias in 6½-inch pots, substrates containing wood had no significant shrinkage, volume loss, or effect on plant growth (Figure 2). Substrates ranging in wood percentage of 20% to 100% were evaluated, and all were assessed to be as stable as the peatlite (80:20) control over the course of the trial. Poinsettias grown in a pine tree substrate were then potted into 10-gallon containers and grown for an additional year to assess the long-term stability of the root balls (Figure 2). These large poinsettias had 6% more root ball volume loss (substrate loss) than plants in the peatlite control after a total of 15 months. No differences in plant growth or flowering were recorded in that trial.

It was summarized that the pine tree substrate used in this trial had adequate particle size to sustain the long production time. It was also concluded that the wood did degrade more than peat under those conditions, but the volume loss was not more substantial due to the plant's roots filling the voids of the slowly degrading substrate, allowing the root ball to remain firm, not soft or rotting, and intact when the pot was removed.

Wood degradation can begin once the trees are harvested. It has been discovered that the handling of freshly harvested pine logs (Figure 3A), trees that have been chipped and stored (Figure 3B), and processed wood substrate materials stored outdoors (Figure 3C) or indoors (Figure 3D) is very important to secure the maximum

Figure 3: **Storage and environment can affect wood stability beginning as logs (A), wood chips (B), or processed and stored outdoors (C) or indoors (D).**

stability and quality of the final wood substrate products. Once processed, wood materials can be dried and stored for years without degradation or loss of quality. If not dry, biological changes can occur. Much is to be learned regarding the processing and potential storage conductions and durations for 100% wood substrate materials. All current indication is these materials can be stored and stable as long or longer than any other organic substrate component being used.

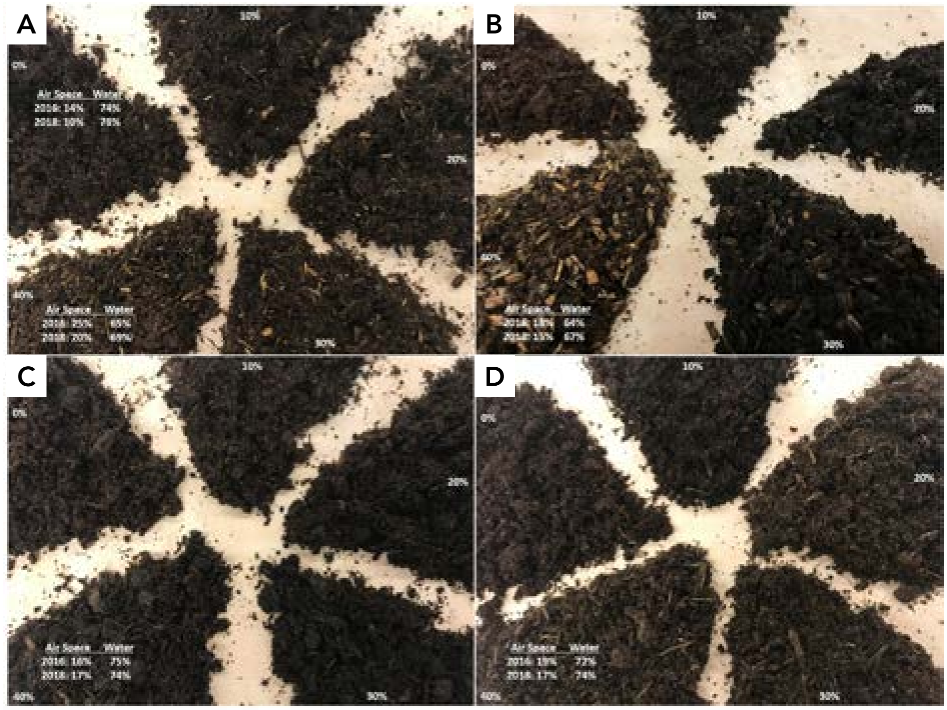

Figure 4: **Here are the results of a two-year substrate stability study evaluating peat moss amended with 10%, 20%, 30%, or 40% hammer-milled pine tree substrate (A), pine wood chips (B), disc-refined ForestGold (C), and extruded GreenFibre (D) with physical property changes shown for the 100% peat and the 40% blends of each wood product.**

Storage Studies

An incubated substrate experiment was conducted at North Carolina State University (NCSU) in the Horticultural Substrates Laboratory from 2016-2018 where we looked at the storage properties and change in physical properties of peat-based substrates amended with 10%, 20%, 30%, or 40% (by volume) of several wood materials, including two hammer-milled products, one disc-refined commercial wood fiber (ForestGold, Pindstrup), and one extruded commercial wood fiber (GreenFibre, Klasmann). The pH of these substrate blends was adjusted to 5.6, moisture content was adjusted to 60%, and they were stored in sealed plastic bags in a controlled environment indoor chamber. No fertilizer (nitrogen) was added.

Substrates were analyzed for physical properties using the NCSU Porometer method immediately after preparation, and again two years later. Presented in Figure 4 are the before-and-after air and water values (percentages) of the 40% wood inclusion rate. Only the 40% is reported, as this was the highest percent wood and thereby should show the most degradation. Data from all other percentages and wood product treatments was recorded as well.

Overall, the substrates had a decrease in air space and an increase in water-holding capacity due to a decrease in particle size over time. It is believed that the addition of nitrogen and increase in storage temperature would have greatly increased the degradation rates of these materials. These data provide support that professional mixes can be stored without nitrogen for long periods of time with no significant changes to the physical properties of the mixes. For retail, substrate mixes that include nutrient packages and other additives are not expected to store as well for as long with no negative changes.

Current research efforts are underway at NCSU to evaluate the breakdown rate of multiple organic substrate materials, including several wood products, European and Canadian peats, coconut materials, pine bark, and Miscanthus. Each material is being trialed at various particle sizes to cover the range of products currently used in container substrates, being that particle size is one of the most important and influential factors in substrate decomposition and stability. These greenhouse trials are being conducted in gallon-size containers with nitrogen amendments and periodic irrigations to simulate product conditions, which stimulate microbial activity and substrate degradation. Substrates in the trial are sampled every three months for 15 months, after which we will determine the respective stability indices for each particle size of each material tested. It is our hope that these data can be the basis of future trials (and understanding) to construct and evaluate the best substrates for long-term crop (fruit trees, ornamentals, etc.) production in the future.

Highly functioning and stable substrates are the foundation of soilless crop production in numerous growing systems around the globe. With innovative thinking, novel research, and tweaked cultural management plans, it is the goal of scientists, substrate manufacturers, and growers to continue improving on the current substrates used today and more importantly have the knowledge and confidence to construct the substrates of the future. GG