Pine Tree Substrates for Greenhouse Crops

By Brian E. Jackson

A process for grinding pine wood into growing substrate, patented by Virginia Tech and researched at North Carolina State University, shows strong promise for commercial operations through plant trials.

Research with wood substrates that began in the Department of Horticulture at Virginia Tech in 2004 has focused on grinding pine trees as a new container substrate often referred to as pine tree substrate (PTS). I was a member of that research team as a graduate student, and now that I have moved into a research faculty position at North Carolina State University I have brought the PTS research to a department with a rich history and reputation for work with container substrates. The interest in wood-based substrates has precipitated many unanswered questions for growers and scientists across the country. This article reports some of the current information on PTS research, including an overview, plant growth trials, long-term crop production in large containers and patent issues.

Pine tree substrates can be produced from freshly harvested pine trees — Loblolly pine has been researched the most, but eastern white pine shows promise — that are chipped and ground in a hammer mill.

Description and Background

Pine tree substrates can be produced from freshly harvested pine trees that are chipped and ground (with or without bark, limbs and needles) in a hammer mill. No plant growth difference was observed with the inclusion of bark, limbs or needles compared to growing in pine wood only. Loblolly pine (*Pinus taeda*) has been the most promising and heavily researched pine species for substrate production, but current research has also shown the successful use of eastern white pine (*Pinus strobus*) as a PTS, which greatly expands the potential of producing PTS further into the Northeast. Pine trees from forest-thinning operations are normally the source of pine wood chips, which are most often used in pulp/paper production, but pines of any age can be harvested and processed into substrates. Pine plantations could likely even be specifi-

cally planted and harvested solely for substrate production; in other words, these facilities could conceivably grow their own substrate.

Marigold root growth is equally healthy in pine-bark substrate as in wood chips.


Healthy root system in poinsettia


Healthy root system in salvia

Plug germination and seedling growth similar in PTS and peat-lite mix

Plant Growth Trials

There have been many successful growth trials of crops grown in PTS in the past five years, including three genera of greenhouse crops, 14 genera of bedding plants, and eight genera of herbaceous perennials. Begonia plants are uniform and similar in growth, both early and late in the production cycle, compared to plants being grown in peat or pine bark mixes (PTS-grown plants require an additional 100-ppm nitrogen during production). Root growth of herbaceous plants grown in PTS is equal — and most often considerably better — than root growth of the same plants grown in peat- or bark-based substrates. Root growth of marigold is healthy and prolific in 100 percent wood chips as well as in 75 percent wood chips compared to root growth in 100 percent pine bark. Other examples of healthy root systems and rootballs are shown with poinsettia and salvia.

Based on our years of research and observations, adding lime is not required for PTS thanks to the inherently high pH (about 6.0) of freshly harvested and ground pine wood. Poinsettias grown in PTS with various amounts of limestone additions showed no statistical improvement in growth. The higher/acceptable pH of PTS without liming seems to be the case only when PTS is produced from pine trees that are processed into substrate within two months of being harvested, or when PTS is produced from freshly harvested trees and stored (as substrate) for up to two months before being used in production. Further studies indicate that after two months and up to one year of storage (as logs or as substrate), the pH of the wood deceases and lime additions are needed before use in production. PTS has shown to be weakly buffered (does not resist pH change), so only low amounts of lime (1.5-3.0 pounds per cubic yard) are needed to raise the pH from about 3.5 to 5.5-6.0. It's also important to note that because PTS is often amended with peat moss or aged pine bark (to improve physical and chemical properties), lime is required in proportion to the ratio of peat moss or pine bark added.

Other initial growth trials have shown the successful use of PTS for seedling/plug production of several bedding plant species, with germination and seedling growth similar to that of peat-based substrates. Initial studies have also shown the successful use of PTS for cuttings of poinsettia and chrysanthemums. Additional work is needed to more thoroughly investigate the most appropriate PTS mixture (e.g., particle size, peat moss addition, irrigation/misting) for propagation of greenhouse and nursery crops.

Long-Term Potential and Stability

To evaluate PTS in long-term production, poinsettia cuttings were grown in either 100 percent PTS or an 80 percent peat and 20 percent perlite (peat-lite) substrate for 17 months. Plants were grown in 3-quart pots for the first six months then stepped up to 3-gallon containers for six months, then they went into 15-gallon containers for the final five months. Plant growth at all stages (six, 12 and 17 months) was equal in both substrates (additional 100-ppm nitrogen in PTS) and the bract floral quality (number and size) was also equal in all plants regardless of substrate. Substrate shrinkage was also similar between PTS and peat-lite at the end of each stage, particularly interesting for the 15-gallon rootballs that were solid and completely intact. Post-production quality (e.g., time to wilting, bract color and longevity, leaf retention) also was similar for plants in both substrates for both years (2007 and 2008) of floral display. When removed from a one-gallon pot after receiving fertilized and irrigated conditions for 12 weeks in a greenhouse, the pine wood retains its particle structure and stability in a container very well.

Alternative Constructions

Research has shown benefits of a PTS constructed by amending ground wood chips with 25 percent of either pine bark, compost, or peat moss. Doing so results in reduction of PTS production costs, improved physical and chemical properties of PTS, and the creation of a dark-colored PTS similar to traditional substrates, which may be a desirable criteria because of consumer preference/expectation. Conversely, some growers are amending peat-based substrates with wood chips as a replacement for pricey perlite. Growers and some substrate companies that have conducted plant growth trials are replacing up to one-third of their peat with PTS, in

Patent Issues for PTS Processes

The process of grinding wood (regardless of the species) for the specific purpose of using the material as a substrate for plant growth is patented by Virginia Tech. There has been much discussion in the industry about how this patent will prevent substrate companies and/or individual growers from developing nursery substrates using wood chips (or other wood-based materials), without approval from and royalties paid to Virginia Tech. One of the major claims of the patent is that a wood substrate must have at least 0.5 percent of the wood chip particles (substrate) having a size of 0.05 mm or less. Based on previously reported data, and my most recent unpublished data, to have this amount of fine particles (below 0.05-mm) would require wood chips to be ground in a 3⁄32-inch or less hammer mill screen. Current research shows that it is uneconomical or practical to grind wood this finely, hence the addition of other materials (such as pine bark, peat and compost) to add those fine particles to give the much-needed water-holding capabilities of a substrate. It is for this similar reason, as stated in the patent, that sawdust is excluded as a part of the patent because it does not have the amount and size of fine particles needed. Therefore, based on research results, if a wood substrate is produced that contains 0.5 percent of its volume in particles 0.05-mm or less, the patent is applicable, and appropriate actions should be taken to respect the patent and its potential licensing requirements. Conversely, if a wood substrate (derived from any species) is produced with larger screens (particles) and constructed using current methods partially outlined in this article (mixing with 25 percent peat moss for example), it is extremely doubtful that the substrate will have the particle range outlined by the patent. To be certain, it is suggested that a particle size distribution analysis be conducted to determine these percentages on wood substrates, or contact the appropriate sources to seek clarification.

Begonias planted in PTS and traditional substrates

addition to testing it as a 100 percent substrate.

Commercialization Efforts

As a result of grower interest in PTS (and wood substrates in general), an effort has been under way with a number of growers to test PTS on a wide range of greenhouse crops. Commercial substrate producers also see the potential of PTS as a viable container substrate that could reduce the costs of substrates for their clients. It is our goal to work with these companies to evaluate PTS for commercial production and marketing. The opportunity also exists for larger growers (greenhouse and nursery), or a consortium of smaller growers, to purchase a hammer mill and produce PTS for themselves where pine chips are available. GPN

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Dr. Brian E. Jackson is assistant professor of ornamental horticulture in the North Carolina State University's Department of Horticultural Science. He can be reached at brian_jackson@ncsu.edu. ***For more information on pine tree substrates (PTS) and other wood substrate research, in addition to a full listing of publications about these substrates, visit www.ncsu.edu/project/woodsubstrates.***

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