Wood Substrates Derived From a Variety of Tree Species Affect Plant Growth

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Significance to the Industry: This research demonstrates that loblolly pine (*Pinus taeda*) is a preferred species for production of a wood-based container substrate compared to a number of other softwood and hardwood species. Loblolly pine is comparatively lower in polyphenolics which may be toxic to tender seedlings.

Nature of Work: For the past 30 years peat moss and softwood bark have been the main constituents of container substrates in the horticulture industry. Peat moss is especially important in the industry because it is a stable material, light weight, and readily available. However, peat moss is a non renewable resource, and it is mined out of wetlands which raises ecological concerns. The cost of peat moss is also increasing due in part to the increased cost of transportation. Softwood bark of consistent quality is sometimes difficult to obtain and will be less available in the future (2) due to increased burning for energy and the movement of the timber and paper industries to other countries. Chipped loblolly pine logs have been shown to be a potential substitute for peat moss and softwood bark as a container substrate (6). However, before the product can be commercialized there seems to be some inconsistencies that need to be addressed. One of these is the presence of toxins. In some studies using hardwood sawdust as a medium, it was found that wood contained phytotoxins that affected the growth of plants (3,4). Most tree species produce these phytotoxic substances; however, some produce more than others. We have evaluated the growth of tomato seedlings in substrates prepared from 11 different tree species, showing that growth was dramatically different between the substrates (unpublished data). The purpose of this study was to determine if differential growth in substrates from different tree species could be related to the relative amounts of polyphenolics in different tree species.

Logs from the following species—loblolly pine (*Pinus taeda*), white pine (*Pinus strobus*), sycamore (*Platanus occidentalis*), red maple (*Acer rubrum*), and white oak (*Quercus alba*)—were harvested in mid-January 2006, debarked, ground in a hammer mill to pass a 4.76 mm (3/16 inch) screen, and amended with 0.6 kg/m^3 (1 lb/yd^3) $CaS0_4$. On February 16, 2006, 3 cm (1.2 inch) tall seedlings of 'Better Boy' tomato (Lycopersicon esculentum) were planted in each substrate in 1-quart containers, and fertilized at each watering (250 mL beaker-applied) with a 200 ppm N solution from a 20N-4.4P-16.6K fertilizer (20-10-20 Peat-lite, Scotts Company, Marysville, OH). There were six plants per treatment. Substrate solution was extracted using the pour-through method (5) on February 28, and analyzed for pH and electrical conductivity (EC). On March 16 plants were severed at the substrate surface, dried, and weighed. To determine the relative amount of polyphenolics that exist in each substrate, total soluble polyphenolics were extracted from four 0.75 g samples of each tree species by soaking in 50 percent methanol for 1 hour at 77º C and filtering. The polyphenolics were determined colorimetrically with a Folin-Ciocalteu reagent according to Anderson and Ingram (1) and expressed as percent dry weight.

Results and Discussion: Plant growth was highest in loblolly pine, intermediate in sycamore and white pine, and lowest in red maple and white oak (Figure 1). The dry weight data is closely correlated with the levels of polyphenolics extracted from each species; substrates that produced the highest growth had the lowest levels of polyphenolics with the exception of sycamore. Sycamore had the same amount of polyphenolics as loblolly pine but lower growth than loblolly pine. However, for the first two weeks, plant growth in sycamore was equivalent to the loblolly, reflective of similar levels of polyphenolics, but by the third week plant growth in sycamore had slowed. The differential in growth rate between sycamore and loblolly pine as time passed is probably due to microbial N immobilization associated with the decomposition of the sycamore. At the end of the experimental period, the root ball of sycamore was black indicating decomposition was well under way compared to the loblolly substrate which remained light tan in color. As well, the substrate solution EC of sycamore was 0.47 dS/cm compared to 1.33 dS/cm for loblolly pine, another indication that microbial immobilization of N was occurring which could account for the lower growth of sycamore compared to loblolly pine. Nitrate N has been shown to be highly correlated with the EC of a substrate solution. We conclude that differential levels of polyphenolics in different tree species may affect their suitability as a container substrate for small herbaceous seedlings. In addition, N immobilization may also be a factor in the suitability of a tree species as a container substrate. Of the trees tested in this current experiment and a former unpublished experiment—loblolly pine (*Pinus taeda*), white pine (*Pinus strobus*), Virginia pine (*Pinus virginiana*), white oak (*Quercus alba*), sycamore (*Platanus occidentalis*), ash (*Fraxinus americana*), locust (*Robinia pseudoacacia*), red maple (*Acer rubrum*), tulip poplar (*Liriodendron tulipifera*), black walnut (*Juglans nigra*), and poplar (*Populus* sp.)—loblolly pine has proven itself to be the best option. Further research needs to be done on how to mitigate the effects of the polyphenolics on plant growth and the role of microbial N immobilization on N availability with substrates produced from trees.

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Figure 1. Shoot dry weight of marigolds grown in wood substrates derived from five different tree species and the corresponding polyphenolic contents of each tree species.