

Nitrogen Immobilization in a Pine Tree Substrate During Short Term Crop Production

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Significance to Industry: Pine tree substrate (PTS), peat-lite (PL), and pine bark (PB) were tested for nitrogen (N) immobilization during a 10 week experiment. Results indicate that PTS has a higher occurrence of N immobilization over 10 weeks compared to PL and PB, which helps to explain the additional N requirement in PTS during crop production compared to PL and PB. Despite the higher fertilizer requirement, the potential for PTS to be successfully used in greenhouse and nursery crop production is evident in the promising results that have been reported in recent years.

Nature of Work: Alternative substrates have been evaluated in the U.S. and throughout the world for many years. The need for new substrates is in response to the increasing costs, reduced availability, and environmental issues surrounding the use of traditional PL and PB substrates. Many of the currently researched substrates are derived from wood-based materials. The biggest concern with wood substrates is their requirement for higher N fertilizer applications to achieve optimal plant growth (3). Jackson et al., (3) reported that Japanese holly and azalea required an additional $1.8 \text{ kg}\cdot\text{m}^{-3}$ ($4 \text{ lb}\cdot\text{yd}^3$) of controlled release fertilizer when grown in PTS to achieve comparable growth to plants grown in PB. Greenhouse crops have also shown the need for additional fertilizer based on work by Wright et al., (7) who reported that chrysanthemums grown in PTS required an additional 100 ppm N to perform as well as plants grown in a commercial PL substrate. It has been hypothesized that N immobilization is the primary reason for the lower nutrient levels that are reported in growth trials when using PTS, but it has not been proven (6, 7). Numerous authors have reported that N immobilization occurs in wood substrates during the production of horticulture crops (1, 2) however, no studies have been conducted on PTS to evaluate its N immobilization occurrence.

The objective of this work was to determine the amount of N immobilization occurring in PTS compared to PL and PB. Pine tree substrate was produced by taking pine chips from coarsely ground pine logs (freshly harvested) and further grinding them in a hammer mill (Meadows Mills, Inc., North Wilkesboro, NC) to pass through a 2.36-mm (3/32 inch) screen. Pine tree substrate was pre-plant incorporated with $0.6 \text{ kg}\cdot\text{m}^{-3}$ ($1 \text{ lb}\cdot\text{yd}^{-3}$) calcium sulfate (CaSO_4). Pine bark and PL were pre-plant incorporated with $2.7 \text{ kg}\cdot\text{m}^{-3}$ ($6 \text{ lb}\cdot\text{yd}^3$) dolomitic lime and $0.6 \text{ kg}\cdot\text{m}^{-3}$ ($1 \text{ lb}\cdot\text{yd}^{-3}$) CaSO_4 . Pine tree substrate was not amended with lime due to its inherently high pH (6.0-6.5). Eighteen plastic 2 liter (2 quart) containers were filled with each of the substrates in Aug. 2007 and placed on a greenhouse bench in Blacksburg VA with average day and night temperatures of 24/19 °C (75/66 °F). All containers were equally fertilized once weekly with 300 ppm N

derived from calcium nitrate [Ca(NO₃)₂] which supplied 150 ppm N, and potassium nitrate (KNO₃) which supplied the remaining 150 ppm N, as outlined by Handreck (2). Every two weeks, three containers (reps) of each substrate were prepared for nitrate determination and then incubated for four days at room temperature. After incubation, nitrate concentrations were determined again on substrate samples from the same containers. The difference between day 0 (initial) and day 4 is the amount of nitrate immobilized during incubation of the substrate samples. Daily and weekly immobilization levels were determined from this data. Data were collected for 10 weeks and the experiment concluded in late Oct. 2007. The experimental design was completely randomized with 18 replications per substrate for a total of 54 substrate filled containers. Data were tested using the analysis of variance procedures of SAS (version 9.1 SAS Institute, Inc. Cary, NC). Data were also subjected to regression analysis using SigmaPlot (version 9.01 SPSS, Inc., Chicago, IL)

Results and Discussion: Results show that PTS has significantly higher levels of N immobilization occurring over 10 weeks than does PL and PB substrates (Figure 1). Peat-lite had the least amount of N immobilization occurring over the course of the experiment followed by PB. Peat-lite had increased immobilization between weeks 0 and 2 and then levels decreased through the end of the experiment (Figure 1). Immobilization in PB increased slightly over the duration of the 10 week experiment while immobilization in PTS increased through 4 weeks and then decreased through the end of the experiment. Even though immobilization levels decrease in PTS over time, levels remain higher than those of PL and PB throughout the 10 week experiment. The trend indicates that over a longer production period, the amount of N immobilized in PTS may be reduced to levels observed for PB substrates. This data helps to explain the lower substrate solution nutrient levels previously reported in PTS (3, 5, 6, and 7). The reason for decreased immobilization in PTS is likely due to a decreased rate of decomposition of the wood in PTS over time. The early stage of wood decomposition generates a large microbial biomass that consumes the easily degraded wood components (hemicellulose, soluble carbohydrates, etc.), but later in the decomposition process the amount of easily degraded wood components decreases resulting in decreased microbial populations, thereby decreasing the amount of N needed for microbial activity (less N immobilization) (4).

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Figure 1. Calculated nitrogen immobilization in peat-lite (PL), pine bark (PB), and pine tree substrate (PTS) over 10 weeks when fertilized weekly with 300 ppm N.

