# Special Research Report 523: Production Technology

## Comparison of Nitrogen Immobilization, Substrate Carbon Dioxide Efflux, and Nutrient Leaching in Peat-Lite, Pine Bark, and Pine Tree Substrates

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## BACKGROUND

Pine tree substrate (PTS) produced by grinding pine trees to a particle size suitable for adequate water holding capacity has been shown to be a suitable container substrate for a wide variety of woody and herbaceous greenhouse crops, but extra nitrogen is required during crop production in PTS when compared to peatlite (PL; 75% peat:25% perlite) or pine bark (PB). Non-composted wood contains large amounts of degradable carbon (C) compounds, but only a small amount of nutrients are available for decomposing microorganisms. This results in a draw-down of the substrate nutrients. Most nursery and greenhouse producers base their fertility management on previous growing experiences with PL and PB substrates. Therefore, traditional greenhouse fertility practices may not be applicable when growing crops in PTS in light of: (1) the higher fertilizer requirements, (2) limited understanding of N microbial immobilization timing and rate, and (3) the unknown leaching potential of nutrients from PTS. Determining the extent and timing of N immobilization and nutrient leaching in PTS must be determined for accurate nutrient management (application timing and rates) strategies when producing plants in PTS. The objectives of our studies were: (1) to compare N immobilization, (2) to determine the substrate $CO_2$ efflux (a measure of microbial activity), and (3) to measure nutrient leaching rates in PL, PB, and PTS over time under greenhouse conditions. Substrate shrinkage was also assessed.

## MATERIALS AND METHODS

The PTS was produced from chipped loblolly pine logs (*Pinus taeda*). Substrates used in this study were PTS ground through a 2.38-mm hammermill screen, PL, and aged PB. A 28-day N immobilization study was conducted on substrates fertilized with 150 or 300 $mg \cdot L^{-1}$ $NO_3$-N. Substrates were incubated for four days after fertilizing, and $NO_3$-N levels were determined at the start and end of the incubation. A second 10-week study was conducted to evaluate the amount of N immobilized in each substrate when fertilized with 100, 200, 300, or 400 $mg \cdot L^{-1}$ N. In addition, substrate carbon dioxide ($CO_2$) efflux ($\mu mol\ CO_2 \cdot m^{-2} \cdot s^{-1}$) was measured as an assessment of microbial activity, an indication of N immobilization. A leaching study on the three substrates was also conducted to determine the amount of nitrate nitrogen ($NO_3$-N), phosphorus (P), and potassium (K) leached over 14 weeks under greenhouse conditions.

## RESULTS

Nitrogen immobilization was highest in PTS, followed by PB and PL in both the 28-day and the 10-week studies (data for 300 ppm N are shown in table 1). Nitrogen immobilization increased as fertilizer rate increased from 100 mg·L$^{-1}$ N to 200 mg·L$^{-1}$ N in PL and from 100 mg·L$^{-1}$ N to 300 mg·L$^{-1}$ N for PB and PTS, followed by a reduction or no further increase in immobilization when fertilizer rates increased beyond these rates. Nitrogen immobilization was generally highest in all substrates two weeks after potting, after which immobilization tended to decrease over the course of several weeks. There was a smaller decrease for PTS compared to PL and PB. Substrate $CO_2$ efflux levels were highest in PTS followed by PB and PL at each measurement in both the 28-day and 10-week studies (data not shown). Patterns of substrate $CO_2$ efflux levels (estimate of microbial populations) at both fertilizer rates and over time were positively correlated to N immobilization occurrence during the studies. Nitrate leaching was lower in PTS than in PB or PL (Table 2).

## CONCLUSIONS

This research provides evidence of increased microbial activity and N immobilization in PTS when compared to PB and PL. Increased N immobilization in PTS explains the lower nutrient (primarily N) levels observed in PTS during crop production, and justifies the additional fertilizer required for comparable plant growth to PL and PB. This research also provides evidence of less $NO_3$-N leaching in PTS compared to PL or PB during greenhouse crop production in spite of the higher fertilizer rates required for optimal plant growth in PTS. Even with increased N immobilization and microbial activity in PTS, no visual difference in substrate shrinkage was observed in PTS compared to PL or PB in any of these studies.

**Table 1.** Nitrate N (mg) immobilized during 4-day incubation at week 0, 4, and 8 for 300 ppm N treatment.

| Substrate | Wk 0 | Wk 4 | Wk 8 |
|---|---|---|---|
| Peat | 4.0 | 2.9 | 2.8 |
| Bark | 7.0 | 6.7 | 6.5 |
| PTS | 14 | 19 | 16 |

**Table 2**. Nitrate N (mg) leached during week 1, 4, and 8 for 300 ppm treatment.

| Substrate | Wk 1 | Wk 4 | Wk 8 |
|---|---|---|---|
| Peat | 4.7 | 72 | 54 |
| Bark | 20 | 85 | 60 |
| PTS | 8.4 | 63 | 35 |

## IMPACT TO THE INDUSTRY

Pine tree substrate is a viable alternate substrate for greenhouse crops. While microbial N immobilization is clearly higher in PTS than in peat substrates, the extra N is easily supplied during production with no added leaching and runoff from production facilities. The cost of extra fertilizer is expected to be offset by a reduced cost for PTS.

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