Cotton Amended Substrates: Wrinkle Free?

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Significance to Industry: Alternative substrates that replace pine bark (PB) completely or partially are needed as (PB) supplies are running short in some areas of the country and prices are increasing. Cotton stalks (CS) and cotton gin trash (CGT) are plentiful waste products of the cotton industry and have shown promise as substrate amendments. Substrates constructed from whole pine trees (PTS) have also shown promise as substrates. However, these cotton wastes have not been evaluated when mixed with pine tree based substrates. Shoot and root growth of azalea and juniper were greatest with PB amended with CGT and smallest with PTS amended with CGT. Substrate bases of PB and PTS blended with composted CS either with or without an additional Nitrogen (N) source produced similar shoot and root growth in both azalea and juniper.

Nature of Work: The nursery industry in the southeast relies very heavily on PB as a substrate. PB is desirable because it is light in weight, well-drained, pathogen-free and disease suppressive. PB has been available as a waste product of the lumber industry; however, current forestry harvesting practices now recommend shredding the bark and small branches of pine trees after harvest and spreading these organic resources on the soil of the land where the trees were harvested. The 2008 Farm Bill included a component known as Biomass Crop Assistance Program (BCAP). This bill assists agricultural and forest land owners and operators in beginning an establishment and producing eligible crops that can be utilized as alternative fuel sources (1). The changes in the forestry industry and BCAP have led to a reduction in the availability of PB and an increase in price and now threaten the availability of the southeastern nursery industry's growing substrate. The need for alternative substrates is becoming critical.

Composted CS and composted CGT mixed with PB have shown promise as alternative substrates (2, 3). Cotton is very abundant in the southeast, comprising 2% of NC's 9.7 billion dollar farm cash receipts and could be easily accessible to containerized plant growers (5). The objective of this experiment was to evaluate the growth of two woody plant species that have susceptibility to *Phytophthora* in six compost amended, PB based or PT based substrates grown under drip irrigation. This project is part of a larger goal to provide the nursery industry in the southeast with regionally available alternative potting substrates that will keep the industry competitive and continue demand for their products in the competitive nursery industry.

Rhododendron obtusum 'Sunglow' and *Juniperus conferta* 'Blue Pacific' were potted on May 7th, 2010 into 3 quart (2.8 L) black plastic containers filled with either PB or PT based substrates that had been amended (v/v) with cotton stalks composted without a N source (CS), cotton stalks composted with a N source (Daddy Pete's Plant Pleaser, 0.5-0.5-0.5, Stony Point, NC) (CS+N), or cotton gin trash (CGT). The pine tree substrate base was produced from freshly harvested loblolly pine trees (*Pinus taeda*) that were delimbed, chipped, and ground in a hammer mill through a ¾ inch screen. A factorial treatment arrangement of these substrate bases (PB and PT) and amendments (CS, CS+N, and CGT) resulted in six substrates: 4:1 PB : CS (PBCS), 4:1 PB : CS+N (PBCS+N), 9:1PB : CGT (PBCGT), 1:1 PT : CS (PTCS), 1:1 PT : CS+N (PTCS+N), and 1:1 PT : CGT (PTCGT) arranged in a RCBD. Additions of CS, CS+N, and CGT were made to PB or PT to achieve similar water holding capacities. Total porosity (TP) (93-86%), airspace (AS) (39-26%), container capacity (CC) (61-54%), available water (AW) (25-21%), unavailable water (UW) (39-27%) and bulk density (BD) (0.26-0.12 g/cc3) of all six substrates were all within acceptable ranges for nursery crop production (10). An industry control of 100 % PB substrate (TP = 88%, AS = 32%, CC = 56%, AW = 16%, UW = 39%, BD = 0.23 g/cc3) was included in the experimental design for comparisons. All substrates were amended with 3.0 lbs/yd3 (1.4 kg.m3) dolomitic lime at mixing. On May 17th, PB-based substrates and the 100% PB control were topdressed with 2.6 g N [15 g (0.52 oz) fertilizer] and PT-based substrates were topdressed with 3.4 g N [20 g (0.71 oz) fertilizer] supplied by a polymer-coated, slow release fertilizer, 17-5-10 (17N-2.2P-0.83K) (Harrell's, Sylacauga, AL). Higher fertilizer rates were used in the PT treatments based on previously published work indicating the fertilizer rates needed to be increased for PT-grown plants (1). Irrigation was applied by a low volume spray stake (PC Spray Stake, Netafim, Ltd., Tel Aviv, Israel) that delivered 3.2 GPH. Irrigation volume was managed to maintain a 0.2 leaching fraction (volume of leached / volume of applied) for each of the six substrates and the 100% PB control. Leaching fractions were measured from each substrate every two weeks and irrigation volume was adjusted accordingly. Additionally, substrate solution was collected every two weeks using the pour-through nutrient extraction method (9) and used to determine electrical conductivity (EC) and pH using a Hanna pH/EC meter (HI 8424, Hannah Instruments, Ann Arbor, MI). On August 26, plants were separated into shoots and roots. Roots of juniper only were washed to remove substrate. All plant parts were dried to a constant weight at 62°C. All variables were tested for differences using analysis of variance procedures and lsd means separation procedures ($p > 0.05$) where appropriate (SAS, 2001).

Results and Discussion: The species by substrate interaction was insignificant for shoot growth so the main effects of substrate and species will be discussed (data not presented). Shoot growth was not different between species (data not presented) while substrate did affect shoot growth (Fig. 1). Shoot growth was greatest with PBCGT (Fig. 1). Jackson (2) also reported similar or greater growth indices for 'Winter Gem' boxwood, 'Firepower' dwarf nandina, 'Midnight Flare' azalea, and 'Renee Mitchell' azalea grown in CGT amended substrates. There were no differences between shoot growth with PBCS+N, PB, PTCS, and PTCS+N (Fig. 1).

Warren et al., (8) reported increased growth of 'Skogholm' cotoneaster as composted CS additions to a PB based substrate increased from 0 to 45%. In our study, we amended a PT based substrate with 50% composted CS and a PB based substrate with 20% composted CS and found no differences in shoot growth of azalea or juniper (Fig. 1). PTCGT produced the smallest shoot growth. Composted cotton burrs resulted in smaller poinsettia plants (shorter, more narrow, smaller inflorescence, and less dry weight) than poinsettia grown with a 1:1 (v/v) peat moss : PB substrate (7).

Substrate affected root growth of juniper (Fig. 2). Root growth was also greatest with PBCGT and least with PTCGT and PBCS+N. Several researchers have reported similar or enhanced root growth of 'Blitz tomato, weeping fig, 'Hot Country' lantana, and croton when grown in substrates amended with cotton gin compost (4, 5) Root growth with PB, PBCS, PTCS, and PTCS+N was not different (Fig. 2).

Since physical properties of all six substrates in this study were within acceptable ranges (see materials and methods), growth reductions in the PTCGT substrate were most likely due to elevated EC levels due to the nutrients in CGT (4) and higher fertilizer additions to the PT-based substrates. Statistical analysis for EC, pH and substrate solution nutrient levels have not been completed as of submission of this paper; however, the 20% addition of CGT to PT in the PTCGT substrate averaged a 2x EC level (0.8 dS.m-1) compared to the 10% addition of CG to PB in the PBCG substrate (EC averaged 0.4 dS.m-1). Several other researchers have reported higher EC levels in substrates amended with cotton stalks (8) cotton gin (2, 3, 4) and cotton burrs (7).

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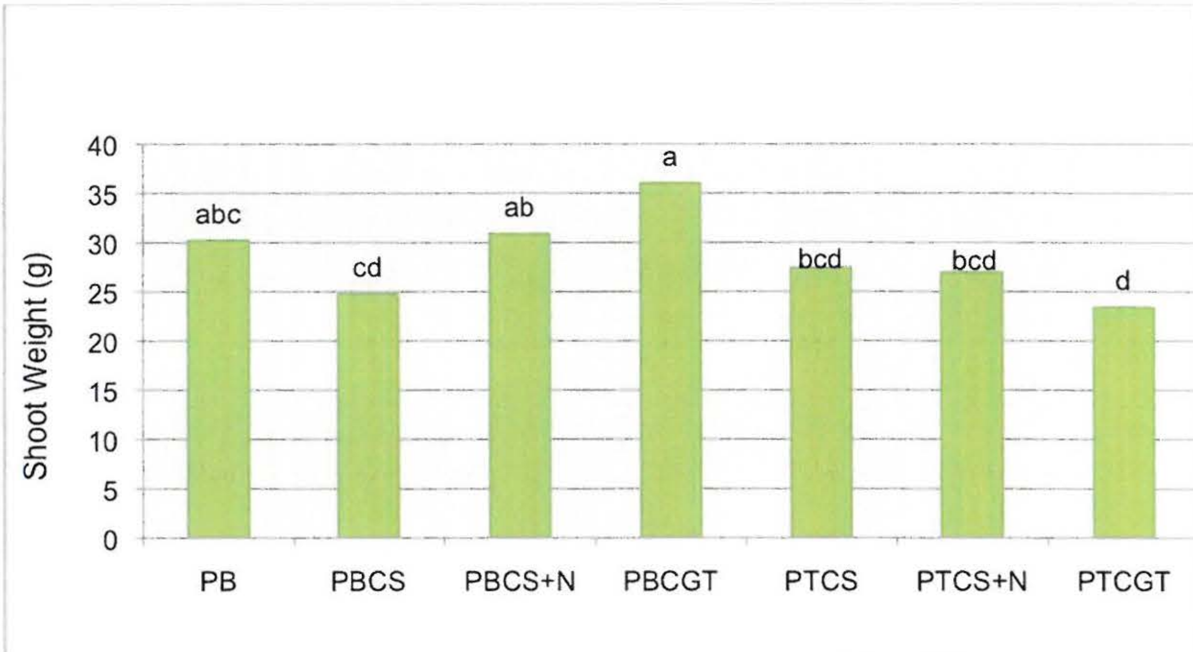

Figure 1. Effect of substrate on juniper and azalea shoot growth. The substrate x species interaction was nonsignificant. Means between substrates with different letters are significantly different from each other based on lsd mean separation procedures ($p>0.05$). The substrates consisted of; 4:1 PB : CS (PBCS), 4:1 PB : CS+N (PBCS+N), 9:1PB : CGT (PBCGT), 1:1 PT : CS (PTCS), 1:1 PT : CS+N (PTCS+N), and 1:1 PT : CGT (PTCGT). CS = composted cotton stalks, CS+N = composted cotton stalks with an nitrogen source added during composting, and CGT = aged cotton gin trash.

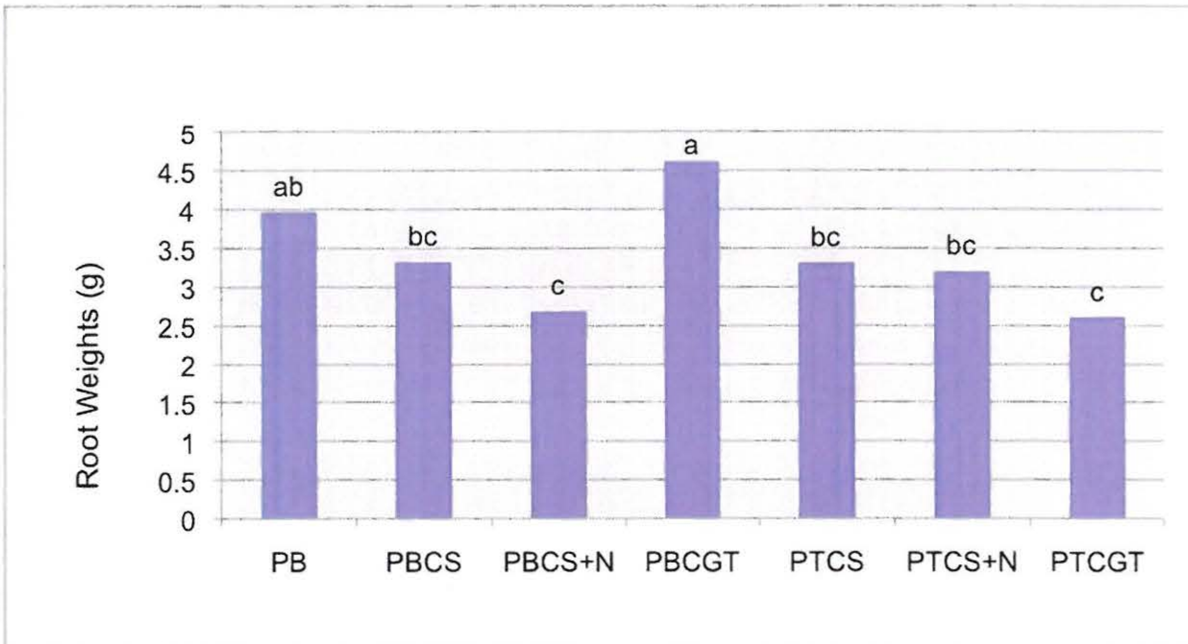

Figure 2. Effect of substrate on juniper root growth. Root dry weight was not determined for azalea. Means between substrates with different letters are significantly different from each other based on lsd mean separation procedures (p>0.05). The substrates consisted of: 4:1 PB : CS (PBCS), 4:1 PB : CS+N (PBCS+N), 9:1PB : CGT (PBCGT), 1:1 PT : CS (PTCS), 1:1 PT : CS+N (PTCS+N), and 1:1 PT : CGT (PTCGT). CS = composted cotton stalks, CS+N = composted cotton stalks with an nitrogen source added during composting, and CGT = aged cotton gin trash.