Particle Size of a Pine Chips Substrate Affects Plant Growth

Thomas N. Saunders, Jake F. Browder, Brian E. Jackson and Robert D. Wright
Virginia Tech, Department of Horticulture, Blacksburg, VA 24061
wrightr@vt.edu

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Significance to the Industry: This research demonstrates that a 100 percent pine chip (PC) substrate can be a suitable container substrate if particle size is adjusted to provide adequate physical properties to support plant nutrient and water requirements.

Nature of Work: The potential use of ground pine trees (*Pinus taeda* L.) (pine chips, PC) as a container substrate for greenhouse and nursery crops has been demonstrated by Wright and Browder (6). The effect of the particle size of PC on plant growth and physical properties, such as water holding capacity and air space, has not been investigated. A proper balance of these two properties is critical to the suitability of a substrate for plant culture (1). A decrease in substrate particle sizes usually results in an increase in water holding capacity (amount of water held after irrigation and drainage) and a decrease in aeration (air space) (3). Gruda and Schnitzler (2) demonstrated that a more finely ground wood fiber substrate had approximately half the air content and twice the amount of water as a coarsely ground substrate. The particle size of PC can be easily altered by the degree of grinding. Therefore, the purpose of this work was to evaluate the influence of PC particle size on the growth of marigold (*Tagetes erecta* Big. 'Inca Gold') and various substrate physical properties. Substrates differing in particle size were prepared by further grinding coarse pine chips from loblolly pine (*Pinus taeda* L.) in a hammer mill fitted with different screen sizes: 1.59, 2.38, 3.18, 4.76, and 6.35 mm (1/16, 3/32, 1/8, 3/16 and 1/4 inch), and amending with 0.6 kg/m^3 (1 lb/yd^3) $CaS0_4$. A peat-lite (PL) substrate composed of 45 percent peat, 15 percent perlite, 15 percent vermiculite, and 25 percent bark, supplemented with dolomitic lime at 3.6 kg/m^3 (6 lb/yd^3) and $CaSO_4$ at 0.6 kg/m^3 (1 lb/yd^3) was used for comparative purposes. Physical properties of each substrate were determined pre-plant according to Tyler et al. (4) on four replicate samples of each substrate using the North Carolina State University porometer method. Particle size distribution was determined by drying three 150 g samples of each substrate at 70º C and placing on a Rotap Shaker for 10 minutes. Marigold (*Tagetes erecta* Big. 'Inca Gold') seeds were planted in 144 plug trays containing a peat-based germinating mix on Feb. 3, 2006. On Feb. 17 uniform size seedling were transplanted into square 1-quart plastic containers with the different substrates. Plants were glasshouse grown in Blacksburg, VA and fertilized at each watering with 200 mg·L^{-1} N using a 20N-4.4P-16.6K fertilizer (20-10-20 Peat-lite, Scotts Company, Marysville, OH). There were five plants per treatment. Substrate solution was extracted using the pour-through method (5) on March 3 and analyzed for pH, EC, and NO_3-N. Nitrate-N was determined with an ion selective electrode. On March 17 shoots were severed at the substrate surface, oven dried, and weighed.

Results and Discussion: Marigold shoot dry weight was highest in PC ground with the 1.59 mm (1/16 inch) screen, and was 27 percent lower in PC ground with the 6.35 mm (1/4 inch) screen (Table 1). Shoot dry weight in PC ground with the 1.59 mm (1/16 inch) screen was equal to shoot dry weight in PL. Substrate solution pH, EC, and nitrate N concentrations were higher in substrates ground with the smaller screens compared to substrates ground with the larger screens (Table 1), probably accounting for the higher shoot dry weight of plants grown in the finer PC. There was a 2-fold increase in percent air space and a 1.5-fold decrease in percent container capacity (amount of water held after irrigation and drainage) (Table 1) for substrates produced with the 1.59 mm (1/16 inch) screen compared to those produced with the 6.35 mm (1/4 inch) screen. The substrates produced with the smaller screen size contained more fines that have a higher affinity for water thus reducing flow and the amount of water—and consequently nutrients—leached with each irrigation. The percent available water was also much higher with the substrates produced with the 1.59 mm (1/16 inch) screen compared to the 6.35 mm (1/4 inch) screen providing more water to support plant growth. Percent air space and container capacity of PL and the 1.59 mm (1/16 inch) PC were not different showing that PC with these important physical properties can be formulated to match commercial substrates. Physical properties for the finer PC substrates ground with the 1.59 mm (1/16 inch) and 2.38 mm (3/32 inch) screens were within the general ranges for easily managed substrates (1). These results show that changing the particle size of a 100 percent PC substrate can affect important physical properties of the substrate such as air space and container capacity. We have also shown that a PC substrate with the proper particle size range can serve as a suitable container substrate for a short-term greenhouse crop.

Literature Cited:

1. Bilderback, T.E., S.L. Warren, J.S. Owen, Jr., and J.P. Albano. 2005. Healthy substrates need physicals too! HortTechnology 15:747-751.
2. Gruda, N. and W.H. Schnitzler. 2004. Suitability of wood fiber substrate for production of vegetable transplants. Scientia Hort. 100:309-322.
3. Nelson, P.V. 2003. Greenhouse Operations and Management. 6th Ed. Prentice Hall, N.J.
4. Tyler, H.H., S.L. Warren, T.E. Bilderback, and W.C. Fonteno. 1993. Composted turkey litter: I. Effect of chemical and physical properties of a pine bark substrate. J. Environ. Hort. 11:131-136.
5. Wright, R.D. 1986. The pour-through nutrient extraction procedure. HortScience 21:227-229.
6. Wright, R.D. and J.F. Browder. 2005. Chipped pine logs: A potential substrate for greenhouse and nursery crops. HortScience 40:1513-1515.

Table 1. Effect of pine chip substrates produced with five different grinder screen sizes and peat-lite on shoot dry weight, substrate pH and EC levels, substrate nitrate concentrations, and substrate physical properties.

Substrates	Shoot dry wt (g)	pH	EC (ds/cm)	NO3 (ppm)	% Fines	Air space	Container Capacity (% vol)	Available water
Peat-lite	4.11 a[z]	5.1 c	1.85 a	121 a	-[y]	16.8 b	68.4 a	46.1 b
PC								
1/16[x]	3.87 a	5.6 a	1.44 b	105 a	53.8	18.2 b	65.1 ab	50.4 a
3/32	3.70	5.3	1.46	109	46.9	23.2	62.5	42.8
1/8	3.13	5.0	1.36	102	29.1	31.8	54.8	33.6
3/16	3.29	4.9	1.28	90	20.4	31.3	47.9	25.7
1/4	2.82	4.8	1.04	75	14.2	39.1	43.3	19.8
Significance[w]	L***	L***	L***	L***	L*	L***	L***	L***
	Q***	Q***	Q***	Q***	Q*	Q***	Q***	Q***

[z]Means separation between peat-lite and 1/16 inch PC by LSD, P<0.05. Means followed by the same letter in the same column are not significantly different.

[y]Data not taken.

[x]Screen size in inches.

[w]*, ***Nonsignificant or significant at P<0.05, or 0.001, respectively, for particle size comparisons.