From Forest Nursery Notes, Winter 2012

259. © Influence of pumice and plant roots on substrate physical properties over time. Altland, J. E., Owen, J. S., Jr., and Gabriel, M. Z. HortTechnology 21(5):554-557. 2011.

Influence of Pumice and Plant Roots on Substrate Physical Properties Over Time

James E. Altland[1,4], James S. Owen, Jr.[2], and Magdalena Z. Gabriel[3]

ADDITIONAL INDEX WORDS. **media, container capacity, air space, total porosity, water holding capacity, water management.**

SUMMARY. **An experiment was conducted to test the hypothesis that either pumice or plant roots maintain air space (AS) and porosity over time, or renders substrates more resistant to shrinkage. Treatment design was a 3 × 2 factorial with three substrate types and either presence or absence of a plant. The three substrates were composed of douglas fir (*Pseudotsuga menziesii*) bark alone or amended with 15% or 30% (by volume) pumice. Substrates were packed in aluminum cores to facilitate measurement of physical properties with porometers at the conclusion of the experiment. Half of the cores with each of the three substrate types were packed with a single plug of 'Autumn Blush' coreopsis (*Coreopsis* sp.) (Expt. 1) or 'Blue Prince' holly (*Ilex ×meserveae*) (Expt. 2). The remaining cores were maintained in the same production environment, but without a plant. Substrate physical properties were measured before the experiment and after 48 days for coreopsis plants and 382 days for holly. Both experiments had relatively similar responses despite using different crops and production times. Summarizing in general overall treatments, AS decreased, container capacity (CC) and total porosity (TP) increased, and bulk density remained constant over time. The presence of a plant in the core tended to exacerbate the decrease in AS and the increase in core capacity. Shrinkage was decreased by the presence of a plant, but only minimally.**

Soilless substrates are dynamic due to their predominantly organic nature, changing both physically and chemically over time. Substrate decomposition, settling, or a combination of the two can cause shrinkage in substrates. This shrinkage or reduction in substrate volume results in a change in physical properties that affect AS and CC. Aendekerk (1997) showed the relative decomposition and shrinkage of several peat sources as a function of substrate pH and sub-irrigation level. While pH and sub-irrigation level both influenced AS, pH as a function of peat source was more influential than irrigation factors. Allaire-Leung et al. (1999) showed that AS in peat substrates decreased and easily available water increased over a 14-month period, with a net effect of no change in TP. Settling and decomposition of peat-based substrates may be more common than in bark-based substrates. Nash and Laiche (1981) reported that increasing levels of peat relative to bark in substrates caused an increase in the amount of shrinkage. However, they also reported that a 4 bark:1 sand substrate had decreased hydraulic conductivity after 5 months, whereas several substrates with varying bark:peat ratios had increased hydraulic conductivity.

Nursery and greenhouse growers attempt to overcome substrate shrinkage by adding components that are not subject to change due to their inert, stable, inorganic composition. Nursery growers in the Pacific northwestern United States use pumice as the primary inorganic substrate component. Pumice is a porous igneous rock found primarily in volcanic regions of the world, including the Cascade Mountain Range in Oregon. The impact of pumice on crop growth and substrate physical properties has been studied throughout the world, as pumice from each volcanic region has unique properties (Gizas and Savvas, 2007; Gunnlaugsson and Adalsteinsson, 1995; Lenzi et al., 2001). Pumice is usually added to nursery substrates at rates of 10% to 20% (v/v) because it is perceived to increase aeration and drainage. Recent research contradicts these perceptions by showing additions of pumice to douglas fir bark (DFB) decreased TP, CC, available water, and water buffering capacity (water occurring between 5.0 and 9.9 kPa), but increased bulk density (D_b) (Gabriel et al., 2009). In addition, it was hypothesized by growers that including a stable inorganic substrate component that cannot decompose would maintain structure in organic substrates and create more uniform physical properties throughout the growing season. It has also been speculated that plant roots form an effective scaffolding that maintains substrate structure and thus limit change to the physical properties of the substrate. Aendekerk (1997) supported this hypothesis by showing an average of 8% shrinkage after 31 weeks across four different peat substrates potted with 'Rubinetta' skimmia (*Skimmia japonica*), but over 18% shrinkage during the same time in containers without a plant. The objective of this research was to test the hypothesis that pumice maintains AS and porosity over time or renders substrates more resistant to shrinkage. A second objective of this research is to test the alternative hypothesis that plant roots alone maintain substrate structure thus preventing shrinkage.

Materials and methods

A 7.5 × 7.5-inch square of 20-mesh fiberglass insect screen (Phifer Wire Products, Tuscaloosa, AL) was used to cover the bottom of aluminum cylinders (sampling cores) 6-inch tall

Mention of proprietary products or company is included for the reader's convenience and does not imply any endorsement or preferential treatment by USDA-ARS.

[1]Research Horticulturist, USDA-ARS, Application Technology Research Unit, OH Agricultural Research and Development Center, 1680 Madison Avenue, Wooster, OH 44691

[2]Assistant Professor, Oregon State University, North Willamette Research and Extension Center, 15210 NE Miley Road, Aurora, OR 97002-9543

[3]Graduate student, Oregon State University, North Willamette Research and Extension Center, 15210 NE Miley Road, Aurora, OR 97002-9543

[4]Corresponding author. E-mail: James.Altland@ars.usda.gov.

Units

To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
2.54	inch(es)	cm	0.3937
25.4	inch(es)	mm	0.0394
1.7300	oz/inch^3	g·cm^{-3}	0.5780
1	Ppm	mg·L^{-1}	1
6.8948	Psi	kPa	0.1450
(°F – 32) ÷ 1.8	°F	°C	(1.8 × °C) + 32
(°F ÷ 1.8) + 255.37	°F	K	(K – 255.37) × 1.8