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

Soilless substrates are dynamic due to their predominantly organic nature, changing both physically and chemically over time resulting shrinkage. This shrinkage, or reduction in substrate volume, results in a change in airspace (AS) and container capacity (CC). The objectives of the study was to test the hypothesis that either pumice or plant roots maintain air space (AS) and porosity over time, and therefore renders substrates more resistant to shrinkage.

The three substrates were composed of Douglas fir (*Pseudotsuga menziesii*) bark alone or amended with 15% or 30% (by volume) pumice with either presence or absence of a plant in the same production environment. Substrates were loaded in cores to facilitate measurement of physical properties with porometers at the conclusion of the experiment. A single plug of 'Autumn Blush' coreopsis (*Coreopsis* sp.) (Expt. 1) or 'Blue Prince' holly (*Ilex x meserveae*) (Expt. 2) was used as the experimental crop. Substrate physical properties were measured before the experiment (Table 1) and after 48 days for coreopsis plants (Table 2) and 382 days for holly (Table 3).

Both experiments had relatively similar responses despite using different crops and production times. In the presence of a plant, the change in AS decreased with increasing pumice rate. Thus, there seems to be validity to this hypothesis. Shrinkage was decreased by the presence of a plant, but only minimally. Overall, AS decreased, container capacity (CC) and total porosity (TP) increased, and bulk density remained constant over time.

Table 1. Initial physical properties of three douglas fir bark (DFB) and pumice (P) substrates.

	Physical properties[z]			
	TP	AS	CC	
Substrate (DFB:P)	(%)[y]			D_b ($g \cdot cm^{-3}$)[y]
100:0	79 a[x]	41 a	38 a	0.18 c
85:15	75 b	35 b	40 a	0.21 b
70:30	76 b	37 b	39 a	0.25 a

[z]TP = total porosity, AS = air space, CC = container capacity, D_b = bulk density.
[y]1 $g \cdot cm^{-3}$ = 0.5780 oz/inch^3.
[x]Means with different letters are significantly different according to Fisher's protected least significant difference test at $\alpha = 0.05$.

Table 2. Physical properties of douglas fir bark (DFB) and pumice (P) substrates after exposure to production environment with or without 'Sunray' coreopsis growing within the core.

		Physical properties[z]								
		AS	ΔAS	CC	ΔCC	TP	ΔTP	D_b	ΔD_b	
Plant	Substrate (DFB:P)	(%)						($g \cdot cm^{-3}$)[y]		Shrinkage (mm)[y]
No	100:0	35	–6	46	8	81	2	0.18	0.00	0.2
	85:15	36	1	46	6	82	7	0.21	0.00	0.1
	70:30	33	–4	48	9	81	5	0.26	0.01	0.1
		NS	Q*	NS	Q*	NS	NS	L***	L**	NS
Yes	100:0	26	–15	48	10	74	–5	0.18	0.00	0.2
	85:15	30	–5	48	8	78	3	0.21	0.00	0.2
	70:30	34	–3	49	10	82	6	0.25	0.00	0.2
		L*	L***	NS	Q*	L*	L**	L***	NS	NS

Table 3. Physical properties of douglas fir bark (DFB) and pumice (P) substrates after exposure to production environment with or without 'Blue Prince' holly growing within the core.

		Physical properties[z]								
		AS	ΔAS	CC	ΔCC	TP	ΔTP	D_b	ΔD_b	
Plant	Substrate (DFB:P)	(%)						($g \cdot cm^{-3}$)[y]		Shrinkage (mm)[y]
No	100:0	39	–2	49	11	88	9	0.15	–0.03	0.9
	85:15	35	0	49	9	85	10	0.22	0.01	0.5
	70:30	35	–2	48	9	84	8	0.24	–0.01	0.6
		L**	Q*	NS	NS	L*	NS	L***	Q***	NS
Yes	100:0	31	–10	53	15	84	5	0.17	–0.01	0.2
	85:15	29	–6	51	11	81	6	0.22	0.01	0.2
	70:30	29	–8	54	15	83	7	0.26	0.01	0.1
		NS	Q**	NS	NS	NS	NS	L***	L***	NS

[z]AS = air space, CC = container capacity, TP = total porosity, D_b = bulk density. The symbol Δ refers to change in the respective parameter from the initial measurement made at the beginning of the study until 382 d later when the experiment was harvested. NS, L, and Q represent no significant rate response, linear, and quadratic rate response with respect to pumice rate, respectively; *, **, *** represent significant effects when $P \leq 0.05$, 0.01, and 0.001, respectively.
[y]1 $g \cdot cm^{-3}$ = 0.5780 oz/inch^3, 1 mm = 0.0394 inch.

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