Container Design Influences Physical Parameters of Different Media

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Additional index words. total porosity, air space, water-holding capacity

Summary. The effect of container design on physical parameters of media with different bulk densities was evaluated. A significant interaction between container design and media for water-holding capacity and air space was found. A container with a polyester fabric bottom had the largest media air space and the smallest water-holding capacity after 24 h of drainage when placed on a column of sand to allow for free drainage from the container medium. For the media tested, a blend of composted pine bark and hardwood bark (PB:HB) appeared to have good physical characteristics for a container medium in the container designs that were evaluated. Container design should be considered when selecting a container medium because physical parameters of a given medium will be influenced.

ished. It has been suggested that air space values for a given medium cannot be reported accurately without regard for container size (Karlovich and Fonteno, 1986). Research with fabric-bottom containers indicated that the perched water table in a container was reduced and media physical properties improved when containers were placed on sand to allow free drainage (Ruter, 1986). Therefore, the purpose of this study was to determine the influence of different container designs on the physical properties of four media.

The media used in this study were: 1) an Etowah loam (EL) (fine-loamy, siliceous, thermic typic Paleudult), 2) Pro-Mix BX (PM) (Premier Brands, Inc., Stamford, Conn.), 3) a 3 nursery grade pine bark : 1 sphagnum peat : 1 river sand blend (PB:SP:S), and 4) a 1 composted pine bark : 1 hardwood bark mix (PB:HB) blended before composting (Svenson, 1986). Containers used were a: 1) conventional round polyethylene 3.8-liter container, four sides and one bottom drain hole (2 cm in diameter) (ZC) (Zarn, Inc., Reidsville, N.C.); 2) a 3.8-liter poly bag, eight sides and eight bottom drain holes (0.6 cm in diameter) (MB) (Menne Nursery Corp., North Tonawanda, N.Y.); 3) a cube of 15 cm, two drain holes per side (0.6 cm in diameter) at bottom, made of 0.32-cm white polyethylene sheeting with a 4-mil black polyethylene bottom (CS); and 4) a cube made of the same material as CS, but with a polyester fabric bottom (mesh crossbonded, 0.25 × 0.13 mm) and no drain holes (CF). Containers with similar internal dimensions were chosen so that equal media volume and depth could be achieved in all four container designs.

The experimental design was a 4 × 4 factorial in a randomized complete block with four replications. There were four container designs and four media. Growth medium (3000 cm³) was added to each container, creating a medium column of ≈ 14 cm. Each container was placed on a 45-cm column of sand to allow for adequate drainage. Physical parameters [total porosity, water-holding capacity (WHC), and air space (AS) (percent by volume)] were determined after 24 h of free drainage using methods adapted from Gessert (1976). Particle size distributions (Table 1) for the PB:SP:S and PB:HB media were tested by screening 250 ml of oven-dried

Growing media and container design are two factors that influence plant growth (Bildersback and Fonteno, 1987; Keever et al., 1985). A problem associated with media in conventional nursery containers is the development of a perched water table. Considerable research has been conducted regarding the development of media with optimal physical properties. Because the bottom of a container acts as a barrier to free drainage, the ideal physical properties of a given medium often are dimin-

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(80C for 24 h) media (three replications) for 5 min using a rotary shaker.

For the media used in this study, total porosity decreased as bulk density increased. The bulk density ($\text{g}\cdot\text{cm}^{-3}$) of the four media were as follows: 1.24 (EL), 0.55 (PB:SP:S), 0.36 (PB:HB), and 0.19 (PM). Total porosities were 53% (EL), 57% (PB:SP:S), 60% (PB:HB), and 73% (PM).

There was a significant interaction between container design and media for WHC (Table 2) and AS (Table 3). For all media, the CF container design resulted in the lowest WHC and the highest AS, while the opposite occurred for the container with the solid bottom (CS). Drainage was improved by the MB container design compared to ZC, as evidenced by the lower WHC and higher AS in all media except PM (Tables 2 and 3).

Lower WHC and higher AS in the PB:HB medium compared to the PB:SP:S medium, which occurred with each container design, can be explained by the larger percentages of particle size distribution (Table 1) found in the sieve sizes ≥ 1.0 mm. For the PB:SP:S medium, 59% of the medium particles were <1.0 mm in size, in contrast to 38% for the PB:HB medium. For all container designs except CF, the EL medium had higher AS compared to the PB:SP:S medium (Table 3).

This research indicated that, for media with different bulk densities and components, water-holding capacity and air space was altered by use of different container designs. For crops requiring improved drainage, a PB:HB medium may be useful because there was 1.8 times more air space compared to the commonly used PB:SP:S nursery medium when based on the particle size distributions found in this study.

The large surface area of the CF container bottom in contact with the column of sand had significantly higher AS for the different media. After 24 h of drainage, AS for the PB:SP:S medium in the CF container was as much as 137% higher compared to the other container designs. The polyester fabric-bottom container (CF) may also improve root development for some plant species due to improved physical properties of the container medium when placed on a bed of sand under nursery conditions (Ruter and van de Werken, 1986). Different physical parameters should be expected if

Table 1. Particle size distributions of a 3 pine bark : 1 sphagnum peat : 1 sand (PB:SP:S, by volume) medium and a 1 pine bark : 1 hardwood bark (PB:HB, by volume) medium.

Media	Mean percent weight on sieve ^a					Pan
	Sieve size (mm)					
	8.0	4.0	2.0	1.0	0.5	
PB:SP:S	1.1	8.2	15.7	15.6	30.2	29.2
PB:HB	1.5	13.7	24.9	22.2	17.7	20.0

^aThree replications, means within columns different at $P = 0.001$.

Table 2. Influence of container design and media on water-holding capacity (WHC, percent by volume $\pm$ SE).

Container ^a design	Media			
	PB:HB	PM	PB:P:S	EL
CF	22 $\pm$ 0.2	35 $\pm$ 0.2	28 $\pm$ 0.2	34 $\pm$ 0.3
MB	25 $\pm$ 0.2	49 $\pm$ 0.3	40 $\pm$ 0.2	35 $\pm$ 0.3
ZC	29 $\pm$ 0.3	44 $\pm$ 0.2	43 $\pm$ 0.3	38 $\pm$ 0.3
CS	32 $\pm$ 0.2	54 $\pm$ 0.3	45 $\pm$ 0.3	38 $\pm$ 0.3

ANOVA

Container design	***
Media	***
Container design $\times$ media	***

^aCF = cube of 15 cm, polyester fabric bottom, no side drain holes; MB = 3.8-liter poly bag, eight bottom and eight side drain holes (0.6 cm); ZC = round conventional polyethylene 3.8-liter container, four side and one bottom drain hole (2 cm); and CS = cube of 15 cm, black polyethylene bottom, two drain holes per side at bottom (0.6 cm).

***Significant at $P = 0.001$.

Table 3. Influence of container design and media on air space (AS, percent by volume $\pm$ SE).

Container ^a design	Media			
	PB:HB	PM	PB:P:S	EL
CF	38 $\pm$ 0.2	38 $\pm$ 0.2	30 $\pm$ 0.2	19 $\pm$ 0.2
MB	25 $\pm$ 0.2	24 $\pm$ 0.3	16 $\pm$ 0.2	18 $\pm$ 0.2
ZC	31 $\pm$ 0.2	30 $\pm$ 0.2	14 $\pm$ 0.2	16 $\pm$ 0.2
CS	28 $\pm$ 0.2	20 $\pm$ 0.2	12 $\pm$ 0.3	16 $\pm$ 0.2

ANOVA

Container design	***
Media	***
Container design $\times$ media	***

^aCF = cube of 15 cm, polyester fabric bottom, no side drain holes; MB = 3.8-liter poly bag, eight bottom and eight side drain holes (0.6 cm); ZC = round conventional polyethylene 3.8-liter container, four side and one bottom drain hole (2 cm); and CS = cube of 15 cm, black polyethylene bottom, two drain holes per side at bottom (0.6 cm).

***Significant at $P = 0.001$.

containers are placed on black plastic or polypropylene ground cover. Other advantages of fabric-bottom containers have been described by van de Werken (1989).

The results of this study indicate an interaction between container design and media that influenced water-holding capacity and air space. Bilderback and Fonteno (1987) found similar results and noted that growers should consider the container-medium combination as a unit and not as two independent factors. Consequently, reporting physical parameters of con-

tainer media without recording container design might result in erroneous conclusions.

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