Expanded Polystyrene as a Substitute for Perlite in Rooting Media©

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INTRODUCTION

Perlite is an important component in soilless potting media. The price of perlite depends on grade and volume ordered, with current prices ranging from $27 to $47 per yard^3.

Expanded polystyrene beads are commonly used in media mixes in the greenhouse industry, but they are less commonly used in the nursery industry. Usually polystyrene beads can be acquired free or for a nominal fee of about $50 per semi truck load if they are picked up by the user at the source, whereas a similar volume of perlite would cost $4000.

Preferred characteristics of a propagation media include: (1) consistent quality, (2) absence of disease and insect pests, (3) absence of toxic chemicals, (4) water-holding capacity, (5) light weight, and (6) adequate drainage and aeration. Other considerations include ease of each component to be mixed with other components, ability to support the cutting, and ease of sticking MacDonald (1986).

The expanded polystyrene (EPS) industry produces a large amount of waste annually. Some EPS waste is used to fill beanbags and similar products, but more waste is produced than can be used. Therefore companies are seeking alternatives for disposing of their waste. Due to the inorganic nature of the product, EPS waste should be consistent from a particular source throughout the year. MacDonald (1986) reported that polystyrene beads are not suitable for use alone for rooting cuttings, but are best mixed with peat moss.

Many inorganic materials such as sand, calcined clay, rock wool, perlite, and vermiculite are commonly used in propagation media. Use of polystyrene products has been limited in the nursery industry due to environmental concerns such as flotation and accumulation in retaining ponds and blowing of material during mixture. Positive attributes include low costs, good drainage, and light weight (which further saves shipping costs). The objective of this study was to determine the potential substitution of styrofoam beads (EPS) for perlite in rooting media of two common deciduous broadleaf taxa and two common conifer taxa.

MATERIALS AND METHODS

Broadleaf. Cuttings were collected from althea (*Hibiscus syriacus* 'Jeanne D' Arc') and compact crimson pygmy barberry (*Berberis thunbergii* 'Atropurpurea Nana' (syn. *B. thunbergii* 'Crimson pygmy') on 9 Sept. 1999. Cuttings from both species were trimmed to 10 cm (3.9 inch). The basal 1 cm (0.4 inch) of althea cuttings was dipped for 5 sec in 1250 ppm liquid IBA, while the barberry cuttings received no auxin treatment. Cuttings were placed in flats of 26.5 cm (10.4 inch) wide × 51 cm (20 inch) long × 7.5 cm (3 inch) deep with one cutting per cell. Trays contained substrates consisting of horticultural grade perlite (PER) or EPS (Insul Bead, Gravette, Arkansas), and Canadian sphagnum peat moss (SPM). The SPM was mixed at rates of 0%, 25%, 50%, 75%, or 100% (by volume) with either PER or EPS. Cuttings were maintained in a polyethylene covered greenhouse under natural photoperiod with a maximum photosynthetic photon flux (PPF) of 810 mmol m^{-2} s^{-1} and maximum/minimum air temperatures of 33/10C (92/50F). Trays were placed on black groundcover fabric under DGT nozzles (A.H. Hummert, St. Louis, Missouri) with an output of 2 liters min^{-1}. Nozzles were placed 40 cm (16 inches) above the trays at 90-cm intervals. Mist cycles were adjusted as necessary, but averaged 6-sec duration every 15 min between 0800 and 1800 h daily. Althea and barberry were evaluated for percentage of cuttings rooted 6 and 8 weeks after planting, respectively.

Conifer. The study was repeated beginning 1 Dec. 1999, with Compact andorra juniper (*Juniperus horizontalis* 'Andorra Compact' (syn. *J. horizontalis* 'Plumosa

Table 1. Chemical and physical properties of propagation media containing various proportions of perlite or expanded polystrene beads with sphagnum peat moss.

Medium	pH	Electrical conductivity (dS m^{-3})	Total porosity (%)	Air space (%)	Water holding capacity (%)	Bulk density (g cm^{-3})
100%	5.3	5.2	83	8	75	0.15
25% PER	5.0	1.7	74	18	56	0.12
50% PER	5.4	3.4	71	24	47	0.17
75% PER	5.7	1.9	68	24	44	0.16
100% PER	6.3	1.0	63	34	29	0.18
Linear	***	***	***	***	**	*
Quadratic	*	NS	NS	NS	NS	NS
Cubic	NS	*	NS	NS	*	NS
25% EPS	5.3	4.3	75	19	56	0.11
50% EPS	5.4	3.5	69	21	48	0.10
75% EPS	5.5	2.4	56	17	39	0.05
100% EPS	5.6	0.3	58	45	13	0.02
Linear	NS	***	*	***	***	***
Quadratic	NS	NS	NS	***	*	*
Cubic	NS	NS	NS	**	NS	*

Table 2. Percentage of althea cuttings rooted in various proportions of perlite (PER) or expanded polystyrene (EPS) with spagnum peatmoss (SPM).

	Cuttings rooted (%)	
Medium	PER	EPS
100% SPM	47.2	
25% PER	46.3	23.8
50% PER	53.1	22.2
75% PER	65.0	31.3
100% PER	82.2	57.2
Linear	***	***
Quadratic	***	***
Cubic	***	***

Compacta') and Woodward globe arborvitae (*Thuja occidentalis* 'Woodwardii'). Cuttings from both species were trimmed to 12 cm (5 inch). The basal 1-cm was dipped for 5 sec in 2500 ppm liquid IBA. Rooting trays and substrates were as described above. Mist was adjusted as necessary, averaging 6-sec duration every 30 min between 1000 and 1700 h daily. Juniper and arborvitae were evaluated 17 and 20 weeks after planting, respectively, for percentage of cuttings rooted and primary root number and length. The pH of each medium was determined with a Compact pH meter (Twin pH B-213, Spectrum Technologies, Plainfield, Illinois) and electrical conductivity was determined with a conductivity meter (Orion, Model 125, Beverly, MA). Total porosity, percent air space, water-holding capacity and bulk density were determined as described by Ingram, et al. (1990).

Statistics. A randomized complete block design was used for each species with 10 replications of 32 subsamples per treatment. Data were analyzed using analysis of variance and trend analysis for percentage of rooted cuttings, root number per cutting, and length of the longest root using PER or EPS concentration in the medium as the independent variable (SAS Institute, Cary, North Carolina).

RESULTS AND DISCUSSION

About 78% of the EPS was 2 to 6.35 mm in diameter. The addition of PER or EPS to peat helped increase air space, but caused a decrease in total porosity and water holding capacity (Table 1). A major physical characteristic of a successful rooting medium is the percentage air space (Joiner and Conover, 1965, Long, 1933, Pertuit and Mazur, 1981), which depends on the depth and the particle size distribution of a medium (De boodt and Verdonck, 1972).

Recommendations for medium aeration (air space) range from 5% to 30% of the medium volume, depending on the species and the method of measurement (De boodt and Verdonck, 1972). Air space ranged from 8% to 45% for the media tested.

The medium pH was relatively unaffected by the presence of EPS, though the

Table 3. Percentage of cuttings rooted, number of roots per cutting, and length of the longest root on compact andorra cuttings rooted in media containing various concentrations of perlite (PER) or expanded polystyrene (EPS) with sphagnum peat moss (SPM).

Component	Concentration (%)	Cuttings rooted (%)	Number of roots per cutting	Length of longest root (cm)
PER	0	78.8	13.8	8.7
	25	89.4	14.6	11.0
	50	98.1	14.2	11.2
	75	90.0	14.7	10.5
	100	61.2	8.0	7.7
	Linear	***	***	*
	Quadratic	***	***	***
	Cubic	*	**	NS
EPS	0	78.8	13.8	8.7
	25	70.9	12.8	8.5
	50	70.0	9.5	6.9
	75	68.8	9.4	7.4
	100	53.8	5.3	5.2
	Linear	**	***	***
	Quadratic	NS	NS	NS
	Cubic	NS	NS	NS

addition of PER tended to increase pH as the concentration of PER increased. Electrical conductivity decreased as the concentration of PER or EPS increased. Bulk density increased with greater ratios of PER to SPM, but decreased as the ratio of EPS to SPM increased.

Rooting of althea differed depending on the ratio of PER or EPS in the rooting medium (Table 2). As the ratio of PER to SPM in the media increased, more cuttings rooted, and there were more roots on the rooted cuttings. More cuttings rooted in the presence of 100% EPS than in other media containing EPS or in SPM alone.

A curvilinear relationship between medium PER concentration and percentage of cuttings rooted, number of roots per cutting, and length of the longest root occurred for juniper (Table 3). The greatest percentage of cuttings (98.1%) rooted at 50% PER while the greatest number of roots and longest roots occurred with 25%, 50% and 75% PER. Rooting percentage, number of roots, and root length decreased linearly as medium EPS concentration increased.

The highest percentage (31%) of arborvitae cuttings rooted in 50% PER or 75%

Table 4. Percentage of cuttings rooted, number of roots per cutting, and length of the longest root on Woodward globe rooted in various cocncentrations of perlite (PER) or expanded polystyrene (EPS) with spagnum peat moss (SPM).

Component	Concentration (%)	Cuttings rooted (%)	Number of roots per cutting	Length of longest root (cm)
PER	0	21	7	4.9
	25	29	8	7.1
	50	31	8	6.6
	75	29	8	6.2
	100	19	4	5.6
	Linear		*	NS
	Quadratic		*	NS
EPS	0	21	7	4.9
	25	19	7	4.9
	50	28	9	6.2
	75	31	9	6.4
	100	26	4	4.2
	Linear		NS	NS
	Quadratic		**	*

EPS (Table 4). Medium component interacted with rate for number of roots and root length. Cuttings rooted in 25%, 50% , or 75% PER had more roots than those in 0% PER or 100% PER. In contrast, cuttings rooted in 50% or 75% EPS had more roots than those rooted in 0%, 25%, or 100% EPS. Root length did not significantly differ regardless of the amount of PER in the rooting medium, but roots were longer with 50% or 75% EPS than with 0%, 25%, or 100% EPS.

Loach (1985) tested three rhododendron cultivars in six media and found divergent results in different media even with related cultivars. Rooting of the four species in our study was also inconsistent. This inconsistency may have been related to the type of roots produced by the species, i.e., thick coarse roots on althea or thin fragile roots on barberry. Environmental differences may also explain differences in rooting among the species. Both conifer varieties were stuck during the winter when transpiration was lower. These species rooted better in media with at least 25% SPM.

This study suggests that substitution of PER with EPS is feasible and may result in a substantial propagation cost reduction, but testing of individual species should take place before incorporating EPS as a standard in the propagation phase.

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