Lightweight Aggregate HydRocks®: A Novel Approach to Rooting and Bare Root Cuttings©

Jeremy M. Pickens, Jeff L. Sibley, Charles H. Gilliam, Glenn B. Fain, Daniel E. Wells, and John W. Olive
Auburn University, Department of Horticulture, Auburn, Alabama 36849
Email: pickejm@auburn.edu

Eugene K. Blythe
Coastal Research and Extension Center & Dept. of Plant and Soil Sciences, Mississippi State University, Poplarville, Mississippi 39470

Cuttings from five common woody species were stuck into HydRocks® (≈ 0.47 cm), pine bark, pine bark and peat moss (8 : 2, v/v), vermiculite, perlite, and sand. Rooted cuttings were evaluated based on root quality, shoot growth, root growth, and rooting percentage. Root quality and root and shoot weight varied depending on species and substrate treatment. Results of these studies suggest that HydRocks can be used as a successful rooting substrate. Cuttings rooted in HydRocks performed as well as conventional substrates in most cases across species in these studies. No differences were seen in rooting percentage between any treatments across species. As a propagation substrate, HydRocks could have greater utility than conventional substrates when ease of handling bare-root cuttings is taken into account.

INTRODUCTION

An alternative to the expense associated with container-grown liners is producing bare-root liners. Purchase cost of bare root liners is generally less expensive than the cost of "buying in" container-grown liners due to a reduction in weight and space. Bare-root-liner production requires little overhead and material cost. The principal expense associated with bare-root-liner production is labor cost. Removing soil or organic substrate from roots is labor demanding, in addition, high pressure water used to remove substrate materials can damage root systems.

The level of difficulty in removing substrate from roots in bare-root-liner production is dependent on the root structure and substrate components. Some Oregon nurseries have converted entire greenhouse floors into in-ground pumice beds where cuttings are directly stuck (Buamsch and Altland 2005). The pumice aggregate is easily removed from the cuttings at harvest and the pumice is reused for many years without being replaced. The reuse of substrate material has the potential to save growers cost associated with re-purchasing substrate and containers.

Inorganic materials such as monolithic slag and ceramic aggregates with stable large particle sizes have been shown to be easily removed from roots while still producing quality plant material (Blythe et al., 2005; Fain and Paridon, 2004). HydRocks® has been evaluated and shown to be easily removed from roots (Pickens and Sibley, 2006; Pickens et al., 2008).

HydRocks is a lightweight expanded clay aggregate marketed for horticulture applications (Big River Industries, Alpharetta, Georgia). HydRocks is a formed by calcining clay at temperatures reaching 2000 ºF. HydRocks is produced from several quarries in the southeast and is generally inert, pH neutral, and has a cation exchange capacity (CEC) of about 8 meq/100 g. HydRocks bulk density for material used in this study was 0.64 g·cm^{-3} (Table 1). HydRocks used in this study was produced in Livingston, Alabama.

The nature of HydRocks and other expanded clays suggest that such could be used in place of pumice within in-ground propagation beds where pumice supply is not readily available. Like pumice, stable properties of expanded clays would allow re-use for many years without replacement, providing a more sustainable and cost effective approach to bare-root-liner production. The objective of this study was to evaluate HydRocks as a rooting substrate when compared to four other common propagation substrates.

MATERIALS AND METHODS

This study was conducted at the Paterson Greenhouse Complex in Auburn, Alabama. On 23 Sept. 2007, cuttings were collected from mature landscape plants in Auburn, Alabama, from the following: *Elaeagnus* ×*ebbingei, Forsythia* ×*intermedia, Ilex cornuta* 'Dwarf Burford', *Illicium parviflorum,* and *Lagerstroemia* 'Natchez'. Semi-hardwood terminal cuttings of *Elaeagnus* ×*ebbingei* were collected and prepared as 4-inch cuttings with a minimum of four leaves, wounded, and treated with 1000 ppm IBA + 500 ppm NAA. *Lagerstroemia* 'Natchez' cuttings were prepared as 3- to 4-inch, wounded subterminal cuttings with three leaves per cuttings and were treated with 1000 ppm IBA + 500 ppm NAA. *Forsythia* ×*intermedia* cuttings were prepared as 3-inch, single-node intermediate cuttings and treated with 1000 ppm

Table 1. Physical properties of HydRocks® and five common rooting substrates.[Z]

Substrate	Air space[Y]	Container capicity[X]	Total porosity[W]	Bulk density (g·cm^{-3})
Screened pine bark	20.4 b[U]	50.2 c	70.8 b	0.21 c
Fafard 3B	12.1 d	68.6 a	80.7 a	0.12 e
Sand	1.3 f	32.9 e	34.3 f	1.45 a
Perlite	17.2 c	48.0 d	65.2 d	0.18 d
Vermiculite	8.7 e	59.8 b	68.5 c	0.19 d
HydRocks®[T]	31.7 a	30.7 f	62.0 e	0.64 b
Recommended range[S]	10.0–30.0	46.0–65.0	50.0–85.0	0.19–0.17

[Z] Analysis performed using the North Carolina State University porometer.
[Y] Air space is volume of water drained from the sample ÷ colume of the sample.
[X] Container capacity is (wet weight - oven dry weight) ÷ volume of the sample.
[W] Total porosity is container capcity + air space.
[U] Means with different letters within columns are significantly different, separated by Duncan's Multiple Range Test ($p \leq 0.05$).
[T] Screened to ≈ 0.47 cm(0.19 in.).
[S] Recommended ranges as reported in *Best Management Practices Guide for Producing Container-Grown Plants* (Yeager et al., 2007).

IBA + 500 ppm NAA. *Illicium parviflorum* and *Ilex cornuta* 'Dwarf Buford' terminal cuttings were prepared as 3- to 4-inch wounded cuttings and treated with 3000 ppm IBA + 1500 ppm NAA. Dip'N Grow® (Dip'N Grow Inc., Clackamas, Oregon) was used for all IBA + NAA formulations. All cuttings were stuck into deep 606 cell packs (205 cm^3 per cell) filled with the following substrate treatments: pine bark fines (screened at 0.25 inch), Fafard® 3B (Fafard Inc., Anderson, South Carolina), construction grade sand, perlite, vermiculite, and HydRocks (screened to 0.19 in.). Cuttings were placed under intermittent mist (5 sec/10 min) in a glass greenhouse. Cuttings were harvested on 12 Feb. 2008 (150 days after sticking) and roots were rated on a quality scale of 1 to 5 (1 = nonrooted cuttings and 5 = greatest quality). Quality of roots was rated respective to the population of cuttings being rated for each species. Fresh root and shoot weights were recorded and rooting percentage was calculated.

The experimental design was a randomized complete block design with six treatments and six blocks. Each pack contained six cuttings (six subsamples) for each treatment. Data was analyzed using generalized linear mixed models [binomial distribution and logit link function for rooting response (presented as percent rooted); normal distribution and identity link function for all other response variables] with the GLIMMIX procedure of SAS (Version 9.1; SAS Institute, Cary, North Carolina, June 2006 release). Substrate was included in the model as the fixed factor and block as a random factor. Comparison of least squares means was carried out with a multiple-comparison-adjusted significance level of 0.05 using the simulation-stepdown method.

RESULTS

***Elaeagnus* ×*ebbingei*.** Based upon a quality scale, cuttings rooted in HydRocks was similar in quality to vermiculite, Fafard 3B, and perlite; cuttings in pine bark received a lower rating (Table 2). No significant differences occurred in root weight across treatments. Cuttings rooted in HydRocks were similar to all treatments in shoot weight (Table 2).

***Forsythia* ×*intermedia*.** Superior and similar root quality ratings were obtained with *F.* ×*intermedia* cuttings rooted in pine bark, Fafard 3B, vermiculite, and HydRocks, while sand and perlite produced the poorest root quality ratings (Table 2). Fresh root weights of cuttings rooted in Fafard 3B and vermiculite were similar and had high root weights. Cuttings rooted in HydRocks were similar to cuttings in pine bark, sand, and perlite in root weight. Cuttings in Fafard 3B, pine bark, and vermiculite were all similar in shoot weight (Table 2). The high root and shoot weights of cuttings in Fafard 3B treatments could be attributed to its containing a starter fertilizer charge that was absent from all other treatments.

***Ilex cornuta* 'Dwarf Burford'.** Cuttings rooted in pine bark, Fafard 3B, sand, and vermiculite were all similar in root quality (Table 2). Perlite produced the lowest quality roots of any treatment. No differences occurred among cuttings across treatments in root weights. Cuttings rooted in HydRocks were similar to cuttings in all other treatments in shoot weight (Table 2).

***Illicium parviflorum*.** Cuttings rooted in pine bark, Fafard 3B, and vermiculite were similar in rooting and had the highest root quality ratings and root weights among treatments (Table 2). Cuttings rooted in perlite were similar to cuttings

Table 2. Rooting response of five woody species rooted in six different substrates.

	Rooting (%)	Root quality rating [Z]	Root (g)[Y]	Shoot (g)[Y]
Elaeagnus ×*ebbingei*				
Pine bark	89 a[Y]	2.7 c[Y]	0.60 a	1.83 b
Fafard 3B	97 a	3.6 ab	0.69 a	2.01 ab
Sand	97 a	3.0 bc	0.60 a	2.20 a
Perlite	94 a	3.6 ab	0.63 a	2.17 ab
Vermiculite	97 a	3.8 a	0.64 a	1.88 ab
HydRocks®[X]	94 a	3.9 a	0.85 a	2.14 ab
Forsythia ×*intermedia*				
Pine bark	100 a	3.9 a	1.85 bc	1.5 abc
Fafard 3B	100 a	4.1 a	2.48 a	1.72 a
Sand	100 a	3.0 b	1.61 c	1.24 c
Perlite	100 a	2.4 b	1.74 bc	1.31 bc
Vermiculite	100 a	4.1 a	2.13 ab	1.66 ab
HydRocks®	100 a	4.0 a	1.59 c	1.32 bc
Ilex cornuta 'Burfordii Nana'				
Pine bark	97 a	3.7 ab	0.51 a	2.61 ab
Fafard 3B	97 a	4.1 ab	0.54 a	2.52 ab
Sand	97 a	3.6 ab	0.51 a	2.82 a
Perlite	84 a	1.9 c	0.41 a	2.72 ab
Vermiculite	97 a	4.4 a	0.53 a	2.31 b
HydRocks®	95 a	3.3 b	0.56 a	2.45 ab
Illicium parviflorum				
Pine bark	99 a	4.0 a	1.95 a	2.92 a
Fafard 3B	97 a	4.3 a	1.73 ab	2.75 a
Sand	97 a	3.1 bc	1.35 bc	2.65 a
Perlite	99 a	2.6 c	1.17 c	2.39 a
Vermiculite	99 a	4.3 a	1.69 ab	2.58 a
HydRocks®	99 a	3.3 b	1.45 bc	2.80 a
Lagerstroemia 'Natchez'				
Pine bark	92 a	4.3 a	1.04 ab	1.77 a
Fafard 3B	94 a	4.1 ab	0.85 ab	1.63 a
Sand	95 a	3.1 cd	0.75 b	1.56 a
Perlite	86 a	2.7 d	0.89 ab	1.32 a
Vermiculite	97 a	4.4 a	1.15 a	1.53 a
HydRocks®	97 a	3.5 bc	0.85 ab	1.46 a

[Z] 1 = non-rooted and 5 = greatest root quality.

[Y] Means within a column and species that are followed by the same letter are not significantly different at the 0.05 level according to the simulation-stepdown method.

[X] Screened to ≈ 0.47 cm(0.19 in.).

rooted in sand and HydRocks in root weight. Excluding pine bark, cuttings rooted in HydRocks were similar in root weight to cuttings rooted in all other treatments. Cuttings in all treatments produced similar results in shoot weight (Table 2).

***Lagerstroemia* 'Natchez'.** Cuttings rooted in pine bark, vermiculite, and Fafard 3B were similarly high in root quality (Table 2). Cuttings rooted in perlite and sand were low in root quality. Root weight of cuttings rooted in HydRocks was similar among all treatments (Table 1).

DISCUSSION

Rooting percentages were high (84% to 100%) and were similar for all substrate treatments across all five species. Cuttings in HydRocks rooted as well as those in conventional substrates in most cases for all species in this study (Table 2). As a propagation substrate, HydRocks could have greater utility than conventional substrates when ease of bare-rooting is taken into account. Offshoot production of mondo grass grown in HydRocks-grown plants were bare rooted twice as fast as plants grown in pine bark-based substrates (Pickens and Sibley, 2006: Pickens et al., 2008) Washing roots with high pressure water is generally used in bare-root liner production. During this study we observed that most cuttings rooted in HydRocks would not require high pressure water to remove substrate from roots. In similar studies we observed that HydRocks aggregates could be removed with a simple shake when substrate was allowed to dry slightly before harvest. Use of HydRocks in propagation has some sustainability advantages. Because HydRocks does not degrade over time, it could potentially be reused for years without replacement. As mentioned previously, bare-rooting of HydRocks grown plants requires less water during harvest. When rooting in an in-ground bed with a re-usable substrate production cost is also lowered because substrate materials are purchased once and there is no cost associated with purchasing plastic containers. The results of this study suggest that HydRocks can be used as a successful rooting substrate for *E. ×ebbingei, F. ×intermedia, I. cornuta* 'Dwarf Burford', *I. parviflorum*, and *L.* 'Natchez'. More work is needed to determine how fertilizer and water requirements might be modified to improve growth of cuttings rooted or held for an extended period of time in a fired clay aggregate such as HydRocks.

LITERATURE CITED

Blythe. E.K., J.L. Sibley, K.M. Tilt, and **B. Zinner.** 2005. Monolithic slag as a substrate for rooting and bare-rooting stem cuttings. J. Environ. Hort. 23:67–61.

Buamscha, G., and **J. Altland.** 2005. Pumice and the Oregon nursery industry. Digger 49(6):18–27.

Fain, G.B., and **K.L. Paridon.** 2004. Production of bare root *Ophiopogon japonicus* using calcined clay as a growth substrate. South. Nurs. Assoc. Res. Conf. Proc. 49:313–316.

Pickens, J.M., and **J.L. Sibley.** 2006. Evaluation of HydRocks as substrate component of horticulture crops. South. Nurs. Assoc. Res. Conf. Proc. 51:314–316.

Pickens, J.M., G.B. Fain, J.L. Sibley, C.H. Gilliam, and **J.W. Olive.** 2009. Evaluation of clay aggregates in perennial offshoot production. J. Environ. Hort. 27:1–6.

Yeager, T., T. Bilderback, D. Fare, C. Gilliam, J. Lea-Cox, A. Niemiera, J. Ruter, K. Tilt, S. Warren, T. Whitwell, and **R. Wright.** 2007. Best management practices: Guide for producing nursery crops. 2nd ed. Southern Nursery Assoc. Atlanta, Georgia.