Effects of Media Quality

On Foliage Species

by

Kathryn C. Shelby

Department of Horticultural Sciences

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Dr. John W. Kelly

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ABSTRACT

Three foliage species *Brassaia arboricola*, *Brassaia actinophylla*, and *Dracaena marginata* were evaluated for growth and quality in a simulated interior environment for six weeks. They were planted in each of four growing media: 1) Metro Mix 200, 2) 50% peat moss:50% perlite, 3) Fisons Sunshine Mix, Blend No. 1, and 4) 10 parts pine bark:3 parts peat moss:2 parts sand. Growth parameters measured were plant height, leaf area, root and shoot dry weights, and chlorophyll a and b content. Media pH and bulk density were also measured. Few significant results were obtained for *B. arboricola* or *B. actinophylla*. *D. marginata* showed a significant increase in height and leaf area in the bark:sand: peat mix. Root dry weight decreased significantly in Fisons and shoot dry weight decreased significantly in Metro Mix 200, peat:perlite, and Fisons. Chlorophyll a content increased significantly in Metro Mix 200 and chlorophyll b content increased significantly in bark:sand:peat. Quality ratings showed that the bark:sand:peat mix produced plants significantly higher in quality than Fisons Sunshine Mix for *D. marginata* but no significant differences in quality between media were obtained for the other species. Media pH showed little change over time, but bulk density increased significantly in Metro Mix 200, peat:perlite, and Fisons.

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This work is dedicated to my parents, B. G. and Wanda Shelby, and to my brother Gilbert. Without my family's love and support, I could not have accomplished what I have in my career.

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INTRODUCTION

Production of foliage plants has increased tremendously in recent years. Current sales figures in the major producing states are nearly six times those of ten years ago (1,14). This trend is due in large part to the recent growth of the interior landscape industry (12).

Interior landscaping involves placing flowering and foliage plants in the interior of a building in a design that's both aesthetically pleasing and functional (18). Since the plants must remain in near-perfect condition while on display, careful attention must be paid to both the growing and maintenance environments. A key factor in the production of quality foliage plants is the growing medium (22).

A growing medium must provide four basic functions to a plant (24, 26):

1) Support- to anchor the plant and hold stems in an upright position; however, the mix should be light weight enough to handle plants easily.

2) Moisture- medium must retain sufficient available water to meet plant requirements from one irrigation to another.

3) Nutrients- medium must contain the essential elements in an available form and in sufficient quantity.

4) Oxygen- when oxygen is deficient, water is not absorbed in sufficient quantity to offset the loss from transpiration, so the

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followed scientific format very well

plant will wilt; soil needs large pores that drain faster so soil is better aerated.

In addition to these functions, a medium used in the interiorscape must have good water holding capacity to allow for only periodic maintenance (18). Most interior landscape companies maintain plants on a weekly basis.

incorporate into #2 above

There is no single best growing medium for all foliage plants (16, 28). One should select media components based on meeting plant requirements, availability, uniformity, and cost. The medium should be sterile and reproducible (4, 26, 28).

Some of the more frequently used medium components and their characteristics are listed below (26):

peat moss- good water and nutrient retention, large pores, acidic pH.

vermiculite- light weight, high water holding capacity, provides good aeration, med-high nutrient holding capacity

sand- provides aeration

perlite- light weight, provides aeration

bark- good water and nutrient retention, provides aeration.

LITERATURE REVIEW

When growers began producing ornamental plants in containers, they first tried to improve native soils for containers. Problems arose because these soils were too variable in physical characteristics (2).

The first attempts to standardize soil mixes came from the John Innes Research Station in England (2, 29). The mixes developed were combinations of soil and organic amendments, but uniformity could only be attained by using a closely defined soil type which was not economical for most growers. This problem and increasing transportation costs led researchers to look for a soilless growing medium (2, 6).

Soilless mixes were developed at several universities including Cornell (5), University of California- Berkeley (3), Texas A&M (15), and the University of Florida (28). There is no one best mix for all plants (16, 28), but a good growing medium will produce uniform, quality plants in the shortest time with the lowest total production costs (28).

Many soilless mixes are peat moss-based, in varying proportions with other aggregates (2, 24). Most contain from 50 to 100 percent peat moss. Peat became an important part of soilless mixes because of its high water holding capacity ~~and high~~ air capacity (2). Conover and Poole (11), Fonteno et al. (16), and Love (23) found that peat-based mixes promoted quality root development if well aerated. Peat is also relatively stable and has a low nutrient status, so it provides a uniformity of background making consistent formulation easy (2).

The low nutrient status makes fertilization very important in media that do not contain soil. Mastalerz (24) found that growth of potted chrysanthemums in soilless media was best when fertilizer was applied at each irrigation.

Poole and Conover (28) suggested some standards for potting mixes, including bulk density of dry medium ranging from .15 - .75 gm/cc^3 and a pH range of 5.5 - 6.5.

Bulk density is an expression of soil weight and takes into consideration solids and pore spaces within a known volume. Soils with high bulk densities are generally "tight" and those with low bulk densities are "open". If a mix is too tight it will hold too much water in its pore spaces, not allowing for sufficient air for healthy root development (4). Fonteno, Cassel, and Larson (16) found that bulk density increases over time due to settling of the medium, but reaches a point of stabilization.

pH is an important consideration because it controls the availability of nutrients to the plant. Within the range suggested, the essential elements are available for uptake by the plant's root system (26). Conover and Poole (13) found that root grade and plant quality were higher at a near-neutral pH than at a slightly acid pH.

Brown and Emino (6) stated that although there have been attempts to relate plant growth with the physical properties of the medium, the plant itself remains the single most important factor in evaluating growing media.

A medium optimal for plant growth is also optimal for growth of fungal pathogens. Plants in a stressed environment such as low light conditions are particularly susceptible to pathogen infestation.

Many interior landscape situations, such as where food and drinks are served, cannot have chemicals sprayed due to the potential dangers. Therefore, diseases must be treated in other ways. Biological controls of fungal pathogens are beneficial fungi which attack the harmful fungi and are much safer than fungicides.

Two such beneficial fungi are *Gliocladium virens* and *Trichoderma* spp. They have enzymes which digest the harmful pathogen. Not much previous work has been done on biological control of fungi, but if effective this could be a possible alternative to chemical controls in interior landscapes.

OBJECTIVES

1) To determine growth characteristics of three foliage species in four growing media

2) To determine overall plant quality as affected by growing media

3) To make recommendations on interior landscape media requirements based on the results

4) To determine the effectiveness of biological control of *Rhizoctonia* root rot in foliage species

MATERIALS & METHODS

Experiment 1

Three foliage species popularly used in interior landscapes were selected for this experiment: Brassaia arboricola, Brassaia actinophylla, and Dracaena marginata. These plants were selected based on availability and adaptability to interior environments (18). Four growing media were used: 1) Metro Mix 200 containing peat moss, perlite, vermiculite, granite sand, macro- and micro-nutrients, and a wetting agent; 2) 50% peat moss: 50% perlite; 3) Fisons Sunshine Mix, Blend No. 1 containing peat moss, vermiculite, macro- and micro-nutrients, and a wetting agent; and 4) 10 parts pine bark: 3 parts peat moss: 2 parts sand.

The plants were received as rooted cuttings planted in four-inch pots. The existing soil was washed off the roots and 25 plants per species were transplanted into each medium in six-inch pots.

The plants were grown to maturity in the greenhouse for two months in a completely randomized design. They were grown under 50% shade, watered as needed, and fertilized at every watering with Peter's 20-20-20 at a concentration of 200 ppm N, P_2O_5 and K_2O.

At the end of eight weeks, the plants were moved to a simulated interior environment for a period of six weeks. Conditions in the interior environment included a temperature of 21°C and light intensity at plant height between 2.9-3.4 $\mu Em^{-2}s^{-1}$. The plants were watered as needed on a weekly basis with reverse-osmosis water and not fertilized (9).

Growth characteristics including plant height, leaf area, chlorophyll a and b content, root dry weight, and shoot dry weight were measured at the beginning and end of the six-week period. Five plants per treatment were harvested after the six-week duration in the interior environment.

Growth parameters were measured at 0 and 6 weeks as follows:

Plant Height- measured from the rim of the container to the growing point.

Leaf Area- all foliage was harvested from the plant and leaf area was measured on a digital leaf area indicator.

Chlorophyll Content- eight 6mm diameter leaf discs were punched from 8 different leaves on the plant and placed in test tubes containing 8 ml N,N-Dimethyl formamide. The test tubes were covered with parafilm and refrigerated for 48 hours. Absorbance was read on a Spectronic 21 at 664 and 647 nanometers for chlorophyll a and b, respectively.

Dry Weights- harvested roots and shoots were placed in paper bags in a $70^{o}C$ drying oven for 72 hours and then weighed.

Before plants were harvested at six weeks, appearance was rated qualitively based on a scale developed for each species. Each plant received a rating between 1 and 10, with 1 being dead and 10 being superior. The scales were based on pigmentation, uniformity, height, and overall appearance (9).

Qualitative Scale:

1- dead

3- sparse foliage, pale color

5- acceptable

8- full, dark green color

10- superior

Soil pH and bulk density were measured at 0 and 6 weeks as follows:

pH- defined as the logarithm of the reciprocal of the total hydrogen ion activity in the media leachates. One part air-dried medium was mixed with five parts distilled deionized water in a plastic cup, stirred at 30 and 60 minutes, and filtered with Whatman #41 filter paper (21,24). pH was measured with an Amber Science Solution Analyzer Model 4503A.

Bulk Density- defined as the weight of the medium sample divided by the total volume of the medium. Oven-dried media samples were allowed to rehydrate to the ambient humidity. Samples of about 250 ml were placed in a 1-liter graduated cylinder and packed by firmly tapping the cylinder 20 times on a hard surface. The weight and volume were recorded (21).

Experiment 2

A second experiment was conducted to compare the effectiveness of biological controls and fungicide treatments of *Rhizoctonia solani* root rot fungus on foliage plants. Eight strains of *Rhizoctonia* were isolated from different plant species including cotton, chrysanthemums, impatiens, and several turf grass species. Isolates were cultured on PDA media in a sterile lab environment. (ref)

Epipremnum aureum, *Philodendron scandens*, and *Brassaia arboricola* plants were innoculated with the pathogen. Two methods of innoculation were employed: 1) agar plugs placed directly into root zone in media, 2) slurry of hyphae and sterile distilled water incorporated into media.

In the first phase of the experiment, seedlings with well established root systems were innoculated using both innoculation procedures. During the second phase, only unrooted cuttings of *E. aureum* were innoculated with the hyphal slurry.

Roots of plants which developed disease symptoms were surface sterilized and cultured on PDA media to check for hyphal growth. Plants were then re-innoculated to complete Koch's Postulates. Less than 1% of plants developed disease symptoms and no plants did when re-innoculated, so the experiment was terminated.

RESULTS & DISCUSSION

Experiment 1

In this experiment, T_1 is considered the beginning of the six-week period in the interior environment. T_2 is the end of the six-week period. Results for each plant species used are discussed separately.

Brassaia arboricola

Results for *B. arboricola* are shown in Table 1. Leaf area increased significantly over time in the peat:perlite mix. Collard et al. (7) and Conover and Poole (10) found that shade grown foliage grew larger and thinner when placed indoors to allow for more efficient low-light photosynthesis.

Dry root weight showed a significant decrease over time in Metro Mix 200, Fisons, and the bark:sand:peat mix and dry shoot weight decreased significantly in Metro Mix 200. Chlorophyll a content showed a significant increase over time in the bark:sand:peat mix. Milks et al. (25) found that lower light levels reduced leaf and root carbohydrate content, while chlorophyll content increased.

Analysis of the quality ratings for this species showed that there were no significant differences between the four media.

Brassaia actinophylla

Results for *B. actinophylla* are shown in Table 2. Leaf area decreased significantly over time with Fisons Sunshine Mix, probably due to more leaf drop in this medium. Dry shoot weight showed a

TABLE 1 - Results between Treatments for *B. arboricola*[z]

		Height (cm)	Leaf Area (cm^2)	Chlorophyll a (A_{664})	Chlorophyll b (A_{647})	Dry Root Wt. (g)	Dry Shoot Wt. (g)
Metro Mix 200	y T_1	23.5a	1241a	.839a	.526a	7.04a	13.7a
	T_2	21.8a	1373a	.836a	.584a	3.13b	10.7b
Peat:Perlite	T_1	21.6a	887b	.763a	.490a	3.77a	10.6a
	T_2	18.1a	1163a	.924a	.558a	2.90a	9.09a
Fisons Sunshine Mix	T_1	26.7a	1493a	.875a	.572a	6.35a	13.4a
	T_2	23.5a	1484a	.926a	.595a	3.41b	11.6a
Bark:Sand:Peat	T_1	26.2a	1208a	.689b	.442a	5.38a	12.8a
	T_2	30.6a	1378a	.808a	.478a	3.34b	12.3a

[z]Numbers with same letter following showed no significant differences at the 5% level by what statistical test?

y - define codes.

TABLE 2 - Results between Treatments for B. Actinophylla[z]

		Height (cm)	Leaf Area (cm^2)	Chlorophyll a (A_{664})	Chlorophyll b (A_{647})	Dry Root Wt. (g)	Dry Shoot Wt. (g)
Metro Mix 200	T_1	7.02a	533a	.506b	.331b	1.11a	3.21a
	T_2	7.61a	609a	.688a	.420a	.928a	2.79a
Peat:Perlite	T_1	7.82a	489a	.550b	.360b	.992a	3.23a
	T_2	7.76a	626a	.695a	.440a	.838a	2.67a
Fisons Sunshine Mix	T_1	7.08a	591a	.544b	.352b	1.07a	3.78a
	T_2	6.48a	457b	.652a	.426a	.832a	1.99b
Bark:Sand:Peat	T_1	7.66a	521a	.519b	.335b	1.19a	3.71a
	T_2	7.87a	589a	.577a	.368a	1.06a	2.79b

[z]Numbers with same letter following showed no significant differences at the 5% level.

significant decrease in Fisons and the bark:sand:peat mix. Hartley (20) showed that very low light intensities result in sparse shoot growth and foliage.

Chlorophyll a and b content showed significant increases over time in all four media. Conover and Poole (7) found that chlorophyll content increased in all plants grown under shade and placed in a low-light interior environment. Plants grown under shade have more irregularly dispersed chloroplasts than sun-grown leaves, which appears to be a mechanism for increasing collection of low and/or diffuse light in heavily shaded situations.

There were no significant differences between the four media in plant quality and appearance.

Dracaena marginata

Results for *D. marginata* are shown in Table 3. Leaf area and height showed significant increases in the bark:sand:peat medium. Poole and Waters (27) found that peat:bark mixtures produced more growth in foliage plants than other peat-based mixes.

Dry root weight decreased significantly in Fisons Mix and dry shoot weight decreased significantly in Metro Mix 200, peat:perlite, and Fisons. A significant increase in chlorophyll a content occurred in Metro Mix 200 and chlorophyll b content increased significantly in the bark:sand:peat mix. Milks et al. (25) found decreased dry shoot and root weights and increased chlorophyll content and growth in *Ficus benjamina* under low-light conditions.

Analysis of the quality ratings showed that the bark:sand:peat mix produced significantly higher quality plants than Fisons.

TABLE 3 - Results between Treatments for *D. marginata*[z]

		Height (cm)	Leaf Area (cm^2)	Chlorophyll a (A_{664})	Chlorophyll b (A_{647})	Dry Root Wt. (g)	Dry Shoot Wt. (g)
Metro Mix 200	T_1	7.72a	837a	.667b	.477a	3.37a	6.17a
	T_2	9.08a	941a	.793a	.483a	2.99a	4.96b
Peat:Perlite	T_1	8.82a	872a	.714a	.442a	4.01a	6.42a
	T_2	7.21a	804a	.735a	.478a	3.08a	4.49b
Fisons Sunshine Mix	T_1	8.92a	865a	.636a	.412a	3.20a	5.96a
	T_2	8.12a	696a	.685a	.440a	1.89b	3.85b
Bark:Sand:Peat	T_1	7.88b	762b	.635a	.340b	3.42a	3.17a
	T_2	10.1a	969a	.629a	.411a	3.01a	5.24a

[z]Numbers with same letter following showed no significant differences at the 5% level.

Physical Properties of Media

Bulk density and pH measurements of the four media are shown in Table 4. pH showed a significant decrease over the six-week period in peat:perlite and bark:sand:peat. Conover and Poole (13) found that the influence of soil pH on water holding capacity was variable.

Bulk density increased significantly over time in all media except bark:sand:peat. Fonteno et al. (16) found that bulk density increases (or decreases?) for a period of several weeks due to settling, but reaches a point of stabilization. The bark:sand:peat medium has a much higher bulk density than the other media, which could be an important factor in media selection.

Cost Analysis

The cost per cubic foot of each medium is shown in Table 5 (16,20). Metro Mix 200 had the highest cost at $3.39/ft^3 and the bark:sand:peat mix had the lowest cost at .58/ft^3. Labor costs of mixing the peat:perlite and bark:sand:peat mixes were not figured into these prices. Therefore, direct cost comparisons are invalid.

TABLE 4 - Physical Properties of Media[z]

		pH	Bulk Density (g/cc)
Metro Mix 200	T_1	7.02a	0.186b
	T_2	7.02a	0.221a
Peat:Perlite	T_1	6.40a	0.105b
	T_2	5.83b	0.144a
Fisons Sunshine Mix	T_1	6.98a	0.111b
	T_2	7.01a	0.126a
Bark:Sand:Peat	T_1	7.27a	0.459a
	T_2	7.07b	0.479a

[z]Numbers with the same letter following showed no significant differences at the 5% level.

TABLE 5 - Cost Analysis of Media

Media	Cost/Ft^3
Metro Mix 200	\$3.39
Peat:Perlite	\$2.18[a]
Fisons Sunshine Mix	\$2.40
Bark:Sand:Peat	\$ .58[a]

[a]Labor costs in mixing these media are not included in these figures. Therefore, cannot directly compare; also must factor in equipment cost

Experiment 2

This experiment had to be terminated because disease symptoms did not develop on plants. Two factors could have contributed to this: 1) environmental conditions may not have been optimum for disease development, and 2) Rhizoctonia strains used may not have an effect on the foliage species used.

main reason – pathological studies such as this are 'tricky', and often meet with results such as this.

CONCLUSION

Few significant differences were obtained for *Brassaia arboricola* or *Brassaia actinophylla*. Media treatments did produce differences in growth and quality for *Dracaena marginata*. These results cannot be conclusive for all foliage species. Selection of a growing medium must be an individual choice for each grower and each species.

Further studies need to be conducted on biological control of fungal diseases in ornamentals. This area of research could have a significant impact on the floriculture industry as biological controls are safer to use than fungicides.

LITERATURE CITED

1. Agricultural statistics. 1983. 1000% increase in foliage market over past decade. Foliage Digest 6(3):13.

2. Atkins, P. S. 1983. For peat's sake, it's an excellent medium. Foliage Digest 6(5):13-14.

3. Baker, C. F. 1957. The U.C. system for producing healthy container-grown plants. Univ. of CA Div. of Agr. Sci. Manual 23.

4. Ball, Vic (Ed.). 1985. Ball Red Book. 14th ed. Reston Pub. Co., Inc., Reston, VA.

5. Boodley, J. W. and R. Sheldrake, Jr. 1967. Cornell peat-like mixes for commercial plant growing. Cornell Agr. Ext. Bul. 1104.

6. Brown, O. D. R. and E. R. Emino. 1981. Response of container-grown plants to six consumer growing media. HortScience 16(1): 78-80.

7. Collard, R. M., J. N. Joiner, C. A. Conover and D. B. McConnell. 1977. Influence of shade and fertilizer on light compensation point of *Ficus benjamina*. J. Amer. Soc. Hort. Sci. 102:447-449.

13. ~~9~~ ~~8~~. Conover, C. A. and R. T. Poole. 1984. Acclimatization of indoor foliage plants. Hort Reviews 6:119-154. AVI Pub. Co., Inc., Westport, Conn.

8. ~~9~~. Conover, C. A. and R. T. Poole. 1975. Acclimatization of tropical trees for interior use. HortScience 10:600-601.

11 ~~10~~. Conover, C. A. and R. T. Poole. 1982. Acclimatizing tropical foliage plants for sale and shipping. Foliage Digest 5(2):7-9.

10 ~~11~~. Conover, C. A. and R. T. Poole. 1981. Effect of soil compaction on physical properties of potting media and growth of Pilea pubescens Liebm. 'Silver Tree'. J. Amer. Soc. Hort. Sci. 106(5):604-607.

12 ~~12~~. Conover, C. A. and R. T. Poole. 1983. Influence of light intensity and fertilizer levels on interior growth of Dieffenbachia and Schefflera. Foliage Digest 6(1):3-4.

9 13. Conover, C. A. and R. T. Poole. 1979. Influence of pH on activity of Viterra 2 and effects on growth and shelf life of Maranta and Pilea. Proc. Fla. St. Hort. Soc. 92:332-333.

14. Crop Reporting Board. 1973-1981. Economics and Statistics Service. U.S.D.A.

15. Dewerth, A. F. and R. L. Odom. 1960. A standard light weight growing medium for horticultural crops. Texas Agr. Expt. Sta. MP 420.

16. Fonteno, W. C., D. R. Cassel and R. A. Larson. 1981. Physical properties of three container media and their effect on poinsettia growth. J. Amer. Soc. Hort. Sci. 106(6):736-741.

17. Frett, John. 1985. Personal communication. Texas A&M University, College Station.

18. Furuta, Tok. 1983. Interior Landscaping. Reston Pub. Co., Inc., Reston, VA.

19. Harpool Seed Co. 1985. Personal communication. Houston, TX.

20. Hartley, David E. 1981. Light requirements for foliage plants. Foliage Digest 4(11):12.

21. Hughes, Henry F. 1985. Rice hulls as a medium component for container grown oaks. MS Thesis, Texas A&M University, College Station.

22. Knauss, J. F. 1979. Facts and suggestions for producing and maintaining pathogen and pest-free soil media. Foliage Digest 2(3):16.

23. Love, Joe W. 1978. Basics of bark media. Foliage Digest 1(8):4-6.

24. Mastalerz, John W. 1977. Growing media, p. 341-421. In: The Greenhouse Environment. John Wiley & Sons, Inc., New York.

25. Milks, R. R., J. N. Joiner, L. A. Garard, C. A. Conover and B. Tjia. 1979. Influence of acclimatization on carbohydrate production and translocation of *Ficus benjamina* L. J. Amer. Soc. Hort. Sci. 104(3):410-413.

26. Nelson, Paul V. 1981. Root media, p. 158-205. In: Greenhouse operation and management. Reston Pub. Co., Inc., Reston, VA.

28 ~~27~~. Poole, R. T. and W. E. Waters. 1972. Evaluation of various potting media for growth of foliage plants. Proc. Fla. St. Hort. Soc. 85:395-398.

27. ~~28~~. Poole, R. T. and C. A. Conover. 1979. Light weight soil mixes. Foliage Digest 2(6):8-11.

29. Poole, R. T., C. A. Conover and J. N. Joiner. 1981. Soils and potting mixtures, p. 179-202. In: J. N. Joiner (ed.) Foliage plant production. Prentice-Hall, Inc., Englewood Cliffs, NJ.