Effects of Growing Medium, Shade Level and Fertilizer Rate on Cladode Color, Yield and Vase Life of *Ruscus hypophyllum*[1]

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Abstract

Ruscus hypophyllum L. (Israeli or Holland ruscus) liners were grown from tissue culture in either Florida sedge peat:builders' sand (3:1 by vol) or a commercial soilless medium (Vergro container mix A) until they were large enough to produce harvestable stems for use as cut foliage (florists' greens). Once established, plants were grown in a shadehouse at 50% or 70% shade and were fertilized with either 5, 10 or 15 g (0.18, 0.35 or 0.53 oz) of 17N-2.6P-10K (17-6-12) controlled-release fertilizer applied every 2 months. Cladode color was not affected by fertilizer level but was affected by both shade level and growing medium, with shade level the more important of the two. Stem numbers and average fresh weight were affected by an interaction of fertilizer rate and growing medium. Maximum stem number occurred at the high fertilizer rate in Vergro and the medium rate in peat:sand while average stem weight was greatest at the high rate in peat:sand and at the medium rate in Vergro. Total stem fresh weight increased as a linear function of fertilizer rate, was 12% higher from peat:sand compared to Vergro, and was 14% greater under 50% compared to 70% shade. There were no commercially significant treatment effects on vase life.

Index words: cut foliage, postharvest

Species used in this study: Israeli or Holland ruscus (*Ruscus hypophyllum* L.)

Significance to the Nursery Industry

Ruscus hypophyllum, under the conditions of this experiment, can be grown from tissue culture liners to salable size in less than two years. Mean vase life of harvested stems stored for 1 month at 4°C (39°F) exceeded 42 days, regardless of growing medium, production shade level, or fertilizer rate. The positive response to increasing fertilizer rate and/or shade level suggests that this crop might give higher production than was obtained in this experiment. With demand for durable cut foliages increasing, *R. hypophyllum* appears to have significant potential.

Introduction

Ruscus hypophyllum L. (Israeli or Holland ruscus) is an evergreen, semiwoody groundcover that can be used in the landscape in warm climates, can be grown indoors, and produces stems that are popular as cut foliage (florists' greens) for use in floral arrangements (3). Unlike the more widely available *R. aculeatus*, *R. hypophyllum* cladodes (branches modified to function as leaves) lack a spine (1) making it easier to handle. Until recently, commercial production of *R. hypophyllum* stems for florists' use has been mainly in Israel and the Middle East (5). In the 1989/90 season, Israel exported 60 million stems of *R. hypophyllum* (4). Plant material, mostly produced from tissue culture, is now available in the United States. Although *R. hypophyllum* is reportedly tolerant of drought and heavy shade (2), specific commercial production information is not available. Such information would help cut foliage producers grow this crop in the U.S. Therefore, an experiment was initiated to grow liners of *R. hypophyllum* produced from tissue culture into plants producing commercially harvestable stems using factorial combinations of growing medium, shade level and fertilizer rates.

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Materials and Methods

On August 14, 1987, *Ruscus hypophyllum* liners from tissue culture (Ceres 2000, Winter Haven, FL 33880) were transplanted, one per pot, into square 10 cm (4 in) plastic pots containing either Florida sedge peat:builders' sand (3:1 by vol.) or a commercial soilless medium (Vergro container mix A) without superphosphate (Verlite Co., Tampa, FL 33687). Pots were held on raised benches in a glasshouse which provided approximately 85% shade. Air temperatures were maintained between 18°C and 35°C (65°F–95°F). Pots were watered two days a week and fertilized once a week with a 20N-8.6P-16.6K (20-20-20) liquid fertilizer containing micronutrients (Miller Chem. and Fert., Hanover, PA 17331). Nitrogen concentration in the fertilizer water was 400 mg/L (400 ppm).

After six months, each plant was potted into a 20 cm (8 in) round plastic container using the same medium in which the plant had been growing. These plants were moved to a shadehouse where knitted polypropylene shade fabric panels provided 50 or 70% shade. Pots were then fertilized with either 5, 10 or 15 g (0.18, 0.35 or 0.53 oz) of Sierra 17N-2.6P-10K (17-6-12) controlled-release fertilizer with micronutrients (Grace/Sierra, Milpitas, CA 95035) applied every 2 months. Each factorial combination of treatments was replicated four times with individual plants being the experimental units. Soil moisture was brought to container capacity 3 times a week (May through October) or 2 times a week (November through April) using overhead irrigation.

Stems were hand harvested for yield and vase life determinations in May 1989, March 1990, and February and

August 1991. All stems harvested were over 25 cm (10 in) in length. Stems used for vase life determinations, 3 to 15 per pot depending on availability, were immersed in water for 5 minutes prior to being placed in polyethylene-lined waxed corrugated fiberboard boxes. Packed boxes were held for one month at 4°C (39°F). After storage, stems were recut and inserted into new blocks of standard floral foam (Smithers-Oasis, Kent, OH 44240) held in plastic trays filled with deionized water. Temperatures in the holding room were maintained at 23°C ± 2°C (74°F ± 4°F) and relative humidities ranged from 40% to 90% to simulate home/office conditions. Cool white fluorescent lamps provided 15 $\mu mol \cdot s^{-1} \cdot m^{-2}$ (approx. 117 foot-candles) of photosynthetically active radiation 12 hours per day. Vase life was terminated when cladodes (stem tissue modified to function as leaves) showed symptoms of desiccation or chlorosis.

Cladode color was measured using an electronic tristimulus chroma meter (CR-100, Minolta, Ramsey, NJ 07446). Chromaticity was measured in Commission Internationale d'Eclairage L★a★b★ color space coordinates and chroma C★ was calculated as:

$$C^* = \sqrt{a^{*2} + b^{*2}}$$

A larger L★ indicates a lighter color, a larger negative a★ indicates a stronger green color, a larger b★ indicates a brighter yellow color, and in this case, a larger C★ indicates a lighter green tone. Tristimulus chroma meter readings have been shown to be useful in providing rapid, non-destructive estimation of leaf chlorophyll content in situ (7).

Statistical analysis was by analysis of variance with regression analysis being used to describe effects of fertilizer treatments when that main effect was significant.

Results and Discussion

Cladode color. Cladode color (L★, a★, b★, and chroma C★) results were similar at the different harvests so only the results from February 1991 are reported. Cladode color was not affected by fertilizer level (data not shown), but both shade level and growing medium did affect color (Table 1). Shade level was the more important of the two as the sum of squares attributable to shade level accounted for 58 to 80% of the total treatment sum of squares. Growing medium sum of squares accounted for only 5 to 9% of the total for L★, a★, b★, and chroma C★ (data not shown). There were no treatment interactions.

Cladodes produced under 50% shade were lighter (L★) and more yellow green (a★, b★, C★) than cladodes produced under 70% shade. Cladodes of plants growing in Vergro and the peat:sand medium were equally dark (L★) but cladodes produced by plants growing in Vergro were slightly brighter green (a★, b★, C★) than those produced using the peat:sand mix. *R. hypophyllum* stems produced under 70% shade were judged to be more marketable than those produced under 50% shade because of their darker green color, but the color difference due to growing medium was not considered commercially significant.

Yield. Both the number of stems produced and average stem weight were affected by the interaction of growing medium and fertilizer rate (Table 2). The number of stems produced increased with increasing fertilizer rate for Vergro but was greatest at the middle fertilizer rate for the peat:sand mix. Average stem weight increased with fertilizer rate in the peat:sand mix but was highest at the middle fertilizer rate in Vergro. Although shade level had no effect on average stem weight, average stem length was 10% longer when produced under 70% (38.2 cm [15 inches]) compared to 50% (34.7 cm [13.7 inch]) shade ($P < 0.0001$).

All three main effects influenced the fresh weight of stems produced (Table 3) and there were no interactions. Yield increased linearly as fertilizer rate increased—with increases of 25 and 37%, respectively, for the middle and high rates compared to the low rate. Stem fresh weight was 14% higher under 50% shade than 70% shade. Fresh weight yield was 12% higher from pots containing the peat:sand mix than from those containing Vergro. This was probably due to the greater water holding capacity of the peat:sand mix (65% versus 53%, by volume, for Vergro) and the relatively infrequent (for potted material) watering. Individual watering regimes based on need might have eliminated this difference due to growing medium.

Table 1. Effects of production shade level and growing medium on cladode color[z] of *Ruscus hypophyllum*.[y]

	Color			
Treatments	L★	a★	b★	C★
Shade levels				
50%	38.9	−12.8	15.4	20.0
70%	36.8	−11.1	11.8	16.3
Growing media[x]				
peat:sand	37.8	−11.7	13.2	17.6
Vergro	37.8	−12.3	14.0	18.6
Level of significance[w]				
Shade level	0.0003	0.0001	0.0001	0.0001
Growing medium	ns	0.0184	0.0367	0.0282

[z]A larger L★ indicates a lighter color, a larger negative a★ indicates a stronger green color, a larger b★ indicates a brighter yellow color and a larger $C^* = \sqrt{a^{*2} + b^{*2}}$ indicates a lighter green tone.

[y]Measured on February 4, 1991. Only the main effects of shade level and growing medium affected cladode color and there were no significant interactions ($P < 0.05$).

[x]Florida sedge peat:builders' sand ratio was 3:1 (by vol) and Vergro used was container mix A without superphosphate.

[w]ns = not significant, numbers indicate calculated probabilities that the differences between main effects means within a column were due to chance alone.

Table 2. Interaction of growing medium and fertilizer rate on stem production and average stem weight of *Ruscus hypophyllum*.[z]

Growing media	17-2.6-10 fertilizer (g/pot)	Number of stems	Average stem weight (g)
Florida sedge peat:builders' sand (3:1, by vol)			
	5	47	7.2
	10	60	7.0
	15	54	7.9
Vergro container mix A			
	5	40	6.9
	10	44	8.3
	15	60	7.0

[z]Growing medium × fertilizer rate interaction significant at $P = 0.034$ level.

Table 3. Effects of growing medium, shade and fertilizer levels on yield of *Ruscus hypophyllum*.[z]

Treatments	Fresh weight of stems (g)
17-2.6-10 fertilizer (g/pot/application)[y]	
5	306
10	381
15	420
Shade level	
50%	393
70%	345
Growing medium[x]	
peat:sand	391
Vergro	346
Significance[w]	
Fertilizer rate	0.0003
Linear	0.0001
Quadratic	ns
Shade level	0.0270
Growing media	0.0344

[z]Only the listed main effects affected yield. There were no significant interactions ($P < 0.05$).

[y]Applied every two months.

[x]Growing media were Florida sedge peat:builders' sand (3:1, by vol) and Vergro container mix A without superphosphate.

[w]ns = not significant, numbers indicate calculated probabilities that the differences between main effects means were due to chance alone.

Vase life. There were no consistent treatment effects on vase life (Table 4). Fronds harvested in May 1989 were not affected by treatments and the overall average vase life of stems exceeded 105 days (median vase life = 108 days). Production shade level was the only factor that affected the vase life of stems from the second harvest; however, the 12% increase in vase life of stems produced under 70% compared to 50% shade was not of commercial significance since the average vase life of stems from 50% shade was 181 days (median vase life = 188 days).

Growing medium had a statistically significant effect on vase life of stems harvested in February 1991, but again the longer (approximately 1 week) vase life of stems produced using Vergro compared to peat:sand was not of practical importance since the stems produced in peat:sand lasted over six weeks on the average (median vase life = 39 days). The overall median vase lives for the three harvests were 108, 194, and 43 days, respectively, for 1989, 1990, and 1991. Reasons for this variation in vase life are unknown at this time. However, other cut foliage crops, for example leatherleaf fern [*Rumohra adiantiformis* (Forst.) Ching], have exhibited similar variations in vase life (6, 8).

Table 4. Effects of shade and fertilizer levels on vase life (in days) of *Ruscus hypophyllum* from three harvests.[z]

Treatments	Harvest date		
	May 1989	March 1990	Feb. 1991
Shade level			
50%	110	181	46
70%	107	202	46
Growing medium[y]			
peat:sand	105	184	43
Vergro	111	199	50
Significance[x]			
Shade level	ns	0.0251	ns
Growing medium	ns	ns	0.0407

[z]Only the listed main effects affected vase life. There were no significant interactions ($P < 0.05$).

[y]Growing media were Florida sedge peat:builders' sand (3:1, by vol) and Vergro container mix A without superphosphate.

[x]ns = not significant, numbers indicate calculated probabilities that the differences between main effects means, within columns, were due to chance alone.

Under the conditions of this experiment, all *Ruscus hypophyllum* liners were capable of producing commercially harvestable stems within 21 months of planting. *R. hypophyllum* tolerated both growing media and shade levels tested. Stems produced during this experiment exhibited very long vase life regardless of treatments. *R. hypophyllum* appears to have potential as a cut foliage crop for production in Florida.

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