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Production of Pre-finished Northern Woody Plants in Florida[1]

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Abstract

The physiological and economic feasibility of producing pre-finished woody landscape plants normally considered restricted to northern climates in the southern states was investigated. Several years of work in Florida indicates that this production scheme is feasible for *Ilex* × *meserveae* S.Y. Hu 'Blue Prince', *Viburnum opulus* L., *V.* × *juddii* Rehd. and *Berberis thunbergii* DC. 'Crimson Pigmy'. *Euonymus alata* Thunb.'Compacta', *Acer rubrum* L., *Magnolia* × *soulangiana* Soul. -Bod. and *Hamamelis virginiana* L. were not viable candidates under production practices considered to date. The estimated costs for producing these plants in 930 cm^3 (1 qt) containers is $0.66, with about 38% of this cost associated with labor.

Index words: photoperiod, chilling, propagation
Species used in this study: Blue prince holly (*Ilex* × *meserveae* S.Y. Hu 'Blue Prince'); European cranberry bush (*Viburnum opulus* L.); Judd viburnum (*Viburnum* × *juddii* Rehd.); Crimson pigmy barberry (*Berberis thunbergii* DC); Winged spindle tree (*Euonymus alata* Thunb. 'Compacta'); red maple (*Acer rubrum* L.); Saucer magnolia (*Magnolia* × *soulangiana* Soul.-Bod.); Witch hazel (*Hamamelis virginiana* L.); cranberry cotoneaster (*Cotoneaster apiculata* Rehd. & E.H. Wils.).

Introduction

Some woody landscape species produced in the extreme southern regions of the United States are suited for planting in northern landscapes. However, there are many northern plants that cannot be produced in this region. These northern plants cannot tolerate the extreme and prolonged heat typical of summers in southern states. The authors suggest a production scheme for pre-finished woody plants in which cuttings from northern plants could be propagated during midsummer in Florida, grown through the winter in unheated structures and shipped to northern nurseries in the spring after a flush of growth. Northern growers could eliminate the need for heated propagation and holding areas and purchase a larger plant from Florida in the spring than they could produce in the same time period.

Daylength differences in northern and southern latitudes have been shown to limit the growth and survival of northern plants in Florida (5). Broschat and Donselman (1) found that extended daylength increased the winter growth rate in 5 of 7 tropical trees grown in Fort Lauderdale, Florida. Van de Werken et al. (4) found that a liner production system which included overwintering in a greenhouse and continuous light produced larger liners of some deciduous trees, but that size advantage may not be apparent after 2 years of field culture.

Ilex crenata 'Hetzi', *Juniperus horizontalis* 'Wiltoni', *Lagerstroemia indica* 'Centennial' and *Viburnum* × *juddii* were larger if overwintered at 18°C (64° F) with long days compared to short days or 4°C (39° F) (2). A 9 hr exposure to 20°C (68° F) resulted in an enhanced growth response of *Pseudotsuga menziessi* seedlings to chilling treatments 4°C (39° F) intended to induce dormancy (3).

A significant problem with vegetative propagation of deciduous plants appears to be spring bud break (2, 3, 6). Initiation of vegetative growth after rooting and not percent rooting may be the limiting factor in such a production system. There are, however, several questions that must be addressed before the possibility of producing prefinished woody plants in Florida could become a reality. Proper propagation and overwintering container sizes, propagation and production growth media, daylength and transplanting schedules must be determined for each species with potential for this production system. Plant dormancy requirements and methods to satisfy such requirements must be considered. Economic feasibility is also an integral part of such a project.

Preliminary research during initiated in Gainesville, Florida during 1982. The first 2 years resulted in a suitable production system of rooting in flats and transplanting to 930 cm^3 (57 in^3) containers in 8 to 12 weeks (unpublished data). It was determined that an extremely well-aerated propagation and growth medium was required under the management provided.

The objectives of this research were to determine: (a) rooting and survival rate under the discussed system; (b) the effects of overwintering environment on growth and development; and (c) the estimated production costs. This was a cooperative effort in 1986 and 1987 of researchers in Florida, Ohio and Pennsylvania.

Materials and Methods

Experiment 1. Effects of overwintering daylength and the provision of a chilling period on the survival and subsequent spring growth of selected northern plants were investigated. Cuttings were taken in Ohio and Pennsylvania on August 8–10, 1985 and shipped by air freight to Gainesville, FL. Stem tip cuttings of *Ilex* × *meserveae* 'Blue Prince', *Vi-*

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burnum opulus, V. × *juddii, Berberis thunbergii* 'Crimson Pygmy', *Euonymus alata* 'Compacta', *Acer rubrum, Magnolia* × *soulangiana* and *Hamamelis virginiana* were stuck in a perlite: vermiculite (1:1 by vol) medium in 20 × 30 × 13 cm flats (8 × 12 × 5 in) after a 5-second dip of the basal end in a K-IBA solution of 5,000 to 8,000 ppm, depending on species. Cuttings were placed under intermittent mist and 30% light exclusion. Rooted cuttings were transplanted into 930 cm^3 containers (1 qt) in 8 to 12 weeks using the a pine bark and Canadian peat moss (3:1 by vol) medium amended with 5.3, 3.0 and 1.8 kg m^{-3} (9, 5 and 3 lbs yd^{-3}) of Osmocote 18N-2.6P-10K (18-6-12), dolomitic limestone and Perk, respectively, and moved to an unshaded greenhouse [10°C min (50° F); 30°C (86° F) max] or 30% shade house. The shade house was covered with a single layer of clear polyethylene from December 15 until February 28. The polyethylene on the sides of this house were raised on clear, warm days to prevent maximum daily temperatures from rising above 30°C (86° F). Winter temperatures did not fall below −5°C (23° F) outside, −1°C (30° F) in the shade house and 10°C (50° F) in the greenhouse. Short day and long day treatments (night interruption from 10:00 pm to 2:00 am) were provided in the greenhouse. Natural day length was maintained in the shade house. The greenhouse-short day, greenhouse-long day and the shade house (natural daylength) treatments were factorially combined with chilling exposures of 7°C (45° F) for 0, 30, 60 and 90 days. The chilling environment was provided by a walk-in cooler with a 10 hr photoperiod (90–100 μ mol m^{-2} sec^{-1}). Scheduling of the chilling treatments was such that all treatments were completed in February, and plants were subsequently acclimated for 2 weeks in 80% shade in the greenhouse described above. Plants were then returned to the environment in which they had been grown before chilling treatments. Ten individual plant replicates per treatment were utilized for each species.

Percent rooting was recorded at transplanting to 930 cm^3 (1 qt) containers. Percent survival, defined as rooted cuttings that initiated a spring growth flush, and shoot and root dry weights were recorded in May 1986.

Experiment 2. Cuttings of *Ilex* × *meserveae* 'Blue Prince', *Viburnum* × *juddii Euonymus alata* 'Compacta', *Berberis thunbergii* 'Crimson Pygmy' and *Cotoneaster apiculatus* were taken in Maryland on July 28, 1986 and shipped via air freight to Gainesville, FL. On July 29, 1986 cuttings were trimmed, dipped in 3000 ppm IBA talc, stuck in flats, as previously described, with perlite and vermiculite (1:1 by vol) and placed under intermittent mist in 50% shade.

After 10 weeks, percent rooting of cuttings was recorded and 90 rooted cuttings of each species were transplanted to containers using the pine bark and peat medium previously described. Forty-five plants were placed in a greenhouse where minimum temperatures were maintained above 10°C (50° F) and 45 were placed in an unheated greenhouse. The lowest temperature recorded in the unheated house was 1.6°C (34° F) as a result of a mild winter. Maximum day temperatures ranged from 29 to 35°C (84 to 95° F). A night interruption was provided in both greenhouses from 10:00 pm to 2:00 am. Plants were fertilized weekly with 200 ppm N from 20N-8.6P-16.6K (20-20-20).

Survival, defined as cuttings that initiated a spring growth flush, was recorded and shoot and root dry weights were determined May 28, 1987.

Production cost estimates. The model for cost estimation consisted of a 9.1 × 24.4 m (30 × 80 ft) metal frame, quonset style greenhouse including frame, doors, fans and vents, heater, thermostats, benches, irrigation system, construction costs and other durable goods with a total initial cost of $8,278 (Table 1). Assuming an 8% charge on the average investment and by using straight-line depreciation, the total annual fixed costs were $1,449 (Table 4). Estimated variable costs were $10,040. The annual production cycle was assumed to be 10 months and the greenhouse would remain vacant for 2 months.

Variable costs per crop were estimated based on a system where cuttings would be purchased and shipped from northern climates. Enough cuttings would be stuck in flats under intermittent mist to yield 18,400 liners for transplanting to 930 cm^3 (1 qt) containers. It was assumed that labor requirements would average 20 hrs per week for this one-greenhouse system and 80% of the cuttings stuck would root.

Results and Discussion

Experiment 1. Excellent rooting was achieved in *Ilex* × *meserveae* 'Blue Prince' (Ohio) (96%), *I.* × *meserveae* 'Blue Prince' (Pennsylvania) (83%), *Viburnum opulus* (Pennsylvania) (88%), *V. opulus* (Ohio) (78%), *V.* × *juddii* (Ohio and Pennsylvania) (86%), *Hamamelis virginiana* (Pennsylvania) (92%), *Euonymus alata* 'Compacta' (Pennsylvania) (97%) and *Berberis thunbergii* 'Crimson Pygmy' (Ohio) (66%). Unacceptable rooting percentage included *Acer rubrum* (Ohio) (25%), and *Magnolia* × *soulangiana* (Ohio and Pennsylvania) (32%). Nursery operators have reported much greater success in rooting *Acer* cuttings than reported here.

There were no interactions between overwintering environment and chilling treatments. The *Acer* and *Magnolia* were dropped from the study due to an inadequate number of acceptable rooted cuttings. The 7°C (45° F) treatments for 30, 60 or 90 days did not enhance plant quality or spring bud break (survival) for plants studied (data not shown).

Table 1. Initial investment, years of life, depreciation and average investment for greenhouse production of prefinished woody plants.

Item	Years of life	Costs ($)	Depreciation[y] ($)	Average Investment ($)
Frame	15	2,400.00	160.00	1,200.00
Door	15	125.00	8.33	62.50
Polylock	5	210.00	42.00	105.00
Heating equipment, etc.	15	757.00	50.67	378.50
Thermostats	15	210.00	14.00	105.00
Ventilation	10	1,865.00	186.50	932.50
Irrigation/Fertilization equipment	10	950.00	95.00	475.00
Benches	5	200.00	40.00	100.00
Construction	15	540.00	36.00	270.00
Mulch and double poly	2	865.00	432.50	432.50
Spray suits	3	75.00	25.00	37.50
Shade cloth and sprayer	5	81.00	16.20	40.50
Total		8,278.00	1,106.20	4,139.00

[z]Quonset type greenhouse.

[y]Straight-line depreciation used.

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Overwintering in a greenhouse (10°C min/30°C max) with long days resulted in the greatest survival of *V. opulus* and *V. × juddii* (approximately 65%) compared to the greenhouse/short day treatment and shade house/natural daylength conditions (Table 2). All *Ilex* and most *Berberis* survived, initiating spring vegetative growth regardless of overwintering treatment while most *Hamamelis* did not initiate shoot growth. Except for *V. opulus* from the Ohio source, shoot and root dry weights of all plants produced under greenhouse/long day conditions were larger than those produced under the other treatments. Future research should be conducted to determine whether or not these differences would be maintained after transplanted to larger containers or into the field.

Experiment 2. More than 90% of the *Ilex, Viburnum* and *Berberis* cuttings rooted, while 70% of the *Cotoneaster* and 63% of *Euonymus* cuttings rooted. Almost all the *Ilex, Berberis*, and *Cotoneaster* initiated spring shoot growth, regardless of overwintering treatment (Table 3). Slightly more viburnums from the heated house survived than from the unheated greenhouse but the average root weight was greater if overwintered in the unheated greenhouse. No *Euonymus* rooted cuttings initiated growth after transplanting, regardless of treatment. Yawney (6) found that a growth flush after rooting and before dormancy of *Acer* increased the winter survival and a 7500 ppm GA spray induced budbreak. *Ilex* shoot dry weight was slightly less in the heated overwintering environment but root dry weights were 41% greater for plants overwintered in the heated greenhouse (Table 3). *Cotoneaster* root dry weight was 33% greater in the greenhouse without heat. *Berberis* root dry weights were unaffected by the overwintering environment, but the shoot dry weight was 53% greater in the unheated house. *Viburnum* shoot dry weights were not different.

Table 2. Effect of overwintering treatment on survival (initiation of spring growth flush) and shoot and root dry weights of selected woody plants. (recorded May, 1986)

Treatment	survival (%)	Shoot dry weight (g)	Root dry weight (g)
	Viburnum × judii (OH)[z]		
GH/SD[y]	75	3.0a	2.4a
GH/LD	100	7.5b	3.6b
SH/ND	88	3.4a	1.8a
	Viburnum opulus (OH)		
GH/SD	37	28.3	11.1
GH/LD	60	30.8	11.2
SH/ND	25	.	
	Viburnum opulus (PA)[z]		
GH/SD	.	.	.
GH/LD	88	38.1a	20.9a
SH/ND	48	16.4b	3.6b
	Ilex × meserveae "Blue Prince" (OH)		
SD/GH	100	20.4a[x]	2.2a
GH/LD	100	30.3b	6.7b
SH/SD	100	17.0a	2.8a
	Ilex × Meserveae '"Blue Prince" (PA)		
GH/SD	100	10.9a	2.0a
GH/LD	100	19.4b	3.4b
SH/SD	100	9.5a	1.8a
	Berberis thunbergii 'Crimson Pigmy' (OH)		
GH/SD	88	2.1a	2.1a
GH/LD	75	5.4b	2.8a
SH/ND	62	.	.
	Hamamelis virginiana (OH)		
GH/SD	12	.	.
GH/LD	38	3.5	6.0
SH/ND	28	.	.

[z]OH and PA refer to cutting sources in Ohio and Pennsylvania, respectively.

[y]Abbreviation: GH—greenhouse, SH—shade house, SD—short day length, LD—long days, ND—natural day length.

[x]Means separated by HSD, 5% level.

Production Cost Estimates. Start-up costs for a 9.1 × 24.4 m (30 × 80 ft) quonset type greenhouse were estimated to be $8,278 (Table 1). The annual production budget (Table 4) that contains variable costs of operation and the fixed costs associated with the investments described in Table 1 indicates that the cost per plant is about $0.66. Durable goods that would be depleted over several production cycles are double poly covering, shade cloth, sprayer, spray suits and mulch. These items would be replaced as indicated in the years-of-life columns in Table 1. The total annual costs of replacing the items would vary as shown in Table 5. A saleable yield of 17,480 plants (95% of 18,400 plants) was assumed. It is assumed that a loan to cover 50% of the cost of items of at least 10 years' life would be made. Loan repayment would occur over 5 years, starting in the second year with only an interest payment in the first year. Over the first 7 years the mean cash costs per plant would be $0.68. For years 2 to 7 the corresponding value is $0.65.

Table 3. Effect of overwintering temperature on survival (initiation of spring growth flush) and the shoot and root dry weight of selected northern species grown in Florida. (recorded May, 1987).

Overwintering treatment	Survival (%)	Shoot dry weight (g)	Root dry weight (g)
	Ilex × meserveae 'Blue Prince'		
Heated	100	27.7*[z]	8.8*
Unheated	100	31.0*	5.2
	Viburnum × juddii		
Heated	100	5.1	3.5*
Unheated	80	5.0	3.8
	Berberis thunbergii 'Crimson Pigmy'		
Heated	100	1.4*	2.7
Unheated	100	3.0	2.2
	Cotoneaster apiculatus		
Heated	100	21.6*	10.3
Unheated	96	21.5	15.4

[z]Significantly different at 5% probability level.

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Table 4. Estimated annual costs for greenhouse production of pre-finished woody plants in Florida.

Item	Unit	Quantity	Price ($)	Cost ($)
Variable Costs				
Cuttings	number	23000	0.04	920.00
Containers	number	18400	0.063	1,159.20
Medium	cubic yards	97	30	2,910.00
Fertilizer	26 lb. sacks	4	16.75	67.00
Pest Control	season	1	39.06	39.06
Labor	hours	1040	4.2	3,368.00
Irrigation	season	1	120	120.00
Heating	months	3	30	90.00
Prop. flats	number	640	0.054	34.56
Prop. medium	cubic ft.	228	1.46	332.88
Total variable cost				$10,040.70
Fixed Costs				
Land	acre	0.25	100	25.00
House[zy]	house	1.0	313.33	313.33
Equipment[zx]	house	1.0	497.45	497.45
Durables[zw]	house	1.0	612.94	612.94
Total fixed costs				$ 1,448.72
TOTAL COSTS				$11,489.42

[z]Fixed costs for house, equipment and durables include depreciation plus 8% of average investments.

[y]Includes costs for frame, door and construction.

[x]Includes costs for ventilation, irrigation and heating equipment and thermostats.

[w]Includes costs for polylock, benches, spraysuits, shade cloth and mulch and double poly.

Table 5. Annual cash expenditures, years 1–7, for greenhouse production of prefinished woody ornamentals.

Year	Annual Loan Payment[zy] ($)	Annual Operation[y] ($)	Replacement[w] ($)	Down Payment[z] ($)	Total Expenditure ($)
1	342.35	10,040.70	1,431.00	3,423.50	15,237.55
2	903.12	10,040.70	0.00	0.00	10,943.82
3	903.12	10,040.70	865.00	0.00	11,808.82
4	903.12	10,040.70	75.00	0.00	11,018.82
5	903.12	10,040.70	865.00	0.00	11,808.82
6	903.12	10,040.70	491.00	0.00	11,434.82
7	0.00	10,040.70	940.00	0.00	10,980.70

[z]Based upon a down payment of 50% for items with an economic life of at least 10 years.

[y]Loan paid years 2 through 6; only interest was paid in year 1.

[x]Includes all annual variable costs.

[w]Includes original purchase of items with economic lives of 5 years or less as well as replacement in appropriate years.

The difference is caused by the expenditure for the initial investment. Labor accounts for 38% of total costs (Table 4). During the years of loan payment (1–6) labor accounts for 36.8% of cash outlays and would account for about 40% of cash costs after the loan was paid (Table 5). Transportation costs from Florida to Ohio or Pennsylvania were estimated to be $0.10 to $0.25 per plant, depending upon exact location and quantity of plants shipped.

These data indicate that potential does exist for production of pre-finished northern plants in the deep south. During some winters in Gainesville, FL, heating would not be necessary for winter protection and the economic benefit derived from supplemental night heating to stimulate plant growth is questionable. However, heating equipment and energy costs are only a small portion of the total cost per plant. The efficiency of the operation, especially labor, the cost of capital and the market acceptance of the product are the 3 critical factors for the success of such a production scheme.

Significance to the Nursery Industry

The prudent nursery operator is constantly investigating the possibilities of new markets and products, and ways to reduce production costs and risks of crop failure. This research introduced the idea of a production system involving propagation and overwintering of northern plant species in Florida. The goal of such a system would be to provide large vigorously growing liners that northern growers could purchase for transplanting into larger containers or the field. The system trades reduced overwintering costs in Florida for increased transportation costs and hopefully results in a superior quart-size liner for nurseries in northern states. *Viburnum opulus, V. × juddii, Ilex × meserveae* 'Blue Prince' and *Berberis thunbergi* 'Crimson Pigmy' offer the greatest potential for this production system among the 8 plants tested to date. Transplanting rooted cuttings from flats to 930 cm^3 (1 qt) containers with a porous medium and overwintering them in a minimally heated or unheated greenhouse with a 4 hour night interruption comprises the optimum production system tested.

Literature Cited

1. Broschat, T.K. and H. Donselman. 1986. Influence of photoperiod on winter growth of seven species of tropical landscape trees. J. Environ. Hort. 4:60–62.

2. Daggett, C. and G.L. Klingaman. 1985. Influence of photoperiod and minimum overwintering temperature on growth of nursery liners. J. Environ. Hort. 3:25–27.

3. Lavender, D.P. and S.G. Stafford. 1984. Douglas-fir seedlings: some factors affecting chilling requirement, bud activity, and new foliage production. Can. J. For. Res. 15:309–312.

4. van de Werken H., J.M. Ruter, and D.B. Williams. 1985. Field performance of three shade tree species as affected by linear production systems. Proc. Southern Nurserymens Assoc. Res. Conf. 30:107–109.

5. Whitcomb, C.E. and J.N. Joiner. 1970. Growth of Northern Conifers in Florida. Florida Nurseryman 15(10):7,36.

6. Yawney, H.W. 1984. How to root and overwinter sugar maple cuttings. Amer. Nurseryman. 160(8):95–96, 98–99, 102.

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