Table 1. Average nutritional status of 'Glory' poinsettia leaves at anthesis from plants treated with varying levels of Mo during growth.

Element	Tissue composition[z]
	% dry wt
N	4.49 ± 0.33[y]
P	0.82 ± 0.15
K	3.42 ± 0.43
Ca	1.42 ± 0.26
Mg	0.54 ± 0.08
	mg/kg dry wt
Al	41 ± 10.6
B	44 ± 6.6
Cu	15 ± 2.3
Fe	149 ± 47.8
Mn	325 ± 111.5
Na	268 ± 42.4
Zn	81 ± 27.8

[z]Foliar concentrations reported were averaged over six Mo treatment, three replications per treatment.
[y]± SD.

height, bract display diameter, or days from start of 8-hr photoperiods to flower for either of the cultivars. 'Dark Red' will not be discussed further, since leaf samples were not analyzed. Plants of 'Glory' averaged 33.9 cm in height, 37.6 cm bract display diameter, and 74.6 days from start of 8-hr photoperiod to flower. Molybdenum treatments did not affect foliar concentrations of any elements measured except Mo (Table 1, Fig. 1), and levels reported in Table 1 are averaged over Mo treatments. No visible phytotoxic effects due to Mo were observed on any plants, and no plants exhibited Mo deficiency symptoms.

The experimental results suggest that poinsettias are highly tolerant of Mo and will accumulate large concentrations of Mo in their leaves. Foliar concentrations >9 mg Mo/kg dry weight have been considered excess for poinsettias (10), but no phytotoxic effects were observed in this study, even for leaves containing 806 mg Mo/kg dry weight. Molybdenum did not affect the foliar content of other nutrients. Levels of all nutrients measured except Mo, P, and Zn were within the range considered normal to high for poinsettias (2, 4, 10). Phosphorus and Zn levels in all plants regardless of treatment were higher than suggested for poinsettias. Overall, no adverse effects of Mo were found within the range of Mo applied.

Molybdenum deficiency is a potential problem in poinsettias production. Since poinsettias appear to be highly tolerant to high Mo levels, the application of Mo at rates recommended should be applied as a preventative measure without concern for Mo toxicity.

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Production System Comparisons for Selected Woody Plants in Florida

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Abstract. **Quercus virginiana* Mill., *Magnolia grandiflora* L., *Liquidambar styraciflua* L., *Ulmus parvifolia* Jacq. 'Drake', *Lagerstroemia indica* L., *Ilex opaca* Ait. 'East Palatka', and *Pinus elliottii* Engelm. were transplanted from 3-liter containers into 36-cm-diameter fabric Field-Gro containers, directly in the field into 36-cm-diameter auger-dug holes, or into 36-cm-diameter × 33-cm-tall black plastic containers. After 1 year, measured growth parameters of the *Magnolia, Ulmus, Lagerstroemia,* and *Pinus* were not affected by production system. Dry weight of *Quercus* and *Liquidambar* roots in the "harvest zone" were greater for trees grown in the fabric Field-Gro containers than those grown directly in the field. *Quercus* height and total carbohydrate content of *Quercus* and *Magnolia* primary root samples were increased by the fabric container. The above-ground container system clearly was inferior to the field-grown systems for production of the *Quercus* and *Liquidambar* under the conditions of this study.**

The production of trees in the field in fabric containers has increased significantly in Florida and many other areas of the world during the past few years. The possible advantages of fabric root barriers for field production include increasing the portion of total tree roots harvested, decreased cost and seasonal constraints of conventional tree harvesting, and enhanced tree establishment in the landscape (5).

van de Werken (4) evaluated several fabrics for such a system in 1982 and concluded that strong, weld-woven fabrics with holes between 0.51 to 1.27 mm in diameter were effective barriers for large roots. Roots growing through the fabric were girdled, and structural root development outside the fabric barrier was limited. Reiger and Whitcomb (2) reported in 1983 on a spun-bonded fabric with a disk of 6-mil polyethylene placed

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Table 1. Effects of production system on growth and final weights of seven woody plants.

Production system	Height change (cm)	Stem diam change (cm)	Shoot fresh wt (g)	Root dry wt (g)[z] Total	Inside	Outside
			Quercus virginiana			
Fabric containers[y]	50 a[x]	2.5	1570 a	496	450 a	46
Field	52 a	2.3	2370 a	377	317 b	60
Container	32 b	2.1	920 b	279		
			Liquidambar styraciflua			
Fabric containers	41 a	4.4 a	2760 a	1444 a	1316 a	128
Field	46 a	3.8 a	2506 a	1066 b	934 b	132
Container	22 b	2.3 b	1201 b	554 c		
			Magnolia grandiflora			
Fabric containers	23	2.4	983	510	446	64
Field	27	2.0	875	367	335	32
Container	22	1.8	713	481		
			Ulmus parvifolia 'Drake'			
Fabric containers	78	2.9	2889	606	447	159
Field	77	3.1	2917	594	392	192
Container	67	2.8	2837	583		
			Lagerstroemia indica			
Fabric containers	62	2.7	2289	780	612	168
Field	68	2.4	2379	765	603	162
Container	56	2.5	2047	650		
			Pinus elliottii			
Fabric containers	29	3.4	1797	455	430	25
Field	26	3.1	1504	372	350	22
Container	26	3.1	1430	329		
			Ilex opaca 'East Palatka'			
Fabric containers	38	2.0	1005	291	264 a	27
Field	32	1.5	757	211	171 b	40
Container	37	2.0	955	234		

[z]Roots were harvested from: Inside = zone within the fabric container and comparable volume for unrestricted, field-grown trees; outside = soil volume remaining to a diameter of 90 cm and depth of 36 to 40 cm.
[y]Fabric container refers to a 36-cm-diameter Field-Gro container.
[x]Means within columns for each species separated by Duncan's multiple range test, $P = 5\%$. All other comparisons are not significant.

Table 2. Effects of production system on the starch and sugar content of primary root segments ≈ 15 to 18 cm radially from the stem.

Production system	Starch (% dry wt)	Sugar (% dry wt)	Total (% dry wt)
	Quercus virginiana		
Fabric container[z]	5.05*	5.64	10.69*
Field	4.28	3.73	8.01
	Magnolia grandiflora		
Fabric container	4.38	20.21*	24.59*
Field	3.64	12.28	15.92
	Liquidambar styracifIura		
Fabric container	5.72	7.07*	12.79*
Field	5.03	15.46	20.49
	Ulmus parvifolia 'Drake'		
Fabric container	8.36	7.90	16.26
Field	10.10	10.23	20.34
	Illex opaca 'East Palatka'		
Fabric container	7.84	6.86	14.70
Field	7.44	9.91	17.35

[z]Fabric container refers to a 36-cm-diameter Field-Gro container.
*Significantly different, $P = 5\%$.

in the bottom of the hole. Whitcomb (5) reported further advancements of the fabric root-restricting container in 1985, and suggested an increased carbohydrate reserve in stem and roots of trees grown in the fabric container compared to those grown directly in the field. Carbohydrate levels in plants have been shown to affect root initiation and development (1).

The fabric containers appear to offer a unique alternative to the nursery operator, but research data from Florida conditions have not been available. Therefore, research was conducted in Leesburg, Fla., at Holloway's Tree Farm in a Leon fine sand (sandy, siliceous, hyperthermic, Aeric Hapalaquads) from Apr. 1985 through Mar. 1986. The responses of seven species to rigid black plastic container, field, and fabric Field-Gro container production systems were determined.

Quercus virginiana (live oak), *Magnolia grandiflora* (southern magnolia), *Liquidambar styraciflua* (sweet gum), *Ulmus parvifolia* 'Drake'('Drake' elm), *Lagerstroemia indica* (crape myrtle), *Ilex opaca* 'East Palatka' ('East Palatka' holly), and *Pinus elliottii* (slash pine) were transplanted from 3-liter containers into three production systems: a) 36-cm-diameter × 36-cm-deep Field-Gro Containers (Root Control, Oklahoma City, Okla.) with field soil backfill, b) directly in the field into 36-cm-diameter auger-dug holes, or c) into 36-cm-diameter × 33-cm-tall black plastic, above-ground containers. Trees were transplanted into the field using an auger system (Hol-O-Fill, Tree Planting Systems, Orlando, Fla.). All plants were irrigated daily with 2 cm of water during the summer through low-volume spray emitters. This irrigation schedule, coupled with the drainage characteristic of the container medium and the field soil, eliminated the possibility of plant stress due to inadequate soil water and aeration levels.

In production systems a and b, the trees transplanted into the field were fertilized with 670 kg N/ha per year from Sierrablend 18–7–10 (18N–3P–8K) + iron (Sierra Chemical Co., Milpitas, Calif.). One-half of the fertilizer was incorporated at transplanting and one-half was surface-applied in a 36-cm-diameter area around the stem 6 months later. Micromax (micronutrient formulation by Sierra Chemical Co.) was incorporated in the backfill at 0.6 $kg \cdot m^{-3}$. The medium for container-grown plants consisted of 3 pine bark : 1 peat : 1 sand (by volume) amended with 1.2 $kg \cdot m^{-3}$ Micromax and 6.0 $kg \cdot m^{-3}$ Sierrablend 18–7–10 (18N–3P–K) + iron. Sierrablend was surface-applied at 50 g/container after 6 months.

The three production systems were replicated six times for each species in a randomized complete block design, and species were analyzed as separate experiments. Stem diameter and height measurements were recorded monthly and root dry weights and shoot fresh weights were determined after 1 year.

Roots from field-grown plants were harvested from two distinct zones. The inside harvest zone was the soil volume within the fabric Field-Gro container or within an equivalent 36 cm (diameter) × 36 cm (depth) soil volume for field-grown trees. The remainder of the soil volume to a diameter of 90 cm, and a depth of 36 to 40 cm was considered the outside harvest zone. All roots were harvested from container-grown plants without consideration of location. Roots were washed and oven-dried before weights were recorded. Root samples (2 to 3 cm in length) also were taken from primary roots just inside the fabric container (including the enlarged area behind the girdle) and from primary roots at the same radial distance from the stem of trees grown directly in the field. Soluble and structural carbohydrates were determined using procedures described by Stamps (3).

Production systems did not influence the change in height or stem diameter or shoot fresh weight for the *Magnolia, Ulmus, Lagerstroemia,* and *Pinus* (Table 1). Fabric container-grown or field-grown *Quercus* were taller than *Quercus* produced in containers. *Quercus* root dry weights were significantly greater inside the 36-cm-diameter fabric root-restricting containers than inside the 36-cm-diameter harvest zone of field-grown trees. There was no difference in total *Quercus* roots due to production system.

Liquidambar trees were 50% taller, with 43% greater stem diameter, 54% more shoot weight, and 56% more total root weight if grown in fabric Field-Gro containers or directly in the field than if grown in aboveground plastic containers (Table 1). There was 29% more sweet gum root dry weight harvested from within the fabric container than from the comparable harvest zone for field-grown trees without root restriction. Fifty percent of the *Liquidambar* trees produced one to four roots that penetrated the polyethylene bottom of the fabric containers. Some of these roots were ≥1.5 cm in diameter. Ninety-one percent and 87% of total *Liquidambar* root weights were in the inside harvest zone for the fabric container-grown and field-grown trees, respectively. However, many *Liquidambar* trees had a few roots that grew deeper than the harvest zone, including some of those planted in fabric containers.

Production systems did not influence shoot growth or total root dry weight of 'East Palatka' holly, but did affect root distribution (Table 1). The percentage of 'East Palatka' holly root weight in the fabric container or comparable harvest zone was greater for trees in the fabric containers (91%) than for field-grown (82%) trees. The percentage of roots in the inside harvest zone for fabric container-grown and field-grown trees did not differ for *Pinus, Magnolia, Ulmus,* or *Lagerstroemia.* There were 88%, 91%, 71%, 78%, and 94% of total root weights in the inside harvest zone averaged across both production systems for *Quercus, Magnolia, Ulmus, Lagerstroemia,* and *Pinus,* respectively.

Total carbohydrate content of primary root samples was greater in the *Quercus* and *Magnolia* if the roots had been restricted by the fabric containers than if grown directly in the field (Table 2). Total carbohydrate content of *Liquidambar* root samples was increased if trees had been grown directly in the field. An increased carbohydrate level in primary root tissue could accelerate root development after transplanting, assuming other environmental and physiological factors were not limiting. The primary contributor to these differences in total carbohydrate levels was the level of soluble sugars for *Magnolia* and *Liquidambar,* whereas starch was the major contributor in *Quercus.*

The effects of fabric containers for field production on growth and the portion of the total root system harvested appeared to be species-dependent. The fabric containers did not result in a growth advantage or increase the percent of roots harvested for *Magnolia, U. parvifolia* 'Drake', *Lagerstroemia,* or *Pinus,* compared to production directly in the field under the conditions described, but *Liquidambar* and *Quercus* responded positively. Producers must decide between these production systems based primarily on economic and marketing strategy factors or any differences in rate of establishment after transplanting. It was clear that container production, following management practices in this experiment, was inferior to either of the field production systems tested for *Quercus* and *Liquidambar.*

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Efficacy of Ancymidol, Daminozide, Flurprimidol, Paclobutrazol, and XE-1019 when Followed by Irrigation

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Additional index words. *Chrysanthemum morifolium*

Abstract. **Vegetative *Chrysanthemum morifolium* Ramat. 'Nob Hill' plants were treated with foliar sprays of ancymidol, daminozide, flurprimidol, paclobutrazol, or XE-1019 and then overhead-irrigated 0.5, 1, 2, 4, 8, or 24 hr later. Irrigation prior to 4 hr reduced the efficacy of daminozide but did not alter efficacy of other chemicals. Efficacy was not affected when similar plants were treated with a medium drench of the same chemicals, except daminozide, and followed with irrigation at 1, 24, or 48 hr. Chemical names used: α-cyclopropyl-α-(4-methoxyphenyl)-5-pyrmidinemethanol (ancymidol), butanedioic acid mono-(2,2-diemthylhydrazide) (daminozide), α-(1-methylethyl)-α-[4-(trifluoromethoxy)phenyl]-5-pyrimidinemethanol (EL-500) (flurprimidol), (±)-(*R**,*R**)-beta-((4-chlorophenyl)methyl)-α-(1,1-dimethylethyl)-1*H*-1,2,4-triazole-1-ethanol (PP-333) (paclobutrazol), and (E)-(*p*-chlorophenyl)-4,4-dimethyl-2-(1,2,4-triazol-1-yl)-1-penten-3-ol (XE-1019).**

Concern is often expressed by commercial growers about the reduced efficacy of growth-retardant chemicals when applications are followed by overhead irrigation or rain. Labels of two commercial growth retardants (B-Nine and Cycocel) indicate that overhead irrigation should be avoided for several hours after foliar application. Cathey (5) reported that the efficacy of ancymidol was not reduced by washing treated plants 5 min after foliar application, but that daminozide efficacy was reduced when treated plants were washed 1 hr after application compared to 24 hr. Very little is known about the effect of irrigation on efficacy of medium drench applications.

Paclobutrazol (1, 3, 6, 7) and XE-1019 (4, 8) are active on a broad range of container-grown ornamental species. Flurprimidol is an analog of ancymidol and is effective on several species (1, 2, 6). This study was designed to evaluate the effects of irrigation on the efficacy of growth retardants applied as a foliar spray or medium drench.

Rooted cuttings of *Chrysanthemum morifolium* 'Nob Hill' were planted one per 12.5-cm plastic container in Vergro Klay Mix (Verlite Corp., Tampa, Fla.). Plants were not pinched and were maintained vegetative by the use of incandescent lights from 2200 to 0200 HR daily. Normal irrigation was applied as needed through a tube system that delivered water to the medium surface without wetting the foliage. Plants were fertilized at each irrigation with a 20N–4.4P–16.6K

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