Biology and Management of the Eugenia Psyllid (*Trioza eugeniae* Froggatt)[1]

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Abstract

Management and biological studies were conducted on eugenia psyllid (*Trioza eugeniae* Froggatt) in California landscapes and at the University of California, Riverside (UCR) in 1989 and 1990. Eugenia psyllid females reproduced the year around in Ventura, California, and laid an average of 119 eggs per female at UCR. Shoot length and number of shoots after pruning were increased when an efficacious pesticide was applied at the time of pruning. Mavrik (fluvalinate) and Tame (fenpropathrin) provided excellent control of adult psyllids and were associated with increased quality of eugenia foliage. Sevin (carbaryl), Diazinon (diazinon), and Orthene (acephate) were not as effective as the pyrethroids in controlling this insect. Superior oil and Insecticidal soap did not control eugenia psyllid. Pruning as a treatment on individual shrubs was not an effective control of the insect, while pruning of an entire hedge was associated with dramatic decreases of psyllids.

Index Words: psyllid, pruning, shoot length, eugenia

Species used in this study: Australian Bush Cherry (*Syzygium paniculatum* Gaertn.); Compact Australian Bush Cherry (*Syzygium paniculatum* Gaertn. 'Compacta')

Insecticides used in this study: Orthene (acephate), O,S-Dimethyl acetylphosphoramidothioate; Mavrik Aquaflow (fluvalinate), (RS)-cyano-3-phenoxybenzyl (R)-2-|2-chloro-4-(trifluoromethyl)anilino|-3-methyl-butanoate|; Tame (fenpropathrin), -Cyano-3-phenoxybenzyl 2,2,3,3,-tetramethyl-1-cyclopropanecarboxylate; Sevin (carbaryl), 1-Naphthyl N-methylcarbamate; Diazinon (diazinon), O,O-Diethyl O-(2-isopropyl-4-methyl-6-pyrimidinyl)phosphorothiote; Volck Oil (superior oil); Safer's Insecticidal Soap (potassium salts of fatty acids).

Significance to the Nursery Industry

Damage caused to Australian bush cherry by the eugenia psyllid was best reduced by application of an efficacious insecticide. Psyllids were controlled with pyrethroid insecticides (Mavrik and Tame); insecticidal soap and oil sprays were not effective. Pruning has limited usefulness in preventing damage caused by eugenia psyllid on individual plants. When pruning is used as an adjunct management tool, all the affected plants should be sheared and the new growth protected with an effective insecticidal spray. No phototoxicity was observed with any material in these trials.

Introduction

The eugenia psyllid, (*Trioza eugeniae* Froggatt) a native of Australia, was first discovered in California in May 1988. The insect has spread quickly along coastal California, but has yet to be found widely in the hot inland valleys. Feeding and damage occur on *Syzygium paniculatum* Gaertn. (=*Eugenia myrtifolia*), commonly known as the Australian bush cherry, which is used extensively in California as a hedge plant or small tree. Eugenia psyllid damage has also been observed on juvenile foliage of *Metrosideros excelsus* Soland., the New Zealand Christmas Tree.

The adult psyllid is a chocolate brown and white, 2 mm (1/16-in) long, membranous-winged insect. Females deposit elongate yellow eggs on the new leaves and shoots of their host. After eggs hatch, newly emerged nymphs crawl to the undersides of leaves where they settle, become immobile and feed by sucking sap. As many as 50 nymphs may settle on a single leaf and commence feeding (4). Feeding causes a pit to develop around each yellowish, scale-like nymph. Excessive pit formation creates severely distorted or blistered leaves and shoots which appear stunted. Nymphs produce excrement in the form of tiny white pellets, some of which collects on foliage and becomes blackened from sooty mold growth. When mature, the nymphs transform into winged adults which escape through slits made in the exoskeleton of the last nymphal stage.

Experiments were conducted in 1989 and 1990 in Ventura and Santa Barbara counties to determine the best methods for control of eugenia psyllid in landscapes.

Materials and Methods

Biological Studies. Biological studies of the insect were conducted in Ventura County and at the University of California, Riverside, in 1989 and 1990. To determine oviposition behavior of eugenia psyllid, single female psyllids together with 2 males were caged on each of 9 *Syzygium paniculatum* Gaertn. in #1 nursery containers and held at a constant temperature of 25°C (77°F) with a 14:10 (L:D) hour daily photoperiod. When oviposition declined or ceased on three of the plants, new plants were substituted.

Two infested eugenia shrubs were sampled for adults approximately weekly from August 1989 until August 1990. Sampling was done by holding an 18.7 × 24.2 cm (8.5 × 11 in) opaque plastic board beneath each shrub, striking the foliage above sharply three times and quickly counting the adult psyllids dislodged on the board. Insects were returned

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to the shrub after counting. In this and in all Ventura County studies, sampling was performed by the same evaluator in a given experiment. Separate evaluators recorded all adult psyllid counts and unsightliness ratings in Santa Barbara County studies.

Management Trials. Six trials were conducted in Ventura and Santa Barbara counties to explore chemical and cultural controls of the psyllid. All spray and pruning trials used the randomized complete block design with five replications of each treatment. All spray applications were made to complete coverage with a hand operated CO_2-pressurized sprayer. Individual plants were treated on all exposed surfaces, while a plywood panel was held between plots during application to avoid drift. When hedges were treated, plots consisted of strips from the ground to the top of the hedge.

In Santa Barbara County, eugenia trees an estimated 8 m in length (26.4 ft) were selected to test the effectiveness of Orthene (Acecaps 97, acephate) applied as an implant. Eight trees were assigned as implant trees and eight trees were left untreated in a completely randomized design. Trees were implanted according to manufacturer's instructions, placing units at 1.57 cm (4 in) intervals around the trunk in a helical pattern.

Sampling for adult psyllids, using the plastic board as previously described, was conducted in all spray trials every seven days after application of treatments. The implant trial was sampled biweekly.

One eugenia hedge was partitioned into 0.61 m (2 ft) wide strips; ten shoots in each plot were tagged at a node with 3 mm (0.13 in) wide paper labels. Five of the ten shoots were sheared with scissors to simulate hedge pruning. The other five shoots were left unpruned. The insecticide treatments described for spray experiment 1 (Table 1) were then applied. Shoots were examined at four weeks for live nymphs, and at eight weeks for live nymphs, number of new shoots and shoot length. Nymphs were counted on adaxial and abaxial leaf surfaces formed beyond the tagged node. Shoot length was measured from the tagged node to the apical meristem. If more than one shoot developed, each shoot was measured; the average shoot length was used in comparisons.

To further test for the effectiveness of pruning for psyllid control, individual landscape plants were sprayed with Mavrik (fluvalinate) and left unpruned, pruned and sprayed, pruned but not sprayed or not sprayed or pruned (control). The pruning treatment removed all meristems (approx. 4.4 cm) (2 in) of shoot growth. Pruning was performed with a gasoline-powered hedge trimmer in this and subsequent pruning studies.

An unsightliness rating was developed to assess psyllid damage to eugenia foliage. The ratings ranged from 0, representing no trace of injury, to 5, representing severe disfigurement.

Sampling for adult psyllids was conducted in all pruning trials every seven days after initiation of treatments. Ratings were taken at the end of various experiments.

Results and Discussion

Biological Studies. The average number of eggs laid by all psyllid females under study was 119. Because females

Table 1. Evaluation of insecticides applied as sprays for control of eugenia psyllid.

	Rate (formulation)		Avg. no. psyllid adults per three beats after (weeks)[z]								
Insecticide	g, ml per 378.5 l	(lb, fl oz per 100 gal)	1	2	4	6	8	10	Unsightliness[y] rating	Psyllid[x] days	Regression[w] coefficient
			Experiment 1. Ventural County.[u]								
Mavrik 2 ec	295 ml	10 oz	4.4 c	0.6 b	6.8 b	13.2 c	4.2 b	4 a		0.82 b	
Insecticidal Soap	6.06 l	1.6 gal	15 ab	15.6 a	66.4 a	44.8 ab	16.46 a	4 a		5.1 a	
Soap + Mavrik	6.06 l + 295 ml	1.6 gal + 10 oz	3.6 c	1.4 b	4.8 b	14.8 c	5.4 b	6 a		0.94 b	
Orthene 75 sp	454 g	1.0 lb	6.2 bc	3.6 b	31.6 a	26.4 ab	12.2 a	6.8 a		2.5 b	
Untreated			19.6 a	10.8 a	66.0 a	82.4 a	17.4 a	5.6 a		5.9 a	
			Experiment 2. Santa Barbara County.								
Mavrik 2 ec	295 ml	10 oz	2.0 b	0.8 b	0.4 b	0.6 b	0.0 c		2.0 b	0.04 b	.626
Sevin 80 s	568 g	1.25 lb	5.0 ab	3.0 ab	1.2 b	2.6 b	4.0 a		2.0 b	0.18 b	(P = .015)
Diazinon 50 wp	454 g	1.0 lb	4.8 ab	7.4 ab	4.4 ab	7.6 ab	10.2 ab		2.8 ab	0.42 ab	
Superior Oil	7.57 l	2 gal	15.4 a	12.6 a	7.4 a	17.4 a	11.8 a		3.6 a	0.76 a	
Untreated			10.2 ab	8.0 ab	5.2 ab	8.6 ab	7.6 ab		3.6 a	0.48 ab	
			Experiment 3. Ventura County.								
Mavrik 2 ec	295 ml	10 oz	3.1 b	2.1 b	6.7 b	5.1 c	47.0 a		1.7 b	0.18 b	.875
Tame 2.4 ec	315 ml	10.7 oz	0.0 d	1.5 b	2.9 c	7.8 bc	48.9 a		0.2 c	0.04 b	(P = .001)
Orthene 75 sp	454 g	1.0 lb	2.6 bc	2.8 b	10.5 b	10.6 b	97.5 a		0.20 b	2.0 b	
Orthene + Tame	227 g + 315 ml	.5 lb + 10.7 oz	1.5 cd	2.1 b	2.6 c	5.4 c	67.0 a		0.6 c	0.07 b	
Untreated			13.6 a	31.2 a	98.9 a	20.4 a	85.9 a		4.8 a	4.5 a	

[z]Mean separation within columns by Duncan's multiple range test, P = 0.05. Each datum is mean of 5 samples. Data were transformed (LogX + 1) before analysis by ANOVA.

[y]Unsightliness ratings based on a scale of 0 to 5. 0: no symptoms on plant; 5: all leaves/shoots disfigured.

[x]Psyllid days are the sum of all psyllid counts divided by the number of days in the sampling period. PD calculated only when treatments were significantly different.

[w]Linear regression of unsightliness ratings on psyllid days.

[u]Expt. 1 applied 7/6/89; expt. 2 applied 8/23/89; expt. 3 applied 4/3/90.

lay eggs only on young unexpanded plant tissue, once egg laying sites were "full" oviposition ceased; when new sites were introduced, oviposition was resumed. When female psyllids were sequestered on a single plant, each laid an average of only 86 eggs. When a new plant was introduced after oviposition ceased, the average number of eggs deposited by those females increased to 152.

Many psyllids have been found to be sensitive to high temperatures (2, 5, 6, 7). High temperature [>30°C (86°F)] sensitivity may explain the coastal distribution of the insect in California. An occurrence of higher than normal temperature (Santa Barbara, June 26, 1990) was associated with dramatic decreases in psyllid populations at all monitoring locations in these studies. Undamaged foliage was observed on many untreated eguenia plants one to two months after this period of high temperature.

Outdoors, eugenia psyllids reproduced the year around in coastal California. Psyllid adults were present during the entire year of sampling (Fig. 1). Although there were no distinct seasonal peaks, psyllid adults were most numerous in the cooler months of the year.

Management Trials. Mavrik and Tame both gave outstanding control of adult insects for up to 8 weeks (Table 1). Orthene was only adequate in its control. Tame combined with Orthene did not control psyllids better than Tame alone (Table 1, Expt. 3). However, Tame treated plants had the lowest rating for unsightliness. Insecticidal soap was ineffective against the psyllid; it did not improve the efficacy of Mavrik when the two materials were applied in combination. Superior oil had no insecticidal effect on eugenia psyllid; oil treated plants had numerically though not statistically higher adult counts then untreated plants (Table 1, Expt. 2). Diazinon and Sevin (carbaryl) failed to adequately control adult psyllids, yet Sevin treated plants did result in a lower unsightliness rating than oil and diazinon treated or untreated plants.

Mavrik was tested many times in the various studies. Usually it gave excellent control of eugenia psyllid but sometimes it failed to provide adequate control when applied at rates less than 295 ml/26.42 l (10 oz/100) gal. At lower rates, Mavrik was effective only for short periods (Fig. 2).

Orthene implants did not provide rapid control of the eugenia psyllid (Table 2), as psyllid response to implantation was found slow in other studies (1, 3). The June 1990 heat wave depressed adult psyllid populations during a portion of the implant trial. When populations recovered, implanted trees remained significantly less populated than untreated trees. Downer et al. (3) found that implants afforded two months of control of peppertree psyllid, *Calophya rubra* Tuthill.

At eight weeks, shoots that were pruned grew to about the same length as unpruned shoots (Table 3). When pruned, however, shoots sprayed with soap plus Mavrik, Mavrik alone, or Orthene, grew significantly longer than untreated shoots. Similarly, axillary buds produced more shoots when protected by these same insecticides. Bud formation on unpruned shoots was not affected by insecticide treatments.

Mavrik and Orthene provided good control of psyllid nymphs on unpruned shoots, yet at eight weeks pruned shoots treated with soap plus Mavrik supported greater nymph numbers than untreated pruned shoots. This may have occurred because shoots not protected by an effective insecticide grew slowly. As a result, suitable egg laying sites were not available and nymphs could not develop. A similar trend was seen for the other insecticides used.

Pruning single shrubs failed to reduce adult populations significantly in any of the studies. However, hedge pruning during the fall decreased adult populations dramatically (Figure 2). That effect may have been due to slow regeneration of

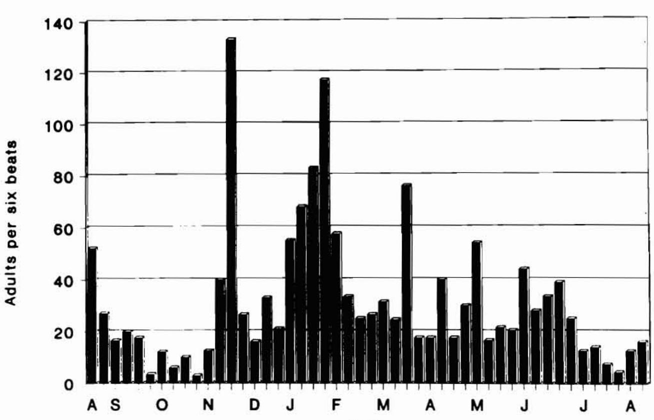

Fig. 1. Adult populations of eugenia psyllid. Ventura, California, 1989–1990.

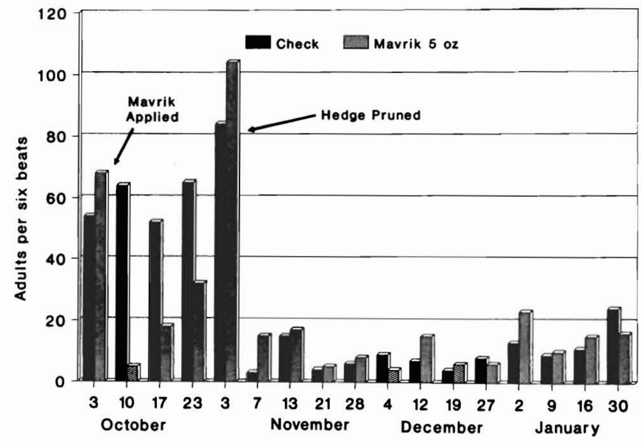

Fig. 2. Adult psyllid number after Mavrik application and pruning. Entire hedge was pruned; one side then sprayed. Control counts taken from unsprayed side. Ventura, California, 1989–1990.

Table 2. Evaluation of implanted acephate for systemic control of eugenia psyllid.

	Avg. no. psyllid adults per three beats after (weeks)[z]						
Treatment	**1**	**2**	**4**	**7**	**8**	**12**	**17**
Acephate[y]							
97% ai (Acecaps 97)	57 a	18 a	10.8 a	.5 a	0 a	1.8 a	5.1 a
Untreated	47 a	22.5 a	17.0 a	1.5 a	0 a	8.4 b	15.1 b

[z]Within columns, treatments with the same letter are not significantly different according to ANOVA at P = 0.05.

[y]Applied May 17, 1990.

Table 3. Effect of shoot pruning with and without insecticide treatments on plant growth and psyllid activity[z].

	Effects measured						
	Shoot length[y] (cm)		Number of shoots[x]		Nymph counts[w]		
	Unpruned	Pruned	Unpruned	Pruned	Unpruned		Pruned
Treatment	8 wks	8 wks	8 wks	8 wks	4 wks	8 wks	8 wks
Mavrik	3.4 ab	5.40 a	0.96 a	1.76 a	1.90 bc	30.4 a	31.1 ab
Insecticidal soap	2.5 b	2.74 bc	0.96 a	1.28 b	10.70 ab	2.7 b	17.1 ab
Soap + Mavrik	5.1 a	4.70 a	1.0 a	1.88 a	3.70 ab	34.9 a	58.6 a
Orthene	4.8 a	4.06 ab	1.04 a	1.76 a	0.04 c	20.7 a	18.0 ab
Untreated	2.6 b	1.98 c	1.00 a	1.04 b	13.20 a	1.6 b	3.4 b

[z]Same experiment and application dates as in Table 1, experiment 1. Means followed by the same letter are not significantly different according to Duncan's multiple range test, P = .05. Data were transformed (logX + 1) before analysis by ANOVA.

[y]Average of five shoots.

[x]Number occurring at each tagged node.

[w]Average number of 5 tagged shoots.

young shoots which are necessary for psyllid reproduction. Dramatic adult population decreases were only observed when all shoots on a hedge were pruned. Psyllid migration from plant to plant may explain poor control from single plant pruning treatments.

High adult psyllid populations were associated with plant unsightliness in a number of experiments (Tables 1 & 4). Pruning in combination with Mavrik application resulted in lower unsightliness ratings in experiments in which adult populations initially were very high (Table 4, Expt. 3). Similar effects were noted when Tame or Orthene were applied prior to development of new growth (Table 1). Yet, adult psyllid counts below ten per three beats were also correlated with unsightly foliage. Adult counts below five per three beats were associated with lower ratings for unsightliness (Table 1, Expt. 3 and Table 4, Expt. 1, 2), but it was not determined how many insects in a sample would produce unsightly foliage. Further studies to develop predictive damage threshold levels based on samples of adult insects are needed.

(*Ed. note:* This paper reports the results of research only, and does not imply registration of a pesticide under amended FIFRA. Before using any of the products mentioned in this research paper, be certain of their registration by appropriate state and/or federal authorities.)

Table 4. Evaluation of Mavrik and complete plant pruning for control of eugenia psyllid.

Treatment[z]		Mean number of psyllid adults per three beats (posttreatment) after (weeks):							
Pruning	Insecticide[u]	1	2	4	6	8	Psyllid[x] days	Unsightliness[w] rating	Regression[v] coefficient
		Experiment 1. Ventura County.[y]							
+	−	12.8 a	11.0 a	13.4 a	4.3 a				
−	+	3.5 b	4.8 b	5.4 bc	1.3 b				
+	+	3.2 b	3.7 b	3.4 c	2.1 ab				
−	−	15.4 a	19.5 a	11.2 ab	3.1 a				
		Experiment 2. Santa Barbara County. Applied 8/23/89							
+	−	6.2 ab	7.0 a	4.6 ab	10.6 a	9.2 a	3.2 ab	0.48 a	.536
−	+	2.0 b	0.8 b	0.4 b	0.6 b	0.0 b	2.0 c	0.04 b	(P=0.015)
+	+	0.8 b	0.6 b	0.4 b	0.2 b	1.8 bc	2.2 bc	0.04 b	
−	−	10.2 a	8.0 a	5.2 a	8.6 a	7.6 ab	3.6 a	0.48 a	
		Experiment 3. Ventura County. Applied 11/3/89							
−	+	80.8 a	0.8 b	11.2 b	14.4 b	5.4 b	2.0 b	2.8 b	.687
+	+	75.2 a	0.6 b	4.8 b	12.6 b	11.6 b	0.84 c	2.6 b	(P=0.005)
−	−	76.4 a	24.0 a	50.4 a	52.2 a	84.2 a	4.8 a	5.3 a	

[z]Pruning or insecticide (Mavrik) treatments performed (+) or not performed (−). Pruning involved shearing with a gasoline powered hedge trimmer. Insecticide treatments were fluvalinate applied as sprays at 10 oz/100 gal.

[y]Mean separation within columns by Duncan's multiple range test, *P* = 0.05. Data were transformed (logX + 1) before analysis with ANOVA.

[x]Psyllid days (PD) are the sum of psyllid counts divided by the number of days in the sampling period. PD calculated only when treatments were significantly different.

[w]Unsightliness rating based on a scale with 0 = no foliar symptoms present and 5 = all foliage severely disfigured.

[v]Linear regression of unsightliness rating on psyllid days.

[u]Expt. 1 applied 8/8/89; Expt. 2 applied 8/23/89; Expt. 3 applied 11/3/89.

Literature Cited

1. Brown, L.R. 1978. Recent experiments on tree trunk implantation and soil application of insecticides in Southern California. Proc. Symp. on Systemic Chemical Treatments in Tree Culture. 281–288.

2. Catling, H.D. 1969. The bionomics of South Africa citrus psylla, *Trioza erytreae* (Del Guercio) (Homoptera: Psyllidae). Vol. 3. The influence of extremes of weather on survival. J. Ent. Soc. S. Afr. 32:272–290.

3. Downer, A.J., P. Svihra, R. Molinar, J.B. Fraser, and C.S. Koehler. 1988. New psyllid pest of California peppertree. California Agric. 42:30–32.

4. Froggatt, W.W. 1901. Australian Psyllidae Part II. Proceedings of the Linnean Soc. of New S. Wales. 90:42–298.

5. Green, G.C. and H.D. Catling. 1971. Weather-induced mortality of the citrus psylla, *Trioza erytreae* (Del Guercio) (Homoptera: Psyllidae), a vector of greening virus, in some citrus producing areas of southern Africa. Agric. Meteorol. 8:305–317.

6. Hodkinson, I.D. 1974. The biology of Psylloidea (Homoptera): A Review. Bull. Ent. Res. 64:325–339.

7. Morgan, F.D. 1984. Psylloidea of South Australia, p. 89–97. *In*: Handbook of Flora and Fauna of South Australia. D.J. Woolman, Government Printer, S. Australia pp. 89–97.

Influence of Container Design on Root Circling, Top Growth, and Post-Transplant Root Growth of Selected Landscape Species[1]

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Abstract

'Delaware Valley White' azalea, 'Green Luster' holly, 'Plumosa Compacta Youngstown' juniper, and 'Shasta' viburnum were grown for 1 to 2 years in four container designs: a conventional straight-walled round container, a square container with corner holes, a round container with stepped-pyramid profiles, and a poly bag. Poly bag, square, and stepped-pyramid containers significantly reduced root circling on all species compared to the traditional straight-walled round container. There were no significant differences in root circling among the three designs. Top growth was harvested at the end of 1 and 2 years. Effect of container design on top dry weight was species dependent. Poly bag, square, and stepped-pyramid containers increased top growth by 11 to 23% compared to the straight-walled round container. However, no one design was consistently superior for 2 years compared to the straight-walled round container. In addition, three of four species did not respond to container design 1 out of 2 years. Plants were transplanted into the landscape after growing for 1 or 2 years in the containers. After 16 weeks in the landscape, 'Green Luster' holly initially grown in poly bag, square, and stepped-pyramid containers had greater new root dry weight and smaller shoot (top):root ratios compared to the straight-walled round container. Top and new root dry weight of 'Shasta' viburnum were significantly affected by container design. However, the shoot:root ratios were not significantly different compared to the straight-walled round container. In the landscape, container design did not significantly affect top dry weight, new root dry weight or shoot:root ratio of 'Plumosa Compacta Youngstown' juniper.

Index words: nursery crops, plant establishment, container-grown, root spiraling

Species used in this study: 'Delaware Valley White' azalea (*Rhododendron* L. sp. 'Delaware Valley White'); 'Shasta' viburnum (*Viburnum plicatum* Thunb. var. *tomentosum* 'Shasta'); 'Green Luster' holly (*Ilex crenata* Thunb. 'Green Luster'); 'Plumosa Compacta Youngstown' juniper (*Juniperus horizontalis* Moench 'Plumosa Compacta Youngstown').

Significance to the Nursery Industry:

Poly bag, square, and stepped-pyramid container designs successfully minimized root circling compared to the straight-walled round container for all species evaluated. However, they did not consistently improve top growth over 2 years compared to the straight-walled round container. The effectiveness of new container designs in enhancing new root generation is species dependent. When planted in the landscape following growth in particular container designs, 'Green Luster' holly was the only species which responded positively to changes in root system morphology induced by initial container growth. Individual species should be tested before growers switch from the traditional straight-walled round container to other designs. The container should provide tangible improvements in growth before recommendations to switch container designs are made.

Introduction

Container production of landscape plants represents over one-half of all landscape plants sold in the United States (2). Unfortunately, container-grown plants often perform poorly after transplanting into the landscape (5, 8). This has been attributed to the smooth-walled, round container in

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