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in reduced number of new shoots and reduced shoot length. Pruning to 8 leafy nodes where visible buds were present resulted in superior plants. This approach might be considered for other broadleaf evergreens such as *Ilex x attenuata* 'Foster's #2,' Foster's holly; *Ilex* 'Nellie Stevens', Nellie Stevens holly; *Prunus laurocerasus,* Cherry laurel; and selected *Rhododendron* species and cultivars. From a landscape maintenance aspect, *Photinia* x *fraseri* should be pruned at regular intervals, perhaps after 25 to 30 cm (10 to 12 in) of new growth, to produce a more desirable plant.

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Transplanting Success with Creosotebush (*Larrea tridentata* (D.C.) Cav.) from Native Stands[1]

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Abstract

The effects of season, root pruning, and transpiration reduction techniques (anti-transpirant spray with and without foliar pruning and foliar pruning alone) on percent survival and rank of creosotebush *(Larrea tridentata)* transplanted from a native stand were estimated. Only season had a significant impact on survival determined 6 months after transplanting. Survival was higher in spring, summer, and fall than in winter. With regard to shrub rank 6 months after transplanting, there was no significant advantage over the most economical treatment combination of not root pruned-foliar pruned. Within this combination the spring and fall transplants were superior to winter transplants with summer transplants intermediate.

Index words: drought tolerant, native shrubs

Introduction

Urban population has increased dramatically in the arid Southwestern United States since 1970, inflating the demand for municipal water and contributing to the depletion of limited ground water reserves. Landscape maintenance may account for 50% or more of total municipal water consumption in this area (2,8). Urban landscapes of native and adapted plants significantly reduce water consumption (2,8,12), but relatively few plant species are commercially available. A greater diversity of plant material is needed to enhance the attractiveness of urban desert landscapes.

Transplanting from a native stand can be integral to the commercial introduction of a new landscape plant, particularly if difficult to propagate (10). The most important factor in transplanting is maintaining the plant's water balance by reducing transpiration and increasing water absorption (6). Transpiration may be reduced with anti-transpirants and by maintaining a favorable root/shoot ratio through foliar pruning. Water absorption may be increased by prior root pruning to encourage rapid root regeneration and by insuring proper soil aeration.

The creosotebush, a native desert shrub with dark green foliage, bright yellow flowers, and showy white fruit, has been recommended as a landscape plant (3, 9, 11). It is, however, difficult to propagate and transplant. We conducted a study to determine methodology for successfully transplanting the creosotebush from native stands. The effects of season, root pruning, and transpiration reduction techniques on the percent survival and rank of transplanted shrubs were estimated. Since the creosotebush has been shown to be particularly susceptible to low soil aeration (7), we were especially concerned with this aspect of transplanting.

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Materials and Methods

Shrubs less than 1 m (3.3 ft) tall were randomly selected from a population growing on a Simona soil near the Hueco Mountains east of El Paso, Texas. This soil is moderately permeable, moderately alkaline, calcereous, gravelly sandy loam with a low available moisture capacity underlain by a layer of indurated carbonate within a depth of 51 cm (1.7 ft). (5). Roots within a radius of about 50 cm (1.6 ft) of the crown were severed to the indurated carbonate layer and the plants bare-root planted into white plastic containers 35.5 cm (1.2 ft) deep and 29 cm (1 ft) inside diameter. Four 1.3 cm (0.5 in) diameter holes equally placed around the circumference of each container near the bottom provided drainage. A layer of gravel 5 cm (2 in) deep in the bottom of the container and a continuous vertical column of gravel 10 cm (4 in) diameter in the medium was used to improve infiltration, drainage, and aeration. The gravel was 1.9 to 2.5 cm (0.75 to 1 in) in diameter. The plants were potted with *in situ* soil and irrigated immediately. Thirty-six mature plants were transplanted into containers in the fall (September), winter (January), spring (April), and summer (July). Eighteen plants were root pruned 3 months prior to transplanting.

Six of the 18 root-pruned and 6 of the 18 non root-pruned plants were sprayed with a 10% solution of a film-type anti-transpirant, di-l-p-menthene (Wilt-Pruf NCF, Nursery Specialty Products, Greenwich, Conn.), prior to digging. Six plants of each group were foliar pruned, and 6 were foliar pruned then sprayed with the anti-transpirant. Foliar pruning was a combination of heading back and thinning out to remove approximately 30% of the foliage.

The plants were placed in complete shade for 3 months then in full sun for 3 months. They were irrigated once a week for the first 2 months, then as needed. Percent survival was calculated six months after transplanting and the shrubs ranked by a scale which estimated the maintenance of original terminal shoots. Dead plants were given a rank of 0. Plants surviving only through the production of new basal shoots were given a rank of 1. Those maintaining original terminal shoots and producing new basal shoots were given a rank of 2 and those maintaining original terminal shoots only were given a rank of 3. The experimental design was a completely randomized analysis of variance. Data distribution indicated a square root transformation on ranks and an arc sin transformation on percent survival were required.

The ability of the gravel column to maintain drainage and aeration was tested by measuring the oxygen diffusion rate (ODR) in container soils with and without the gravel column and *in situ* soil. The ODR was also measured in containers with dead shrubs and compared to those with live shrubs and to the *in situ* soil to determine if a low ODR may have contributed to plant mortality. Five measurements were made with platinum microelectrodes (Oxygen Diffusion Ratemeter, Jensen Instruments, Tacoma, Washington) in each of 4 containers, a total of 20 replications per mean. The experimental design was a completely randomized analysis of variance with subsamples and the means were compared via orthogonal contrasts.

Results and Discussion

Shrubs ranged in height from 45 to 90 cm (1.5 to 3 ft) prior to transplanting. No significant correlation between height and rank ($r = 0.05$, $N = 144$) was observed. Neither root pruning nor foliage treatment significantly affected survival, but season did (Table 1). The mean survival was 98.6 percent for shrubs transplanted in the spring, summer, and fall. Seasonal variation in root regenerating potential and container soil temperature may have been involved in the low survival of shrubs transplanted in the winter. January mean daily temperature in El Paso is -1 °C, which is well below the optimum temperature reported for root growth (1).

There was a third order season-root-foliage treatment interaction on shrub rank with no significant advantge over the most economical combination of not root pruned-foliage pruned (Table 2). Within this combination spring and fall transplants were superior to winter transplants with summer transplants intermediate. These data tend to support previous reports that film-type anti-transpirant effectiveness is reduced by high ambient temperature, high solar insolation, and low atmospheric humidity such as occurs in El Paso (4,6).

Container soils became dispersed and impermeable when irrigated often, affecting ODR. Container soils with the gravel column maintained an ODR comparable to the soil *in situ* and above that reported to be required for maximum root growth (0.66 mg cm^{-2} min^{-1}) (7) for at least a week while the ODR in container soils without the gravel column decreased to a level comparable to those soils in containers for 6 months (Table 5). the ODR of container soils in which shrubs had died 6 months after transplanting was significantly higher than that of the live shrubs. Container soils as a group were significantly lower than that of the soil *in situ* (Table 5) and below the level that reportedly greatly reduced root growth (ca. 0.43 mg cm^{-2} min^{-1}), but not as low as that reported to cause death (0.14 mg cm^{-2} min^{-1}) (7). Low soil ODR values probably did not influence shrub survival though they may have influenced ranks. Apparently the gravel column maintained a high ODR allowing maximum root growth during a critical early time period of unknown duration. New roots may have been well established by the time ODR had declined to critical levels.

Significance to the Nursery Industry

As an interim procedure to establish the creosotebush as a landscape plant we would suggest transplanting

Table 1. Effect of season on percent survival of creosotebush shrubs 6 months after transplanting.

Season	Survival (%)
Spring	99.5 a[z]
Summer	98.5 a
Fall	97.8 a
Winter	81.0 b

[z]Means within columns followed by the same letter are not significant according to the Waller-Duncan's Bayesian K-ratio t (LSD) rule at $K = 100$ ($p = .05$) (13).

Table 2. **Effect of season-root-foliage treatment interactions on the mean rank of creosotebush shrubs 6 months after transplanting from a native habitat.**

	Treatment					
	Root pruned			Not-root pruned		
Season	**Anti-transpirant**	**Anti-transpirant plus Foliage Pruning**	**Foliage Pruning**	**Anti-transpirant**	**Anti-transpirant plus Foliage Pruning**	**Foliage Pruning**
Spring	2.1 abc[z]	1.8 abc	2.0 abc	2.0 abc	0.5 cde	2.0 abc
Summer	2.4 ab	1.0 abcde	2.1 abc	2.4 ab	2.1 abc	1.6 abcd
Fall	1.9 abc	1.2 abcd	2.1 abc	0.6 cde	2.6 a	2.1 abc
Winter	0.6 cde	0.1 e	0.3 de	1.1 abcd	0.8 bcde	1.0 abcde

[z]Means within columns and rows followed by the same letters are not significant according to the Waller-Duncan's Bayesian K-ratio t (LSD) rule at K = 100 (p = .05) (13).

Table 3. **Effect of containerization on oxygen diffusion rate (ODR) of native soils used in transplanting creosotebush.**

	Oxygen Diffusion Rate (mg cm^{-2} min^{-1})		
Duration in Container	***in situ* Soil**	**Containers with Gravel Column**	**Containers without Gravel Column**
one week		0.69 a[z]	0.26 b
		Pooled Containers	
	0.66 a	0.47 b	
		Containers with Dead Shrubs	Containers with Live Shrubs
six months		0.40 a	0.22 b
		Pooled Containers	
	0.66 a	0.24 b	

[z]Means within rows followed by the same letter are not significant according to orthogonal contrasts in the analysis of variance at p = .01.

foliar-pruned native creosotebush in the spring and fall without prior root pruning. The shrubs should be transplanted into containers and irrigated in the field. Native soil can be used as a medium if appropriately amended to maintain aeration. We would like to stress that this is an interim procedure, until propagation and production practices have been established. Only those shrubs growing on a shallow soil and on a site destined for vegetation clearing should be transplanted with landowner permission.

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