Pruning effects on root length density, root biomass, and arbuscular mycorrhizal colonization in two shrubs in a simulated xeric landscaped yard

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ABSTRACT

Although shoot pruning is a common landscape practice, little research has focused on its effects on the roots and mycorrhizal associations of woody landscape plants. In this study, we examine the effects of shoot pruning on root length density, root biomass, and arbuscular mycorrhizal (AM) colonization of two woody shrubs commonly used in xeriscape™ landscapes in the Phoenix metropolitan area, *Nerium oleander* and *Leucophyllum frutescens*. Seven experimental plots were established using landscape practices typical of arid, urban environments, including drip irrigation and decomposed granite mulch, and three pruning treatments were initiated (2 plots per treatment + 1 unpruned control plot). These treatments included 1) shearing every 6 weeks, 2) heading back every 6 months and 3) rejuvenation pruning (cutting back to 0.5 m) every year. Roots were sampled at the base of three plants of each species by soil coring to a depth of 20 cm. The first root sampling occurred in the late winter, after the shearing and heading treatments had been imposed, but prior to the first rejuvenation pruning. A second root sampling occurred during active growth in the late spring. The two species responded differently to pruning, and the effects varied depending on the date of sampling.

Figure 1. *Nerium oleander* and *Leucophyllum frutescens* after different pruning treatments. Clockwise from lower left: *Nerium* after rejuvenation pruning; unpruned *Nerium*; *Nerium* after heading back; *Leucophyllum* after rejuvenation pruning; *Leucophyllum* after heading back; sheared *Leucophyllum*.

INTRODUCTION

Plants in urban landscaping are often highly modified by shoot pruning. Pruning has obvious effects on aboveground portions of plants, but the effects on root systems and mycorrhizae are poorly understood. To date, no research has been performed on the effects of shoot pruning on the roots and mycorrhizae of woody landscape plants.

Hartley and Amos (1999) studied the effect of defoliation on root length and AM colonization in *Nardus stricta* L. and *Calluna vulgaris* (L.) Hull, two Scottish moorland plants. Defoliation had no effect on the root length of *Nardus* plants, but decreased root length of *Calluna*. Both plants exhibited a large decrease in mycorrhizal colonization due to defoliation.

In a study of pruning effects on roots in an *Acacia saligna* (Labill.) H. L. Wendl. hedgerow planting in Kenya, Peter and Lehmann (2000) found that root development was altered significantly by pruning. Root length density (RLD) was significantly diminished by pruning. The pruned trees had a higher proportion of dead roots to live roots and their roots had a lower glucose content than in the unpruned trees. Pruning also negatively affected the ability of the trees to absorb P and Mn by decreasing the size of the root system.

In this study, we examine the effects of pruning on the roots and mycorrhizal associations of Texas sage (*Leucophyllum frutescens* I. M. Johnst.) and oleander (*Nerium oleander* L.), two shrubs commonly used in xeric landscaping in metropolitan Phoenix, Arizona, USA.

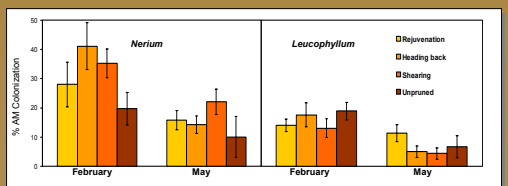

Figure 2. Percent AM colonization of *Nerium oleander* and *Leucophyllum frutescens* roots at 0-20 cm depth in February and May 2001. Note: in February, the rejuvenation pruning had not yet been performed.

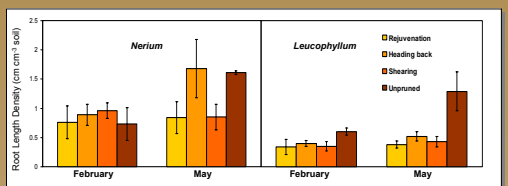

Figure 3. Root length density of *Nerium oleander* and *Leucophyllum frutescens* roots at 0-20 cm depth in February and May 2001. Note: in February, the rejuvenation pruning had not yet been performed.

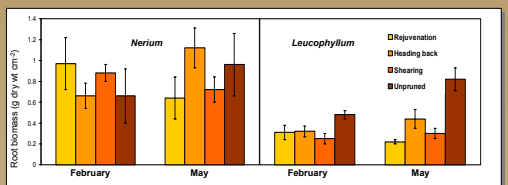

Figure 4. Biomass of *Nerium oleander* and *Leucophyllum frutescens* roots at 0-20 cm depth in February and May 2001. Note: in February, the rejuvenation pruning had not yet been performed.

MATERIALS AND METHODS

Site description

The study was carried out at the Desert Botanical Garden in Phoenix, Arizona, USA (33.45° N and 111.95° W, elevation 390 m). Mean annual precipitation is 195 mm. The soil is a coarse-loamy, mixed, superactive, hyperthermic *Typic Haplocalcid*, (National Cooperative Soil Survey 1997).

Experimental design

Seven experimental plots (10 m × 10 m) were established at the site in 1999 and each planted with six *Leucophyllum frutescens* I. M. Johnst. 'Green Cloud™' (Texas sage) plants and six *Nerium oleander* L. (Oleander) plants. Water is applied at the base of each plant by drip irrigation once per week in the winter and twice per week in the summer. Three pruning treatments were performed (2 plots per treatment + 1 unpruned control plot) in a randomized block design. The treatments included 1) shearing every 6 wk, beginning in early 2000; 2) heading back in November 2000 and again in February 2001; and 3) rejuvenation pruning (cutting back to 0.5 m) in February 2001 (Fig. 1).

Root sampling and processing

Root sampling was carried out in February and May 2001. The February sampling was done immediately prior to the pruning treatments. At this time, the rejuvenation pruning had not yet been performed. The roots of three individuals of each shrub species in each plot (n=42) were destructively sampled at 30 cm from the base of the plant. Soil cores were removed with an auger (5 cm dia.) at a depth of 20 cm. In May, one *Leucophyllum* sample and three *Nerium* samples were discarded due to irrigation problems. Roots were washed free of the soil using a hydropneumatic root washer. Live fine roots (<2 mm in diameter) were weighed, and a subsample (*ca.* 0.1 g) was removed for determination of root length density and arbuscular mycorrhizal colonization. The remaining roots were dried in an oven at 65° C for 48 h and re-weighed to determine total dry weight. The AM colonization subsample was fixed in 70% ethanol, then cleared, bleached, and stained with 0.05% Trypan blue by a modification of the procedure of Koske and Gemma (1989). Root length of the subsample was determined with the gridline-intersect method of Giovanetti and Mosse (1980). The roots were then transferred to a glass slide to quantify percent AM colonization with the method described by McGonigle et al (1990).

Data analysis

All root length density, root biomass, and mycorrhizal colonization data were compared by one-factor and two-factor analyses of variance using SigmaStat 2.03 (SPSS). In case of significant effects, means were compared using the Tukey or Bonferroni test at P = 0.05.

RESULTS AND DISCUSSION

There was a trend for pruning to have a stimulatory effect on AM colonization in* Nerium *in February, although treatment effects were not significant. AM colonization in* Leucophyllum *was unaffected by pruning treatments in both February and May (Fig. 2).
Analysis of colonization of *Nerium* roots at depths of 20-40 and 40-60 cm may help clarify whether this trend is truly significant. Stimulation of AM colonization could be due to increases in carbon allocation to the roots caused by heading back and shearing (the rejuvenation treatment had not yet been applied in February).

***Leucophyllum* RLD and root biomass were negatively affected by pruning in May, but not in February.**
There were also no differences in root development among the different pruning treatments in May, indicating that *Leucophyllum* root growth is diminished equally regardless of the type of pruning used. Effects of pruning may not have been evident in February because this species is winter-deciduous, so active root growth is unlikely at this time.

Pruning did not significantly affect* Nerium *RLD and root biomass at either sampling time, although a trend towards an increase in RLD and biomass by the 6 mo heading back treatment was evident in May (Figs. 3 and 4).
In *Nerium*, the heading back treatment stimulated branching, while rejuvenation pruning completely eliminated the photosynthetically active portions of the plant and frequent shearing limited the amount of new foliage available to fix carbon.

AM colonization decreased significantly in both species from February to May, due entirely to seasonal factors (Fig. 2).
Seasonal effects on colonization appeared to be independent of pruning effects.Seasonal factors such as higher soil temperatures and lower water input via rainfall in May could have contributed to the decrease in colonization.

Root RLD and biomass was suppressed in all of the pruned* Leucophyllum *plants from February to May. Nerium root development from February to May was unaffected by both pruning and seasonal factors (Figs. 3 and 4).
Nerium, which is photosynthetically active throughout the winter, may have been better able to recover from the February pruning than *Leucophyllum*, which is dormant in the winter.

CONCLUSION

Shoot pruning has varying effects on the roots and mycorrhizae of woody landscape plants, depending on the type of pruning used, the plant species, and the season. While *Nerium* AM colonization and root growth are generally unaffected or slightly stimulated by pruning, colonization and root growth in *Leucophyllum* tend to be negatively affected. Further analysis of samples taken at greater depths will help elucidate the differences between pruning treatments.

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