Leaf Physiology of Four Landscape Trees in Response to Commercial Parking Lot Location

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Brachychiton populneus (bottle tree) at two locations, median (left) and perimeter (right) in a Phoenix commercial parking lot. Images by Sarah B. Celestian.

Introduction

Trees are planted in parking lots to give shade and enhance environmental aesthetics. But elevated thermal microenvironments caused by expansive parking lot surface areas might contribute to the poor performance of many parking lot trees, especially in the desert southwest. We evaluated effects of parking lot location on leaf physiology of four southwest landscape tree species.

Methods

1. Leaf physiology of four landscape trees, *Brachychiton populneus* (bottle tree), *Fraxinus velutina* (Arizona ash), *Prosopis alba* (mesquite) and *Ulmus parvifolia* (Chinese elm) was studied during spring and summer of 2002 at 11 parking lots in the greater Phoenix area.
2. A series of rules were established to guide the selection of parking lot trees (Celestian and Martin, 2004a).
3. Maximum leaf gas exchange fluxes (Martin and Stabler, 2002) were measured with an LI-6200 (LI-COR Biosciences, Lincoln, NE) portable photosynthesis system in open system mode during spring and summer 2002.
4. Leaf chlorophyll concentrations of bottle tree, Arizona ash, and Chinese elm were measured by randomly sampling 28 fully-expanded sun leaves per each of six trees per planting location using a SPAD 502 meter (Minolta Camera Co., Osaka, Japan). Chlorophyll concentrations were calculated from regression models of SPAD values to actual chlorophyll concentrations (R^2 values ranged from 0.86 to 0.98), which we developed for each tree species using the chlorophyll extraction and determination method described by Arnon (1949).
5. For mesquite, 10 leaflets from 10 fully expanded mesquite sun leaves per planting location were collected for extraction and determination of chlorophyll concentration also using the method described by Arnon (1949).

Prosopis alba (mesquite) at two locations, median (left) and perimeter (right), in a Phoenix commercial parking lot. Images by Sarah B. Celestian.

Table 2. Significance probabilities and F ratio generated by an analysis of variance (ANOVA) of the effects of commercial parking lot planting location (landscape median and perimeter) and month (April and August 2002) on net carbon assimilation (A), stomatal conductance (g_s), internal leaf to ambient CO_2 concentration (Ci/Ca), and leaf chlorophyll concentration (Chl) of four landscape tree species in Phoenix, Arizona.

Tree species ANOVA	A	g_s	Ci/Ca	Chl
Brachychiton populneus				
Location	0.0001	0.0147	0.3238	0.0001
Month	0.0001	0.0001	0.0092	0.0001
Location*month	0.0001	0.0001	0.1639	0.0001
F ratio	23.45	17.48	12.09	7.41
Fraxinus velutina				
Location	0.0001	0.4510	0.0002	0.0001
Month	0.0001	0.0001	0.0001	0.3351
Location*month	0.0001	0.4517	0.0001	0.3351
F ratio	15.67	28.83	46.16	11.92
Prosopis alba				
Location	0.0930	0.0614	0.1910	0.0001
Month	0.0041	0.0001	0.0001	0.4340
Location*month	0.2367	0.0652	0.1638	0.0077
F ratio	10.45	9.96	97.88	2.96
Ulmus parvifolia				
Location	0.0009	0.8806	0.0561	0.0001
Month	0.0001	0.8776	0.0001	0.0001
Location*month	0.0061	0.0004	0.0002	0.0001
F ratio	9.81	6.15	16.26	9.39

Overview of Results

1. Gas exchange fluxes were lower for bottle tree, Arizona ash, and Chinese elm located within narrow parking lot landscape medians compared with the same aged trees in large landscape areas on the parking lot perimeters.
2. Leaf gas exchange fluxes of mesquite were less affected by parking lot location than the other three tree species.
3. Reduced A during summer was most related to lower gs for bottle tree. Otherwise,
4. Leaf chlorophyll of bottle trees in medians was highest in April, otherwise leaf chlorophyll was always lowest for median trees regardless of taxa or season.

Table 1. Effect of commercial parking lot planting location (landscape median and perimeter) during April and August 2002 on leaf carbon assimilation (A), stomatal conductance (g_s), internal leaf to ambient CO_2 concentrations (Ci/Ca), and leaf chlorophyll concentration (Chl) of four landscape tree species in Phoenix, Arizona.

Tree species Planting location	A (μmol/m²/s) Apr	A Aug	g_s (mmol/m²/s) Apr	g_s Aug	Ci/Ca Apr	Ci/Ca Aug	Chl (mg/g) Apr	Chl Aug
Brachychiton populneus								
Landscape median	6.0[Z]	5.7	82.1	64.7	0.60	0.55	5.6	4.0
Perimeter	9.5	6.2	112.5	59.5	0.58	0.50	5.1	4.3
Fraxinus velutina								
Landscape median	9.2	7.4	117.0	178.0	0.58	0.76	4.2	4.3
Perimeter	11.6	12.2	156.9	241.6	0.58	0.70	4.6	4.7
Prosopis alba								
Landscape median	7.9	5.3	73.6	85.6	0.46	0.67	3.6	4.5
Perimeter	8.2	6.5	75.9	103.6	0.47	0.66	5.4	4.7
Ulmus parvifolia								
Landscape median	6.7	8.6	121.2	110.0	0.66	0.57	3.6	4.0
Perimeter	7.1	10.9	110.2	123.9	0.69	0.54	4.2	5.0

[Z] Values are treatment means. For gas exchange variables, n=24. For chlorophyll concentration, n=168, except for *Prosopis alba*, n=10.

Conclusion Statement

Inhibition of tree leaf physiological processes in parking lot medians may in part be explained by elevated rhizosphere and air temperatures (Celestian and Martin, 2004b). These studies reveal that mesquite leaf physiology was least affected by parking lot location, and may be the best of these four landscape trees for use in desert Southwest parking lot landscape median locations. Landscape architects and urban foresters and planners in cities of the desert southwest should consider mesquite for use in parking lot landscape medians, because these trees were able to maintain relatively large canopy volumes, physiological function, and an aesthetically pleasing appearance even when planted in narrow parking lot landscape medians.

Literature Cited

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