Urban Land Use and Surface Cover: Effects on Soil Temperatures

Sarah B. Celestian and Chris A. Martin, Urban Horticultural Ecology Lab, Department of Plant Biology, Arizona State University, Tempe, AZ USA 85287-1601

Visit us on the Web at
http://lsweb.la.asu.edu/cmartin/martinlab.html

Introduction

Urban systems have a mixture of heterogeneous surface cover types, ranging from asphalt to turf. These surface covers are often associated with human land use and may have differing effects on spatial and temporal patterns of soil temperatures. In the root zone within 30 cm of the ground surface, temperature fluctuations strongly influence biotic and abiotic processes such as microbial activity, movement of water and nutrients, and plant root growth, all of which may effect the above ground growth and appearance of landscape trees (Craul, 1985). In the eastern United States, impervious surface covers have been shown to have a warming effect on root-zone soils (Graves and Dana, 1987). Though eastern soil temperatures under asphalt were found to be more than 10ºC higher than soil temperatures not associated with asphalt (Halverson, 1981), these temperatures were never considered to be supraoptimal. The effect of landscape surface cover types on root-zone soils temperature patterns in the urban southwestern United States is unknown. Our objective was to learn how different surface cover types impact diel patterns of soil root-zone temperatures in an urban Southwest environment.

Materials and Methods

During 35 days of summer 2002 (June 1 to July 15), we recorded diel patterns of soil temperatures, 30 cm below the ground surface, at four sites in the metropolitan Phoenix area. Each site had a different surface cover type. The four sites and their surface cover types were: 1) commercial parking lot medians surrounded by asphalt, 2) mesic landscape with turf surface cover, 3) xeric landscape with inorganic surface cover, and 4) remnant Sonoran Desert. Soil temperatures were measured at 30 cm below the ground surface using either copper constantan thermocouples attached to a 23X micrologger (Campbell Scientific, Logan, Utah) or portable data loggers (WatchDog 100-Temp 2K, Spectrum Technologies, Plainfield, Illinois). Radiation shielded thermocouples or data loggers also recorded air temperature at 3 m above the ground. Soil and air temperatures were recorded every hour and mean daily temperatures for each hour for the 35 day period were reported. Air temperature data from the xeric, mesic and desert sites were pooled and a single mean air temperature value is reported.

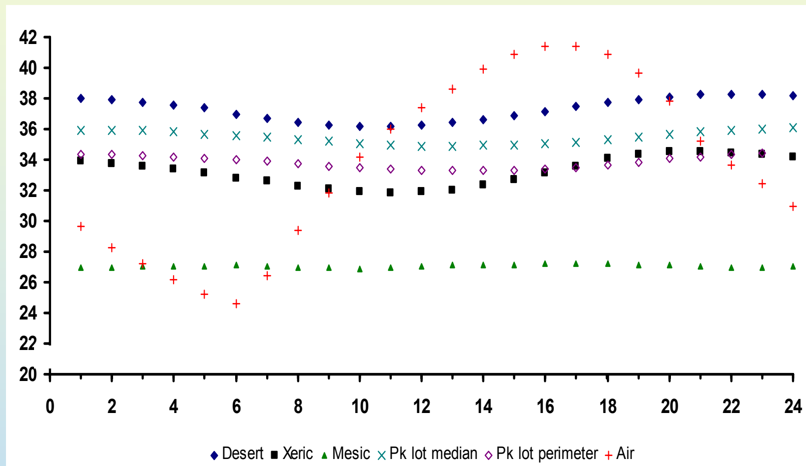

Fig. 1. Soil temperatures at different land use types for 35 days of summer
Values are treatment means ± standard error, N = 36, DESERT, XERIC, MESIC; N = 180, Pk lot median, Pk lot perimeter. Standard errors are smaller than symbol size.

Results

- The remnant desert site had the highest mean soil temperature (38.3ºC).
- The xeric site was generally about 8ºC higher than soil temperatures at the mesic site. The mesic site had the lowest mean maximum soil (27.2ºC).
- In the parking lot, the highest mean soil temperature was in the median (36 ºC) and the lowest mean soil temperature was in the perimeter (33.3 ºC).
- Highest soil temperatures were recorded around midnight at all sites
- Lowest soil temperatures were recorded around noon at all sites.

Conclusions

These results indicate that surface cover type does effect the amplitude of temporal patterns of soil temperatures in the urban Southwest. The pattern and amplitude of temperature patterns under non-vegetative surface cover types were similar.

Data logger

Remnant desert

Xeric

Mesic

Parking lot median

Parking lot perimeter

References

Graves, W. R. and M. N. Dana. 1987. Root-zone temperatures monitored at urban sites. HortScience. 22(4):613-614.

Halverson, G.H. and G.M. Heisler. 1981. Soil temperatures under urban trees and asphalt.USDA For. Serv. Gen. Tech. Rpt. NE-481:1-6.

Craul, P.J. 1985. A description of urban soils and their desired characteristics. J. Arbor. 11(11):330-339

Acknowledgements

This research was funded in part by the International Society of Arboriculture and by the National Science Foundation's Central Arizona Phoenix LTER grant no. DEB-9714833.