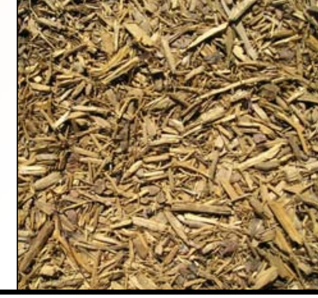
A comparison of inorganic and organic surface mulches on rates of soil respiration



Catherine K. Singer and Chris A. Martin, Department of Applied Biological Sciences, Arizona State Polytechnic, 7001 East Williams Field Rd., Mesa, AZ 85212

Introduction

Landscape soils in the Phoenix area are often covered with mulch materials for dust abatement purposes, to moderate soil temperatures and conserve soil moisture. Other studies by Singer and Martin (2005) show that inorganic and organic mulches differentially affect urban landscape soil temperatures in arid climates. Accordingly, inorganic and organic landscape mulches might have an impact on soil respiration (Rs) because Rs flux dynamics are temperature and moisture dependent.

Materials and Methods

To determine the effect of surface mulch type on Rs flux dynamics, we applied three mulch treatments (one inorganic and two organic) at a depth of 5-cm during April 2004 to 14 pre-existent drip-irrigated, xeric landscape CAP LTER research plots located at the Desert Botanical Gardens. Mulches were installed in the following manner:

- Red Mountain Coral decomposing granite (DG), 1/4" minus screened, applied to four plots
- Composted ponderosa pine residue (PPR), 3/4" minus screened, applied to four plots
- Chipped urban tree trimmings (LTT), approximately 3/4" unscreened, applied to four plots
- Bare soil control (BS), two plots

Each plot contained six drip-irrigated *Nerium oleander* 'Sister Agnes' shrubs that had been previously planted in May 1999 (Stabler, 2003). In each plot, Rs flux measurements (µmol/m^2/s) were made in spring, summer, and fall during 2004 and 2005 at two locations: an open, un-shaded location and underneath the canopy of *N. oleander*. Rs measurements were made with a LI-6000 soil respiration chamber attached to a LI-6200 portable photosynthesis system (LI COR Biosciences, Lincoln, NE).

Results

- During both years, Rs flux was significantly higher ($P < 0.001$) under *N. oleander* shrub canopy than in the open, un-shaded location (Tables 1 & 2) except for fall 2004 ($P = 0.377$, Table 1).
- Mulch type nested with location of measurement did not affect Rs flux dynamics (both locations) during the hot, dry summers of both years and fall 2005 ($P = 0.227$, $p = 0.505$, and $P = 0.306$, respectively, Tables 1 & 2).
- Specifically, soil mulched with landscape tree trimmings had the highest Rs fluxes in spring and fall 2004 ($P = 0.009$ and $P < 0.001$, respectively, Table 1).
- Soil mulched with decomposing granite had the highest Rs fluxes in spring 2005 following an abnormally wet winter (Table 2).

References

Singer, CK and CA Martin (2005) Effects of three landscape surface mulches on thermal processes in a drip-irrigated xeric landscape, 7th Annual CAP LTER Poster Symposium.

Stabler, LB (2003) Ecosystem response of urban plants in response to landscape management, *PhD Dissertation*, Arizona State University.

This research was funded in part by NSF CAP LTER grant no. DEB-9714833 and the International Society of Arboriculture John Z. Duling Grant Program

Conclusion

During times of decreased precipitation, mulch type does not affect Rs fluxes. During the wet fall of 2004 and spring of 2005, rates of soil respiration were influenced by the presence of organic and inorganic mulches. Furthermore, Rs is affected by the location of plants in the landscape. Rs flux appears to be more dependent on the presence of drip-irrigated root systems in the landscape than on the thermal environment created by landscape surface mulches.

Table 1. Spring, summer and fall soil respiration (Rs) fluxes by mulch type and location (open un-shaded location and under drip-irrigated *N. oleander* canopy) during 2004.

		Rs (µmol/m^2/s)		
Mulch	Location	Spring	Summer	Fall
LTT	open	-0.33 ab	-0.54 a	-4.41 c
LTT	canopy	-1.71 c	-1.64 b	-3.14 bc
PPR	open	-0.44 ab	-0.51 a	-1.29 a
PPR	canopy	-1.00 b	-1.44 b	-1.64 ab
DG	open	-0.61 ab	-0.55 a	-0.76 a
DG	canopy	-1.10 bc	-1.36 b	-1.30 a
BS	open	-0.20 ab	-0.28 a	-1.12 ab
BS	canopy	-1.05 bc	-2.06 b	-2.56 abc
Mulch		P = 0.080	P = 0.613	P < 0.001
Location		P < 0.001	P < 0.001	P = 0.377
Mulch[Location]		P = 0.009	P = 0.227	P < 0.001

Table 2. Spring, summer and fall soil respiration (Rs) fluxes by mulch type and location (open un-shaded location and under drip-irrigated *N. oleander* canopy) during 2005.

		Rs (µmol/m^2/s)		
Mulch	Location	Spring	Summer	Fall
LTT	open	-1.10 a	-0.90 a	-0.54 a
LTT	canopy	-1.60 ab	-3.36 c	-2.17 c
PPR	open	-0.94 a	-0.87 a	-0.69 ab
PPR	canopy	-1.19 a	-3.37 c	-1.47 bc
DG	open	-1.05 a	-1.06 ab	-0.56 a
DG	canopy	-2.64 b	-2.64 bc	-1.58 bc
BS	open	-0.74 a	-0.83 a	-0.61 ab
BS	canopy	-2.26 ab	-2.51 abc	-1.28 abc
Mulch		P = 0.022	P = 0.518	P = 0.329
Location		P < 0.001	P < 0.001	P < 0.001
Mulch[Location]		P = 0.009	P = 0.505	P = 0.234