In situ litter decomposition and litter quality in a Mojave Desert ecosystem: effects of elevated atmospheric CO2 and interannual climate variability

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Abstract Rising atmospheric CO2 has been predicted to reduce litter decomposition as a result of CO2-induced reductions in litter quality. However, available data have not supported this hypothesis in mesic ecosystems, and no data are available for desert or semi-arid ecosystems, which account for more than 35% of the Earth’s land area. The objective of our study was to explore controls on litter decomposition in the Mojave Desert using elevated CO2 and interannual climate variability as driving environmental factors. In particular, we sought to evaluate the extent to which decomposition is modulated by litter chemistry (C:N) and litter species and tissue composition. Naturally senesced litter was collected from each of nine 25m diameter experimental plots, with six plots exposed to ambient [CO2] or 367 μL CO2 L⁻¹ and three plots continuously fumigated with elevated [CO2] (550 μL CO2 L⁻¹) using FACE technology beginning in April 1997. All litter collected in 1998 (a wet, El Nin˜o year; 306mm precipitation) was pooled as was litter collected in 1999 (a dry year; 94 mm). Samples were allowed to decompose for 4 and 12 months starting in May 2001 in mesh litterbags in the locations from which litter was collected. Decomposition of litter produced under elevated CO2 and ambient CO2 did not differ. Litter produced in the wetter year showed more rapid initial decomposition (over the first 4 months) than that produced in the drier year (27±2% yr⁻¹ or 7.8±0.7 gm⁻² yr⁻¹ for 1998 litter; 18±3% yr⁻¹ or 2.2±0.4 gm⁻² yr⁻¹ for 1999 litter). C:N ratios of litter produced under elevated CO2 (wet year: 37±0.5; dry year: 42±2.5) were higher than those of litter produced under ambient CO2 (wet year: 34±1.1; dry year: 35±1.4). Litter production in the wet year (amb. CO2: 25.1±1.1 gm⁻² yr⁻¹; elev. CO2: 35.0±1.1 gm⁻² yr⁻¹) was more than twice as high as that in the dry year (amb. CO2: 11.6±1.7 gm⁻², elev. CO2: 13.3±3.4 gm⁻²), and contained a greater proportion of Lycium pallidum and a lower proportion of Larrea tridentata than litter produced in the dry year. Decomposition, viewed across all treatments, decreased with increasing C:N ratios, decreased with increasing proportions of Larrea tridentata and increased with increasing proportions of Lycium pallidum and Lycium andersonii. Because litter C:N did not vary by litter production year, and CO2 did not alter decomposition or litter species/tissue composition, it is likely that the impact of year-to-year variation in precipitation on the proportion of key plant species in the litter may be the most important way in which litter decomposition will be modulated in the Mojave Desert under future rising atmospheric CO2.