Soil moisture regime and soil type affect the decomposition of graminoid litter grown under three levels of atmospheric CO_2

Virginia L. Jin, Richard L. Haney, Philip A. Fay, and Wayne H. Polley. USDA, Agricultural Research Service

Background/Question/Methods

Increases in atmospheric CO_2 can augment the quantity and change the quality of plant carbon (C) inputs into grassland soils. Soil moisture interacts with substrate characteristics and soil properties to affect decomposition and transfer of plant-derived C into soil organic matter (SOM). Thus, predicted changes in precipitation regime coupled with changes in plant C inputs due to increasing atmospheric CO_2 could impact long-term C storage in grassland soils. To examine the interactions between litter quality, soil properties, and soil moisture availability on grassland litter decomposition, we incubated 4 levels of litter additions (no litter, or litter from *Bouteloua curtipendula* grown under 280, 380, or 55 $\mu L\ L^{-1}\ CO_2$) on 3 contrasting Blackland Prairie soils (Austin, Bastrop, Houston soil series) in a full factorial experiment using 5 levels of dry-rewet frequency (0x, 1x, 2x, 4x, or 8x over 112 days) and 4 levels of soil moisture (10%, 25%, 35%, 50% of water holding capacity). Cumulative CO_2 production ($\mu g\ C\ g^{-1}$ dry soil) over the 112 day incubation period was measured and compared with initial litter C-to-N ratios (C:N).

Results/Conclusions. Carbon mineralization from soil+litter (total C_{min}) was significantly affected by the four-way interaction between litter, soil type, dry-rewet frequency, and soil moisture treatments ($P < 0.0001$). Cumulative CO_2 production was affected most strongly by soil type, then by soil moisture level, litter type, and dry-rewet frequency, respectively. Total C_{min} was lowest in the sandy Bastrop soils and increased for Austin and Houston black clays. Total C_{min} also increased significantly with increases in soil moisture level and dry-rewet frequency. Mineralization of litter C only (i.e. cumulative CO_2 from soil+litter – cumulative CO_2 from soil only) tended to decrease in all soils for litter grown at 380 or 550 $\mu L\ L^{-1}\ CO_2$ compared to 280 $\mu L\ L^{-1}\ CO_2$, particularly in the wettest soils (50% WHC). Initial C:N ratios in litter were significantly different between all CO_2 treatments, increasing with growth CO_2 concentration (63, 74, 81, respectively). Decreasing N availability from litter with higher C:N may have limited microbial mineralization of litter C. Thus, greater litter inputs from enhanced plant productivity under increasing atmospheric CO_2 and a longer retention time of plant-derived C due to reduced decomposition might contribute to C sequestration in grassland soils. Potential changes in grassland soil C storage, however, will be controlled by the timing and amount of precipitation, which are predicted to change over the 21st century.