Plant Productivity Responses to Rising Atmospheric CO_2 and Warming in Semi-Arid Grassland in Wyoming, USA

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Key words: aboveground biomass, C_3, C_4, global change, plant species

Introduction There is little information on the responses of native grasslands to combined global change factors. This experiment examines how plant productivity in a northern mixed-grass prairie near Cheyenne, WY, USA responds to combined CO_2 enrichment and warming.

Materials and methods The Prairie Heating and CO_2 Enrichment (PHACE) experiment consists of thirty 3-m diameter circular plots in native semi-arid grassland at the USDA-ARS High Plains Grasslands Research Station, west of Cheyenne, WY, USA. The focus of this presentation is on 20 plots assigned to factorial combinations of two CO_2 and temperature treatments:
ct present [CO_2] & present temp
cT present [CO_2] & warm [+1.5/3.0℃ day/night]
Ct elevated [CO_2] (600 ppm) & present temp
CT elevated [CO_2] & warm,
with five replications. Measurements of aboveground plant biomass (AGB) were determined in late July each year, the time of peak aboveground biomass. Results are presented for two years only, the pre-treatment year of 2005 and in 2007 when treatments had begun.

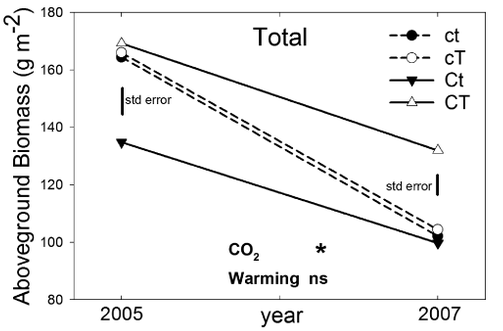

Figure 1 *Peak seasonal aboveground biomass prior to treatments (2005) and as affected by growth at variable CO_2 (C&c) and temperature (T&t) (2007). * indicates treatment significance at $P \leq 0.05$ level.*

Results Both total (Figure 1) and functional group (Figure 2) AGB differed in some of the treatment plots prior to initiation of the CO_2 and warming treatments, so statistical tests for treatment effects were performed by evaluating differences in AGB before (2005) and after (2007) treatments had begun. Total AGB declined from 2005 to 2007 (significant year effect), but declined 13.5 g m^{-2} more under present ambient [CO_2] (c), indicating elevated CO_2 (C) enhanced AGB in 2007 (Figure 1). Warming had no effect on total AGB. The C_3 grasses, which dominate this grassland, displayed similar AGB responses to CO_2 and warming as total AGB (Figure 2). However, AGB of C_4 grasses was enhanced in 2007 by both CO_2 (C) and warming (T). Warming (T) increased C_4 productivity more at elevated (C) than at ambient (c) [CO_2].

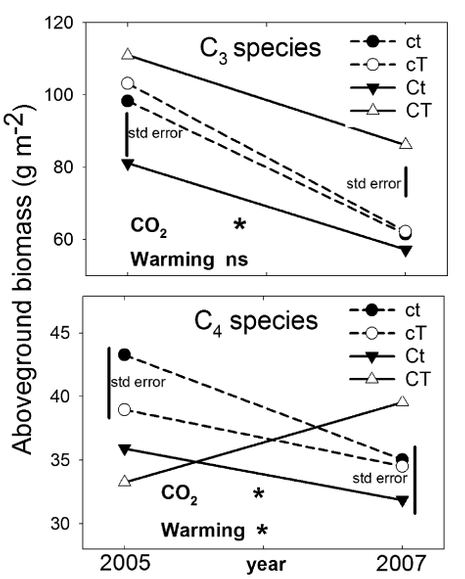

Figure 2 *Peak seasonal aboveground biomass of plant functional groups prior to treatments (2005) and as affected by growth at variable CO_2 (C&c) and temperature (T&t) (2007). * indicates significance at $P \leq 0.05$ level.*

Conclusions These preliminary results confirm results of Morgan et al. (2004) that CO_2 enrichment increases plant production in semi-arid grasslands. Further, they suggest combined rising CO_2 and temperature may enhance productivity of warm-season, C_4 grasses.

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