Nitrogen Fixation Controls Old-field Ecosystem Response in a Multi-Factor Climate Change Experiment

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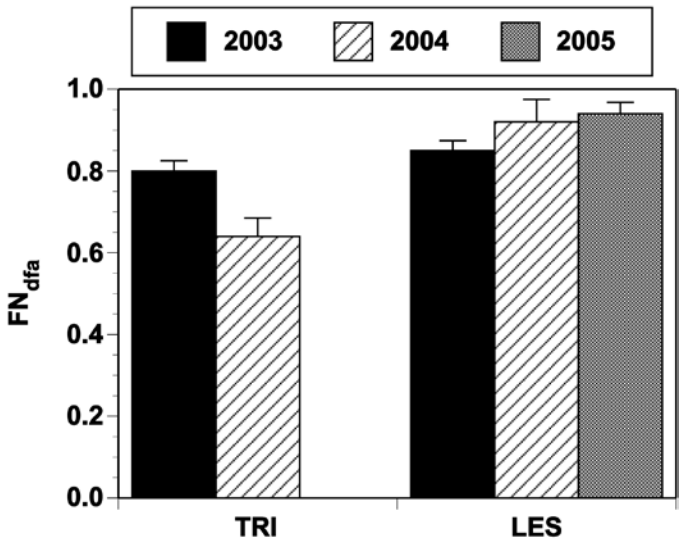
- Nitrogen fixation under combinations of elevated CO_2, temperature, and soil moisture in constructed old-field communities was measured as a response and interpreted as a driver for ecosystem change.
- Nitrogen fixation by legumes contributed 44 to 51% to standing stocks of aboveground nitrogen in the ecosystem annually.
- Symbiotic nitrogen fixation had a dominant influence on old-field species composition. The legume *Lespedeza* became dominant within three years.
- Multi-species studies allow us to observe and understand complex interactions among environmental factors and dynamic changes in community composition under climate change.



Fraction of plant tissue nitrogen derived from nitrogen fixation by *Trifolium* (TRI) and *Lespedeza* (LES) during the three year climate change experiment. Lespedeza dominated aboveground biomass in the constructed old-fields by 2005.

Reference: Garten CT Jr, Classen AT, Norby RJ, Brice DJ, Weltzin JF, Souza L (2008) Role of N_2-fixation in constructed old-field communities under different regimes of [CO_2], temperature, and water availability. Ecosystems 11: 125-137.

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The effects of climate change on nitrogen fixation have not been studied from the perspective of potential multi-factor interactions or their indirect consequences on ecosystem response and nitrogen cycling. We examined the effect of different combinations of elevated atmospheric carbon dioxide and temperature (300 ppm and 3 ° C above ambient, respectively) and soil moisture on nitrogen fixation and community response in constructed old-field ecosystems in east Tennessee. The old-field communities included seven planted herbaceous species, including two legumes (*Lespedeza cuneata* and *Trifolium pratense*). Effects of the climate treatments on nitrogen fixation varied from year-to-year, however nitrogen fixation annually contributed between 44 to 51% to the standing nitrogen stock in aboveground old-field biomass. The biomass of a key legume (*Lespedeza*) increased over time at the expense of other plant species. Ecosystem nitrogen fixation was influenced more by temporal changes in plant community composition than by external treatments that included changes in temperature, carbon dioxide concentration, and soil moisture. Nitrogen fixation conveyed an overall advantage to *Lespedeza* in competition with other plant species and contributed to a progressive increase in the importance of *Lespedeza* to total aboveground biomass irrespective of manipulated environmental factors. Changes in species composition over time in the old-field community had larger impacts on the nitrogen cycle than the response of individual species to the experimental treatments. Although seemingly unresponsive to the environmental manipulations, symbiotic nitrogen fixation was a primary controller in changing old-field species composition during the three year experiment. Single species experiments on effects of climate change overlook such complex interactions between the environment and ecosystem response.

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