Organismal composition and photosynthetic traits of biological soil crusts in prairie ecosystems of the Great Plains

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Introduction

Biological soil crusts (BSCs) are soil-surface microecosystems composed of a close association between living organisms and soil particles (Belnap and Lange, 2003). Although the presence and relative proportion of organisms is dependent upon many factors, BSCs are comprised of algae, cyanobacteria, fungi, lichens, and non-vascular plants (Belnap et al., 2001). Equally as variable as their organismal composition, BSCs have several ecological functions including carbon fixation, nitrogen fixation, nutrient relations, soil stabilization, water relations, and floral community development (Belnap et al., 2001). While BSCs have been studied throughout the American West, little work has been done in the Great Plains region, where they are less prominent among the dominant vascular plant communities (Belnap and Lange, 2003).

Objectives

The purpose of this research was to establish a basic understanding of BSCs in prairie ecosystems with emphasis on organismal composition and photosynthetic traits. The future goal is that this knowledge can be applied to the assessment, conservation, and restoration of BSC communities and their associated grassland ecosystems throughout the world.




Materials and Methods

- Four prairie sites were chosen for their particular ecosystem type and the range of the local BSC communities were mapped using GPS coordinates.
- Late-successional, undamaged BSCs were randomly selected for study with a random point generator.
- Seasonal measurements were performed at each site in July, October, January, and April. Organismal identification and photosynthetic measurements were performed four times during the study, once during each season.
- Photosynthesis measurements were taken in situ under ambient conditions with a Li-Cor LI-6400 Portable Photosynthesis System (Li-Cor Biosciences; Lincoln, Nebraska) and a custom Pyrex gas exchange chamber.
- Samples for determining organismal composition were obtained from the cores produced from the photosynthesis samples. These cores were transported to the lab for further analysis.

Short Grass Prairie
Nunn, Colorado

Dominated by lichens with a smaller portion of bryophytes.

Sandsage Prairie
Fowler, Kansas

Dominated by lichens with very few bryophytes.

Mixed Grass Prairie
Russell, Kansas

Dominated by lichens with a smaller portion of bryophytes.

Tall Grass Prairie
Manhattan, Kansas

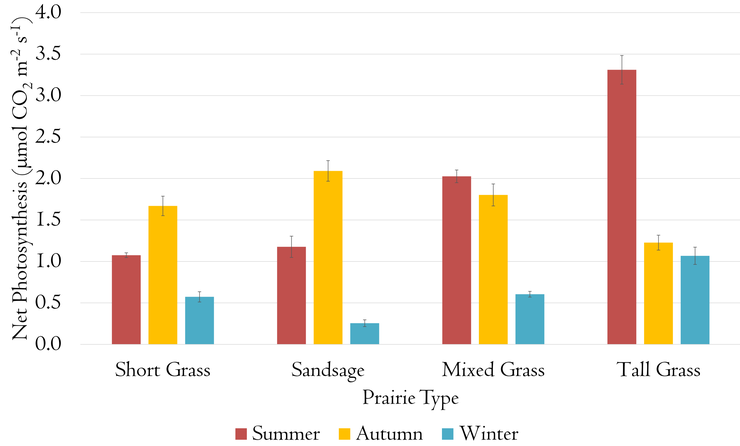
Dominated by equal portions of lichens and bryophytes.

Prairie Type	Short Grass	Sandsage	Mixed Grass	Tall Grass
Average annual precipitation	320 mm	515 mm	660 mm	835 mm
Average annual temperature	8.7 °C	13.5 °C	12.5 °C	12.7 °C
Average annual high temperature	17.5 °C	21.0 °C	19.2 °C	19.5 °C
Average annual low temperature	-0.1 °C	6.0 °C	5.3 °C	5.9 °C

Results

- Lichens, bryophytes, and cyanobacteria were found at all sites with lichens being the most dominant organisms. Bryophytes were codominant with lichens in tall grass prairie, secondarily dominant in short and mixed grass prairies, and less dominant in sandsage prairie. Cyanobacteria and other organisms comprised a smaller portion.
- Photosynthesis varied considerably between seasons and sites, but there was a general correlation between increased photosynthesis rates with increased temperature.

Photosynthesis Rates of Biological Soil Crusts in Four Prairie Ecosystems during Three Seasons



Discussion

This novel research has documented the presence of BSCs in the Great Plains as well as some of their ecological functions. Their role in nutrient input, water relations, erosion prevention, and community development make them a critical part of our ecoregion, and this information could be incorporated into the conservation, restoration, and management of prairie ecosystems.

Acknowledgements

This research was supported by Fort Hays State University, Konza Prairie Biological Station, Central Plains Experimental Range, Prairie Biotic Research, Good Karma Dairy, and FHSU Fleharty Fellowship.

Works Cited

Belnap, J., Lange, O., 2003. Biological Soil Crusts: Structure, Function, and Management. Ecological Studies. Volume 150. Springer-Verlag. Heidelberg, Germany.
Belnap, J., Kaltenecker, J., Rosentreter, R., Williams, J., Leonard, S., Eldridge, D., 2001. Biological Soil Crusts: Ecology and Management. United States Department of the Interior. Denver, Colorado.