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Biological soil crusts as key drivers for CO_2 fluxes in semiarid ecosystems

Sonia Chamizo (1), Isabel Miralles (2), Emilio Rodríguez-Caballero (1), Raúl Ortega (3), Mónica Ladrón de Guevara (2), Lourdes Luna (2), and Yolanda Cantón (1)

(1) Department of Agronomy, Almería, Spain , (2) Experimental Station of Arid Zones (EEZA-CSIC), Almería, Spain , (3) Department of Biology and Geology, University of Almería, Almería, Spain

The quantification of carbon (C) fluxes for the different ecosystems and the knowledge of whether they act as sources or sinks of C has acquired especial importance during the last years. This is particularly demanding for arid and semiarid ecosystems, for which the available information is very scarce. In these ecosystems, the interplant spaces are commonly covered by a thin layer of organisms including cyanobacteria, green algae, lichens and mosses, which are known as biological soil crusts (BSCs) and, though practically negligible, play a fundamental role in regulating gas exchange into and from soil. BSCs represent the main organisms capable of respiration and photosynthesis in the interplant spaces and are considered the main source of organic carbon in many arid and semiarid areas. Although several studies have pointed to the predominant role of BSCs as sources of CO_2, on the contrary, other studies have emphasized their important role as sinks of CO_2, being required to establish their precise effect regulating CO_2 fluxes.

The main purpose of this study was to enlighten the role of BSCs on CO_2 fluxes. With this aim, CO_2 fluxes were measured on different BSC types (cyanobacteria-, lichen- and moss-dominated BSCs) after several rainfalls and periods of soil drying in two semiarid ecosystems of SE Spain. CO_2 exchange was measured using infrared gas analyzers (IRGA): net flux was measured with a transparent custom chamber attached to a Licor Li-6400, and respiration with a respirometer EGM-4 (PPsystems). Photosynthesis was determined as the difference between both measurements. Our results showed that moisture was the major factor controlling CO_2 fluxes in BSCs. During the summer season, when soil was dry, all BSCs showed CO_2 fluxes close to 0. However, once it rains and BSCs become active, a significant increase in photosynthesis and respiration rates was found. Whereas respiration was the main CO_2 flux in bare soils, in BSCs regardless respiration was higher, these CO_2 emissions were compensated, during several days following the rain, by CO_2 fixation through photosynthesis, thus resulting in a positive net flux or net uptake of CO_2. However, differences were observed between BSC types. Moss-dominated BSCs, regardless being more developed than cyanobacteria and lichen BSCs, showed lower net photosynthesis rates because of their higher respiration rates. These findings support the idea that BSCs act as important C sinks during the periods when they are active, although the rate of CO_2 assimilation may greatly depend on the type of BSC. The results of this study demonstrate the need to consider the effect of different types of BSC in C balance models on local to global scales to improve our knowledge on C quantification and to make more accurate predictions of the effects of climate change in arid and semiarid regions where this type of soil cover is a key ecosystem component.