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Both biocrust cover and soil warming increased inorganic and organic P fractions in a semi-arid ecosystem of Central Spain

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Semi-arid and arid ecosystem represents 41% of Earth's surface, and climate change is expected to increase this percentage of drylands. The increase in aridity has a profound effect on biogeochemical cycles, inducing an imbalance in the soil nitrogen (N): phosphorus (P) ratio, with subsequent impacts on ecosystem services. In addition, primary productivity in terrestrial ecosystems can be destabilized by the increase of atmospheric N deposition, and P may become the most limiting nutrient in these altered ecosystems. Some studies have shown that aridity and climate change influence N cycling in drylands, however the resilience of labile and recalcitrant, inorganic and organic fractions of P in semi-arid ecosystems is still unknown. Our main hypothesis stipulates that soil warming might induce an increase of the inorganic P fractions versus the organic ones because of a rise of biological activity in drylands, but these variations may be modulated by the presence of Biological Soil Crust (BSC) and counteracted by the predicted precipitation decrease. We tested how warming (ambient vs. $\sim$2.5 $^{\circ}$C increase), rainfall exclusion (ambient vs. $\sim$30% reduction in total annual rainfall) and biocrust cover (incipient vs. well-developed biocrusts) alter organic and inorganic P fractions (resin-P, $NaHCO_3$-P, NaOH-P, HCl-P and residual P) in a 5-yr field experiment. We performed a combination of classic methods of soil P fractionation to determine proportions of organic and inorganic P, representing different indexes related to availability and recalcitrance of P. The presence of BSC had a great influence through an increase in all P fractions. Soil warming increased inorganic P ($NaHCO_3$-P, NaOH-P and HCl-P) but also organic P fractions ($NaHCO_3$-P and NaOH-P) f. In addition, we detected an increase in the recalcitrance-to-labil P ratio over time possibly due to microbial immobilization. The rainfall exclusion experiment had no effect on any P fractions. Our results suggest that global warming may alter significantly the P biogeochemistry both directly and indirectly by influencing the BSC cover in drylands.

Key-words: P fractionation, global warming, rainfall exclusion, biocrust