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Photodegradation processes in arid ecosystems: controlling factors and potential application in land restoration

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Water availability plays a fundamental part in controlling biotic processes in arid ecosystems. However, recent evidence suggests that other decisive drivers take part in these processes. Despite low annual rainfall and microbial activity, unexplained high rates of litter decomposition, net nitrogen mineralization, soil enzymatic activity and carbon turnover have been observed in arid ecosystems. These observations have been partly explained by photodegradation, a process that consists of the breakdown of organic matter via solar radiation (UV) and that can increase decomposition rates and lead to changes in the balance of carbon and nutrients between plants, soil and atmosphere. A complete understanding of these mechanisms and its drivers in arid ecosystems remains a critical challenge for the scientific community at the global level. In this research, we conducted a multi-site field experiment to test the effects of photodegradation on decomposition of organic amendments used in ecosystem restoration. The study was carried out during 12 months in two study areas: the Pilbara region in Western Australia (Southern Hemisphere) and the Cabo de Gata Nijar Natural Park, South Spain (Northern Hemisphere). In both sites, four treatments were applied in replicated plots (1x1 m, n=4) that included a control (C) with no soil amendment; organic amendment covering the soil surface (AS); organic amendment incorporated into the soil (AI); and a combination of both techniques, both covering the surface and incorporated into the soil (AS-AI). Different organic amendments (native mulch versus compost) and soil substrates were used at each site according to local practices, but in both sites these were applied to increase soil organic matter up to 2%. At the two locations, a radiometer and a logger with a soil temperature and soil moisture probe were installed to monitor UV radiation and soil conditions for the duration of the trial. Soil microbial activity, soil CO_2 efflux, and the organic matter fractions (including total OC and hydro-soluble C) were measured repeatedly during the experiment. At the end of the experiment, levels of the soluble fraction of C, soil CO_2 efflux and soil microbial activity were significantly ($p< 0.05$) higher in those plots amended in the surface in both sites. These increases in the surface reflect a fast C decomposing process that can be directly related to UV radiation, evidencing the critical role of photodegradation on the decomposition of the organic matter. These processes can be critical at global scales as they can contribute to forcing biogechemical cycles; however, responses will vary depending on the type of the substrate and organic amendment.