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Development and hydrology of biological soil crusts – first results from a surface inoculation experiment

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Representing a set of various micro-biocoenoses, biocrusts often reside in adjacent patches, which not necessarily relate to structural elements of the habitat, like (micro-) topography or vegetational patterns. Such biocrust patches may become more stable through the formation of mutually dependent ecohydrological regimes. For example, algal patches inhibiting infiltration and generating runoff alternate with runoff-receiving moss patches possessing high water holding capacities. Here, we preliminarily report on a lysimeter field experiment where natural biocrust isolates were used for surface inoculation to (I) prove stochastic vs. deterministic biocrust development and (II) to quantitatively relate biocrust development to soil hydrology. Lysimeter sand was collected from 3-4 m below surface at natural dune outcrops in south-eastern Brandenburg, Germany (Glashütte (GLA) and Neuer Lugteich (LUG)), where biocrust samples were collected at the respective dune bases. The lysimeters were designed to prevent runoff. In a completely randomized full-factorial design, three factors were considered. (A) Inocolum in three treatments (bare control, mosses, algae), (B) mineral substrate texture in two treatments (GLA: 55% and LUG: 79% particles >630 μm), and (C) surface compaction in two treatments (control, 41.5 kN m^{-2} for 30 seconds). The samples were kept dry and re-moistened to -60 hPa two days before inoculation. After a species inventory, the inoculate was isolated by gently washing off sand particles from the biocrust samples. Algal/lichen crusts were dominated by *Zygogonium ericetorum* and *Cladonia* sp. at both sites. All moss crusts were dominated by *Polytrichum piliferum* and *Ceratodon purpureus*, whereas *Brachythecium albicans* was present at GLA only. 20 g of homogenized moist inoculate were spread over the surface of each lysimeter (Ø 19 cm, 22 cm depth). We performed autochthonous inoculation, i.e. biocrust isolates collected from GLA were used for inoculation of GLA substrate etc. The experiment started at 12.02.2015 and was located at an open area in the vicinity of a meteorological station, where all relevant for HYDRUS modeling data, as well as global radiation have been recorded every 10 min. Crust development was monitored by non-destructive NDVI imaging and a per lysimeter determination of the areal share of biocrust developmental stages: mineral surface (NDVI $\leq$ 0), BSC1 (0 < NDVI $\leq$ 0.15), BSC2 (0.15 < NDVI $\leq$ 0.40) and BSC3 (NDVI > 0.40). The general water balance equation and the amount of lysimeter leachate were used to determine evaporation and changes in water stocks by regular weighing. Biomass growth was inhibited in summer compared to autumn, where mosses developed faster than algae. Finer grained substrate promoted biocrust growth. Evapotranspiration increased with biomass development, presumably because the amount of water held close to the surface increased with biomass. It can be expected that this effect strengthens with increasing amounts of silt and clay. Biodiversity studies are pending, but incipient biocrust growth in the controls points to atmogenic superinfection. So far, it can be concluded that availability of water, depending on both precipitation and substrate texture, were the driving factors of biocrust development. Apart from runoff losses in hillslope conditions, biocrusts are hypothesized to take advantage over their vascular competitors by preventing water infiltration into deeper soil through increased evapotranspiration.