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Hydraulic and nutritional feedback controls surface patchiness of biological soil crusts at a post-mining site.

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In a recultivation area located in Brandenburg, Germany, five types of biocrusts (initial BSC1, developed BSC2 and BSC3, mosses, lichens) and non-crusted mineral substrate were sampled on tertiary sand deposited in 1985-1986 to investigate hydrologic properties of crust patches. It was the aim of the study to demonstrate that (I) two types of BSC with alternative nutritional and hydraulic feedback modes co-exist in one area and that (II) these feedback modes are synergic. The sites to sample were selected by expertise, trying to represent mixed sites dominated by mosses, by lichens, and by visually in the field observable surface properties (colour and crust thickness) for the non-crusted substrate and BSC1 to 3. The non-crusted samples contained minor incrustations of the lichen *Placynthiella oligotropha*, young leaflets of the moss *Ceratodon purpureus*, as well as very sparsely present individuals of the green algae *Ulothrix spec*., *Zygogonium spec*. and *Haematococcus spec*. The sample BSC1 was not entirely covered with microphytes, crust patches were smooth, and *P. oligotropha* was observed to develop on residues of *C. purpureus* and on unspecified organic detritus. BSC2 covered the surface entirely and was dominated by *P. oligotropha* and by *Zygogonium spec*. The sample BSC3 consisted of pad-like patches predominantly growing on organic residues. The moss sample was dominated by *C. purpureus* and *Zygogonium spec*. growing between the moss stemlets directly on the mineral surface, the lichen sample was dominated by *Cladonia subulata* with sparsely scattered individuals of *C. purpureus*. Hierarchical cluster analysis revealed that BSC2 was floristically and chemically most similar to the moss crust, whereas BSC3 was floristically and chemically most similar to the lichen crust. Crust biomass was lowest in the non-crusted substrate, increased to the initial BSC1 and peaked in the developed BSC2, BSC3, the lichens and the mosses. Water infiltration was highest on the substrate, and decreased to BSC2, BSC1 and BSC3. Non-metric multidimensional scaling revealed that the lichens and BSC3 were associated with water soluble nutrients (NO_3, NH_4, K, Mg, Ca) and with pyrite weathering products (pH, SO_4), thus representing a high nutrient low hydraulic feedback mode. The mosses and BSC2 represented a low nutrient high hydraulic feedback mode. These feedback mechanisms were considered as synergic, consisting of run-off generating (low hydraulic) and run-on receiving (high hydraulic) BSC patches. Three scenarios for BSC succession were proposed. (1) Initial BSCs sealed the surface until they reached a successional stage (represented by BSC1) from which the development into either of the feedback modes was triggered, (2) initial heterogeneities of the mineral substrate controlled the development of the feedback mode, and (3) complex interactions between lichens and mosses occurred at later stages of system development. It was concluded that, irrespective of successional pathways, two synergic feedback mechanisms contributed to the generation of self-organized surface patchiness. Such small-scale microsite differentiation with different BSCs has important implications for the vegetation in post-mining sites.

Reference

Fischer, T., Gypser, S., Subbotina, M., Veste, M. (2014) Synergic hydraulic and nutritional feedback mechanisms control surface patchiness of biological soil crusts on tertiary sands at a post-mining site. Journal of Hydrology and Hydromechanics 62(4):293–302