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Use of coal ash for enhancing biocrust development in stabilizing sand dunes

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In dryland environments, biocrusts are considered ecosystem engineers since they play significant roles in ecosystem
processes. In the successional pathway of crust communities, the new areas are colonized after disturbance by pioneers such as filamentous cyanobacteria - Microcoleus spp. This stage is followed by colonization of green algae, mosses, and lichens. Aggregation of soil granules is caused by metabolic polysaccharides secreted by cyanobacteria and green algae, gluing the soil particles to form the crust layer. It was suggested that incorporating dust into the biocrusts encourages the growth of cyanobacteria, leading to a strengthening of the biocrusts' cohesion. Moreover, biocrusts cover a larger portion of the surface when the soil contains finer particles, and it was observed that at least 4-5% of clay and silt is required to support a measurable biocrust. While natural and undisturbed sand dunes are generally stabilized by biocrusts in the north-western Negev desert, stabilization of disturbed and movable sand dunes is one of the main problems in this desertified land, as in vast areas in the world. Daily breezes and seasonal wind storms transport sand particles to populated and agricultural areas causing damages to field crops and livelihood. Moving sand dunes consist of relatively coarse grains (250-2000 m) with a low percent of clay and silt. This phenomenon negatively affects cyanobacterial colonization rate, even in relatively wet desert areas (100-250 mm rainfalls). In order to face the problem it was suggested to enrich the dune surface by using coal fly-ash.
The research was conducted in two stages: first, examining the feasibility in Petri-dishes in laboratory conditions and in Experimental Aeolian Greenhouse conditions. The results showed that adding coal fly-ash and biocrust inoculum increased aggregate stability, penetration resistance and shear strength, as opposed to the control-sand plot. Using mobile wind-tunnel simulations, sand fluxes in the experimental plots under different wind speeds (5 to 9 m s-2) showed significant differences in favor of the treatment of coal fly-ash + biocrusts inoculum, compared to the controls (sand, sand + biocrusts and sand + coal fly-ash).