Use of coal ash to stabilize soil surfaces for the prevention of erosion damage in sandy soil by enhancing development of biogenic crusts

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Abstract

The sandy soils in the northern Negev are naturally stabilized by biogenic crusts (formed by photosynthetic microorganisms) that have not been exposed to anthropogenic disturbances. Recently, 20 square kilometers of the sandy dunes, situated in the northern part of the Halutza sands, south of the Kerem Shalom district, was prepared for agricultural settlements. Extensive land tracts in the area, are composed of stable sand dunes, have and are still undergoing development and preparation for agricultural purposes. The preparation of areas for agricultural development involves leveling the surface with heavy equipment. This affects the soil surface natural stability, and exposes the agricultural land to wind erosion and to sand migration from the nearby dunes to the cultivated land (Fig. 1a,b,c). The migration of sand grains, which damages the crops and vegetation, has severe economic implications (Fig. 1d).

Stabilized sandy soil surface contain more clay and silt relative to that found in migrating dunes. This contributes considerably to the development of biogenic crusts (BSC) that stabilize the dunes. In this study the researchers' hypothesis is that the use of fly ash, which is rich in particles from the fine clay and silt segments, will help create conditions that contribute to the stabilization of the soil surface in dunes adjacent to agricultural areas. This is in order to enhance the development of BSC and restore the natural balance. The re-stabilization of the sandy surface in areas suffering from imbalance will contribute to reducing the damage to adjacent agricultural areas and their crops.

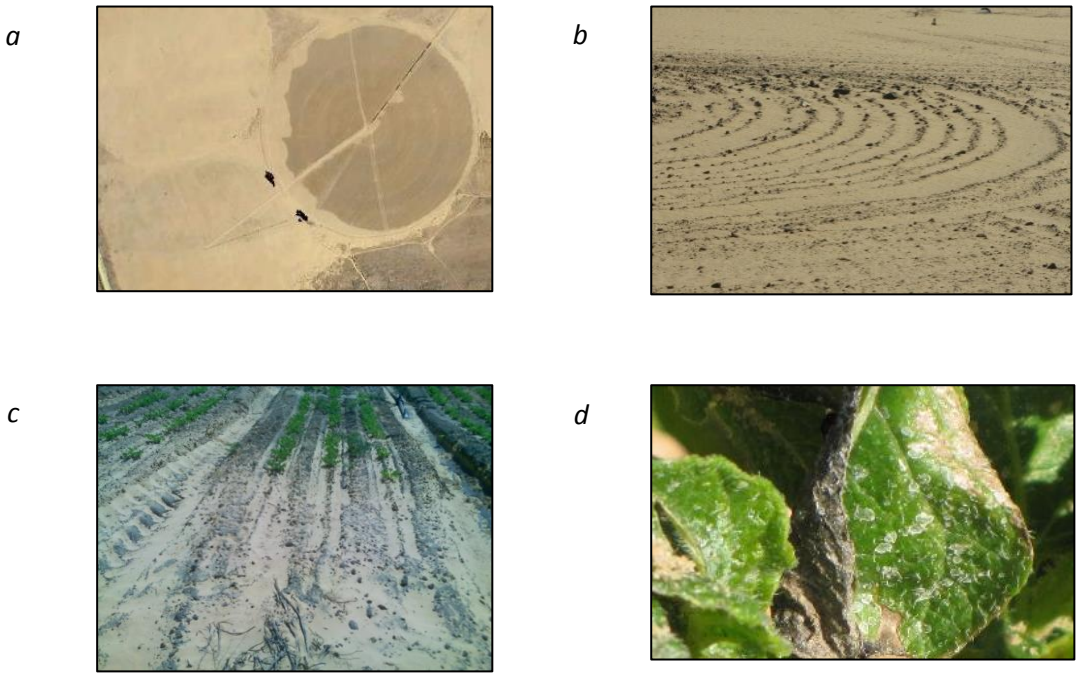

Fig. 1: *a*. Sand migrating into irrigated areas, *b*. Planted area covered by migrating sand, *c*. Agricultural crop (peanuts) covered by migrating sand and *d*. Leaf's damage by sand particles.

The study included physical, chemical and biological tests and examined the effect of adding coal ash to the sandy layer on the development and stabilization of a BSC and the efficiency of how it functions in the field, in two principal stages:

Laboratory experiments to prove feasibility and to determine the optimal concentration of coal ash that contributes to the creation of a viable biogenic crust (Fig. 2a).

Wind tunnel experiments that examined the effects of BSC growth on sandy trays with and without flying coal ash (Fig. 2b).

Testing for applied feasibility in experimental plots was done in two levels: greenhouse (Fig. 2c) and sand dune area (Fig. 2d) where agricultural land is being prepared in the Halutza sands. Both experiments include the addition of coal ash to the experimental plots at the optimal level as obtained in the laboratory and the wind tunnel experiments.

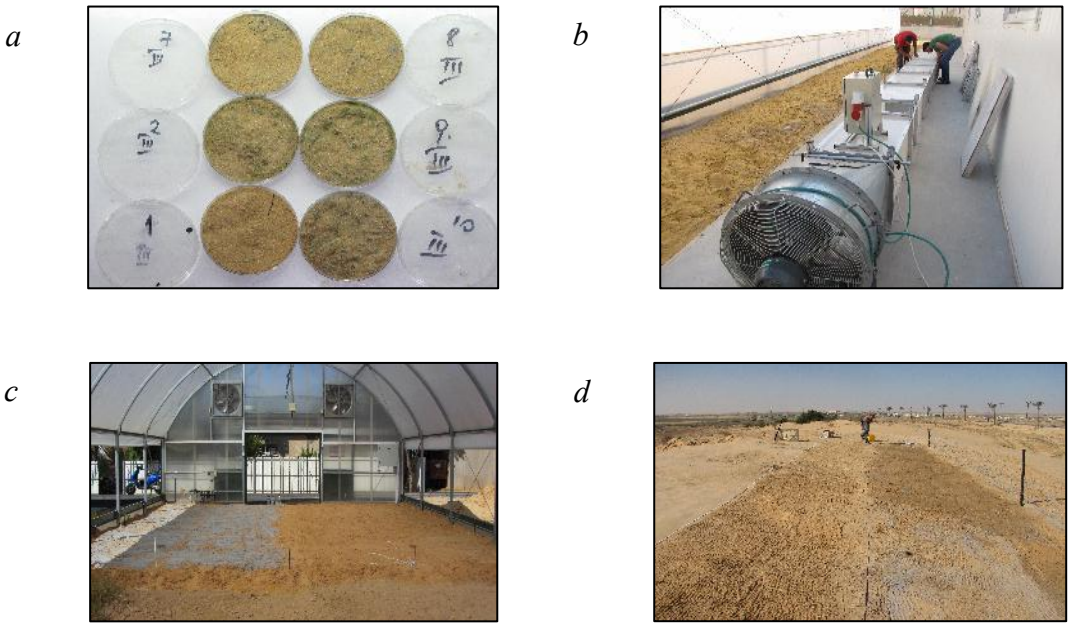

Fig. 2: *a*. Biogenic crust develops in Petri-dish experiment, *b*. Wind tunnel with tray's experiment, *c*. Greenhouse experiment. and *d*. Field experiment

The results showed that the inoculants did not affected by the flying coal ash and that two percent's are the optimal for BSC development. All the bio-physiological parameters of the BSC and the aggregate soil stability in the soil surface increased. The wind tunnel results showed the importance of the developed BSC in preventing soil erosion. In all the field experiment the control untreated plots showed the lack of stability and relatively high erosion availability.