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The effect of soil type and crust cover on the absorption of atmospheric water vapor – laboratory and field trials

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In arid and semiarid environments non-rainfall water inputs (NRWI) are an important source of water. In Israel's Negev desert direct absorption of atmospheric water vapor is the dominant NRWI and is strongly affected by soil properties, in particular clay content. The presence of a surface crust layer, whose physical and physico-chemical properties are substantially different from those of the underlying undisturbed substrate will likely affect the absorption patterns. The objective of our study was to quantify the effect of soil type (loess vs. sand) and crust cover (crust vs. crust removed) on direct atmospheric water absorption.

The loess soil samples were obtained in an open field adjacent to the Jacob Bluestein Institutes for Desert Research (BIDR), Ben-Gurion University of the Negev (30˚51' N, 034˚46' E, 470 m a.s.l); and the sand samples from the Nizzana Sand Dune area (30˚58'N, 034˚24'E, 226 m a.s.l.). The loess crusts were physically induced while those present on the sand samples were of biological origin.

A field experiment was carried out in the open field adjacent to the BIDR. Four undisturbed 50 cm depth soil samples (sand and loess with crust and with crust removed) were placed in micro-lysimeters and automatically weighed at 30 min. intervals. This field experiment was carried during the dry season of May to October 2016.

The field study was supplemented with a laboratory experiment in which undisturbed samples (1, 3, 7 and 10 cm) obtained from the above-mentioned sites were used. Oven-dry samples were exposed during 6 days to constant temperature and relative humidity conditions (25±1 oC and 85±5 %, respectively) in sealed chambers. Mass changes were recorded at varying time intervals.

The adsorption process in the field started in the late afternoon with the arrival of the sea breeze and ended with sun rise. On a daily basis, the crusted loess sample adsorbed more water than the crusted sand sample, and the crust removed loess soil absorbed more water than the crust removed sand. The crusted samples generally absorbed less water than the corresponding non-crusted ones.

The results of the laboratory tests showed that loess samples with crust and with crust removed absorbed similar water amounts for all sample depths throughout the study period. The crusted sand samples however absorbed systematically more water than the crust removed samples for all sample depths.

We conclude that the higher resistance of crusts to gaseous flux, a result of their higher bulk density and smaller pores, does not limit water vapor flux into the deeper soil layers and does not explain the field results.