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Water Retention and Structure Stability in Smectitic or Kaolinitic Loam and Clay Soils Affected by Polyacrylamide Addition

Amirakh Mamedov (1) and Guy Levy (2)

(1) Institute of Soil Science and Agrichemistry, ANAS, Baku, Azerbaijan (amrakh03@yahoo.com), (2) Institute of Soil, Water and Environmental Sciences, ARO, Bet Dagan, Israel (vwguy@volcani.agri.gov.il)

Studying the effects of polyacrylamide (PAM) on soil aggregate and structure stability is important in developing effective soil and water conservation practices and in sustaining soil and water quality. Five concentrations of an anionic PAM (0, 25, 50, 100 and 200 mg L^{-1}) with a high molecular weight were tested on loam and clay soils having either a predominant smectitic or kaolinitic clay mineralogy. The effects of the PAM and of soil texture on soil water retention at near saturation and on aggregate and structure stability were investigated using the high energy moisture characteristic (HEMC) method. The S-shaped water retention curves obtained by the HEMC method were characterized by the modified van Genuchten (1980) model that provided: (i) the model parameters α and n, which represent the location of the inflection point and the steepness of the water retention curve, respectively; and (ii) the soil structure index, SI =VDP/MS, where VDP is the volume of drainable pores, an indicator of the quantity of water released by a soil over the range of applied suctions (0-5 J kg^{-1}), and MS is the modal suction representing the most frequent pore sizes (> 60 μm). In general, the treatments tested (clay mineralogy, soil type and PAM concentration) resulted in: (i) a considerable modification of the shape of the water retention curves as indicated by the changes in the α and n values; and; (ii) substantial effects on the stability indices and other model parameters. The contribution of PAM concentration to soil structure stability depended on the clay mineralogy, being more effective in the smectitic soils than in the kaolinitic ones. Although kaolinitic soils are usually more stable than smectitic soils, when the latter were treated with PAM (25-200 mg L^{-1}) the opposite trend was observed. In the loam soils, increasing the PAM concentration notably decreased the differences between values of the stability indices of the smectitic and kaolinitic samples. The results suggest that determining the efficacy of different PAM applications in the field in improving water retention and soil structure is complex. Therefore soil properties (clay mineralogy, soil texture) and field conditions (moisture content) should be considered when determining the optimal rate of PAM application. The mechanisms responsible for PAM-soil interaction impacts on soil structure, stability indices and model parameters are discussed in the paper.