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Effect of climatic conditions on the development of soil water repellency in soils treated with the wastewater of the olive oil production

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The disposal of untreated wastewater on soil can induce severe water repellency. The final degree of water repellency may strongly depend on the environmental conditions prevailing during and after disposal. Also unpolluted soil can develop severe water repellency upon exposure to extreme heat or draught events. The induced water repellency can be either persistent or of transient nature. However, the underlying mechanisms are not yet completely understood. The objective of this study was to investigate how climatic conditions determine the development and persistence of water repellency following wastewater disposal. Our hypothesis was that amphiphilic organic wastewater compounds physically sorb onto surfaces, which renders them hydrophobic. Depending on temperature and moisture, those compounds are degraded, chemically incorporated into SOM, or irreversibly sorbed to soil particles during the time after the first waste water-soil contact. According to our hypothesis, biological communities favor degradation and transformation of OM of waste water into SOM under moist soil conditions. This would reduce the initial hydrophobization. In contrast, drying irreversibly renders soil hydrophobic and phytotoxic due to immobilization of OMW OM in the soil.

To test these hypotheses, we investigated effects of olive mil wastewater (OMW), the effluent originating from olive oil production, directly applied to soil. In Israel and Palastine, olive oil production generates large amounts of OMW within a short period of time between November and January. As sewage facilities do not accept OMW, it is often disposed onto soil, which leads to severe soil and groundwater pollution. If the above mentioned hypotheses match, pollution and hydrophobization might be minimized if the wastewater is discharged at the right time of the year. In order to test this, we conducted field (2-3 years) and laboratory (60 days) experiments in Israel (Gilat, arid climate) and in the West Bank (Bait Reema, Mediterranean climate) to assess the effect of climatic conditions during OMW application on the development of water repellency as a function of time. In the field experiments, OMW was applied to the soil in winter, spring, and summer, the latter with and without subsequent irrigation to keep the field moist for at least 6 weeks after OMW application. Most effects were strongest for the summer scenario without additional irrigation (field and lab) where the field effect persisted for at least 6 months. In contrast, summer application on moist soil only resulted in a slight and temporarily enhanced water repellency. Spring application induced a clearly less severe water repellency than summer application under dry conditions. Water repellency in the field developed more dramatically and with higher persistence in Gilat, which can be explained by its coarser soil texture but also by the more arid conditions. Repellency developed gradually during the hot summer time following OMW application in spring and summer plots and in the summer scenario of the lab incubation experiments, suggesting a contribution of abiotic processes inducing repellency. The results clearly show that extreme heat and/or drought may induce persistent water repellency and that abiotic and physicochemical mechanisms including drought-induced, irreversible sorption of amphiphilic substances to soil particles are capable to render water repellency persistent.