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Rainfall simulation experiments and Water Drop Penetration Time measurements shed light on the impact of water repellency on soils under organic farming management in Eastern Spain

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Water repellency is a well-know soil property since the research of professor Stefan Helmut Doerr recovered and powered the research developed by professor DeBano (Atanassova and Doerr, 2011; ; Jordán et al., 2011; Bodí et al., 2012; González Peñaloza et al., 2012 Bodí et al., 2013; García Moreno et al., 2013; Jordán et al., 2013; Badía-Villas et al., 2014; Jordán et al., 2013; Jiménez Morillo et al., 2015). However, little is known about the impact of water repellency in surface runoff generation, although usually is accepted that when more soil water repellent is a soil, higher will be the surface runoff discharge (Stoff et al., 2011; Madsen et al., 2011; León et al., 2013; Lozano et al., 2013; Mataix-Solera et al., 2013; Santos et al., 2015). And the impact of the water repellency and then the higher surface wash discharge can trigger high erosion rates (Kröpfl et al., 2013; Mandal and Sharda 2013; Zhao et al., 2013). However these relationships were not demonstrated as the most water repellent soils are the one with high organic contents, and those soils do not have soil losses, probably due to the high infiltration rates due to the macropore flow.

Rainfall simulation experiments can shed light in the runoff generation mechanism as they can control the rainfall intensity (Bodí et al., 2012; Iserloh et al., 2012; Iserloh et al., 2013), and inform about the main mechanism of the soil erosion process Cerdà and Jurgensen, 2011; Daugherty et al., 2011; Podwojewski et al., 2011; Dunkerley, 2012; Garel et al., 2012; Jouquet et al., 2012; Kibet et al., 2013; Butzen et al., 2014; Ma et al., 2014; Martínez Murillo et al., 2013).

To determine the relationship between surface runoff generated under simulated rainfall (Cerdà, 1988a; 1988b; Cerdà et al., 1998; Ziadat and Taimeh, 2013) with a small rainfall simulator (0.25 m2) and water repellency measurements with the Water Drop Penetration time methods were done (Bodí et al., 2012). The results show that the most water repellent soils generate a fast surface runoff that use to be infiltrate in macropores (cracks and fauna) and that runoff at plot scales was negligible in water repellent soils.

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References

Atanassova, I., Doerr, S. H. 2011. Changes in soil organic compound composition associated with heat-induced increases in soil water repellency. European Journal of Soil Science, 62(4), 516-532.

Badía-Villas, D., González-Pérez, J. A., Aznar, J. M., Arjona-Gracia, B., & Martí-Dalmau, C. 2014. Changes in water repellency, aggregation and organic matter of a mollic horizon burned in laboratory: soil depth affected by fire. Geoderma, 213, 400-407.

Bodí, M. B., Doerr, S. H., Cerdà, A., Mataix-Solera, J. 2012. Hydrological effects of a layer of vegetation ash on underlying wettable and water repellent soil. Geoderma, 191, 14-23.

Bodí, M.B. Doerr, S.H., Cerdà, A., Mataix-Solera, J. 2012. Hydrological effects of a layer of vegetation ash on underlying wettable and water repellent soils. Geoderma, 191, 14-23. http://dx.doi.org/10.1016/j.geoderma.2012.01.006

Bodí, M.B., Muñoz-Santa, I., Armero, C., Doerr, S.H., Mataix-Solera, J., Cerdà, A. 2013. Spatial and temporal variations of water repellency and probability of its occurrence in calcareous Mediterranean rangeland soils affected by fires. Catena, 108, 14-24. http://dx.doi.org/10.1016/j.catena.2012.04.002

Butzen, V., Seeger, M., Wirtz, S., Huemann, M., Mueller, C., Casper, M., Ries, J. B. 2014. Quantification of Hortonian overland flow generation and soil erosion in a Central European low mountain range using rainfall

experiments. Catena, 113, 202-212.
Cerdà, A. 1998a. Effect of climate on surface flow along a climatological gradient in Israel. A field rainfall simulation approach. Journal of Arid Environments, 38, 145-159.
Cerdà, A. 1998b. The influence of aspect and vegetation on seasonal changes in erosion under rainfall simulation on a clay soil in Spain. Canadian Journal of Soil Science, 78, 321-330.
Cerdà, A., Jurgensen, M. F. 2011. Ant mounds as a source of sediment on citrus orchard plantations in eastern Spain. A three-scale rainfall simulation approach. Catena, 85(3), 231-236.
Dougherty, W. J., Mason, S. D., Burkitt, L. L., Milham, P. J. 2011. Relationship between phosphorus concentration in surface runoff and a novel soil phosphorus test procedure (DGT) under simulated rainfall. Soil Research, 49(6), 523-528.
Dunkerley, D. 2012. Effects of rainfall intensity fluctuations on infiltration and runoff: rainfall simulation on dryland soils, Fowlers Gap, Australia. Hydrological Processes, 26(15), 2211-2224.
García-Moreno, J., Gordillo-Rivero, Á. J., Zavala, L. M., Jordán, A., & Pereira, P. 2013. Mulch application in fruit orchards increases the persistence of soil water repellency during a 15-years period. Soil and Tillage Research, 130, 62-68.
Garel, E., Marc, V., Ruy, S., Cognard-Plancq, A. L., Klotz, S., Emblanch, C., Simler, R. 2012. Large scale rainfall simulation to investigate infiltration processes in a small landslide under dry initial conditions: the Draix hillslope experiment. Hydrological Processes, 26(14), 2171-2186.
González-Peñaloza, F.A., Cerdà, A., Zavala, L.M., Jordán, A., Giménez-Morera, A., Arcenegui, V. 2012. Do conservative agriculture practices increase soil water repellency? A case study in citrus-cropped soils. Soil and Tillage Research, 124, 233-239. http://dx.doi.org/10.1016/j.still.2012.06.015
Granged, A. J., Jordán, A., Zavala, L. M., Bárcenas, G. (2011): Fire-induced changes in soil water repellency increased fingered flow and runoff rates following the 2004 Huelva wildfire. Hydrological Processes, 25: 1614-1629.
Iserloh, T., Ries, J.B., Arnaez, J., Boix Fayos, C., Butzen, V., Cerdà, A., Echeverría, M.T., Fernández-Gálvez, J., Fister, W., Geißler, C., Gómez, J.A., Gómez-Macpherson, H., Kuhn, N.J., Lázaro, R., León, F.J., Martínez-Mena, M., Martínez-Murillo, J.F., Marzen, M., Mingorance, M.D., Ortigosa, L., Peters, P., Regüés, D., Ruiz-Sinoga, J.D., Scholten, T., Seeger, M., Solé-Benet, A., Wengel, R., Wirtz, S. 2013. European small portable rainfall simulators: a comparison of rainfall characteristics. Catena, 110, 100-112. Doi: 10.1016/j.catena.2013.05.013
Iserloh, T., Ries, J.B., Cerdà, A., Echeverría, M.T., Fister, W., Geißler, C., Kuhn, N.J., León, F.J., Peters, P., Schindewolf, M., Schmidt, J., Scholten, T., Seeger, M. (2012): Comparative measurements with seven rainfall simulators on uniform bare fallow land. Zeitschrift für Geomorphologie, 57, 193-201. DOI: 10.1127/0372-8854/2012/S-00118.
Jiménez-Morillo, N. T., González-Pérez, J. A., Jordán, A., Zavala, L. M., Rosa, J. M., Jiménez-González, M. A., & González-Vila, F. J. (2014). Organic matter fractions controlling soil water repellency in Sandy soils from the Doñana National Park (Southwestern Spain). Land Degradation & Development.| DOI: 10.1002/ldr.2314
Jordán, A., García-Moreno, J., Gordillo-Rivero, Á. J., Zavala, L. M., Cerdà, A. 2014. Organic carbon, water repellency and soil stability to slaking under different crops and managements: a case study at aggregate and intra-aggregate scales. SOIL Discussions, 1(1), 295-325.
Jordán, A., Zavala, L. M., Mataix-Solera, J., Doerr, S. H. 2013. Soil water repellency: origin, assessment and geomorphological consequences. Catena, 108, 1-5.
Jordán, A., Zavala, L. M., Mataix-Solera, J., Nava, A. L., & Alanís, N. 2011. Effect of fire severity on water repellency and aggregate stability on Mexican volcanic soils. Catena, 84(3), 136-147.
Jouquet, P., Janeau, J. L., Pisano, A., Sy, H. T., Orange, D., Minh, L. T. N., Valentin, C. 2012. Influence of earthworms and termites on runoff and erosion in a tropical steep slope fallow in Vietnam: A rainfall simulation experiment. Applied Soil Ecology, 61, 161-168.
Kibet, L. C., Saporito, L. S., Allen, A. L., May, E. B., Kleinman, P. J., Hashem, F. M., Bryant, R. B. 2013. A protocol for conducting rainfall simulation to study soil runoff. Journal of visualized experiments: JoVE, (86).
Kröpfl, A. I., Cecchi, G. A., Villasuso, N. M., Distel, R. A. 2013. Degradation and recovery processes in Semi-Arid patchy rangelands of northern Patagonia, Argentina. Land Degradation & Development, 24: 393- 399. DOI 10.1002/ldr.1145
Cerdà, A., Schnabel, S., Gómez-Amelia, D. & Ceballos, A. 1998. Soil hydrological Response under simulated rainfall in the Dehesa ecosystem, Extremadura, SW, Spain. Earth Surface Processes and Landforms, 23, 195- 209
León, J. Bodí, M.B., Cerdà, A., Badía, D. 2013. The contrasted response of ash to wetting. The effects of ash type, thickness and rainfall events. Geoderma, 209-210, 143-152. http://dx.doi.org/10.1016/j.geoderma.2012.01.006
Lozano, E., Jiménez-Pinilla, P., Mataix-Solera, J., Arcenegui, V., Bárcenas, G. M., González-Pérez, J. A., Mataix-Beneyto, J. 2013. Biological and chemical factors controlling the patchy distribution of soil water repellency among plant species in a Mediterranean semiarid forest. Geoderma, 207, 212-220.

Ma, W., Li, Z., Ding, K., Huang, J., Nie, X., Zeng, G., Liu, G. (2014). Effect of soil erosion on dissolved organic carbon redistribution in subtropical red soil under rainfall simulation. Geomorphology, 226, 217-225.
Madsen, M. D., Zvirzdin, D. L., Petersen, S. L., Hopkins, B. G., Roundy, B. A., Chandler, D. G. 2011. Soil water repellency within a burned piñon–juniper woodland: Spatial distribution, severity, and ecohydrologic implications. Soil Science Society of America Journal, 75(4), 1543-1553.
Mandal, D., Sharda, V. N. Appraisal of soil erosion risk in the Eastern Himalayan region of India for soil conservation planning. Land Degradation & Development, 24: 430-437. 2013. DOI 10.1002/ldr.1139
Martínez-Murillo, J. F., Nadal-Romero, E., Regüés, D., Cerdà, A., Poesen, J. 2013. Soil erosion and hydrology of the western Mediterranean badlands throughout rainfall simulation experiments: A review. Catena, 106, 101-112.
Mataix-Solera, J., Arcenegui, V., Tessler, N., Zornoza, R., Wittenberg, L., Martínez, C., Jordán, M. M. 2013. Soil properties as key factors controlling water repellency in fire-affected areas: evidences from burned sites in Spain and Israel. Catena, 108, 6-13.
Podwojewski, P., Janeau, J. L., Grellier, S., Valentin, C., Lorentz, S., Chaplot, V. 2011. Influence of grass soil cover on water runoff and soil detachment under rainfall simulation in a sub-humid South African degraded rangeland. Earth Surface Processes and Landforms, 36(7), 911-922.
Santos, J. M., Verheijen, F. G., Tavares Wahren, F., Wahren, A., Feger, K. H., Bernard-Jannin, L., Nunes, J. P. (2015). Soil water repellency dynamics in pine and eucalupt plantation in Portugal - a high- resolution series. Land Degradation & Development. DOI: 10.1002/ldr.2251
Stoof, C. R., Moore, D., Ritsema, C. J., Dekker, L. W. 2011. Natural and fire-induced soil water repellency in a Portuguese shrubland. Soil Science Society of America Journal, 75(6), 2283-2295.
Zhao, G., Mu, X., Wen, Z., Wang, F., and Gao, P. 2013. Soil erosion, conservation, and Eco-environment changes in the Loess Plateau of China. Land Degradation & Development, 24: 499- 510. DOI 10.1002/ldr.2246
Ziadat, F. M., Taimeh, A. Y. 2013. Effect of rainfall intensity, slope and land use and antecedent soil moisture on soil erosion in an arid environment. Land Degradation & Development, 24: 582- 590. DOI 10.1002/ldr.2239