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Water transfer between rock fragments and fine earth in remoulded soils

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Stony soils cover about 30% of the surface soils of Western Europe, and 60% in Mediterranean areas. Rock fragments may alter the physical, chemical and agricultural properties of soils. They are also a potential reservoir of water and nutrients for plants, suggesting that the stony phase of soil can participate in water supply to crops and affect the storage capacity of soil water. This implies the existence of water transfer between rock fragments and fine earth. To better understand the interaction between the fine earth and rock fragments, we studied the water transfer between pebbles and fine earth on remoulded soils in presence and absence of plants.

Experiments were conducted on remoulded soils in containers (3 L), under controlled conditions. Pebbles and fine earth were collected separately from the Ap horizon of a calcareous lacustrine limestone silty soil located in the central region of France. Pebbles were mixed with fine earth to reach a bulk density of the fine earth of 1.1 g/cm3. Four modalities with different percentage in volume of pebbles were created:
0%p: 0 % pebbles + 100 % fine earth + plant
20%p: 20 % pebbles + 80% fine earth + plant
40%p: 40 % pebbles + 60% fine earth + plant
40%: 40 % pebbles + 60% fine earth
Fifteen containers were created for each modality and cuttings of Populus robusta were planted in the three first modalities. All containers were saturated, then irrigated by capillarity and controlled to maintain a moderate water stress continuously. After three months, the containers were saturated again and then allowed to dry. At that time, plants were from 27 to 43 cm height depending on the modality. Soil samples were collected at 5 dates following this second saturation: D0 = soil water content equal to the Available Water Content, Day 2 = D0 + 2 days, Day 4 = D0 + 4 days, Day 7 = D0 + 7 days, Day 11= D0 + 11 days. At each sampling date, three containers for each modality were used to measure the gravimetric water content separately for fine earth and pebbles, and at five depths. Differences in water content between pebbles and fine earth, and between dates, were analysed by a variance analysis (ANOVA, threshold at 5%).

Results showed different behaviours for water loss between fine earth and pebbles during a drying period of 11 days. While water content of fine earth decreased from the beginning and onward, pebbles only started to lose water several days after. To study the effect of pebbles proportion, modalities "0%p", "20%p" and "40%p" were compared. Fine earth of modality without pebbles (0%p) lost water faster compared to modalities with pebbles ("20%p" and "40%p") from the 7th day. Meanwhile, pebbles lose water only from the 4th or 7th day. In addition, comparisons of containers at 40% with and without plants ("40%p" and "40%") showed that the water content decreased at a similar rate for the fine earth while the drying of the rock fragments was more pronounced with a plant at the end of the drying period. The moisture of fine earth reduced on average 1.3 times faster with a plant than without. So, plants enhanced the drying processes due to their transpiration but did not seem to modify the water transfer trends.
This study showed a water transfer from pebbles towards fine earth occurs, especially when drought starts to be severe, which could be benefit to plant.