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微小重力による粒子拘束力の減少が多孔質体水分移動速度へ与える影響

Effects of reduced particle constraining force due to microgravity on a water flow rate in porous media

人見晋貴 [1], 佐藤直人 [2], 丸尾裕一 [1], 野川健人 [1], 登尾浩助 [2],
Shinki HITOMI[1], Naoto SATO[2], Yuichi MARUO[1], Kento NOGAWA[1] and Kosuke NOBORIO[2]
[1] 明治大学大学院農学研究科，Graduate School of Agriculture, Meiji University
[2] 明治大学農学部，Meiji University School of Agriculture, Meiji University

1. Introduction

Growing plants in soil-like media in a spacecraft needs to know water behaviors under microgravity conditions. Sato et al.[1)] found that gravity little affected water infiltration rates in microgravity experiments for densely packed porous media. They suggested that infiltration may be inhibited by an increased distance between particles in loosely packed porous media[1)]. However, for loosely packed porous media, only a limited number of infiltration experiments have been conducted. Therefore, we evaluated how particle movements affected infiltration rates under microgravity in this study.

2. Materials and Methods

We conducted vertical upward infiltration experiments under microgravity conditions made with a 50 m drop tower (COSMOTORRE, Uematsu Electric Co.,Ltd). During each drop, microgravity conditions lasted about 2.5 seconds. An acrylic column (135 mm long with the inner diameter of 24 mm) was filled with 0.8 mm diameter glass beads at a bulk density of 1.56 g/cm3. Two packing conditions were reproduced to fixed and unfixed particle conditions. We made fixed conditions by packing glass beads densely, whereas unfixed conditions were made by making a gap at the top of the column, creating a margin where particles could move. The filling height in unfixed condition was 2.5 cm. After that we installed these columns vertically and connected them to the water source. Degassed distilled water was supplied from the bottom end of the column under microgravity. The wetting front was captured by a digital microscope (400-CAM025, SANWA SUPPLY), and the wetted area was calculated by image analysis.

3. Results and Discussion

Figure 1 shows the glass beads under 1G and microgravity. The glass bead moved 0.12 mm after microgravity started. The relationship between wetted area and elapsed time is shown in Figure 2. The approximate straight lines for the two conditions show no difference in the infiltration rate. This result indicates that porous particles' movement does not inhibit water infiltration under short-period microgravity conditions.

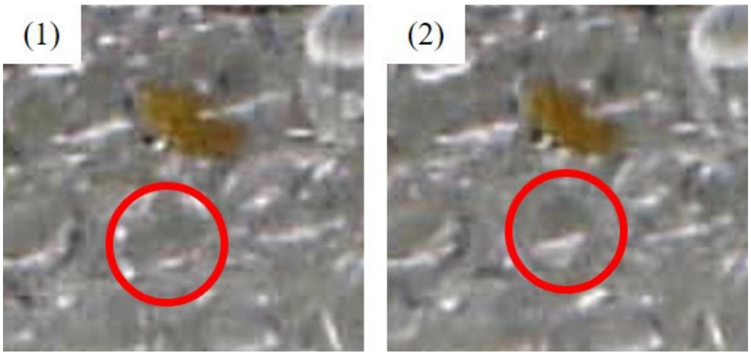

Figure 1. the glass beads under 1G (1) and under microgravity (2). The red circles indicate their location.

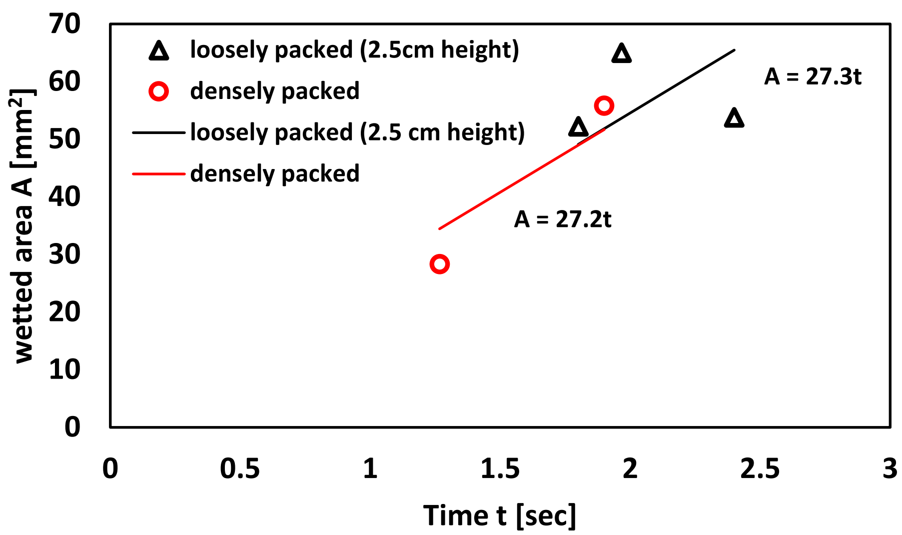

Figure 2. Comparison of infiltration volume between loosely and densely filled

Reference

1) 佐藤直人. 2019. 多孔質体中の水分挙動の重力依存性. 明治大学大学院農学研究科博士論文