Geophysical Research Abstracts
Vol. 21, EGU2019-12088, 2019
EGU General Assembly 2019

The effect of the clod size on evaporation and apparent vapor diffusion coefficient

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In the cultivation of upland crops in clayey paddy fields, huge clods with some centimeters are formed by tillage, especially in the first year after conversion from flooded rice. Such poor tilth causes quick water depletion in the seedbed layer, and decreases germination rate. This study aimed to clarify the effect of the clod size on vertical water profile, evaporation rate, and apparent vapor diffusion coefficients by a laboratory experiment.

We conducted evaporation experiments using cylindrical columns filled with artificially made clods with a diameter of 1 cm (columns with small clods: S column) and 3 cm (columns with large clods: L column), in duplicate. These clods were composed of 20% Ca-bentonite, 20% Na-bentonite and 60% sand and the initial gravimetric water contents were about 0.4. The diameters of the columns were 9.7 and 15.3 cm for the S and L columns, respectively. The thickness of the clod layer was 13 cm and the dry bulk densities of the S and L column were 0.67 and 0.70 g cm^{-3}, respectively. The matric potential at the bottom of the layers was controlled to be -18 cmH_2O. The experiment was conducted in the greenhouse in which the air temperature in daytime and nighttime was 30 ˚C and 25 ˚C, respectively, and the relative humidity was 60 %.

The upward water flux from the bottom of the clods layer was much less than the evaporation rates, and dry soil layers (DSL) were formed in every column. The evaporation rates from L columns were larger than those from S columns through the experiment. Quasi equilibrated water contents of L columns observed after 29 days was smaller than that of S columns at the most depths. The difference of the water content within each clod measured at the 4th layer from the surface of the L column was smaller than that between the adjacent clods, indicating that contact points of clods highly hindered water transmission. The apparent vapor diffusion coefficients in L and S columns were 7 and 4 times larger than the molecular diffusion coefficient, respectively. These results show the upward movement of liquid water was more hindered in larger clods layer, while the accelerated vapor movement induced deepening of the dry soil layer.