Altering water and soil heat regimes with hot water applied for soil disinfection

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Applying hot water for soil disinfection becomes popular in Japan. Hot water application aims to disinfect soil pests with heat of hot water from 75 to 95 °C. Keeping soil temperature over 55 °C for 10 seconds to 4 hours has the effects on disinfecting the soil pests. The amount of hot water application is usually decided by farmer’ s experiences. Excess amount of hot water applied would result in ground water pollution and high fuel costs for a water boilers. The main objective of this study was to find out the unique differences between changes in the volumetric water content and the soil temperature in soil applied hot and tap water. In addition, because previous studies about temperature dependency of soil physic parameters were under around 60 °C, we figured out the temperature dependencies of the dielectric permittivity and thermal property.
We measured the changes in the volumetric water content and the soil temperature in upland soil treated hot and tap water. The amount of both treated water was 185 L m^{-2}. The hot and tap water were prepared as 95 °C with a water boiler and 25 °C, respectively. The volumetric water content was estimated by dielectric permittivity measured with TDR (Time Domain Reflectometry) sensor and the soil temperature was measured with the type-T thermocouple at 5, 10, 20, 40, 60, 80, and 100 cm deep from the soil surface, respectively. Temperature dependencies of the thermal diffusivity and the dielectrics permittivity were revealed. The thermal diffusivity and the dielectric permittivity of Kanto loamy soil were measured from 30 to 90 °C every 10 °C with the cylinder method and TDR, respectively.
The volumetric water content increased from soil surface to deeper soil with hot water application. The volumetric water content in soil in tap water treatment was higher 0.15 m^3 m^{-3} than it in hot water treatment from 5 to 20 cm depth during each water application. Soil temperature from 5 to 40cm was kept over 55 oC more than 4 hours, especially, soil temperature above 10 cm soil depth was raised over 80 oC for a few hours. The dielectric permittivity at 55 and 70 °C in high water content is smaller 15 and 30 % than it at 25 °C. We observed those differences between the volumetric water content in each treatment, because the temperature dependency of the dielectric conductivity.
Temperature dependences of dielectric permittivity of Kanto loamy soil were different at each water content. Especially, it was stronger at high water content. We observed that traveling time of waveform for calculating dielectric permittivity changed shorter with rising soil temperature. Temperature dependence of thermal diffusivity of Kanto loamy soil was strongest at relative water content is around 0.3. We thought that temperature dependency was enhanced by exiting the water vapor.

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