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[1]Study on the Estimation of the Volume Water Content in the Culture Soil during Plant Cultivation using Sound Vibration

音波振動を用いた植物栽培土壌の体積含水率推定に関する研究

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1. Introduction

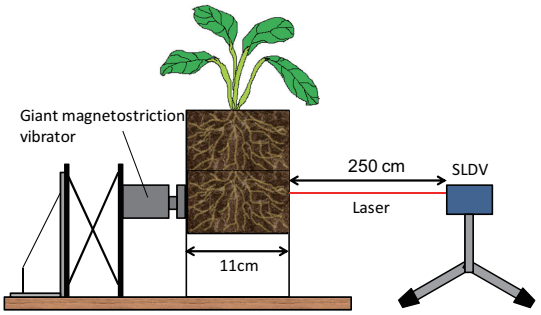
Saving water of the agriculture water is required now because the global shortage of water is becoming the realistic fear. Therefore, the irrigation method using the difference of soil water potential attracts attention [1]. This method has the nature to keep water content inside ground constant. However, effective saving water is not able to be performed, because the water distribution in soil is difficult to grasp. Therefore, we propose a method of monitoring and imaging of the water content in the rooting zone using a sound vibration [2-5]. This time, the soil water measurement during plant cultivation using the sound wave vibration was examined.

2. Soil moisture measurement using sound vibration

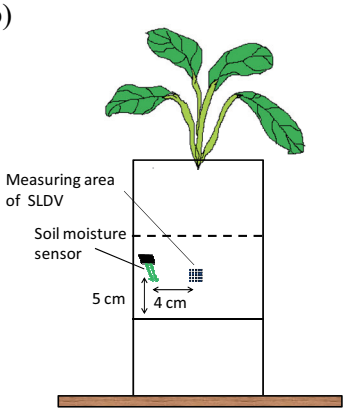
2-1 Experimental Setup

Experimental setup is shown in Fig.1. This time, the cultivated plant (Komatsuna) in measuring container ($15 \times 11 \times 25.5\text{cm}^3$) was carried out vibration measurement. It was performed to measure the volume water content that vary with time by the water supply from the outside and absorption by plant. The measurements are propagation velocity and volume water content. Giant magnetostrictive vibrator (NDS Corp, GPC-1) and Scanning Laser Doppler Vibrometer (SLDV, Polytec Corp, PSV400-H4) were used to measure the propagation velocity. Measurement procedure is shown below: First, fixed with a jack in the measurement container, vibrator to generate vibrations in the soil. SLDV measures the vibration transmitted through the soil. The output waveform uses the burst wave of 1 kHz of sine wave, 5 cycles and propagated distance is about 11 cm. Also, the soil is the culture soil which was sieved of 2 mm. Shown in Fig.1 (b), soil moisture sensor (Decagon devices Inc, EC-5) was set up near the measuring area of vibration measurements. Measurement at five minute intervals was continued for 10 days. Water supply was the three hours of 3 days and 6 days after the start of measurement (Δ h=3). Outside the time has not been water.

(a)



(b)



(c)

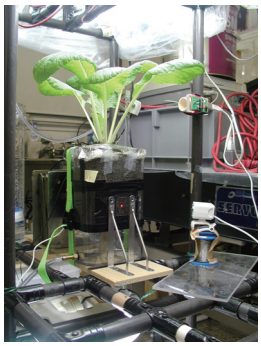


Fig.1 Experimental Setup
(a) Side view, (b) Front view, (c) Photograph

Environmental conditions at the time of measurement are shown in the following.

[1]Soil surface was consideration is covered with a film to prevent evaporation, so as not to touch the air.
[2]ON/OFF time of lighting above the measurement container is 7:00,18:00.
[3]Air conditioning setting in the laboratory is a constant (25℃,heating).

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3. Measurement result of the 10 days

Fig.2 shows the changes with time of the propagation velocity and volume water content obtained by this experiment. Also, square wave above the graph indicates the time that ON/OFF of the lighting. We can confirm that the value of propagation velocity and volume water content is sudden change in a short time of water supply. In addition, these values are in response to ON/OFF of lighting. Change in the inclination of each measurement value by the ON/OFF of the illumination is presumed that the difference occurs in the transpiration rate of the plants. The relationship between the propagation velocity and volume water content was shown in Fig.3. In this figure, negative correlation seen in the propagation velocity and volume water content. And, This result was showed a similar trend to report long-term measurement of two years of Lu[6].

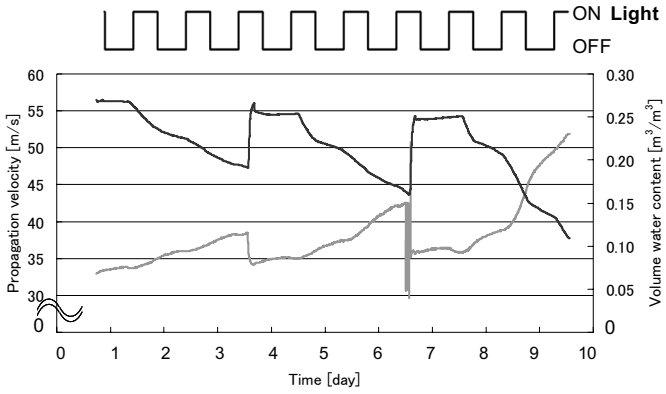

Fig.2 The experimental result of propagation velocity and volume water content.
■:volume water content, ■:propagation velocity

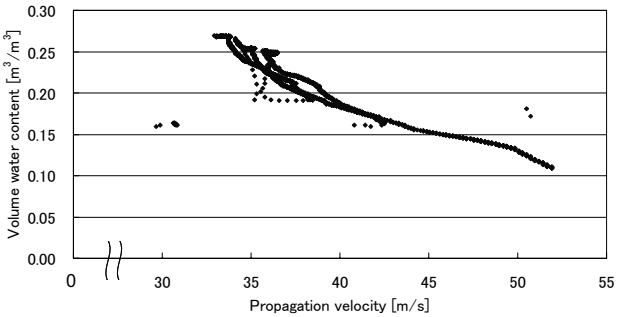

Fig.3 The relationship between the propagation velocity and volume water content.

4. Measurement results of the plant after cutting

After the experiment, the plant was cut from the base. Then, the measurement performed in the same way. In this experiment, the supply for 3 hours at the start of measurement and allowed to stand. Fig.4 shows the change of propagation velocity and volume water content after the plant was cut. From Fig.4, in the situation from plants are not grown, no change was observed in the volume water content and the propagation velocity can be confirmed. In other words, we can be seen that the results of the previous section is due to water absorption of plant.

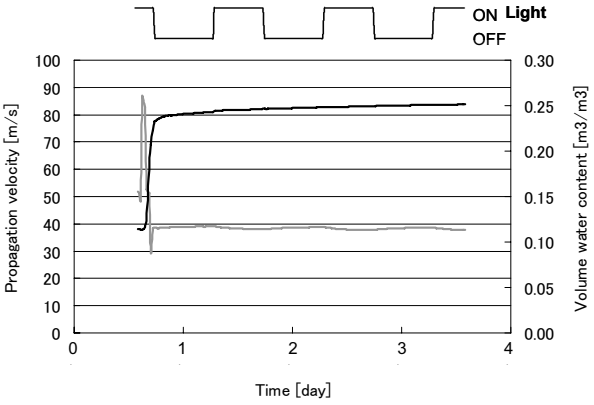

Fig.4 The experimental result of propagation velocity and volume water content after the cutting the plant.
■:volume water content, ■:propagation velocity

5. Conclusion

As a result of vibration measurements in the soil the plant is grown, a negative correlation was observed in the volumetric water content and the propagation of sound. From this result, we can confirmed that it is possible to estimate the water status of the plant rhizosphere by measuring the propagation velocity in the soil.

Acknowledgment

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