STUDY ON PLANT HEALTH CONDITION MONITORING USING ACOUSTIC RADIATION FORCE

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ABSTRACT

When considering a future water problem, saving of water for agricultural use is important, and there is the optimal irrigation control as the one effective means. However, in order to realize it, it is necessary to grasp for what water the plant needs now in un-invading and real time. Then, we examined whether evaluation of plant health condition would be possible using change of the resonance frequency which occurs when vibrating a leaf and a stalk. It became clear from the experimental result using the acoustic radiation force of a parametric speaker that a plant water stress state can estimate from change of resonance frequency.

Keywords: Plant health monitoring, Acoustic radiation force, Laser displacement sensor, Parametric speaker

INTRODUCTION

In recent years, irrigation method using the negative pressure difference attracts attention from the point of view of water saving. By measuring water distribution of soil, active irrigation control will be performed (T.Sugimoto et.al., 2013). However, in order to realize optimal irrigation control, it is necessary to grasp for what water the crops need now in un-invading and real time. Generally, if a plant runs short of water, a leaf will wilt. However, it is very difficult to judge a plant water stress from the wilt of the leaf. Therefore, in our laboratory, the water stress which the plant has received is studied about

whether the evaluation is possible from the change of the resonance frequency of a leaf and a stalk (M. Sano et al., 2013).

EXPERIMENTAL SETUP USING ACOUSTIC RADIATION FORCE

In our previous study, we confirmed that the resonance frequency of a leaf is influenced by the water stress to the plant. Thus the vibration measurement of a leaf was expected to be a new inspection technique for monitoring the health condition of the plant. However, we faced some problems on building an automatically measuring system for a long period of time, because we used an air gun for a vibration source. Therefore, for the automatic measuring, we attempted to use a loudspeaker, as well as for the frequency control of the vibration. But it was not successful to vibrate the leaf in low frequencies with usual speakers. Fortunately, we found that it is possible not only to vibrate a leaf and a stalk very efficiently but also to control the frequency freely by using the acoustic radiation force generated by a high power ultrasonic speaker (Fig. 1). Therefore, the experiment about the ability of monitoring the health condition of the plant under cultivation by measuring the resonance frequency of the leaf using this acoustic radiation force was conducted in this study. We confirmed that a high power ultrasonic speaker could use as a non contact vibration source of vibration of a leaf. According to this fact, long-time vibration measurement of a leaf was attained. From the experimental result (Fig. 2), it is shown that the reaction to water stress is clearly regarded as change of the resonance frequency. As a future task, the difference in the vibration characteristic of a leaf and a stalk will be considered, and also we are going to develop the most suitable irrigation control using this phenomenon.

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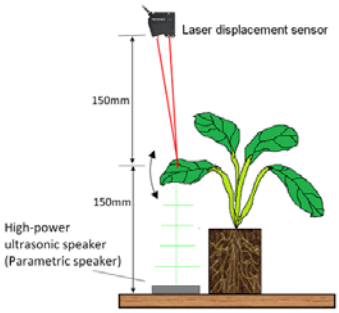

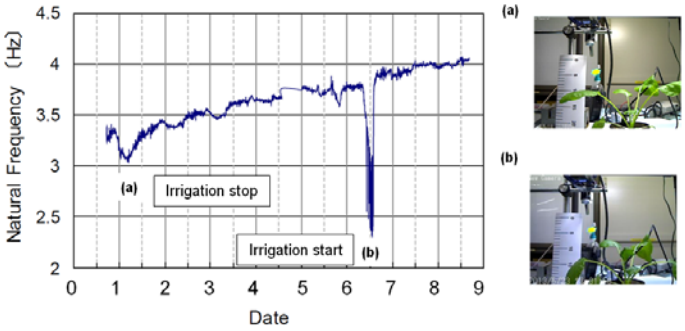

Fig. 1. Experimental Setup.

Fig. 2.The example of the long-term experimental result.