

Bioelectrical Impedance Spectroscopy (BIS) Monitoring of Lettuce during 19 Hours[†]

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Abstract: In this study, a lettuce leaf was monitored using a bioimpedance spectroscopy technique for 19 hours (6 am to midnight). Water was supplied just after 6 am, and the leaves were irradiated with growing LEDs from 8 am to 8 pm. During 19 hours, at every hour, the impedance (resistance and capacitance) of the lettuce was obtained at various frequencies from 1 kHz to 100 kHz. A significant change of impedance after events (watering and LED on) was observed. It implies BIS impedance monitoring can be used for near-realtime monitoring of plant growth. The experimental analysis shows that the bioimpedance system can be used to quantitatively measure the growth and health status of the lettuce leaf. Moreover, the authors propose to use four parameters, the characteristic frequency and the phase of Cole-Cole graph, and the resistance ratios $R_{100\text{kHz}}/R_{1\text{kHz}}$, and $R_{100\text{kHz}}/R_{50\text{kHz}}$ for plant leaf monitoring. When the leaf enters healthier conditions, the characteristic frequency of Cole-Cole graph is getting smaller and the phase is getting bigger. These facts were predicted by referring to the previous articles. However, the authors found the characteristic frequency and the phase angle are not enough to explain the healthiness of lettuce leaf. The proposed two resistance ratio shows different aspects of the healthiness of lettuce leaf during 19 hours more clearly.

Keywords: Bio-Impedance Spectroscopy; Quantitative measure for plant growth; Leaf monitoring; Spectroscopy; Characteristic frequency of Cole-Cole graph and the phase angle; Resistance ratio at different frequencies.