Citrus greening (huanglongbing): Fast electrochemical detection and phytomonitoring of tree diseases

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The electrical signaling in higher plants represents a promising method to diagnose diseases and environmental stresses by monitoring the plant's fast electrical communication coincident with environmental changes.[1-4] Biologically closed electrical circuits in plants operate over large distances in biological tissues and can be found using the Charge Stimulation Method. The activation of such electrical circuits can lead to various physiological and biochemical responses. The cells of many biological organs generate electric potentials that can result in the flow of electric currents. Electrical impulses may arise as a result of stimulation. Once initiated, these impulses can propagate to adjacent excitable cells. The change in transmembrane potential can create a wave of depolarization which affects the adjoining, resting membranes. Thus, when the plasma membrane is stimulated at any point, the action potential can propagate over the entire length of the cell membrane and along the conductive bundles of tissue with constant amplitude, duration, and speed. Electrical signals can propagate along the plasma membrane for short distances in plasmodesmata, and for long distances in conductive bundles. Action potentials in higher plants hold promise as the information carriers in intracellular and intercellular communication during environmental changes. In this work we present methods for the monitoring and stimulation of a plant's electrical activity. In addition to fundamental theoretical concepts, we present our experience in the configuration and development of a custom data acquisition system and the results from plant experiments.

Citrus greening is probably the most important disease of citrus in the world. Huanglongbing (HLB) is also known as Citrus Greening disease because fruit tends to turn green after ripening due to the citrus vein phloem degeneration. Early detection of HLB is very important, because citrus trees usually do not visually present symptoms of HLB, such as yellowing and mottling of leaf veins and misshapen green-colored fruit, for years.

The phloem is a sophisticated tissue in the vascular system of plants. Representing a continuum of plasma membranes, the phloem is a potential pathway for transmission of electrical signals. It consists of two types of conducting cells: the characteristic sieve-tube elements, and the companion cells. Here we show that citrus greening infection induces a very strong decrease in amplitude of electrical potential difference in a citrus tree tissue or in a fruit. A new method, consisting of a data acquisition system interfaced with a computer and Ag/AgCl electrodes connected to trees, was used for measuring of electrical potentials and the detection of citrus greening in a tree's tissue. The amplitude and time dependence of a registered electrical potential difference in a leaf, stem or fruit is sensitive to a tree's health. Infected trees have a very low DC signal in comparison with healthy citrus trees. This electrophysiological method permits fast detection of citrus greening in citrus trees and can be used for the detection of some other diseases in plants and trees. The new electrochemical method of infected citrus trees detection *in vivo* can be used in groves for early detection of infected citrus trees to prevent the disease from spreading. An additional benefit will be the reduction of infested fruit coming to juice producers.

We developed new electrochemical sensors and data acquisition systems for the monitoring of plant growth and for the determination of plant health and stress.

References

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