Portable High-Throughput Digital Confocal Microscope for Early Disease Detection

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Abstract

Northern corn leaf blight (NCLB), caused by the fungus *Setosphaeira turcica*, is one of the most devastating corn diseases in the U.S. and has reduced Indiana yields for the last decade. NCLB can cause significant yield loss if conditions are favorable for early disease onset near tassel/silk (VT/R1) growth stages. Therefore, early detection and timely disease management are essential to mitigate yield loss and optimize fungicide applications. Remote sensing technologies have broad applications in plant phenotyping areas, but they present specific challenges in the early detection of diseases, particularly for diseases where lesions first appear in the lower crop canopy. While laboratories can provide more accurate results than remote sensing, their throughput is limited. To achieve higher throughput and more precise measurements for improved early disease detection, a portable digital microscope prototype has been developed. Distinct from other portable microscopes, this device can detect pathogens and directly monitor their growth on live plant tissue due to its 1 nm spatial resolution. Moreover, it is built with a confocal configuration to capture high-resolution reflective images, thereby outperforming traditional microscopes in throughput. This feature also permits repetitive non-destructible measurements on a single leaf and accommodates leaves of varying thicknesses. By analyzing time-series images of infected leaves, this portable digital microscope has proven its ability to detect spores and germ tubes of the pathogen before symptoms are visibly apparent. It has the potential to effectively bridge the gap between precision and throughput, providing critical insights into disease management.

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