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DETECTION OF THE RENIFORM NEMATODE *ROTYLENCHULUS RENIFORMIS* ON COTTON USING HYPERSPECTRAL IMAGERY

A.T. Kelley
Graduate Research Assistant
G.W. Lawrence
Associate Professor
H.K. Lee
Graduate Research Assistant
Department of Entomology and Plant Pathology
Mississippi State University
Mississippi State, MS
K.S. McLean
Assistant Professor
Auburn University
Auburn University, AL

Abstract

Cotton (Gossypium hirsutum L.) is an important cash crop in 14 states in the US including the state of Mississippi (Creech et al. 1998). To ensure high crop yields, cotton producers must reduce weeds and pests such as insects that abate cotton plant development. Oftentimes, plant-parasitic nematodes are the primary pests responsible for cotton plant stress resulting in reduced cotton yields, thus decreasing producer economic returns (Birchfield and Jones 1961; Birchfield 1962.)

The root-knot nematode (*Meloidogyne incognita*, Kofoid and White) and the reniform nematode (*Rotylenchulus reniformis*, Linford and Oliveira 1940) are the two most prevalent nematodes on cotton (Creech et al. 1998). M. incognita is present on cotton in all cotton producing states. However, *R. reniformis* is newly emerging nematode species quickly spreading throughout the southeastern United States.

Reniform nematodes were identified as cotton parasites in Georgia by Steiner in 1940 (Birchfield 1962). These nematodes inhibit cotton plant development resulting in reduced plant growth and sometimes plant death. Cotton crop yield loss up to 40-60% has been due to reniform nematode infestations (Lawrence et al. 1990). Visible symptoms of the reniform nematode on cotton include reduced root system, reduced boll size, reduced plant size, and exhibition of a yellowish cast of plant and sometimes a purplish hue to leaf margins (Birchfield and Jones 1961).

In Mississippi, the reniform nematode was identified on cotton in 1980. Since identification in Mississippi, the reniform nematode has become a great economic pest of cotton and has been found in 51 different counties (Lawrence et al. 1990). Due to the lack of nematode resistance in midsouth varieties and because transgenic cotton varieties do not reduce nematode infestations, cotton producers must depend on crop rotation and nematicides to manage nematode populations (Creech et al. 1998).

To determine the reniform nematode as the primary contributor to yield loss, and to determine the necessary nematicide management program to be used, cotton producers must first collect numerous soil samples from the cotton field(s) in question. The samples are sent to a laboratory where nematode extraction and identification can take place. This is an extensive and sometimes costly process that can take several weeks to complete possibly causing the producers to miss the window of opportunity to initiate the necessary nematode management program. However, by using hyperspectral imagery, this process may be eliminated saving cotton producers both time and money.

By using a remote sensing device, such as a hand-held hyperspectral spectroradiometer, we can collect spectral information about plants in areas of the spectrum that we cannot observe with our eyes alone. The human eye only sees scattered light in the visible portion of the spectrum viewing green vegetation as healthy plants and plants with a yellowish tone as unhealthy. However, our eyes are not sensitive to light scattered in other regions, such as the near-infrared region (NIR), of the electromagnetic spectrum (Hatfield, 1990). In the NIR region of the electromagnetic spectrum, plants exhibit high reflectance providing meaningful information about plant characteristics (Hatfield and Printer 1993). By using a hyperspectral spectroradiometer, reflected radiation wavelengths can be measured in over 200 different bands. From these many bands, information collected and stored from wavelengths is used to develop a hyperspectral image. The hyperspectral image represents reflectance properties allowing us to visually analyze spectral information of our object of interest.

To date, spectral reflectance analyses have been useful in agricultural related research including weed area estimation, plant and crop disease detection, and vegetation map development. (Everitt, J. H. et al. 1999; Hatfield and Pinter 1993; Malthus and Madeira 1993; Menges et al. 1985; Nutter 1989; Richardson et al. 1985).

The reniform nematode has been studied by Gausman et al. (1975) using a Beckman Model DK-2A spectrophotometer to determine if differences of cotton leaf reflectance are detectable. Reflectance levels of cotton leaves of plants inoculated with the reniform nematode and leaves of plants not inoculated with the nematode were measured. Gausman et al. found that nematode stressed leaves have lower reflectance values than non-stressed leaves suggesting a potential for distinguishing nematode infested cotton plants from non-infested cotton plants by analyzing the leaves' spectral reflectance values.

Therefore, hyperspectral imagery may be a useful remote sensing tool in correlating cotton plant stress and nematode population thresholds enabling cotton producers to test for nematode presence while avoiding the time consuming and sometimes costly soil sampling process presently used today.

The objectives of this research are to:

1. Correlate hyperspectral data from hand-held hyperspectral spectroradiometer, aerial camera, and visual observations to plant stress caused by known levels of the reniform nematode in a controlled field environment.
2. Compare hyperspectral data from known reniform population levels to aerial images developed from production fields naturally infested with the reniform nematode.

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