Diseases and Fertility

ESTIMATING COTTON YIELDS USING SMALL-FORMAT AERIAL PHOTOGRAPHY

M. C. Parton, Research Assistant, Office of Arid Lands Studies and E. N. Mulrean, Extension Specialist, Plant Pathology

Summary

In 1981, the University of Arizona's Department of Plant Pathology and Office of Arid Lands Studies (Arizona Remote Sensing Center) began a joint research project to map and estimate concomitant reductions in yield caused by Phymatotrichum root rot (PRR) using simulated orbital and airborne imagery. With support from the U.S. Department of Agriculture, Cooperative States Research Service and NASA-Ames Research Center, substantial progress has been made in improving estimates of yield . While work to date has been limited to cotton, future studies will include additional crops and other diseases.

* * *

During the last five years, we have made considerable progress mapping the distribution and interseasonal spread of PRR using large format (9x9 inch) color infrared aerial photography. Recently, airborne digital imagery has been provided by NASA-Ames. Thematic Mapper Simulator (TMS) imagery has been valuable in mapping the distribution of PRR with University of Arizona's Digital Image Analysis Laboratory (DIAL) digital classifications.

In June 1983, we began evaluating small-format photography (35 mm) for PRR mapping. While conventional color transparency film was adequate for mapping PRR, color infrared film probably would be superior for mapping conditions producing gradual stress on plants. With a conventional 50 mm lens, at a flight altitude of 7,000 feet above the ground, a single 35 mm frame covered approximately 0.67 square miles (425 acres). The minimum resolution distance was approximately five feet.

The chief advantage of small-format aerial photography is that it provides low-cost spot coverage of selected fields. Five scattered fields (combined area 1,920 acres) can be covered in 40 minutes flying time, available at local rates for $80.00 (including plane and pilot). Film and processing costs were nominal. A single photographic mission providing continuous coverage of 25 square miles (needed to pick up all five fields in 9x9 inch color film) could cost as much as 15 of these small-format missions.

The use of small-format aerial photography allows repetitive coverage for monitoring crop disease conditions, like PRR in cotton, that change rapidly over time. The use of this data source has enabled us to map temporal distribution patterns that, in turn, may be used to characterize spread direction and rate, as well as edaphic conditions that are conducive to movement of the disease.

Ground Reflectance Monitoring of PRR in Cotton

The use of orbital (TM or MSS) or airborne imagery must be supported with ground-collected reflectance data. One phase of our study involves characterizing ground reflectance of both healthy and diseased cotton plants. Field data were collected using a hand-held radiometer (Radiometrics RMR-10) that measured radiance across a spectral range of 0.4 to 1.0 micrometers (visible blue to reflected infrared light). A conventional black-and-white photograph was taken at each site using a 35-mm camera with a wide-angle lens from a distance of 1 meter above the canopy. The photographs were used to develop values for cover density and relative leaf/soil area for a sample site. This information then was used to model field reflectance by providing measurements to support accurate digital classifications of healthy and diseased plants.

The reflectance characteristics of a row of cotton were assessed by taking sequential measurements along a transect. When transects were aligned to include a PRR kill zone, a characteristic reflectance pattern (spectral signature) was observed as a "hill" in the visible wavelength and a "valley" in the infrared wavelengths (Figure 1).

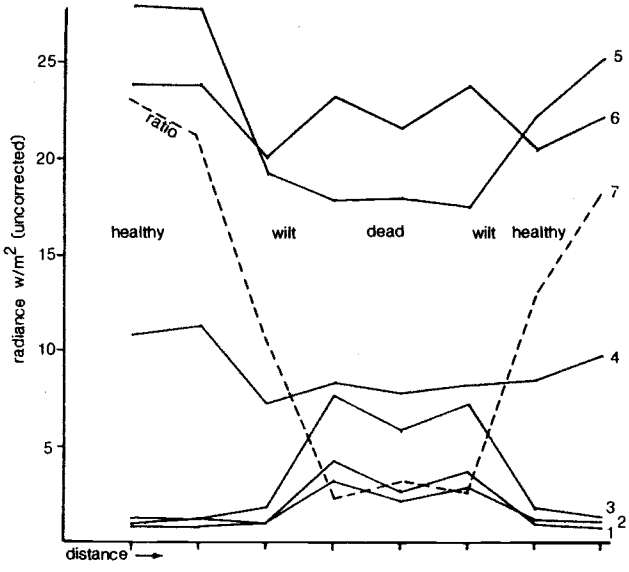
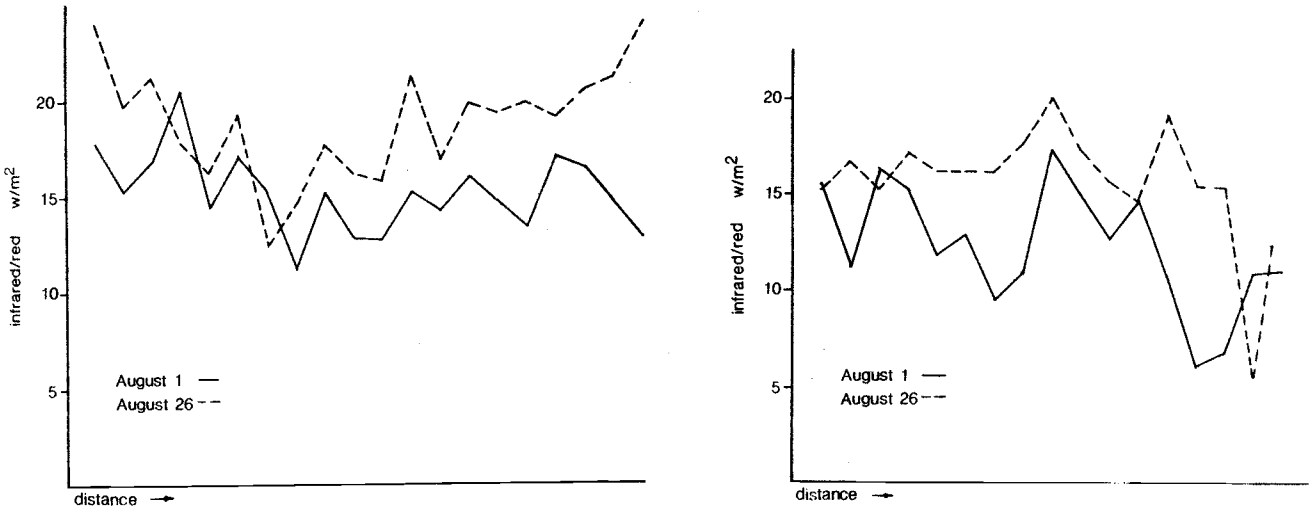


Figure 1. Radiance curves for Phymatotrichum root rot kill zone.
1: .4 - .5 micrometers
2: .5 - .6 micrometers
3: .6 - .7 micrometers
4: .7 - .8 micrometers
5: .8 - .9 micrometers
6: .9 -1.0 micrometers
7: .4 -1.0 micrometers

The transect signature that typifies a PRR kill zone can be compared with sample transect data to identify current development of the disease. Two sample transects were taken on

two dates (Figure 2). The first site (Figure 2a), while showing a pronounced dip in the center for both dates, does not drop to values associated with PRR kill zones. The higher values for the transect on the later date probably indicated leaf maturation. The variance in values along the transect are characteristic of healthy cotton fields.

The radiance pattern associated with a kill zone of PRR was characterized with hand-held radiometer field readings (Figure 2b). By comparing this signature with sample transect values, a natural variance within healthy cotton and an actual PRR kill pattern can be rapidly discriminated. However, a change in values associated with plant maturation must be taken into account.



a) Transect 1 - healthy site

b) Transect 2 - kill zone site

Figure 2. Radiance readings for transects (infrared/red ratio value plot)

This model provides tentative values that can be used to calibrate digital image data for accurately classifying disease zones within fields. Ongoing field characterization also may allow us to discriminate different diseases within a variety of crops.

Application of TMS Imagery to Assessing Crop Losses in Cotton

Again in 1983, NASA-Ames Research Center provided TMS imagery of the Marana area so we could further evaluate the applicability of TM imagery in assessing losses from agricultural diseases. The necessary ground support data were collected in anticipation of the TMS overflight. The effects of last fall's floods prevented us from completing these experiments as anticipated; however, the collected imagery is being classified to map PRR with data collected during previous seasons. In addition, we are now evaluating this imagery to assess flood damage to these fields.