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ADVANCES IN AERIAL PHOTOGRAPHY

Detecting Avocado Phytophthora Root Rot The Use of Multispectral Photographical Techniques

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ABSTRACT

In recent months, intensive investigations into the detection of root rot have been carried out in certain selected avocado orchards in the Eastern Transvaal Lowveld. Multi-spectral techniques, which are superior to conventional infra-red photography, appear as an exciting new development, enabling one to distinguish at a glance between diseased and healthy trees. Not only are differences more clear-cut but it becomes possible to grade the trees into different classes of infection simply by examining the photographs and noting differences in colour intensity of individual trees. Even diseased sectors on individual trees can be detected by this method.

THE PROBLEM

Avocado root rot caused by the fungus *Phytophthora cinnamomi* is one of the major obstacles in the production of avocados (Zentmyer, Paulus, Gustafson, Wallace and Burns, 1965). In California it is estimated that over 2,200 hectares of avocadoes have been destroyed by this pathogen. This amounts to approximately 23% of the total planting (Borst, 1970). In South Africa the infection in individual orchards may vary from 5% to as high as 80%. The overall root rot infection in South African avocado orchards is thought to be approximately 20%. A survey currently being conducted will enable a more reliable estimate to be made of this problem.

INFECTION LOCI MUST BE DETECTED IN INDIVIDUAL ORCHARDS IN ORDER TO PREVENT DISEASE SPREAD

The presence of root rot should ideally be detected at an early stage and extent of the infection mapped. When this has been done, control measures (such as soil fumigants, chemical and dry barriers and careful irrigation methods) may be implemented.

How can the infected areas be located in individual orchards?

(i) By making a ground survey and inspecting and rating every tree once or possibly

twice a year. The problem is that unless trained, the ordinary grower will find difficulty in rating his trees especially in the early stages of disease infection. Difficulties can sometimes be experienced in distinguishing root rot infected trees from those severely infected with sun-blotch virus. This can only be ascertained at present by making laboratory culture tests which is obviously not possible for the ordinary grower.

(ii) Through the use of aerial photographic techniques, similar to those outlined by Yost and Wenderoth (1969), orchards can be photographed at a height of 1,500 metres and by photographic colour differences, even an untrained person can separate out the diseased from healthy trees in a fraction of the time required for ground surveys.

EXPERIMENT CONDUCTED IN AN INFECTED AVOCADO ORCHARD NEAR NELSPRUIT. EASTERN TRANSVAAL, SOUTH AFRICA

(a) Preparation

Prior to the actual aerial photography, the spectral (wave-length) characteristics which distinguish the diseased avocado trees from the healthy ones were ascertained. In order to do this, a specially designed mobile laboratory obtained spectral reflectance data in the field. This laboratory contains spectroradiometers and related electric and optical equipment. The instrument readings were fed into a computer and the resultant reflectance information was used to establish the anomalous wavelengths. Four spectral filters centered about these wavelengths were then fitted to a special four-lens multispectral camera.

Aerial photographs were then made with the four-lens camera. The exposure of each band and the subsequent processing of the film required great precision so as to avoid the introduction of photographic anomalies not related to the objects being photographed. The processed film was finally put into a viewer which combines the different bands into a single colour composite. On this image, differences in each band are made to appear as various enhanced colours, thus facilitating the recognition of the diseased avocado trees. In order to compare this advanced technique with more conventional aerial photography, aerial photos were taken at the same time using conventional colour and colour infra-red photography.

The diseased trees were identified on the three different types of photography and compared with the ground data referred to in (b) below.

(b) Disease Ratings

Every tree in the area selected for multispectral photography was closely examined by trained personnel and classified according to the stage of infection into one of four categories:

The visual symptoms used for this tree classification were as follows:

(i) Healthy: No symptoms of root rot could be detected on close visual inspection.

(ii) Stage 1: (diseased): Leaves appear to be smaller than normal; tree may be slightly stunted in growth; indications of a slight leaf chlorosis and wilt.

(iii) Stage 2: (diseased): Leaves are chlorotic and wilted; moderate defoliation of entire tree or severe defoliation of sectors of the tree.

(iv) Stage 3: (diseased): Advanced stage of root rot; general chlorosis and severe defoliation; branches clearly visible.

(c) Results

A close analysis of the experimental results was made and the most important results are given below:

(i) With the use of multispectral photography, one hundred per cent of the stage 2 and 3 root rot infected trees were correctly classified.

(ii) Infected sectors on otherwise healthy trees could be detected by multispectral photography. When a further ground survey was made it was found that individual branches had been correctly identified as diseased with the use of multispectral photography.

(iii) Most of the trees classified in the ground survey as stage 1 diseased were identified on the multispectral imagery. However, some trees classified in the ground survey as healthy showed up as diseased on the multispectral imagery. This may indicate previsual detection of the disease. Further inspections of the test area will be made to investigate this.

(iv) For comparison, false-colour infra-red and standard colour photography were also used. The false-colour infra-red resulted in 20% of the stage 2 and 3 diseased trees being incorrectly classified. The standard colour photography was essentially worthless for the detection of the disease.

(d) Discussion

The results of this experiment show that it is possible to detect disease patterns in root rot infected orchards from multispectral photographs taken at a height of over 1500 metres. The method was sufficiently sensitive to detect diseased sectors on otherwise healthy trees. From ground observations made in this experiment, difficulty was frequently experienced in distinguishing stage 1 diseased from healthy trees. The presence of a slight leaf chlorosis and indications of a wilt on the trees were used as criteria in these cases. However, in this experiment some trees classified as healthy from the ground surveys showed up as diseased on the multispectral imagery. It is possible that the presence of the disease was detected by this method before any visual symptoms were evident. Periodic checks will be made on these trees to see if they show any signs of deterioration in condition in ensuing months.

The specificity of this method was demonstrated by the fact that only root rot infected trees showed up on the multi-spectral imagery while trees affected by sun blotch, even in severe stages of infection, could not be detected on the photographs.

POSSIBLE FUTURE APPLICATIONS OF THIS TECHNIQUE

A number of pests and diseases affecting citrus and sub-tropical fruits could possibly be detected on a large scale using aerial photographic techniques. A few of the more important problems are listed below:

(i) Citrus Root Rot

In so far as root rot in avocados is a problem and surveys to determine the disease spread are essential, the same applies in the case of root rot of citrus On certain large citrus estates in South Africa a 10% replacement programme, especially in older orchards, is envisaged annually due to root rot disease. Such a programme could possibly be greatly facilitated through the use of aerial photographic techniques.

(ii) Sun-blotch Disease on Avocados

Until an effective indexing programme is developed we cannot be certain of the incidence of sun-blotch in avocados in South Africa. It is thought that a number of trees may act as hidden carriers of this disease. A reliable method for detecting this disease would therefore greatly facilitate in helping to solve this problem.

COSTS INVOLVED USING AERIAL PHOTOGRAPHIC TECHNIQUES

The costs involved in using these advanced multispectral techniques are comparable with those of conventional aerial photography. Nevertheless, a programme of this nature would probably have to be undertaken by larger organizations, Co-ops or groups of farmers, and would have to be implemented on a fairly large scale in order to warrant the expense involved.

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