Use of Portable Videotaping for Aerial Infrared Detection of Potato Diseases

F. E. MANZER and G. R. COOPER, Professors, Department of Botany and Plant Pathology, University of Maine, Orono 04469

ABSTRACT

Manzer, F. E., and Cooper, G. R. 1982. Use of portable videotaping for aerial infrared detection of potato diseases. Plant Disease 66:665-667.

A portable black and white video camera, modified and filtered to record near-infrared radiation, was used to obtain imagery of potato plots infected with late or early blight. The monitor shows healthy foliage as white and diseased foliage as varying shades of gray. Correlation of image density and disease severity appeared to be linear through the range of light to moderate infection. Evidence of previsual disease identification was also obtained. Black and white Polaroid prints taken from the monitor provided a reference that could be taken to the field. Practical advantages and limitations of the video equipment and photographic methods are compared.

Use of infrared photographic techniques for aerial detection of crop disease was recently reviewed by Toler et al (3). They emphasized that more information can be obtained by using false color infrared film than by using black and white infrared photography. Use of color, however, imposes the penalties of greater costs and longer, more exacting film processing procedures. We have found that many potential users of false color films are discouraged by the need to do their own film processing in order to reduce delays in obtaining information needed immediately. Because the processing of black and white infrared film is faster and much less demanding, this film may be the more prudent choice when its use provides the desired information. Even use of black and white film has handling problems that cause inconvenience or delays (1). When the primary intent of disease detection is to determine the need for control measures, delays can be costly. Ideally, the needed aerial imagery should be obtainable without delay, either before or after the flight. This level of timeliness can be achieved by use of a portable black and white video camera modified and filtered to obtain imagery in the near-infrared range. A preliminary report of work with this equipment has been presented (2).

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MATERIALS AND METHODS

The video equipment consisted of a SONY SLO-340 videocassette recorder and a SONY AVC-3450 video camera. The major modifications to the camera were addition of a Tiffen 87 infrared filter and replacement of the normal video tube in the camera with a silicon diode array tube. Any qualified video technician can obtain and install the tube and prepare the camera for infrared operation. A neutral density filter (Inconel 1.0 from Corion Corp.) that effects a threefold

F-stop reduction was found necessary to reduce sensitivity to a working range of from F-5.6 to F-11 under normal daylight conditions. Because of the need to reduce motion of the hand-held camera, a Kenyon Gyro Stabilizer (Model KS-4, Ken-Lab, Inc.) was used. The camera modifications gave the added advantage of protecting the unit from damage due to accidental exposure to direct sunlight.

The airplane used for this study was a Cessna 170B flown at an airspeed of approximately 100 kph at altitudes of 300–400 m. All of the imagery was taken at varying oblique angles through an open window on the left side of the aircraft.

Most of the subject areas were on Aroostook Farm at Presque Isle, ME. The fields examined were potato plots used for tests on the efficacy of experimental fungicide treatments for control of late blight or early blight. Each treatment was replicated five times in plots three rows wide and 8 m long. Rows used for sprayer travel were artificially inoculated to provide a source of infection for the test plots.

Aerial imagery was taken several times during the growing season to record disease progress. Visual ratings of disease were made on the ground before and after the flights. Differences in efficacy of the fungicides used in the test plots provided a wide range in degree of disease development.

RESULTS

Imagery obtained with the television equipment recorded healthy foliage as white and diseased foliage as varying shades of gray. The most severely infected plots gave the darkest images and those that were lightly infected appeared as light gray (Fig. 1). Visual correlation of image density and ground-rated disease severity appeared to be linear at least through the range of light to moderate infection, and evidence of previsual disease detection was also obtained. No attempts were made to measure the range of duration of the previsual period because varying environmental conditions can cause wide variations in the rate of progress of a disease. During dry, inactive periods, field ratings were in good agreement with ratings based on aerial infrared imagery made the same day. However, during periods favoring disease progress, imagery ratings were 1–3 days ahead of field ratings.

Comparison of video images with the potato plots from which they were taken was accomplished by using black and white Polaroid film (ASA 3000) to photograph the monitor screen. Although there was some loss of resolution, Polaroid prints gave a rendition of the video image that proved adequate for field reference.

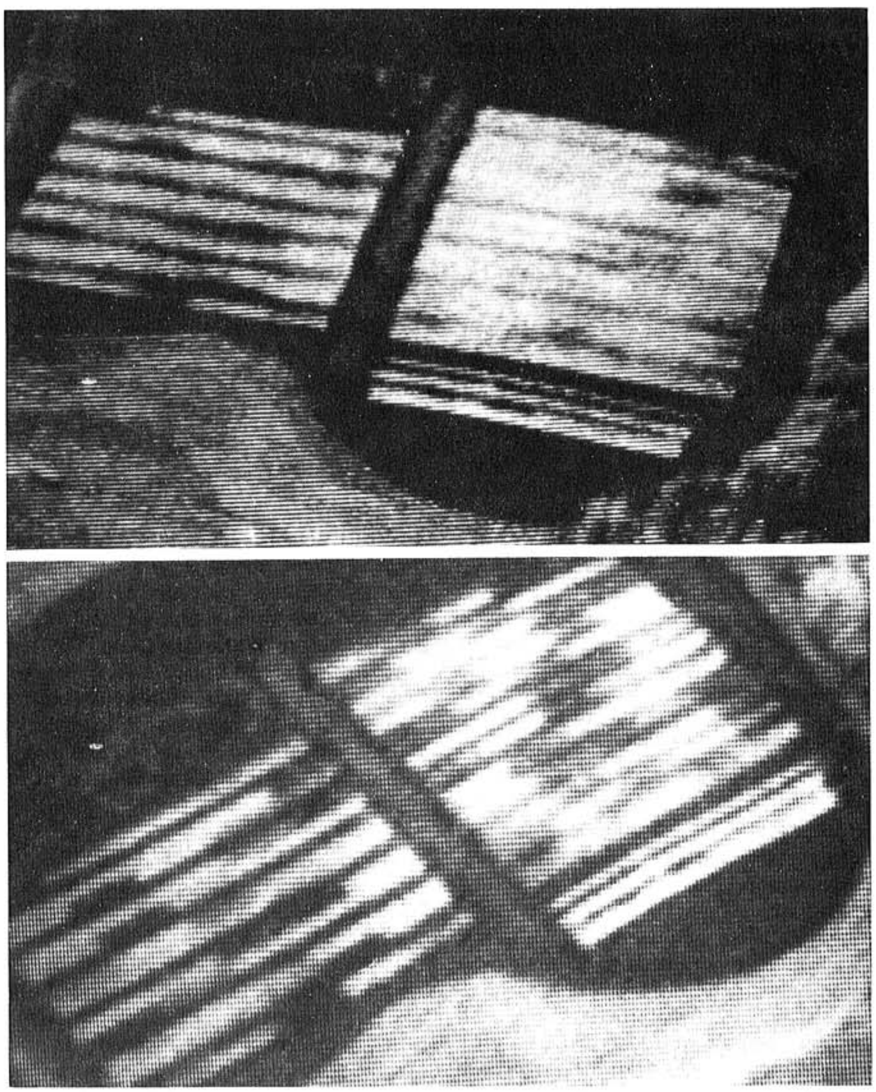

Fig. 1. Infrared videotaped imagery photographed from a television monitor. Potato late blight was moderate (dark areas) in early August (**top**) and advanced in late August (**bottom**) in the same fungicide efficacy test with cv. Katahdin potatoes. Some 2.7 × 8 m plots and inoculated rows (1.8 × 50.0 m) used for sprayer travel are discernible.

DISCUSSION

The video infrared imagery was similar to black and white infrared photographs obtained by Manzer and Cooper (1). The major advantage that disease detection via infrared video has over even black and white photography is, as previously mentioned, timeliness. Instant viewing of the tapes, even while in the air, allows an operator to radio information directly, if need be, to those applying disease control measures. A further advantage of video equipment is that the operator sees the subject in the viewfinder exactly as it appears on the tape. This makes it possible to take zoom-lens close-up shots of any area that may be of special interest. An added feature is the simultaneous sound recording that allows the operator to dictate information on geographic location and other pertinent details.

Some disadvantages of the system, compared with black and white photography, are its higher initial cost, poorer resolution, additional weight and bulk, and the requirement of an electrical power source. Although the equipment described represents an investment of about $5,000, quality aerial cameras, film, and processing are not appreciably lower. Image resolution could be a problem for certain surveys but it was adequate for locating even small areas of late or early blight infection in potato fields. Should it prove desirable, high resolution photography in either false color or black and white infrared could be taken to provide hard copy backup data for the videotaped data. A high quality video monitor will also improve the imagery, compared with that shown on the average television receiver. The recording equipment can be easily carried with a shoulder strap, and the camera is no more difficult to handle than the average 70-mm photographic camera. A lightweight, rechargeable electrical power pack is provided as part of the unit, and the 12-V electrical system of an airplane can also be used. On balance, we suggest that video infrared survey can become a useful and practical tool, particularly in IPM programs. As did infrared photography, video infrared may find uses in other disciplines. Further improvement of the equipment including use of false color may also be possible.

ACKNOWLEDGMENT

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