MONITORING A VIRUS DISEASE OF WHEAT USING AERIAL INFRARED PHOTOGRAPHY

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The soil-borne mosaic disease of wheat is caused by a virus (WSBMV) and probably is transmitted from plant to plant by a fungus known as *Polymyxa graminis* Led. (1). This fungus vector is an obligate parasite living in the roots of many cereals and grasses. Before a vector was known the disease was associated with certain soils, hence the name.

The disease was first reported in Illinois in 1919 (2, 3), and described as a virus disease in 1923 (4, 5). It has been observed throughout the soft red winter wheat growing region of Illinois, Indiana and Ohio since that time, and later outbreaks were reported from Missouri, Nebraska and Kansas (6).

WSBMV was first observed in Oklahoma in 1952 in the valley of the Chickaskia River in north central Oklahoma (7). It has spread in all directions and increased in intensity until at this time it is found in all areas of the state where wheat is grown. It has been this inexorable spread and intensification that has prompted our continued monitoring of the disease.

Symptoms are first observed in late winter or early spring (late February or early March) in most areas of Oklahoma. As the season progresses the yellowing and streaking symptoms fade, but the stunting remains, leaving a ragged appearance to infected fields. Differences between healthy and diseased fields are readily apparent. Stunting of susceptible varieties may be significant and yellowing symptoms also may be pronounced, but ordinarily only light-green mottle and streak symptoms appear. The severe stunting and rosetting symptoms of the disease have not been observed in Oklahoma. The degree of symptom expression, and the amount of damage caused by the disease, are directly related to temperature. In a spring season that is cooler than average the symptoms and damage are more severe than in a season warmer than average. Forage for grazing, particularly in late winter and early spring may be reduced by as much as 50 percent (8), while grain harvests may be reduced from 20 to 50 percent, depending upon temperature and the severity of the WSBMV (7, 9, 10, 11).

Initial surveys made by surface observations provided a poor and often misleading sample, since only a few hundred acres could be studied more or less superficially. The contrast between healthy and diseased areas of fields, and between fields of resistant and susceptible cultivars, is more pronounced from the air. Surveys by light aircraft provide better observations covering several million acres, and allow for a better photographic record of infected areas. Initially, color film (Kodachrome or Ektachrome) was used for this purpose with satisfactory results. These surveys revealed the tendency of the disease to be more prevalent and more severe in the drainage channels and areas. This would be expected since the suspected vector produces zoospores that require water for movement through the soil. Some infestation patterns do not follow the natural drainage areas, however. We are not able to explain this phenomenon unless it may be related to spread of the vector by soil clinging to implements moved from field to field.

Color infrared film also has been used for crop and disease surveys and for monitoring (12, 13, 14). We used such a film (Ektachrome Infrared) for photographs of WSBMV-infected wheat plots taken from April 1 to 5, 1980. These photographs were taken from 12 noon to approximately 2:30 pm at an altitude of 300 to 500 ft. at an angle of from 45° to 60° relative to the surface of the earth. We used exposures of 1/125 to 1/250 sec. at f stops of 9 to 16 with a Kodak number 12 yellow filter. The soil surface was dry at the time the photographs were made.

The use of color infrared film did not produce any new information with respect to observations of disease distribution, nor did it enhance the contrast between healthy and diseased areas. When we used this film to photograph our wheat breeding and cultivar test plots planted in cooperation with Cargill, Inc., near Winfield, Kansas, we observed what we thought were differences in degree of symptom expression, just as we had seen with the unaided eye and with the use of color fi1m. When we compared these color infrared photographs with observations on the ground, however, we found that the variations in shade of color were due to segregation for resistance and susceptibility within lines or cultivars rather than to different levels of symptom severity. Differences in degree of yellowing, for example, were not separated by the film under these conditions. All plots that were susceptible to any visible degree appeared to be the same shade of intensity on the color infrared photograph.

We had already scored disease symptom severity in a larger scale cultivar trial on the Plant Pathology Farm, Oklahoma State University, Stillwater, Oklahoma, on a scale of 0 to 9 where 0 was no evidence of disease and 9 was extreme yellowing and stunting. When we photographed those plots with color infrared film we found, again, that the healthy and resistant cultivars stood out distinctly. These photographs also revealed that there were no observable differences between cultivars with disease ratings of more than 0. Cultivars with disease ratings of 8, for example, could not be distinguished from those with ratings of 3 or 4. Apparently, there are factors for vigor in some of the cultivars that effect the expression of symptoms of this disease, and these factors are totally unrelated to actual susceptibility to the virus. We intend to study this phenomenon further with both aerial and ground-based photographs since it may have significant influence on our evaluation of heritability of resistance.

The heritability of resistance to this disease has never been satisfactorily determined. The classification of segregating generations has been done by visual rating of disease symptom severity. Perhaps these factors for vigor that are unrelated genetically may well obscure the true disease reaction. The use of color infrared film to classify the reaction of segregating generations may clarify our knowledge of the inheritance of resistance to the soil-borne mosaic disease in wheat.

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