THE EXPERIMENTAL APPROACH IN ASSESSING DISEASE LOSSES IN CEREALS: LEAF AND HEAD DISEASES OTHER THAN RUSTS AND SMUTS

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Experiments designed to estimate losses from diseases in barley have been carried out over a period of years at several locations. The following methods were used:

Comparison of plots protected by a fungicide with those not so protected in the same experiment (1, 2, 4);

Comparison of plots inoculated with a specific disease with plots not inoculated (3);

Evaluation of the differential in yield of a variety resistant to a disease and one susceptible to it by comparisons of tests in heavy disease infestation with tests in which the disease had little or no effect (6, 7).

The primary objectives of the experiments were to determine the extent of losses from disease and to establish useful relationships between disease readings and effects of disease on yield and quality (5).

To what extent have these objectives been met?

The estimates of disease losses have been useful in providing an approximation of losses resulting from the complex of diseases attacking barley. Aside from the series of experiments on speckled leaf blotch at Winnipeg (C. D. A.), the estimates of losses from specific diseases must be regarded with reservations because of the difficulty of estimating individual disease effects where a complex of diseases exists, and because of inadequate sampling. However, when related to survey information, the experiments have provided an indication of the importance of breeding for resistance to the diseases involved.

The second objective is far from being met satisfactorily, but there is work in progress. This would seem to be a critical area because of the obvious difficulty and expense of adequate sampling by means of experiments in which controls are created with fungicides; and thus the need for reliable estimates based on surveys.

Some problems with the experimental approach

The problem of adequate sampling through wide distribution of experiments over a period of years is basic to obtaining reliable loss estimates by this means. Besides the difficulty of adequate sampling, other problems are encountered in experiments:

Obtaining adequate disease control – Two or three applications of a fungicide may be adequate in some circumstances, but positive control may require five to seven. For Septoria passerinii Sacc., which has an incubation period of 19-21 days and in which secondary infection is of minor significance, protection from the boot stage to 6-8 days after heading is critical. With net blotch caused by Pyrenophora teres (Died.)Drechs. there is evidence that early spraying is critical, and the same is probably true of spot blotch caused by Bipolaris sorokiniana (Sacc. in Sorok.) Shoem. The most complete control has been obtained with fungicide sprays begun about the flag-leaf stage and applied thereafter at no more than 10-day intervals. However, more frequent spraying may be required if rainfall is heavy, or if temperature and humidity are conducive to infection and to spread of the diseases.

Interference from diseases not controlled – Some experiments have been influenced by the occurrence of powdery mildew or bacterial streak, which are not controlled by the fungicides used for the diseases that are critically important in the prairies. For control of mildew, an over-all spray of Karathane can be valuable.

Obtaining disease in plots – Inoculation entails extra work and is often unsuccessful. The scope of an experiment can often be extended by seeding at more than one date. At Winnipeg, diseases usually increase with later seeding, and a better estimate of losses is obtained by using as many as three dates of seeding. (In 1966, an intermediate seeding date gave the heaviest disease readings, but the principle holds.)

Relating disease readings to losses – In a specific experiment, the relationship between disease readings and loss often appears meaningful, but examination of a number of experiments (1, 3) reveals wide fluctuations that are presumably not due to readings by different individuals. Experience with this type of work suggests a number of factors that should be considered in attempting to assess the re-

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lationship of leaf area destroyed to losses in yield and quality:

The time of infection in relation to the stage of the host;

The severity of the first-cycle infestation;

The environment from the onset of disease effects to maturity of the host;

The relative proportion of different diseases present.

The last point could well be highly critical, since there is little information on the combined effects of diseases on the host. Assessment of individual disease effects is the logical starting point, but obtaining exclusive infection by a disease is difficult without the use of highly selective fungicides or varieties primarily susceptible to one disease.

Literature cited

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DISCUSSION OF THE PAPER BY W.C. MC DONALD, S. B. HELGASON, W.P. SKOROPAD, AND H.A.H. WALLACE

A. E. Hannah: Were any of the chemicals applied systemic or were they all local in their action?

S. B. Helgason: In all of the experiments with which I am familiar the fungicides used were protectants and had no systemic action at all. To the best of my knowledge there have been few tests conducted in Canada in which systemics were employed.

W. C. McDonald: I wish to make a comment on another aspect of this general subject. The cost of research is great. There seems to be a trend toward research project costing at the present time. It therefore may be important to include in the assessment of plant disease losses the benefits derived from research in disease control. I think that differential varieties for resistance can be used to show increased productivity resulting from the use of resistant varieties, and also to show the losses that can occur. One could use plant breeders' lines in such work if they were more appropriate than licensed varieties. The cost of conducting such a series of tests would not be high and the tests should permit the derivation of dollars and cents estimates for some of our losses. Too, such tests may prevent our becoming complacent on the danger of plant diseases. Some work along this line that I did for the years 1954 and 1962 indicated that in 1962, except for resistant varieties, we would have had the worst rust epidemic recorded in western Canada. In that year the average provincial yield was 26 bu/acre; the yield of 'Marquis' was 9. 1. In 1954 our provincial average was 13 bu/acre and the yield of 'Marquis' about 11.

W. J. White: Have there been any studies done to establish whether fungicides in the absence of disease have any depressing or stimulating effects on yield?

S. B. Helgason: The particular fungicides used in these experiments are not phytotoxic. There have been some, of course, used in experiments that are somewhat phytotoxic. There has been evidence that suggested that in the absence of disease, some dithiocarbamates may increase yields slightly. However, it is difficult to define slight increases that frequently are not statistically significant. I know of very few cases where in the absence of disease the reverse occurs, i.e. where the sprayed plots yielded less.

G. J. Green: With reference Dr. McDonald's comment on losses estimated on the basis of small plots, I think that such estimates would be extremely conservative and I suspect that all estimate figures cited today are also conservative. There is quite a difference between having a few 10-ft rows of a susceptible variety in a million acres of resistant material, and a million acres of a susceptible variety. The dynamics of development of an epidemic would differ greatly. I think the damage in small plots would be much less than in vast acreages of susceptible material.

W. E. Sackston: This point is mentioned by Van der Plank in his approach to epidemiology. Working in an area where there is abundant disease one obtains different reactions than working in an area where the population is mostly resistant and only some susceptible. This aspect certainly requires consideration.

J. W. Martens: Some work is underway on the effect of fungicides in the absence of disease.

D. W. Creelman: In potatoes it has been shown repeatedly that dithiocarbamate fungicides do increase yields in the absence of late blight.

W. E. Sackston: This effect has sometimes been attributed to leaf feeding with some of the metallic components.