THE EXPERIMENTAL APPROACH IN ASSESSING DISEASE LOSSES IN CEREALS: WHEAT STREAK MOSAIC

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Before we can assess the losses caused by a plant disease in any particular field we must be able to measure disease intensity, and we must establish the relationship between varying disease intensities and loss in yield or quality., Ideally, information on both these phases of disease-loss assessment should be obtained in studies carried out over numerous crop years and under a range of growing conditions. Such a fund of knowledge can then be used to make reasonably reliable estimates of the losses caused by that disease on a regional or national scale.

Using this approach we estimated that winter wheat yields in southern Alberta were reduced by 18% when wheat streak mosaic became epiphytotic in the 1963-64 crop. The results of these studies have been published (2), and the present report is confined to a detailed description of the procedures we used in assessing these disease losses.

Measuring disease intensity

Our study was carried out on a farmer's 25-acre field of winter wheat that was naturally infected with the wheat mosaic virus. No other leaf or head diseases were evident.

Our first measurement of disease intensity was based on the streak mosaic symptoms on samples collected from the immature crop at the end of May. Plants pulled from a 1-m length of row at each of 100 regularly spaced sampling sites were classified into three disease categories on the basis of their distinctive streak mosaic symptoms (Fig. 1). Plants

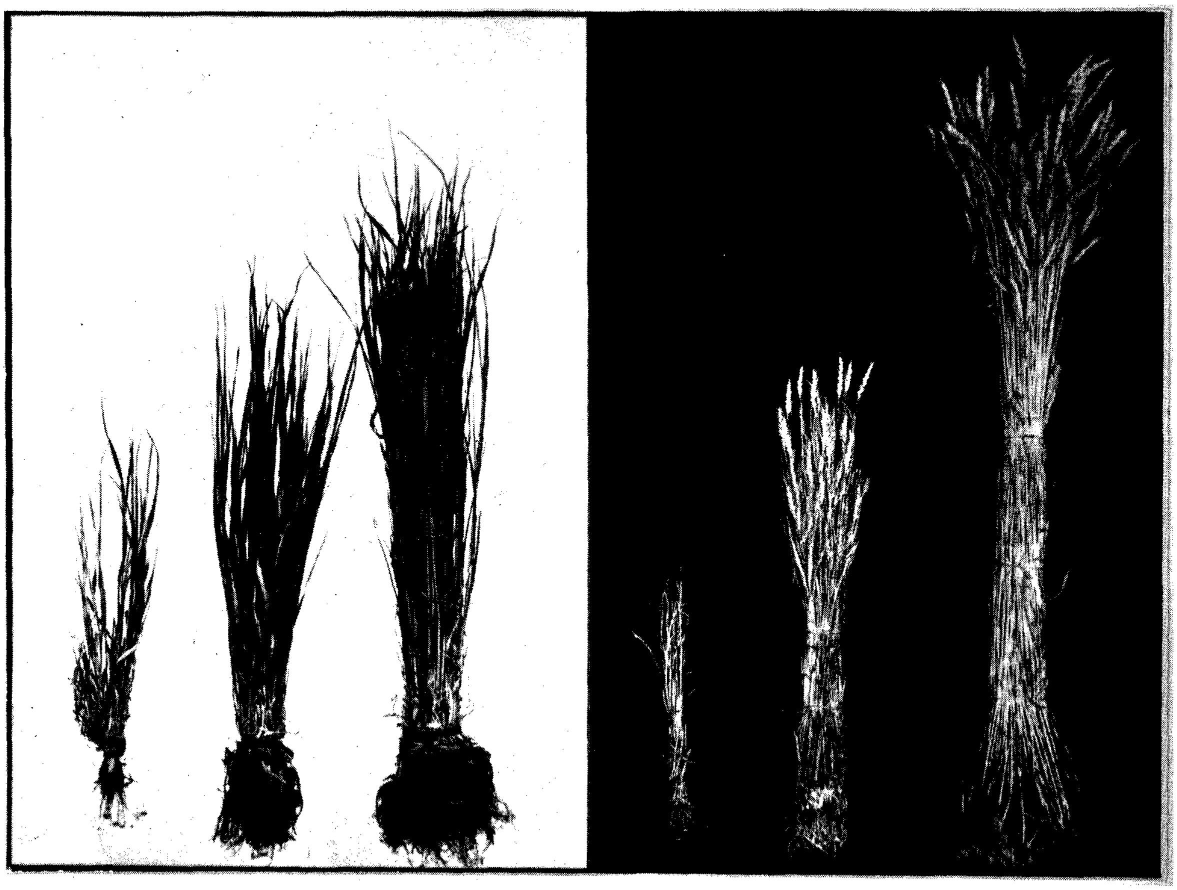

Figure 1. Plants classified, from left to right, as severe, stunted, and healthy as they appeared in May (left) and at maturity (right).
(from Atkinson and Grant, 1967)

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classified as severe were dwarfed and had many completely yellowed leaves. Plants classified as stunted had definite but less-conspicuous streak mosaic symptoms. Plants without symptoms were classified as healthy. When these disease severity data from the 100 consecutively numbered sampling sites were arbitrarily grouped into odd and even numbered sites they showed excellent agreement (Table 1). This indicates that the procedures followed in collecting and classifying the May samples were reliable. However, in order to establish a disease-intensity-yield relationship, we needed a measure of disease intensity in the mature crop from which yield data could also be obtained.

Table 1. Numbers and percentages of plants in three disease categories from field samples of winter wheat collected in May[a], 1964

Disease' category	Odd-no. samples		Even-no. samples	
	No.	%	No.	%
Severe	245	20	242	19
Stunted	465	35	470	36
Healthy	571	44	592	46

[a] The data from 100 consecutively numbered sites are grouped arbitrarily into odd- and even-numbered samples.

When the crop matured in mid-July, 25 one-square-yard yield samples were collected by pulling all the plants from one linear yard in each of six adjacent rows. The sites sampled corresponded approximately with the location of every fourth site sampled in May (Fig. 2). Fortunately, plants belonging to the disease categories used in classifying the immature plants in May could easily be recognized when mature (Fig. 1). Plants that had died without forming grain were classified as severe. The plants that produced grain fell into two distinct groups, stunted and healthy. Stunted plants were about half the height of healthy ones and had fewer and smaller heads.

Compared with the May samples, those collected in July had a smaller percentage of plants classified as severe. We attributed this primarily to the premature senescence and disintegration of severly diseased plants. This interpretation can be supported by appropriate calculations, which show that fewer plants were present in July than might reasonably have been expected had all fhe plants present in May survived. When plants classified as severe were excluded from the comparison, the

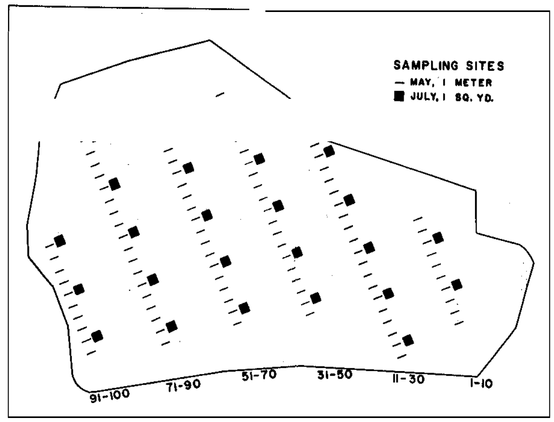

Figure 2. Plot of a 25-acre winter wheat field showing the distribution of sites sampled for wheat streak mosaic in May and July.

May and July samples contained 45% and 42% stunted plants, respectively. This agreement shows that we had correctly identified the original disease categories in the mature plants. It also supports our earlier observation (1) that spread of the disease was negligible in the spring of 1964.

Determining the relationship between disease intensity and yield

Confident that we could recognize the various disease categories in the mature plants, we attempted next to establish a relationship between yield and disease intensity. Plants in the stunted and healthy categories within each of the 25 yield samples were threshed separately and attempts were made to relate these yield data to disease intensity expressed in terms of percent stunted plants. Plants classified as severe were excluded from these calculations because we believe that their loss was fully compensated for by the remaining plants in the population. Our judgment was based on the fact that the severely affected plants had died early and that excellent moisture and fertility conditions had prevailed.

A meaningful relationship between disease intensity and yield was not at first apparent. When the total grain yield in grams from each square-yard sample was plotted against disease intensity, the result was a rather unimpressive scatter diagram (Fig. 3).

Realizing that inherent productivity differences throughout the field were probably obscuring the relationship between disease intensity and yield, we attempted to utilize the healthy plants within each sample as an internal check plot. The relationship of disease intensity to yield became obvious when the total grain yield of each square yard sample was expressed as a percentage of a theoretical "potential yield" calculated according to the following equation:

$$\%\text{yield} = \frac{W}{W_1 \times N} \times 100$$

where W = the total weight of grain produced at a site, W_1 = the mean weight of grain produced by healthy plants at that site, and N = the total number of stunted and healthy plants at the site.

When the percentage yield data were calculated for each of the 25 samples and plotted against the appropriate disease intensity, a highly significant regression was evident (Fig. 3). This graph also shows that the yield of stunted plants, expressed as a percentage of the yield of healthy plants at the same site, was relatively constant within the range of disease intensities encountered. This indicates that in the moderately affected field that we sampled, the reduction in yield caused by the disease was directly related to the number of plants classified as stunted. Incidentally, stunted plants yielded an average of 34 kernels compared with 96 for healthy ones.

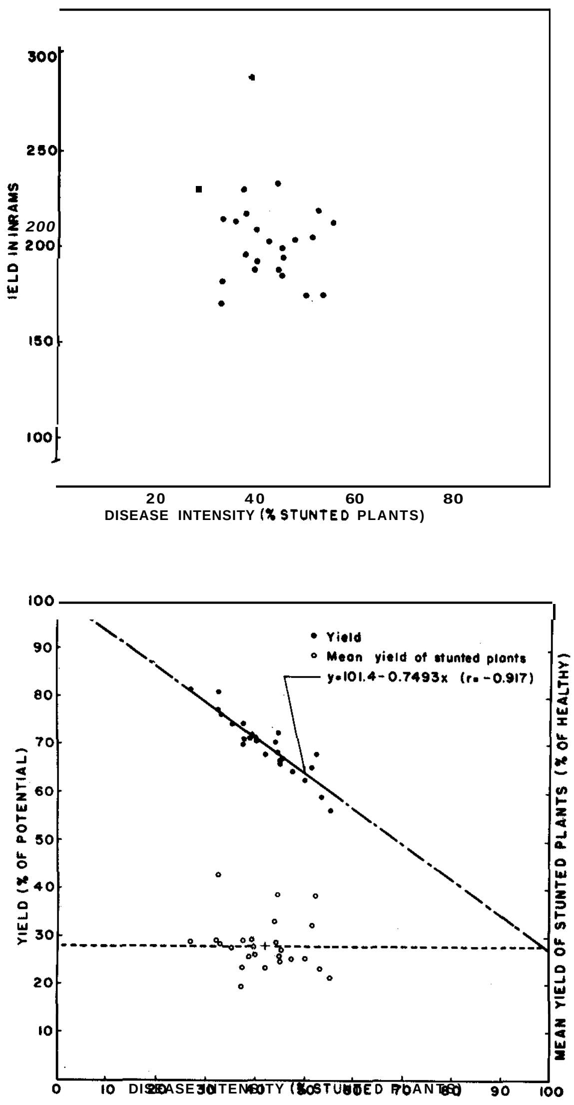

Figure 3. Relationship of yield to disease intensity shown by square-yard samples of mosaic affected winter wheat. Yield is expressed in grams (above) and as a percentage of a calculated potential yield (below).

Estimating the losses in the 1963-64 southern Alberta winter wheat crop

As an adjunct to our disease intensity-yield studies we carried out a survey of winter wheat acreage and streak mosaic damage with the cooperation of the elevator agents of southern Alberta. Reports such as that shown in Figure 4 were received from more than 1,100 winter wheat growers. Of the 31,430 acres of winter wheat reported to be infected with streak mosaic, 20,100 acres were cultivated out because of the disease.

These acreage data provided a basis for estimating losses caused by the streak mosaic epiphytotic We estimated an average yield of 30 bu/acre for a healthy crop and an average reduction of 10 bu/acre caused by the disease. On the basis of the relationship between disease intensity and yield that was developed for the moderately infected crop (Fig. 3), this estimate corresponds to a disease intensity of 46%. Since most infected crops in the winter wheat area appeared to be more severely diseased than the one we studied, our estimate is undoubtedly conservative. Nevertheless, based on these estimates, winter wheat losses for the acreage surveyed exceeded 700,000 bu, or 18% of the potential yield.

Literature cited

1. Atkinson, T.G. and M.N. Grant. 1964. Development of wheat streak mosaic in southern Alberta during 1964. Can. Plant Dis. Surv. 44:259-264.

2. Atkinson, T. G., and M.N. Grant. 1967. An evaluation of streak mosaic losses in winter wheat. Phytopathology 57: 188-192.

WHEAT STREAK MOSAIC DAMAGE REPORT*

Name of Owner or Operator ....Cleve Ross.......

Mailing Address ....Box 880 Coaldale, Alta.

Location: Section	Township	Range	Total no. acres sown to winter wheat	No. acres infected with w. s. mosaic	No. acres cultivated out because of w. s. mosaic damage
1	10	19	120	120	120
12	10	19	200	200	200
26	10	19	320	320	120
			640	640	440

*Your cooperation in supplying this information will assist the winter wheat research program at the Lethbridge Research Station.

Figure 4. Report farm used to obtain acreage information on the severity of wheat streak mosaic.