Barley losses due to common root rot in the Prairie Provinces of Canada, 1970-72

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Barley (*Hordeum vulgare)* was surveyed in 1970-72 on the Canadian prairies for losses due to common root rot *[Cochliobolus* sativus]. It was estimated that 54 million bushels or 10.3% of the crop was lost annually to this disease. Over the 3-year period losses were more consistent in Alberta (8 - 11%) than in Manitoba (0 - 14%) and Saskatchewan (6 - 20%), where considerably higher lossess occurred in 1972. A decrease in the numbers of heads per plant with increasing severity of disease contributed to the yield loss.

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De 1970 a 1972, des etudes ont ete effectuees dans les Prairies sur Jes pertes causees a l'orge par la pourriture commune des racines *[Cochliobolus sativus]*. On estime a 54 millions de boisseaux ou 10.3% de la recolte les pertes annuelles dues a cette maladie. Au cours de la periode de trois ans, les pertes ont ete plus constantes en Alberta qu'au Manitoba et en Saskatchewan ou des pertes beaucoup plus graves ont été enregistrees en 1972. La baisse du nombre d'epis par plant en fonction de l'accroissement de la gravite de la maladie a contribue a baisser les rendements.

Several comprehensive surveys have been conducted in western Canada to estimate losses in yield of wheat due to common root rot caused by ***Cochliobolus sativus*** (Ito & Kurib.) Drechsl. ex Dastur, conidial state ***Bipolaris sorokiniana*** (Sacc. in Sorok.) Shoem., syn. ***Helminthosporium sativum*** Pamm. King & Bakke., and by ***Fusarium*** spp. (2,3). The most recent series of surveys, in 1969-1971 by Ledingham et al. (2), indicated an annual loss of some 30 million bushels for the Prairie Provinces.

Though some reports indicate substantial yield loss in certain cultivars of barley due to C. ***sativus*** (7), we are not aware of any comprehensive survey of root rot losses in barley in any major barley-producing country in the world.

Wheat and barley are important crops in western Canada and both have been subject to common root rot for as long as they have been grown in spite of the many changes in agronomic practices, crops, and cultivars. Rotation with crops other than wheat and barley could reduce the incidence of root rot but a period of several years between susceptible crops has been seldom practical on the prairies (2).

The need to determine the losses caused by common root rot should be appreciated at a time when research priorities are being critically evaluated. This report presents the results of a cooperative survey covering Manitoba, Saskatchewan, and Alberta for the crop years 1970, 1971, and 1972 designed to estimate the yield reductions in barley attributable to common root rot. The first 2 years of this survey were coincident with the last 2 years of a 3-year root rot survey in wheat (2).

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Methods and materials

Selection of survey routes and fields within crop districts (CD) in Manitoba and Saskatchewan and census districts (CD) in Alberta and the methods of sampling, of classifying plants for disease, and of calculating field, district, and provincial losses were similar to those described for wheat (2). In 1970 the sampling technique was that used in the wheat study in 1969 and 1970, i.e. plants taken from 1-yd^2 quadrats; in 1971 and 1972 plants were taken on a diagonal traverse similar to that used in the 1971 wheat survey (2). Samples in 1970, 1971, and 1972, respectively, were obtained from 72, 79, and 121 fields in Alberta; from 21, 28, and 42 fields in Saskatchewan; and from 11, 10, and 32 fields in Manitoba. Approximately 250 plants were collected in each field in 1970, and 130-150 plants in 1971 and 1972.

Results

Percentage loss by CD for the three provinces for the 3 years is given in Table 1. In Table 2 acreage, yield, total production, percent loss, potential production, loss in bushels, and number of fields involved in the survey are summarized by province and year. The percent losses in 1970, 1971, and 1972 were as follows: 11.1%, 8.4%, and 10.0% in Alberta; 8.2%, 6.0%, and 20.6% in Saskatchewan; and 2.0%, 2.3%, and 13.8% in Manitoba.

In Table 3 are shown the distribution of plants in the diseased, unclassified and clean (healthy) categories in

Table 1. Percent losses from root rot of barley in the Prairie Provinces, 1970–1972

	Alberta			Saskatchewan			Manitoba		
Year	* C.D.	Fields	Loss %	* C.D.	Fields	Loss %	* C.D.	Fields	Loss %
1970	1	1	– 7.2	6	11	8.1	1	2	– 5.0
	2	4	12.0	7	4	5.2	2	1	2.2
	3	3	6.2	8	1	20.5	4	2	– 0.6
	4	1	9.7	9	5	8.6	5	1	18.7
	5	4	18.5				10	2	–19.8
	6	8	2.2				13	2	5.1
	7	3	– 9.1						
	8	19	11.1						
	10	10	10.8						
	11	13	17.6						
	12	3	18.6						
	13	5	15.9						
	Mean		11.1			8.2			– 2.0
1971	1	4	– 6.6	2	3	– 4.4	2	1	– 8.6
	2	9	5.3	3	3	8.0	3	1	– 4.1
	3	6	12.9	5	1	6.1	4	1	–16.1
	4	5	7.8	6	13	9.1	5	1	9.7
	5	16	10.5	7	2	3.4	10	2	9.5
	6	10	9.8	8	1	0.7	11	3	1.0
	7	9	13.9	9	5	4.9	12	1	20.9
	8	15	11.9						
	10	8	9.3						
	11	11	14.1						
	15	16	0.3						
	Mean		8.4			6.0			2.3
1972	1	5	– 2.7	1	3	23.7	1	1	– 2.6
	2	8	17.4	2	2	15.2	2	3	3.7
	3	5	11.8	3	3	28.3	3	5	15.2
	4	3	– 4.1	4	2	25.3	4	1	0.3
	5	11	7.4	5	3	13.4	5	3	18.8
	6	9	2.9	6	9	25.8	7	2	13.4
	7	7	– 2.9	7	8	26.1	8	2	34.9
	8	26	13.3	8	7	10.5	9	2	–26.1
	10	16	17.4	9	5	16.0	10	4	16.7
	11	16	11.2				11	4	23.7
	12	5	20.2				13	3	18.9
	13	10	8.4						
	Mean		10.0			20.6			13.8

* C.D.= Census district (Alberta), crop district (Saskatchewan, Manitoba)

Table 2. Barley losses in Alberta, Saskatchewan, and Manitoba due to common root rot, 1970–72

Province and year	Acreage ('000)	Yield (bu/ac)	Production ('000 bu)	Loss %	Potential production ('000)	Loss ('000)	No. of fields sampled
Alberta							
1970	4,700	42.1	198,000	11.1	222,621	24,621	74
1971	6,100	39.3	240,000	8.4	262,114	22,114	109
1972	5,200	44.2	230,000	10.0	255,669	25,669	121
Saskatchewan							
1970	3,300	43.0	142,000	8.2	154,700	12,700	21
1971	6,300	45.2	285,000	6.0	303,191	18.191	28
1972	4,600	38.5	177,000	20.6	222,922	45,922	42
Manitoba							
1970	1,500	34.0	51,000	– 2.0			11
1971	2,200	45.7	100,500	2.3	102,866	2,366	10
1972	2,100	40.5	85,000	13.8	98,630	13,630	32

Table 3. Percentage of plants in the various disease categories in the three provinces, 1970–72

Province and year	Clean	Slight	Moderate	Severe	Unclassified
Alberta					
1970	20.8	21.3	15.5	27.3	15.0
1971	40.5	33.0	10.7	7.4	8.4
1972	33.9	30.6	11.5	12.1	11.9
Saskatchewan					
1970	62.9	21.8	6.3	4.3	4.5
1971	47.2	36.2	8.2	5.5	2.9
1972	22.2	42.2	14.7	4.8	16.1
Manitoba					
1970	3.1	37.4	8.5	5.2	45.7
1971	8.5	33.0	22.4	20.0	17.0
1972	10.5	26.9	18.7	11.6	33.7

the three provinces for the years 1970, 1971, and 1972. The average losses in yield of each disease class and the unclassified group, relative to the clean class, for the prairie provinces in each year are presented in Table 4. The mean reduction for the three years was 9.4%, 17.1%, and 29.7% for the slight, moderate, and severe disease categories respectively. It is obvious that root rot reduces the numbers of heads per plant (Table 5); in some cases by 33% (Alberta, 1971) and in others by as little as 6% (Alberta, 1972). Although average loss during the 3 years was greatest in the gray wooded and Luvisol soil zone and least in the brown soil zone, it was most consistent in the black soil zone.

Discussion

Losses in yield of grain of considerable magnitude were found to occur in barley crops, the estimated average annual loss during 1970-1972 for the Prairie Provinces being 10.3%. Generally, common root rot intensity is greater in barley than in wheat (unpublished survey data), and losses in barley may be proportionately higher than in wheat. Indeed, a comparison of estimated losses in these crops over the years 1970 and 1971 when parallel studies (2) were conducted supports this contention. The 2-year average losses in Alberta were 6.0% in wheat (2) and 10.5% in barley and in Saskatchewan 7.1% in wheat (2) and 14.4% in barley. Insignificant losses were recorded in both crops in Manitoba. The apparently greater resistance of wheat might be due to the relatively less diversified genetic composition of the commonly grown cultivar Thatcher and its derivatives compared to the much broader genetic base represented by barley cultivars.

During the 3-year period of the study, the average yields of barley (Table 2) exceeded the 10-year averages, 1962-1971, which were: Alberta 36.7, Saskatchewan 37.7, and Manitoba 35.3 bu/ac. Since the high yields probably reflected good growing conditions of 1970-1972 and since stress factors such as drought are believed to aggravate common root rot, even higher losses than those reported may occur frequently.

Table 4. Percent loss in yield in barley in root rot classes, derived from a comparison of yields from clean and diseased plants

Province and year	Slight	Moderate	Severe	Unclassified
Alberta				
1970	9.4	17.2	25.1	22.5
1971	12.3	17.7	30.5	6.0
1972	11.6	15.6	27.1	9.5
Mean	11.1	16.8	27.5	9.3
Saskatchewan				
1970	14.3	24.7	29.9	30.0
1971	13.1	27.5	35.6	6.4
1972	23.8	38.4	48.8	19.3
Mean	13.7	30.2	38.1	18.5
Manitoba				
1970	− 2.6	10.7	28.1	− 7.3
1971	4.3	− 5.7	27.0	4.2
1972	8.8	7.5	15.2	22.8
Mean	3.5	4.2	23.4	6.6
Grand mean	9.4	17.1	29.7	11.5

Table 5. Average number of heads per barley plant in different root rot disease classes from the three prairie provinces, 1970–72

Province and year	Clean	Slight	Moderate	Severe	Unclassified
Alberta					
1970	1.9	1.6	1.6	1.5	1.4
1971	2.1	1.8	1.7	1.4	1.6
1972	1.6	1.4	1.5	1.5	1.5
Saskatchewan					
1970	2.0	1.9	2.0	1.7	1.6
1971	2.4	2.1	1.9	1.7	1.6
1972	2.0	1.8	1.8	1.5	2.1
Manitoba					
1970	1.6	1.5	1.5	1.3	1.5
1971	1.5	1.7	1.5	1.1	1.5
1972	1.7	1.6	1.8	1.6	1.3

Losses by districts sometimes were derived from samples of one or a few fields (Table 1), particularly in Manitoba and Saskatchewan. If such samples contained few clean or conversely few diseased plants, the estimates of loss could be misleading. The sampling was considered minimal; however, in view of the vast area to be surveyed and the time available for collecting and processing samples, the input was considerable. The change in sampling procedures in 1971 was made in anticipation that a more representative field sample would result. Comparative data showing this is lacking, though this sampling method resulted in a saving in time and convenience.

In Manitoba and Saskatchewan, one person in each province sorted the plants into disease classes while in Alberta three workers were responsible. The multiplicity of observers was not considered a serious weakness. Any individual differences in placing plants into the various categories would not appreciably affect the overall loss estimates. They would affect only the distribution within the classes and not the total effect on yield.

The percent losses in the prairies over the 3-year period ranged from a slight negative loss in Manitoba in 1970 to a 20% loss in Saskatchewan in 1972. It is interesting to note that there was also a slight negative loss in wheat due to root rot in Manitoba in 1970 (2). The significance of the slight yield increase for barley in Manitoba is questionable in view of the rather small sample, the very large number (45.7%) of plants in the unclassified section, and the rather small number of plants in the severe and moderate classes. The slight gain in yield may be due to recovery from early infections followed by enhanced growth and yield (6).

As with wheat, the discer is the most common machine used for seeding barley in the Prairie Provinces. This seeder more or less broadcasts the seed and depth placement is not precise. Seeds near the surface produce plants with short internodes, which cannot reliably be rated for disease by the method we employed and such plants were placed into the unclassified category. Unpublished data prepared by Dr. M. L. Kaufmann at the Lacombe Research Station indicate that barley seeded at a depth of 2.5 cm generally gives higher yields than that sown 7.5 cm deep; however there were exceptions to this with some varieties and in certain years. This may explain the large number of heads in the unclassified category in the 1972 Saskatchewan sample (Table 5).

Plants in the slight, moderate, and severe categories generally suffered progressive reduction in tillering, as evidenced by numbers of heads produced. The effect of

Table 6. Yield losses due to common root rot in barley in the four major soil zones of the prairie provinces, 1970–72

Year	Soil zone	No. of fields	Percent loss
1972	Brown	19	13.4
	Dark brown	33	13.0
	Black	128	12.0
	Gray–wooded and luvisol	14	21.5
1971	Brown	17	3.4
	Dark brown	30	12.0
	Black	73	10.7
	Gray–wooded and luvisol	17	0.5
1970	Brown	8	4.1
	Dark brown	9	7.8
	Black	78	9.3
	Gray–wooded and luvisol	5	19.9

root rot may, therefore, cause yield reductions in several ways, such as by reducing the numbers of heads, the numbers of kernels per head, and the weight of kernels produced. Ledingham et al. (2) indicated that kernel weight reduction was minimal in wheat suffering from common root rot.

Unlike the loss data reported for wheat by Ledingham et al. (2), barley yield losses were lower in the brown soil zone than in the black or gray zones (Table 6). The greater loss in the latter zones may reflect the popularity in these regions of earlier maturing varieties such as Olli and Gateway, which have a shorter growing season. These varieties are very susceptible to root rot and they comprised 27% of all barley grown in Alberta in 1972 (1). The exception was the negligible loss in the Luvisol in 1971, which represented samples from the Peace River area of Alberta.

The 4-class rating system (2), which applies weights of 2, 5, and 10 to the slight, moderate, and severe disease categories, was not used in assessing losses in this study, though there is no doubt that in these categories significant yield reductions could be demonstrated where the sample was sufficiently large. This is clearly shown in Table 4. The percent loss for each class of disease in barley was slightly greater than the losses reported from wheat (2); the trend was similar except in the unclassified group, where a yield loss was found in barley but not in wheat. Also it is possible that not all varieties suffer similar yield losses from similar amounts of root rot. Little data is available on the effects of agronomic practices on the yield of crops affected by root rot. However Pittman and Horricks (5) stated that well-nourished plants are little affected by root rot, especially if severe infection occurs late in the growth of the plant.

Some limited data (4) indicated that severe disease in some cultivars, such as Jubilee and Centennial, caused smaller yield reductions than a comparable level of disease in Gateway. Some indication of differential tolerance may also be derived from a comparison of loss estimates in Alberta and Saskatchewan. In 1970 and 1971 greater reductions in yield occurred in Alberta. In 1972 a similar situation also would be anticipated on the basis of cultivar reactions; in Saskatchewan 80% of the barley acreage consisted of the moderately resistant cultivars Conquest (41%), Betzes (23%), and Bonanza (16%); in Alberta (1) Conquest (23%), Betzes (23%), and Bonanza (7%) accounted for 53%, while 32% of the acreage consisted of the moderately susceptible cultivars Galt (14%), Olli (10%), and Gateway (8%). Despite the proportionately higher acreage of apparently resistant cultivars in Saskatchewan in 1972 the estimated loss was twice that of Alberta.

Losses in 1970, 1971, and 1972 in the Prairie Provinces were 37, 42, and 84 million bushels, respectively. It is obvious that common root rot does substantially reduce barley yields on the Canadian prairies and that research efforts should continue to be devoted to the control this disease by chemical, agronomic, or plant breeding methods.

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Literature cited

1. Brewing and Malting Research Institute. **1973.** Barley varieties in western Canada **1964-1974.** Barley Briefs, September **20, 1973.** Brewing and Malting Barley Research Institute, Winnipeg, Manitoba.
2. Ledingham, R. J., T. G. Atkinson, J. S. Horricks, J. T. Mills, L. J. Piening, and R. D. Tinline **1973.** Wheat losses due to common root rot in the prairie provinces of Canada, **1969-1971**. Can. Plant Dis. Surv. 53:113-122.
3. Machacek, J. E. **1943.** An estimate of loss in Manitoba from common root rot in wheat. Sci. Agric. 24:70-77.
4. Piening, L. J. **1973.** Differential yield response of ten barley cultivars to common root rot. Can. J. Plant Sci. 53:763-764.
5. Pittman, U. J., and J. S. Horricks **1972.** Influence of crop residue and fertilizers on stand, yield, and root rot of barley in southern Alberta. Can. J. Plant Sci. 52:463-469.
6. Sallans, B. J. **1959.** Recovery in wheat from early infections by ***Helminthosporium sativum*** and ***Fusarium culmorum***. Can. J. Plant Sci. 39:187-193.
7. Wood, L. S., J. J. Christensen. and J. W. Lambert. **1954.** ***Helminthosporium sativum*** becomes destructive on hitherto resistant varieties of barley. Phytopathology 44:511. (Abstr.).