BARLEY DISEASES IN SOUTH AND CENTRAL ALBERTA IN 1971-73 DISTRIBUTION, SEVERITY, AND YIELD LOSSES

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Abstract

The distribution and severity of barley diseases and estimates of yield losses associated with them were determined in south and central Alberta by standardized methods of field survey and disease assessment. In 1971 common root rot (Cochliobolus sativus and Fusarium spp.) caused an estimated loss of 6.0%, scald (Rhynchosporium secalis) 1.1%, net blotch (Pyrenophora teres) 0.5%, and loose smut (Ustilago nuda) 0.5%. The loss in yield from these diseases was estimated at 20.3 million bu. leaving an estimated harvest of 216 million bu. Spot blotch (Cochliobolus sativus), speckled leaf blotch (Septoria spp.), and bacterial blight (Xanthomonas translucens) were found occasionally but caused little damage.

Introduction

The occurrence of diseases in the western Canadian barley crop has been reported annually for over 40 years (3). However, there are few reports on the quantitative distribution of diseases and even fewer that attempt to estimate the losses in yield that occurred (7, 8, 10). This study was undertaken as part of a program to determine the severity of barley diseases in south and central Alberta and to assess the losses they cause.

Materials and methods

The province was stratified for survey purposes into Census Divisions (CC) as these were the smallest areas for which crop acreage and yield statistics were available (1). The acreage sown to barley in each CD in 1971 was estimated before the survey started, as follows:

$$\text{Acreage 1971} = A \times \frac{\text{Total Alberta acreage 1971}}{\text{Total Alberta acreage 1970}}$$

where A is the acreage sown to barley in the CD in 1970. A preliminary estimate was needed because the acreage estimates for intraprovincial subdivisions were available only several weeks after the growing season was completed. The number of barley fields chosen for examination in each CD was based on a sampling target of one field for each 48,000 acres sown. The approximate location for each field to be sampled was marked on a map before the survey started (Fig. 1). These locations were chosen to coincide with acreage concentrations of barley within each CD. There were too few acres of barley in CD 9 and CD 14 to warrant sampling and time was not available to assess the barley crop in northern Alberta (CD 15).

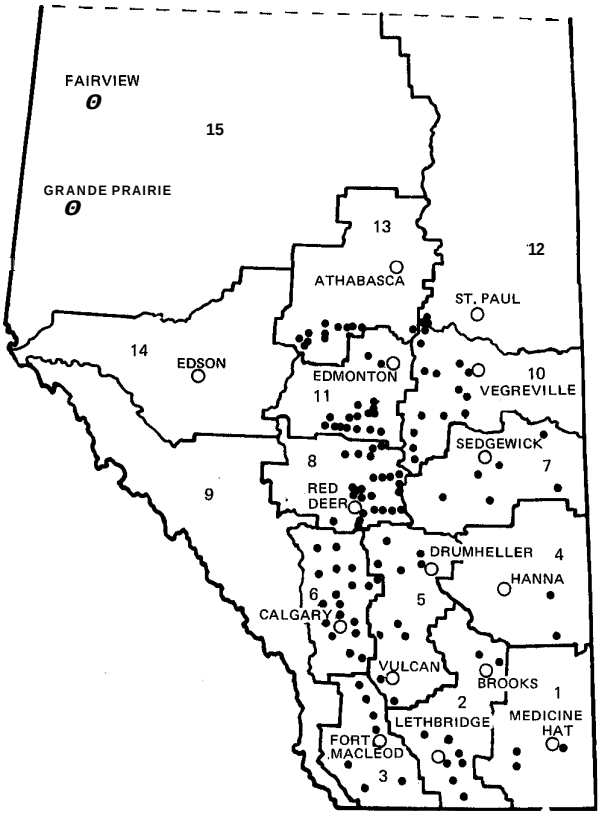

Figure 1: Map of Alberta, showing Census Divisions and locations of fields sampled for barley diseases.

Each field examined was within a 5-mile radius of the preselected approximate location and was the first one encountered in which the plants were at Growth Stage 10.5 (all spikes emerged from sheath) (4). Variety was not a criterion in field selection, either 2-rowed or 6-rowed varieties were examined. We avoided sampling fields that bordered major highways. In each

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Table 1. Barley production and number of fields assessed for diseases in Alberta, 1971

Census Division*	Acres sown ('000) 1970	Acres sown ('000) 1971	Yield, 1971† Bu/acre	Yield, 1971† Total bu ('000)	Fields assessed
1	111	198	35.4	7,018	4
2	363	517	46.5	24,060	10
3	240	316	42.5	13,434	7
4	87	173	30.9	5,345	2
5	467	666	48.4	32,214	10
6	473	569	45.8	26,080	18
7	259	366	42.1	15,410	6
8	616	650	35.1	22,842	24
10	490	666	39.2	26,094	14
11	444	544	40.3	21,918	17
12	120	178	32.1	5,715	3
13	416	507	26.8	13,567	12
15	614	750	35.0	26,280	0
Total	4,700	6,100	39.3	240,000	127

* Production in Census Divisions 9 and 14 was groupedwith that of 6 and 13, respectively.

† See reference 1.

field surveyed, five plants were chosen at each of 10 sites situated 50 paces apart on an "inverted V". The first site was 50 paces from the edge of the field with six sites on the entry arm and four on the exit arm. The plants selected were those nearest the toe of the forward shoe at the end of the 50th pace.

The rating for each disease on each plant was recorded on a standard form to allow analysis by computer. Disease severities were assessed as follows: Common root rot, 0 = clean, 1 = slight, 2 = moderate, 3 = severe (6); Smuts, 0 = no smut, 1 = smutted plant; Virus diseases, 0 = no symptoms, 1 = leaf symptoms, 2 = stunted plant (2); Leaf diseases, mean percentage of leaf area affected on the flag and penultimate leaves of the main tiller (4). In addition, notes were made on diseases present in the field but not recorded from the 50 plants sampled.

Yield losses from root rot were estimated using the method of Ledingham (6); for loose smut by percent smutted plants = percent yield loss (9, 11); for leaf diseases by percent yield loss = 0.5 x mean area affected by the disease on the flag and Fenultimate leaves based on the principle of James et al. (5). Loss values for CD's represent the means for all fields sampled within the CD. Yield losses in bu were estimated separately for each CD by:

$$[100 \times B/(100 - \%\ \text{loss})\,3 - B$$

where B = total bu produced.

Weighted percent loss from a disease for the surveyed area was $100[A/(A + B)]$, where A = estimated loss in bu from the disease in CD's 1 to 13, and E = total bu harvested in CD's 1 to 13 (1).

Results

The most serious disease encountered on barley in Alberta in 1971 was common root rot caused by Cochliobolus sativus (Ito & Kurib.) Drechsl. ex Dastur and Fusarium spp. The disease was found in almost every field examined and caused an estimated loss of 6.091 in the surveyed area (Table 2). The disease was most severe in CD 4 and 13 and was least severe in CD's 3, 6, and 12. Several leaf diseases were widespread in the surveyed area. The scald pathogen Rhynchosporium secalis (Oud.) Davis was widely distributed on the basal leaves of barley (Table 3), occurring cn 95% of the 127 fields examined. In the southern region (CD's 1 to 6), there was little spread to the upper leaves and yield loss was low. In the central region (CD's 7 to 13), scald was more frequently found on the flag and penultimate leaves and yield loss was greater. Yield loss from scald in one field reached 25.7% with the average loss being 1.1%. Net blotch

Table 2. Severity and yield loss from common root rot of barley in south and central Alberta, 1971

Census Division	Severity*	Yield loss %	Yield loss bu ('000)
1	0.64	6.9	520
2	0.68	7.0	1,811
3	0.34	3.5	487
4	1.03	10.4	620
5	0.53	5.4	1,839
6	0.34	3.5	946
7	0.85	9.1	1,543
8	0.60	6.0	1,458
10	0.56	5.7	1,577
11	0.82	8.4	2,010
12	0.33	3.3	195
13	1.29	15.0	2,394
Total		6.0	15,400

* Scale of 0 (least) to 3 (most)

Table 3. Barley fields with symptoms, leaf area affected, and yield loss from scald (*Rhynchosporium secalis*) in south and central Alberta, 1971

Census Division	% fields with symptoms: Basal leaves	% fields with symptoms: Upper leaves	% leaf area affected*	Yield loss %	Yield loss bu ('000)
1	100	50	0.02	<0.1	1
2	100	90	0.12	<0.1	14
3	100	57	0.03	<0.1	2
4	50	0	0.00	0	0
5	90	60	0.09	<0.1	15
6	94	83	1.02	0.5	134
7	100	67	1.84	0.9	143
8	96	67	3.83	1.9	446
10	86	86	3.65	1.8	485
11	100	65	6.22	3.1	704
12	67	0	0.00	0	0
13	100	92	9.87	4.9	704
Total				1.1	2,648

* Mean area of flag and penultimate leaves affected by the disease.

(Pyrenochora teres (Died.) Dreschsl.] was present on the lower leaves of most barley crops in the southern part of the province (Table 4). In the central region, incidence of this disease was lower. Damage to the upper leaves was generally light, resulting in an estimated yield loss of 0.5%. Loose smut [Ustilago nuda (Jens.) Rostr.] was noted in 42% of the 127 fields examined. However, infection levels were generally low (Table 5). The greatest infection level recorded in an individual field was 6%. Mean yield loss due to smut was 0.5%. Bacterial blight [Xanthomonas translucens (Jones, Johns, & Reddy) Dowson] occurred in 23 of the 127 fields examined. Damage to the upper leaves was as high as 4.8% of the leaf area in individual fields. Mean loss for the surveyed area was 0.1% with CD's 5 and 8 having the greatest loss, 0.3 and 0.2%, respectively. Spot blotch (Cochliobolus sativus) symptoms were noted on the lower leaves in many fields in the southern part of Alberta and in a few fields in the area scuth of Edmonton in CD 11. The disease was rare on the upper leaves and loss was considered negligible. Speckled leaf blotch (Septoria spp.) was rare in Alberta in 1971, occurring in only two fields in the southwestern part of CD 10.

No symptoms of barley yellow dwarf were encountered in the surveyed fields although in CD 3 moderate damage was found in barley and oats that were sown in late-July for use as fall pasture and examined for the disease in mid-September (T. G. Atkinson, personal communication). Stem rust (Puccinia graminis Pers.), leaf rust (Puccinia recondita Rob. ex Desm.), ergot [Claviceps purpurea (Fr.) Tul.], covered smut [Ustilago hordei (Pers.) Lagerh.], and false loose smut (Ustilago nigra Tapke) were not encountered in any of the 127 barley fields examined in the 1971 survey.

There was a marked regional difference in the distribution of 2-rowed and 6-rowed barleys in this survey. In the south, 6-rowed barleys occurred in only 35% of the fields sampled whereas, in the central part of the province, they were found in 92%.

An allocation-of-resources analysis (12) was used with selected root rot, scald and net blotch data to determine where future changes in the sampling procedures could best be made. Relative costs were estimated as plants = 1, sites = 2, and fields = 60. The analysis suggested a reduction in the number of sites per field and an increase in the number of fields sampled.

Discussion

The incidence and severity of common root rot in Alberta was determined at Growth Stage 10.5 in this study. The loss was estimated using Ledingham's (6) equation which was

Table 4. Barley fields with symptoms, leaf area affected, and yield loss from net blotch (*Pyrenophora teres*) in south and central Alberta, 1971

Census Division	% fields with symptoms: Basal leaves	% fields with symptoms: Upper leaves	% leaf area affected*	Yield loss: %	Yield loss: bu ('000)
1	100	25	0.02	<0.1	1
2	100	80	0.40	0.2	48
3	86	86	0.13	<0.1	9
4	100	100	0.50	0.3	13
5	100	100	1.14	0.6	185
6	94	89	0.22	0.1	29
7	100	100	1.24	0.6	96
8	54	38	4.03	2.0	470
10	64	64	0.65	0.3	85
11	53	24	0.11	t0.1	12
12	100	33	2.93	1.5	85
13	67	58	1.07	0.5	73
Total				0.5	1,106

* Mean area of flag and penultimate leaves affected by the disease.

Table 5. Barley fields affected and yield loss from loose smut (*Ustilago nuda*) in south and central Alberta, 1971

Census Division	% fields with smut: Trace*	% fields with smut: >2%	Yield loss: %	Yield loss: bu ('000)
1	0	25	0.5	35
2	20	20	0.8	194
3	43	14	0.6	81
4	0	0	0	0
5	30	0	0	0
6	33	17	0.4	105
7	17	50	1.0	156
8	29	8	0.4	92
10	21	21	0.9	237
11	18	18	0.8	177
12	67	0	0	0
13	33	8	0.4	54
Total			0.5	1,131

* Trace = <2% of heads affected.

developed to relate root rot severity in wheat at Growth Stage 11.3 (hard dough) to the yield loss. Ledingham's equation may have to be modified to obtain an accurate estimate of loss from root rot in barley, especially when the disease is assessed before the hard dough stage.

Yield loss estimates as determined for scald by James et al. (5) have not been experimentally proven to apply for other barley leaf diseases. However, the relationship will serve as a reasonable approximation for assessing the losses from other leaf diseases until more accurate equations are derived.

The loss from scald. and presumably other leaf diseases of barley, is related primarily to the degree of damage sustained by the flag and penultimate leaves (5). In 1971, estimated losses from scald and net bloth in Alberta were low because the upper leaves escaped serious infection even though the lower leaves were often severely diseased. Hot, dry weather during late July and early August, when the upper leaves were susceptible, appeared to have arrested the spread of the diseases at this critical period and prevented more serious losses.

The number of fields sampled in each CD in 1971 was based on the relative distribution of barley acreage in 1970 (see Table 1). In 1971, there was a large (30%) increase in barley acreage and also a change in its relative distribution. This resulted in higher than average ratios of fields sampled/acres sown in CD's 4, 5, 7, and 12. However, it is unlikely that the high ratios in these four CD's had a *major* effect on the accuracy of the loss estimates obtained in this study as the acreage involved was less than 20% of the total.

We found that 6-rowed varieties occupied 35% of the fields in the south and 92% of those in the central region. These values agree with the proportions reported by the Brewing and Malting Barley Research Institute. Winnipeg, Manitoba. From this, it may be inferred that our method of selecting fields also selected individual varieties in relation to the acreage they occupied. The eleven barley varieties commonly grown in Alberta in 1971 varied somewhat in resistance to certain diseases that caused measurable losses. However, if, as we suggest above, our field selection technique was unbiased, the lower losses occasioned by the use of resistant varieties should be accurately accounted for in the severity and loss estimates.

Loss assessment studies of the type described provide an estimate of the relative economic impact of the diseases in a crop within an agricultural region. In addition, they provide a "benchmark" from which to determine whether certain diseases are increasing or decreasing in prevalence and

severity. Bacterial blight, for example, was restricted in distribution in 1971 but caused moderate damage in certain fields. Further monitoring of incidence and severity will enable accurate prediction of the potential threat of this disease to barley production in Alberta.

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