BARLEY SMUTS IN MANITOBA AND EASTERN SASKATCHEWAN, 1972–74[1]

P.L. Thomas

Abstract

Losses from barley smuts in Manitoba and eastern Saskatchewan were calculated to be 0.6% in 1972, 0.2% in 1973, and 0.9% in 1974. The major change in the last 6 years has been an increase in infection on the six-rowed varieties, accompanied by a decrease on the two-rowed varieties.

A biotype of Ustilago nuda that can infect the variety Conquest was detected in Alberta, Saskatchewan, and Manitoba. The level of infection in fields containing this biotype remained low, indicating that the Jet type of resistance in commercial varieties is still of value.

Résumé

Au Manitoba et dans l'est de la Saskatchewan, on a évalué à 0.6% en 1972, 0.2% en 1973 et 0.9% en 1974, les pertes attribuables aux charbons de l'orge. Depuis les 6 dernières années, le principal changement a été un accroissement de l'infestation des variétés à six rangs et une reduction de celle des variétés à deux rangs.

On a observe en Alberta, en Saskatchewan et au Manitoba un biotype de Ustilago nuda qui peut infester la variété Conquest. Le niveau d'infestation des champs où l'on a trouvé ce biotype est demeuré faible, ce qui prouve que le type de resistance Jet des variétés commerciales conserve

Incidence of smut in barley in farm fields

surveys providing data on the occurrence and importance of the barley smut fungi [(Ustilago nuda (Jens.) Rostr., U. nigra Tapke, and U. hordei Pers. (Lagerh.)] in Manitoba and Saskatchewan were made in 1969, 1970, and 1971 (1,5,6). The losses due to these smuts in Manitoba were calculated to be 0.24% in 1969, 0.30% in 1970, and 0.50% in 1971. The loss in eastern and northern Saskatchewan in 1970 was calculated to be 0.56%. U. nuda was reported to have caused 0.50% loss in south and central Alberta in 1971(2).

The author surveyed barley fields in Manitoba and eastern Saskatchewan in 1972, 1973, and 1974. Fields that were between the heading and the late soft dough stages were selected at random at 5-20 mile intervals depending upon the frequency of barley in the area. The routes were designed to traverse a variety of crop districts and were modified yearly. An estimate of the percentage of plants infected at each site was made while walking an ovoid path of approximately 100 meters in the field. The results are shown in Table 1.

Conditions adverse to the development of smut appear to have affected the 1973 crop, although the estimate may be low because the survey was made relatively early in the season. The stage of crop development at this time, early heading, facilitated the detection and collection of U. nuda but would tend to make U. hordei more difficult to detect.

The high proportion of affected fields, especially of six-rowed barley in 1974, has practical implications. The actual proportion of fields affected would be expected to be higher than that observed due to the difficulty of detecting trace-level infections in the relatively small area examined in each field. Therefore, inoculum for future infection exists in most fields and, given favorable conditions, could cause extensive damage in any given year.

Contrary to the results of the earlier surveys (5, 6), the two-rowed varieties exhibited less infection than the six-rowed varieties. This has apparently resulted from

[1] Ccntribution No. 641, Research Station. Agriculture Canada, 25 Dafce Road, Winnipeg, Manitoba R3T 2M9.

Table 1. Incidence of smut in barley in Manitoba and eastern Saskatchewan, 1972-74

Year	Number of fields examined		% fields affected			Mean % infected plants		
	2-rowed	6-rowed	2-rowed	6-rowed	All varieties	2-rowed	6-rowed	All varieties
1972	43	64	37	56	49	0.3	0.7	0.6
1973	100	144	44	47	46	0.1	0.3	0.2
1974	43	107	44	9	62	0.1	1.0	0.9

a decrease in infection on two-rowed varieties and a corresponding increase on the six-rowed varieties, since the mean percentage of infected plants has not dramatically changed from **1969** to **1974.** An explanation may be found in rhe distribution of the barley varieties grown in Manitoba during this period as reported by the Federal Grain Co. Ltd. **(1969-71)** and the three Pool Elevator Companies **(1972-74).** The six-rowed variety Conquest and its close relative Bonanza have comprised approximately **40-50%** of the barley acreage since **1968.** The two-raved variety Pergus is a more recent introduction, having increased from *8.2%* of the acreage in **1971** to **36.6%** in **1974,** mainly as a replacement for Herta. Therefore an increase in the aggressiveness of the pathogens on Conquest and Bonanza would explain the increased frequency of smuts on six-rowed varieties, while the decrease on the two-rowed barley could be explained if Fergus were less susceptible to the smuts than Herta. Evidence for these assumptions will be presented later in this paper.

The distribution of the three species of Ustilago is shown in Table 2. Except for U. hordei in **1973.** the percentage of fields affected by each of the three species increased over the 3-year period. The apparent increase of U. nuda on six-rowed barley may be due to the existence of a new race which will be discussed later. The increases in the percentages of fields affected for the other variety - species combinations, providing they are significant, could be due to varietal changes, more favorable conditions for fungus development, or more aggressive *forms* of the pathogens.

The mean percentage of plants infected with U. nuda has shown a downward trend, despite the increases .in the percentage of fields affected. The change appears to be larger for the two-rowed varieties, perhaps due to the increase in the acreage *of* Pergus. Seed treatment with systemic fungicides may also be affecting the prevalence of U. nuda.

U. nigra appears to be increasing on the six-rowed varieties. The major change in the six-rowed population was the increase in acreage of Bonanza at the expense of Conquest. Since the two varieties are very closely related and have very similar reactions to smut under laboratory conditions, the increase .in U. nigra probably results from either more favorable conditions or more aggressive forms of the pathogen.

With the exception of **1973,** there appears to be an increase in the mean percentage of infection for U. hordei on the six-rowed varieties. However, the significance of the

Table 2. Incidence of three speciesofUstilago on barley infield surveys, 1972-74

Ustilago species and type of barley affected		% fields affected			Mean % infected plants		
		1972	1973	1974	1972	1973	1974
U. nuda	2-rowed	37	38	55	0.3	0.1	0.1
	6-rowed	8	12	13	0.2	0.1	0.1
	all varieties	17	24	25	0.2	0.1	0.1
U. nigra	2-rowed	2	5	11	tr*	tr	tr
	6-rowed	36	37	43	tr	0.1	0.3
	all varieties	23	24	38	0.1	0.1	0.3
U. hordei	2-rowed	12	4	33	tr	tr	tr
	6-rowed	36	24	43	0.4	0.2	0.5
	all varieties	27	16	42	0.3	0.1	0.4

* tr = trace, <0.1%.

differences between the infection percentages must be judged with caution; e.g. in a population of 100 fields cne field with 10% infection increases the mean percentage of infection by 0.1.

Physiologic specialization of U. nuda

Aqueous suspensions of the spores from all of the U. nuda collections were inoculated into florets of Conquest barley at anthesis. All inoculations were conducted on plants growing in growth cabinets and the inoculated seed was grown subsequently in greenhouses.

Three of the 18 collections in 1972 were found to be virulent: on Conquest and other derivatives of Jet: (7). Subsequently 12 of the 55 collections from 1973 were also found to be virulent on Conquest. The virulent collections from 1973 were found to be from more widely spread locations than the 1972 collections, ranging from Beausejour in eastern Manitoba to wauchope in southeastern Saskatchewan and Canora in east-central Saskatchewan. In 1973, collections were forwarded from Prince Edward Island, Nova Scotia, Ontario, Saskatchewan, and Alberta. Collections from flanna, Lethbridge, and Champion in soutnern Alberta were virulent on Conquest, considerably extending the range of the new biotype.

The level of infection attributed to natural infection by the new biotype nas been trace, with the exception of one field at 1% and another at 5%. The widespread incidence of the new biotype has not yet, therefore, resulted in an increase in the mean percentage of infected plants.

Table 3. Infectivity of *U. nuda* collections, 1972

	% infection after floral inoculation		
Collection no.	Bonanza	Fergus	Herta
72- 20*	0	26	64
72- 40	0	60	67
72- 58	0	24	60
72- 66*	36	16	64
72- 70a	0	23	70
72- 70*	20	44	55
72- 73	0	12	56
72- 76	0	57	48
72- 81*	0	59	40
72- 82*	17	67	78
72- 84	0	25	67
72- 85	0	36	65
72-146	0	16	39
72-147	0	32	57
Control	0	0	0

Collected from a 6-rowed variety. The remaining collections were from 2-rowed varieties.

There were sufficient spores of 14 of the collections of U. nuda from Manitoba and Saskatchewan to inoculate the remainder of the varieties that are currently recommended for farm use in Manitoba. The three collections that previously attacked Conquest were found to be virulent on the Jet resistance present in Bonanza (Table 3). The level of infection on Fergus was lower than that on Herta in all but two instances, indicating that Fergus is less susceptible than Herta to U. nuda.

As reported earlier (7), the varieties Trebi, Titan, Warrior, Compana, Valkie, and hybrids carrying gene Un8 were resistant to the collections from 1972 that were virulent on Conquest. That data had suggested (7) that 72-66 was virulent on Un8 in hybrid PR28. However, further testing has revealed that hybrids with Un8 are totally resistant to 72-66 and that the infection of PR28 was spurious. It was considered possible that the resistance due to Un in Trebi, Titan, and Warrior and the resistance in Valkie and Compana could be used in future breeding programs because these varieties are not currently grown commercially in Manitoba and eastern Saskatchewan. It was assumed that since there is no selection pressure by the host for the virulence genes capable of attacking the above varieties the necessary virulence would be lost from the natural population of the pathogen (3). The test for this assumption was to use the spores from the 14 collections that infected Herta (Table 3) to inoculate Trebi, Valkie, and Compana. CI 13662 was also included as a source of Un8. Collection 72-146, from a two-rowed barley growing near Winnipeg Beach, Man., was the only collection to give infection. Trebi was 48% infected, Compana 75%, Valkie 80%, and CI 13662 0%. The presence of this biotype limits the use of Un, Valkie, and Compana in breeding for resistance to U. nuda at the present time. Un8 appears to be a suitable candidate.

Several additicnal varieties have been screened for their reaction to 72-66. Ogalitsu, Golden Melon, Charlottetown, Olli, Parkland, Husky, and Gateway 63 were all very susceptible (>35% infection). Jet is apparently only moderately susceptible (approximately 10% infection). This means, however, that there are no additional genes for U. nuda resistance in Jet that would be of value.

Seed from plants of Ccnquest barley that had been inoculated with 72-66 was treated with a systemic fungicide to ascertain the practicality of control by such a practice. Forty grams of seed were treated with Vitaflo 280 (carbathiin 14.9%, thiram 13.2%) at the commercially recommended rate of 1.5 oz of fungicide per bushel of barley (42.5 g/21.8 kg). The seed was planted in the field in

ten 2.1–m rows, along with 4 g of untreated seed in two rows as a control. The control gave 21.61 infection while the treated material gave 2.9% infection, Therefore Vitaflo appears to give a significant measure of control of the new biotype.

Physiological specialization of U. nigra and U. hordei

The 1972 field collections of U. nigra and U. hordei were used to inoculate seed of the four varieties that are currently recommended in Manitoba. The inoculum was prepared by mixing one to three smutted heads in 400 ml of water in a Waring Blendor (4). Approximately 200 seeds of each variety were then treated in either 200 ml or 400 ml of the inoculum for 15 seconds in the Blendor. The seed from each treatment was planted in the field in two 2.1–m rows. The relatively high percentage infection figures (Tables 4 and 5) for the U. hordei collections numbered 72–7 to 72–42 were probably due to the use of 200 ml rather than 400 ml of inoculum. This treatment resulted in extensive damage to the seed and was therefore discontinued. However it was relatively effective and did not unduly impair the germination of the seed.

All of the U. nigra collections were apparently capable of producing some infection on all four varieties (Table 4). Three of the four U. hordei collections from two-rowed varieties did not infect the six-rowed Varieties (Table 5). The remainder of the U. hordei collections were similar to the U. nigra collections in their ability to produce infection in all of the commercial varieties. The infection percentage for toth U. nisra and U. hordei was almost invariably lower on Pergus than on Herta, demonstrating that Fergus is less susceptible than Herta to these species as well as to U. nuda. These data corroborate the assumption that the reduced mean percentage of infection found in the 1972, 1973, and 1974 surveys may have been due to the increased acreage of Fergus.

Table 4. Infectivity of *U. nigra* collections, 1972

	%infection after seed inoculation			
collection no.	Bonanza	Conquest	Fergus	Herta
72- 5	9	5	10	33
72- 34	5	6	5	18
72- 38	13	7	9	43
72- 42	9	6	10	42
72- 44	12	7	14	29
72- 48	14	7	10	36
72- 52	8	7	8	41
72- 56†	4	3	6	16
72- 61	6	7	8	29
72- 62	3	5	10	12
72- 66b	3	3	3	8
72- 66d	7	4	5	26
72- 70†	6	3	4	20
72- 74	5	6	9	32
72- 78	8	6	14	50
72- 86		3	5	20
72- 90	7	5	12	39
72- 98	11	9	11	30
72-100	7	4	10	38
72-103	10	6	4	17
72-108	12	9	6	12
Uninoculated control	0	0	0	0

† collected from 2-rowed varieties. The remaining collections were from 6-rowed varieties.

Conclusions

No dramatic changes have been observed in the level of barley smut infection in the last 6 years. The major changes observed were a decrease in the mean percent infection of the two–rowed varieties and an increase in

Table 5. Infectivity of *U. hordei* collections, 1972

	%infection after seed inoculation			
Collection no.	Bonanza	Conquest	Fergus	Herta
72- 7	32	5	9	21
72- 20	60	42	15	64
72- 24	8	37	10	23
72- 27	45	16	20	45
72- 34	25	7	15	40
72- 38	20	29	27	28
72- 42	9	14	13	35
72- 51	9	3	1	16
72- 52	7	3	2	6
72- 57	6	4	0	14
72- 61	13	8	5	15
72- 62	5	3	5	10
72- 64	7	2	1	9
72- 66	6	2	2	9
72- 70	9	6	3	11
72- 72	9	10	4	13
72- 74	2	3	4	3
72- 76†	6	4	4	10
72- 86	7	11	4	15
72- 90	7	8	10	14
72- 95	5	5	1	13
72-124†	0	0	4	10
72-139	13	12	8	19
72-146	0	0	7	15
72-155	12	11	7	25
72-156†	0	0	7	17
Control	0	0	0	0

† Collected from 2-rowed .varieties. The remaining collections were from 6-rowed varieties.

infection on the six-rowed varieties. These changes were attributed to Fergus being less susceptible than Herta to smuts and to the presence of forms of the pathogens that are more aggressive on the six-rowed varieties.

The biotype of U. nuda that can infect Conquest has been detected in a large area; however, the level of infection in individual fields has remained low. This, together with the existence of a large proportion of the U. nuda population that is avirulent on Conquest and Bonanza, indicates that the resistance derived from Jet is still of value in our commercial varieties. This resistance should be complemented or replaced by new types of resistance tc counter the potential threat that the new biotype represents.

The proportion of barley fields affected by smut in Manitoba and eastern Saskatchewan has not been reported previously. The calculation appears to have value since it should provide some information on the distribution of the inoculum available to infect subsequent crops. For example, the level of infection in the 1975 crop may reflect the high proportion of fields that were affected in 1974.

The advent of systemic fungicides has relegated U. nuda to the same status as U. nigra and U. hordei in terms of chemical ccntrol. Therefore the effort relegated to Smut resistance in breeding programs should be evenly distributed among the three species.

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