THE OCCURRENCE OF LOOSE SMUT RESISTANCE IN 42, 28 AND 14 CHROMOSOME WHEATS¹

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ABSTRACT

A total of 865 spring wheat varieties, and selections from the 14, 28 and 42 chromosome groups, were inoculated in 3 successive years with a mixture of Canadian collections of loose smut, *Ustilago tritici* (Pers.) Rostr. At the end of the first year, 231 were rated immune; after the second inoculation, 188; and after the third, 162. These included 116 from the 42 chromosome group, 43 from the 28, and 3 from the 14. Although some of the reduction in immune or resistant types after the first year may have resulted from escapes, it is probable that most of these showed susceptibility to new collections added in the second and third years.

INTRODUCTION

In the early part of this century losses caused by loose smut, *Ustilago tritici* (Pers.) Rostr., were quite appreciable in North America. Tapke (2) estimates that, in the period 1917-1926, annual losses from this disease were more than 10,000,000 bushels in the United States. No comparable figures are available for Western Canada. In recent years, however, loose smut has been relatively unimportant in wheat production in the Prairie Provinces. The principal varieties grown are Thatcher and Selkirk, which are immune and highly resistant, respectively. The only highly susceptible variety released in the last decade was Lee which, at its widest distribution in 1954, occupied only 20 per cent of the Manitoba and a smaller percentage of the Saskatchewan acreage.

Tapke (2) listed the reaction for 234 varieties and lines available to him in 1929. Of these, he found 13 which were immune. In 1957, observation rows of nearly 1,100 spring wheat varieties were grown in the field at Winnipeg in order to determine their possible value as plant breeding or genetic material. As many of the varieties as possible were inoculated to a mixture of loose smut collections to assess their resistance. In this paper are listed those varieties which remained immune after 3 years of inoculation.

MATERIALS AND METHODS

The wheat varieties grown in the 1957 genetic nursery were obtained from 28 countries of the world. One or two heads of 865 of the spring types were inoculated with a mixture of 26 collections of loose smut gathered throughout Canada in 1956.

Inoculation was effected by means of a Meyer's Silver Prince sprayer which was set to deliver the spore suspension at a pressure of 270 pounds per square inch (1) through a fine jet nozzle. In this method the wheat head is held in one hand while the spray is directed at the florets. The high pressure of the jet stream forces the glumes open, allowing the inoculum to enter the florets. The operation was carried out 1 or 2 days following anthesis of the central spikelets of selected heads.

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The inoculum was prepared by shaking equal numbers of smutted heads of each collection in a pail of water and straining the suspension into the sprayer tank through a screen of sufficiently large mesh to allow spores to pass through but to hold back rachis and floral parts. Enough water for a 4-hour supply was added. Fresh inoculum was prepared after 4 hours' use to ensure viability of the spores.

In 1958 the inoculated seed of each variety was sown in hills in a field nursery and the plants examined for smut infection. If even one head were smutted the variety was discarded. Where no infection occurred, one or two heads were again inoculated, this time with 26 collections of loose smut which had been collected in 1957. The inoculated seed was sown in 1959 and treated in a similar manner. The procedure was repeated in 1960 making a total of 3 successive years of testing.

RESULTS AND DISCUSSION

Of the 865 inoculated varieties grown in 1958, only 231 were rated immune. These were further reduced in 1959 to 188 and, after elimination in 1960, 162 remained. Of these, 116 were in the 42 chromosome group, 43 in the 28, and 3 in the 14. These varieties are grouped in Table 1 according to chromosome number. Where possible, sub-groups such as Thatcher and its derivatives are placed together. Certain agronomic and disease reaction data, recorded in 1957, are included to show the relative value of the varieties for characteristics other than loose smut resistance.

A. B. Campbell* has shown that Thatcher possesses a dominant gene for loose smut immunity. This is reflected in the immunity displayed by Thatcher and its derivatives. Other groups of spring wheat include some of the Kenya varieties and varieties with Supremo, Africa 43 or Maria Escobar as a common parent. None of the varieties listed in Table 1 was tested by Tapke (2).

A narrow genetic base was used for screening each variety. In the first year only one or two heads were inoculated and, since succeeding inoculations were made on plants grown from seed which had been inoculated, all tests were made on plant progenies tracing directly to these original heads. Thus, if the variety were heterogeneous for resistance, and an immune genotype were selected by chance, the variety would be considered immune. Heterogeneity for loose smut resistance may be more widespread than is usually realized. Unless wheat breeding programs are designed to incorporate loose smut resistance, no selection is made for this characteristic, and a variety may be released which carries both resistant and susceptible lines. In many tests for varietal reaction, some varieties are immune, others carry trace to 30 per cent smut, while still others are completely or nearly completely susceptible. The question is whether all those in the trace-to-30 per cent group are susceptible, or whether only a portion of the population is susceptible. Physiologic specialization in *Ustilago tritici* may provide a second alternative. This organism passes through a sexual cycle in each generation and as a result many races may be present. Thus, in those cases where 80 to 100 per cent infection is observed,

*Personal communication

TABLE 1. — AGRONOMIC AND DISEASE DATA FOR 1957 ON VARIETIES AND SELECTIONS OF SPRING WHEAT IMMUNE TO LOOSE SMUT FOR A 3-YEAR PERIOD

Winnipeg Genetic No.* WG 57-	Origin of seed	Days to head	Days to mature	Leaf rust %	Stem rust %	Lodging resist- ance 1-9	Awne- ness	Black chaff 1-9
<i>42 Chromosomes</i>								
09	USA	65	106	T	T	4	Ad	1
10	"	66	106	T	0-20	6	Ad	1
11	"	64	99	0	0	4	Ad	2
15	"	64	98	0	T	4	Ad	3
17	"	66	106	T	3	4	Ad	1
358	"	62	96	60	5	2	Ad	3
356	"	62	97	70	15	2	Al	2
1063	Canada	62	94	60	60	3	Al	4
203	Germany	63	99	50	40	2	Al	2
1070	USSR	57	91	80	10	2	Al	5
676	USA	66	100	50	30	3	Ad	6
982	Canada	64	99	50	10	3	Al	6
961	"	63	97	40	1	1	Al	7
984	"	63	100	T	1	3	Ad	3
310	USA	66	99	25	20	1	Al	3
1050	"	59	94	50	40	2	Al	2
377	"	63	97	50	10	2	Al	4
742	Mexico	64	98	5	0	4	Ad	6
741	"	64	100	20	0	3	Ad	4
727	"	60	97	0	T	3	Ad	5
726	"	62	96	5	0	5	Ad	8
81	"	61	97	15	2	2	Ad	1
942	USA	63	100	T	1	3	Ad	7
752	Mexico	63	101	5-10	0	2	Ad	8
206	Kenya	65	99	60	20	3	Al	2
209	"	64	102	50	60	2	Al	3
871	"	65	100	40	0	2	Al	3
18	"	69	101	3-5	5	6	Al	1
873	"	75	104	5	30	3	Al	2
224	"	65	103	60	30	6	Al	2
1085	"	58	90	20	80	3	Al	4
97	"	62	98	80	1	2	Al	2
96	"	65	99	70	1	2	Al	3
22	"	66	105	15	40	2	Al	2
23	"	64	98	10-50	0	5	Al	2
897	"	65	103	5	15	2	Al	3
899	"	72	100	15	40	1	Al	2
901	"	63	99	80	1	2	Al	6
650	"	65	106	80	30	2	Al	2
935	Mexico	65	103	1	20	4	Ad	2
49	"	62	97	0	T	2	Ad	3
139	"	66	103	5	0	3	Al	2
148	Mexico	60	91	0	0	1	Al	6
733	"	59	97	0	0	3	Ad	6
123	"	64	99	0-60	T	1	Al	2
721	"	61	99	40	T	2	Al	4
746	"	65	97	0	0	5	Ad	3
70	"	64	102	0	20	2	Al	3
152	"	63	98	T	0	2	Ad	3
734	"	63	99	0	0	4	Ad	4
74	S. Africa	63	97	0	5	2	Al	3
158	Mexico	61	94	0	0	2	Al	9
921	S. Africa	64	103	0	40	3	Al	6
922	"	63	102	0	30	3	Al	4
923	"	65	100	0	30	2	Al	6

TABLE 1. — *continued*

Winnipeg Genetic No.* WG 57-	Origin of seed	Days to head	Days to mature	Leaf rust %	Stem rust %	Lodging resist- ance 1-9	Awne- ness	Black chaff 1-9
<i>42 Chromosomes</i>								
924	S. Africa	65	100	0	25	3	Al	5
925	"	64	102	0	40	1	Al	4
926	"	64	102	0	30	1	Al	3
927	"	65	103	0	40	1	Al	4
928	"	65	103	0	25	2	Al	4
929	"	65	103	0	10	1	Al	2
930	"	65	98	0	5	2	Al	3
931	"	66	104	0	20	2	Al	2
932	"	65	103	0	10	5	Al	3
933	"	62	95	50	1	6	Ad	7
107	S. Africa	64	98	0	5	1	Ad	2
1076	USA	59	93	50	5	5	Ad	5
939	Peru	62	99	0	15	3	Ad	3
94	"	63	96	T	0	1	Ad	4
801	"	64	99	T	0	2	Ad	7
802	"	63	98	1	0	2	Ad	8
1072	USA	59	94	60	10	4	Ad	2
835	Colombia	63	97	T	0	4	Al	6
111	Argentina	65	101	5	0	4	Ad	3
214	"	65	98	0	80	3	Ad	2
233	"	65	99	T	70	4	Ad	2
704	"	63	98	0	T	5	Ad	8
245	USA	66	101	40	5	4	Al	4
674	"	61	99	30	5	3	Al	8
675	"	65	97	50	20	4	Al	4
1005	Canada	58	92	10	5	3	Seg.	5
682	USA	60	104	5	0	1	Ad	2
776	"	60	103	1	0	2	Ad	4
778	"	61	104	5	0	3	Al	5
673	"	61	107	40	0	7	Ad	3
340	"	64	99	80	50	5	Ad	4
347	"	64	99	70	T	3	Ad	2
350	"	63	97	40	90	3	Ad	6
646	"	63	99	50	40	2	Ad	2
545	Italy	62	96	5	90	1	Ad	4
661	"	64	95	0	50	2	Seg.	4
519	Switzerland	63	95	30-90	100	2	Ad	2
522	"	64	97	30	80	1	Seg.	3
517	"	64	98	50	50	1	Seg.	4
518	"	64	98	30	40	1	Seg.	2
630	Canada	61	97	70	40	2	Ad	2
821	Chile	65	102	30	0	2	Al	6
823	"	61	99	1	0	3	Al	8
824	"	62	107	1	0	2	Ad	3
825	"	61	106	T	0	2	Ad	6
822	"	61	99	10	0	3	Al	3
830	Colombia	71	107	5	25	2	Al	4
831	"	61	95	3	5	3	Al	7
832	"	64	98	60	T	5	Al	8
1024	Australia	60	88	100	100	2	Al	5
183	"	61	92	90	100	2	Al	3
443	Canada	62	93	60	90	1	Al	2
422	"	68	96	80	90	2	Al	2
625	Eire	68	99	40	90	1	Al	2
87	Canada	60	97	10-80	70	1	Al	2
1054	USA	59	88	10	100	3	Ad	2

TABLE 1. — *continued*

Winnipeg Genetic No.* WG 57-	Origin of seed	Days to head	Days to mature	Leaf rust %	Stem rust %	Lodging resist- ance 1-9	Awne- ness	Black chaff 1-9
<i>42 Chromosomes</i>								
758	Mexico	60	97	15	0	3	Al	8
1143	Czechoslovakia	55	84	100	100	3	Ad	8
498	Canada	67	97	30	100	3	Ad	2
1110	Czechoslovakia	62	94	30	100	3	Ad	3
490	Canada	70	110	15	90	3	Ad	2
<i>28 Chromosomes</i>								
343	Australia	64	97	0	30	4	Ad	3
344	"	64	95	0	T	4	Ad	3
387	Italy	62	97	0	T	5	Ad	3
391	"	62	97	0	15	4	Ad	3
683	USA	64	100	0	0	8	Ad	2
685	"	67	106	0	5	7	Ad	5
690	"	63	101	0	1	5	Ad	3
810	"	63	94	0	0	7	Ad	3
811	"	62	95	0	15	6	Ad	4
812	"	64	95	0	0	8	Ad	5
816	"	64	99	0	0	6	Ad	3
808	"	61	95	0	0	6	Ad	5
807	Canada	68	95	0	2	5	Ad	3
688	"	68	107	0	30	9	Al	5
817	Tunis	65	99	0	0	5	Ad	5
839	Portugal	68	106	0	40	7	Ad	2
944	"	62	90	5	0	6	Ad	7
691	Ethiopia	62	99	T	0	6	Ad	4
945	"	62	94	1	0	7	Ad	3
947	"	63	95	T	0	5	Ad	6
951	"	65	96	5	T	5	Ad	4
949	Spain	65	95	0	0	4	Ad	4
950	France	66	97	0	T	6	Ad	5
952	Arabia	63	94	0	0	5	Ad	4
1152	Cyprus	60	95	T-5	T	4	Ad	5
703	Egypt	62	95	0	T	9	Ad	7
304	Canada	60	94	T	0	2	Ad	3
312	"	73	102	5	10	3	Ad	2
482	"	70	100	T	40	4	Ad	2
483	"	69	100	2	90	4	Ad	2
485	"	69	100	0	60	2	Ad	4
1121	Czechoslovakia	66	100	5	100	3	Ad	3
1125	"	66	95	T	80	6	Ad	2
1128	"	68	102	0	80	3	Ad	—
1126	"	62	94	0	90	5	Ad	2
486	Canada	66	95	40	100	4	Ad	2
1017	USA	62	92	80	50	5	Ad	3
837	Canada	68	102	0	0	6	Ad	2
1049	"	60	93	0	40	4	Ad	1
1051	"	59	93	2	40	4	Ad	3
445	"	75	96	5	90	2	Ad	2
1095	Czechoslovakia	62	93	0	20	4	Ad	2
1096	"	61	95	0	70	3	Ad	3
<i>14 Chromosomes</i>								
1073	USA	59	94	0	0	6	Ad	1
447	Canada	69	107	0	1	4	Ad	1
694	USA	65	100	T	60	8	Ad	2

*Variety or selection names

42 Chromosomes

09	Frontana-Thatcher
10	"
11	"
15	"
17	"
358	H-44 x Thatcher
356	Thatcher
1063	Thatcher selection
203	Hochzucht (similar to Thatcher)
1070	Kostoff's triple hybrid (sim. to That.)
676	Pilot ² x Thatcher
982	Thatcher x Regent
961	Thatcher ⁶ x Kenya Farmer
927	Red Egyptian Type 170918
928	" 170918-2c
929	" 170919
930	" 170919-1c
931	" 170922
932	" 170922-1c
933	" 170923
107	" 170925
1076	H-44-24
939	Maria Escobar
94	Maria Escobar x H-44-Marquis
801	"
802	"
984	(Canus x Thatcher) x (482.B x Regent)
310	Double Cross 825-4
1050	Marquillo x Waratah
377	Newthatch
742	(Mentana x Merit-Kenya) x (Kenya-Gular-Pilot) - (Kenya 58-Newthatch)
741	Merit (Newthatch-Marroqui) Kentana x (Kenya-Gular-Pilot) x (Kenya 58-Newthatch)
727	(Kenya-Redman-Dundee) x Newthatch
726	Candael-Newthatch-Kentana
81	(Kenya-Gular-Pilot) x (Kenya 58-Newthatch)
942	Willet
752	Willet x Lerma
206	Kenya I-40-34
209	" I-40-45
871	" I-49-157
18	" 117A
873	" 117A I-49-161
224	" 235.A.1.A.4
1085	" B.256.G
97	" B.286
96	" 294.B.2.A.3
22	" 321.AD.1.C.3
23	" 321.BT.1.B.1
897	" 338.Z.2.G.2
899	" 340.Y.4.A.1
901	" 340.Y.6.B.3
650	" 351.AS.1.B.2
935	Supremo
49	Peru x Supremo
139	Supremo-Kenya x Egypt-Timstein
148	Supremo-Timstein-Kenya
733	Supremo 211 x Lerma
123	Supremo ² x Kenya
721	Kenya-Supremo x Yaqui
746	Wisc. 245 x Supremo 51

42 Chromosomes

70	(Mayo x Peru-Supremo) x (Peru-Kenya)
152	Mayo (Pelon, Colorado-Renown ² - Supremo) Kentana ²
734	"
74	Africa 43
158	Africa 43 x Yaqui 50
921	Red Egyptian Type 170915
922	" 170915-3c
923	" 170916
924	" 170916-2c
925	" 170917
926	" 170917-2c
1072	(Ceres-Hope) x Florence
835	Riccio x Yaqui-Kentana
111	Argentina No. 49-4824
214	Klein 40
233	Sinvalocho M.A.
704	Magnif disro
245	Mida-Cadet
674	Lee x 1831
675	Rescue x 1831
1005	(Mida-Cadet) x (McMurachy- Exchange x Redman), R.L. 2667
682	K 338 AA x Ns 3880-191, ND 52
776	" ND 57
778	" ND 59
673	Lee-Frontana II-47-10
340	Rival
347	Mercury
350	Premier
646	Russell
545	Oleata Calandria
661	Leone
519	B 1
522	B 15
517	263-25-2
518	263-27-2
630	C.D. 3872-4. C.A.N. 3740
821	Lleafen
823	Rosella
824	76 R
825	22 R
822	Redondo Negro
830	Frontana-Egypt Na 95
831	(Mida-Kenya 117 A) Frontana
832	Salles-McMurachy x Mayo 48
1024	Bunyip
183	Bobs
443	Red Bobs
422	Renfrew
625	Rosa Karn x Karn II
87	Cailloux
1054	Chinese x Webster
758	(Timstein-Kenya 58 x Gabo) Lee
1143	<i>T. vulgare</i> Vill.
498	<i>T. aestivum</i> L. var. ferrugineum
1110	<i>T. compactum</i> Host.
490	<i>T. spella</i> L. var. coeruleum

28 Chromosomes

343	Gaza
344	"
387	Patrizio 6
391	Capeiti 8
683	Yuma, Ld. 364
685	Towner, Ld. 370

28 Chromosomes

- 690 Sentry
810 C.I. 3255 x Khapli-D.C. 50
811 "
812 "
816 Khapli-D.C. x Carleton 50
808 Ld. 340-Khapli x P.I. 94701
807 Golden Ball-Tumillo-Mindum,
 R.L. 1714
688 R.L. 3206
817 Medeah AP 9
839 Tremes preto
944 Amarai bianco tipo
691 St. 464
945 C.I. 7805
947 C.I. 7875
951 Camadi
949 Rojal de Almeria
950 Tounse
952 Arabian
1152 Giza
703 Beladi 116
304 Khapli
312 Black Persian
482 *T. durum* var. affine
483 *T. durum* var. hordeiforme
485 *T. durum* var. leucomelan
1121 *T. turgidum* L. 0-10-868
1125 *T. turgidum* L. 0-10-769
1128 *T. turgidum* L. 0-10-751
1126 *T. turgidum* L. 0-10-824
486 *T. turgidum* L. var. gentile
1017 *T. dicoccoides* I-38-55
837 Yaroslav emmer
1049 Emmer R.L. 116
1051 Early emmer R.L. 114
445 *T. polonicum* var. levissimum
1095 *T. pyramidale* 0-10-911
1096 *T. pyramidale* 0-10-920

14 Chromosomes

- 1073 *T. aegilopoides* I-38-21
447 *T. monococcum* var. hornemanii
694 Einkorn C.I. 2433

the variety may be susceptible to many biotypes, but where a low level is observed the variety may be susceptible to only a few of these: only those seeds infected by a virulent biotype give rise to smutted plants. New biotypes, therefore, may explain the sudden susceptibility of a number of immune varieties observed in the present investigation, since some new collections were included in the mixture each year.

Inoculation by means of a high pressure jet sprayer can be considered quite effective as many of the more susceptible varieties carried up to 100 per cent infection in the first year of testing. However, more refined tests using needle inoculation might possibly reveal some susceptibility in the varieties which were retained. Such a procedure should be followed before the varieties reported herein as immune are used in a program breeding for resistance or in genetic studies for inheritance of resistance. Subject to these qualifications, it is considered that these varieties will be of value in the plant breeding and genetic fields.

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