EFFECTS OF NATURAL INFECTIONS OF CROWN RUST AND STEM RUST ON YIELD AND QUALITY OF OATS IN MANITOBA[1]

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Abstract

Losses in groat yield and quality of oats caused by crown rust, Puccinia coronata Cda. f. sp. avenae Eriks., and stem rust, P. graminis Pers. f. sp. avenae Eriks. & E. Henn., in Manitoba were measured during 1965–1970. In representative commercially grown cultivars under field plot conditions, natural infections caused significant reductions in groat yield, ranging from 6.8% to 30% in most years.

Introduction

The FAO symposium on crop losses held in Rome in 1967 focused attention on the need for specific information on the economic importance of plant diseases (4). Data on losses due to specific diseases are important to plant breeders and pathologists if they are to make the most efficient use of limited resources. In Manitoba, losses caused by rust in oats have been monitored on a continuing basis since 1963. Annual rust loss experiments take into account the epidemiology of the pathogen in relation to the stage of development of the host. They also provide current data on the prevalent varieties and permit a data-based assessment of losses in commercial production.

Loss investigations prior to 1963 have been reviewed (2). In 1963 and 1964 groat yield was reduced by 15% on the average when the commonly grown cultivar Carry was subjected to natural epidemics of crown rust in the Red River Valley (2). At the flowering stage in late-seeded oats, infection levels of naturally occurring crown rust rated 30% reduced yield by 25%. Similar levels of infection at a later stage of development reduced yields by less than 10% (2). Yield data obtained in 1967 indicated that maneb, the rust protectant chemical used in these experiments, had no effect on yield in the absence of rust (5). In Ontario, Clark (1) obtained yield increases of about 20% by chemically protecting oats from natural crown rust infection. This paper presents data for 5 years on the effect of crown and stem rust of oats on the yield and quality of oats in Manitoba.

Materials and methods

A split-plot design, with maneb treatments for main plots and cultivars as subplot treatments, was used to assess the effect of stem rust and crown rust on yield and kernel characteristics. Six replicates were planted in 1965, 1966, and 1970 and 12 replicates in 1968 and 1969. Also two different seeding dates were used in 1965, 1966, and 1969. Five of 12 replicates in 1968 and in the late-seeded test of 1969 were discarded due to weather damage or virus infection. Each subplot consisted of 4 rows 5.6 m long with either 23- or 30-cm spacing between rows. Buffer plots were used to separate main plot treatments. In 1969, the plots were surrounded by solid-seeded oats to simulate field conditions.

The cultivars 'Victory' or 'Eagle' were used in each test; both are highly susceptible to crown rust and stem rust. 'Lodi' was used in the 1965 and 1966 tests to differentiate between crown and stem rust losses because it is susceptible to stem rust but was moderately resistant to crown rust in tests in 1965. Either 'Garry' or 'Kelsey' was used as a cultivar representative of commercial production although both are susceptible to crown rust and stem rust. Maneb (Dithane M-22, 80% maneb W.P., Rohm and Haas Co. of Canada, West Hill, Ont.) sprays were applied to half of the main plots weekly and after heavy rains, at the rate of 3 liters of 0.33% aqueous solution (w/v) per subplot beginning in mid-July. Yield data were obtained by harvesting all the plants in 5-m lengths of the two center rows of each subplot.

Results and discussion

Maneb gave excellent control of both rusts every year. In 1965 moderate to heavy infections of both crown rust and stem rust developed (Table 1), resulting in combined reductions in average groat yields for early

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Table 1. Severity of oat crown rust and stem rust, expressed as % area of flag leaf or culm affected, in untreated plots at various stages of plant development

Date	Oat cultivar	Early seeding			Late seeding		
		Plant stage	Crown rust %	Stem rust %	Plant stage	Crown rust %	Stem rust %
1965							
June 12		Seeded					
June 18					Seeded		
Aug. 3	Victory		2			tr	
Aug. 18	Garry		8			3	
	Lodi		1			tr	
	Victory		8			3	
Aug. 23	Garry		10	1		5	1
	Lodi		4	1		2	tr
	Victory		10	10		5	5
Aug. 30	Garry		30	2		15	2
	Lodi		5	2		3	1
	Victory		20	20		10	15
Sept. 8	Garry			5		40	10
	Lodi			8		10	15
Sept. 16	Victory	Harvested		40		40	40
Sept. 20	Garry	Harvested				50	10
	Lodi	Harvested				10	15
	Victory	Harvested				60	50
Sept. 21					Harvested		
1966							
May 31		Seeded					
June 9					Seeded		
Aug. 15	Eagle		1			1	
	Garry	Late milk	1		Early milk	1	
	Lodi		tr			tr	
Aug. 25	Eagle		50			20	
	Garry	Late dough	8		Late milk	3	
	Lodi		tr			1	
Aug. 31		Harvested					
Sept. 6	Eagle				Late dough	25	22
	Garry					10	5
	Lodi					1	4
Sept. 8					Harvested		
1968							
June 3					Seeded		
Aug. 2	Eagle					10	
	Kelsey				Early milk	1	
Aug. 28	Eagle					48	
	Kelsey					14	
Sept. 24					Harvested		
1969							
May 22		Seeded					
June 5					Seeded		
Aug. 15	Eagle	Early dough	12				
	Kelsey		5				
Aug. 25	Eagle					73	
	Kelsey					45	
Sept. 4		Harvested					
Sept. 12					Harvested		
1970							
June 23					Seeded		
Aug. 31	Eagle				Late milk	tr-3	tr
	Kelsey				Late milk	tr-3	tr
Sept. 10	Eagle				Dough	1	3
	Kelsey				Dough	1	3
Sept. 28	Eagle						38
	Kelsey						40

Table 2. Effect of natural infections[t] of crown rust and stem rust on groat yield in oats

Year and cultivar	Early seeding			Late seeding		
	Maneb-treated	Non-treated	% difference[ft]	Maneb-treated	Non-treated	% difference
	Groats in kg/ha					
1965						
Garry	3627	3169	12.6*	3467	3130	9.7
Lodi	3316	3149	5.0*	3369	3269	3.0
Victory	3704	2956	20.2*	3157	2413	23.6**
1966						
Eagle	2915	2613	10.4*	1925	1501	22.0*
Garry	2205	2055	6.8*	1778	1599	10.0
Lodi	2477	2353	5.0*	1847	1839	0.3
1968						
Eagle				3403	2366	30.4**
Kelsey				3541	2616	26.1**
1969						
Eagle	3505	2603	25.7**	2822	1773	37.2**
Kelsey	3401	2493	26.7**	3585	2485	30.7**
1970						
Eagle				1961	1660	15.3*
Kelsey				2401	2220	7.4*
Mean all years	3144	2674	14.9	2771	2239	19.2

* and ** significant at the 5% and 1% levels, respectively.

† Stem rust did not develop in the 1966 early seeding or in the 1968 and 1969 plots; however, septoria leaf spot affected yield in nontreated plots in 1969. In 1970 the yield losses were caused primarily by stem rust.

†† Difference as % of treated.

Table 3. Effect of natural crown rust and stem rust infections on quality in oats expressed as thousand kernel weight and liter weight

Year and cultivar	Early seeding			Late seeding			Early seeding			Late seeding		
	Maneb-treated	Non-treated	% difference[†]	Maneb-treated	Non-treated	% difference	Maneb-treated	Non-treated	% difference	Maneb-treated	Non-treated	% difference
	Thousand kernel weight (g)						Liter weight (g)					
1965												
Garry	32.3	30.6	5.3**	31.4	29.6	5.7**	499	480	3.9**	480	454	5.4
Lodi	34.5	33.0	4.3**	33.4	31.0	7.2**	493	485	1.6**	419	461	3.8
Victory	32.3	29.4	8.8**	30.9	27.3	11.7**	513	472	8.0**	470	409	12.9**
1966												
Eagle	28.1	28.6	-1.7	27.8	26.0	6.5	502	483	3.8	463	455	1.4
Garry	29.5	29.3	0.7	29.5	30.6	-3.6	483	485	0.5	467	476	1.9
Lodi	33.0	33.1	-0.1	35.7	36.4	-1.9	485	480	1.1	454	461	1.4
1968												
Eagle				29.6	25.2	14.8**				454	428	5.9**
Kelsey				27.7	24.7	10.8**				454	427	6.2**
1969												
Eagle	27.0	24.5	9.2**	30.0	25.4	15.3*	404	381	5.7*	386	325	15.3**
Kelsey	25.6	23.6	7.8**	32.1	29.2	9.0*	423	394	7.0*	411	376	9.0**
1970												
Eagle				27.0	24.5	9.3*				396	311	4.9*
Kelsey				29.1	28.7	1.3				454	441	2.8*
Mean all years	30.3	29.0	4.3	30.3	28.2	6.9	475	457	3.7	447	424	5.1

* and ** significant at the 5% and 1% levels, respectively.

† Difference as % of treated.

and late seeded crops of 21.9%, 11.2%, and 4.0% for 'Victory', 'Garry' and 'Lodi', respectively (Table 2). Thousand kernel weights and liter weights were also reduced in most cases (Table 3). The loss in 'Garry' was 6% greater than that in 'Lodi', suggesting that about half the yield reduction was caused by crown rust.

In 1966 both rusts developed to significant levels only on 'Eagle', and in this cultivar significant reductions in yield occurred at both dates of seeding. The significant reduction in yield in early-seeded 'Garry' and 'Lodi' is surprising because of the light infections.

In 1968 Kelsey and Eagle were seeded on only one date, and crown rust caused an average reduction in yield of 28%. Thousand kernel weights and liter weights were reduced by an average of 12.8% and 6%, respectively.

Crown rust developed again in 1969 and overall average reductions in yield were approximately 30%, with significant adverse effects on both quality measurements. In that year a leaf spot, caused primarily by Septoria sp., developed on the plants, and unsprayed plots nearing maturity had infections that covered an average of 5.4% and 12% of the flag leaf area for the early seeded and late seeded plots, respectively. Since maneb also controlled this disease, not all of the yield loss in untreated plots is attributable to crown rust.

In 1970 very little crown rust developed, and the yield losses of 15.3% and 7.4% for 'Eagle' and 'Kelsey', respectively, must be attributed to the late infection of stem rust. These results confirm previous observations that stem rust can cause serious losses even if severe infections develop only after the milk stage (3).

These data clearly indicate that either or both of the oat rusts causes significant yield and quality reductions in oats in Manitoba in most years.

Acknowledgment

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