Crown Rust in Oats: When Are Fungicide Applications to Control Crown Rust of Economic Benefit to Producers?

by
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1) Objectives

a) To determine if and when fungicides should be applied to oats in eastern Saskatchewan as crown rust resistant genes in oats are overcome by crown rust**.**

b) To determine if a common belief in Manitoba that a fungicide application is improving yield in the absence of crown rust, is true in Saskatchewan

2) Summary

In 2009, 2010, 2011 this trial was conducted at six locations in each year, four in Saskatchewan (Indian Head, Melfort, Saskatoon, and Canora) and two locations in Manitoba (Brandon and Portage la Prairie). The test was successfully carried out at all locations. In 2009, at Portage la Prairie bird damage may reduce the value of this site while at Saskatoon irrigation and crown rust resulted in a high level of lodging that may complicate the interpretation of the data. In 2010 excess water damaged the plots at Canora and Saskatoon. In 2011, the first seeding date at Portage La Prairie was not seeded due to wetness. The data has been collect and entered in to the computer for 2009, 2010 and 2011. Statistical analysis has been carried out. A cross section of the data is presented at the end of the document. Preliminary conclusions indicate that seeding date had the largest effect on yield, with a 12 bu acre^{-1} decrease with delayed seeding. The largest benefit from fungicides occurred in the cultivar most susceptible to crown rust, AC Morgan, when crown rust infection was high. This combination resulted in a 18 bu acre^{-1} increase in AC Morgan and only a 2 bu acre^{-1} increased in the rust resistant cultivar, Leggett. Under normal growing conditions benefits from fungicides have been limited in the absence of crown rust. Preliminary results indicate that if rust race overcomes all the rust resistance genes in a cultivar than the grower should scout for crown rust

in his oats. There does not appear to be a big benefit to applying a fungicide on oats in the absence of crown rust.

3) Methods and Materials

The experimental design is a split split plot with 4 reps and various plot sizes depending on the location. The factors and levels are listed below

a) Main plot: Seeding Date
- i) May 5 - 15
- ii) June 1- 5

b) Split: Fungicide (applied at flag leaf)
- i) No Fungicde
- ii) Fungicide (Headline)

c) Split-Split: Cultivar
- i) Very Susceptible to crown rust (AC Morgan)
- ii) Susceptible to crown rust (CDC Orrin)
- iii) Partially resistant to crown rust (CDC Boyer)
- iv) Cultivar with best possible resistance at time of trial (Leggett)

This study was conducted at 6 locations, four in Saskatchewan (Indian Head, Melfort, Saskatoon and Canora), and two in Manitoba (Brandon and Portage La Prairie). The target plant density was 300 plants m^2. The target for nitrogen was for the combination of fertilizer N and residual soil N (0-60cm depth) to equal 80 kg N ha^{-1}. In addition 20 kg P ha^{-1},10 kg K ha^{-1} and 10 kg S ha^{-1} were added at seeding. Glyphosate was applied before seeding for each seeding date at all locations at 450 grams acid equivalent L ha^{-1}. All in-crop broadleaf herbicide applications were determined separately for each seeding date and according to weed species and density. Excellent broadleaf weed control was achieved at all sites.

d) Data Collection:

A Soil test was conducted at each site with N sampled at two soil depths, 0-15 cm and 15-60 cm, and P,

K, and S were sampled at just one depth, 0-15 cm. Oat plant populations were determined 3 to 5 wk after seeding and oat panicles were counted after panicle emergence. Both plants and panicles of the tame oat were measured in two 1-m sections of crop row within each plot. Crown Rust ratings were conducted using a modified Cobb Scale on control plots when sprayed and all plots at the milk stage. Ten flag leaves and 10 penultimate leaves were rated for each plot. Then rate all plots at the milk stage. Stem rust and leaf diseases were rated at the same time on the same leaves as the crown rust ratings were conducted. Leaf diseases other than crown rust were rated using both the Horsfall - Barratt scale and the MacFadden Scale. Physiological maturity was reached when kernel moisture was approximately 30 to 35%. Lodging was rated in each plot at physiological maturity using a 1 to 9 scale (1 = standing, 9 = completely lodged). Each sample was cleaned using a dockage tester as specified by the Canadian Grain Commission's Official Grain Grading Guide (2006). Grain yield was expressed on a clean grain basis with 13% kernel moisture. Kernel weight, expressed per 1000 seeds (g), was calculated by weighing 700 to 1000 kernels. Kernel panicle^{-1} was calculated using panicles m^{-2}, grain yield and kernel weight. Kernel m^{-2} was calculated using grain yield and kernel weight. Thin seed was recorded as the portion of the grain sample mass that fell through a 1.98- × 19.05-mm slotted screen (5/64" × 3/4" slotted sieve) and plump seed as the portion of the grain sample mass that stayed on top of a 2.18- × 19.05-mm screen (5.5/64" × 3/4" slotted sieve). Test weight was measured as specified by the Canadian Grain Commission's Official Grain Grading Guide (2006). Groat percentage was determined using a compressed-air oat laboratory dehulling machine. A 50-g sample was used with a dehulling time of 60 sec, an air pressure of 690 kPa and a blast gate aperture of 1.5–2.0 cm (Doehlert et al. 1999; Doehlert and McMullen 2001). Groat percentage was recorded as the mass of the groat divided by the mass of whole oat multiplied by 100.

4) RESULTS

The data was analysed by separating the sites with high levels of crown rust from sites with low levels of crown rust. When this was done the sites with a low level of crown rust had a significant cultivar effect on grain yield, test weight, lodging and crown rust on both the flag leaf and the penultimate leaf (Table 1). In addition the application of a fungicide increase grain yield by 276 Kg ha^{-1} (Table 2). As expected, the application of a fungicide decrease crown rust infection on both the flag and penultimate leaves. The difference between the two seeding dates was not large enough to be statistically significant.

At the sites with a high level of crown rust the fungicide x cultivar and seeding date x cultivar interactions were significant for grain yield and test weight (Table 1). AC Morgan and CDC Boyer both had higher grain yields when a fungicide was applied. Leggett, with the best crown rust resistance, was not affected by the application of a fungicide and neither was CDC Orrin. The test weight of all the cultivars except Leggett was increase by the application of a fungicide (Table 2). The application of a fungicide reduced the disease severity of crown rust on both the flag and penultimate leaves in all the cultivars except Leggett. The application of a fungicide decreased lodging in AC Morgan. At the sites with a high level of crown rust delayed seeding reduced the grain yield of AC Morgan and the test weight of AC Morgan, CDC Boyer and CDC Orrin (Table 3).

Further statistical analysis will be carried out on all measured variable and the current statistical approach will be refined.

Table 1. The Analysis of the effect of cultivar, seeding date and fungicide on the seed yield and development of oats with differing levels of Crown Rust infestation.

	Grain yield		Test weight		lodging		Crown Rust at Milk stage Flag leaf		Penultimate	
Effect	**Low Crown rust**	**High Crown rust**	**Low Crown rust**	**High Crown rust**	**Low Crown rust**	**High Crown rust**	**Low Crown rust**	**High Crown rust**	**Low Crown rust**	**High Crown rust**
					(P value)					
Cultivar (C)	**< 0.001**	0.005	**< 0.001**	< 0.001	**< 0.001**	**< 0.001**	**< 0.001**	< 0.001	**< 0.001**	< 0.001
Fungicide (F)	**0.006**	< 0.001	0.227	< 0.001	0.536	**0.047**	**0.008**	< 0.001	**0.034**	< 0.001
F*C	0.686	**0.009**	0.894	**< 0.001**	0.543	0.485	0.217	**0.116**	0.352	**0.009**
Seeding date (SD)	0.297	0.106	0.361	0.011	0.208	0.422	0.691	**0.010**	0.649	**0.011**
SD*C	0.792	**0.006**	0.857	**0.001**	0.444	0.717	0.925	0.693	0.981	0.527
SD*F	0.386	0.320	0.417	0.108	0.536	0.623	0.699	0.269	0.980	0.323
SD*F*C	0.937	0.871	0.995	0.321	0.848	0.982	0.912	0.435	0.969	0.598
					(% variance)					
site*SD	2%	**36%**	**64%**	**34%**	**32%**	**27%**	6%	1%	0%	4%
site*SD*F	0%	0%	0%	1%	0%	5%	0%	13%	8%	11%
site* SD*F*C	8%	0%	**30%**	**17%**	**61%**	**20%**	**39%**	**25%**	**34%**	**35%**

Table 2. The response of oats yield and development to cultivar, seeding date and fungicide with differing levels of Crown Rust infestation.

	Low Crown rust	High Crown rust		
		No Fungicide	Fungicide	Significance
		Grain yield (kg ha^{-1})		
AC Morgan	5504	3270	3954	**
CDC Boyer	4806	3141	3445	*
CDC Orrin	5152	3500	3658	
Leggett	4852	3567	3596	
LSD	226			
No Fungicide	4940			
Fungicide	5216			
LSD	193			
		Test weight (g 0.5L^{-1})		
AC Morgan	245	216	240	**
CDC Boyer	237	229	238	*
CDC Orrin	248	234	243	*
Leggett	248	248	248	
LSD	1			
No Fungicide	244			
Fungicide	245			
LSD	1			
		Lodging (1-9)		
AC Morgan	1.5	3.2	1.8	*
CDC Boyer	3.8	4.6	4	
CDC Orrin	1.8	3.5	2.9	
Leggett	2	3.5	3.1	
LSD	3.7			
No Fungicide	2.4			
Fungicide	2.2			
LSD	2.8			
		Flag leaf ratings (modified Cobb Scale)		
AC Morgan	0.5	22.3	3.5	**
CDC Boyer	0.2	4.3	0.8	**
CDC Orrin	0.1	4.2	1.2	**
Leggett	0.1	0.7	0.3	
No Fungicide	0.3			
Fungicide	0.1			

		Penultimate leaf ratings (modified Cobb Scale)		
AC Morgan	0.7	34.4	6.2	**
CDC Boyer	0.2	9.7	1.2	**
CDC Orrin	0.2	10.4	2	**
AC Morgan	0.1	0.9	0.5	
No Fungicide	0.3			
Fungicide	0.1			

Table 3. The effect of seeding date and cultivar on the grain yield and test weight of oats

	May	June	Significance
	Grain yield (kg ha^{-1})		
AC Morgan	4128	3096	*
CDC Boyer	3453	3133	
CDC Orrin	3944	3214	
Leggett	3893	3270	
	Test weight (g $0.5L^{-1}$)		
AC Morgan	246	210	**
CDC Boyer	243	224	*
CDC Orrin	252	225	**
Leggett	255	240	