Integrated Disease Management of Leaf Spots and Crown Rust of Oat

J. Taylor[1], C. Kirkham[2], J. Woytowich[1], T. Dament[1], J. Liu[1], G. Peng[3], H.R. Kutcher[1]

[1]Crop Development Centre, University of Saskatchewan, 51 Campus Drive, Saskatoon, SK, S7N 5A8
[2]Agriculture and Agri-Food Canada, Box 1240, Melfort, SK, S0E 1A0
[3]Agriculture and Agri-Food Canada, 107 Science Crescent, Saskatoon, SK, S7N 0X2

Abstract

Crown rust and leaf spots can reduce the yield and quality of oats. The objective of this research was to determine the effect of conventional fungicides, Actigard® and oat cultivars that vary in resistance to crown rust on leaf spot and crown rust severity, and oat yield and quality. Two experiments were established at two locations in Saskatchewan: Saskatoon and Melfort. Experiment 1 consisted of three oat varieties: AC Morgan (crown rust susceptible), CDC Dancer (intermediate) and CDC Morrison (resistant) and three fungicide treatments: check (unsprayed), propiconazole and pyraclostrobin. Experiment 2 consisted of the application of Actigard® at two rates: 8.75 g ai/ha and 26.25 g ai/ha; three crop growth stages: seedling, boot and heading; on two varieties: CDC Dancer and CDC Morrison, with an unsprayed check for each variety. At Saskatoon, crown rust was observed while leaf spot severity was low. At Melfort, no crown rust was observed and leaf spot severity was low. Fungicide reduced the severity of crown rust and increased yield and quality of oat at Saskatoon for the susceptible variety (AC Morgan) and somewhat for the moderately susceptible variety (CDC Dancer). The crown rust resistant variety (CDC Morrison) did not benefit from fungicide. Leaf spots were reduced by fungicide application at Melfort, but little increase in yield or quality was detected. There was little difference between AC Morgan and CDC Morrison for leaf spot symptoms, but CDC Dancer appeared to suffer slightly more than the other varieties. There was no impact of fungicide on beta-glucan content at either location, although there were differences among varieties, but only at Saskatoon. Actigard® was not observed to have any positive or negative effects on disease severity (crown rust or leaf spots) or any of the factors measured, including nutritional characteristics, at either location, although there were differences among varieties for many of the factors measured.

Introduction

Crown rust (*Puccinia coronata Corda* f. sp *avenae* Eriks) and leaf spots (*Pyrenophora avenae* Ito & Kuribavayashi and *Phaeasphaeria avenae* (Weber) Eriks) on oat cause yield and quality reduction. Crown rust is considered the most economically important disease of oat in Saskatchewan, while leaf spotting diseases are observed annually, usually at low to moderate levels. Oat growers are questioning the benefit of fungicides and resistant varieties to control these diseases. In addition, products that have no direct activity against target pathogens, but stimulate induced systemic acquired resistance (SAR) in the plant are available, such as Actigard®.

Materials and Methods

Two field plot experiments at each location were established at the Goodale Research Farm, just outside Saskatoon and on the research field of the Northeast Agriculture Research Foundation at Melfort (Agriculture and Agri-Food Canada, Melfort). Both experiments were designed as randomized complete blocks (RCBDs) with four replicates. All varieties were seeded at 250 seeds/m^2.

At Saskatoon, both experiments were inoculated with a mixture of crown rust races to ensure a high risk of infection. Inoculation was made onto spreader rows of AC Morgan, which had been planted between the replicates and as borders to the plots to ensure good crown rust development. Inoculation occurred at the 2-3 leaf stage, when the weather was cool and moist. A few days after inoculation the weather became hot and humid; this was conducive to crown rust development. Experiments at Melfort were not inoculated.

At both locations disease ratings were conducted on the check plots before fungicide and Actigard® application. All plots were assessed at flowering and the soft dough stages. Only results from the soft dough stage are reported here. Leaf spotting diseases were rated using the Horsfall – Barratt scale (0-11), which were then converted to a percent leaf area affected by the diseases (Appendix 1) as illustrated by (Horsfall, J.G. et al. 1945). The modified Cobb scale (Appendix 2) as illustrated by (Peterson et al. 1948) was used to assess crown rust based on the average severity (% leaf covered in pustules) of the flag and penultimate leaves.

Data was analyzed with analysis of variance (ANOVA) and treatment means separated by least significant difference tests using Statistical Analysis System (SAS) software.

Experiment 1 consisted of three oat varieties and three fungicide treatments. Oat cultivars were selected based on resistance to crown rust. AC Morgan was chosen as the crown rust susceptible, CDC Dancer as the intermediate, and CDC Morrison as the resistant cultivar. Fungicide treatments included: an unsprayed check, propiconazole (Bumper®) and pyraclostrobin (Headline®). Fungicides were applied at the flag leaf fully unfurled, growth stage 39 of the BBCH growth stage scale (Lancashire et al. 1991), using a tractor mounted sprayer.

Experiment 2 consisted of the application of Actigard®, a product that stimulates plant defense reactions against pathogens (systemic acquired resistance) but has no direct activity against target pathogens. Actigard® was applied at two rates: 8.75 g ai/ha and 26.25 g ai/ha, with a check (unsprayed). Timing of application was at the three crop growth stages: seedling, boot and heading on each of the two cultivars; CDC Dancer and CDC Morrison.

Results

<u>Experiment 1:</u> Evaluation of fungicides and oat varieties for crown rust and leaf spot diseases, yield, and nutritional characteristics of oat

Disease Severity

At Saskatoon in 2012, crown rust was the most prevalent disease observed. The unsprayed treatment on AC Morgan exhibited crown rust severity of 91% (Figure 1). The fungicides pyraclostrobin and propiconazole reduced crown rust severity to 33% and 43%, respectively. Results were similar for CDC Dancer, but less dramatic than AC Morgan. Crown rust severity on the unsprayed treatment of CDC Dancer was 36%, which was reduced to 22% by propiconazole, and 12% by pyraclostrobin. CDC Morrison did not exhibit any crown rust symptoms illustrating its excellent resistance. As a result there were no differences due to fungicides.

Crown rust was not observed at Melfort in 2012. Leaf spot symptoms were slightly more severe at Melfort, compared to Saskatoon, but were still considered low (Figure 2). Disease severity of CDC Dancer (unsprayed check) appeared to be somewhat greater (12%) than for AC Morgan (5%) or CDC Morrison (7%). Both fungicides decreased leaf spot severity in all varieties from the unsprayed treatment, although because severity was low, the reduction in severity was limited.

Yield

There was no yield difference among varieties at Saskatoon (Figure 3). Both fungicides increased yield of AC Morgan compared with the unsprayed check (1354 kg/ha). Pyraclostrobin increased yield of AC Morgan (3375 kg/ha) by 149%, and propiconazole (2527 kg/ha) by 87%. Fungicides also increased yield of CDC Dancer compared with the unsprayed check, but not as dramatic as for AC Morgan: pyraclostrobin by 30% (increase of 955 kg/ha) and propiconazole by 20% (631 kg/ha). Yield of CDC Morrison did not benefit from fungicide application. Without fungicide application (unsprayed checks), the yield CDC Morrison (3917 kg/ha) was greater than yield of CDC Dancer (3161 kg/ha) and much greater than yield of AC Morgan (1354 kg/ha).

Yield differences among varieties for all fungicide treatments were also not statistically significant at Melfort in 2012 (Figure 4). However in the absence of fungicide, CDC Morrison (3692 kg/ha) appeared to yield less than CDC Dancer (4403 kg/ha) or AC Morgan (5388 kg/ha). There was a slight (9%), but statistically significant ($P<0.05$), reduction in yield of AC Morgan with the application of fungicide: pyraclostrobin (5012 kg/ha) or propiconazole (4882 kg/ha) compared to the unsprayed check (5388 kg/ha). There was no statistical difference between fungicides. For CDC Dancer, propiconazole increased yield by 12% to 4939 kg/ha compared with the untreated check 4403 kg/ha. The difference between the pyraclostrobin treatment (4608 kg/ha) and the unsprayed check or the propiconazole treatment was not significant for CDC Dancer. There was no difference between fungicide treatments and the untreated check for CDC Morrision.

Beta-glucan

The beta-glucan content was considerably higher for CDC Morrison (6.8%) than either AC Morgan (4.7%) or CDC Dancer (4.6%) at Saskatoon (Figure 5), but there was no differences observed at Melfort (Figure 6). There was no impact of fungicide on beta-glucan content at either Saskatoon or Melfort.

<u>Experiment 2:</u> Effect of Actigard® on crown rust and leaf spot diseases, yield and nutritional characteristics of oat

In Experiment 2, at both Saskatoon and Melfort, for both cultivars, no differences among treatments in disease severity, yield or beta-glucan content were observed for either rate or timing of Actigard® application. Only results from Saskatoon are shown here for disease severity, yield and beta-glucan (Figure 7).

Disease Severity

Differences in leaf spot severity were detected between CDC Dancer (7.3% averaged over Actigard® treatments) and CDC Morrison (average 9.0%) at Saskatoon, but no difference was detected at Melfort. Leaf spot severity was low at Saskatoon (average severity of the checks was 8.5%). At Saskatoon there was severe crown rust (unsprayed check 33%) on CDC Dancer, but no crown rust symptoms on CDC Morrison.

Yield

Yield of CDC Morrison (3666 kg/ha average of Actigard® treatments) was greater than that of CDC Dancer (average 3407 kg/ha) at Saskatoon, possibly reflecting the severe crown rust severity that occurred on CDC Dancer.

Beta-glucan

Beta-glucan content was higher for CDC Morrison (6.9% average of Actigard® treatments) than CDC Dancer (4.7%), but only at Saskatoon.

Preliminary Conclusions

Crown rust, caused by *Puccinia coronata*, was the primary pathogen present at Saskatoon in 2012 and disease was severe in field plots and neighboring fields. At Melfort, crown rust was not observed while leaf spotting pathogens were identified in the field trials Based on a single site-year of data, fungicide application reduced crown rust on the disease susceptible variety AC Morgan and resulted in improved yield and quality compared with the unsprayed check. The severity of crown rust was much reduced on the moderately susceptible variety

CDC Dancer and the yield and quality improvement much less than for AC Morgan. CDC Morrison was highly resistant to crown rust and as a result did not benefit from fungicide application. Leaf spot diseases were very low at Saskatoon for all varieties. At Melfort, leaf spot severity was low, but all varieties were observed to have decreased disease severity with fungicide application. However, there was limited yield improvement due to fungicide at Melfort. There appeared to be no relationship between fungicide application and beta-glucan content at either location, although there were differences among varieties for some of the factors measured at Saskatoon only. Actigard® was not observed to have any positive or negative effects on disease severity (crown rust or leaf spots) or any of the factors measured at either location, although there were differences among varieties for many of the factors measured.

Acknowlegments

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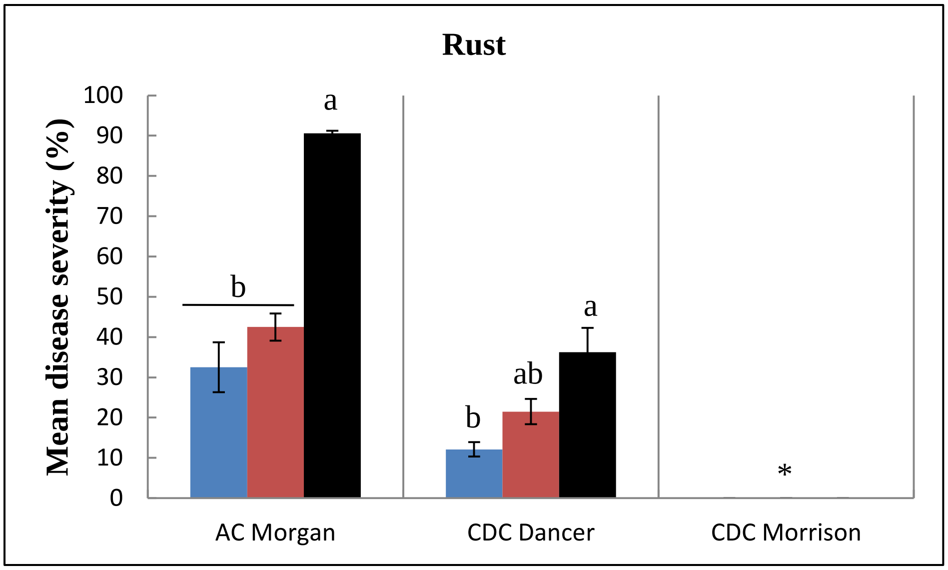


Figure 1. Crown rust symptoms on oat (cvs. AC Morgan, CDC Dancer and CDC Morrison) treated with pyraclostrobin ( ), propiconazole ( ) or untreated ( ) at Saskatoon, SK in 2012. Severity was measured as the leaf area covered by crown rust pustules (average of the flag and penultimate leaves). Note that CDC Morrison did not display crown rust symptoms.

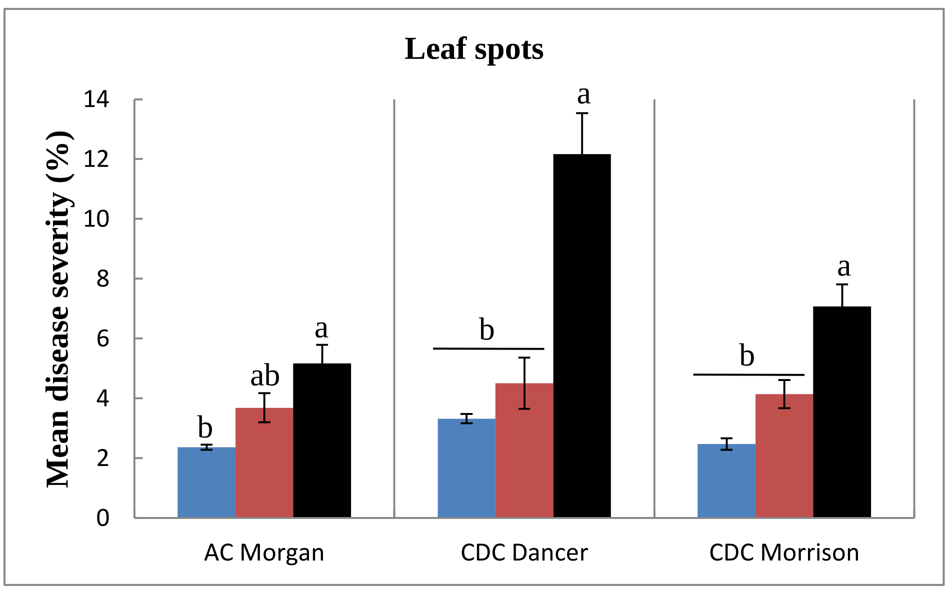


Figure 2. Leaf spot disease symptoms on oat (cvs. AC Morgan, CDC Dancer and CDC Morrison) treated with pyraclostrobin ( ) or propiconazole ( ), or untreated ( ) at Melfort, SK in 2012. Severity was measured as the leaf area covered by leaf spot lesions (average of the flag and penultimate leaves).

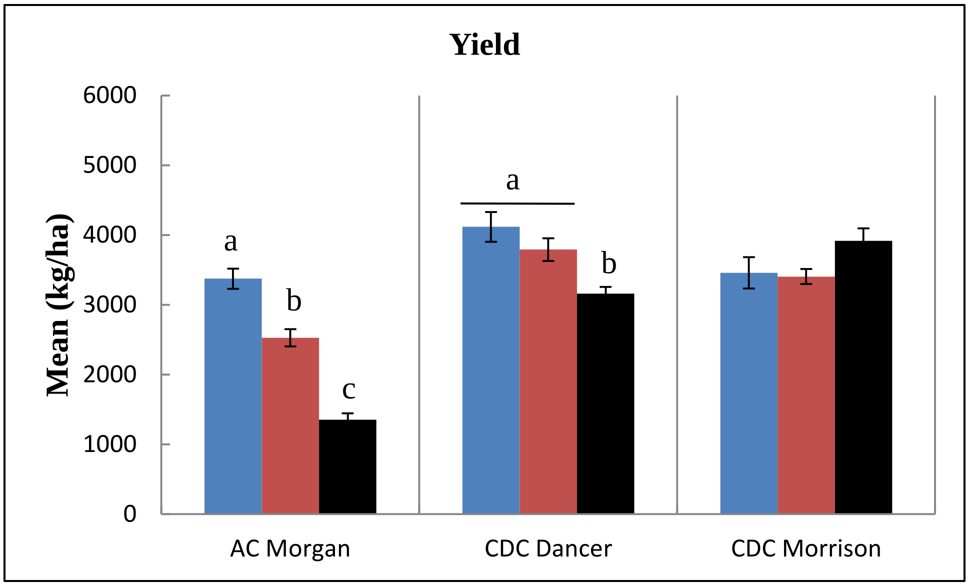


Figure 3. Yield of oat (cvs. AC Morgan, CDC Dancer and CDC Morrison) treated with pyraclostrobin ( ) or propiconazole ( ), or untreated ( ) at Saskatoon, SK in 2012.

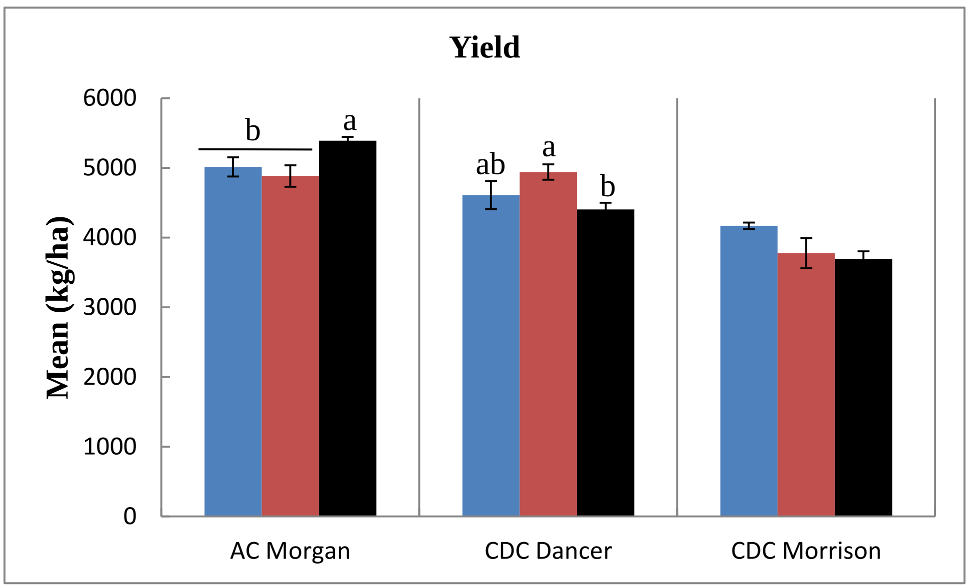


Figure 4. Yield of oat (cvs. AC Morgan, CDC Dancer and CDC Morrison) treated with pyraclostrobin ( ) or propiconazole ( ), or untreated ( ) at Melfort, SK in 2012.

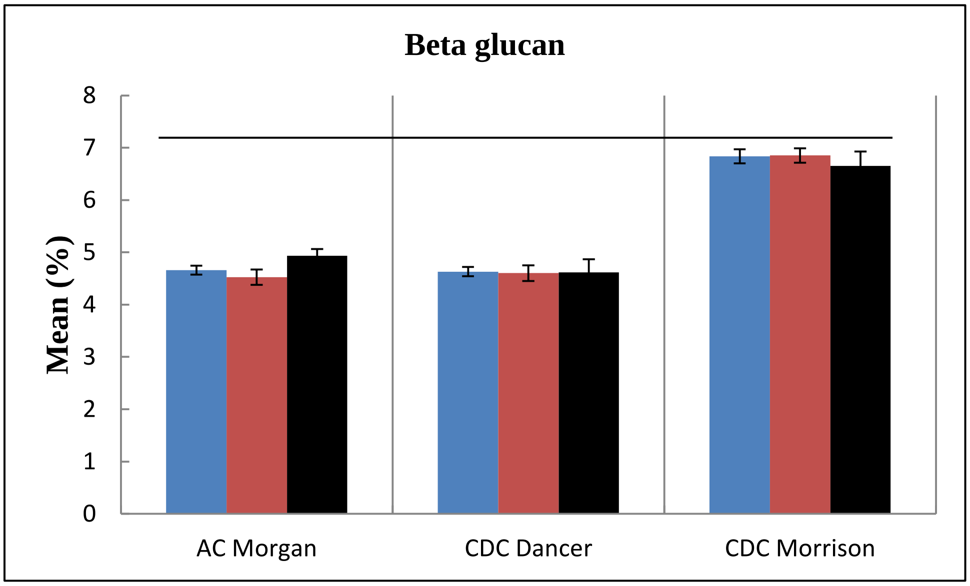


Figure 5. Beta glucan content (%) of oat (cvs. AC Morgan, CDC Dancer and CDC Morrison) treated with pyraclostrobin ( ) or propiconazole ( ), or untreated ( ) at Saskatoon, SK in 2012.

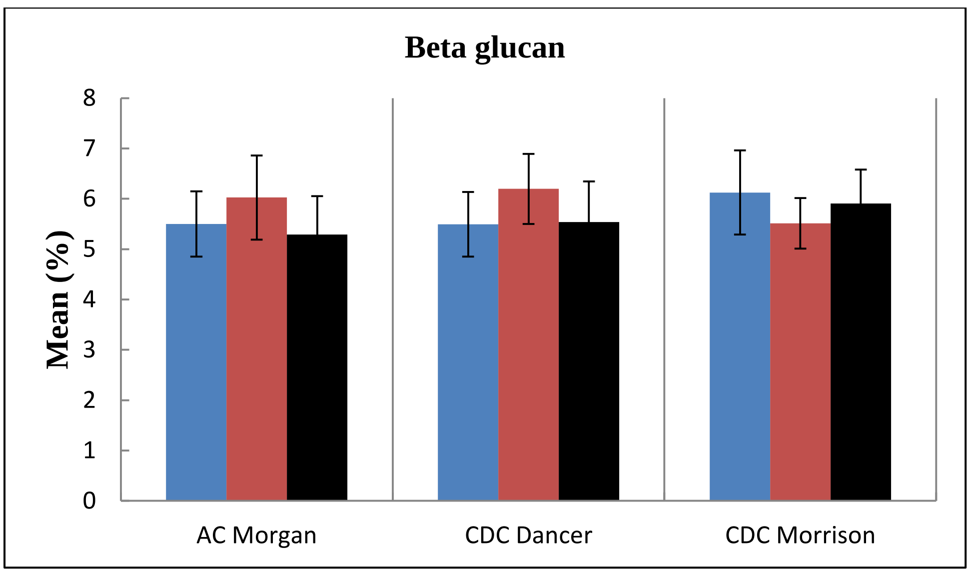


Figure 6. Beta glucan content (%) of oat (cvs. AC Morgan, CDC Dancer and CDC Morrison) treated with pyraclostrobin ( ) or propiconazole ( ), or untreated ( ) at Melfort, SK in 2012.

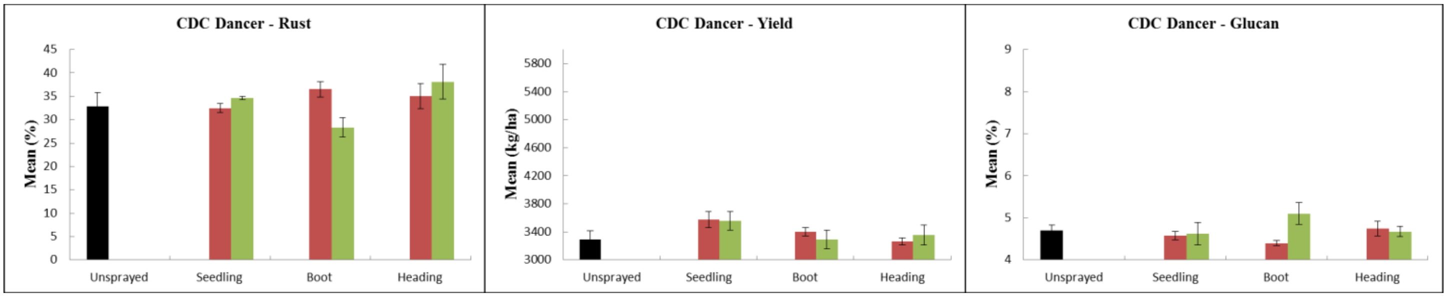
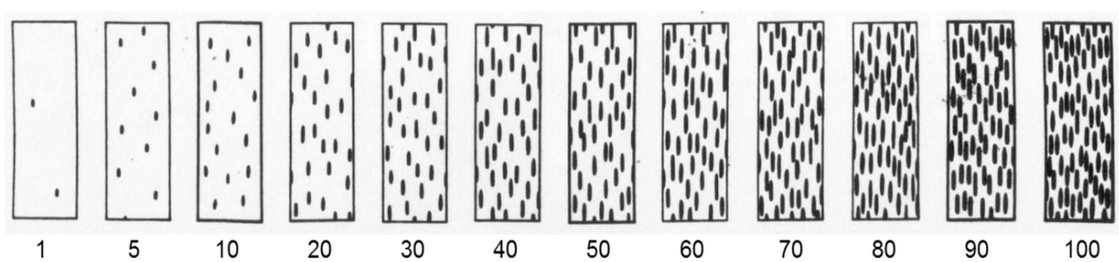


Figure 7. Saskatoon: A) crown rust severity of flag and penultimate leaves at soft dough (%), B) yield (kg/ha) and C) beta-glucan content (%) of oat cultivar CDC Dancer in response to two rates of Actigard: 8.75 ( ) and 26.25 ( ) g a.i./ha applied at three crop growth stages compared to the unsprayed check ( ).

Appendices

Grade	% Diseased	% Healthy	Grade Formula
0	0	100	1.17
1	0-3	97-100	2.34
2	3-6	94-97	4.68
3	6-12	88-94	9.37
4	12-25	75-88	18.75
5	25-50	50-75	37.50
6	50-75	25-50	62.50
7	75-88	12-25	81.25
8	88-94	6-12	90.63
9	94-97	3-6	95.31
10	97-100	0-3	97.66
11	100	0	98.62

Appendix 1. Horsfall-Barratt scale (with conversion to percentage) used to rate flag and penultimate (flag-1) leaves for severity of leaf spots on oat (Horsfall et al. 1945).



Appendix 2. Modified Cobb scale used to rate crown rust on oat (Peterson et al., 1948).