EFFECT OF AGRONOMIC TREATMENTS ON FOLIAR DISEASES OF WINTER WHEAT IN NORTHEAST SASKATCHEWAN

by

D.K.Tompkins, D.B.Fowler and A.T.Wright

ABSTRACT

The development of foliar plant diseases on winter wheat with differing agronomic treatments was studied. The foliar diseases included powdery mildew (*Erysiphe graminis*) and diseases of the Septoria complex (*Septoria* spp. and *Pyrenophora tritici-repentis*). Agronomic treatments included: nitrogen fertility, cultivar, and seed rate/row spacing. High nitrogen fertility, short stature, and wide row spacing were found to favour the development of powdery mildew. Short stature and high seed rate were found to favour the development of Septoria.

INTRODUCTION

Growing conditions in northeast Saskatchewan are typically more humid than many other parts of the province. Recent work suggests that higher than normal seed rates and narrow row spacings produce a favourable grain yield response in this region (Tompkins *et al*, 1989). However, changes in crop management produce changes in the micro-environment within the crop canopy, that may result in increased problems with foliar pathogens. This study was undertaken to determine the effect of some agronomic practices on the development of foliar pathogens that commonly occur in the area.

Powdery mildew development is favoured by conditions of high humidity and cool temperature (Wiese, 1977). Increased nitrogen fertility (Boquet and Johnson, 1987) and wide row spacing (Broscious *et al*, 1985) have been reported to increase powdery mildew. Increased seed rate has been reported to both increase (Smith and Blair, 1950) and decrease (Broscious *et al*, 1985) infestation.

Whereas powdery mildew ascospores and conidia are wind borne (Wiese, 1977), Septoria conidia are splash dispersed (Sanderson *et al*, 1983). Septoria conidia also require a period of post inoculation leaf wetness (or high humidity) in order for infection to take place (Holmes and Colhoun, 1974). Consequently, Septoria development is favoured by conditions of wet weather and cool or moderate temperatures (Martens, 1984). Short plant stature has been reported to increase Septoria severity (Eyal, 1981). Increased seed rate has been reported to both increase (Broscious *et al*, 1985) and decrease (Eyal, 1981) Septoria infestation.

MATERIALS AND METHODS

1) Critical Point Evaluations

Field experiments were established using a split plot design with two to four replicates. Cultivars, Norstar and Norwin, were main plots, and various seed rate and row spacing combinations were subplots. Treatment combinations included a seed rate of 140 kg/ha with 9 and 36 cm row spacing, a 35 kg/ha seed rate with 9 and 36 cm row spacing and 70 kg/ha seed rate with 18 cm row spacing. This last treatment combination represents a relatively conventional seed rate and row spacing while the other treatments provide extreme combinations.

An offset double disk press drill, custom built to allow different seed rate and row spacing combinations, was used. After seeding in late August or early September, 75 kg P_2O/ha from monoammonium phosphate fertilizer was broadcast. In early May, all plots received 100 kg N/ha as broadcast ammonium nitrate fertilizer. Plots at the Carrot River site in 1987 also were also broadcast fertilized with 20 kg SO_4/ha applied as ammonium sulfate and 80 kg K_2O/ha applied as potash. In mid-July, evaluations of disease severity were made on the flag leaf and flag leaf-1 using the Horsefall-Barrett scale. Only after statistical analysis were these scale results translated back to real values. Seven sites were evaluated for Septoria: 1 site at Aylsham in 1986, 2 sites at Carrot River in 1987, 3 sites at Carrot River in 1988 and 1 site at Melfort in 1988. Five sites were evaluated for powdery mildew: 1 site at Aylsham in 1986, 2 sites at Carrot River in 1987, and 2 sites at Carrot River in 1988.

2) Disease Development Test

Field experiments were established using a split-split plot design with two replicates. Nitrogen fertility treatments, 0 vs 100 kg applied N/ha were main plots, cultivars, Norstar and Norwin, were subplots, and the same seed rate and row spacing combinations were sub-sub plots. Fertility did not significantly affect Septoria levels, so it was analyzed as a split plot design with four replicates. Seeding and fertilizing were carried out as for the above test. Disease evaluations were made throughout the growing season using the Horsefall-Barrett scale to monitor disease progress. Four sites were evaluated for Septoria: 1 site at Carrot River in 1987, 2 sites at Carrot River in 1988 and 1 site at Melfort in 1988. Three sites were evaluated for powdery mildew: 1 site at Carrot River in 1987, and 2 sites at Carrot River in 1988.

RESULTS AND DISCUSSION

1) Septoria

Due to the unusually dry weather in 1987 and 1988, Septoria levels were relatively low.

a) Critical Point Evaluations

There was significantly more Septoria present on the flag leaf of the semi-dwarf cultivar, Norwin, than the tall cultivar, Norstar (Table 1). There was no difference on the flag leaf-1.

Table 1. Effect of cultivar on Septoria severity, at seven sites, 1986-1988.

	Septoria severity (% leaf area covered)	
Cultivar	Flag Leaf	Flag Leaf-1
Norwin	12.2a	13.1a
Norstar	7.0b	13.1a

Within a column, means followed by the same letter are not significantly different at p=0.05.
[1] Flag leaf-1 values represent the mean of 6 sites.

Seed rate and row spacing combination had a significant effect on Septoria severity on the flag leaves of both cultivars (Table 2). Contrasts showed that seed rate was the component that was significant while both row spacing and the interaction between seed rate and row spacing were not significant. For the flag leaf-1, the effect of seed rate was significant only at p=0.10.

Table 2. Effect of seed rate and row spacing combination on Septoria severity of two winter wheat cultivars at seven sites, 1986-1988.

	Septoria severity (% leaf area covered)			
Row space-Seed Rate	Flag leaf		Flag leaf-1[1]	
(cm) (kg/ha)	Norwin	Norstar	Norwin	Norstar
9-140	15.0a	8.9a	15.0a	15.9a
36-140	13.1ab	8.0ab	16.9a	13.1a
18-70	12.2abc	6.6b	15.0a	9.4a
36-35	10.3bc	6.1b	12.2a	14.0a
9-35	8.9c	6.1b	8.9a	12.2a

Within a column, means followed by the same letter are not significantly different at p=0.05.
[1]Flag leaf-1 values represent the mean of 6 sites.

b) Disease Development Test

The disease development studies confirmed the same general trends as the critical point studies. Development of Septoria on the tall cultivar, Norstar, was significantly less than on the semi-dwarf, Norwin (Fig 1).

Figure 1. Regression showing effect of winter wheat cultivar on Septoria development on flag leaves, at four sites, 1987-1988.

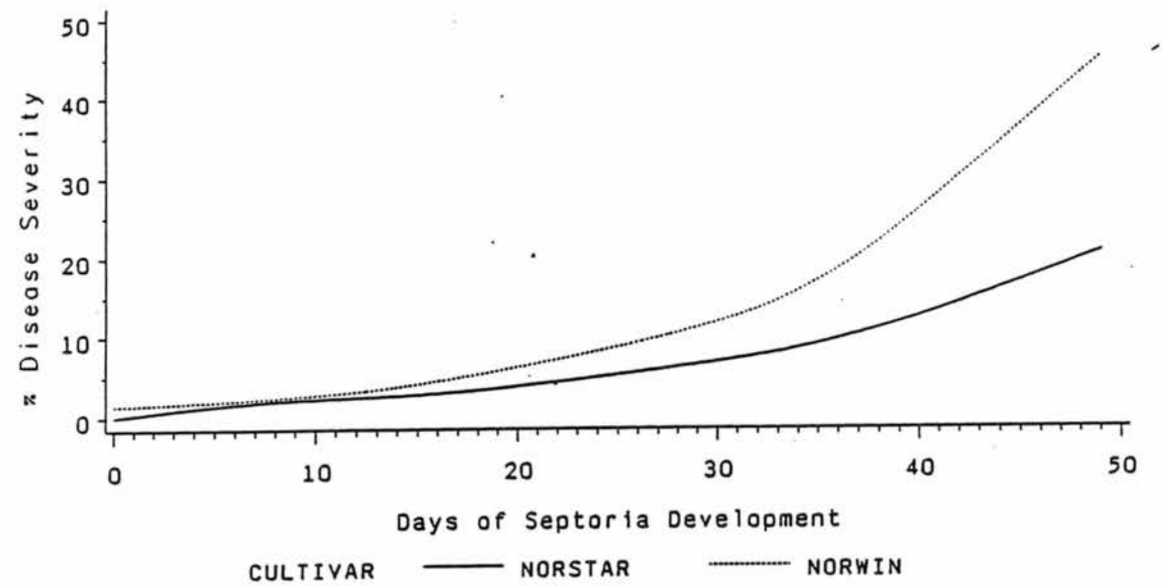
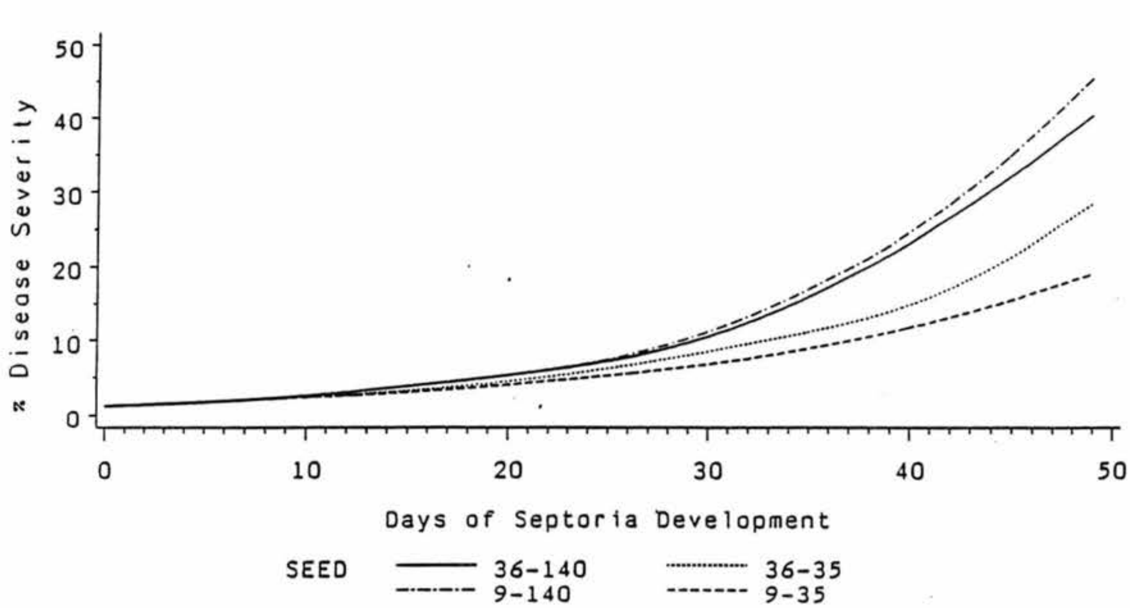


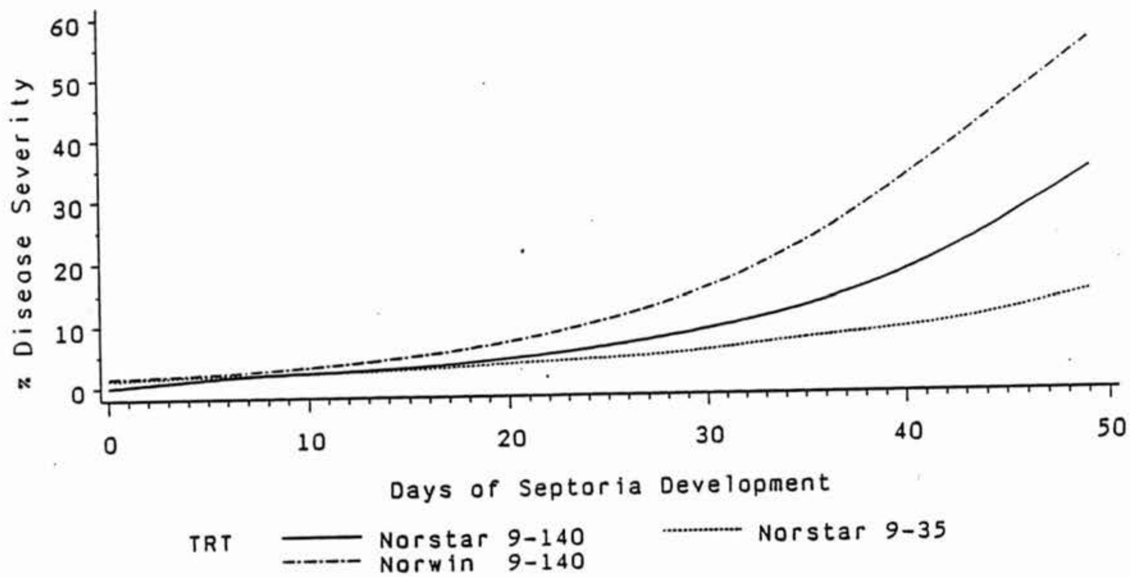
Figure 2. Regression showing effect of seed rate and row spacing on Septoria development on flag leaves of two winter wheat cultivars, at four sites, 1987-1988.



This may be partially a function of different genotype. However, it is also likely due to plant height and the vertical distance between adjacent leaves, as the disease did arrive later on the flag leaves of Norstar than Norwin.

The effect of seed rate and row spacing on disease development is illustrated in Fig 2. There were significant differences between the high and low seed rates, but not between row spacings. Figure 3 summarizes some of the differences in Septoria development among selected agronomic treatments. Septoria severity was greater on Norwin at high seed rate than Norstar at high seed rate which, in turn, had greater Septori severity than Norstar at the low seed rate.

Figure 3. Regression showing effect of winter wheat cultivar and seed rate on Septoria development, at four sites, 1987-1988.



2) Powdery Mildew

Uncharacteristically dry weather, particularly in the spring of 1987 and 1988 meant that powdery mildew epidemics were late developing and for the most part remained at low levels.

a) Critical Point Evaluations

As with Septoria, more powdery mildew occurred on the flag leaves of the semi-dwarf cultivar Norwin than the taller Norstar (Table 3). This same trend occurred on the flag leaf-1, but the differences were not significant.

Powdery mildew differed from Septoria in that both seed rate and row spacing significantly affected disease levels. Highest levels of powdery mildew occurred with wide row spacing and high seed rate (Table 4). There was also a significant cultivar by seed rate interaction. With increased seed rate powdery mildew severity increased more on Norwin than on Norstar. When considering the flag leaf-1, however, seed rate is relatively more important than row spacing for both cultivars.

Table 3. Effect of cultivar on the severity of powdery mildew. Results of five sites, 1986-1988.

	Powdery Mildew Severity (% leaf area covered)	
Cultivar	Flag Leaf	Flag Leaf-1[1]
Norwin	12.1a	10.3a
Norstar	7.0b	7.0a

Within a column, means followed by the same letter are not significantly different at p=0.05.
[1]Flag leaf-1 values represent mean of 4 sites.

Table 4. Effect of cultivar and seed rate and row spacing combination on severity of powdery mildew on flag leaf and flag leaf-1 at five sites, 1986-1988.

	Powdery Mildew Severity (%leaf area)			
	Flag Leaf		Flag Leaf-1[1]	
Row Space-Seed Rate (cm) (kg/ha)	Norwin	Norstar	Norwin	Norstar
36-140	17.8a	8.9a	15.0a	8.4a
36-35	14.0ab	8.0ab	11.23bc	7.5ab
9-140	14.0ab	6.1b	13.1ab	6.6bc
18-70	11.2b	6.6ab	9.4c	7.0abc
9-35	5.6c	6.1b	5.2d	5.6c

Within a column, means followed by the same letter are not significantly different at p=0.05.
[1] Flag leaf-1 values represent the mean of 4 sites.

These results suggest that wide row spacing is more important when the wind dispersed conidia have the furthest to travel, i.e. the flag leaves of a tall cultivar. As the dispersal distance up the plant becomes less important, the higher seed rate becomes more of a modifying influence on disease development as it affects the micro-environment.

b) Disease development Test

Powdery mildew is a biotrophic pathogen that requires green plant tissue to develop. Conditions that promote rapid plant growth also promote powdery mildew development. The effect of high nitrogen in promoting powdery mildew growth is illustrated in Figure 4.

Seed rate and row spacing both can also affect powdery mildew development (fig. 5). The regression curves '36-140', '9-140', and '36-35' do not differ significantly from each other. Only the '9-35' which has neither wide row spacing or high seed rate shows a lower rate of powdery mildew development. Of interest is the fact that there does seem to be a lag in the development of powdery mildew for the curve represented by '9-140', i.e. the combination of high seed rate and narrow spacing.

Figure 4. Regression showing effect of nitrogen fertility on the development of powdery mildew development on flag leaves of two cultivars, at two sites, 1987-1988.

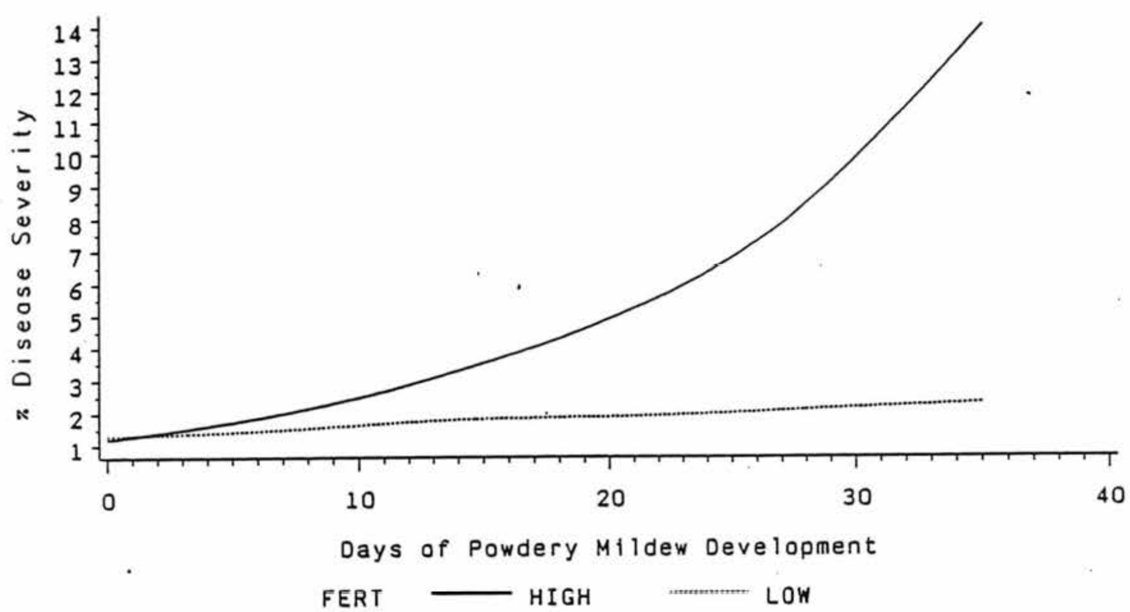


Figure 5. Regression showing effect of seed rate and row spacing on powdery mildew development on the flag leaves of two winter wheat cultivars, at three sites, 1987-1988.

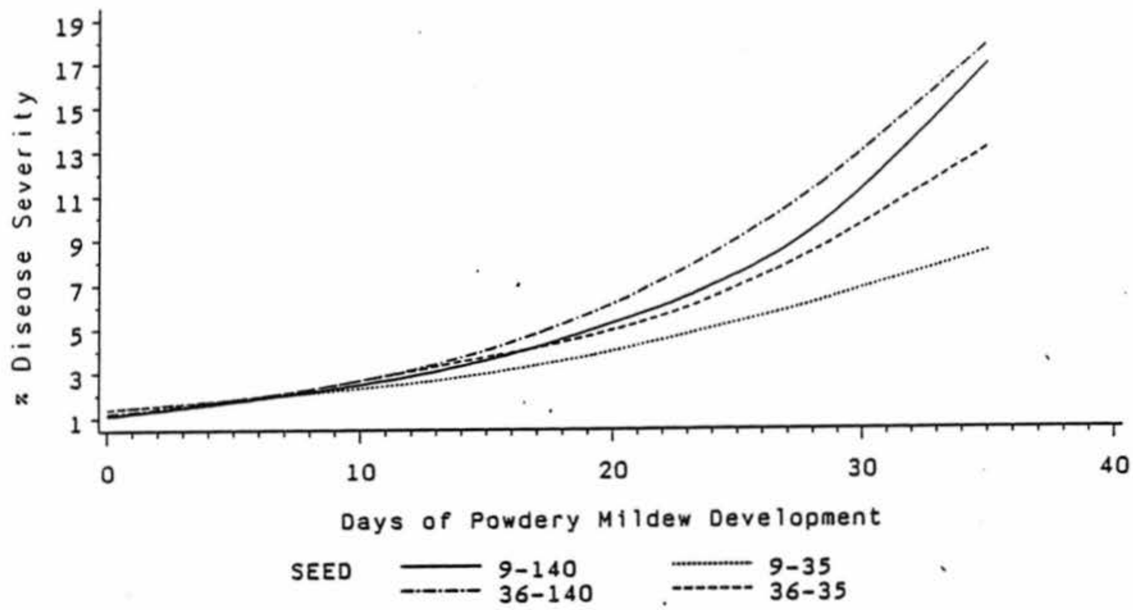
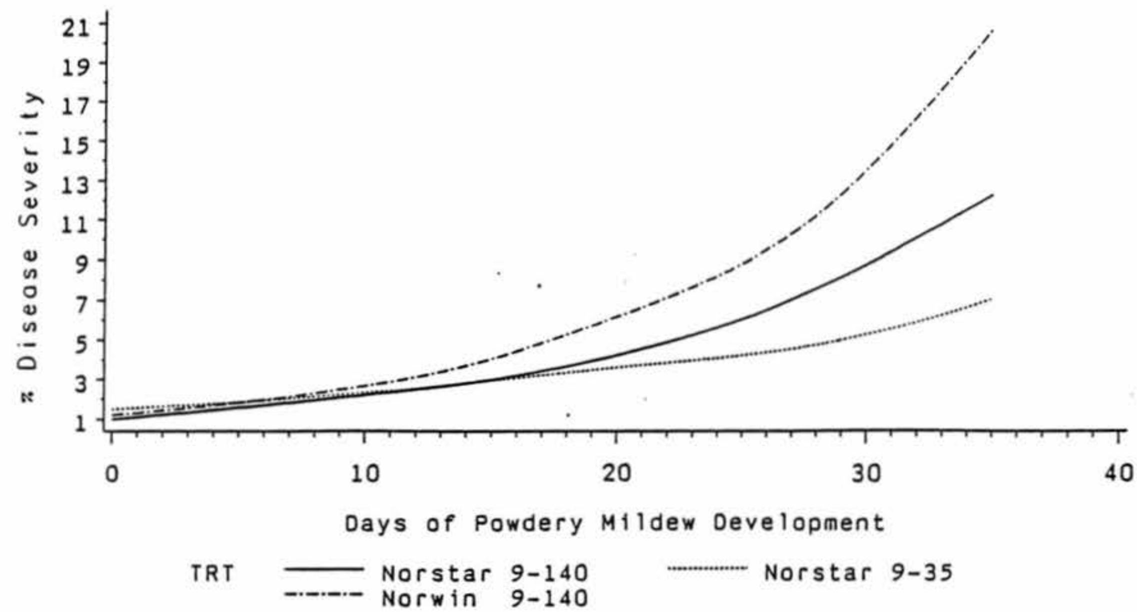


Figure 6. Regression showing effect of winter wheat cultivar and seed rate on powdery mildew development, at three sites, 1987-1988.



Finally, the effects of both cultivar and seed rate are illustrated in figure 6. Short stature and high seed rate both promote powdery mildew development.

CONCLUSIONS

1) Septoria development is promoted by short stature, and high seed rate. Row spacing had no effect on Septoria development.

2) Powdery mildew devlopment is promoted by high fertility, short stature, wide row spacing and high seed rate. Wide row spacing is most important in circumstances where the wind dispersed conidia have a greater distance to travel. Therefore in consdering the development of powdery mildew on the flag leaves of a tall cultivar, such as Norstar, wide row spacing is more important than seed rate. Where dispersal is less of a limiting factor, seed rate becomes additionally important, with high seed rate favouring disease build-up. Another way to express this is that wide row spacing favours dispersal and high seed rate favours disease build-up at a given location.

3) With the utilization of higher seed rates in northeast Saskatchewan, it might be expected that plant diseases become an increasing problem.

LITERATURE CITED

1) Boquet,D.J., and C.C.Johnson.1987. Fertilizer effects on yield, grain composition, and foliar disease of doublecrop soft red winter wheat. Agron.J. 79:135:141.

2) Broscious,S.C., J.A.Frank, and J.R.Frederick.1985. Influence of winter wheat management practices on the severity of powdery mildew and Septoria blotch in Pennsylvania. Phytopathology 75:538-542.

3) Eyal,Z.1981. Integrated control of Septoria disease of wheat. Plant Disease 65:763-768.

4) Holmes,S.J.I., and J.Colhoun. 1974. Infection of wheat by Septoria nodorum and S. Tritici in relation to plant age, air temperature and relative humidity. Trans.Br.Mycol.Soc. 63:329-338.

5) Martens,J.W., W.L.Seaman, and T.G.Atkinson. 1984. Diseases of Field Crops in Canada. The Canadian Phytopathological Society, Harrow, Ontario.

6) Sanderson,F.R., A.L.Scharen, and P.R.Scott. 1983. Sources and importance of primary infection and identities of associated propagules. In: Septoria of Cerals --Proc. of Workshop Aug.2-4, 1983. Montana State University, Bozeman, Montana. pp527-533.

7) Smith,H.C., and I.D.Blair. 1950. Wheat powdery mildew investigations. Ann.Appl.Biol. 37:570-583.

8) Tompkins,D.K., A.T.Wright, and D.B.Fowler. 1989. Seed rate and row spacing studies on winter wheat in northeast Saskatchewan. In: Soils and Crops Workshop Feb.16-17, University of Saskatchewan, Saskatoon, Saskatchewan.

9) Wiese,M.V. 1977. Compendium of Wheat Diseases. The American Phytopathological Society. St.Paul, Minn.