Overwintering of stripe rust in southern Alberta

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A survey conducted in 1986 found that stripe rust had overwintered on winter wheat fields in southern Alberta. Mild weather conditions during the winter followed by a cool, wet spring allowed the survival and early buildup of stripe rust which ultimately resulted in an epidemic on soft white spring wheat. A comparison of weather conditions from 1980 to 1987 showed that outbreaks of stripe rust were inversely related to negative degree days (NDD) in December and January. Warm, dry conditions during April and May in 1987 appeared to limit stripe rust development.

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Au cours d'une enquête réalisée en 1986, on a determine que le champignon responsable de la rouille jaune striée avait passe l'hiver dans des champs de blé d'hiver du sud de l'Alberta. Un hiver doux, suivi d'un printemps frais et humide, a permis a la rouille striée de survivre et de se multiplier tôt, ce qui a donne lieu a une épidémie sur le blé tendre blanc de printemps. Une cornparaison des conditions atmosphériques entre 1980 et 1987 a permis de déceler que les épidémies de rouille striée étaient inversement corrélées au nombre de degrés-jours négatifs pour dbcembre et janvier. Il semble que la prevalence de conditions chaudes et sèches en avril et en mai 1987 ait freine la proliferation de la rouille striée.

Introduction

Stripe rust caused by ***Puccinia striiformis*** West. (syn. ***P. glumarum*** Eriks. and Henn.) poses a serious threat to the production of soft white spring wheat (***Triticum aestivum*** L. em Thell) in southern Alberta. Early infection of the leaves and heads of wheat can drastically lower yield and also result in downgrading because of shrivelled grain (3). Stripe rust epidemics occur infrequently in this area, but each year low levels of stripe rust are usually detected in soft white spring wheat.

Puccinia striiformis has no known alternate hosts and must survive the year in the uredial state on infected hosts. Sharp and Hehn (7) reported that stripe rust overwintered in Montana as mycelia in infected leaves of winter wheat. They found that dormant mycelia could survive as long as the fall-infected leaves survived. Coakley and Line (1) found that by using 7°C as a base, stripe rust survival and severity on winter wheat in Washington state could be predicted based on the number of negative degree days (NDD) or positive degree days (PDD) at specific times of the year. They chose 7°C as a base in their study because it is considered to be the optimum temperature for stripe rust development. They demonstrated that stripe rust survival in winter wheat was inversely related to NDD in December and January and to PDD from April to the end of June.

Sanford and Broadfoot (5) were the first to report that stripe rust could overwinter on winter wheat in southern Alberta. However, in a subsequent study they were unable to observe any signs of winter survival of stripe rust on fall infected leaves (6). In recent years, stripe rust was generally considered to be reintroduced each year into southern Alberta by airborne spores blown in from the Pacific Northwest of the United States and that local fields of winter wheat were not an important source of inoculum.

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This study examines the overwintering of stripe rust on winter wheat in southern Alberta, relates it to weather conditions, and discusses its importance in the epidemiology of this disease.

Materials and methods

Sixty-six fields of Norstar winter wheat were surveyed throughout southern Alberta in 1986. The fields examined were selected at random and stripe rust severity was determined at five sites selected at 50-m intervals along a transect of each field. At each site the percentage of a leaf area infected on the bottom, middle and top third of 20 plants was visually estimated according to the modified Cobb scale (4). The data from each field were summarized as a mean of the percentage leaf area infected on the bottom third of the crop. The stage of crop development was also recorded for each field.

In 1987, twenty-three fields of winter wheat were surveyed for stripe rust. The fields sampled were located primarily in the Lethbridge and Bow Island areas.

Data from the weather stations in Lethbridge, Taber, Bow Island and Medicine Hat were used to determine the total number of NDD in December and January in the winters of 1980-81 to 1986-87. Similarly, the number of PDD and total precipitation between April and June were determined for each year from 1981 to 1987. Degree days were calculated according to the formula described by Coakley and Line (1):

Degree days = daily average temperature − 7°C.

This weather information was related to differences in stripe rust severity in different years.

Results and discussion

This study was prompted by the detection of stripe rust on winter wheat in the first week in May 1986. The infected winter wheat fields were located primarily around Lethbridge and always in areas where irrigated soft white spring wheat had been grown during the previous summer (Fig. 1). In fields

Table 1. Total number of negative degree days in December and January and positive degree days between April and June at four locations in southern Alberta.

	Lethbridge		Taber		Bow Island		Medicine Hat	
	NDD[a]	PDD[b]	NDD	PDD	NDD	PDD	NDD	PDD
1980-81	695.7	417.1	699.3	471.9	696.8	476.3	792.8	492.1
1981-82	1238.5	395.2	1192.2	462.9	1212.0	487.8	285.3	474.3
1982-83	618.2	423.8	621.1	454.1	771.0	508.1	757.1	510.4
1983-84	1007.2	411.1	1056.5	456.5	1167.9	552.9	241.6	498.3
1984-85	923.5	483.8	1014.4	461.5	1138.2	571.3	187.3	546.7
1985-86	502.6	527.4	500.2	530.2	563.5	631.5	657.9	598.9
1986-87	450.0	616.7	471.9	652.0	506.0	743.5	592.8	694.4

[a]NDD = Negative degree days, based on average daily temperature in December and January,
[b]PDD = Positive degree days, based on average daily temperature between April and June.

where stripe rust was present, only the lower third of the plant was infected. These observations, together with information that stripe rust was not a problem in the Pacific Northwest of the United States in 1986 (Personal communication E.R. Sharp to R.L. Conner), indicated that stripe rust overwintered on winter wheat in southern Alberta in 1986.

A series of circumstances worked in combination during the fall of 1985 and the winter and spring of 1986 which ultimately resulted in a stripe rust epidemic in the summer of 1986. It was noted in the fall of 1985 that a number of late-seeded fields of soft white spring wheat were heavily infected with stripe rust even though there had been little stripe rust present during the summer. These late-seeded fields of irrigated soft white spring wheat acted as a source of inoculum to nearby fields of winter wheat after they emerged. The winter of 1985-86 was relatively mild and there was adequate snow cover to protect the infected leaves during the coldest periods of the winter. Coakley and Line (1) reported that in Washington State total NDD in December and January of between 500 and 710 would allow a light to moderate buildup of stripe rust on susceptible winter wheat provided that the total PDD from April to June did not exceed 560. The number of NDD in December and January was well within the range that would allow good survival of stripe rust (Table 1). Cool, wet conditions in June and July 1986 allowed the stripe rust to spread from winter wheat to soft white spring wheat and ultimately resulted in an epidemic on soft white spring wheat.

The number of NDD during the winter of 1986-87 was low enough to allow stripe rust survival (1) but no stripe rust was detected in any of the 23 fields surveyed in 1987. Dry, warm conditions during April and May of 1987 (Table 2) caused early senescence of infected leaves and prevented further spread of the disease.

The winters that preceded 1985-86 had high numbers of NDD in December and January indicating that conditions were unfavorable for stripe rust survival (Table 1). Stripe rust was a problem on soft white spring wheat in 1981. There is a remote possibility that stripe rust survived the 1980-81 winter but it is more likely that the disease spread in from heavily infected fields in the Pacific Northwest. In the years be-

Table 2. Amount of precipitation received in April and May between 1981 and 1987 at four locations in southern Alberta.

	Precipitation (mm)[a]			
Year	Lethbridge	Taber	Bow Island	Medicine Hat
1981	139.0	97.4	79.4	86.8
1982	43.6	35.0	79.1	105.4
1983	61.0	61.3	102.1	60.7
1984	45.6	46.1	40.2	50.8
1985	70.9	91.9	81.7	84.7
1986	89.2	85.4	75.1	89.7
1987	35.9	54.6	22.6	37.1

[a]Based on data from the Daily Weather Bulletin issued by Climatic Services - Central Region, Environment Canada.

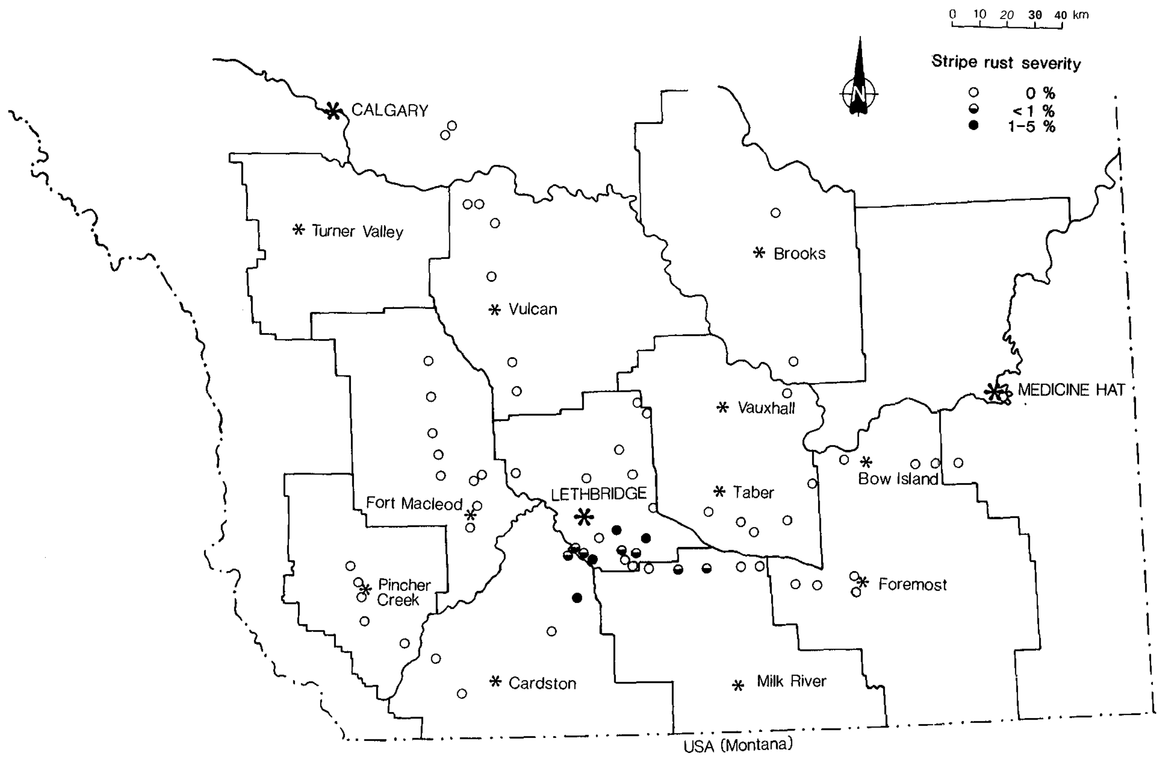

Figure 1. Map showing rust severity and the approximate location of winter wheat fields surveyed in **1986.**

tween 1982 and 1985 stripe rust never became a problem because severe conditions during the winter resulted in the death of infected leaves. With the exception of 1987, weather conditions between April and June in all the years studied were cool and wet enough to allow a stripe rust buildup if the pathogen had survived the winter (Tables 1 and 2).

Coakley and Line (2) found that their prediction model did not always accurately forecast stripe rust severity at all locations and had to be further modified by standardizing NDD data according to the long-term mean for each location. Currently there are insufficient data on stripe rust survival on winter wheat in southern Alberta to allow meaningful comparisons of different predictive models on stripe rust survival but it seems likely that a more reliable model will be developed as more information on stripe rust survival is obtained. The impact of other factors on winter survival such as weather conditions during November or February, which often can be the coldest period of the winter, should also be considered. The amount of snow cover during the winter is another factor that can be limited in some years and could directly affect stripe rust survival in southern Alberta.

Stripe rust appeared to have little effect on the yield of Norstar winter wheat (Conner and Thomas, unpublished data). It was also noted that Norstar had a lower level of infection than most other winter wheat entries tested at the Lethbridge Research Station. This indicates that Norstar carries field resistance to stripe rust and this limited the spread of the disease in winter wheat. The occurrence of this disease on winter wheat is of concern because under favorable conditions it allows stripe rust to build up and spread onto soft white spring wheat early in the growing season.

Acknowledgement

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