SASKATCHEWAN WINTER WHEAT DISEASE SURVEY

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Although spring wheat has been grown in Saskatchewan for over one hundred years, much work remains to be done to understand the diseases that plague this crop. While sharing many of the same disease problems, winter wheat requires special attention because of its overwintering habit and the particular agronomic practices associated with its production.

To identify the diseases affecting winter wheat, a survey of commercial fields was done in 1985, 1986 and 1987. Because disease development is dependent on weather conditions it was necessary to make observations over several growing seasons. In 1985, winter wheat fields were located with the assistance of rural municipality offices. In 1986 and 1987, lists of field locations were acquired through a mail survey with the help of elevator agents. Each field was sampled 1-3 times, from early May until mid-July to mid-August, depending on the maturity of the crop. Not all fields were visited each time. At each sampling date, forty plants from each field were evaluated for foliar, head and root diseases.

In the first sample disease was evaluated on the basis of incidence ie. percentage of the 40-plant sample with symptoms. In 1985, from flag leaf emergence (Zadoks growth stage 45) foliar diseases were evaluated by rough visual estimates for severity based on the average percentage area of the flag leaf affected. In 1986, a 0-9 scale which included both the height on the plant at which symptoms were observed and the severity of these symptoms (Couture, 1980) was used (Table 1). A rating of 0 indicated a plant free from symptoms while a rating of 9 indicated that more than 50% of the flag leaf was affected. In 1987, a modified version of this scale was used (Table 1). The number of classes was increased from 9 to 11 in order to include intermediate stages of disease progress through the canopy.

Tables 2 and 3 indicate disease incidence and severity data for all diseases observed in the survey in 1986 and 1987, respectively.

Leaf spot, caused by *Pyrenophora tritici-repentis* and/or *Septoria* spp., was present in most fields on the lower leaves prior to flag leaf emergence (Figures 1, 2

and 3). By anthesis (G.S. 60), the disease had reached mild to moderate levels, although it was more serious (up to 8.6) in some fields in 1986 (Figures 4 and 5). Glume blotch symptoms were not apparent until the latter part of the season. At that time close to 100% of the plants had some level of infection although severity was not evaluated.

Figure 6 shows the previous crop history of winter wheat fields sampled in 1987. Crops planted into stubble of barley, and winter, spring and durum wheat and into chemical fallow had a higher incidence of seedlings infected in the first sample (Table 4). This supports previous findings elsewhere that the pathogens overwinter on the stubble of the preceding crop so that infection of seedlings in the fall and/or spring occurs earlier in these fields (Broscious et al., 1985; Harrower, 1974; Lamey, 1982; Rees and Platz, 1980). Canola stubble does not harbour the leaf-spotting pathogens and consequently, air-borne inoculum from out-of-field sources such as neighbouring fields or grassy weeds are probably responsible for the presence of leaf spot in fields on non-host stubble. It is worthy of note that crops planted on chemical fallow had more initial disease than those on summerfallow. These fields had been planted to wheat previous to the fallow season. This suggests that inoculum can survive on the unburied trash. In 1986, by the time of anthesis, differences were no longer apparent due to the spread of spores by the wind. In 1987 at the same stage of development of the crop, durum stubble fields had significantly more severe leaf spot than crops on canola stubble. It is recognized that in the prairies tan spot, part of the leaf spot complex, is prevalent on durum wheat, especially in the southwestern part of the province. The lower disease severities observed in 1987 indicate that disease spread within fields was more important than between fields as evidenced by lower levels of leaf spot in canola stubble fields.

Different agroclimatic zones, as indicated by crop districts, had no apparent effect on primary leaf spot incidence in 1987 or on the severity of disease later in the season. When crop district was added as a covariate, the effect of previous crop was no longer significant. This suggests that the two variables are confounded, ie. the effects of crop district cannot be separated from the effects of previous crop since certain crops, such as durum in the southwest, are widely grown in certain areas of the province and rarely in others.

In 1985, powdery mildew was prevalent in fields in crop district 8 and the eastern part of C.D. 9 (Figure

7). Infection of leaves in the lower canopy was apparent in mid-June, just before heading. With good moisture conditions, a lush, dense canopy developed and powdery mildew was extensive, affecting up to 25% of the flag leaf. In the two following years, this disease was found in 50% of the fields sampled at heading. By the begining of July, most fields had low levels of powdery mildew. Dry conditions during most of the spring resulted in a less dense canopy (and therefore a lower humidity within the canopy). Germination of the spores of the causal organism (Erysiphe graminis) and the early infection process require high humidity. Since these conditions were not met until later in the season, disease development was not as rapid nor was disease severity as high as had been seen in wetter years.

The bleached heads and blackened stem bases associated with take-all were observed in most fields in the northeast in 1985 (Figure 8). In most cases severity was limited to less than 1% of the field although in one location 30-40% of the field was affected. In 1986 and 1987, take-all was observed with much less frequency due to dry conditions throughout the season.

In 1985 and 1987 neither leaf nor stem rust posed a major problem in the winter wheat crop. Symptoms were first noted in late June in the eastern part of the province which is recognized as a "rust zone" (Figure 9). Rust did not develop extensively as a result of dry conditions throughout most of the growing area.

Conditions in 1986 were exceptionally favourable for the development of stem rust. It was first observed in the Outlook area around June 11, about a month earlier than usual. By June 23 it was found in fields in the Swift Current, Unity and Maidstone areas. Leaf rust was also found in trace amounts across the province at this date (Figure 10). As the epidemic progressed, stem rust was found in all parts of the province (Figure 11). Apparently the rust epidemic was brought about by a combination of early arrival of inoculum blown in from the south, suitable environmental conditions (especially frequent, heavy dews) and the presence of the very susceptible cultivar, Norstar, which dominated the acreage. The predominant race of rust (C53) was unchanged from recent previous years' rust surveys.

The severity of rust at the soft dough stage varied from trace to severe across the province. Yield loss attributable to stem rust was not directly evaluated, but appeared to range from negligible to about 130 kg/ha (20 bu/A). Management practices had a definite effect on the impact of stem rust on yield. Early seeded crops

appeared to escape much of the yield loss. However later seeded fields suffered badly. This was observed in seeding date trials as well as in commercial fields. In a survey of fields during the fall of 1986 there was no sign of early seedling infection by the stem rust pathogen. A field experiment was carried out in which plants inoculated with stem rust were put out under field conditions over the winter and recovered in the spring. No rust developed on these plants when they began growth again indicating that the pathogen probably does not overwinter in Saskatchewan.

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Table 1: Disease rating scales (0-9), 1986 and (0-11), 1987

Severity		% Leaf area with disease symptoms		
		Lower	Middle	Upper
0-9	0-11			
0	0	0	0	0
1	1	0-1	0	0
2	2	2-5	0	0
3	3	6-10	0	0
	4	6-10	0-1	0
4	5	11-25	2-5	0
5	6	26-50	6-10	0
	7	>50	6-10	0
6	8	>50	11-25	2-5
7	9	>50	26-50	6-10
8	10	>50	>50	11-25
9	11	>50	>50	26-50

These scales were based on that developed by Couture (1980).

TABLE 2 Severity of Leaf Spot, Leaf Rust, Stem Rust, Powdery Mildew and Glume Blotch, 1986

	Sampling Date													
	May 20–June 5	June 16–27				July 3–9				July 21–30				
Crop District	% Plants w LS[1]	LS[2]	LR[3]	SR[4]	PM[5]	LS	LR	SR	PM	LS	LR	SR	PM	GB[6]
1	54.5	4.62	T	0	0	--	--	--	--	--	--	2.26	0	T
2	25	3.45	T	0	0	--	--	--	--	--	--	7.95	0	3.15
3	17.6	3.6	1.0	T	0	--	--	--	--	--	--	4.17	0	3.15
4	0	2.92	T	T	0	--	--	--	--	--	--	--	--	--
5	43.6	--	--	-	-	6.67	3.30	T	T	--	--	--	--	--
6	25	4.39	4.89	T	0	--	--	--	--	--	--	13.8	0	T
7	0	4.6	3.01	T	T	--	--	--	--	--	--	--	--	--
8	46.2	--	--	-	-	5.34	1.32	T	T	--	--	T	T	T
9	33.0	--	--	-	-	4.3	T	0	3.0	--	--	T	T	T

[1]Average % of plant with leaf spot; [2–6]Average severity of leaf spot, leaf rust, stem rust, powdery mildew and glume blotch, respectively; T=trace (1%)

Values are averages of all fields sampled in each crop district visited at sampling dates.

Approx. growth stage at sampling date: May 16 - June 15 -- tillering to booting; June 16 - June 27 -- flag leaf emergence to anthesis; July 3 - 9 -- anthesis to soft dough; July 21 - 30 -- kernel ripening

TABLE 3: Severity of Leaf Spot, Powdery Mildew, Rust Glume Blotch and Take-all, 1987

Crop District	Sampling Date: May 12 – June 5 % Plants LS[1]	PM[2]	June 9 – 25 LS[3]	PM[4]	R[5]	July 7 – 21 LS	PM	R	GB[6]	TA[7]
1	12.9	0	4.2	0	0	–	–	–	–	–
2	18.9	0	5.0	0	0	–	–	–	–	–
3	28.3	0	4.5	0	0	–	–	–	–	–
4	1.3	0	2.6	0	0	–	–	–	–	–
5	45.0	0	5.0	0.3	0.2	7.8	0.3	0.3	24.1	0
6	16.3	0	4.6	0	0	–	–	–	–	–
7	–	–	4.0	0	0	–	–	–	–	–
8	25.0	28.2	4.7	0.1	2.3	6.9	4.4	4.1	97.5	0.2

[1,2,6,7]Average % of plants with leaf spot, powdery mildew, glume blotch, and take-all respectively.

[3,4,5]Average severity (0-11) of leaf spot, powdery mildew, and leaf rust respectively.

Values are averages of all fields sampled in each crop district visited at sampling dates.

Approx. growth stage at sampling date: May 12 – June 5 -- 4-leaf to pre-booting; June 9 – 25 --Flag leaf emergence to end of anthesis; July 7 – 21 -- soft dough

Table 4: Effect of previous crop on initial leaf spot incidence and later severity

Previous Crop	Percent Infected Plants[1]	Disease severity (0-11)
barley	47.00a[2]	4.04ab
durum	36.89ab	4.99a
winter wheat	24.19abc	4.79ab
spring wheat	20.85abc	4.13ab
chem fallow	17.77abc	3.91ab
canola/mustard	14.69 bc	2.81 b
summerfallow	7.22 c	4.20ab

[1] Percentage of plants per 40-plant sample with leaf spot symptoms.

[2] Values followed by the same letter are not significantly different using Duncan's Multiple Range test.

Values are averages of all fields sampled with each type of previous crop without considering crop district.

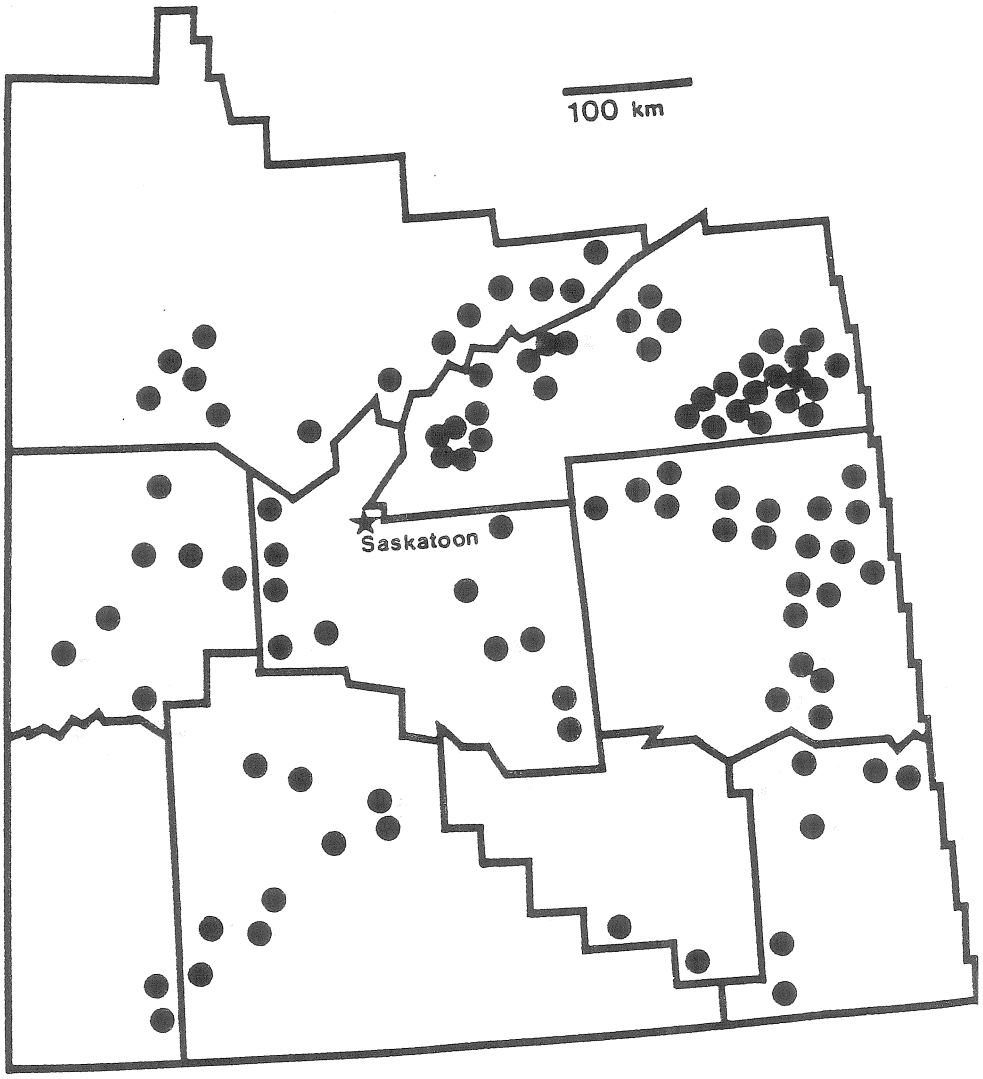

Figure 1 Leaf spot incidence, 1985

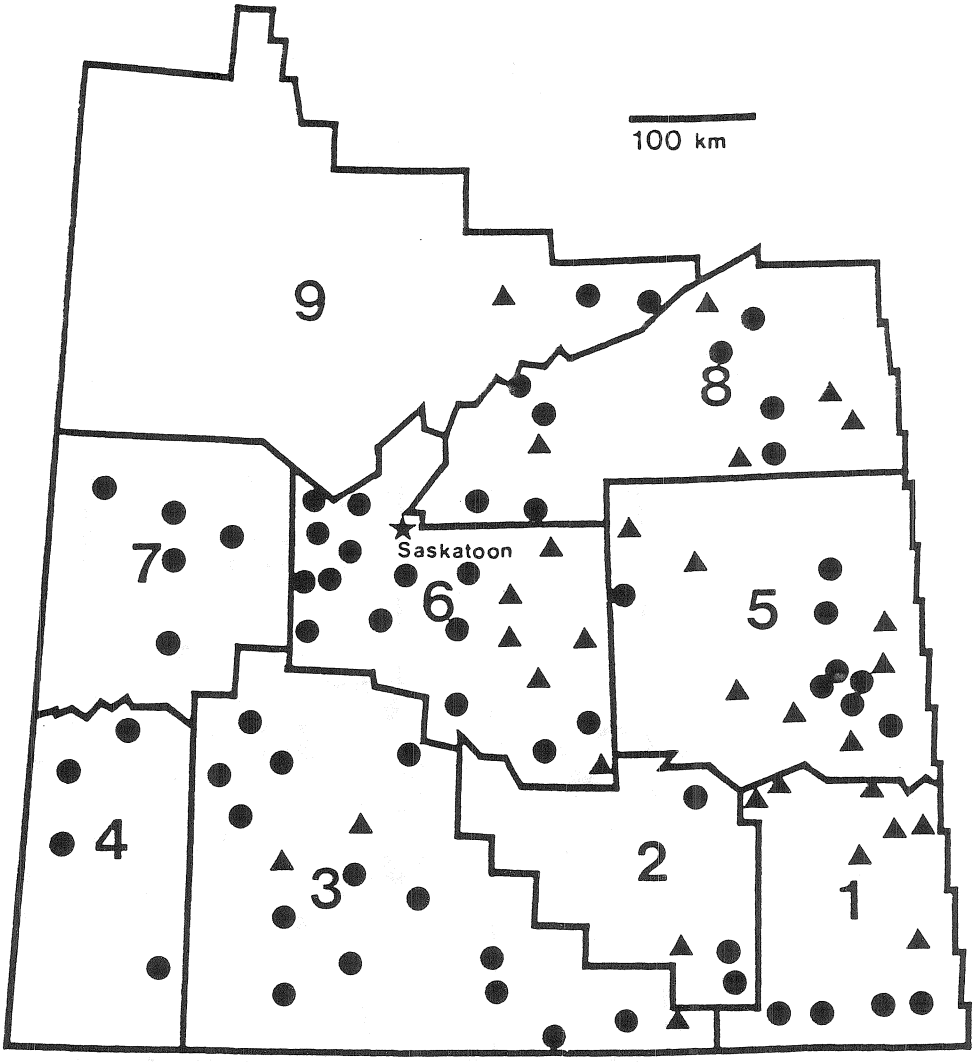

Figure 2 Disease incidence, Sample 1, 1986

● no disease
▲ trace leaf spot

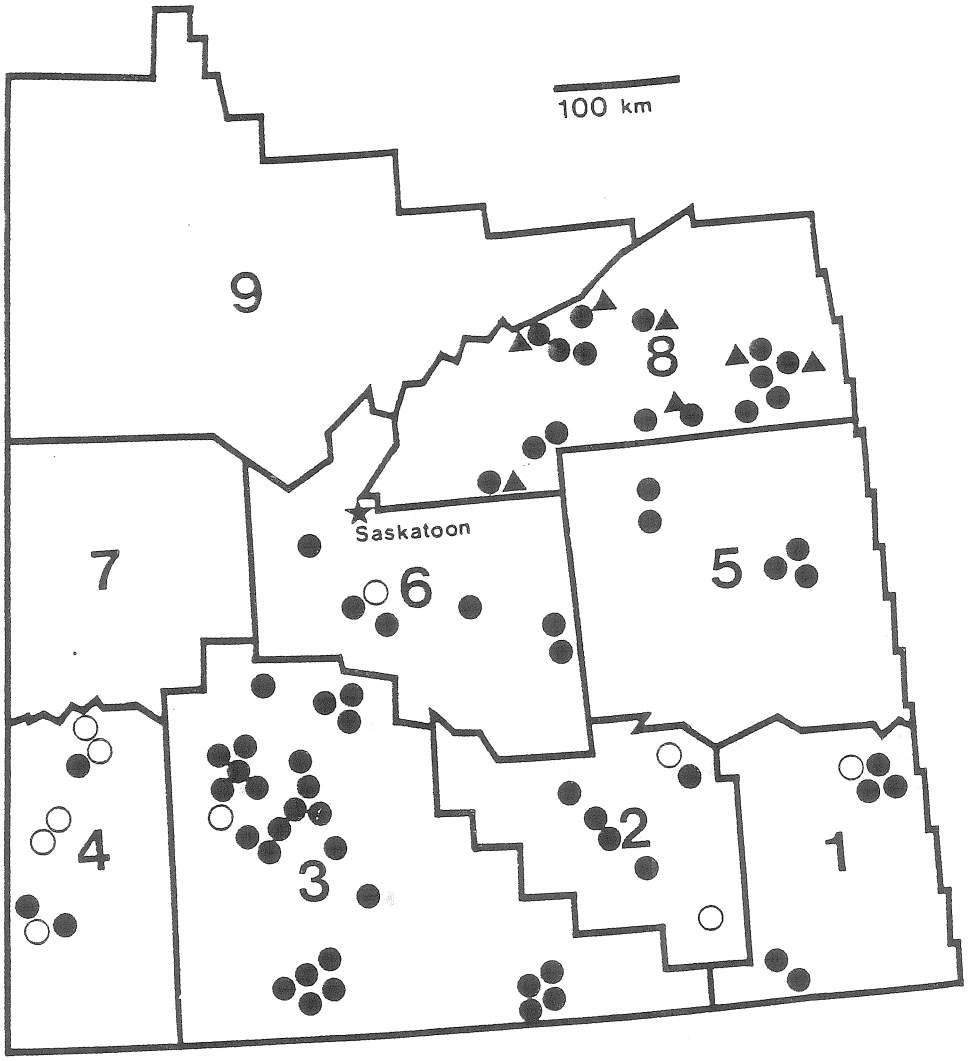

Figure 3 Disease incidence Sample 1, 1987

○ no disease
● trace leaf spot
▲ trace powdery mildew

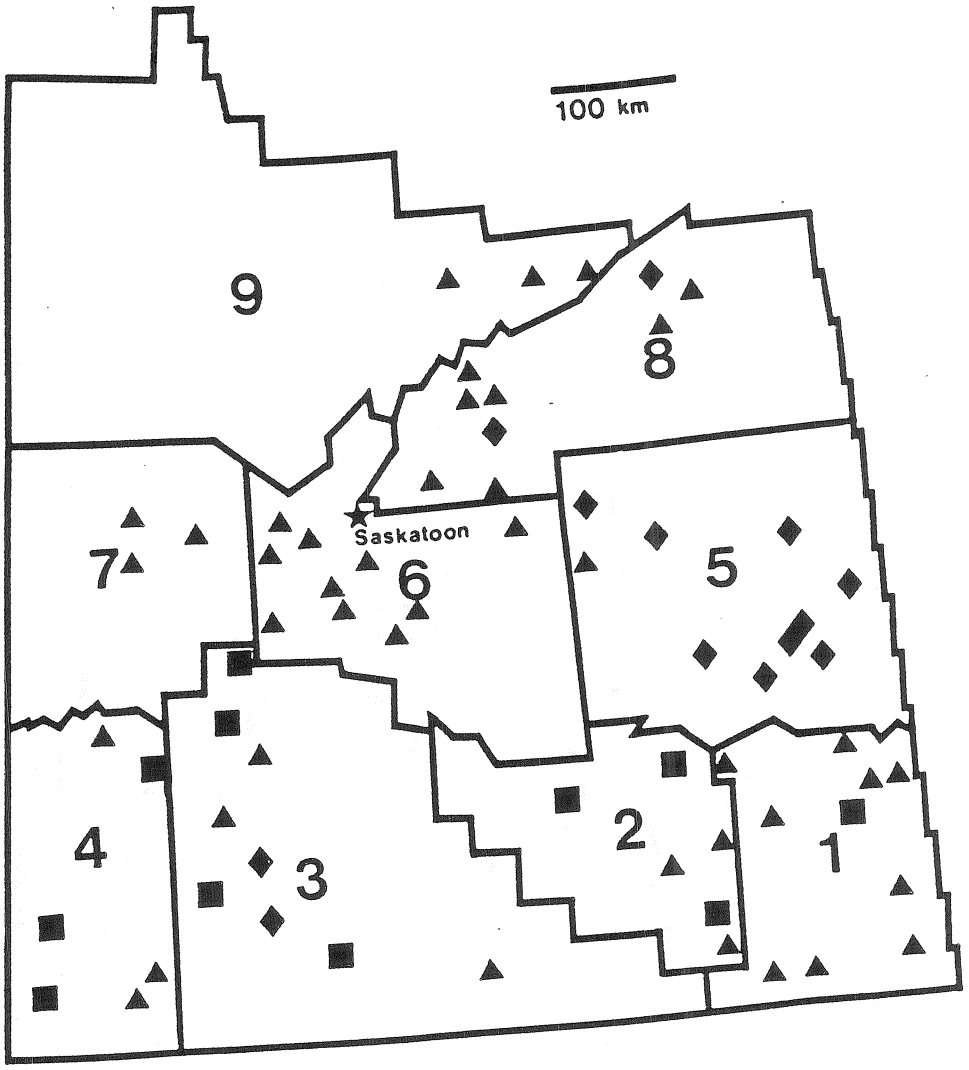

Figure 4 Leaf spot severity, Sample 2, 1986

■ mild (1-3)
▲ moderate (4-7)
◆ severe (8-9)

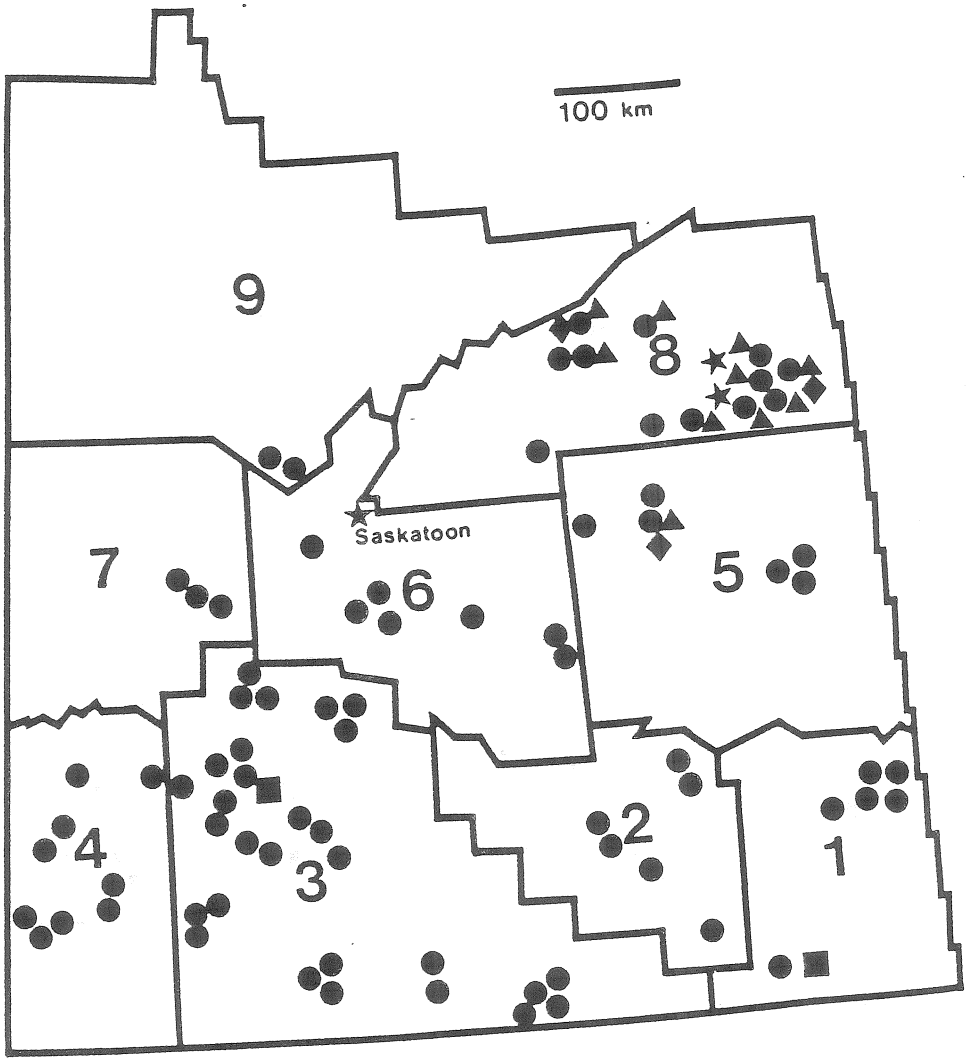

Figure 5 Disease severity, Sample 2, 1987

● mild leaf spot
■ moderate leaf spot
▲ trace powdery mildew
◆ trace rust
★ trace take-all

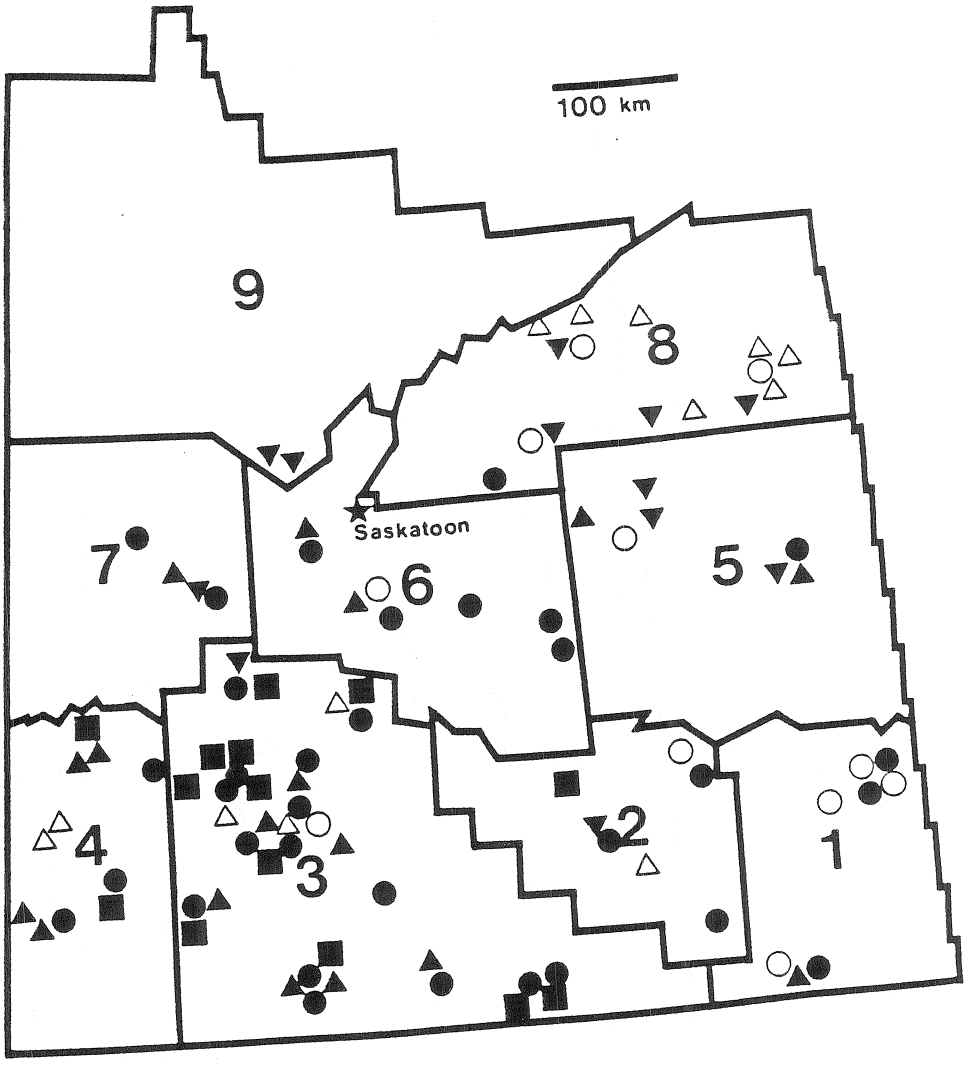

Figure 6 Previous crop history of fields surveyed in 1987

- ● winter wheat
- ▲ spring wheat
- ■ durum
- ▼ barley
- ○ canola
- △ summer fallow/chem fallow

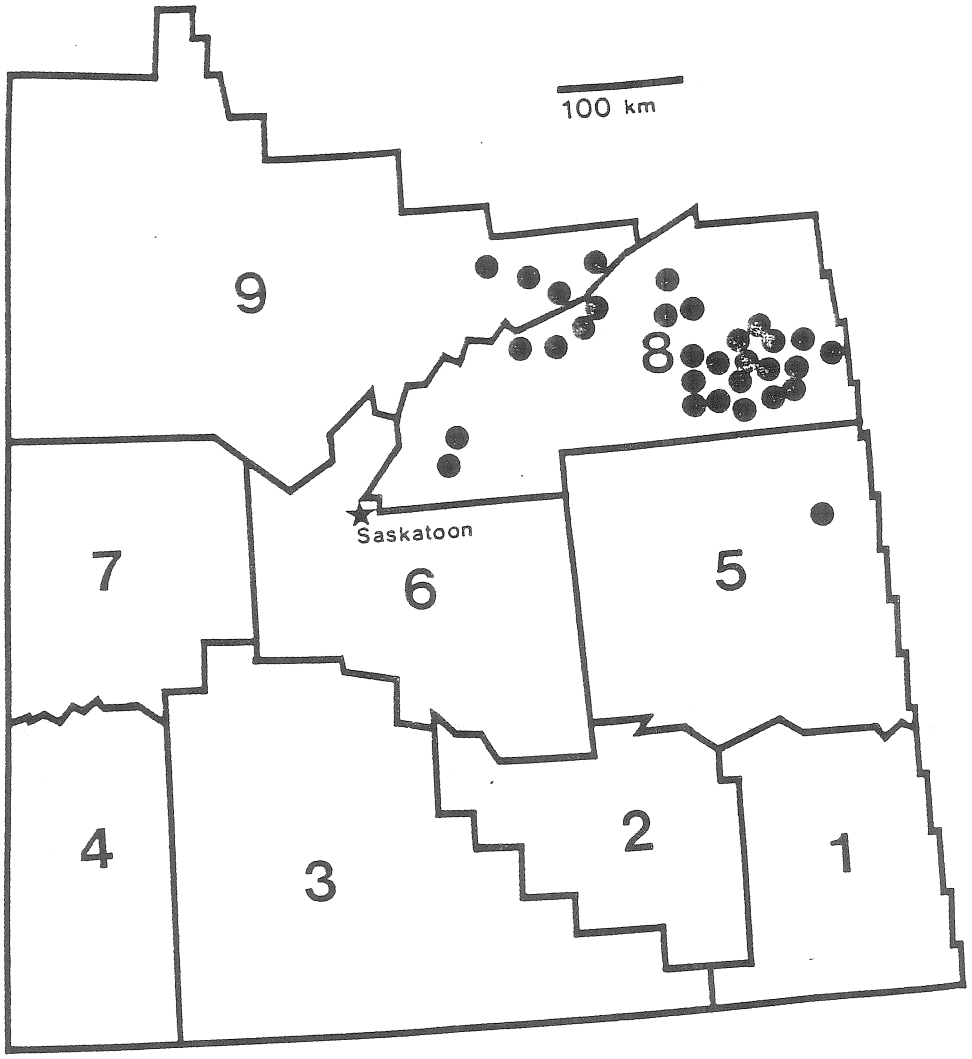

Figure 7 Powdery mildew incidence, 1985-87

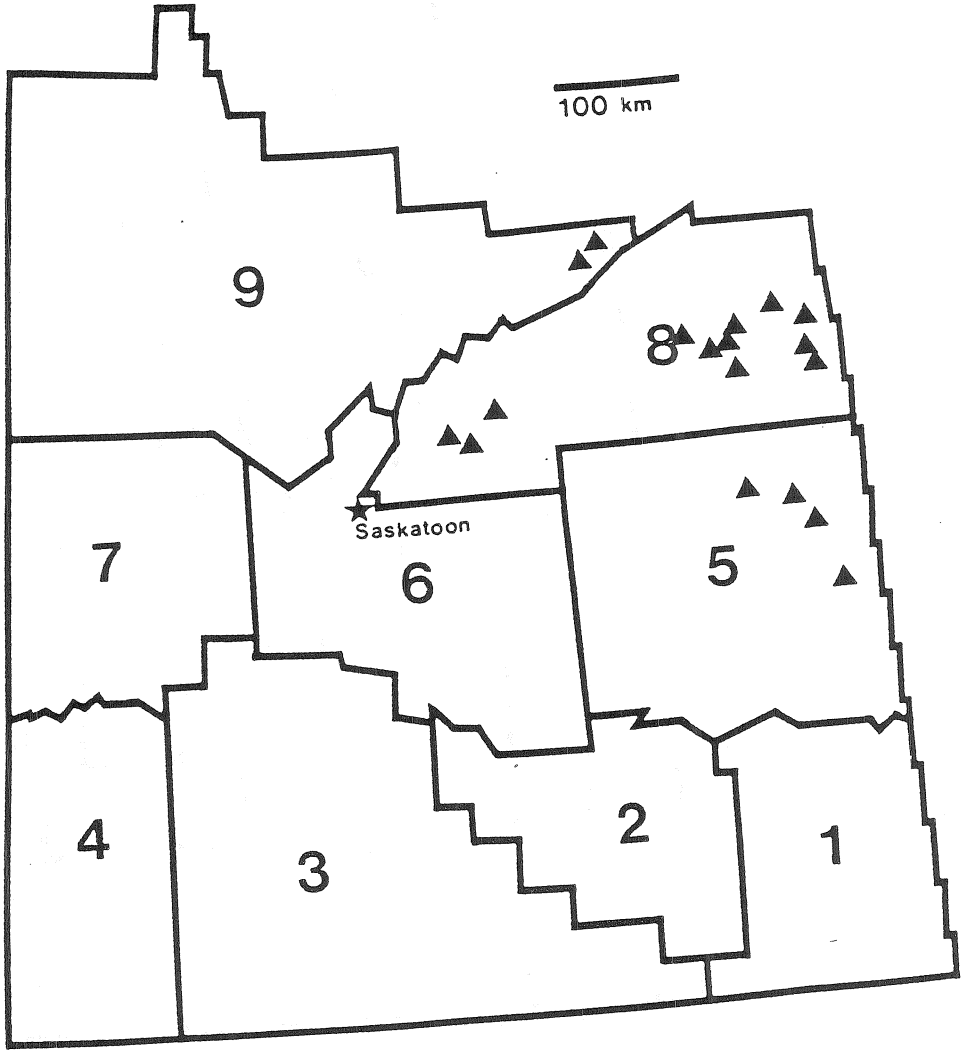

Figure 8 Take-all incidence, 1985-86

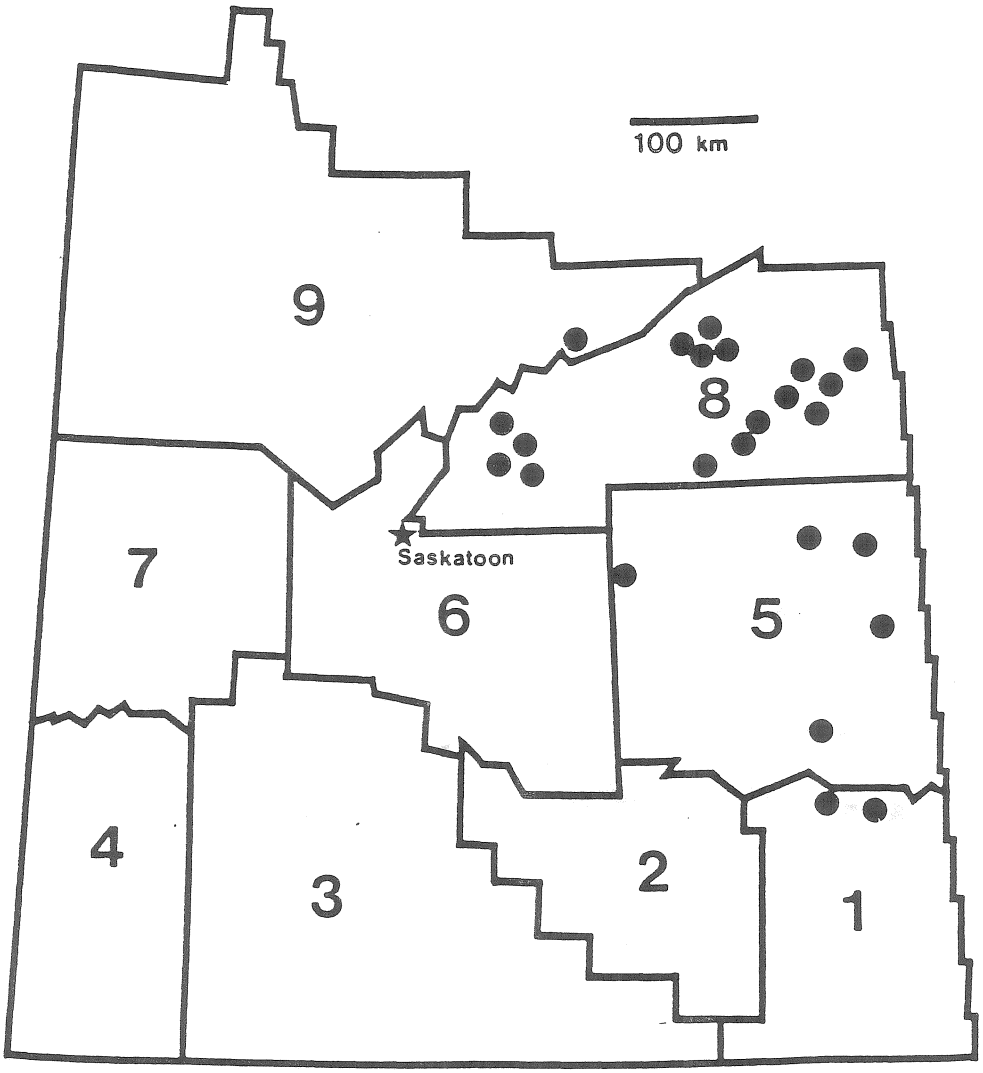

Figure 9 Leaf and stem rust incidence, 1985 and 1987

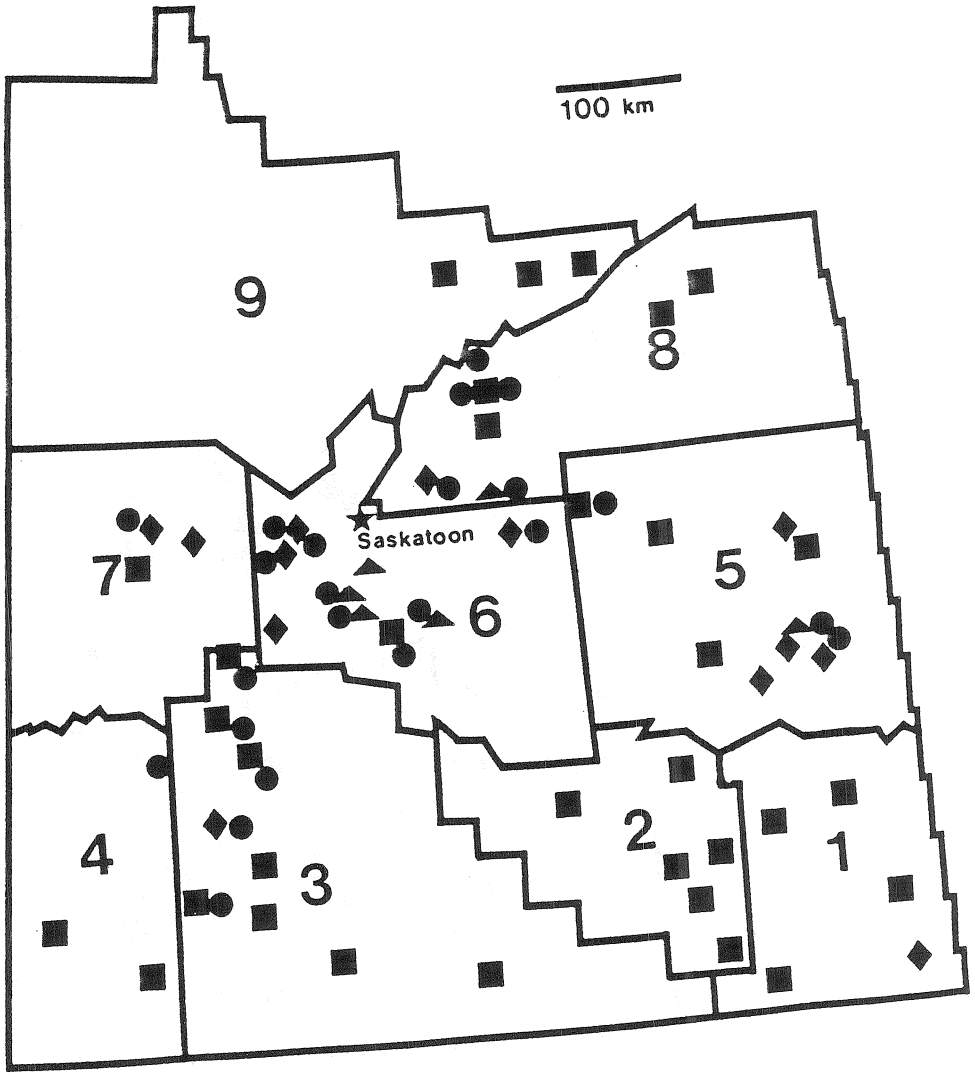

Figure 10 Leaf and stem rust, June 16 - July 9, 1986

■ mild leaf rust
◆ moderate leaf rust
▲ severe leaf rust
● trace stem rust

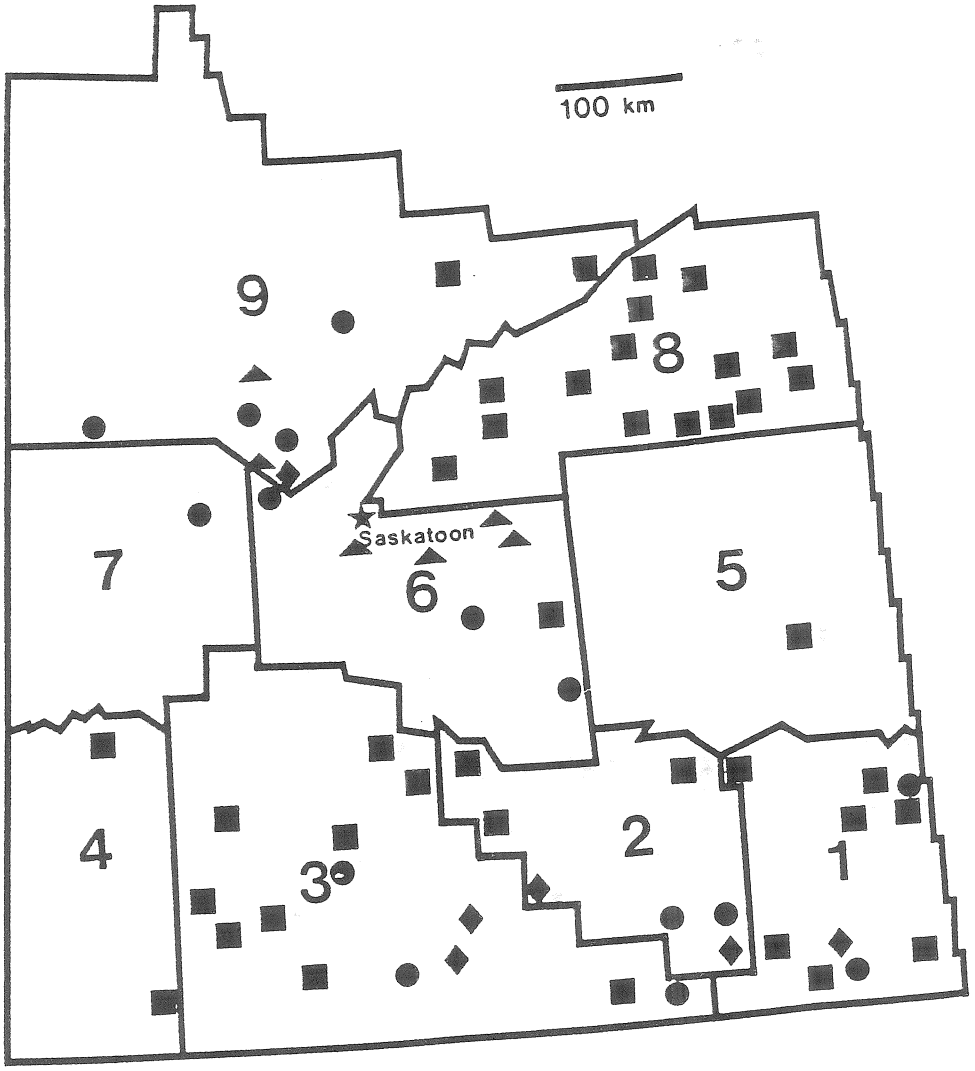

Figure 11 Stem rust severity, July 21 - 30, 1986

■ 1 - 5 %
● 6 - 10 %
◆ 11 - 25 %
▲ > 25 %