Distribution, severity, and relative importance of leaf spot diseases of wheat in western Canada in 1974[1]

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The leaf spot diseases spot blotch *[Bipolaris sorokiniana],* tan spot *[Drechslera tritici-repentis*], and speckled leaf blotch *[Septoria avenae* f. sp. *triticea]* caused insignificant damage to wheat *(Triticum aestivum* and *T. durum*) in western Canada in 1974, although infections were widespread. Spot blotch and tan spot occurred commonly in Manitoba and Saskatchewan but were rare in Alberta. Speckled leaf blotch, the least common disease, was found in all three provinces. Artificial inoculations indicated that spot blotch symptoms were distinguishable from those of tan spot and speckled leaf blotch, but that symptoms of the last two diseases were difficult to differentiate. Tan spot and speckled leaf blotch killed infected leaves within 21 days. The widespread distribution and potential for foliar damage of *D. tritici-repentis* indicate that it is the most important leaf spot pathogen of wheat in western Canada.

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En 1974, l'helminthosporiose *[Bipolaris sorokiniana],* la tache helminthosporienne *[Drechslera tritici-repentis]* et la tache septorienne *[Septoria avenae* f. sp. *triticea] ont cause des dégâts négligeables au blé dans l'ouest du Canada, même si les infections etaient largement repandues. L'helminthosporiose et la tache helminthosporienne etaient frequentes au Manitoba et en Saskatchewan, mais ont ete rarement observees en Alberta. La tache septorienne, maladie la moins courante, a ete constatee dans les trois provinces. Des inoculations artificielles ont révélé que les symptômes de l'helminthosporiose se distinguaient de ceux de la tache helminthosporienne et de la tache septorienne. mais qu'il était difficile de differencier ces deux dernieres maladies. lesquelles détruisent les feuilles infectees en moins de 21 jours. La large distribution de la tache helminthosporienne et les possibilites de dégâts foliaires montrent que c'est la plus importante tache des feuilles du blé dans l'ouest du Canada.*

The fungi *Bipolaris sorokiniana* (Sacc. in Sorok.) Shoem., *Drechslera tritici-repentis* (Died.) Shoem., and *Septoria avenae* Frank f. sp. *triticea* T. Johnson have been associated with the leaf spot disease complex on wheat in Manitoba and Saskatchewan in recent years (1,7,8). These organisms cause the foliar diseases spot blotch, tan spot or yellow leaf blotch, and speckled or septoria leaf blotch, respectively. In disease loss surveys in 1969, 1970, and 1971, the various diseases were recorded as a single entity, "leaf spots", because of similar field symptoms. Leaf rust caused by *Puccinia recondita* Rob. ex Desm. was not included in the leaf spot category. Yield losses from leaf spots, as a percentage of potential production, were calculated to be 3.0% in Manitoba in 1969 (7), 3.2% in Manitoba, and 4.2% in Saskatchewan in 1970 (8), and 3.5% in Manitoba in 1971 (1). These were the largest or second largest components of the total yield loss in the three years.

In Alberta in 1970, wheat leaf diseases caused by *Septoria* sp. and by *Erysiphe graminis* DC. ex Mérat were found, but losses were unimportant (9). Studies in North Dakota showed that in some years *Helminthosporium sativum* (syn. *Bipolaris sorokiniana)* and *S. avenae* f. sp. *triticea* caused severe leaf spot damage to wheat (2) and that *Pyrenophora trichostoma* (Fr.) Fckl. (perfect stage of *D. tritici-repentis)* caused the most prevalent foliar disease in the region and accounted for significant yield losses (3,4).

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Because leaf spot diseases of wheat have been [prevalent and caused significant losses in recent years, this study was initiated in 1974 to assess the present importance of these diseases in western Canada and to elucidate techniques for their detection and identification.

Materials and methods

The first of two disease surveys was carried out from 27 July to 3 August 1974. It encompassed wheat growing regions in the southern and central portions of the three prairie provinces and extended from Winnipeg, Manitoba westward to Calgary, Alberta. The second survey, on 26 and 27 August extended from 30 miles north to 60 miles south of Winnipeg. Wheat fields were examined and sampled for diseases at 5-20 mile intervals along the routes.

In each field, leaf spot disease incidence and severity was observed along a 10-m diagonal transect, commencing 10 m from the edge of the road. Disease severity ratings were based on the number and size of lesions on the upper two leaves of plants using a scale with the values 0, 1, 2, 3, and 4. Qualitatively, these numbers correspond to no infection, light, moderate, heavy, and very heavy infections respectively, but they also agree closely with the quantitative values 0, 1, 5, 25, and 50% of total leaf area affected, as illustrated by James (5). In addition, the value trace (tr) was used for very light infections when the number of lesions averaged less than one per leaf on the plants examined.

Usually no attempt was made to distinguish between diseases. A total disease rating for leaf spots was recorded along with the stage of growth and the type of wheat grown (common, ***Triticum aestivum*** L., or durum, ***T. durum*** Desf.).

When leaf spot symptoms were present, a number of flag and second leaves were collected for isolation and identification of the pathogen(s). If symptoms were present on the lower leaves only, these leaves were collected for isolation of pathogenic species although the disease severity rating of the field was zero.

Fungi were isolated from lesions by placing surface sterilized sections of infected leaf tissue in petri dish moist chambers, incubating for 48 to 96 h at 20°C to induce sporulation, and transferring the conidia produced to plates of 10% V8-juice agar with a sterile needle. Identification of isolates was based on published morphological and cultural characters (6,10,11). A maximum of three separate attempts was made to isolate pathogenic species from each collection. Negative results or the presence only of known saprophytic species, resulted in a change in the leaf spot severity rating to zero.

Pathogenicity of isolated cultures was tested by inoculation of healthy wheat seedlings. Five to eight seeds of the common wheat cultivars Glenlea, Manitou, and Napayo were planted in three clumps per 15 cm clay pot. They were kept in a growth cabinet at 17 - 22°C and a 16-h photoperiod. The plants were inoculated at the three- to four-leaf stage, incubated for 24 h at 20°C and 100% R H, and checked for disease development 7 days after inoculation. Inoculum of ***D. tritici-repentis*** was prepared by homogenizing a 7-day-old single spore culture grown on 10% V8-juice agar with 100 ml sterile distilled water in a Waring Blendor. ***Septoria avenae*** f. sp. ***triticea*** cultures were of mass conidial origin and were grown in 40 ml potato-sucrose liquid medium for 7 days, made up to 100 ml with water and homogenized as above. One drop of Tween 20 per 50 ml of suspension was added to all inocula used. Plants were inoculated by dipping each clump of leaves into the inoculum suspension in a 250 ml graduated cylinder and swirling the contents for approximately 15 sec. Inoculum of ***B. sorokiniana*** was prepared by washing the conidia and conidiophores from the surface of a 7-day-old culture growing on 10% V8-juice agar, and adjusting the concentration to produce an aqueous suspension of 10^4 propagules per ml. This was sprayed on the plants at a rate of about 7 ml suspension per pot with a DeVilbis atomizer fitted to an electric pump. Symptoms were recorded 7 days after inoculation and some plants were kept for an additional 14 days to observe disease development.

Results

Manitoba, Saskatchewan, and Alberta survey

The route followed, some points of reference, and the location of the 141 wheat fields sampled for this survey are shown in Fig. 1. Plants in most fields were in flower or in the milky-to soft dough stages of growth. Seventy-nine locations (56%) were rated disease-free, that is, showed no disease on the upper two leaves. Symptoms of leaf rust, powdery mildew, or leaf spots were found in the remaining 62 (44%) fields. Leaf rust was found in trace amounts in 30 fields (21% of the total, 48% of those diseased) throughout the surveyed region. Powdery mildew was seen only in Alberta, where disease severity in the nine fields involved was in the tr–1 range with one field rated at 1–2, that is light to moderate infection. The lower leaves on most plants were more heavily infected. Leaf spots were seen at 43 (31% of total, 69% of those with disease) of the sampled locations. Typically the lesions were small (1–3 mm long), roughly oval in shape, and they ranged in color from light tan to dark brown. There was little or no chlorosis evident in most cases. In a few instances, minute pycnidia were clearly visible in the lesions, and these were rated for disease severity as ***Septoria*** sp. symptoms. Only trace amounts were recorded. Overall, leaf spot severity was rated as very light (tr) at all locations other than one field in west-central Saskatchewan where a light to moderate (1–2) infection was found.

Isolations made from the 43 collections with leaf spot symptoms yielded cultures of ***D. tritici-repentis*** from 23 (54%), ***B. sorokiniana*** from 16 (40%) and ***S. avenae*** f. sp. ***triticea*** from 9 (21%). The distribution is shown in Fig. 1 A, B, and C. In addition, ***D. tritici-repentis*** was isolated from lower leaves from two fields in south-central Saskatchewan, and ***B. sorokiniana*** and S. ***avenae*** f. sp. ***triticea*** from one field west of Yorkton. There was no difference in leaf spot incidence or severity on common and durum wheat. Thirty-one of the 141 fields sampled were planted to durum cultivars.

D. tritici-repentis was isolated from leaf spots in collections from all three Prairie Provinces but was found only once in Alberta. The greatest concentration of this pathogen was in central Saskatchewan from Saskatoon to the Alberta border. Eight out of nine fields sampled in this 150 mile section were infected, and one of these had the highest leaf spot severity found in the survey. ***B. sorokiniana*** was not found in Alberta, but was widespread in the other two provinces. S. ***avenae*** f. sp. ***triticea*** was isolated less frequently than the other two pathogens, but was found in all three provinces primarily along the northern transect of the survey route.

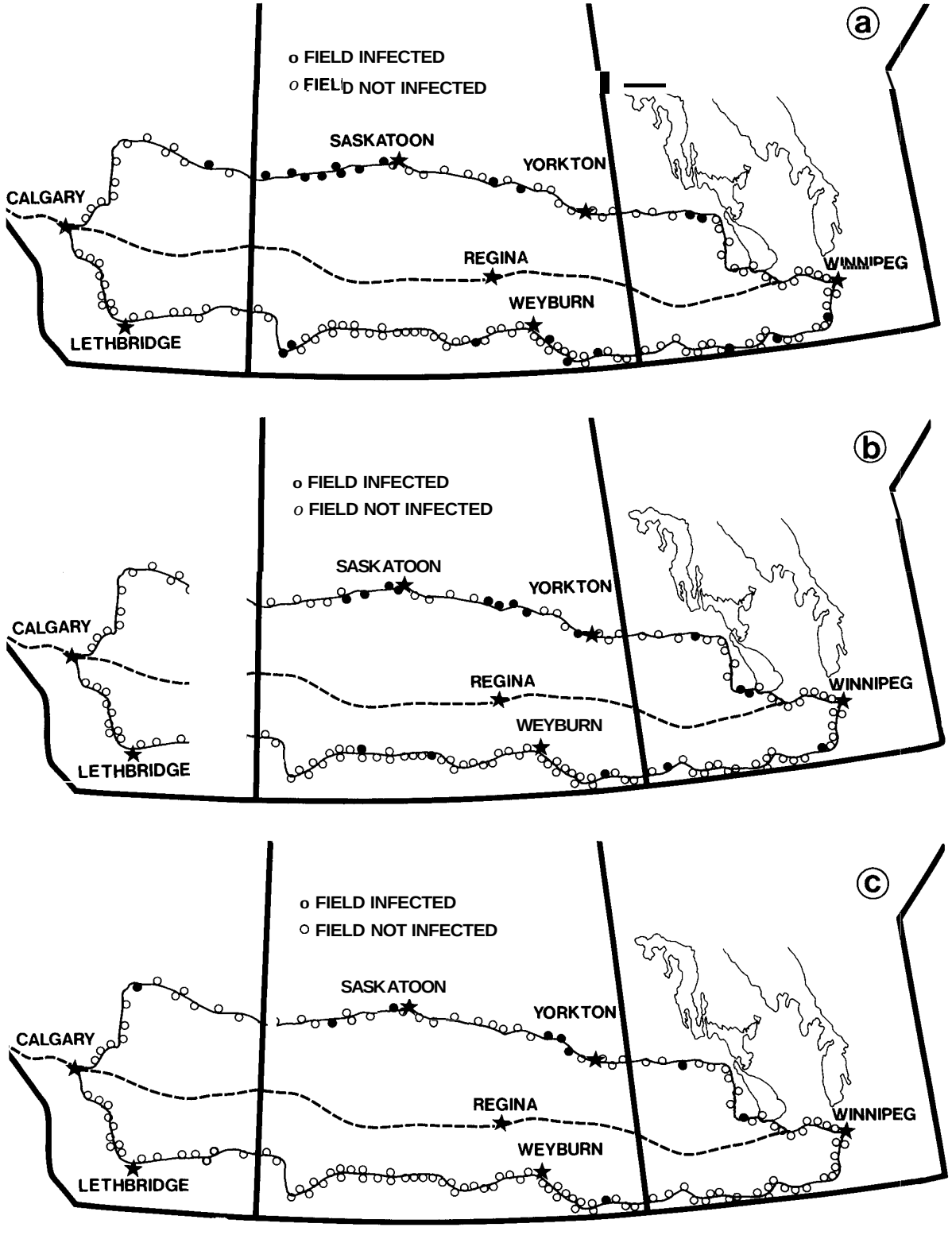

Figure 1. Distribution of wheat fields infected with A) tan spot [*Drechslera tritici-repentis*]; B) spot blotch [*Bipolaris sorokiniana]* and C) speckled leaf blotch [*Septoria avenae* f. sp. *triticea*] on the Canadian Prairies during 1974.

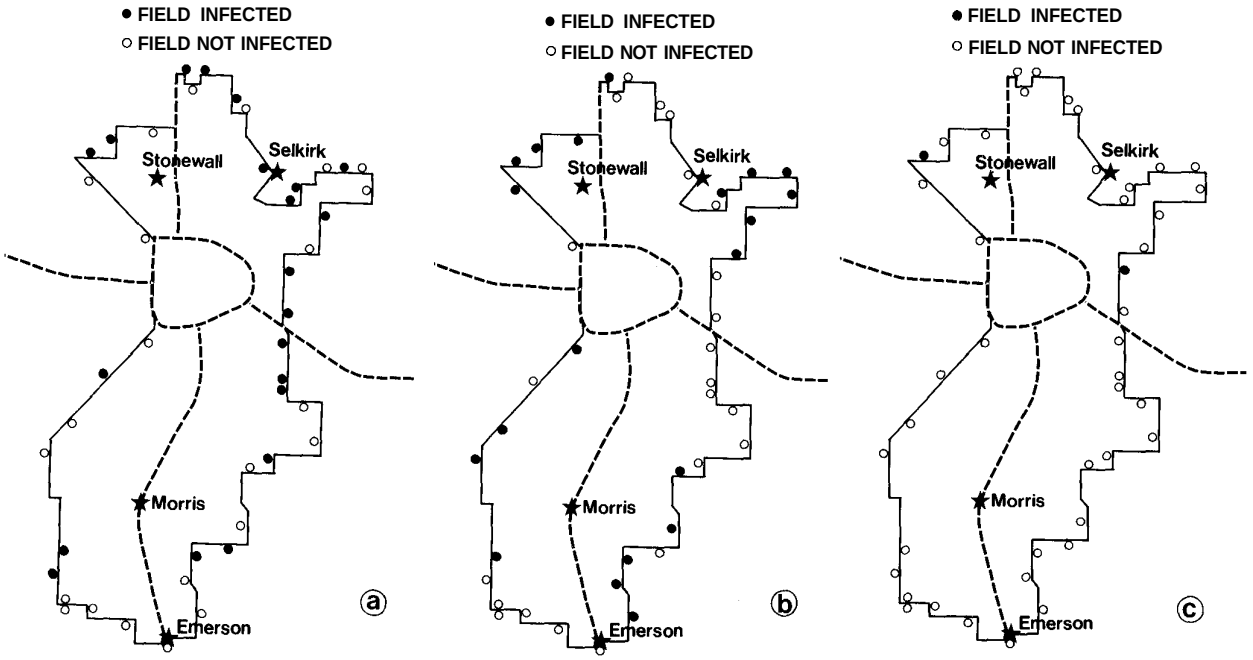

Figure 2. Distribution of wheat fields infected with A) tan spot [*Drechslera tritici-repentis];* B) spot blotch [*Bipolaris sorokiniana]* and C) speckled leaf blotch [*Septoria avenae* f. sp. *triticea]* in the Winnipeg, Manitoba, region during 1974.

Winnipeg region survey

The locations of the 43 wheat fields sampled are shown in Fig. 2. The plants were all at the milky-to soft dough stage. Foliar diseases were found in all fields, with leaf spots present in 39 (91%) and leaf rust in 36 (84%). Leaf rust incidence was moderate at many locations and heavy at a few others. Leaf spot severity was very light to light (tr-1) in most fields, but light to moderate (1-2) in a few cases. *D. tritici-repentis* was isolated from 22 (56%) of the 39 collections showing leaf spot symptoms, ***B. sorokiniana*** from 25 (64%) and S. ***avenae*** f. sp. ***triticea*** from 2 (5%). The first two pathogens were found throughout the surveyed region but ***Septoria*** was rare (Fig. 2, **A, B,** *C).*

B. sorokiniana sporulated profusely in moist chambers within 48 h. Sporulation of *D. tritici-repentis* was variable; usually small numbers of spores were produced but in a few collections sporulation was heavy. One of the heavily sporulating isolates was from the field in Saskatchewan with the highest leaf spot severity. Sporulation on agar medium was proportionate to that on incubated leaf material. Transfer of *D. tritici-repentis* by the single spore method from either leaf lesions in moist chambers or culture plates was difficult because the conidia shrivelled quickly when the petri dish tops were lifted and the cultures exposed to ambient laboratory air. The conidia either fell from the conidiophores or became undistinguishable from them so that finding and transferring single spores was difficult, particularly from poorly sporulating cultures. Pycnidia of ***S. avenae*** f. sp. ***triticea*** were present on infected leaf material after 72 to 96 h. They were light reddish-brown, and some exuded pink-colored gelatinous droplets containing conidia of the pathogen.

Abundant symptoms were produced on wheat seedlings inoculated in the laboratory with all three pathogens. Lesion development after 7 days was similar to that found on the top leaves of mature plants in field surveys. Spot blotch lesions were small, irregularly oval, dark brown with a lighter center, and surrounded by a slight chlorotic zone (Fig. 3). Symptoms of tan spot and speckled leaf blotch were difficult to distinguish from each other. Lesions of both diseases were light tan in color, often with a darker center, irregularly oval to pointedly elongate, and often with distinct chlorotic zones extending in a longitudinal direction (Fig. 3). About 21 days after inoculation, lesions caused by ***B. sorokiniana*** were little changed from those described above. Their development seemed arrested, and unaffected leaf parts remained green in color. In contrast, the leaves infected with the other two pathogens became chlorotic and by 21 days after inoculation were shrivelled and necrotic. This process was often more rapid in leaves inoculated with *D. tritici-repentis.* Only a few leaves of the plants infected with S. ***avenae*** f. sp. ***triticea*** developed pycnidia after 21 days in the growth cabinet.

Discussion

In 1974 conditions for disease development were poor across the prairies for pathogens requiring frequent or prolonged periods of precipitation and high humidity. In

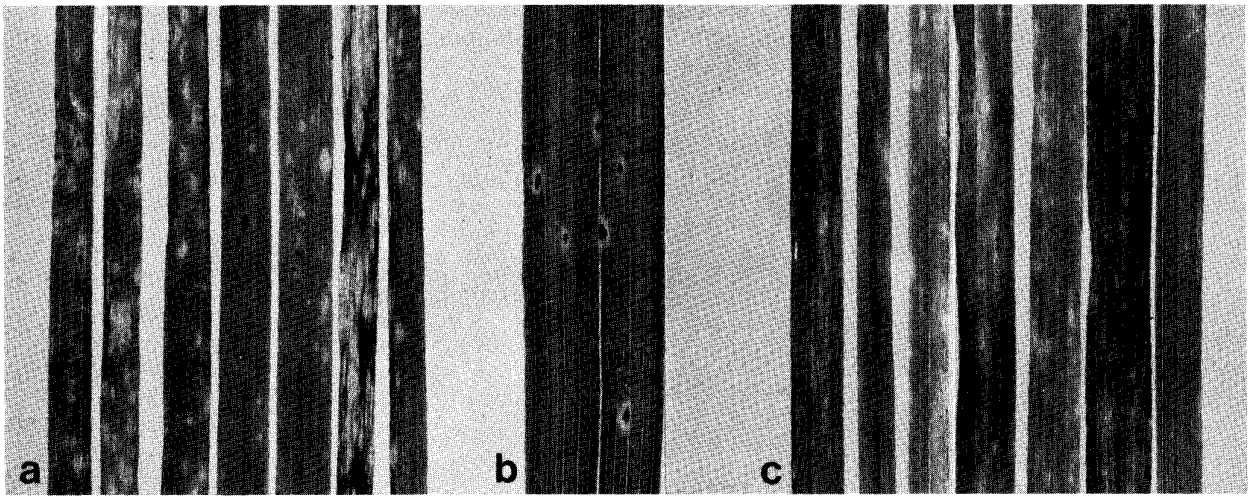

Figure 3. Symptoms produced by A) ***Drechslera tritici-repentis;*** B) ***Bipolaris sorokiniana;*** and C) ***Septoria avenae*** f. sp. ***triticea*** on wheat leaves 7 days after inoculation

several regions, little or no rain fell for the first 2 months of the growing season and consequently disease incidence was low. During the second survey, later in the growing season, infections were more common but severity remained low. Rainfall in the Winnipeg region in the latter part of August presumably favored infection, but little disease development was evident at the time of this survey. Fungal leaf spots likely did not cause appreciable reductions in wheat yields on the prairies during 1974. It is likely that with more favorable environment conditions for disease development and/or more extensive surveys of the crop regions, particularly in Alberta, the distribution and severity of this group of pathogens would be greater than that found in 1974.

Leaf spot symptoms were readily induced on potted wheat plants using the methods of inoculation described. Inoculation by the dipping method, as carried out for ***D. tritici-repentis*** and *S.* ***avenae*** f. sp. ***triticea,*** was quite tedious but necessary because preliminary tests had shown inoculum made up primarily of mycelial fragments was reliable only if applied in this manner. Inoculum consisting largely of conidia, such as that of ***B. sorokiniana,*** could be applied successfully by the spraying method.

Symptoms produced by ***B. sorokiniana*** were distinct from those of the other two leaf spot pathogens. It is possible that familiarity with symptoms would permit field identification of spot blotch. It is unlikely, however, that field symptoms of tan spot and speckled leaf blotch could be reliably distinguished. Although the occurrence of pycnidia in tan-colored lesions would indicate infection by ***Septoria,*** pycnidia are not always present. Septoria lesions with pycnidia are often found in abundance very late in the growing season on senescent wheat foliage, but most develop too late to cause appreciable yield losses.

The sparse sporulation of many isolates of *D.* ***tritici-repentis*** and the difficulty at times in recognizing the conidia suggests that this pathogen may have been underestimated in the past. This study indicates that because of its widespread distribution in two of the prairie provinces in 1974 and its potential to cause severe damage to young foliage ***D. tritici-repentis,*** the incitant of tan spot, is the most important leaf spot pathogen of wheat in western Canada.

Literature cited

1. Hagborg, W.A.F., A.W. Chiko, G. Fleischmann, C.C. Gill, G.J. Green, J.W. Martens, J.J. Nielsen, and D.J. Samborski. 1972. Losses from cereal diseases in Manitoba in 1971. Can. Plant Dis. Surv. 52:113-118.
2. Hosford, R.M. Jr. 1969. Diseases of wheat in North Dakota. Wheat Newsletter. 15:101.
3. Hosford, R.M. Jr. 1971. A form of ***Pyrenophora trichostoma*** pathogenic to wheat and other grasses. Phytopathology 61:28-32.
4. Hosford, R.M. Jr. 1971. Wheat leaf blight and blotch - Losses and control. North Dakota Farm Res. 19(1):5-8.
5. James, W.C. 1971. A manual of assessment keys for plant diseases. Canada Dep. Agric Publ. 1458.
6. Johnson, T. 1947. A form of ***Leptosphaeria avenaria*** on wheat in Canada. Can. J. Research, C, 25:259-270.
7. McDonald, W.C., J.W. Martens, G.J. Green, D.J. Samborski, G. Fleischmann, and C.C. Gill. 1969. Losses from cereal diseases and value of disease resistance in Manitoba in 1969. Can. Plant Dis. Surv. 49:114-121.
8. McDonald, W.C., J.W. Martens, J. Nielsen, G.J. Green, D.J. Samborski, G. Fleischmann, C.C. Gill, A.W. Chiko, and R.J. Baker. Losses from cereal diseases and value of disease resistance in Manitoba and eastern and northern Saskatchewan in 1970. Can. Plant Dis. Surv. 51:105-110.
9. Piening, L.J. 1971, A disease survey of cereals in central and northern Alberta. 1970. Can. Plant Dis. Surv. 51:101-104.
10. Shoemaker, R.A. 1959. Nomenclature of ***Drechslera*** and ***Bipolaris,*** grass parasites segregated from ***'Helminthosporium'***. Can. J. Bot. 37:879-887.
11. Shoemaker, R.A. 1962. ***Drechslera*** Ito. Can. J. Bot. 40:809-836.