Black point incidence in soft white spring wheat in southern Alberta and Saskatchewan between 1982 and 1987

R.L. Conner and A.D. Kuzyk[1]

Analysis of results from a 6-year survey of irrigated fields of soft white spring wheat determined that the annual percentage of fields in southern Alberta that would have been downgraded because of black point ranged between 19 and 54%. In 1982 and 1984, disease incidence was substantially higher in Saskatchewan and would have caused downgrading in almost every field sampled. Regional differences in black point incidence were apparent each year and usually were related to differences in amount of precipitation received during the last week in July and the first two weeks in August, which corresponds to the time when kernel development occurred in most fields. Large differences in black point incidence were observed between fields in the same area, which suggested that disease incidence was also being influenced by differences in irrigation and cultural practices. No consistent relationship was found between type of irrigation system and disease incidence. Isolations from infected kernels indicated that black point was caused primarily by *Alternaria alternata* and that *Cochliobolus sativus* was of only minor importance.

Can. Plant Dis. Surv. 68:1, 27-31, 1988.

D'après l'analyse des résultats d'une enquête de 6 ans sur les champs irrigués de blé blanc tendre de printemps, le pourcentage annuel de champs dans le sud de l'Alberta qui auraient été classes à la baisse en raison de l'infection par le point noir s'établissait entre 19 et 54 %. En 1982 et 1984, la frequence de la maladie était nettement supérieure en Saskatchewan et aurait entraîné une baisse de classement dans presque tous les champs échantillonnés. Chaque année, il y avait des differences régionales dans la fréquence de point noir qui étaient habituellement liées aux differences dans la quantité de precipitations au cours de la dernière semaine de juillet et des deux premieres semaines d'août, soit pendant le développement du grain dans la plupart des champs. On a observe de grandes differences dans la frequence de point noir entre les champs d'une même region, ce qui donne à penser que les differences dans l'irrigation et les pratiques culturales peuvent également influer sur la frequence de la maladie. On n'a pas trouvé de relation constante entre le type de système d'irrigation et la frequence de la maladie. D'après la frequence d'isolement des divers organismes pathogènes dans les grains infectés, le point noir était causé surtout par *Alternaria altemeta* et très rarement par *Cochliobolus sativus*.

Introduction

Black point is a leading cause of downgrading in soft white spring wheat grown in western Canada (2). In North America, black point is caused primarily by *Alternaria alternate* (Fr.) Keisler = (*A. tenuis* Nees.) or *Cochliobolus sativus* (Ito and Kurib.) Dreschl. ex Dastur, conidial state *Bipolaris sorokiniana* (Sacc. in Sorok.) Shoem., syn. *Helminthosporium sativum* Pammel, King and Bakke. (1,6,7,9,10). The relative importance of these fungi in causing black point varies between years and with location (1,6,7,9). Fielder and Owens, the soft white spring wheat cultivars currently grown in western Canada, are susceptible to *A. alternata* (5).

Black point is characterized by a brown to black discoloration of the germ end of the kernel. Grain containing more than 10, 15 or 35% black point kernels is downgraded to grades C.W.S.W. 2, 3 and Canada Western Feed, respectively (3). The nutritional properties of the flour are not impaired by the disease but the discolored appearance of the flour is regarded unfavorably by the consumer (2).

Black point incidence is strongly influenced by environmental conditions. The disease is most serious under irrigation or in areas receiving heavy rainfall during kernel development (4,7). It is therefore frequently a problem in soft white spring wheat which is grown exclusively under irrigation. Timing of irrigation has a major effect on black point incidence (4). In areas where air-borne spores of the pathogens are not limiting, heavy irrigation during the milk or mid-dough stages (Growth stages 11.1 and 11.2 respectively, Feekes scale) (7) results in a sharp increase in black point incidence. In western Canada, the crop is grown under either a flood-, pivot- or wheel move-irrigation system. The influence of the type of irrigation on black point incidence has not been reported.

The objectives of this study were to survey commercial fields of soft white spring wheat to determine the extent of downgrading caused by this disease, determine the influence of type of irrigation system on disease incidence, and identify the fungi responsible for the disease.

Materials and methods

Field survey. Between 1982 and 1987, soft white spring wheat fields throughout the irrigated region of southern Alberta were surveyed for black point at the end of the growing season. In Alberta, 75 fields were examined in 1982, 107 in 1983, 110 in 1984, 111 in 1985, 79 in 1986, and 72 in 1987. In Saskatchewan, samples were received from 17 fields in 1982 and 14 fields in 1984. Fields were randomly selected but an attempt was made to sample fields in the same vicinity that were grown under flood-, pivot- and

[1] *Research Station, Agriculture Canada, Lethbridge, Alberta, T1J 4B1.*

Accepted for publication December 22, 1987.

wheelmove-irrigation systems. Only ripe fields were sampled and areas with high numbers of late fields were left for sampling at a later date. In each field, approximately 30-40 spikes were collected from sites well into the irrigated portion of each field. Between 1982 and 1985, samples from different sites within each field were combined into a single sample. In 1986 and 1987, three samples taken at 50-m intervals from each field were collected separately and used to determine black point incidence. Field samples were air-dried for a week or more before they were threshed and examined for black point symptoms. The incidence of black point in a field was determined based on the average percentage of black point kernels in 200-kernel samples from each site. Information on precipitation during each growing season was obtained from weather stations located in Lethbridge, Taber, Vauxhall, Brooks, Bow Island, Medicine Hat, and Outlook. Weather information was used to explain any obvious regional differences in disease incidence.

Identification of causal organisms. The identity of the fungi infecting the kernels was determined from a 100-kernel sample containing healthy and black point kernels. The kernels were surface-sterilized in a 1:1 mixture of 6% sodium hypochlorite and 95% ethanol for 45 seconds. Then the kernels were aseptically transferred on to moistened filter paper in sterile petri dishes and were placed in the dark at 21°C for 5 days after which they were examined under the stereomicroscope. A small percentage of the fungi did not sporulate and could not be identified in this manner. The non-sporulating fungi were induced to sporulate by plating surface-sterilized seed on potato dextrose agar. Two weeks later, the identity of the fungi growing from each infected seed was determined.

Each year, a paired comparison was made of the percentage of kernels infected by A. *alternata* in samples of healthy and black point kernels from 10 fields. Thirty healthy and black point kernels from each field were surface-sterilized, plated on moist filter paper and later examined for colonization by A. alternafa. A paired t-test was used to determine whether the black point samples differed significantly from the healthy samples for number of kernels infected by A. alternata.

Results and discussion

Each year, black point incidence in an area was influenced by the amount of precipitation received in the last week in July and first two weeks in August (Table 1). This coincided with the period when most crops were at the milk and dough stages, which are the stages most prone to the disease (4). Dry conditions during the early stages of kernel development always resulted in a low disease incidence but it was also noted in several instances that substantial rainfall during this period did not result in a high black point incidence.

In 1982 and 1984, disease incidence was substantially higher in Saskatchewan than in Alberta (Table 2). In both years, the high disease incidence appeared to be due to heavier precipitation in the Lake Diefenbaker area in July and August. Only one field out of the 31 fields surveyed in Saskatchewan during 1982 and 1984 would not have been downgraded because of high black point incidence.

Regional differences in black point incidence were apparent in Alberta in each year of the study. In 1982, dry conditions rasulted in a low black point incidence in most Alberta fields (Fig. 1). Only the area southeast of Brooks had a high incidence of black point and this area received the heaviest rainfall during the last week of July and the first two weeks of August (Table 1). In 1983, black point incidence was highest in fields near Taber and Brooks, which also had heavy rainfall during kernel development (Fig. 2). In 1984, frequent showers at the end of July and in early August appeared responsible for a higher disease incidence than in the two previous years (Fig. 3). The major exceptions were the Bow Island-Medicine Hat areas where dry conditions generally kept black point incidence low. In 1985, the extremely dry conditions around Lethbridge kept black point incidence low (Fig. 4). Medicine Hat and Bow Island received a heavy shower at the middle of August but this did not offset the effect of dry conditions prior to this and did not result in a high black point incidence. Ihe occasional shower in the other areas resulted in higher levels of disease. Conditions in Alberta during 1986 and 1987 were generally conducive for disease development (Fig. 5-6). However, disease incidence was low around Lethbridge and Taber in 1986 because of low rainfall in July and August. In 1987, high black point incidences in the Lethbridge area appeared to be related to a heavy rainfall (46 mm) on July 23-24, which resulted in heavy dew formation during the early stages of kernel development. Other locations did not receive heavy precipitation on this date but subsequent rainfalls during early kernel development (Table 1) were responsible for high incidences of black point.

Table 1. Amount of rainfall received in the last week of July and first two weeks in August at locations surveyed between 1982 and 1987*.

	Rain (mm) received at:						
Year	Lethbridge	Taber	Vauxhall	Brooks	Bow Is.	M. Hat	Outlook
1982	10.8	10.2	22.6	20.0	17.4	11.1	31.4
1983	15.2	22.9	17.6	36.5	0.5	5.8	**
1984	30.9	51.2	24.2	51.6	13.4	10.9	58.0
1985	7.0	31.5	21.8	26.0	21.8	25.0	**
1986	9.1	18.9	21.2	33.1	26.5	26.7	**
1987	19.8	38.8	26.6	77.0	82.8	14.2	**

Bow Is. = Bow Island, M. Hat = Medicine Hat.

* Based on data from the Daily Weather Bulletin issued by Climate Services – Central Region, Environment Canada.

** Area not sampled.

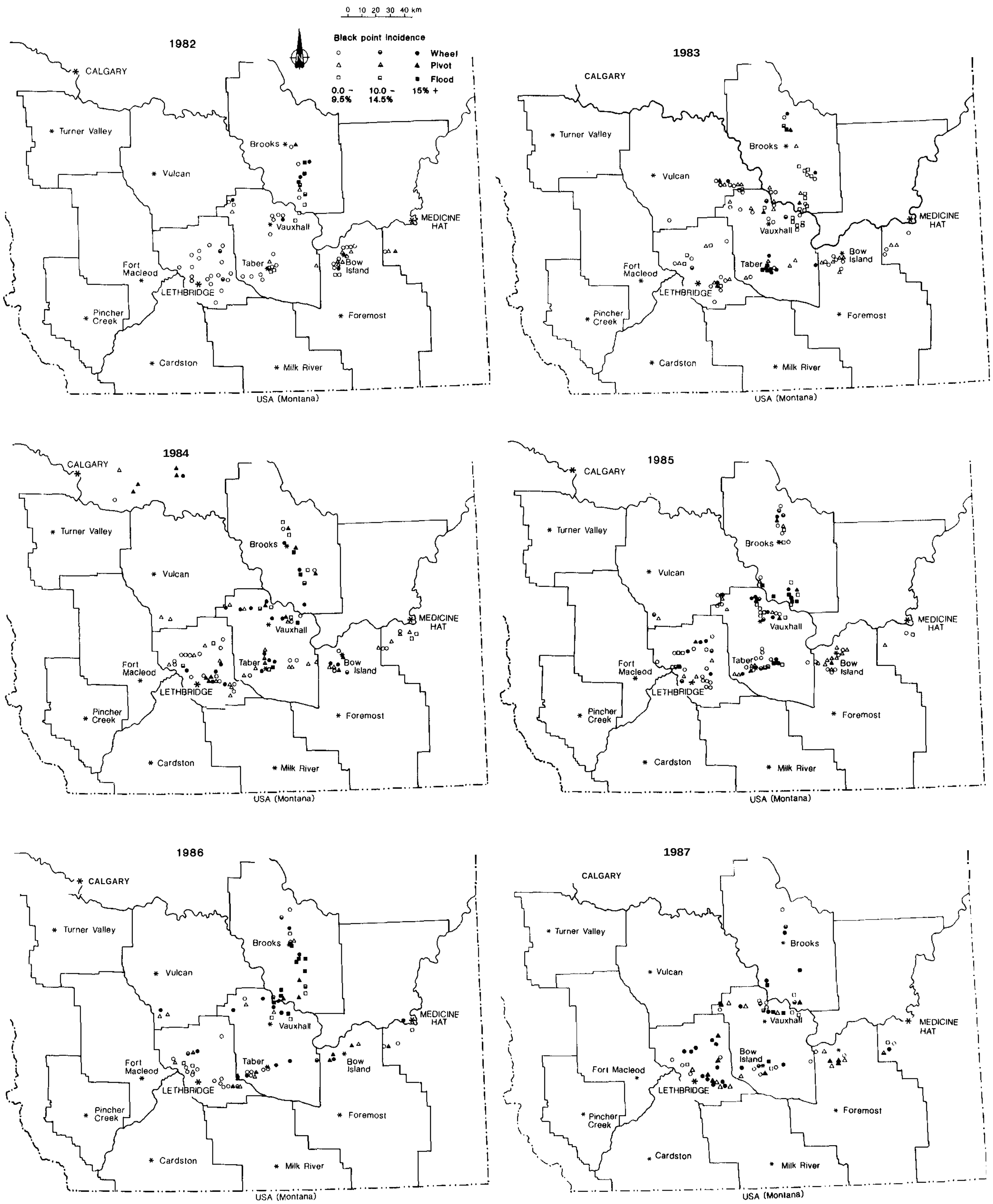
Table 2. Distribution of black point incidence in soft white spring wheat fields under different irrigation systems between 1982 and 1987.

Type of irrigation and year	Average black point incidence	Number of fields with black point incidence (%): 0.0–9.5	10.0–14.5	15.0–35.0	35.0 +	Total field number
1982 Alta.*						
Flood	9.7 ± 2.5†	6	2	3	0	11
Pivot	3.0 f 1.3	11	2	0	0	13
Wheelmove	5.0 ± 1.0	44	2	5	0	51
1982 Sask.						
Flood	25.2 f 6.0	0	1	2	1	4
Pivot	19.1 f2.0	0	5	6	0	11
Wheelmove	37.0 f 1.0	0	0	0	2	2
1983 Alta.						
Flood	6.0 f 1.4	21	1	4	0	26
Pivot	6.3 f 1.0	27	3	1	0	31
Wheelmove	7.5 f 1.1	39	3	8	0	50
1984 Alta.						
Flood	8.1 ± 1.8	12	3	3	0	18
Pivot	11.0 ± 1.7	27	5	11	2	45
Wheelmove	13.4 f1.9	26	1	17	3	47
1984 Sask.						
Flood	21.0 ± 10.0	1	0	1	1	3
Pivot	25.5 ± 3.3	0	1	7	1	9
Wheelmove	14.5 f3.5	0	1	1	0	2
1985 Alta.						
Flood	11.5 ± 2.0	11	2	9	0	22
Pivot	6.8 ± 1.4	22	5	2	1	30
Wheelmove	9.4 ± 1.2	39	9	8	3	59
1986 Alta.						
Flood	14.4 ± 3.0	7	3	5	3	18
Pivot	13.3 ± 2.2	10	5	6	1	22
Wheelmove	11.2 ± 1.5	20	5	14	0	39
1987 Alta.						
Flood	14.8 ± 3.8	7	1	4	1	13
Pivot	18.1 ± 3.9	11	2	6	3	22
Wheelmove	18.9 ± 2.9	15	4	12	6	37

* Alta. = Alberta, Sask. = Saskatchewan. † Mean +standard error of the mean.

It was observed in dry years that irrigation in many fields continued until quite late in the growing season and might have increased disease incidence. In most years, the low black point incidence in the area north and west of Lethbridge appeared to be due to a combination of dry conditions and the early curtailment of irrigation caused by a lack of sufficient water reserves in the irrigation district.

No consistent relationship was found between disease incidence and type of irrigation system (Table 2). Each year, high disease incidences were found in at least a few fields grown under each type of irrigation system. During the study, the type of irrigation system associated with the highest average black point incidence was evenly split between wheelmove- and flood-irrigation with 3 years each. However, the apparent



Figs. 1-6. Maps showing black point incidence and the approximate location of the fields of soft white spring wheat surveyed between 1982 and 1987.

Table 3. Identity of the fungi infecting samples of soft white spring wheat from Alberta and Saskatchewan between 1982 and 1987.

Year	Prov.*	Percentage of kernels infected with :					
		Black Point**	*Alternaria*	*C. sativus*	*Fusarium*	Other?	Healthy
1982	AB	5.3 ± 0.8 ††	30.9 ± 1.7	0.6 fO.1	2.1 ± 0.2	5.1 ± 0.4	61.4 ± 2.0
1982	SK	22.7 f2.3	38.6 f2.9	0.9 f0.2	1.1 f0.2	2.2 ± 0.4	57.1 f3.0
1983	AB	6.8f0.7	24.3 10.8	0.6 fO.1	4.4 f0.3	9.0 ± 0.4	61.6 ± 1.2
1984	AB	11.6f1.1	23.0 ± 1.2	0.8f0.1	2.1f0.2	6.5 f 0.4	67.7 f 1.4
1984	SK	23.0 f3.0	51.6 f3.2	0.6 f0.3	1.9 k0.4	3.6 ± 3.6	42.4 f 3.7
1985	AB	9.2 f0.9	42.0 ± 1.6	0.8 fO.1	2.6 f0.2	9.3 f0.5	45.0 ± 1.7
1986	AB	12.5 ± 1.2	50.6 f1.3	0.2 fO.1	3.3 f0.2	26.1 k0.9	19.3 ± 1.3
1987	AB	17.9f1.9	57.0 ± 1.7	0.3f0.1	2.0 ± 0.2	6.0 f0.5	34.7 f 1.6

* AB = Alberta, SK = Saskatchewan.

** Black Point = black point incidence.

† Other = mainly ***Cladosporium*** spp., ***Penicillium*** spp. and ***Aspergillus*** spp.

†† Mean ± standard error of the mean.

differences between irrigation systems often appeared to be due to differences in disease incidence between areas where certain irrigation systems were more common. For example, black point incidence in flood-irrigated fields tended to be higher in certain years because flood irrigation was concentrated primarily in areas where disease incidence tended to be high in all irrigated fields (Figs. 1-6).

During the 6 years of the study, the annual percentage of fields that would have been downgraded by at least one grade ranged from 19-54%. Even in extremely dry years, black point incidence was still high in a number of fields. Variation in disease incidence between fields in the same area was at least partially due to differences in irrigation and cultural practices. Factors such as time of irrigation and seeding date could have directly influenced black point incidence. Differences in seeding date would result in exposure to different environmental conditions at critical stages of development such as the milk and mid-dough stages. It was observed in 1985 that late-seeded fields had substantially higher incidences of black point; this was likely due to exposure to heavy rainfall just prior to harvest. The same year, it was also noted in partially swathed fields which had been exposed to a prolonged period of heavy rainfall after swathing that a higher disease incidence occurred in samples taken from the swath than in samples taken from the standing crop in the same fields.

When isolations were made from seed samples, a large percentage of apparently healthy kernels were infected with ***Alternaria*** spp. (Table ***3)***. Several other studies (6,10) have also reported that a high percentage of healthy kernels were also infected with ***Alternaria*** spp. It appears that in many cases infection occurred either too late or under unfavorable conditions for further disease development. However, each year there was a significant (**P** = 0.05) correlation (***r*** = 0.5 - ***0.7)*** between black point incidence and the percentage of kernels infected with ***A, alternata***. A paired comparison of samples of healthy and black point kernels indicated that a significantly higher percentage of kernels from the black point samples were infected with ***Alternaria.*** Each year, ***C. sativus*** infected only a low percentage of seed. These results clearly indicate that ***C. sativus*** is of only minor importance as a cause of black point in the irrigated areas of southern Alberta and Saskatchewan.

Acknowledgements

The authors thank L.T. Bohrson for providing us with seed samples from fields in Saskatchewan. We also thank N. Nakahama for preparing the figures in this paper.

Literature cited

1. **Brentzel, W.E. 1944. The black point disease of wheat. N. Dak. Agric. Stn. Bul. 330. 14 pp.**
2. **Canada Grains Council. 1982. The soft white spring wheat industry in Canada. Canada Grains Council, Winnipeg. Pp. 58-61.**
3. **Canadian Grain Commission. 1987. Official Canadian grain grading guide. Canadian Grain Commission, Winnipeg.**
4. **Conner, R.L. 1987. Influence of irrigation timing on black point incidence in soft white spring wheat. Can. J. Plant Pathol. (in press).**
5. **Conner, R.L. and J.B. Thomas. 1985. Genetic variation and screening techniques for resistance in soft white spring wheat. Can. J. Plant Pathol. 7:402-407.**
6. **Hanson, E.W. and J.J. Christensen. 1953. The black point disease of wheat in the United States. Univ. Minn. Tech. Bull. 206. 30 pp.**
7. **Kilpatrick, R.A. 1968. Factors affecting black point of wheat in Texas 1964-67. Texas Agric. Exp. Stn. Misc. Publ. 884. 11 pp.**
8. **Large, E.C. 1954. Growth stages in cereals. Illustration of the Feekes scale. Plant Pathology 3:128-129.**
9. **Machacek, J.E. and F.J. Greaney. 1938. The "black-point" or "kernel smudge" disease of cereals. Can. J. Res. C. 16:84-113.**
10. **Russell, R.C. 1943. The relative importance, from the pathological standpoint, of two types of smudge on wheat kernels. Sci. Agric. 23:365-375.**