Some aspects of Sclerotinia sclerotiorum in Saskatchewan, 1970–75[1]

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Sclerotinia stem rot occurred in 62% of fields of *Brassica* spp. surveyed in Saskatchewan in 1975, with a mean percentage infection of 1.9%. It was most commonly found, and most widely distributed, in fields in the traditional rapeseed-growing areas of the northern cultivated regions of the province. Preliminary data suggest that in heavily affected fields yield losses of 10 - 15% can occur and these result largely from reductions in thousand kernel weight. Six new Canadian and eight new Saskatchewan host records for *Sclerotinia sclerotiorum* (syn. *Whetzelinia sclerotiorum)* are presented. Pod infections on *B. campestris* and *B. napus* are described in detail.

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En 1975 une enquête a ete realisee sur la pourriture sclerotique de *Brassica* spp. dans les champs de producteurs en Saskatchewan. Soixante-deux pourcent des champs ont ete infectes et le taux moyen d'infection a ete 1.9 pourcent des plantes. Des champs infectes ont ete plus courants et la maladie a ete plus reparties dans chaque champ infecte dans les regions traditionelles de la culture de colza de la Province. Ce sont au nord de la region recoltee de la Saskatchewan. Des donnes preliminaires suggerent que dans les champs tres atteints les pertes de rendement de 10 a 15% peuvent arriver et que ces pertes sont principalement dues a la diminution du poids des graines. On signale pour la premiere fois le *Sclerotinia sclerotiorum* sur six especes au Canada et sur huit especes en Saskatchewan. On decrit aussi en detail les infections de la cosse de *B. campestris* et *B. napus.*

An extensive survey of *Sclerotinia sclerotiorum* (Lib.) deBary, the cause of stem rot of various plant species, was done in Saskatchewan in 1970 (2). At that time it appeared that the disease on *Brassica* spp. was becoming more widely distributed in the province since it was found in a higher percentage of rapeseed fields than during earlier surveys. Future surveys at intervals of several years were suggested to monitor further spread of the disease.

The present paper deals primarily with a survey of the incidence of sclerotinia stem rot in fields of *Brassica* spp. in Saskatchewan in 1975. The results are compared with data from 1970 and subsequent years (2,9). In addition, some new or noteworthy records of *S. sclerotiorum* from 1971 to 1975, and some preliminary data on the effect of stem rot on rapeseed yield, are presented.

Methods

Survey of Brassica spp.

Fifty-two fields, mostly in Crop Districts 8 and 9, the traditional rapeseed growing regions of Saskatchewan, were visited in the period August 23 - September 4, 1975. The locations of the fields and the species of *Brassica* in each field are shown in Figure 1. The choice of fields was essentially arbitrary, but no major bias was involved. At the time of the survey all fields were ready or almost ready to be swathed.

Samples of 25 plants were scored for the disease in four widely separated areas of each field; usually each sample area was at least 100 m from the others. A distinction was made between basal stem infection, in which the diseased bleached portion of the stem extended to the soil surface, and aerial infection, in which there was at least some healthy tissue between the infected tissue and the soil surface. Presumably aerial infection resulted from ascospores. Percentage infections were calculated for each field. When the disease was observed in a field, but not among the plants sampled, the infection was recorded as a trace, but the manner in which the disease was distributed relative to the four sample areas was noted.

New or noteworthy records of S. sclerotiorum, 1971–75

In the period 1971–75, infections by *S. sclerotiorum* were observed on many plant species in Saskatchewan. In some cases these represented new records of the fungus or unusual symptom types. Isolations from diseased material were generally made using routine laboratory procedures, and cultures of *S. sclerotiorum* were retained.

Effects of stem rot infection on rapeseed yield and quality

Unsuccessful attempts were made to study the effects of disease on rapeseed yield in the field in 1970 and 1971

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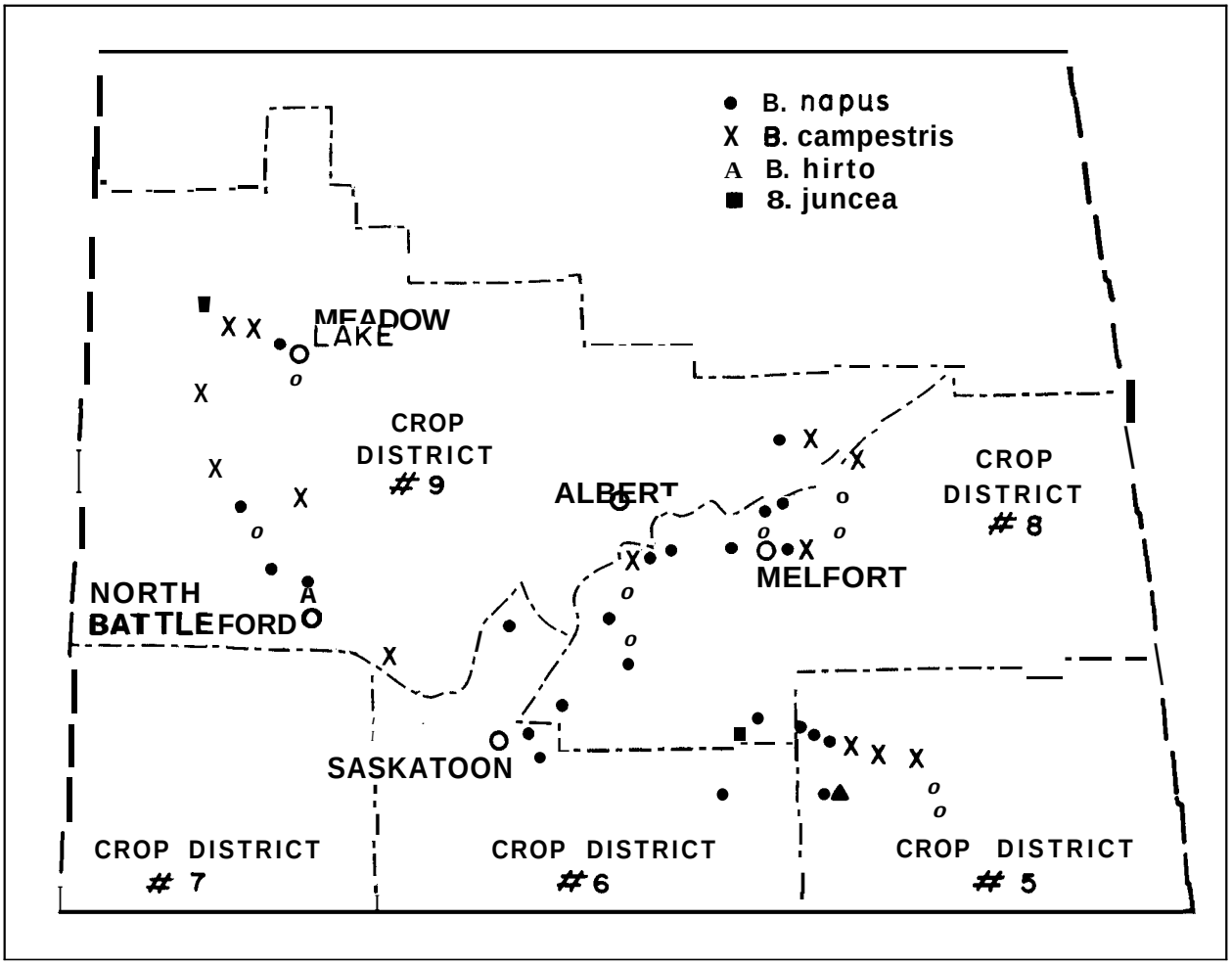

Figure 1. Map of central Saskatchewan showing locations of fields of *Brassica* spp. surveyed in 1975.

by artificial inoculation in replicated plots (L. J. Duczek, R. A. A. Morrall, and D. L. McKenzie, unpublished data). Very low levels of infection were achieved and such experiments were abandoned. A different approach was used in 1975.

In the Maidstone area [50 miles NW of North Battleford (Figure 1)], which was not included in the quantitative survey but where infection occurred in nearly all fields, four fields were selected for yield loss assessment. Samples were collected after swathing by randomly gathering bundles of plants from the swaths. Plants were separated into diseased and healthy categories and threshed. Yield losses were calculated on the basis of the percentage difference in yield between healthy and diseased plants. Thousand kernel weights and oil and protein content were determined on the samples.

Results and discussion

Survey

Sclerotinia stem rot was much more common in Crop Districts 8 and 9 than in 5 and 6 (Table 1). In Districts 5 and 6 the disease was not found in any of the 25-plant samples from the 16 fields visited; in those fields plants affected by stem rot were seen occasionally but in only 2 fields was the disease found in more than 1 of the 4 areas examined. On the other hand, in Districts 8 and 9 combined, 78% of the fields contained infections, the disease was quite widely distributed in 50% of the fields, and a mean of 2.7% of the plants was infected.

Basal stem infection was usually more common than aerial infection, although most fields contained both types (Table 1). The mean percentages of basal stem

Table 1. Distribution and levels of Sclerotinia infections in fields by Crop District

	Crop District 5	6	8	9	Total (whole province)
No. of fields surveyed	10	6	20	16	52
Rapeseed acreage* ($\times 10^3$)	310	208	596	483	1,800
Relative intensity of survey index**	1.1	1.0	1.2	1.1	1.0
Percentage of fields of occurrence of disease					
Basal stem infection	20	33	70	63	54
Aerial infection	10	17	55	69	44
Total infection	20	33	80	75	62
Percentage of fields where disease is present in various numbers of sample areas***					
0	80	67	20	25	38
1	10	17	25	13	17
2	0	0	5	13	6
3	10	0	10	18	12
4	0	17	40	31	27
Mean percentage					
Basal stem infection	0	0	2.0	1.6	1.3
Aerial infection	0	0	0.6	1.3	0.6
Total infection	0	0	2.6	2.9	1.9

* Saskatchewan Department of Agriculture, official estimates.

** The index, which is based on a standard of one for the whole province and the assumption that the mean size of fields surveyed was the same in each crop district, was computed as follows:

$$\text{Index} = 1 \times \frac{\text{No. fields surveyed in C.D.}}{52} \times \frac{1800 \times 10^3}{\text{acreage of rapeseed in C.D.}}$$

*** Either in 25-plant samples or nearby.

infections and of aerial infections were largely additive, since very few plants had two independent zones of infection on the stem. The overall provincial percentage infections of **1.3** (basal stem), 0.6 (aerial), and **1.9** (total) (Table 1), became **1.2, 0.6,** and **1.8%** respectively, when they were adjusted according to the different intensity of survey in different crop districts.

There is no evidence to suggest that sclerotinia stem rot has become more widely distributed in Saskatchewan since **1970,** except perhaps in Crop District **9** (Table **2).** Differences between years in the percentage of fields where the disease was observed must be considered in relation to the fact that several different sampling methods were used to obtain the data. Two independent surveys in 1970 gave quite different results even for Crop Districts **8** and **9,** where the numbers of fields examined were substantial. Ironically, higher values were recorded in a survey which considered only basal stem infection **(2);** however that survey was more than twice as extensive as the other **(9).** Variations in weather between years will affect the incidence of stem rot, although it is expected that weather would have more effect on the percentage of infected plants within a field than on the percentage of fields with infection. Probably the only significant increase between **1970** and **1975** was in Crop District **9,** where the fields in which basal stem infection occurred increased from **48%** to 63%. However, it is worth noting that in **1975** the total percentages of fields infected in Crop Districts **8** and **9,** and in the whole province, were the highest ever recorded **(2.9).**

New or noteworthy records

Conners **(1)** listed **85** species or varieties distributed among **26** families on which ***Sclerotinia sclerotiorum***

Table 2. Percentage of *Brassica* spp. fields in which sclerotinia stem rot was observed

Survey data	Crop District 5	6	7	8	9	Combined 8 + 9	Total (whole province)
1970 – Basal stem infection only (Reference 2)	17	25	33	69	48	60	53
1970 – Total infection (Reference 9)	0	33	–*	42	41	42	40
1971 – Total infection (Reference 9)	0	67	0	23	22	22	19
1972 – Total infection (Reference 9)	0	50	–	42	7	26	25
1975 – Basal stem infection	20	33	–	70	63	67	54
1975 – Total infection	20	33	–	80	75	78	62

–* not sampled

Table 3. New host records for *Sclerotinia sclerotiorum* from Saskatchewan, 1971–75

Host	Location of Collection	Date of Collection	New Record for Canada (C) or for Saskatchewan (S)
Liliaceae			
Asparagus officinalis L. var. *altilis* L., Asparagus	Saskatoon	9/71	C
Umbelliferae			
Anethum graveolens L., Dill	Saskatoon	9/71	C
Compositae			
Senecio vulgaris L., Groundsel	Meadow Lake	4/9/75	C
Tagetes erecta L., Aztec marigold	Saskatoon	20/9/75	C*
Solanaceae			
Petunia hybrida Vilm., Common garden petunia	Saskatoon	9/71	C*
Campanulaceae			
Campanula rapunculoides L., Rampion	Saskatoon	10/71	C*
Urticaceae			
Urtica dioica L. ssp. *gracilis* (Ait.) Selander U. *gracilis* Ait., Nettle	Rapid View	4/9/75	S
Leguminosae			
Trifolium pratense L., Red clover	Codette	8/71	S

* In these cases previous records of *S. sclerotiorum* exist on unidentified species of the host genus.

Table 4. Effect of sclerotinia stem rot on yield in four fields of rapeseed

Field No.	No. of samples	No. of plants	Percent plants infected	Healthy: Yield per plant (g)	Healthy: Thousand kernel wt. (g)	Diseased: Yield per plant (g)	Diseased: Thousand kernel wt. (g)	Percent reduction in yield per plant	Percent reduction thousand kernel wt.	Percent yield loss
1	5	543	61.9	1.55	3.22	1.31	2.56	22.2	20.5	13.7
2	2	369	30.1	2.47	3.89	1.58	2.39	38.0	38.6	11.4
3	2	259	62.2	1.54	3.20	1.19	2.33	22.7	20.9	14.9
4	2	365	20.3	2.20	4.11	1.04	2.20	54.5	46.5	11.1

[sensu Purdy (13)] had been found in Canada. In Saskatchewan the fungus had been reported on 16 different species or varieties. Duczek and Morrall (2) erroneously stated in 1971 that no reports of *Sclerotinia* on new hosts in Canada had appeared since Conners' compendium (1), and listed a number of new Canadian and Saskatchewan records. A detailed search of the *Canadian Plant Disease Survey* from 1965 to the present, and of other sources (6, 14), reveals 13 new host species records for Canada and 18 for Saskatchewan in the last 10 years. To these may be added 6 Canadian and 8 Saskatchewan records on miscellaneous plants collected from 1971 to 1975 (Table 3). This brings the number of species and families from which S. *sclerotiorum* has been reported in Canada to 104 and 28 respectively. Corresponding figures for Saskatchewan are 42 and 12. A complete list of recorded host species in Canada of this highly destructive pathogen is available on request from the senior author.

In 1975 two previously unreported types of sclerotinia disease symptom on rapeseed were observed. The first involved pod infection, in which, on otherwise healthy, maturing inflorescences, individual pods and their peduncles were bleached and brittle (Figure 2A). These symptoms were distinct from those of general premature ripening and discoloration of the inflorescence that result from stem infections. The insides of infected pods contained cottony fungal mycelium and shrivelled seeds (Figure 2B); surface sterilized seeds consistently yielded S. *sclerotiorum* when plated on agar, indicating internal mycelial infection. Occasionally small sclerotia of the fungus developed on the pod surface (Figures 2A & 2C). Pod infections were found in two of the fields included in the survey, one each of ***B. napus*** and ***B. campestris.*** It is noteworthy that in the field of ***B. napus*** there were few stem infections. Pod infections were also observed in 1975 in several heavily diseased fields in the Maidstone area. Platford and Bernier (12) mentioned the occurrence of pod infections in Manitoba in 1973 but did not describe them; pod infections have also been seen in Central Alberta (D. Stelfox and A. W. Henry, personal communication).

In view of the fact that lesions on the upper stem of rapeseed, and head blight of sunflower, both due to late-season aerial infection by *S. sclerotiorum,* are common in western Canada, it is surprising that pod infections have seldom been reported before. *Sclerotinia sclerotiorum* has also been reported to be only very rarely seedborne on rapeseed, either in the form of sclerotia mixed with seedlots (after commercial cleaning), or in the form of mycelium in the testa (10). However, extensive pod infections could lead to a much higher incidence of seedborne infection in future.

The second new type of disease symptom was the secondary infection by *S. sclerotiorum* of "staghead inflorescences" caused by *Albugo cruciferarum.* In this case the previously formed stagheads were bleached, and sclerotia developed on their surface (Figure 2D). These symptoms were found in two fields. Petrie and Vanterpool (11) reported on a substantial number of secondary fungi that had been found on, or isolated from, stagheads over a period of 15 years, but they never observed *S. sclerotiorum.*

Effects on yield and quality

In the four fields in the Maidstone area selected for yield loss assessment, infection ranged from 20% to 62% of the plants; these values were much higher than those in the majority of fields included in the survey (Table 1). In the four fields infection appeared to have occurred at flowering time or later, permitting diseased plants to set seed. All diseased plants produced some seed. Reduction in yield per plant varied from 22.2% to 54.5% (Table 4). There appeared to be an inverse relationship between the percentage of plants infected and the reduction in yield per plant. The overall yield loss, however, was highest in the fields with the highest ratio ot infected to healthy plants. The losses, ranging from 11.1% to 14.9% were surprisingly low, considering that in two of the fields over 60% of the plants were infected. Percent reduction in thousand kernel weight of samples from diseased plants closely paralleled percent yield reduction per plant. Most of the loss in yield could

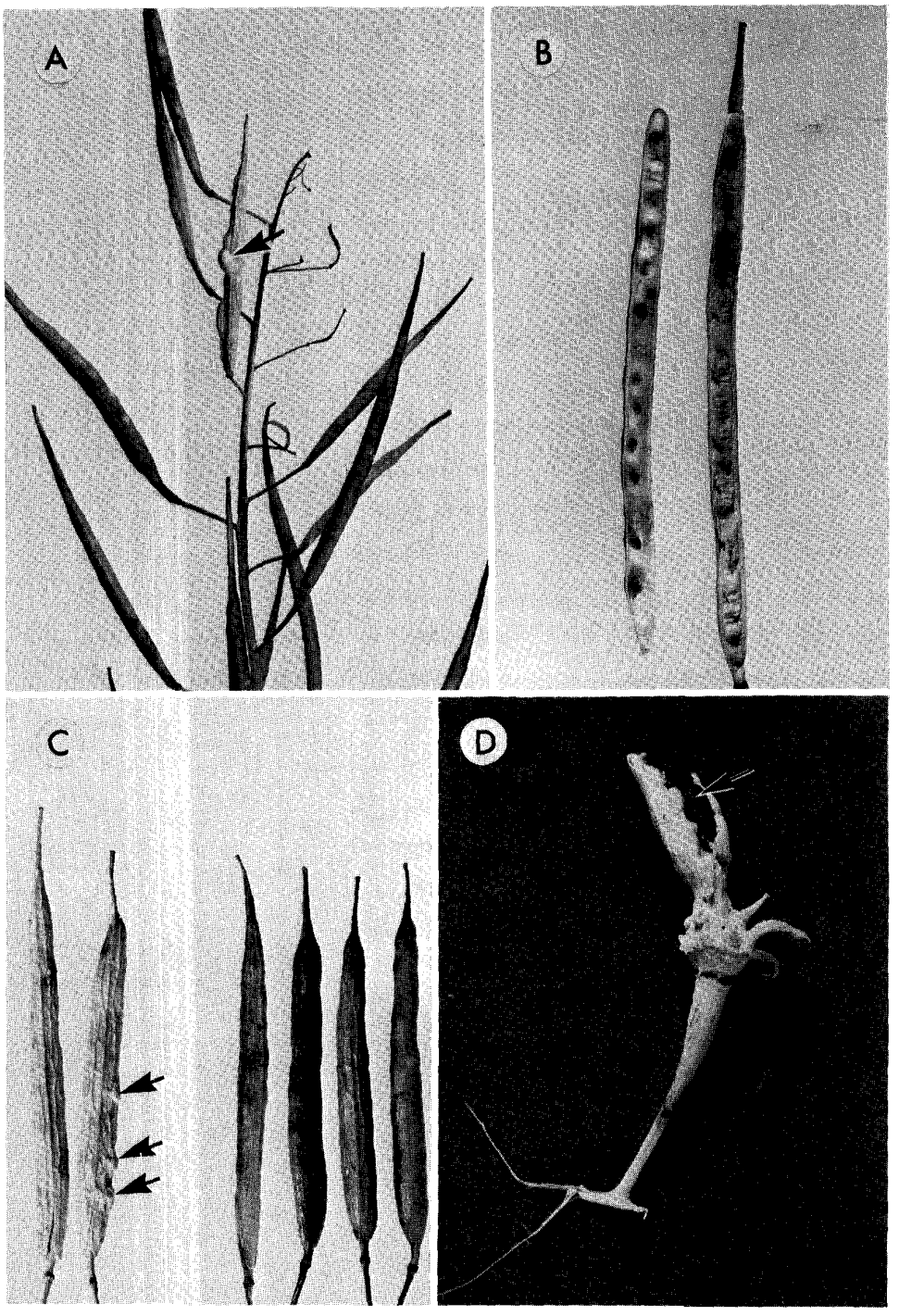

Figure 2. Symptoms of *Sclerotinia sclerotiorum* infection on rapeseed. 2A) Single infected pod on mature inflorescence. 2B) Infected pod split open to show fungal mycelium and shrivelled seed. 2C) Two infected pods beside four healthy pods from identical plants. 2D) Staghead caused by *Albugo* infection secondarily infected with S. *sclerotiorum*. (Note: arrows indicate developing or mature sclerotia of the pathogen).

thus be attributed to a reduction in seed size. However the loss assessment method used may underestimate on-the-farm losses because infected plants ripen prematurely, resulting in shattering before the crop is harvested, and some of the smaller, shrunken seed from diseased plants may be lost with the chaff during combining.

Protein content of samples from diseased plants was comparable to samples from healthy plants. Although a trend towards slightly reduced oil content occurred in seed from diseased plants, the reduction was not consistent.

General conclusions

Although stem rot of rapeseed does not affect a large percentage of plants on an overall provincial basis (Table 1), and there is little evidence that it has become more widely distributed in Saskatchewan since 1970 (Table 2), ***Sclerotinia sclerotiorum*** remains a substantial threat to production. Under favorable conditions it severely affects individual fields (2,9). In the present study there were four fields in the quantitative survey with over 10% infected plants and four fields in the Maidstone area with over 20% infected plants. When the disease is present at such high levels it has a marked effect on yield (Table 4). While it apparently does not affect oil and protein content, its most serious effect on quality is perhaps the occurrence of sclerotia mixed in the seed. Sclerotia in the upper parts of the stem due to airborne infection are of nearly the same density as seed and are not separated during combining. Notwithstanding the observations of Petrie (10), data obtained from the Canadian Grain Commission indicate that sclerotia are now commonly found in the harvested crop.

Since 1970 ***Sclerotinia sclerotiorum*** has been reported in Saskatchewan as a common pathogen of sunflower and field pea (3, 5, 7, 8) in addition to rapeseed; it also occurs occasionally on the mustards, lentil, fababean, and buckwheat (3, 4, 7, 8). Its wide alternative host range on crop plants and weeds, and the ability of sclerotia to survive more than one year in the soil, have to be considered in relation to crop rotations. Crop diversification programs and a possible trend towards reduced summerfallowing could add new dimensions to the sclerotinia problem.

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