SCLEROTINIA IN SASKATCHEWAN IN 1970

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Abstract

Sclerotinia was recorded on 18 plant species in Saskatchewan in 1970. New Canadian records were on Solidago canadensis var. salebrosa, Linum usitatissimum, and Lens culinaris. The average provincial infection rate of rape (Brassica campestris and B. napus), based on a stubble survey of 94 fields in Crop Districts 5 to 9, was 0.53%. It appears that the distribution of sclerotinia stem rot has increased steadily since 1957 in the major rapeseed growing areas of Saskatchewan.

Introduction

The principal purpose of this work was to make a quantitative survey of sclerotinia stem rot of rapeseed in Saskatchewan. The incidence of this disease was studied in earlier general surveys of rape diseases by Vanterpool and Petrie (2,3,4,6,7) but quantification of severity was imprecise. The ratings that they employed, namely trace, slight, moderate and severe, serve a limited purpose since they tend to be meaningful only to the investigators concerned. Furthermore, their surveys were, of necessity, conducted in restricted parts of fields which were easily accessible on foot from adjacent roads (Vanterpool, personal communication). Our work employed a technique which, despite some limitations, gave rates of infection based on measurements all around the fields.

Earlier reports (1) and preliminary data from 1969 indicated that several other plant species are hosts of Sclerotinia in Saskatchewan. Thus, some attempt was made to extend the survey to other host species, though in most cases quantitative study was impossible in the time available.

Stem rot of rape is usually thought to be caused by Sclerotinia sclerotiorum (Lib.) de By. However, there is some dispute in the literature concerning the classification of this and other species of the genus. Conners (1) does not accept Purdy's (5) "broader concept of S. sclerotiorum", which includes S. sclerotiorum (Lib.) de By., S. trifoliorum Eriks., S. minor Jagger, S. sativa Drayt. & Groves, and S. intermedia Ramsey. Though work is currently in progress in this laboratory on variability of sclerotinia, and isolations were made from many collections, no attempt was made in the survey to differentiate species or strains of the fungus from different hosts or geographic locations. However, it is likely that most of the plants were infected with S. sclerotiorum sensu stricto. Similarly, owiiig to the state of the crops at sampling (see Methods), Brassica campestris L. (Polish rape) and B. napus L. (Argentine rape) were not distinguished in the survey.

The weather in the 1970 growing season in central Saskatchewan was marked by abnormally low rainfall in May, followed by up to 6 inches by the end of June in most districts. Such conditions might he expected to have favored apothecium production by overwintered sclerotia of Sclerotinia at a critical time in the development of susceptible crops and, therefore, to have enhanced infection. However, our knowledge of the behaviour of the fungus under field conditions in Saskatchewan is insufficient to allow more than this vague statement concerning the relationships between weather and the severity of disease.

Methods

Rape

Ninety-four fields, mostly in Crop Districts 8 and 9, the major rapeseed growing areas of Saskatchewan, were visited between late August and early October. Only swathed or combined fields were surveyed since sampling necessitated driving into the fields. The numbers of diseased plants were recorded in five 1-m^2 quadrats in each field and mean numbers of infected plants per m^2 were calculated. Plants were considered diseased if the remaining stems were bleached and shattered and/or contained sclerotia. The quadrats were placed 10–30 m from the edge of a field, usually at each of the four corners and halfway down one side. The survey deviated from this standard pattern in nonrectangular fields, but in all cases quadrat samples were widely dispersed in each field. In the main rapeseed growing areas fields were surveyed approximately 10 miles

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Table 1. Incidence of *Sclerotinia* in rape fields in Saskatchewan, 1970

Crop District and area	No. of fields surveyed	Rapeseed acreage* (X 10^3)	Relative intensity of survey index**	Percentage of fields sampled in 6 infection categories based on numbers of infected plants per m^2						Mean number of infected plants per m^2
				0	Tr***	0.20-0.99	1.00-9.99	10.00-19.99	>20.00	
1, 2, 3, 4 Southern Saskatchewan	0	25.5	0							
5 Yorkton-Wynyard	12	460.1	0.5	83	0	17	0	0	0	0.07
6 Saskatoon	12	100.8	2.5	75	0	25	0	0	0	0.05
7 Wilkie-Kindersley	3	57.7	1.1	67	33	0	0	0	0	0
8 Tisdale-Nipawin	38	665.3	1.2	32	6	41	15	3	3	2.00
9 Meadow Lake-Prince Albert	29	690.6	0.9	52	7	31	10	0	0	0.22
Total (whole province)	94	1999.5	1.0	51	5	32	10	1	1	0.87

* Dominion Bureau of Statistics, July 1970 estimate.

** The index indicates the coverage in a crop district relative to a standard of one for the whole province, based on the assumption that the mean size of fields surveyed was the same in each crop district.

$$\text{Index} = 1 \times \frac{\text{No. of fields surveyed}}{94} \times \frac{1999 \times 10^3}{\text{acreage of rapeseed}}$$

*** Trace indicates fields in which disease was found only outside the quadrats. This represents an infection rate of <0.20 plants/m^2.

apart along arbitrarily chosen roads traversing the area. The total number of plants in the quadrats was counted in approximately every 6th field as a basis for calculating a mean number of plants per m^2 for Saskatchewan and, hence, a percentage infection rate. Where infected plants did not occur in the quadrats but were seen elsewhere in the field, the infection was rated as a trace.

Other host species

Those other crops and plants examined for Sclerotinia infection were determined largely by serendipity during traverses of rapeseed growing areas. However, some fields of sunflowers, peas, and lentils were deliberately included on advice from agricultural representatives in the province. A single field of yellow mustard was surveyed by the same method as for rapeseed. All the plants in garden plots, and several representative rows in the fields of sunflower were counted to determine percentage infections. The common and scientific names of the host plants examined are listed in Table 4.

Results

Rape

The per m^2 infection rates of the fields were grouped into six arbitrary categories (Table 1). The intensity of the survey in each crop district varied and an index was calculated according to the total acreage and the number of fields sampled. For example, Crop Districts 5 and 6 were surveyed respectively 0.5 and 2.5 times as intensely as the average for the province. No fields were surveyed in Crop Districts 1 to 4 because of the low acreage of rapeseed in these areas.

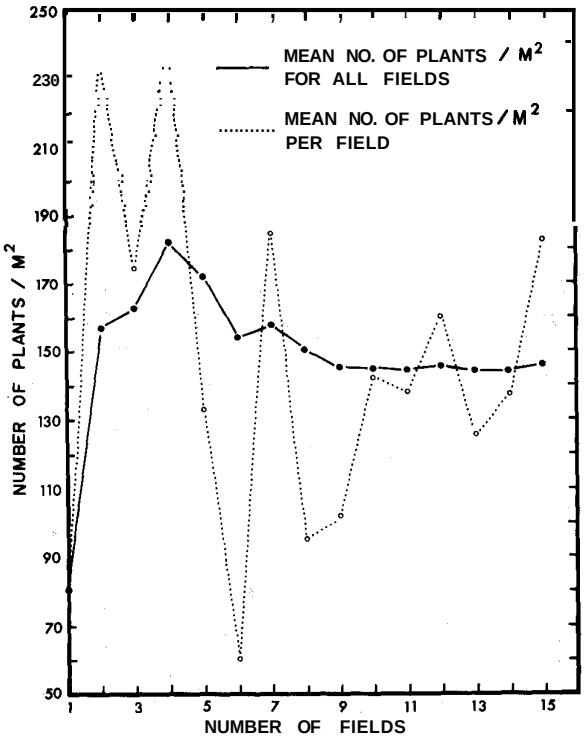

Figure 1. Mean number of plants/m^2 for each field and for all fields.

$$\text{Mean no. plants/m}^2\text{ for all fields} = \frac{\Sigma\ \text{mean no. plants/m}^2\text{ for n fields}}{n}$$

Crop Districts 5, 6, and 7 had Sclerotinia in 33% or less of the fields, each with less than 1 infected plant per m^2. The average infection rates in these districts were 0.07 plants per m^2 or less. The heaviest infection rate for a district, 2.00 plants per m^2, occurred in Crop District 8, where 68% of the fields were infected. However, 48% of the fields were in the trace–0.99 plants per m^2 infection categories. In Crop District 9, where 48% of the fields were infected, the average infection rate was 0.22 plants per m^2, and in 38% of the fields the infection rate was in the trace–0.99 plants per m^2 range

Figure 1 shows that the total numbers of plants per m^2 in rapeseed fields varied widely, for a low of 60.2 to a high of 242.0. However, by including progressively larger numbers of fields in the calculation, the mean for all fields counted levelled off at about 145. This would be a reasonably reliable estimate of the average numbers of plants per m^2 for Saskatchewan. While the variation between fields did not permit the calculation from our data of reliable percentage infection rates of individual fields, the figure of 145 plants per m^2 was used to calculate a percentage infection rate for the whole province that was considered to be reasonably reliable. Using the figure in Table 1 of 0.87 infected plants per m^2, which was the average of all fields sampled, calculation gave a provincial infection rate of 0.60%. However, this figure was biased by the relative intensity of survey in different crop districts, and a more reliable calculation was made by taking into account the relative acreages in different crop districts. The mean infection rates in each of Crop Districts 5 to 9 (Table 1) were multiplied by the respective acreages for the districts. These products were then added and the sum divided by the total acreage in those crop districts. This gave a mean provincial infection rate of 0.77 plants per m^2 or 0.53%.

In all fields with Sclerotinia in Crop Districts 5, 6, and 7 the disease was recorded in only one quadrat, or as a trace (Table 2). This means that the disease was probably prevalent in only one area of each field. Fields in Crop Districts 8 and 9 tended to have more uniform infection, but most still had disease in only one or two quadrats. Most fields in the province with the disease appearing in less than three quadrats had an infection rate of less than 1.00 plant per m^2, while fields with disease appearing in three to five quadrats usually had an infection rate greater than 1 plant per m^2 (Table 3). In the only field that had more than 20 infected plants per m^2, disease occurred in all five quadrats.

A stubble survey with quadrats has advantages over previous surveys (2, 3, 4, 6, 7). Rating over the entire field is clearly more realistic than surveying along one edge, since in 58% (46+10) of infected fields in this survey the disease occurred at only one locus (Table 2). Moreover, numerical infection rates are more meaningful statistically than disease categories. By concentrating on the plants inside a quadrat,

'Table 2. Uniformity of *Sclerotinia* distribution in rape fields by crop districts

Crop District	No. of fields with disease	Percentages of infected fields where *Sclerotinia* occurred in various numbers of quadrats					
		Tr†	1	2	3	4	5
5	2	0	100	0	0	0	0
6	3	0	100	0	0	0	0
7	1	100	0	0	0	0	0
8	26	8	35	23	11	8	15
9	14	14	50	29	0	0	7
Total	46	10	46	22	6	4	11

† Tr = trace, indicating fields in which the disease was found only outside the quadrats.

Table 3. Uniformity of *Sclerotinia* in rape fields relative to disease ratings

No. of quadrats with disease per field *	No. of fields	Percentages of fields with *Sclerotinia* in 6 infection categories based on numbers of infected plants per m^2				
		Trace	0.20–0.99	1.00–9.99	10.00–19.99	>20.00
Trace	5	100	0	0	0	0
1	22	0	100	0	0	0
2	9	0	67	33	0	0
3	3	0	67	33	0	0
4	2	0	0	100	0	0
5	5	0	0	60	20	20
Total	46	11	65	20	2	2

* Trace indicates fields in which the disease was found only outside the quadrats.

infected specimens were noted which normally would have Seen missed in scanning because they lacked stereotyped disease symptoms, although containing sclerotia inside the stems. Nevertheless the stubble–quadrat technique probably slightly underestimates infection rates, because stubble is crushed by machinery and some infected plants may be missed. Also, as noted earlier on mustard (3), and observed by us in 1970 on rape, some Sclerotinia infections occur higher up on the stem and do not extend to the base. A survey of stubble will exclude such plants.

There is some disadvantage to using infection rates per unit area, rather than percentage infection rates, when there is a wide fluctuation in the total number of plants per unit area. However, this is compensated for by the fact that numbers of infected plants per unit area are a direct measurement of the total amount of disease, whereas percentage infection rates are not. Frequently the latter are quoted in the literature without reference to total numbers of plants in the area. Particularly in the case of diseases like sclerotinia stem rot, an appreciation of disease spread is dependent on a knowledge of the actual density of diseased plants. A given amount of inoculum could cause a similar number of plant infections in two fields, which, because of differing plant densities, might differ in percentage infection rates by a factor of 2 or more. An apparent twofold difference such as that could be quite misleading in assessing the disease potential of the two areas, and relating the severity of disease to weather conditions. Hence, surveys which rely on assessing diseases on a fixed number of plants collected in each field have important limitations from the epidemiologist's viewpoint.

Other host species

Sclerotinia disease was found on a number of other crops, common weeds, and garden plants (Table 4). Most disease occurred as basal stem rot except on tomato, vegetable marrow, buttercup squash, and pumpkin, where it also occurred in the fruit. Three dryland sunflower fields in Crop District 2 were surveyed but showed no evidence of Sclerotinia. However, a 1.7 acre irrigated plot of sunflower near Saskatoon had 14% infection, while six gardens in Crop Districts 6 and 8, with plots of 100 to 600 plants, had respectively 0, 7, 8, 33, 36, and 51% infection. This survey was somewhat prejudiced as usually only gardens with wilted plants were examined closely. Sclerotinia was found on other garden plants including lettuce, .squash, pumpkin, bean, peas, tomato, and hollyhock from widely dispersed points in Crop Districts 5 to 9. The disease was found on minor legume field crops in Crop District 8 (Melfort-Nipawin) in fields of seed sweet clover, seed alfalfa, field peas, and lentils. Specimens on flax and Canadian goldenrod were also found in this district. The prevalence of Sclerotinia on Canada thistle and perennial sow thistle throughout the province stresses the importance of weed control in slough areas, roadsides, and fenceways (2,3).

Discussion and conclusions

Since Conner's compendium (1) no reports of Sclerotinia on new host species in Canada have appeared in the Canadian Plant Disease Survey or elsewhere, to our knowledge. Thus, Sclerotinia on Solidago canadensis L. var. salebrosa (Piper) Jones, Linum usitatissimum

Table 4. Host plants on which *Sclerotinia* was found in Saskatchewan in 1970

Common name	Scientific name	Remarks
Rape a) polish b) argentine	*Brassica campestris* L. *Brassica napus* L.	See text.
Mustard, yellow	*Brassica hirta* Moench 'yellow'	One field, 0.3% infection, surveyed same as rape.
Canadian goldenrod	*Solidago canadensis* L.* var. *salebrosa* (Piper) Jones	Specimens in field of seed sweetclover.
Canada thistle	*Cirsium arvense* (L.) Scop.**	In three locations, two in rape fields, one near heavily infected sunflower.
Perennial sowthistle	*Sonchus arvensis* L.	In seven locations, five associated with rape or sunflower.
Sunflower	*Helianthus annuus* L.	See text.
Lettuce	*Lactuca sativa* L.	In three garden locations.
Squash-vegetable marrow	*Cucurbita pepo* L.**	All in same market garden; infection extensive on all 3 hosts.
Pumpkin	*Cucurbita pepo* L.**	
Buttercup squash	*Cucurbita maxima* Duchesne**	
Lentils	*Lens culinaris* Medik.***	In one field.
Alfalfa	*Medicago sativa* L.	In one field.
Sweetclover, yellow	*Melilotus indica* (L.) All.	In three fields.
Bean	*Phaseolus vulgaris* L.	In one garden.
Pea	*Pisum sativum* L.**	In one field and one garden.
Flax	*Linum usitatissimum* L.*	In one field.
Hollyhock	*Althaea ficifolia* (L.) Cav.**	In one garden.
Tomato	*Lycopersicon esculentum* Mill,**	In one garden.

* New Canadian record, not listed in Conners (1).

** New Saskatchewan record, not listed in Conners (1).

*** New Canadian record, host not listed in Conners (1).

L., and Lens culinaris Medik. are new records for Canada. Similarly several new records for Saskatchewan are indicated in Table 4.

Previous survey reports (3,7) have mentioned the possibility of an increase of common rapeseed diseases over the years in Saskatchewan. Although it is not possible to compare the quantitative data of 1970 with data for previous years (see Results), it is possible to compare the relative percentages of fields with Sclerotinia present (Table 5). Surveys before 1970 were conducted almost entirely in Crop Districts 8 and 9, so that in Table 5 the 1970 figures are taken only from these districts. The data indicate that Sclerotinia is probably becoming increasingly widespread. It is likely that the apparent increase in infected fields in 1970 is partly due to more careful surveying. The possibility that earlier surveys missed fields with low levels of infection because they covered only parts of the fields is emphasized in Table 3, which indicated that in most such fields Sclerotinia was found in only one quadrat. On the other hand, part of this effect may have been offset by the stubble survey missing infections restricted to areas higher on the plant stems.

The above discussion suggests the need for future surveys of Sclerotinia, though perhaps not always on an annual basis. Inoculum may become generally distributed in Crop Districts 8 and 9, and perhaps elsewhere, in 5 to 10 years. Increased sales and continuing markets have already established rapeseed as a major crop in Saskatchewan and the acreage in the province

Table 5. *Sclerotinia* infection on rapeseed as recorded in disease surveys since 1957 in Saskatchewan Crop Districts 8 and 9

Year of survey	Acreage in province* (10^3)	Fields surveyed (no.)	Fields infected (%)	Reference
1957	520	38	5.3	Vanterpool (6)
1962	167	n.a.**	trace	Vanterpool (7)
1965	555	40	27.5	Petrie and Vanterpool (2)
1966	731	52	39.0	Petrie and Vanterpool (3)
1967	600	28†	32.1	Petrie and Vanterpool (4)
1969	1000	40	2.5	Crop Districts 7 and 9, (Petrie, pers. comm.)
1970	2000	67	59.7	In text

* Reference: Saskatchewan Dep. Agr. 1969. Annual Report.

** n.a. = figures not available.

† Includes rapeseed and mustard.

quadrupled from 1968 to 1970. If production continues with varieties exhibiting little disease resistance, inoculum will increase locally in favorable years and will become more widely distributed. There will then be the potential for widespread epidemics in some years, instead of the localized severe outbreaks observed in 1970 (Table 1). Since most of the new crops being grown in Saskatchewan, in particular sunflower, field peas, and safflower, are known hosts of Sclerotinia, the risk is not confined to rapeseed. It remains for plant breeders and pathologists to incorporate into their programs means to attack this possible threat.

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