Patterns of ascospore discharge by *Leptosphaeria maculans* (blackleg) from 9- to 13-month-old naturally-infected rapeseed/canola stubble from 1977 to 1993 in Saskatchewan

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Ascospores of ***Leptosphaeria maculans*** (blackleg) often began to be produced on rapeseed/canola stubble in Saskatchewan in June, nine months after harvest. However, few ascospores usually were discharged before July 31, and rapeseed crops generally were flowering or podding by mid-July and were more resistant to infection. The number of samples discharging ascospores was positively correlated with the number of days with measurable rainfall in April, June, and various combinations of months from April to July. The mean number of ascospores caught per trapping date and maximum number of spores collected (most productive date) were also related to days with measurable rainfall in the April to July period. Total rainfall was less important than its frequency. Ascospore numbers were negatively correlated with number of days from April to June or July having a maximum temperature of 30°C or more. Strains of L. ***maculans*** differed in numbers of ascospores produced and in seasonal ascospore discharge patterns, with those from cruciferous weed hosts sporulating earlier and producing larger numbers of spores.

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En Saskatchewan, les ascospores de ***Leptosphaeria maculans*** (jambe noire) font leur apparition sur le chaume de Canola en juin, c'est-a-dire neuf mois après la récolte. Par contre, avant le 31 juillet, en general, peu d'ascospores avaient été éjectés. Le colza fleurissait ou produlsait des cosses vers la mi-juillet, ce qui augmentait sa resistance à l'infection. Le nombre d'échantillons où des ascospores avaient été ejectes était directement corrélé au nombre de jours pour lesquels on a pu enregistrer des precipitations en avril et en juin, et la combinaison de différents mois entre avril et juillet. La moyenne des ascospores retrouvés le jour de la capture et les quantités maximales de spores recueillies (le jour le plus productif) étaient également liées aux jours pour lesquels on a pu enregistrer des precipitations pendant la periode allant d'avril a juillet. Le taux de precipitations a été moins important que la frequence. Le nombre d'ascospores était anticorrélé au nombre de jours, entre avril et juin ou juillet, où la temperature maximale a été de 30 °C ou plus. Le nombre d'ascospores dans les souches de L. ***maculans*** ainsi que le mode d'éjection des ascospores ont varie. Les ascospores provenant des mauvaises herbes cruciformes ont produit des spores plus tôt dans la saison et en plus grand nombre.

Introduction

Rapeseed/canola (*Brassica napus* L. and B. *rapa* L.) is most susceptible to infection by ***Leptosphaeria maculans*** (Desm.) Ces. & de Not. (blackleg) prior to the 6-leaf stage of growth **(6)**. In western Canada canola is usually seeded between mid-May and early June and most stem infections are initiated 20-40 days after a crop is seeded (13). Therefore, June is a critical period in the development of blackleg in Saskatchewan. Earlier evidence indicated that, in the current year, ascospore discharge by ***L. maculans*** from the previous year's infected canola stubble began in July, which is too late to have a major impact on developing crops **(6)**. In Australia and Europe, ascospores from the remains of the preceding crop were discharged as early as the seedling stage of the current crop, causing severe losses (2,3). In Ontario, pseudothecia of ***L.*** maculans were produced on the current year's spring rape stubble one month after harvest, and mature ascospores were available to infect seedlings of the next crop of either winter or spring rape. The foregoing does not take into account the role played by inoculum from 2-year-old and older stubble residue. Limited data from Saskatchewan are available (6,10).

Shortly after a virulent strain of ***L. maculans*** was found in Saskatchewan on stubble from three 1975 crops (5) it exhibited the mid- to late-season pattern of ascospore discharge typical of indigenous weakly virulent strains.

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However, a few exceptions to this seasonal pattern were detected in samples of 1976 stubble residue. Ascospore discharge by virulent ***L. rnaculans*** began from the crop residue in one individual field in May and June, 1977 (6). This raised the possibility of the initiation of basal stem cankers during the stage of greatest host susceptibility. It was important to determine whether ascospore discharge by virulent ***L. rnaculans*** could occur from 9- to 10-month-old stubble sufficiently often to materially raise the level of blackleg incidence and severity. The present study examined the induction of ascospores on field-infected stubble on which they had not occurred previously. It was continued over a number of years to define trends in sporulation patterns, principally to more early-season discharges by the virulent form of blackleg.

Materials and methods

Blackleg-infected stubble of rapeseed/canola from the previous year's crop and stems of cruciferous weeds were collected annually in April throughout central Saskatchewan. Strains of ***L. rnaculans*** present in the material were determined by plating pieces on V-8 agar (8). A 7-cm piece including a portion of the basal stem and taproot was cut from each plant. At least 50 samples, each consisting of 20 stem segments, were prepared annually and tested for sporulation at least monthly between April and October in ascospore liberation tunnels (4). Samples were weighed and spore numbers expressed per 10 g of residue. They were placed on 17 x 9 cm wire grids, moistened thoroughly with water and inserted in the tunnels. The air flow was adjusted to 13,000 cc/min using a Rotameter (Brooks Rotameter Co., Lansdale, PA). Five tunnels were run concurrently for 1.5 hours. Spores were caught on vaselined slides and stained with cotton blue in lactophenol (1) prior to being counted. Samples were stored outdoors in well-drained wooden flats or white plastic pots 8 cm high x 11 cm in diameter. Rainfall was recorded on site using a Springfield rain gauge and temperature extremes recorded using a Springfield maximum/minimum thermometer (Springfield Instrument Co., Wood-ridge, NJ). Reference also was made to the Monthly Meteorological Summary for Saskatoon prepared by the Atmospheric Environment Service of Environment Canada. Correlations between measurements of sporulation and temperature and moisture variables were sought using the SAS GLM statistical package procedure (SAS Institute Inc., 1989) following transformation of spore numbers to LOG (no. spores + 0.5).

Attempts were made to correlate stage of crop development in the current year with abundance of ascospores discharged from the remains of the previous year's rapeseed crop. The percentage of the Saskatchewan rapeseed crop planted and the stage of crop development on certain dates were obtained from crop and weather reports compiled by the Economics (formerly Statistics) Branch of Saskatchewan Agriculture and Food, Regina. Most blackleg stem infections are initiated between 20 and 40 days after seeding (13). This range was used to calculate the "window" which occurred annually for the initiation of stem infections.

Results

At least three patterns of sporulation were recognizable during the 16-year period: an early, a late, and a very late pattern (Tables 1 to 3). The early pattern, which was found in 1979, 1981, 1982, 1984, 1987, 1989, 1990, 1991, and 1993 (and perhaps in 1977) was characterized by the initiation of ascospore production in a high percentage of samples in June and/or July in the year after crop growth. This was often accompanied by the production of abundant ascospores in July. Sometimes an early start to sporulation was followed by a summer and/or autumn of poor ascospore production, as in 1984 and 1989. The late pattern was typified by the production of few ascospores prior to August or September, as in 1980, 1983 and 1992. In the very late pattern, little or no sporulation occurred in the year following crop growth, and appreciable numbers of ascospores were not discharged until June or July of the second year after crop growth, as in 1985, 1986 and 1988. Five of the 16 years stand out as having relatively low overall ascospore productivity: 1984, 1985, 1986, 1988 and 1990 (Table 1). Three of these (1985, 1986 and 1988) fall into the very late pattern of ascospore discharge. The mean percentages of total ascospores discharged before July 31 were 1.8 for the years 1977–82, 14.1 for 1983–88, and 10.0 for 1989–93.

A number of statistically significant correlations were obtained between measurements of sporulation and temperature, and between sporulation and moisture variables. Selected rainfall and temperature data have been summarized in Table **4.** Total rainfall in May + June was correlated with the mean annual sporulation (Table 5). The correlation between total May rainfall and the mean annual sporulation or maximum sporulation (the mean number of ascospores caught annually on the most productive date) approached significance but the correlations between total April or June rainfall and the mean annual sporulation or maximum sporulation did not. Total rainfall was less important than its frequency. The number of days with measurable rainfall produced a number of significant correlations. However, when the number of days with "trace" precipitation were added to those with measurable rainfall, no significant correlations were found. The number of samples producing ascospores in July was significantly correlated with days with measurable rainfall in April, June, and for various combinations of months. The number of samples producing ascospores in August was significantly correlated with days with measurable rainfall in July and from April to July. Days of measurable rainfall in August was correlated with the mean annual sporulation and maximum sporulation. Maximum sporulation generally occurred in late summer or in autumn (Table 3). The total number of days from April to July, inclusive, with a maximum temperature of 30°C or more was negatively correlated with the number of samples producing ascospores in August (Table 5). The total number of days from April to June, inclusive, having a temperature maximum of 30°C or more was negatively correlated with LOG of the mean annual sporulation and LOG of the maximum sporulation. Other negative correlations which approached significance were number of days in June with temperature maxima of 25°C or more and LOG of the mean annual sporulation or LOG of the maximum sporulation. In addition, the number of samples producing ascospores in June was positively correlated with both the mean annual sporulation and maximum sporulation.

Rapeseed cultivars changed frequently during the 16 years of the study. In 1977, Torch, Tower and Midas were most commonly grown (Prairie Grain Variety Surveys by the three Prairie Wheat Pools, 1977–92). By 1982, Candle, Regent and Altex predominated. From 1984 to 1989, Tobin and Westar took up most of the hectarage, but these were quickly replaced after 1989 by more blackleg-resistant cultivars such as Legend. By 1993, the very blackleg-susceptible cultivar, Westar, had almost disappeared.

Seeding of the Saskatchewan rapeseed crop generally was completed before the end of the first week of June, and the "window" for the initiation of blackleg stem infections was usually closing by mid-July. Very few ascospores were caught in June, and most of the sporulation in July occurred in the latter half of the month. Early sporulation by the pathogen and late completion of seeding of the rapeseed crop coincided infrequently, examples being 1982 and 1991. In July 1982, ascospores were obtained from 94% of the 1981 samples. Also, crop development was unusually late in 1982, and the blackleg infection "window" occurred from June 6 to July 24. However, ascospore production in July 1982, was very variable and several samples produced no ascospores before August, whereas others discharged several hundred ascospores on July 13. On this date, 32% of the crops were still at the rosette stage and 5% at the seedling stage. The remaining 63% were flowering or podded and therefore more resistant to infection. Both early- and late-sporulating 1981 samples originated from several different parts of Saskatchewan, and were obtained even from individual fields. In 1991, the infection window was June 1 to July 21. Sporulation from July 8 to 15 was abundant on 1990 stubble, averaging 418 spores/10 g/1.5 hrs. However, development of rapeseed crops was more advanced by July 15 than in 1982, with 1% in the seedling stage, 15% in the rosette stage, and 83% flowering or podded. In 1987, the infection window was May 23 to July 10. On average, 96 spores were caught in 1.5 hours during the second week of July. However, by this time only 2% of the crop remained at a susceptible stage of growth. In most other years, July sporulation by *L. maculans* was poor. For example, in 1981 and 1990, crop development by mid-July was similar to that in 1991, but very few ascospores were produced before July 31. In Saskatchewan, a cereal crop usually follows rapeseed in the rotation. By July 10, 1982, 20% of Saskatchewan cereal crops were at the jointed stage, over 40% at the shot blade stage, and 30% were heading (Saskatchewan Agriculture Crop and Weather Reports). By July 8, 1991, the corresponding percentages were 26, 53, and 17, respectively.

Sporulation by two weakly virulent strains of *L. maculans* on rapeseed stubble was also examined. However, the material available was limited because the virulent form of *L. maculans* predominated in rapeseed fields over most of the study period. There was only sufficient material infected by the "Puget Sound" strain (11) to provide data for five years and only three years' data were available for the "sisymbrium" strain (7) (Table 6). The sisymbrium strain consistently produced larger numbers of ascospores on rapeseed stubble than did the Puget Sound strain or the virulent strain (Table 2 and 6). The sisymbrium strain discharged ascospores from its "natural" hosts, *Sisymbrium loeselii* L. and *Descurainia sophia* (L.) Webb (Table 7), earlier and often in greater numbers than it did from rapeseed stubble, although the opportunities for direct comparisons are limited. The "thlaspi" strain (7) of *L. maculans* from *Thlaspi arvense* L. discharged large numbers of ascospores annually, beginning well before July 31 (Table 7). This strain was found only very rarely on rapeseed stubble.

Discussion

The different seasonal patterns of sporulation in *L. maculans* were caused primarily by environmental factors. Temperature and frequency of precipitation from April to August in the year after crop growth had a profound effect on sporulation by *L. maculans* on year-old stubble. Poor and erratic ascospore production in several years between 1984 and 1990 is attributable to high temperatures and low moisture. Nevertheless, when conditions improved, the pathogen's ascospore production on year-old stubble reached unprecedented levels in 1989 and 1993.

An examination of weather records suggests possible explanations for the sporulation patterns observed in individual years. High temperatures appear to be responsible for reduced sporulation of *L. maculans* in 1984 and 1988. In July and August, 1984, the temperature reached or surpassed 30°C on 31 days. The mean temperature for both July and August 1984, was 28°C. The mean maximum temperature for June 1988, was 29°C, compared to the long-term average of 22°C. Temperature maxima for June 3-6, 1988, ranged from 36-41°C. Very dry conditions in June 1985, and June 1992, are implicated in poor or delayed sporulation in those years. Rainfall in June 1985 was 19%, and in June 1992 it was 25% of the 30-year average. Cool wet conditions in July and August 1992, appeared to stimulate sporulation, as 56% of the samples began to produce spores in August. There was little beneficial effect of above average rainfall in April, May, and July 1985, as 77% of the samples failed to produce ascospores. In 1980, rainfall for April to July was 56% of the 30-year average, which likely contributed to delayed sporulation. Cool moist conditions in August 1980 coincided with induction of sporulation in 76% of the samples. Rainfall in May 1989, was 236% of normal, and in June, 104% of normal. This may explain the early start to sporulation. Then hot weather intervened from mid-July to mid-August and no additional samples produced ascospores until September. Relatively poor sporulation in 1986 may have resulted from hot weather (31–35° maxima) between May 26 and June 1. In 1990, the typical late-season increase in spore numbers did not materialize (Tablel) likely because the rainfall from August to October was 22% of the average for these three months.

Higher than average temperatures and lower than average rainfall appear to have contributed substantially to poor, delayed or interrupted sporulation in 8 of the 16 years. In the five years when *L. **maculans*** exhibited very early sporulation and released large numbers of spores, wet conditions prevailed in May and June in 1981, 1982, 1991, and 1993. In 1987, April to July rainfall was only 64% of normal. However, above average temperatures were recorded in March, April and May, which may have provided a stimulus to sporulation by the pathogen.

Strains of *L. **maculans*** from cruciferous weeds produced spores in much greater numbers and earlier in the growing season on their “natural” hosts than did the “brassica” strains (the Puget Sound and virulent strains). Some of the former strains also appeared to respond in a different manner to environmental conditions (Petrie, unpublished). As some of the cruciferous weed hosts are winter annuals, the strains developing on them could have become established earlier than could strains inhabiting ***Brassica*** species.

This study shows that ascospore discharge by *L. **maculans*** from the previous year’s stubble generally will not occur early enough in the current year to have a great impact on developing rapeseed crops. Over the 16 years, ascospores were discharged in June from 21% of the samples (Table 2) but with few exceptions, only very low numbers were trapped, i.e. only a mean of 9% were discharged before July 31 (Table 1). As a cereal is almost always planted in the year following rapeseed, it appears unlikely that significant numbers of ascospores discharged under a cereal crop in early July could escape the plant canopy and be blown to adjoining rapeseed crops. Therefore, the number of rapeseed crops at a very susceptible stage of growth would usually be limited, the number of ascospores available from year-old stubble would usually be small, and only a fraction of the available spores likely would reach susceptible crops. Inoculum from 2-year-old and older rapeseed stubble residue would have a much greater impact on developing rapeseed crops, as ascospores from this material usually are discharged in considerable numbers in May and June, and old stubble residue capable of producing ascospores (and pycnidiospores) often is present under developing rapeseed crops (Petrie, unpublished).

No trend toward an earlier seasonal pattern of sporulation (i.e. consistent heavy sporulation in May and June) is evident from the data. Early sporulation in the virulent strain, as in 1991, was paralleled by earliness in the Puget Sound strain, was not repeated in subsequent years, and **is** attributed to environmental conditions. The frequent replacement of rapeseed cultivars further complicates attempts to identify trends in sporulation. However, environmental factors appear to have a much greater impact on sporulation patterns in *L. **maculans*** than differences in cultivars (Petrie, unpublished). For example, between 1984 and 1989, when Westar made up 50% or more of the hectarage, sporulation levels were low in four of the six years (Table 1). Periodic monitoring for trends in seasonal ascospore discharge patterns in *L. **maculans*** should continue, as the ability to sporulate profusely on 9- to 10-month-old stubble could confer a competitive advantage to a virulent strain which would be significant epidemiologically.

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Table 1. Average numbers of ascospores released by *Leptosphaeria maculans* from rapeseed/canola stubble in the year after crop growth.

Year spores produced	Mean % spores off before July 31 (and range)	Mean no. spores per 10 g sample / date*	Mean maximum no. spores per 10 g (best date)
1977	0.37 (0.02 – 0.97)	1,264 ± 315	4,344 ± 1,301
1979	2.42 (0.00 – 6.81)	508 ± 169	1,862 ± 612
1980	0.01 (0.00 – 0.03)	939 ± 188	3,112 ± 450
1981	3.23 (1.20 – 8.21)	365 ± 119	1,122 ± 387
1982	3.15 (0.08 – 5.51)	1,698 ± 285	5,301 ± 1,221
1983	0.09 (0.00 – 0.34)	538 ± 84	2,106 ± 324
1984	39.57 (2.59 – 91.94)	270 ± 92	575 ± 152
1985	1.74 (0.00 – 49.28)	22 ± 21	82 ± 86
1986	29.10 (0.00 – 100.00)	10 ± 3	32 ± 9
1987	14.03 (2.10 – 29.80)	1,425 ± 415	3,296 ± 1,074
1988	0.00	1	1
1989	1.09 (0.01 – 4.24)	4,234 ± 1,283	16,636 ± 2,494
1990	9.69 (3.40 – 15.79)	147 ± 44	423 ± 101
1991	30.95 (25.47 – 42.53)	2,815 ± 564	4,911 ± 1,215
1992	2.50 (0.00 – 8.11)	1,171 ± 366	3,635 ± 970
1993	5.83 (0.34 – 15.16)	4,041 ± 1,483	11,364 ± 4,486
Average	9.00 (2.20 – 23.70)	1,216 ± 339	3,675 ± 930

* For mean number of ascospores discharged per year, multiply the values in this column by 4.

Table 2. Pattern of ascospore discharge by *Leptosphaeria maculans* from stubble of rapeseed/canola in the year after crop growth.

Year spores produced and pattern*		Month and % samples in which sporulation was initiated				% samples producing ascospores
		June	July	August	September	
1977	E	11.9	36.9	46.0	5.1	100.0
1979	E	31.4	33.3	11.8	20.6	97.1
1980	L	0.0	11.9	76.1	11.9	100.0
1981	E	10.0	70.0	20.0	0.0	100.0
1982	E	17.0	76.6	6.4	0.0	100.0
1983	L	7.5	22.5	30.0	37.5	97.5
1984	E	38.6	7.1	0.0	21.4	67.1
1985	VL	2.7	0.0	4.1	16.2	23.0
1986	VL	9.1	10.6	27.3	6.3	53.0
1987	E	36.4	61.8	1.8	0.0	100.0
1988	VL	0.0	0.0	0.0	5.5	5.5
1989	E	78.0	0.0	0.0	25.0	100.0
1990	E	37.7	27.3	21.7	13.3	100.0
1991	E	17.7	82.3	0.0	0.0	100.0
1992	L	7.3	34.6	56.4	1.8	100.0
1993	E	28.0	52.0	20.0	0.0	100.0
16-yr. average		20.6	32.9	20.1	10.3	84.0

* Seasonal pattern of ascospore discharge: E = early, L = late, VL = very late.

Table 3. Three seasonal patterns of ascospore discharge by virulent Leptosphaeria maculans from rapeseed/canola stubble in the year after crop growth illustrated using one representative field for each year.

Year spores produced	Month and number of ascospores discharged / 10 g residue / 1.5 h ± s.d.			
	June	July	August	Sept. - Oct
Early discharae Dattern				
1984	275 ± 103	1,856 ± 2,191	39 ± 34	31 ± 36
1987	1	1,584 ± 687	8,683 ± 1,713	3,228 ± 734
1993	2	2,744 ± 1,904	27,617 ± 3,677	7,295 ± 2,309
Late discharae Dattern				
1980	0	0	640 ± 544	8,000 ± 2,400
1983	0	0	3	1,767 ± 1,336
1992	0	1	60 ± 80	5,028 ± 1,251
Very late discharae Dattern				
1985	0	0	0	6
1986	8	1	2	0*
1988	0	0	0	6 ± 8**

* Spores caught June, 1987 = 1,874 ± 1,193.
** Spores caught July, 1989 = 3,663 ± 1,552.

Table 4. Selected meteorological data for Saskatoon, 1977-1993.*

Year	No. days with measurable rain in April	May	June	July	August	Total rainfall May + June (mm)	Total days April-June ≥ 25°	Total days April-June ≥ 30°C	Total days April-July ≥ 30°C
1977	6	18	6	11	8	164	23	3	5
1979	17	10	17	10	4	114	12	3	11
1980	3	4	11	9	14	63	29	8	12
1981	11	5	16	14	8	94	12	3	7
1982	10	13	11	11	13	136	10	2	3
1983	6	13	11	12	7	161	12	2	6
1984	5	10	11	4	8	99	14	4	12
1985	8	9	8	7	9	88	7	0	6
1986	4	9	13	13	7	108	19	6	8
1987	6	8	12	11	11	61	24	6	12
1988	2	5	8	7	11	34	35	14	23
1989	5	13	10	9	11	155	14	3	10
1990	10	6	16	10	5	87	21	3	5
1991	10	7	17	10	7	208	8	0	1
1992	7	13	7	15	11	61	16	2	2
1993	10	9	11	10	16	95	13	3	4

* Monthly Meteorological Summary, Atmospheric Environment Service, Environment Canada.

Table 5. Correlations between ascospore numbers, temperature, and moisture variables obtained over a 16-year study from **1977** to **1993.**

Variables		Correlation coefficient, r[1]
LOG of the mean annual sporulation and:		
Total rainfall, May + June		+ 0.52*
Days with measurable rain,	April + May	+ 0.51*
	May + June	+ 0.54*
	April + May + June	+ 0.51*
	April to July, inclusive	+ 0.53*
	April to August, inclusive	+ 0.68**
LOG of maximum sporulation and:		
Total rainfall, May + June		+ 0.52*
Days with measurable rain,	April + May	+ 0.54*
	May + June	+ 0.54*
	April + May + June	+ 0.51*
	April to July, inclusive	+ 0.53*
	April to August, inclusive	+ 0.69**
No. samples producing ascospores in July and:		
Days with measurable rain,	April	+ 0.55*
	June	+ 0.54*
	May + June	+ 0.58
	April + May + June	+ 0.63**
	April to July, inclusive	+ 0.62**
No. samples producing ascospores in August and:		
Days with measurable rain,	July	+ 0.55*
	April to July, inclusive	+ 0.51*
	April to August, inclusive	+ 0.52*
Days with measurable rain, August and:		
Mean annual sporulation (av. no spores/date/year)		+ 0.51*
Maximum sporulation (av. no. spores on most productive date)		+ 0.50*
No. samples producing ascospores in June and:		
Mean annual sporulation		+ 0.54*
Maximum sporulation		+ 0.63**
No. days with temp. maxima of 30°C and over (April-July) and:		
No. samples producing ascospores in August		- 0.57*
LOG mean annual sporulation		- 0.59*
LOG maximum sporulation		- 0.58*
No. days with temp. maxima of 30°C and over (April-June) and:		
LOG mean annual sporulation		- 0.61*
LOG maximum sporulation		- 0.62*

[1] **Probabilities: *P *10.05,* **P 50.01**

Table 6. Average numbers of ascospores released by the weakly virulent "Puget Sound and "sisyrnbriurn" strains of ***Leptosphaeria maculans*** from rapeseed/canola stubble in the year after crop growth.

Year spores produced	Mean % spores trapped before July 31 (and range)		Mean no. spores per 10 g sample/date ± S.E.	Mean maximum no. spores per 10 g (best date)
Puaet Sound strain				
1977	0.80	(0.0 4.4)	1,246 ± 314	4,061 ± 984
1979	3.62	(0.0 16.0)	241 ± 77	854 ± 246
1980	0.05	(0.0 .2)	771 ± 221	2,756 ± 820
1990	4.92	(0.8 13.3)	824 ± 218	1,805 ± 405
1991	32.05	(8.5- 59.1)	2,161 ± 494	4,445 ± 1,123
Sisvmbriurn strain				
1977	0.23	(0.0 1.4)	1,772 ± 498	5,998 ± 901
1979	5.97	(0.1- 20.8)	1,053 ± 294	3,577 ± 1,008
1980	0.18	(0.0 1.8)	1,473 ± 159	4,524 ± 850

Table 7. Average numbers of ascospores released by the "sisymbriurn" and "thlaspi" strains of ***Leptosphaeria maculans*** from their "natural" weed hosts in the year after plant growth.

Year spores produced	Host*	Mean % spores trapped before July 31	Mean no. spores per 10 g sample / date	Mean maximum no. spores per 10 g (best date)
Sisvmbrium strain				
1976	DS	30.9	2,442 ± 530	3,750 ± 1,399
1977	SL	0.6	11,194 ± 393	40,000 ± 2,828
1979-1	DS	23.2	1,570 ± 747	2,780 ± 2,662
1979-2	SL	44.5	2,337 ± 541	3,179 ± 1,370
1991	SL	42.4	9,812 ± 1,566	16,607 ± 6,057
Thlaspi strain				
1979	TA	57.9	15,750 ± 1,560	32,500 ± 6,455
1980	TA	22.6	10,645 ± 1,680	21,908 ± 5,994
1982	TA	51.6	21,000 ± 2,848	29,333 ± 1,155
1991-1	TA	37.5	34,342 ± 9,674	75,386 ± 58,950
1991-2	TA	78.7	13,723 ± 5,645	31,039 ± 18,171

* Host species: **DS** = *Descurainia sophia*, **SL** = *Sisymbrium loeselii*, **TA** = *Thlaspi arvense*.