# Cochliobolus sativus Conidia Populations in Soils Following Various Cereal Crops

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ABSTRACT

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The effect of 12 cultivars of various cereal crops on numbers of conidia of *Cochliobolus sativus* in row soil adjacent to and incorporated with the stubble was investigated. Experiments were conducted at two locations in Saskatchewan and conidial populations were determined by the flotation-viability method. The largest number of conidia was found after cropping with barley, followed by two cultivars of wheat (Lake and Neepawa) and then five other cultivars of wheat and Prolific rye. Lowest populations occurred after cropping with the two cultivars of oats. Nevertheless, this study indicated that oats, even though considered to be highly resistant to the pathogen, contributed a significant number of *C. sativus* conidia to the soil and thus is not desirable in a rotation for the purpose of controlling common root rot of cereals caused by *C. sativus*.

*Additional key words:* common root rot, *Triticum aestivum, Hordeum vulgare, Avena sativa, Secale cereale, Helminthosporium sativum.*

*Cochliobolus sativus* (Ito and Kurib.) Drechs. ex Dastur [imperfect state, *Helminthosporium sativum* P. K. and B. = *Bipolaris sorokiniana* (Sacc. ex Sorokin) Shoemaker] is the primary cause of common root rot of cereals in western Canada. This pathogen is perpetuated by soil-borne conidia formed on the crowns and subcrown internodes of infected host plants and liberated and distributed throughout the soil by cultivation and wind movement. Ledingham and Chinn (5) found many conidia of *C. sativus* on the crowns of wheat and barley, but few on crowns and roots of well-established stands of bromegrass and crested wheatgrass. Chinn et al. (2) found conidial populations of *C. sativus* ranging from 8 to 893, with an average of 188 per gram of soil, in 100 cultivated fields in Saskatchewan. More recently, in a crop rotation study (1) I observed a consistently greater population of *C. sativus* conidia following barley compared to wheat (477 and 209 conidia per g of soil, respectively). This suggested that the two cereals might differentially influence the numbers of *C. sativus* conidia in the soil.

This paper reports differences in populations of *C. sativus* conidia in experimental plots seeded to a number of cultivars or breeding lines of wheat, barley, oats, and rye.

## MATERIALS AND METHODS

The flotation-viability method (2) was used to determinate the total and viable populations of *C. sativus* conidia in soils cropped to seven cultivars of wheat *(Triticum aestivum* L.), two of barley *(Hordeum vulgare)*, two of oats *(Avena sativa)*, and one of rye *(Secale cereale)*. The 12 cultivars each were seeded during May 1974 at Saskatoon and Scott, Saskatchewan, in four replicated plots using a randomized block design on 12 ranges. Plots were 180 cm long and comprised four rows spaced 30 cm apart. Seeding rate was 125 seeds per row. The four plots in a range were separated by 60-cm pathways and the 12 ranges by 120-cm pathways. Plots and pathways were kept free of weeds. At maturity (early September), the crops were swathed, removed, and discarded. Soil and stubble were taken in early October from each of the two center rows of each plot as follows: a furrow (7.5 cm wide by 6.4 cm deep) was dug the entire length of each row with a clean sharp aluminum scoop. About 7.5 kg of soil, roots, subcrown internodes, and stubble were collected in the process, put in plastic bags, and brought to the laboratory. To obtain a uniform distribution of conidia in the soil including those from the various plant parts, the plant material was broken into small pieces, thoroughly mixed with the soil, and then, as much of the mixture that could be was passed through a 6-mm wire mesh screen. Material that did not pass through the screen was remixed with the screened soil. This mixing and screening procedure was repeated five times through the 6-mm screen and then two more times through a 4-mm wire mesh screen. The screened soil so obtained is referred to here as the row soil. One determination was made with each soil sample on the total and viable population of *C. sativus* conidia on a dry weight basis. The conidial number in the two center rows of each of the four replicate plots was averaged and recorded. When determinations could not be made immediately, the soils were stored at 2 C. Final determination was completed in late December. Determinations also were made in June and again in October on total populations of *C. sativus* from eight random sites along the pathways.

## RESULTS

The total populations of *C. sativus* from the uncropped soil (pathways) were quite similar, whether taken in June or October; with the latter determination they averaged 56 and 6 conidia per g soil at Saskatoon and Scott, respectively. Since conidia in the pathways represented a background deposit not related to the treatments they were considered residual and were subtracted from the populations in the row soil to give a more accurate indication of the number produced by the crops in the current year. Their numbers were small in relation to conidia produced by the test cultivars; thus, they were of little consequence in the analysis.

Only the total populations were analyzed statistically because the percentages of viable conidia were uniformly high, ranging from 81% to nearly 100%. No significant difference in conidial population was found within the replicates.

In general, conidia numbers in row soil were in the following descending order: barley, wheat, rye, and oats (Table 1). Some exceptions to these trends were encountered. For instance, at Scott the populations following both barley cultivars were significantly higher than those following the two wheat cultivars, Lake and Neepawa, but at Saskatoon only one barley cultivar, Olli, had a significantly higher count than the same two wheat cultivars. Within wheat more conidia were associated with Lake and Neepawa than the other cultivars.

Conidial populations of *C. sativus* were many times greater at Saskatoon than Scott regardless of cultivar grown. Populations ranged from 25 times higher subsequent to the oats cultivar, Kelsey, to 51 times higher following the durum wheat cultivar, Hercules.

## DISCUSSION

The numbers of conidia found in the various wheat plots at both locations were of the same order and magnitude found in a previous study (2). If the 5,982 and 2,869 conidia per gram of row soil after Lake and line 1464, respectively, at Saskatoon are considered as distributed throughout entire plots this would reduce the count to one-quarter of these numbers since the row soil (7.5 cm) was one-quarter the width of an entire row (30 cm). Thus the converted numbers of 1,498 and 717 conidia/g of plot soil indicate that they are at the level of the top 1% of the fields sampled in that study (3). At Scott, converted populations of 38 and 24 conidia/g plot soil after Lake and 1464 indicate that they were equivalent to those in the lower quartile. It is possible that these converted numbers are on the low side because wind could disseminate conidia from the plants to the remaining three-quarters of a row. Data from unpublished work, however, indicated that any addition was minimal. This was further suggested by insignificant differences in conidial numbers in the soil between the June and October sampling of the pathways.

In general, the population counts indicate that barley contributed most, wheat and rye less, and oats the least to conidial population of *C. sativus* in the row soil. This supports my earlier unconfirmed observation made in conjunction with the rapeseed study (1) namely, that barley crops contributed more than wheat crops to population of *C. sativus* in soil. Chulkina (3) also noted that the highest degree of infestation was after barley, less after wheat, and least after oats.

Populations of *C. sativus* conidia in soil probably are associated with the level of infection in the crops. According to R. J. Ledingham *(personal communication)* disease levels in barley regularly were higher than those in wheat and that of numerous barley cultivars that were rated, cultivar Olli was most susceptible. On the other hand, 680, a highly resistant wheat, contributed as much, if not more, to conidial population than 1464, a highly susceptible wheat.

Oats are highly resistant to *C. sativus* (6), and gave the lowest conidia population of all cereals tested, but still contributed over 1,500 conidia per gram of row soil at Saskatoon. Whether this is due to a lower level of infection or to less sporulation on infected tissues is not known. Oats in a rotation with wheat or barley is then not likely to prevent population increases sufficiently to influence common root rot in subsequent cereals. This is in agreement with the findings of Ledingham (4) who found only a slight benefit from oats on the disease in a subsequent wheat crop.

Many factors may be responsible for the vast differences in populations of *C. sativus* conidia between the plots at Saskatoon and Scott. The amount of sporulation seems to be independent of the degree of infection since the incidence and severity of common root

TABLE 1. Mean number of *Cochliobolus sativus* conidia present per gram of row soil after cropping with various cereal cultivars at Saskatoon and Scott, Saskatchewan, Canada

| Cereal | Cultivar | Saskatoon | Scott |
|---|---|---|---|
| Barley | Olli | 8647 a[z] | 302 a[z] |
| Barley | Bonanza | 7066 ab | 248 a |
| Wheat | Lake | 5982 bc | 152 b |
| Wheat | Neepawa | 5774 bc | 155 b |
| Wheat | Hercules | 5248 cd | 103 cd |
| Wheat | Cypress | 4999 cde | 106 c |
| Wheat | Glenlea | 4009 def | 99 cde |
| Wheat | 680[y] | 3732 ef | 100 cde |
| Rye | Prolific | 3547 f | 92 cde |
| Wheat | 1464[y] | 2869 fg | 97 cde |
| Oats | Harmon | 1715 g | 57 e |
| Oats | Kelsey | 1510 g | 60 de |

[y]Cultivars 680 and 1464 were developed at this laboratory for their resistant and susceptible characteristics, respectively.
[z]Location means followed by the same letter do not differ significantly at $P = 0.05$ as determined by Duncan's multiple range test.

rot are quite similar at these two stations (Chinn, *unpublished,* from this and other studies). The difference probably is not due to moisture and temperature since Saskatoon and Scott are only about 160 km apart and both are in a similar climatic zone. The clay loam soil at Saskatoon produced plants that were slightly larger, had more tillers and, consequently, had more surface area than those grown on the loam soil at Scott, and it is unlikely that these differences in plant growth could be responsible for producing 25 to 51 times more conidia at Saskatoon than at Scott. Perhaps soil factors influenced the plant constituents which in turn influenced conidia production, or there may have been a different level of sporulation inhibitors in the two soils.

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