Seasonal Transmission of Wheat Spindle Streak Mosaic Virus

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ABSTRACT

The percentages of wheat plants that developed wheat spindle streak mosaic from soil-borne infection at Ottawa were lower in plots sown in late October than in those sown 2 to 8 weeks earlier, but winter survival was also lower, hence late seeding is not recommended as a practical means to escape infection.

By removing wheat plants from the field at different dates, washing their roots, then replanting in sterile soil and growing at about 10 C for symptom development, it was found that plants could become infected during late September through October, and in April and May. Infection occurred most rapidly during mid- to late-October, but symptoms did not develop in the field until May. Plants infected in April or May did not develop symptoms in the field because the temperature became too high too soon.
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In Ontario most winter wheat is sown in mid- to late-September. During this period the temperature of the soil at seed depth is predominantly between 20 C and 15 C. Growth occurs during a period of generally declining temperatures until late October or early November when the temperature becomes too low for further growth until late April. The development of wheat spindle streak mosaic virus (WSSMV) in wheat appears to be determined primarily by the infectivity of the soil and the duration of periods with suitable temperatures in the fall and again in the spring (1, 2). In controlled conditions infection occurred between 8 C and 17.5 C, but 15 C was optimum. Disease symptoms developed at 5 C to 15 C, but the optimum was about 10 C.

Experiments were conducted to determine the relation of date of seeding to the infection of winter wheat with WSSMV, and to determine the dates when infection via soil could occur in the field.

MATERIALS AND METHODS.—The plot tests were conducted in a field at the Central Experimental Farm, Ottawa, in which wheat had been grown on a 3-year rotation from 1952 to 1967, then annually. The soil was highly infectious for WSSMV.

For date-of-seeding tests, five cultivars of wheat were sown in 4-row plots 3 m long with four replicates for each of five seeding dates from late August through October. After growth resumed in May, estimates were made of plant survival and the percentages of the plants with WSSM symptoms.

Tests to determine dates of transmission via soil in the field were done with Talbot wheat seedlings transplanted into the field, or plants from plots sown at 2-week intervals. About 30 plants were removed from each plot at 2-week intervals, their roots were washed, and they were replanted in pots of sterile soil. They were then grown in a cabinet at 6 to 12 C with 10,000 lux of light 12 hours per day for 90 days for symptom development. Soil temperature at the 5-cm depth is from records taken at a nearby site at the Central Experimental Farm, by the Meterological Branch, Department of Transport, Canada.

RESULTS.—*Dates-of-seeding in relation to symptom development.*—The results of tests in which five cultivars of winter wheat were sown at intervals of approximately 2 weeks from late August to late October were similar for seedings done in 1968 and in 1969, hence only the data for the latter are presented here (Table 1). A lower percentage of cultivar Rideau plants developed symptoms than of the other cultivars including Genesee, Kent, Richmond, and Yorkstar. The lowest percentages of diseased plants for

all cultivars occurred in the plots sown late in October, but the stand of plants surviving the winter was also drastically reduced in the late-sown plots. It appears that the dates at which wheat can be sown for reduced fall infection are too late for satisfactory winter survival of wheat in the Ottawa area.

Dates of infection of fall-sown wheat.—Talbot wheat was sown in plots of infectious soil on 17 September, 30 September, 8 October, and 15 October 1970; and plants were removed at different times, washed, and grown at 6 to 12 C for symptom development (Fig. 1). The first samples of plants in which infection was demonstrated were collected 15 October from plots sown 8 October. By 23 October, only 10 to 20% of the plants from each

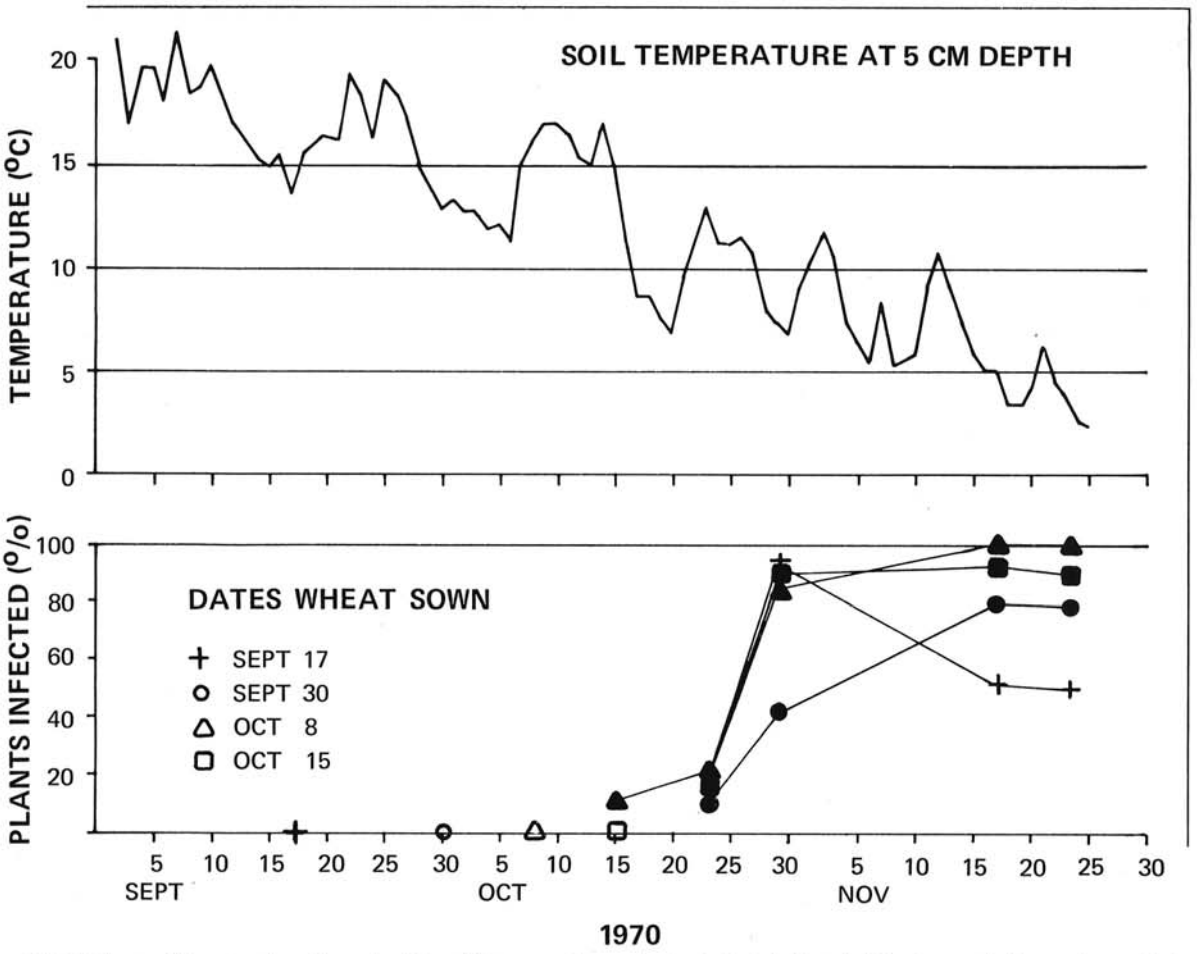

Fig. 1. Mean soil temperature (5-cm depth) and the percentages of wheat plants infected with wheat spindle streak mosaic by different dates in plots of infectious soil at Ottawa in 1970.

TABLE 1. Date of seeding in relation to stand and the development of wheat spindle streak mosaic (WSSM) in winter wheat, Ottawa, 1969-70

Date sown	Genesee		Kent		Richmond		Rideau		Yorkstar	
	Stand[a] (%)	Mosaic-diseased[b] (%)	Stand (%)	Mosaic-diseased (%)	Stand (%)	Mosaic-diseased (%)	Stand (%)	Mosaic-diseased (%)	Stand (%)	Mosaic-diseased (%)
August 28	60	93	73	95	70	95	75	54	70	83
September 9	88	98	85	95	93	98	95	10	93	85
September 25	75	90	75	88	80	95	85	20	75	85
October 9	17	61	19	75	50	90	68	55	49	58
October 25	18	33	14	43	15	45	14	3	14	25

[a]Estimated percentage of plants surviving the winter.
[b]Estimated percentage of plants developing mosaic symptoms characteristic for WSSM.

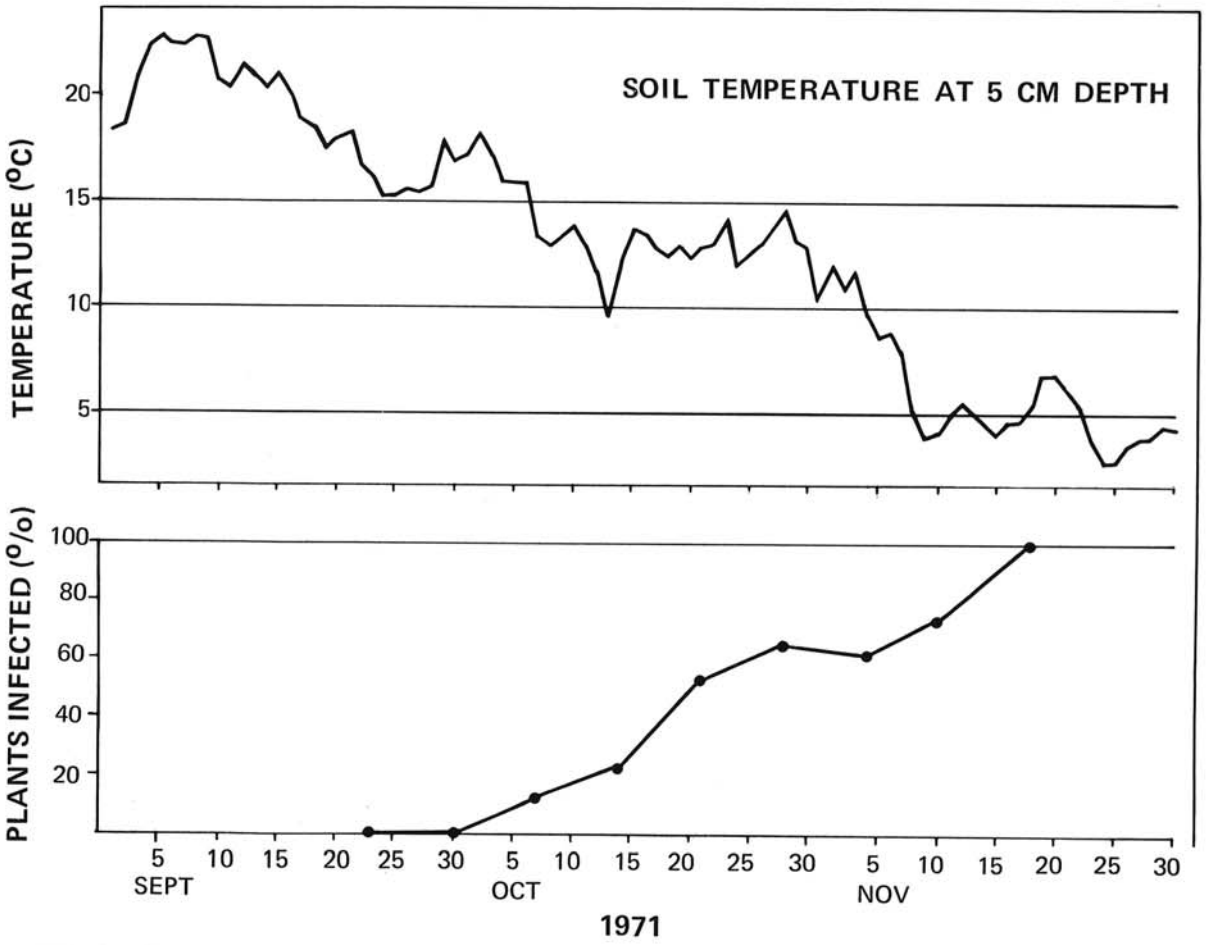

Fig. 2. Mean soil temperature (5-cm depth) and the percentages of wheat plants infected with wheat spindle streak mosaic by different dates in plots of infectious soil at Ottawa in 1971.

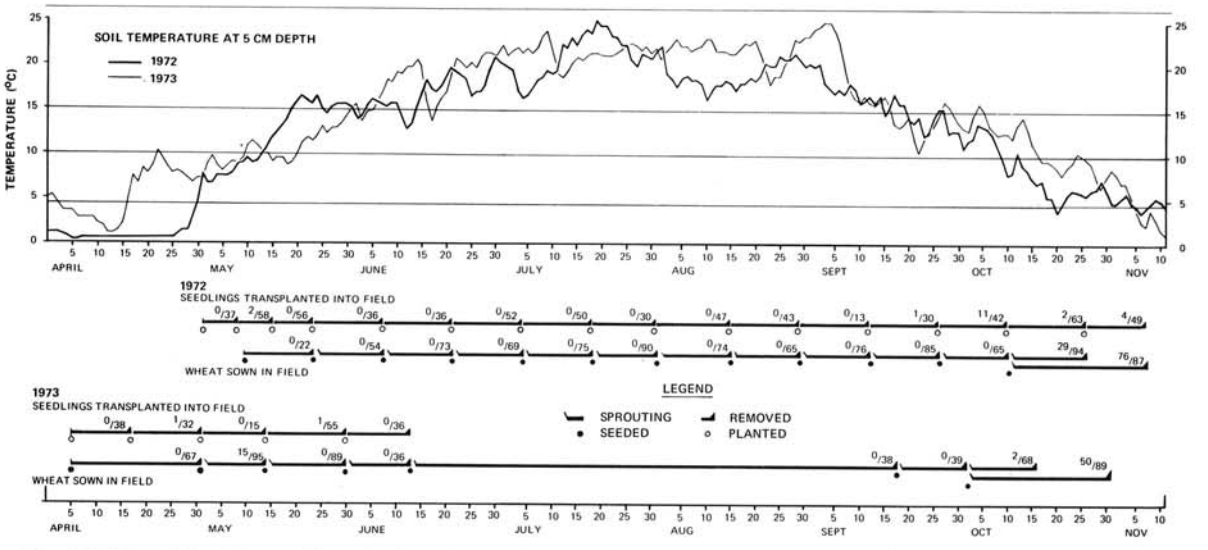

Fig. 3. Mean soil temperature (5-cm depth) and numbers of wheat plants infected/numbers in test samples growing for successive periods in infectious field soil at Ottawa in 1972 and 1973.

seeding date were infected, but by 29 October 40 to 90% of the plants were infected. During the latter period of most rapid increase in numbers of infected plants, the daily mean temperature of the soil at 5 cm was predominantly between 15 C and 8 C. By 17 November all plants were infected in plots sown 8 October, but some plants appeared to have escaped infection in plots sown either earlier or later.

In similar tests in 1971, with plants from a plot sown 23 September and samples removed weekly for testing, infection was found in plants collected at an earlier date (7 October) (Fig. 2). Percentage infection appeared to increase more gradually than in 1970, but reached 100% by 18 November. The soil temperature (5-cm depth) during the period of transmission (30 September to 18 November) decreased from about 17 C to about 5 C.

Seasons of transmission in the field.—The results of tests to detect transmission to wheat sown or transplanted into the field at 2-week intervals from early spring to late fall in 1972 and 1973 are shown in Fig. 3 along with the daily mean temperature of the soil at the 5 cm depth. In 1972, transmission was detected only from 8 to 15 May, and from 12 September to 7 November. In 1973, a low percentage of plants became infected between 15 April and 30 May. Transmission occurred most rapidly in October. During all these periods the temperature of the soil at 5 cm was predominantly between 5 C and 15 C. In both years, the remaining plants in the fall-sown plots in which high percentages of infection had occurred developed WSSM symptoms the following May. However, none of the plants developed symptoms in the field from infection that occurred in April or May.

DISCUSSION.—It appears that at Ottawa most infection of wheat plants with WSSMV normally occurs during a brief period in October when the soil temperature is predominantly below 20 C, but above 5 C. This coincides with results at controlled temperatures (1, 2) indicating that little infection occurs at 17.5 to 20 C, or at 5 C or lower. Infection from soil occurs most rapidly at 15 C, but lower temperatures are necessary for symptom development. Symptoms appeared to develop optimally at 10 C. However, Wiese and Hooper (3) reported that a period at lower temperature in a growth chamber (1 C or -2 ± 15 C in an outdoor cold frame) increased both symptom severity and the percentages of test plants affected. Their suggestion of a vernalization effect fits logically with the sequence of temperature experiences for winter wheat in nature. After infection occurs in October at temperatures around 15 C, the plants are subjected to much lower temperatures in late fall and winter which may shorten the incubation time for the disease. When there is a return to temperatures suitable for symptom development in the spring (5 to 15 C), the development of symptoms appears to be rapid.

Although there was no evidence that overwintered plants became infected in the spring, spring infection can occur. A low percentage of test seedlings planted in the field in the spring became infected in late April and in May. However, there is little possibility that any plants infected in the spring would develop symptoms in the field because the period with favorable temperatures (5 to 15 C) is too short in the spring at Ottawa, for infection and incubation to be completed before warmer temperatures prevent further development of the virus.

LITERATURE CITED

1. SLYKHUIS, J. T. 1970. Factors determining the development of wheat spindle streak mosaic caused by a soil-borne virus in Ontario. Phytopathology 60:319-331.
2. SLYKHUIS, J. T. 1974. Differentiation of transmission and incubation temperatures for wheat spindle streak mosaic virus. Phytopathology 64:554-557.
3. WIESE, M. V., and G. R. HOOPER. 1971. Soil transmission and electron microscopy of wheat spindle streak mosaic. Phytopathology 61:331-332.