Effects of drying on the transmissibility of wheat spindle streak mosaic virus in soils from wheat fields in Ontario[1]

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Most soil samples collected in May each year, 1970 to 1973, from areas in winter wheat (Triticum *aestivum*) fields in which 90 to 100% of the plants had distinct symptoms of wheat spindle streak mosaic showed little or no infectivity to wheat test plants grown in them before they were dried. However all were infectious when tested after they had been dried in a greenhouse and kept in polyethylene bags for 4 to 5 months; at that time the percentages of test plants infected ranged from about 5% to 100% for different soils.

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La plupart des echantillons de sol preleves en mai (de 1970 a 1973) dans les champs de ble d'hiver *Triticum* aestivum manifestant de 90 a 100% de symptômes typiques de mosaique striée n'ont pratiquement pas provoque d'infection sur des plants de ble cultivés avant le sechage du sol. Cependant, tous les echantillons etaient infectieux apres sechage en serre et conservation en sacs en polyethylene pendant quatre a cinq mois. Au bout de ce temps, le pourcentage de ble infecté variait d'environ 5% a 100%selon l'echantillon de sol.

During annual surveys for wheat spindle streak mosaic (WSSM) in Ontario (1), diseased plants and soil samples were collected from many of the fields for tests to determine the presence of the virus (WSSMV). As noted for such collections in **1969** (4), the numbers of test plants that became infected from the soil samples from different fields varied greatly. Since highly infectious soils were desired for experiments on various aspects of transmission of the virus, selected collections were made each year from areas in which the disease was most prevalent, and these were tested to ascertain their infectivity.

The following is a report of the results of tests to verify the infectivity of soils collected in May each year, **1970** to **1973,** from areas of different winter wheat fields in which all plants showed distinct symptoms of WSSM, and the effects of drying on the results achieved.

Materials and methods

The soils were dug, including the roots of diseased plants, to a depth of **8** to **10** cm, placed in polyethylene bags and kept moist until the first tests for soil infectivity were started 1 to **2** weeks later. After the samples were removed for the May test, the remainder of each collection of soil was dried thoroughly on a greenhouse bench, then stored in polyethylene bags in the greenhouse. In October, the dried soils were tested for infectivity by the same procedures and under the same growth conditions as used for the earlier tests that year.

The tests for infectivity of the soils collected in **1970, 1971,** and **1972** were done by placing a **4-5** cm layer of the soil to be tested on top of a sterilized potting soil mixture **(3** loam soil: 1 sand: 1 peat moss) in one **12** cm pot for each soil. Winter wheat *(Triticum aestivum* L. cv. Kent) was sown in the field soils **(20** seeds per pot) and grown in growth chambers at **12°C** during a **12** h light period (10,000 lux) alternating with **6°C** during a **12** h dark period. Final counts for numbers of plants with symptoms were made **120** days after seeding.

In **1971**, two sets of pots of each soil were tested in October, one in the regulated growth cabinets at 6-12°C, the other in a greenhouse in which the temperature fluctuated from about **4°C** to 16°C, but was principally around **10°C.**

Since it was found that the optimum temperature for infection from soil was **15°C** and the optimum for incubation of the virus was about **10°C** (2), the tests in **1973** were done by sowing Kent wheat in two 7.5-cm pots of each of the **soils,** keeping them at **15°C** for **4** weeks, then transplanting the plants into 12-cm pots of sterile potting soil and growing them at **6-12°C** for an additional **90** days.

Results and discussion

The results of soil infectivity tests showed major variations among the soils, and also between the tests done in May and October each year (Table 1). There was little or no transmission from most of the soils in **1970** and **1971** collections when tested shortly after they were collected in May and before they were dried. Transmission from these and most of the **1972** and **1973** collections was greatly increased after the soils were kept dry until October, but even then, transmission ranged from about 5% for some to **100%** for other soils.

The conditions of testing also affected results. In 1971, when an additional replication of test pots was placed in

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Table 1. Transmission of wheat spindle streak mosaic virus from soil samples from fields of diseased wheat in Ontario when tested immediately after collection in May each year, and after dry storage until October

Year	Field no.*	Location	Time tests started: May	October	October
1970	17	Palmyra	0/20**	3/21**	
	19	Port Crew	1/19	1/20	
	26	Colchester	0/20	9/18	
	28	Wheatley	0/19	7/21	
	40	Clinton	0/19	8/20	
	43	Bond Head	0/18	10119	
		non-infectious soil	0/21	0120	
1971	14	Victoria	0/20**	0/19**	13/20?
	17	St. Williams	0/20	10/20	12/17
	35	Blenheim	1/19	8/11	20/20
	42	Kingsville	1/20	3/16	14/20
	43	Port Alma	0/16	2/20	1/20
	64	Bond Head	0/19	0/17	6/20
	72	Ottawa	0/20	9/19	18/19
	73	Ottawa (mosaic-free)	0/19	0/20	0/20
1972	4	Vineland	3/14**	6/18""	
	10	Dunnville	1/14	2/18	
	14	Wallacetown	2/14	12/21	
	22	Port Alma	0/15	20/20	
	24	Port Alma	4/17	9/20	
	46	Exeter	4/19	1/18	
	61	Bond Head	0/20	14/19	
	63	Bond Head (mosaic-free)	0/20	0/21	
1973	1	Ottawa	6/62††	41/51††	
	41	Amherstburg	2/29	12/35	
	43	Port Alma	0/35	16/35	
	53	Arkona	0/38	15/35	
	59	Exeter	8/36	13/35	
	64	Clinton	0/36	25/35	
	67	Clinton	11/34	15/39	
	82	Bradford	13/32	7/38	
	92	Workworth	0/37	18/34	
		non-infectious potting soil	0/33	0/38	

* 90-100% of the plants were diseased in the areas of each field where all except the non-infectious samples were collected.

** Kent wheat grown in soils in cabinets at 12 ± 1°C duringa 12 h light period (10.000 lux) and 6 ± 0.5°C during a 12 h dark period.

† Kent wheat grown in soils in a greenhouse with temperature 10 ± 6°C.

†† Kent wheat grown in two 7.5 cm pots of infectious soils at 15°C for 4 weeks then transplanted into sterile soil in 12 cm pots and grown in cabinets at 12°C during 12 h light period and 60C during 12 h dark period.

a greenhouse in which the temperature was about 10 ± 6°C, a higher proportion of the test plants in most of the soils developed symptoms at these variable temperatures than at the more precisely regulated growth cabinet conditions with the temperature alternating regularly between 6°C and 12°C at 12 h intervals.

Although no direct comparisons were made in the tests reported here, tests done by growing wheat in infectious soil at 15°C for 4 weeks, then transplanting and growing at 6°to 12°C for symptoms to develop, as in 1973 (Table 1), generally result in higher percentages of plants developing symptoms than tests in which the

plants are grown continuously at any one daily temperature regime (2). Even with this procedure, we seldom achieve infection of all test plants even in the most highly infectious soils. Usually most plants become infected in plots of highly infectious soil at Ottawa in October and sometimes in pots of infectious soil kept outdoors through October (23). Wiese and Hooper (5), noting the high infection in pots of infectious soil kept outdoors in the fall in Michigan, reported that symptom severity and percentage of test plants infected were increased by cool and freezing temperatures. A period of such conditions, which was not included in our tests, may be necessary for maximum disease development.

There appear to be several factors affecting the transmissibility of WSSMV from soil. Although certain sequences of temperature are of major importance, moisture content and other factors may also affect the infectivity of the soil at specific times. The low infectivity of most soil samples shortly after collection from the field in May each year indicates a lack of reliability of soil tests done immediately on non-dried soil samples collected at that time. Tests done after the soil samples have been dried for a period appear more reliable. We have not determined the effects of much shorter periods of drying soils collected in May. However, other tests have indicated that keeping soil moist has a temporary suppressive effect on infectivity. At present we have no satisfactory explanation for the great differences in infectivity of soils collected from different fields in which WSSM appeared to be equally prevalent, but the explanation is probably related to the concentration or activity of the vector, and possibly to failure to provide conditions that would activate the vector and virus optimally in all the soils.

Literature cited

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Correction

In the article by G.J. Green entitled "Air-borne rust inoculum over western Canada in 1974", volume 55, no. 2, page 49, the last entry in column 1, Table 1 should read "1974 total".