Stimulating Effects of Transplanting on the Development of Wheat Spindle Streak Mosaic Virus in Wheat Plants Infected from Soil

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ABSTRACT

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The percentage of wheat plants that developed wheat spindle streak mosaic was increased by uprooting plants after 4 weeks in infectious soil at 15 C, then with or without washing, replanting in the same or in noninfectious soils before growing at 10 C. It appears that several treatments causing injury of the roots after infection from soil stimulate symptom development.

Additional key words: viruses, soil-borne virus of wheat.

Experiments to determine the numbers of wheat plants infected with wheat spindle streak mosaic virus (WSSMV) after specific periods in infectious soil required removing the plants from the soil, washing the roots to remove all soil particles, dipping the roots in a fungicidal solution (1 g captan per liter water) to assure surface decontamination, then replanting in sterile soil and growing at 10 C for symptom development (2, 4). These procedures inevitably caused varying degrees of abrasion and root breakage, especially when separating intertwined root systems. It was suspected that injury, loss of roots, and the effects of the fungicides might be detrimental to the establishment of the virus in the roots hence might cause a reduction in the numbers of infected plants that developed symptoms.

The results of two experiments to determine the effects of transplanting and other manipulations of plants after growing in infectious soil at 15 C for 4 weeks, and the effects of different transplanting soils are shown in Table 1. The lowest percentage of plants developed symptoms in pots in which the plants were left undisturbed in the infectious soil and moved to 10 C. No significant increases in percentages of plants developing symptoms occurred if the roots and the unbroken soil mass were removed from the small pots (7.5-cm diameter) and transferred into larger pots (12-cm diameter), and more infectious soil, noninfectious field soil, or sterile soil was added below and around the ball of roots and soil to fill the larger pot without disturbing the roots. However, the addition of quartz sand (0.2- to 0.4-mm grit size) around the root-soil mass resulted in a much higher percentage of plants developing symptoms. Similarly, the percentages of plants developing symptoms was increased by removing the plants from the infectious soil and re-planting them in either infectious soil, noninfectious nonsterile soil, sterilized soil, or sand. Washing the roots or dipping them in an aqueous suspension of captan had no added effect. However, the percentage of plants developing symptoms was increased by dipping the washed roots in a suspension containing benomyl and thiram each at 100 $\mu g/ml$. Also, all plants developed symptoms after being transplanted into noninfectious soil amended with 5 g NH_4NO_3 per kg of soil. This quantity of NH_4NO_3, which prevents or reduces infection by WSSMV when mixed with infectious soil before sowing wheat (1), also caused discoloration and stunting of the roots of the wheat plants growing in the soil.

In other tests, infection was prevented or the percentage of plants infected was significantly reduced when seedlings were grown for 4 weeks in infectious soil treated with 100 $\mu g/g$ of benomyl, PCNB ($Cl_5C_6NO_2$), thiram or zineb. However, when plants were grown in nontreated infectious soil for 4 weeks, then transplanted into noninfectious sandy loam soil treated with these chemicals at the above concentrations, the numbers of plants that developed symptoms were not reduced.

Tests were done to determine if the increased percentages of plants developing symptoms could result from root-to-root transmission during washing of groups of plants after removal from the infectious soil, or during growth and intermingling of roots after transplanting into sterile soil. After 4 weeks in four different infectious soils at 15 C, 40 plants were removed from each soil and each plant was washed separately and planted singly in a 7.5-cm diameter pot of sterile soil. Forty other plants from each of the soils were washed in groups of ten and the groups were planted in 10-cm diameter pots of sterile soil. The numbers of plants that developed symptoms ranged from 5% from one infectious soil to 88% from another. However, for each soil the plants developing symptoms were about equal for those washed and replanted singly and those washed and replanted in groups of 10. Therefore, root-to-root transmission was not a cause of the increases in numbers of plants developing symptoms after transplanting from infectious soils.

The experiments described above indicate that when wheat seedlings are grown in infectious soil at 15 C, substantially all infection occurs by the 4th week, but under growth room conditions many of the infected plants may not develop symptoms if left undisturbed in the infectious soil. The development of symptoms is stimulated by transplanting and other manipulations that

TABLE 1. Effects of different transplanting manipulations and soils on the percentages of Kent wheat plants which developed wheat spindle streak mosaic symptoms at 10 C after growing in infectious soil at 15 C for 4 weeks

Transplanting manipulation and soil[a]	Plants (%) with mosaic symptoms in experiment: A[b]	B[c]
Not transplanted, grown in 12-cm diameter pots of infectious soil	21	
Soil and undisturbed roots repotted from 7.5- to 12-cm diameter pot with infectious soil		32
Soil and undisturbed roots repotted from 7.5- to 12-cm diameter pot with noninfectious soil		24
Soil and undisturbed roots repotted from 7.5- to 12-cm diameter pot with sterile soil	30	
Soil and undisturbed roots repotted from 7.5- to 12-cm diameter pot with quartz sand		76
Soil shaken from roots, plants into infectious soil		59
Soil shaken from roots, plants into noninfectious soil	54	53
Soil shaken from roots, plants into sterile soil	54	42
Soil shaken from roots, plants into quartz sand		70
Roots washed, plants into infectious soil		47
Roots washed, plants into noninfectious soil		52
Roots washed, plants into sterile soil	61	35
Roots washed, plants into quartz sand		62
Roots washed, dipped in captan (1 g/liter), plants in sterile soil	63	
Roots washed, dipped in benomyl and thiram (100 mg/g), plants in sterile soil	80	
Roots washed, plants in noninfectious soil with NH_4NO_3 (5 g/kg)	100	
Plants grown in noninfectious soil, replanted	0	0

[a]Except for the first treatment, test seedlings grown in 7.5-cm diameter pots of infectious soil were repotted or replanted in 12-cm diameter pots of different soils. There were four replicates of each treatment with 15-20 plants per pot.
[b]Least significant difference ($P = 0.05$) = 23; LSD ($P = 0.01$) = 32.
[c]Least significant difference ($P = 0.05$) = 18; LSD ($P = 0.01$) = 24.

cause physical injury to the root system.

These results contrast with results of experiments which showed that transplanting or rubbing the leaves of young wheat plants before inoculating reduced their susceptibility to WSSMV transmitted by the artist's airbrush method (3).

Under normal field conditions in Ontario, wheat sown in infectious soil in the fall becomes infected during October (4). During the subsequent winter and early spring the plants are subjected to freezing and thawing of the soil which results in root damage. Perhaps this damage, like the effects of transplanting, stimulates the development of symptoms in infected plants when growth resumes in the spring. Physical damage caused by freezing and thawing may be one of the factors involved in the "vernalization" effects suggested by Wiese and Hooper (5) resulting from exposure of plants to variable temperatures (-2 ± 15 C).

LITERATURE CITED

1. SLYKHUIS, J. T. 1973. Characteristics of suppression of wheat spindle streak mosaic by nitrogen fertilizers. Can. J. Plant Sci. 53:477-483.
2. SLYKHUIS, J. T. 1974. Differentiation of transmission and incubation temperatures for wheat spindle streak mosaic virus. Phytopathology 64:554-557.
3. SLYKHUIS, J. T. 1975. Factors critical to mechanical transmissibility of wheat spindle streak mosaic virus. Phytopathology 65:582-584.
4. SLYKHUIS, J. T. 1975. Seasonal transmission of wheat spindle streak mosaic virus. Phytopathology 65:1133-1136.
5. WIESE, M. V., and G. R. HOOPER. 1971. Soil transmission and electron microscopy of wheat spindle streak mosaic. Phytopathology 61:331-332.