THE POTENTIAL OF CORN AND WHEAT TO PERPETUATE WHEAT STREAK MOSAIC IN SOUTHWESTERN ONTARIO

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Abstract

Aceria tulipae (K) transmitted wheat streak mosaic virus from ripening kern ——— corn (Zea mays) and wheat (Triticum aestivum) in the field until about 2 weeks before either crop was ready to harvest. Wheat infected in the fall was therefore a source of virus and vector under field conditions for infection of corn plants early in the following summer, and likewise infected corn was a source of infection for fall-sown wheat in September and October.

Introduction

Wheat streak mosaic has been recognized on winter wheat in southwestern Ontario since Play 1964 (8), and on corn since August 1965 (6). The red striping of the corn pericarp known as kernel red streak is caused by the feeding of Aceria tulipae (K) on the kernels (4,7). Kernel red streak has been very widespread in southwestern Ontario since 1965, indicating that large populations of mites are present on kernels in most corn fields.

Since winter wheat is present in fields in southwestern Ontario from late September to late July, and corn from late May to October, the mite could transfer the virus in June and July from ripening kernels of wheat to corn and in October from kernels of corn to winter wheat. So far wheat streak mosaic virus has been found infrequently in this area, for reasons'which are not known. A possible limitation on this cycle in the field is that at the time the mites leave each crop in large numbers they have been feeding on the pericarps of the ripening grains, which might not be good sources of virus for mite transmission.

Experiments were done to determine the potentialities of maturing wheat and corn as sources of viruliferous mites capable of infecting young plants of the alternate crop.

Methods

Movement of mites and virus from wheat to corn

To provide virus sources in a winter wheat crop, volunteer winter wheat (Triticum aestivum L.) plants that were infested with mites and showing symptoms of wheat streak mosaic were transplanted to eight sites in a winter wheat crop at the Harrow Research Station on November 9, 1967. At each site, plants in the two outer rows of a square yard plot (0.84 m^2) were replaced by infected plants. On May 1 and Play 8 heavily infested wheat leaves from a greenhouse culture of healthy mites were placed on the infected plants in four of the eight plots. Mites were counted at intervals from May to July on the infected and nearby rows.

Movement of mites and virus from ripening wheat heads was detected by placing trap plants and Vaseline-coated slides in or near the infected rows, and by testing wheat heads in the greenhouse for mites and virus. Further details are given in discussing the results of these tests.

Movement of mites and virus from corn to wheat

Sources of mites and virus in a corn crop were established by placing heads from the infected wheat rows in the whorls of 16 corn (Zea mays L. 'Pioneer 371') plants in the field on July 9. At this time the corn plants were 2 ft high. Similar corn plants received pieces of wheat leaf from a greenhouse culture with virus and mites. Some of the latter plants and some healthy ones were infested with healthy or with viruliferous mites on August 12 by placing pieces of healthy or infected wheat leaf with mites beneath the husks.

Ears were collected from these plants on several occasions in the fall and tested for the presence of mites and transmissible virus by pulling back the husks and laying the ears in trays of wheat seedlings. For weekly periods in the fall, vaseline-coated slides and trays of wheat seedlings were also set out as traps for mites between the corn rows at the height of the ears.

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Results

Development of mites on wheat

Some mites on the transplanted infected plants survived the winter, for mites were found on these plants from June 7 onwards (Table 1), but they were not found on plants 2500 per m^2. Elites could be found for 10 rows (about 6 ft) beside the infected rows, and for 4 ft along the rows containing the infected plants; similar spread was recorded by Orlob (5). Mite populations declined rapidly in the first 2 weeks of July, and many left the plants, for they were trapped in large numbers at this time on vaselined slides exposed for periods of about 5 days at

Table 1. .Mites counted on winter wheat plants and caught on trap slides, 1968

Date	Site examined	No. of mites ver site examined* — Plots with overwintered mites plus mites in May: Infested row	Adjacent row	2nd row away	Plots with overwintered mites only: Infested row	Adjacent row	2nd row away	Mites caught on vaselined slides (No./inch^2/day)	Crop notes
May 24	Within 1 cm of ligule of 2nd leaf from top	19.3	2.6	1.4	0.0	0.0	n.c.**		Corn emerging
June 7	Within 1 cm of ligule of flag leaf	40.2	34.9	12.0	2.8	n.c.	n.c.		Wheat anthesis
June 20	Within 1 cm of ligule of flag leaf	0.2	0.2	0.2	0.0	0.0	0.0		Grain half size
June 7	Loner spikelet (glumes)	5.8	0.6	0.2	0.1	n.c.	n.c.		
June 20	Lower spikelet (glumes)	33.2	3.9	4.8	0.7	0.0	0.0		
June 28-July 3								3.7	
July 2	Lower spikelet (kernel)	21.7	13.1	15.5†	0.2	0.0	0.0		Grain milky inside
July 3-8								7.7	
July 8	Loner spikelet (kernel)	5.4	9.5	10.1††	0.8	0.2	0.5		Grain moist dough inside
July 8-10								12.4	
July 10-15								10.2	
July 18	Lower spikelet (kernel)	0.0	0.0	2.3	n.c.	n.c.	n.c.		(Most kernels (hard, mites on (immature grains
July 15-22								1.6	Wheat harvested July 30

* Mean of 5-10 counts on each of 4 plots.
** n.c. = no count made.
† On 2 July mites were also found on rows 3-10 (avg. 3.1 per kernel) and for 4 ft along row beyond the infected length; none were found in the general crop.
†† On 8 July mites were also found on rows 3-10 (avg. 6.8 per kernel) and in the general crop (0.4 per kernel).

in the general crop until July 8. There were many more mites throughout the season on the plants that received additional mites in May. The mites were found, as described by Kantack and Knutson (2), near the ligules of the upper leaves and eventually on the glumes and on the developing kernels, where large numbers were found in the kernel groove. In the plots reinfested in May the highest populations, averaging 33 mites per spikelet, were found on June 20. This would correspond to about 500 mites per wheat head, or about 200,000 per square meter. On plants in adjoining rows, which were somewhat later in maturing, peak populations of mites were found on July 2. In the general crop on July 8 there were 0.4 mites per kernel, or about the height of the ears (Table 1). The crop was harvested on July 30.

Transmission of virus from wheat to corn

Very few visibly infected wheat plants were apparent apart from those in the original yard lengths, but many wheat heads from the four adjacent rows proved to be harboring infective mites when placed on corn seedlings in the greenhouse, and infective mites were also detected on plants in the 11th and 13th rows away from the infested rows on July 9 (Table 2, Test B).

Nearly all potted trap plants of corn and wheat placed in the field for 2-week periods

Table 2. Transmission of wheat streak mosaic from winter wheat to test plants of corn or wheat by field populations of mites

	TEST A				TEST B				
	Transmission of virus to equal numbers of corn and wheat plants in contact with or 18 inches from infected wheat plants				Transmission of virus to corn seedlings from heads* of wheat plants infested with overwintered mites plus mites added in May, and from heads of wheat from nearby rows				
	% of trap plants infected with virus					No. of corn seedlings infected/no. tested			
	Rows with overwintered mites plus mites in May		Rows with overwintered mites only						
Period of exposure of trap plants	Contact	la inches	Contact	la inches	Date	Infested wheat row	Adjacent wheat row	3rd row away	4th row away
May 24-June 10	80	89	5	0					
May 31-June 18	100	93	7	0					
June 10-28	70	50	a	12	June 11	9/12			
June la-July 3	a3	50	10	37	June 20	12/12	4/6		
June 28-July 10	80	100	33	25	July 2	12/12	4/6	2/3	
July 3-19	97	100	73	100	July 9	10/12		7/8	4/41
July 10-19**	91	100	66	75					

* Wheat heads were tied to corn seedlings in this greenhouse test.
** Crop harvested July 30.
† Rows 9-17 were also tested on July 9, and heads from rows 11-13 contained infective mites.

in contact with or near plants that received mites in May became infected over the whole test period, May 24 - July 19 (Table 2, Test A). In the plots containing only mites that had developed from over-wintered populations, increasing proportions of test plants were infected fror May 24 onwards when they were in contact wit plants in the original yard lengths, and from June 10 onwards when they were in the centers of the plots with these plants. In early July, most trap plants in these plots also became infected.

Mites migrated from the wheat heads in large numbers in the 4th and 3rd weeks before harvest, and they could still transmit the virus to test plants in the 3rd week before harvest. Few mites remained on the wheat heads 2 weeks before harvest.

Transmission of virus from corn to wheat

The corn plants that received viruliferous mites in July or August did not show disease symptoms. Nevertheless, when ears were collected from these plants between September 13 and October 25 and placed on trays of wheat seedlings, mites were always detected and usually they transmitted the virus (Table 3). Mites and virus were obtained from a few of the ears collected on November 5, when the crop was harvested. Mites were not detected on vaselined slides in this period, but trap plants placed between the corn plants for periods of 7 to 11 days during October and early November became infested with mites, and a few plants became infected with the virus (Table 3). It is evident, therefore, that mites have the potential to transmit the virus from ripening corn kernels to wheat during October and early November, i.e. for several weeks after winter wheat usually germinates.

Discussion

This investigation ha5 shown that wheat streak mosaic virus can readily be transmitted by mites from ripening wheat and corn kernels until about 2 weeks before harvest of either crop. This confirms the assumption that winter wheat and corn grown in close association can provide under field conditions sources 'of infection for each other, and thus can be complementary in the perpetuation of wheat streak mosaic virus and its vector A. tulipae.

In southwestern Ontario, wheat streak mosaic, although widespread, has infected so far only occasional plants of winter wheat and corn. In the autumns of 1966-68 wheat streak mosaic was seen in individual wheat plants every few paces in 16 of 42 fields examined, while in corn the disease was seen on occasional plants in 8 of 33 fields examined in late July and early August of those years. However, in this experiment the virus was recovered from wheat and corn plants that did not have symptoms, and infection' may be more frequent than visual surveys suggest.

Del Rosario and Sill (1) found that A. tulipae from wheat adapted easily to several corn varieties, and readily transferred the virus from wheat to corn and back to wheat. Most virus isolates from wheat in southwestern Ontario were mechanically transmissible to the susceptible corn hybrid CH159 X CH3. The widespread occurrence of

Table 3. Transfer of mites and wheat streak mosaic from ears of corn to test seedlings of wheat

Source of infective or healthy mites used to infest corn in field	Ears placed on trays of wheat seedlings					Trays of wheat seedlings placed between corn rows			
	Sept. 13	Sept. 27	Oct. 11	Oct. 25	Nov. 5	Oct. 2-9	Oct. 9-18	Oct. 18-25	Oct. 25-Nov. 5
Winter wheat heads with mites and virus from field crop, July 9	0.7(+)†	1.0(+)	12.3(+)	0.3(+)	0.0(+)	0(+)	0(+)	0(+)	0(+)
Leaves with infective mites from culture, July 9	5.8(+)	5.8(+)	2.2(+)	0.0(+)	0.0(-)	0(-)	1(+)	0(+)	0(+)
Leaves with infective mites from culture, July 9, and healthy mites, Aug. 12	11.0(+)	8.8(+)	10.5(+)	0.8(+)	0.2(-)	0(+)	0(-)	0(+)	0(-)
Leaves with infective mites July 9 & Aug. 12	13.5(+)	4.5(+)	1.5(+)	0.5(+)	0.0(-)	0(+)	0(+)	1(+)	0(+)
Leaves with infective mites Aug. 12	17.4(+)	2.0(+)	0.0(+)	0.0(+)	0.2(-)	0(+)	0(+)	0(+)	0(-)
General crop	0.0(+)	0.0(+)	0.0(+)	0.2(+)	0.0(+)	0(+)	0(+)	0(+)	0(+)

† Figures represent avg no. of seedlings infected out of 50, and symbols in brackets indicate that mites were (+) or were not (-) detected on the test seedlings.

kernel red streak in recent seasons shows that mites reach a high proportion of corn plants, and should wheat streak mosaic become prevalent in a particular area it might well persist at a high level under present crop rotation practices.

Nault and Styer (3) reported that in Ohio high populations of Aceria tulipae were found on wheat in early summer and on corn in early fall, and that large numbers of this mite were trapped as these crops matured. They considered that the movement of mites and virus from wheat to corn in early summer and from corn to wheat in the fall could pose a threat to these crops in the Corn Belt.

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