Variation in Transmission of an Isolate of Barley Yellow Dwarf Virus by Rhopalosiphum padi

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ABSTRACT

Progeny of individual *Rhopalosiphum padi* that had effected an occasional transmission of the MAV isolate of barley yellow dwarf virus were no more likely to transmit MAV in subsequent tests than were progeny of individuals that originally failed to transmit the virus. Such occasional loss of specificity in the virus-aphid relationship does not appear to be based on genetic variation within the colony of *R. padi*. Phytopathology 61:753-754.

Additional key words: aphid transmission of virus, *Macrosiphum avenae*, aphid clones.

Rhopalosiphum padi (Linnaeus) is an efficient vector of some isolates of barley yellow dwarf virus (BYDV), such as RPV and PAV, but it rarely transmits other isolates of the virus, such as MAV and RMV, which in turn are transmitted efficiently by *Macrosiphum avenae* (Fabricius) and *R. maidis* (Fitch), respectively. In one series of tests, for example, *M. avenae* transmitted MAV to 100% of the plants infested, but in parallel tests *R. padi* transmitted MAV to only 3% of the plants (2). Such occasional transmissions represent a loss of MAV vector specificity. We are interested in study of these infrequent transmissions because they provide an approach to an understanding of the mechanism of vector specificity. Similar occasional transmissions in the field could impede identification of important vectors, could be a factor in changes in predominating virus isolates in an area, and could affect other aspects of BYDV epidemiology.

Previous tests (3) have shown that occasional transmissions of MAV by *R. padi* do not involve any alteration of MAV or selection of virus variants from the MAV-infected plants. Little is known, however, about possible variation among individual aphids that effect such an occasional transmission. Genetic variation within an aphid species can be a key factor in virus transmission. For example, clones of *R. padi* are known to differ in ability to transmit the RMV isolate of BYDV (4). Variations within a single aphid clone, such as the clone of *R. padi* used in this laboratory (2), are unexpected, but these expectations are based more on reasonable assumptions than on experimental data.

In the present study we examined the possibility that individual *R. padi* which occasionally transmit MAV are genetic variants. We compared the ability of progeny of such individuals to transmit MAV with that of progeny of other individual *R. padi* that originally failed to transmit the virus.

In two separate experiments, single *R. padi* that had fed for 2 days at 15 C on detached oat leaves infected by the MAV isolate of BYDV were transferred to each of 100 oat seedlings (*Avena byzantina* K. Koch 'Coast Black'). At the end of a 5-day inoculation test feeding period at 21 C in a growth chamber (16-hr light period), the individual aphid (or, more frequently, nymphs produced by it) was transferred from the oat seedling to caged barley plants in an attempt to derive an aphid colony from each of the 200 test aphids. The oat seedlings were then fumigated and placed in a greenhouse where they were observed periodically for at least 4 weeks. Five of the 200 oat plants became infected by BYDV. Colonies were derived from three of the five corresponding *R. padi*. As controls for further tests, three additional colonies of *R. padi* were selected from progeny of three aphids that did not transmit, but that had fed on the same MAV-infected leaf as did the corresponding transmitters. Selection of newly emerged nymphs from each of the six colonies assured that they were free of BYDV. Before aphids from the colonies were used, freedom from virus was confirmed by failure of about 70 aphids from each colony to transmit virus following a 5-day feeding on oat seedlings.

Colonies derived from each of the six individual *R. padi* were compared in five separate experiments. In each experiment, progeny from an individual that had transmitted MAV in the original test were compared with progeny of an individual that had failed to transmit the virus. The paired colonies were used to infest six opposite half-leaves of oats infected by MAV. Controls for each colony were provided by infesting healthy leaves and by infesting a half-leaf from a plant infected by RPV or PAV. Following a 2-day acquisition feeding on the half-leaves at 15 C, the aphids were transferred, at the rate of about 10 aphids/plant, to seedlings of Coast Black oats. Aphids from each half-leaf were transferred to three individually caged seedlings in one 4-inch pot for a 5-day inoculation test feeding in the growth chamber. At the end of the inoculation test feeding period, plants were fumigated to kill all aphids, and observed in the greenhouse for 4 weeks (2).

All colonies transmitted both RPV and PAV to all plants infested (Table 1). Transmission of MAV occurred from 16 of 90 leaves to 23 of 536 plants. From nine of the leaves the transmission was effected only by colonies from "nonvector" aphids. From three leaves, only progeny of "vector" aphids transmitted. In four cases, transmissions occurred from both halves of the MAV-infected leaf. From all but three of the

TABLE 1. Transmission of three isolates of barley yellow dwarf virus by colonies of *Rhopalosiphum padi* from single aphids that had transmitted (+) or failed to transmit (—) in an original test with the MAV isolate

Colony no. and previous transmission history	Transmission[a] in tests with virus isolate shown			
	MAV	PAV	RPV	None (control)
1+	0/89	9/9	6/6	0/15
2—	9/89	9/9	6/6	0/15
3+	1/90	9/9	6/6	1/15
4—	3/90	9/9	5/5	0/15
5+	6/88	9/9	6/6	0/15
6—	4/90	9/9	5/5	0/15

[a] Number of plants that became infected over number infested with about 10 aphids that had fed for 5 days at 21 C on Coast Black oat seedlings following a 2-day acquisition feeding at 15 C on detached half-leaves. The one infected plant in the control group represents accidental contamination (with the PAV isolate) during handling and not contamination of the aphid colony, because none of the 18 plants infested with aphids that had fed on MAV-infected leaves in the individual experiment became infected.

half-leaves, only one of the three infested plants in a pot became infected. In the three exceptions, which involved colonies 2, 4, and 6, two of the three test plants became infected. Neither in the individual experiments nor in the total number of transmissions (Table 1) was there any indication that progeny of the "transmitters" were more likely to transmit MAV than were progeny of "nontransmitters".

Subsequent comparative tests were made of each plant that became infected in these experiments, following feeding by *R. padi* on MAV-infected leaves, to determine whether any alteration or selection of virus variants had occurred. That the three original individual *R. padi* had transmitted unaltered MAV was shown in comparative transmission tests with four aphid species. Virus was transmitted from the three plants by *M. avenae* (to 9 of 9 plants), but not by *R. padi* (to 0 of 9 plants), *R. maidis* (to 0 of 9 plants), or *Schizaphis graminum* (Rondani) (to 0 of 9 plants). Comparative transmissions were also carried out on each of the 23 plants that became infected following feeding by aphids from the *R. padi* colonies on MAV-infected leaves (Table 1). These tests confirmed that the occasional transmissions by *R. padi* involved MAV, and not some variant of it, because virus from the infected plants was transmitted to 69 of 69 test plants by *M. avenae*, but to 0 of 69 plants in parallel tests with *R. padi*. None of 30 plants infested as controls in this series of experiments became infected.

In another kind of experiment, about 0.02 μliters of MAV from a concentrated preparation (14 μg of virus/ml) were injected directly into the hemocoel of aphids from each of the six colonies of *R. padi*. Five injected *R. padi* from each colony were placed on each of 12 oat seedlings for a test feeding period of 5 days. None of the 72 infested plants became infected. Three of four plants infested with injected *M. avenae* became infected in a parallel test. None of 280 control aphids transmitted virus. Again, progeny of *R. padi* that had effected occasional transmission of MAV were not different from progeny of *R. padi* that did not transmit MAV in the original test.

Although no genetic variation among the colonies of *R. padi* was found in these tests, we do not discount the possibility that such variation may occur in other populations of *R. padi*. The clone of *R. padi* from which the six test clones originated had been derived initially from a single viviparous female, and it had been reselected (via a single viviparous female) every few years during the 15 years in which we used it (2). Variation among individual *R. padi* may be the basis for the occasional transmissions of MAV, but these data indicate that any such variations have a physiological, not a genetic basis.

Variation in the virus may be the key factor that permits occasional transmission of MAV by *R. padi*. Perhaps the barrier that normally prevents virus transmission within the "nonvector" aphid might be overcome by virions with an atypical protein capsid structure. The source of virus may be important. In these experiments, for example, there was a tendency for the occasional transmissions to occur more often from younger source leaves than from older ones, a phenomenon that may be similar to the cyclical transmissibility of BYDV described by Gill (1). It is also possible that the occasional loss of MAV specificity results not from variation within just one of the three biological systems, but from precise interactions among them.

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