Tests for Transmission of Pea Enation Mosaic Virus by Oligophagous Mustard and Grain Aphids

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ABSTRACT

The oligophagous grain aphids, *Macrosiphum avenae, Rhopalosiphum padi,* and *Schizaphis graminum* transmit pea enation mosaic virus (PEMV) from pea to pea, a nonhost of the vector, if placed on barley, a natural vector host, for a 48-hour incubation period following virus acquisition. The oligophagous mustard aphids, *Brevicoryne brassicae* and *Hyadaphis erysimi,* failed to transmit PEMV when induced to feed on sinigrin-treated PEMV-infected pea and sinigrin-treated pea test plants.

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An examination of the lists of aphid vectors which transmit the circulative viruses reveals that, with few exceptions, both vectors and viruses share common host plants (2). The known or presumed phloem acquisition and inoculation of these viruses requires more than a superficial association of the aphid vector with the virus host plant. Vector specificity of the circulative viruses reflects aphid-host compatibility, which may obscure the potential of many aphid species to transmit viruses from nonhosts.

Matthews (3) has suggested the use of specific plant chemicals to induce aphids to feed on unnatural hosts for experimentally increasing the range of viruses transmitted by particular aphids. With this suggestion in mind, I expanded upon Wensler's (7) study to detail the stimulatory effects of the mustard oil glucoside, sinigrin, on two oligophagous Cruciferae-feeding aphids, the cabbage aphid, *Brevicoryne brassicae* (L.) and the turnip aphid, *Hyadaphis erysimi* (Kaltenbach) (6). Although both of these species have been reported as nonvectors of the legume-restricted pea enation mosaic virus (PEMV) by Heinze (1), it is unlikely that either species ingested

plant sap or virus in his study. The systemic incorporation of an aqueous sinigrin solution to the severed petioles of nonhost legumes ensures prolonged phloem sieve tube ingestion by the turnip aphid (6). This technique was used in the present study in an attempt to transmit PEMV with the two Cruciferae-feeding species. A second "host alternating" technique was also used in an effort to transmit PEMV with three Gramineae-feeding aphid species.

Pea seedlings, inoculated 7-10 days previously, were systemically treated (6) with a 0.1% sinigrin solution for 24 hours before being infested with adult *B. brassicae* or *H. erysimi*. After 24 hours, adults were removed leaving behind numerous 1st instar nymphs deposited by adults. Nymphs were allowed a 96-hour acquisition access period before being placed on pea test plants sprayed to run-off with a 0.1% sinigrin solution. Aphids were placed five per plant on test plants within 30 minutes after sinigrin treatment for a 48-hour inoculation access period. None of 200 *B. brassicae* nor 200 *H. erysimi* transmitted PEMV to any pea test plants.

These results suggest that *B. brassicae* and *H. erysimi* are nonvectors of PEMV for reasons other than inability to feed in phloem sieve elements where circulative viruses are known or thought to be acquired and inoculated. Both species fed extensively on systemically treated leaves during the virus acquisition access period. This was indicated by aphid growth and development during the 96-hour access period. Aphids did not settle and feed as readily on sinigrin-sprayed test plants as they did on systemically treated source plants. Aphids were observed to initiate numerous test probes, however, which is consistent with earlier observations (6). Such brief inoculation probes in nonvascular tissue by vector aphids will result in transmission of PEMV to pea (4, 5). To date, neither of these aphid species is known to transmit a circulative virus.

An oligophagous aphid which is capable of feeding for a brief period on a nonhost infected with a circulative virus may acquire virus, but may die before the incubation period has elapsed and it can transmit the virus. If, after a brief virus acquisition access period on a non-host, an aphid can be transferred to its normal host to complete the virus incubation period, it might successfully transmit a circulative virus when it is subsequently transferred back to the nonhost test plant. Grain aphids were chosen as potential candidates to test this idea since I previously noted that certain of these species would occasionally infest peas or broadbean in the greenhouse. These infestations were shortlived; the aphids eventually died or wandered from these unnatural hosts. To test for limited survival of four grain aphid species, 100 each of *Macrosiphum avaenae* (F.), *Rhopalosiphum maidis* (Fitch), *R. padi* (L.), and *Schizaphis graminum* (Rondani) were placed on pea seedlings for 96 hours. Observations 48 hours after infestation revealed that *R. padi* settled, larviposited, and survived surprisingly well on this "nonhost". *M. avenae* and *S. graminum* settled less well, but over 90 of each species were recovered. Only four *R. maidis* were recovered and therefore this species was eliminated from further studies. After 96 hours, less than 10% of the remaining three species could be recovered alive. Subsequently, groups of 50 second- and third-instar *M. avenae, R. padi,* and *S. graminum* were allowed access to PEMV-infected pea seedlings for 48 hours, survivors were transferred back to their normal host, barley, for a 48-hour virus incubation period and then transferred (five per plant) to pea test seedlings for a 48-hour inoculation access period. The experiment was replicated four times. *M. avenae, R. padi,* and *S. graminum* transmitted PEMV to 23, 14, and 8 of 24 test plants, respectively. Equal numbers of aphids from stock colonies did not transmit virus to 24 test plants each.

Data compiled by Kennedy et al. (2) reveal that the grain aphids are "outstandingly successful" as vectors of circulative viruses. Not only are they successful as vectors of circulative viruses from the Gramineae, but in two instances they vectored nonGramineae viruses, filaree red leaf by *R. padi* and beet western yellows by *M. avenae*. Results presented here further demonstrate the versatility of grain aphids as vectors of aphid-borne circulative viruses, and raise the question of their potential as universal vectors of this group of viruses.

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