Aphid Transmission of Peanut Mottle Virus

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ABSTRACT

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Aphis craccivora and *Myzus persicae* were used in peanut mottle virus (PMV) transmission studies. Aphids starved 4-6 hours in glass dishes were allowed to probe one time on an infected leaf, and then transferred singly to healthy peanut seedlings. Both aphids transmitted four of the five known strains of PMV in a stylet-borne manner. Efficiency of transmission was similar (21-54%) for two mild mottle strains and the severe mosaic strain, it was significantly reduced (9-18%) for the chlorotic line pattern strain, and the necrosis strain was not transmitted by the aphids. Transmission rates were about two and one-half times as great for *M. persicae* as for *A. craccivora*. Also, *M. persicae* remained infective after acquisition for 12 hours as compared to 2 hours for *A. craccivora*. The acquisition host was usually peanut, but the transmission results were not altered when *Pisum sativum*, a host with a higher concentration of all strains of PMV, was used. After an acquisition probe on peanut, a single probe by *A. craccivora* on non-PMV hosts (pepper and cotton) reduced the transmission to peanut by 50-69%. Feeding on nonhosts did not affect PMV transmission by *M. persicae*.

Additional key words: dependent transmission from a mixed infection.

Peanut mottle virus (PMV) is a serologically distinct virus of the potato virus Y group with flexuous rod particles (3). Previous studies (1, 2, 5) have shown that PMV is transmitted in the stylet-borne, nonpersistent manner by several aphid species.

Resistance in peanut to PMV has not been found (8). Therefore, the development of a control program will depend on a thorough knowledge of the epidemiological factors affecting the peanut disease. With this in mind, aphid transmission studies were conducted to compare transmission rates of two aphids commonly found in peanut fields, to determine the ability of aphids to transmit different strains of PMV, and to determine the effect of viruliferous aphids feeding on hosts not susceptible to PMV. A preliminary report has been published (13).

MATERIALS AND METHODS

The five strains of PMV used in this study have been described previously (11). They were maintained in *Arachis hypogaea* L. 'Starr'. Aphid transmissions were made from leaves infected 12-15 days.

Aphis craccivora Koch. and *Myzus persicae* Sulz. were collected in early spring of 1973 from a peanut volunteer and from a weed (*Rudbeckia hirta* L.) growing in a peanut field, respectively. *Aphis craccivora* was maintained on *Vigna sinensis* (Torner) Savi 'Early Ramshorn' and *M. persicae* on Chinese cabbage (*Brassica chinensis* L.) in laboratory cages.

For transmission tests, adult apterous aphids were given a 4- to 6-hour fasting period (in glass containers) before allowing them to make a single probe of 30-60 seconds on an infected peanut leaflet. After each probe, a single aphid was placed on a healthy peanut plant in the 3- to 5-leaf stage. The test plants were sprayed with an insecticide 12-16 hours later, and then maintained in a aphid-free greenhouse for symptom development. Each treatment was repeated three or four times with 20 aphids each.

RESULTS

Virus source.—Previous studies (10) have shown that PMV concentration is much higher in pea (*Pisum sativum* L. 'Little Marvel') than in peanut. Therefore, initial studies compared the ability of aphids to acquire PMV from the two hosts. Although pea had three times as much infective virus as peanut, the test aphids acquired and transmitted virus equally well from both hosts. Since peanut is the primary natural host of PMV in Georgia, it was used as the acquisition host in subsequent studies.

Differential transmission rate by two aphid species.—*Myzus persicae* consistently transmitted PMV at a higher level than *Aphis craccivora*. In a total of 20 tests, *M. persicae* was more efficient in transmission in every test (Tables 1, 2, 3). In eight tests with PMV-M2 and 620 aphids per species, the transmission level was 52% for *M. persicae* and 22% for *A. craccivora;* these values are significantly different, $P = 0.01$.

Transmission of PMV strains.—The five PMV strains could be put into three groups based on aphid transmission. Strains M1, M2, and S were readily transmitted, strain CLP was transmitted at an intermediate level, and strain N was not transmitted by either aphid species (Table 1).

Retention of infectivity.—After a single probe on plants infected with PMV-M2, aphids were kept in sterile glass containers and transfers were made to test plants at various time intervals. *Myzus persicae* was able to transmit virus for at least 12 hours, but *A. craccivora* became nonviruliferous between 2 and 4 hours (Fig. 1).

TABLE 1. Transmission efficiency of five strains of peanut mottle virus (PMV) by two aphid species

PMV strain	Plants infected[a,b] by:	
	Aphis craccivora	*Myzus persicae*
M1	17/80 x	32/80 x
M2	26/80 x	40/80 xy
CLP	7/80 y	13/80 z
N	0/80[c]	0/80[c]
S	24/80 x	43/80 x

[a]Number infected per number tested; one aphid per plant.
[b]Treatments with uncommon letters (x, y, z) in the same column are significantly different ($P = 0.05$) according to Duncan's multiple range test.
[c]Data for treatment N were not included in the statistical analysis because no transmission occurred.

The transmission efficiency of *A. craccivora* declined 80 and 85% for the first and second hours, respectively. During the same time periods, the infectivity loss was 64 and 78% for *M. persicae*. The rates of loss of transmission efficiency were not significantly different for the two aphids.

Consecutive probing.—After acquiring PMV-M2 by making a single probe on a peanut plant, individual aphids were allowed to make a single probe on healthy plants of two nonhosts of the virus, *Capsicum frutescens* L. and *Gossypium hirsutum* L., or on peanut before they were placed on test peanut plants. The probe on the intermediate plant species had no effect on the transmission by *M. persicae* (Table 2). However, transmission by *A. craccivora* was reduced approximately 50% by the same treatment. The reduction for *A. craccivora* was similar for all three intermediate plant species (Table 2).

Transmission of the necrosis strain.—Failure of the two aphid species to transmit the necrosis strain (strain N) could not be attributed to low virus concentration in the plant because previous studies (11) established that PMV-N concentration in peanut is three to four times higher than strains M1, M2, and CLP. Furthermore, increasing the number of aphids to five per plant did not cause transmission. When aphids fed on plants simultaneously inoculated by hand with strains M2 and N, strain N was transmitted by both aphid species (Table 3). In fact, *M. persicae* transmitted strain N at a higher level than strain M2. It must be noted, however, that it is not known if the plants with necrotic symptoms were also infected with strain M2. Strain N was also transmitted if aphids fed on plants infected with strain M2 alone before feeding on N-diseased plants (Table 3). No transmission occurred with the reciprocal probing sequence.

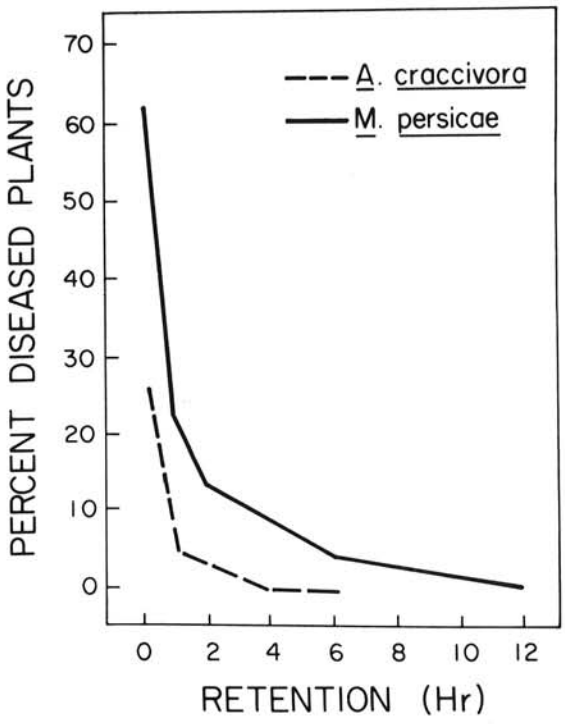

Fig. 1. Retention of infectivity of peanut mottle virus by two aphid species. After acquisition of virus, aphids were kept in glass containers until the specified test period.

DISCUSSION

The rate of transmission of PMV by *M. persicae* was

TABLE 2. Effect of peanut mottle virus viruliferous aphids probing on healthy plants (both host and nonhost) before feeding on test peanut plants

Probing sequence[a]			No. of peanut plants infected[b]	
Acquisition species	Intermediate species	Transmission species	*Aphis craccivora*	*Myzus persicae*
Peanut	Pepper	Peanut	11/80	50/80
Peanut	. . .[c]	Peanut	22/80	48/80
Peanut	Cotton	Peanut	5/80	35/80
Peanut	. . .[c]	Peanut	13/80	35/80
Peanut	Peanut	Peanut	6/60	33/60
Peanut	. . .[c]	Peanut	11/60	31/60

[a]Each aphid made one probe each on the acquisition and intermediate species and then was transferred to the test plants to determine rate of transmission.
[b]Number infected per number tested; one aphid per plant.
[c]Aphids moved directly from the acquisition species to the transmission one.

TABLE 3. Influence of the M2 strain of peanut mottle virus on aphid transmission of the N strain of PMV

Probing sequence		No. of plants infected[a]			
		Aphis craccivora		*Myzus persicae*	
First	Second	M2	N	M2	N
N	. . .	. . .	0/80	. . .	0/80
M2	. . .	8/80	. . .	44/80	. . .
N+M2[b]	. . .	12/80	1/80	22/80	26/80
M2	N	13/80	2/80	20/80	6/80
N	M2	7/40	0/40	15/40	0/40

[a]Number infected per number tested; one aphid per plant.
[b]Peanut plants were simultaneously inoculated with both strains N and M2.

clearly much greater than by *A. craccivora*. This is in contrast to Behncken's study (1) which indicated similar transmission efficiences for the two vectors, both at the lower level of *A. craccivora* in our study. Since *M. persicae* transmitted four PMV strains at a higher level than *A. craccivora* (Table 1), it seems probable that the difference in transmission efficiencies of *M. persicae* between Behncken's study and ours was due to different clones of the aphid.

Different rates of transmission may be important in at least two ways, and both relate to our belief that the primary source of inoculum of PMV is peanut seed (7, 12). First, with similar population densities of the two aphids, the secondary spread and the final incidence level of PMV in a peanut field would be greater with the presence of *M. persicae* than *A. craccivora*. Second, it would be undesirable to attempt the production of PMV-free seed peanuts in areas known to have high populations of *M. persicae*.

Although the complete loss of ability to transmit PMV occurred much sooner with *A. craccivora* than *M. persicae* (Fig. 1), the rates of loss during the first 2 hours were similar for both aphids. Therefore, differences in retention of PMV may be due to different amounts of virus acquired initially or to whatever factor causes the difference in transmission efficiencies, and not to an ability to remain infective for a longer period in *M. persicae*. If the alate forms of the aphids have similar retention abilities, the presence of *M. persicae* would be important in a program to produce PMV-free seed. *Myzus persicae* could transmit PMV over a longer distance from a commercial production peanut field to a seed-producing one than *A. craccivora*.

Studies to determine the population densities of various aphids in peanut fields have not been made. However, *A. craccivora* seems to be the one most frequently reported by researchers throughout the world (1, 2, 5, 15). A critical study to relate aphid populations to spread of PMV in individual fields would be very helpful in understanding the epidemiology of the peanut mottle disease.

The aphid transmissibility relationship between PMV strains N and M2 is another example of dependent transmission from a mixed infection (14). Both *M. persicae* and *A. craccivora* were able to transmit strain N only with the aid of the helper strain M2. Failure of the aphids to transmit strain N probably explains the extremely low incidence of the N-caused disease in peanut fields (11). Strain N causes a very serious disease (11) and would be an important factor in peanut production if it became prevalent. Kassanis and Govier (6) and Lung and Pirone (9) have proposed that some transmission factor, necessary for aphid transmission is present in leaves of plants infected with some specific transmissible virus isolates and not present in leaves infected with nontransmissible isolates. Strain N may also fail to produce a necessary transmission factor. If so, it will probably remain unimportant in the field unless its genetics become altered.

Evidence from two sources indicate that PMV concentration in the host is not related to aphid transmission. First, PMV was transmitted equally well from two hosts with significant differences in PMV concentration. Second, strains N and S have higher levels of infectious virus than strains M1, M2, and CLP (11). However, strain N was not transmitted at all and strain S was at the same rate of efficiency as strains M1 and M2.

The possibility of producing PMV-free peanut seed in a field surrounded by nonhosts of PMV might be enhanced if *A. craccivora* is the prevalent vector. A single probe by a viruliferous aphid on pepper and cotton reduced its transmission efficiency by 50%.

If the production of PMV-free peanut seed, or seed with very low levels of seed transmission, is a desirable goal of a control program, the location of the seed-producing field should be influenced by the prevalence of specific aphid species. The incidence of PMV in certain areas of Texas was very low in 1974 (4), and current studies are being conducted to determine the species and population of aphids in those areas.

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