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VECTOR-VIRUS RELATIONSHIP OF BITTER GOURD MOSAIC VIRUS

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ABSTRACT

The minimum acquisition feeding and inoculation feeding period of vector *A. malvae* were found to be 30s and 1 min respectively. But the percentage of transmission was maximum when an acquisition feeding period of 30 min inoculation feeding period of 2 h were given. Influence of starvation before acquisition and inoculation feeding period proved that pre-acquisition starvation for 2 h produced maximum infection but post-acquisition starvation decreased the percent infection. The vector could retain the virus for 1 h only. A single aphid could transmit the virus to healthy test plants, but maximum percentage of transmission was obtained with 10 aphids.

KEY WORDS : Acquisition threshold, Inoculation threshold, pre- aquisition fasting, post-acquisition fasting.

The experiments to study the vector-virus relationships were conducted by using one of the efficient vectors ie.*Aphis malvae*. Bitter gourd plants showing typical symptoms of bitter gourd mosaic virus were collected from the field and the culture of the virus was maintained in insect proof glass house by repeated transfers to healthy plants by mechanical inoculation. Virus free aphid colonies were maintained on *Solanum torvur* plants in an insect rearing cage. In all the inoculation trials only fully grown apterous aphids were used. During feeding of the aphids, the test plants were kept in insect proof cages. The aphids were killed at the end of the required feeding period by spraying the plants with 0.1% Dimethoate. In the case of short feeding periods of less than 5 min the individual aphids were watched through a magnifying lens and the time of feeding was determined with the help of stop watch after the aphids had settled down to feed.

MATERIALS AND METHODS

Acquisition threshold

A large number of non viruliferous aphids (*A. malvae*) were collected, given a pre-acquisition starvation for one hour. Batches of 10 aphids each were given acquisition feeds of 20 and 30S, 1,2,5,10,15,30 and 45 min and 1 and 2 h on diseased leaves before transferring them to healthy bitter gourd plants. The aphids were then allowed to remain for 24 h on the test plants and after that they were killed by spraying 0.1% Dimethoate.

Inoculation threshold

Non viruliferous aphids were given one hour pre-acquisition fasting and an acquisition feeding period of 30 min. Then the viruliferous aphids in groups of 10 were transferred to individual healthy test plants. Each batch was given seperate inoculation feeding periods, *viz.*, 30 S, 1, 2, 5, 10, 15, 20, 30 and 40 min, 1, 2, 4, 8 and 24 h. The aphids were killed after specific inoculation feeding period by spraying 0.1% Dimethoate.

Effect of pre-acquisition fasting of the vector on the transmission

In order to estimate the effect of pre-acquisition starvation on the efficiency of the vector to acquire the virus, the insects were starved for different periods, *viz.*, 30 min, 1, 2, 3, 4, 5, 6, and 12 h. Batches of 10 aphids from each of these categories were given an acquisition feeding period of 30 min and released on test plants to feed for 24 h. After the inoculation feeding period, the insects were killed by spraying 0.1% Dimethoate. The controls with equal number of aphids were maintained without pre-acquisition starvation. The plants were kept under observation in insect proof glass house.

Effect of post-acquisition fasting of the vector on the transmission

A large number of aphids were starved for one hour and allowed an acquisition feeding period of 30 min. After that batches of 10 aphids were

starved for different periods of 30 min 1, 2, 3, 4, 5, 6 and 12 h after that they were transferred to healthy test plants and allowed to feed for 24 h. After the inoculation feeding period, the insects were killed by spraying 0.1 % Dimethoate and the plants were kept under observation. The control was maintained with equal number of aphids with out post-acquisition fasting.

Retension of infectivity by the vector

The experiments were conducted with viruliferous insects, which were transferred in succession to a series of healthy bitter gourd plants after giving a definite inoculation feeding period on each plant. Groups of aphids were starved for one hour and allowed an acquisition feeding period of 30 min to make them viruliferous. Groups of 10 aphids were then transferred in succession to a series of five healthy plants transferring the insects after a definite interval. The different feeding intervals allowed in different series were 30 min, 1, 1.5, 2, 2.5 and 3 h. The aphids were killed from the fifth plant of the different series using 0.1% Dimethoate. The experiment was repeated twice

Minimum number of aphids required for transmission

Single aphid as well as groups of 2, 3, 5, 10, 15, 20, 25 and 30 were released on each test plant after allowing a pre-acquisition starvation period of one hour, an acquisition feeding period of 30 min and an inoculation feeding period of 24 h to determine the minimum number of aphids required for the transmission of the virus. After the inoculation feeding, the insects were killed by spraying 0.1% Dimethoate and the plants were kept under observation for the development of symptoms.

RESULTS AND DISCUSSION

Minimum acquisition feeding period required by *A. malvae* for the transmission of bitter gourd mosaic virus was found to be 30 S. When the acquisition feeding period was increased the percent transmission also increased and the maximum transmission of 60 percent was obtained when acquisition feeding period was increased the percent transmission also increased and the maximum transmission of 60 percent was obtained when acquisition feeding period of 30 min was given.

In the present study the minimum inoculation feeding period required by the vector to transmit bitter gourd mosaic virus was found to be 1 min (Table 2). The per cent transmission was found to increase with the increase in inoculation feeding period and reached a maximum of 90 per cent when 2 h inoculation feeding period was given. As the inoculation feeding period was further increased, the per cent transmission declined and reached 60 per cent with 24 h inoculation feeding period.

Jaganathan and Ramakrishnan (1971) observed that the viruliferous aphid *A. gossypii* acquired the melon mosaic virus with a short acquisition feeding period of 5s and transmitted with a short inoculaiton feeding period of 5s. Singh (1981 a) reported that *A. gossypii* could transmit pumpkin mosaic virus with minimum acquisition feeding period and inoculation feeding period of 20s and 10s respectively. In the present study differences in the minimum acquisition feeding period and

Table 1. Acquisition threshold *Aphis malvae* on the transmission of bitter gourd mosaic virus

Acquisition feeding period	No. of plants infected / No. of plants inoculated		No. of plants infected out of 20	Per cent trans-mission
	Experiment I	Experiment II		
20s	0/10	0/10	0	0
30s	1/10	1/10	2	10
1 min	3/10	2/10	5	25
2 min	3/10	3/10	6	30
5 min	4/10	3/10	7	35
10 min	5/10	4/10	9	45
15 min	5/10	5/10	10	50
20 min	5/10	6/10	11	55
30 min	6/10	6/10	12	60
45 min	6/10	5/10	11	55
1 h	5/10	4/10	9	45
2 h	3/10	3/10	6	30

Pre-acquisition fasting - 1 h
Inoculation feeding - 24 h
Number of aphids per plant - 10

Table 2. Inoculation threshold *Aphis malvae* on the transmisson of bitter gourd mosaic virus

Inoculation feeding period	No.of plants infected / No. of plants inoculated		No. of plants infected out of 20	Per cent trans-mission
	Experiment I	Experiment II		
30a	0	0	0	0
1 min	2/10	3/10	5	25
2 min	3/10	3/10	6	30
5 min	5/10	4/10	9	45
10 min	5/10	5/10	10	50
15 min	5/10	6/10	11	55
20 min	6/10	5/10	11	55
30 min	6/10	6/10	12	60
45 min	7/10	8/10	15	75
1 h	8/10	9/10	18	90
2 h	9/10	9/10	18	90
4 h	8/10	8/10	16	80
8 h	7/10	8/10	15	75
24 h	6/10	6/10	12	60

Pre-acquisition fasting - 1 h
Aquisition feeding - 30 min
Number of aphids per plant - 10

inoculation feeding period of *A. malvae* to transmit bitter gourd mosaic virus may be due to the efficiency of the vector, type of host, climatic factors etc.

Table 3. Effect of pre-acquisition fasting of *Aphis malvae* on the efficiency of transmission of bitter gourd mosaic virus

Pre-acquisi-tion fasting period	No.of plants infected / No. of plants inoculated		No. of plants infected out of 20	Per cent trans-mission
	Experiment I	Experiment II		
No fasting	4/10	3/10	7	35
30 min	7/10	4/10	11	55
1 h	6/10	6/10	12	60
2 h	8/10	7/10	15	75
3 h	6/10	5/10	11	55
4 h	4/10	3/10	7	35
5 h	2/10	2/10	4	20
6 h	0/10	0/10	0	0
12 h	0/10	0/10	0	0

Acquisition feeding - 30 min
Inoculation feeding - 24 h
Number of aphids per plant - 10

Table 4. Effect of pre-acquisition fasting of *Aphis malvae* on the efficiency of transmission of bitter gourd mosaic virus

Post-acquisition fasting period	No.of plants infected / No. of plants inoculated		No. of plants infected out of 20	Per cent trans-mission
	Experiment I	Experiment II		
No fasting	7/10	5/10	12	60
30 min	5/10	5/10	10	50
1 h	4/10	4/10	8	40
2 h	4/10	3/10	7	35
3 h	0/10	0/10	0	0
4 h	0/10	0/10	0	0
5 h	0/10	0/10	0	0
6 h	0/10	0/10	0	0
12 h	0/10	0/10	0	0

Pre-acquisition fashing - 1 h
Acquisition feeding - 30 min
Inoculation feeding - 24 h
Number of aphids per plant - 10

Investigations on the influence of pre-acquisition fasting showed that starvation of *A. malvae* before acquisition of virus resulted in an increase in the percentage of transmission. The increase in percent transmission was found only up to 2 h pre-acquisition fasting and there after the per cent transmission was decreased. The efficiency of

Table 5. Retension of infectivity *bphis malvae*

Feeding period on each test plant		Infection in successive transfers / Serial number of plants tested				
		1	2	3	4	5
30 min	a	+	+	-	-	-
	b	+	+	-	-	-
1 hr	a	+	-	-	-	-
	b	+	-	-	-	-
1 h 30 min	a	+	-	-	-	-
	b	+	-	-	-	-
2 h	a	+	-	-	-	-
	b	+	-	-	-	-
2 h 30 min	a	+	-	-	-	-
	b	+	-	-	-	-
3 h	a	+	-	-	-	-
	b	+	-	-	-	-

a = replication 1 b = replication 2
+ = symptom produced - = No symptom produced

Table 6. Minimum number of *Aphis malvae* required for the transmission of bitter gourd mosaic virus

No. of aphids per plant	No. of plants infected		No. of plants infected out of 20	Per cent transmission
	No. of plants inoculated			
	Experiment I	Experiment II		
1	1/10	1/10	1	10
2	3/10	2/10	5	25
3	4/10	5/10	9	45
5	5/10	6/10	11	55
10	6/10	6/10	12	60
15	6/10	5/10	11	55
20	5/10	6/10	11	55
25	5/10	5/10	10	50
30	5/10	4/10	9	45

Pre-acquisition fasting - 1 h
Acquisition feeding - 30 min
Inoculation feeding - 24 h

the vector to transmit the virus was completely lost when starved for 6 h (Table 3).

Experiments on retension of infectivity by *A. malvae* revealed that the vector lost its infectivity after 1 h in all the 6 series of experiments carried out (Table 5). Thus the virus could not persist inside the vector for long period. Non persistent nature of retention of infectivity of mosaic viruses of cucurbits by the vector *A. gossypii* and other aphids were reported (Nagarajan and Ramakrishnan, 1971 a & b, Jaganathan and Ramakrishnan, 1971). Since in the present investigation the infectivity was lost after 1 h of acquiring the virus the transmission of bitter gourd mosaic virus by *A. malvae* can be termed as non persistent type as suggested by Nagarajan and Ramakrishnan (1971 b) and Singh (1982). Non persistent manner of transmission of snake gourd mosaic virus (*Cucumis* virus 1) by *A. gossypii* and *A. craccivora* had been reported by (Dubey *et al.*, 1974 ; Joseph and Menon, 1978)

The minimum number of aphids required for successful transmission of bitter gourd mosaic virus was also worked out and it was found that a single viruliferous aphid could cause successful transmission of the virus and the percent transmission was more when the number of aphids per plant was increased (Table 6). Similar results was obtained in the transmission of water melon mosaic virus to water melon, cucumber, pumpkin and squash by *M. persicae* (Almedia and Borges, 1983). Maximum infection of 60 per cent was obtained in the present study when 10 viruliferous aphids were used for the transmission of the virus.

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