

The Virus-Vector Relationship of the Jute Leaf Mosaic Virus (JLMV) and its Vector, *Bemisia tabaci* Gen. (Hemiptera: Aleyrodidae)

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Abstract: The study was conducted at Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh to find out virus-vector relationship in JLMV of jute during 2010-2011. So far, 12 different diseases have been recorded on jute in Bangladesh. Among these diseases jute leaf mosaic is considered as the most devastating one. The minimum acquisition feeding period of 30 min was required for whitefly on a JLMV source that resulted in 12.5% transmission and for cent percent transmission 48 h AFP was required. A minimum feeding period of 15 min was required by a viruliferous whitefly to cause infection on jute test plants; this gave 10% transmission. With inoculation access of 48 h on jute test plants, the transmission rose to 100%. Starving the vector for 30 min and 5 h pre-acquisition resulted 10 and 100% transmission of JLMV respectively. Extending the fasting period beyond 5 h resulted in a reduced transmission level. Starving the vector for 30 min and 4 h post-acquisition resulted 30 and 95% transmission of JLMV, respectively. Extending the fasting period beyond 4 h resulted in a reduced transmission level. Higher transmission rates were obtained when the younger leaves on tomato plants were used for acquisition and inoculation. The young seedlings up to the age of 20 days were found to be highly vulnerable to the virus.

Key words: Acquisition access, inoculation access, jute, nonviruliferous, preacquisition fasting, preinoculation fasting, viruliferous

INTRODUCTION

Jute (*Corchorus capsularis* L. and *Corchorus olitorius* L.) is an important fibre crop of Bangladesh. Jute is being grown in Bangladesh for more than one hundred years. Among the jute growing countries of the world, Bangladesh ranks second in respect of production (Islam and Rahman, 2008). In 2010-2011, 8.40 million bales of jutes were produced in the country from 1.75 million acres of land (BBS, 2011). Jute is one of the mainstays of Bangladesh economy. It accounts for about 6% of the foreign currency earning from export. Still today Bangladesh is the largest supplier of jute and jute goods in the international markets. Jute fibres have versatile uses for making hessians, blankets, sacks, gunny bags, carpets, furnishing fabrics, mats, ropes and packaging materials. Besides the use of jute fibres, jute sticks and root stamps are traditionally being used as house construction materials and fuels in the rural areas. The young green leaves of jute contain minerals and proteins, which are edible and are popular as leafy vegetable. Now a days attempt is being made to popularize the jute plants for making pulp in paper industries. Jute plants suffer from different diseases among them leaf mosaic has been reported to be the most damaging one. This disease was first reported by Finlow (1917). The leaf mosaic of jute has wide spread occurrence in the major jute growing

countries of the world, namely Bangladesh, Burma, India (Ghosh and Basak, 1951). Leaf mosaic of jute has been considered to be one of the most important limiting factors of jute cultivation (Harender *et al.*, 1993). The disease is characterized by symptoms such as small yellow flakes on the lamina during the initial infection stage which gradually increases in size to form green and chlorotic intermingled patches producing a yellow mosaic appearance. The incidence of the disease has been found to be around 50% on some of the leading *C. capsularis* cultivars. It was also observed from the survey that infection reduces plant height to the extent of 20% and thus adversely affects the yield of the fiber (Ghosh *et al.*, 2008). The disease has been reported to be transmitted through grafts, seed and pollen (Ghosh and Basak, 1951; Saha, 2001). Whitefly transmission of the disease has also been reported Verma *et al.* (1966), Ahmed (1978) and Ahmed *et al.* (1980). Severe infestation of whitefly may result in defoliation of jute and it causes reduction of yield. Considering the importance of the above background, the present research program was designed to study on virus-vector relationship in JLMV of jute.

MATERIALS AND METHODS

An investigation was carried out at Department of Plant Pathology, Bangladesh Agricultural University,

Mymensingh to observe the virus-vector relationship in JLMV of jute. The jute plants having JLMV infection were collected from the field and were used as JLMV mother plant. Healthy colonies of whiteflies were maintained on tobacco plant under insect proof case and used throughout transmission study. A wooden micro-case of 60×60 cm was made, where the top was made by glass and side covered by 60 mesh nylon net which helped to protect whitefly inside the case. This micro-case was used for whitefly transmission.

Determination of number of whiteflies required for transmission of JLMV: This study was carried out to determine the minimum number of the viruliferous vector required for successful transmission of the virus. The whiteflies collected from the healthy colony were first allowed to feed on diseased plant by giving 24 h acquisitions feeding period and they were allowed to feed on healthy jute seedlings of 20 days old for 24 h of inoculation feeding period. In case of acquisition feeding on diseased jute plants, a known number of whiteflies viz. 1, 3, 5, 10, 15 and 20, respectively whiteflies per seedling of test plant were allowed in the case. Afterward the plants were sprayed with Rogor (0.2%) to kill the whiteflies. Five jute seedlings were used for each treatment and the experiment was repeated twice.

Influence of acquisition feeding period on JLMV transmission: To determine the minimum acquisition feeding period, the non-viruliferous whiteflies were collected in small case and were allowed to feed the diseased jute plants by giving an acquisition feeding period of 1, 3, 5, 10, 15 and 30 min, 1, 3, 5, 24 and 48 h, respectively after which they were transferred accordingly to healthy jute plants for inoculation feeding period of 24 h. Five viruliferous whiteflies per plants were allowed for feeding the test plants for each test and then the plants were sprayed with Rogor (0.2%) for killing the whitefly. The seedlings were then allowed to grow.

Influence of inoculation feeding period on JLMV transmission: In order to determine the minimum inoculation feeding period, the whiteflies were allowed for an acquisition feeding period of 24 h. The viruliferous whiteflies were transferred to healthy jute plants for inoculation feeding period of 1, 3, 5, 10, 15 and 30 min, 1, 3, 5, 24 and 48 h, respectively. Five viruliferous whiteflies were allowed to feed on each test plant and the plants were sprayed with Rogor (0.2%). Later the seedlings were allowed to grow.

Influence of pre-acquisition fasting period on JLMV transmission: To determine the effect of pre-acquisition fasting feeding period on the rate of transmission of JLMV, the non-viruliferous whiteflies were collected in small case and were allowed to starve for different periods viz., 15 and 30 min, 1, 2, 4 and 5 h, respectively. They

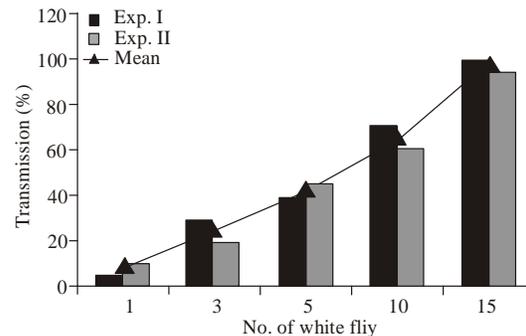


Fig. 1: Number of whiteflies required for transmission of JLMV to jute plants cv. D-154

were then given 24 h acquisition and 24 h inoculation feeding periods. After the treatment, the plants were sprayed with Rogor (0.2%) and then allowed to grow.

Influence of post-acquisition starvation period on JLMV transmission: To determine the effect of post-acquisition fasting period on the rate of transmission of JLMV, the non-viruliferous whiteflies were collected in small case and were allowed to acquire the virus for 24 h and then subjected them to different starvation period viz. 0.0 and 30 min, 1, 2, 3 and 4 h. Thereafter, an inoculation feeding period of 24 h was given for these whiteflies to feed on the test plants. Then the plants were sprayed with Rogor (0.2%) and finally allowed to grow.

Effect of age of the jute plant and its susceptibility to JLMV: To determine the age of the jute plants and its susceptibility of JLMV, the seedlings were grown in nylon net box. Seedlings of nine days old were transplanted in 6 trays and covered by nylon net. The viruliferous whiteflies were collected and allowed for transmitting the virus to plants of 15, 20, 30, 45, 60 and 75 days after transplanting. Thereafter, the plants were allowed to grow for studying the symptoms.

RESULTS AND DISCUSSION

Determination of number of whiteflies required for transmission of JLMV: It has been observed that even one individual whitefly was capable of transmitting the virus (Fig. 1). When 3, 5 and 10 viruliferous whiteflies plant⁻¹ were released; the disease transmission was 25, 42.5 and 65%, respectively. It was found that 15 whiteflies could transmit JLMV to a range of hundred percent transmissions. The findings of the study showed that a maximum of 15 viruliferous whiteflies required for effective transmission of JLMV.

Influence of acquisition feeding period on JLMV transmission: It was found that the whitefly required a

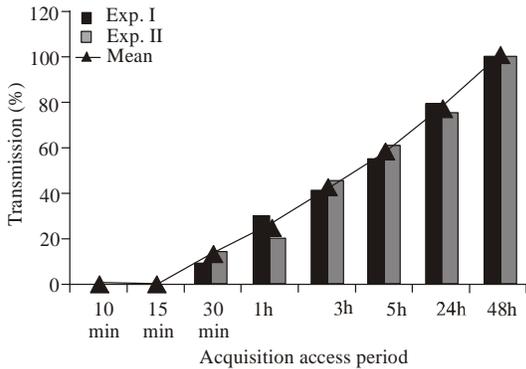


Fig. 2: Influence of acquisition feeding period of whitefly on transmission of JLMV to jute plants of cv. D-154

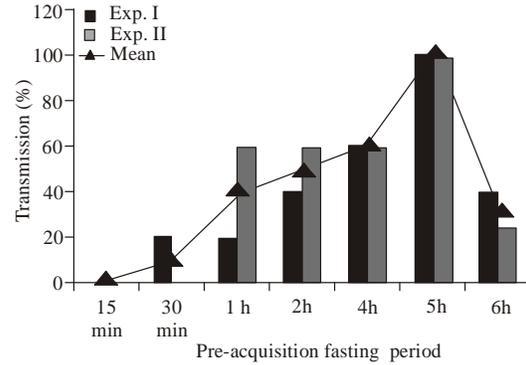


Fig. 4: Influence of pre-acquisition fasting period of whitefly on transmission of JLMV to jute plants of cv. D-154

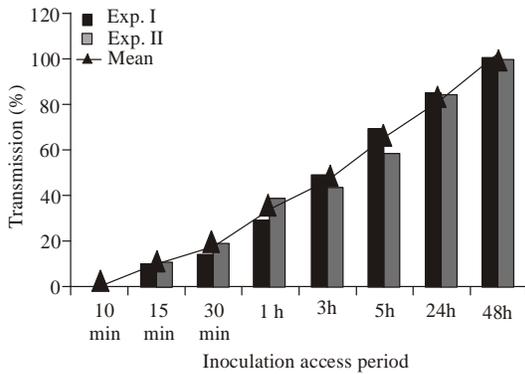


Fig. 3: Influence of inoculation feeding period of whitefly on transmission of JLMV to jute plants of cv. D-154

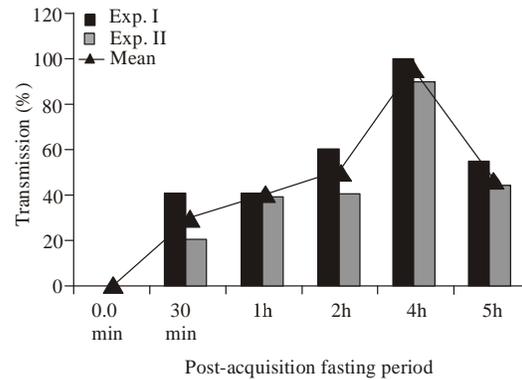


Fig. 5: Influence of post-acquisition fasting period of whitefly on transmission of JLMV to jute plants of cv. D-154

minimum period of 30 min acquisition feeding period to acquire JLMV for transmission (Fig. 2). But the vector required 48 h acquisition feeding period for successful transmission of JLMV into jute plants, where 100% plants were found to show the disease symptoms

Influence of inoculation feeding period on TYLCV transmission: The results of the present study are presented in Fig. 3. It was found that at least 15 min of inoculation feeding period were required to transmit the virus TYLCV, though the per cent of transmission was 10.00. However, 100.00% transmission was recorded when 5 h of inoculation feeding period was given to whitefly.

Influence of pre-acquisition starvation period on TYLCV transmission: This experiment was conducted to know the minimum pre-acquisition starvation period of the vector to be viruliferous in order to transmit the disease. The results are presented in the Fig. 4. It was observed that at least 30 min of pre-acquisition starvation period was required to transmit the virus and the mean per cent of transmission was 10.00. However, 100.00%

transmission was recorded when 5 h of pre-acquisition starvation period was given to the whitefly.

Influence of post-acquisition starvation period on JLMV transmission: This experiment was conducted to know the minimum post-acquisition fasting period of the vector to be viruliferous in order to transmit the disease. The results are presented in the Fig. 5. It was observed that at least 30 min of post-acquisition fasting period were required to transmit the virus and the per cent of transmission was 30.00. However, 100.00% transmission was recorded when 4 h of post-acquisition starvation period was given to the whitefly.

Effect of age of the jute plant and its susceptibility to JLMV: The jute plants were artificially inoculated at all the growth stages. The young seedlings up to the age of 20 days were found to be highly vulnerable to the virus (Fig. 6). When 30, 45, 60 and 75 days, respectively old plants were inoculated; the percentages of transmission were 85, 60, 35 and 20, respectively. This indicated that as the age of the seedlings increased, their susceptibility to virus infection decreased accordingly.

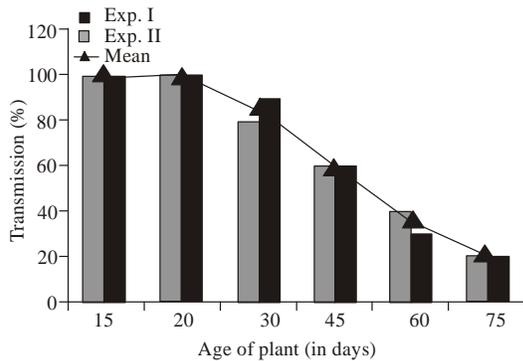


Fig. 6: Effect of age of jute plants of cv. D-154 on susceptibility to JLMV

Studies on epidemiology of JLMV revealed that even a single whitefly was capable of transmitting the disease although 15 whiteflies are required to cause 100% transmission. There found a positive correlation between number of whitefly and transmission of the causal agent. The results were comparable to that of other begomovirus like Tomato Leaf Curl Virus (Muniyappa *et al.*, 2000) and Pumpkin Yellow Vein Mosaic Virus (Muniyappa *et al.*, 2003) which required 5-15 adult viruliferous whiteflies to get 100% transmission. Earlier Capoor and Ahmad (1975) noticed a maximum infection 77.3% with 20 whiteflies. Subramanian (1979) reported that 15 whiteflies were required to cause cent percent transmission of yellow mosaic virus in *Lablab niger*. Cohen *et al.* (1983) found that five whiteflies caused 100% infection in squash leaf curl virus infected squash plant. Raghupathy (1989) reported that 15 to 20 whiteflies were required to cause effective transmission of yellow mosaic disease of urdbean and soybean, respectively. However, three whiteflies were sufficient to secure hundred percent transmission of TYLCV in tomato (Raghupathy, 1995). Further, a single viruliferous whitefly has been shown to be successfully transmitting some of the other whitefly borne viruses like yellow vein mosaic of okra (Varma, 1952), pumpkin yellow mosaic virus Capoor and Ahmad (1975) and Jayashree *et al.* (1999). The minimum acquisition feeding period required for the vector (*B. tabaci*) for successful transmission of JLMV was found to be 30 min though the percentage of infection increased with the increase in acquisition feeding period (100% infection at 48 h of acquisition feeding period). The minimum acquisition feeding period required for the vector (*B. tabaci*) for successful transmission of the causal agent of the jute leaf mosaic was found to be 30 min though the percentage of infection increased with the increase in the Acquisition Feeding Period (AFP). The findings of the present study are in accordance with the

findings of Ghosh *et al.* (2008). However, Capoor (1949) reported that whiteflies required at least 15 to 30 min, respectively of colonization on the plant to introduce their stylets into the phloem tissues. Probably for this reason, in the present investigation, only very low percentage of insects acquired JLMV in 30 min of acquisition feeding on infected plants. In the present study, the minimum inoculation feeding period required by the whitefly for successful transmission of the virus was 30 min although the percentage of infection increased with in increase in the Inoculation Feeding Period. In the present study the minimum inoculation feeding period (IFP) required by the whitefly for successful transmission of the virus was 30 min although the percentage of infection increased with the increase in the inoculation feeding period. The findings of the present study are in accordance with the finding of Ghosh *et al.* (2008). The findings of the present study are in accordance with the findings of Cohen and Nitzany (1966), Seetharama Reddy and Yaraguntiah (1981) and Jiang *et al.* (2000). In the present study the minimum pre-acquisition starvation period required for the vector for successful transmission of the virus was 30 min though the percentage of infection was increased with the increase in pre-acquisition starvation period (100% infection at 5 h of pre-acquisition starvation period). But this finding has been differed by Capoor (1949) and Jayashree *et al.* (1999). They stated that in order to fix the whiteflies in their feeding position, it was necessary to starve them for at least 3 h before releasing them on the host plants and this might be the reason for increased disease transmission with the vectors starved before the acquisition feeding period. The results of post-acquisition starvation period of whiteflies required for the vector for successful transmission of the virus was 30 min although the percentage of infection was increased with the increase in pre-acquisition starvation period (100% infection at 5 h of pre-acquisition starvation period). This has also been differed by Capoor and Ahmad (1975). They reported that 2 h starvation of whiteflies before acquisition gave maximum infection, while starvation after acquisition led to reduction in transmission in PYVMV inoculated pumpkin plants. This reduction in transmission efficiency was directly proportional to the increase in the length of post-acquisition starvation period. However, post-acquisition starvation period was effective up to 4 h in the case of Okra Yellow Vein Mosaic Virus (OYVMV) as reported by Varma (1952). The study on the age of the jute plants on the susceptibility of the virus, JLMV made herein indicated that jute plants could be infected at all growth stages. However, the young seedlings were recorded to be highly sensitive to JLMV and thereafter, the susceptibility turn to reverse showing less susceptible to the virus. This kind of findings has been reported in case of jute leaf curl virus by Seetharama Reddy (1978).

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