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Relationship of Whitefly Population Build up with the Spread of TYLCV on Eight Tomato Varieties

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ABSTRACT

The performance of eight tomato varieties namely BARI-T1 (Manik), BARI-T2 (Ratan), BARI-T4, BARI-T5, BARI-T6 (Apurba), BARI-T7 (Chaity), BARI-T11 and BARI-T12 were evaluated in respect to prevalence and spread of TYLCV (Tomato Yellow Leaf curl Virus) in relation to whitefly population buildup in the field. Data were collected on the three growth stages of the plant namely early (transplanting to first flowering) mid (first flowering to first harvesting) and late (first harvesting to last harvesting). The virus prevalence percentage in eight tomato varieties varied depending on early, mid and late stage of infection as well as tomato varieties. It ranged from 42 to 69%. There was a poor and insignificant quadratic polynomial relationship ($y = -0.0059x^2 + 0.2826x - 1.5378$ & $R^2 = 0.0962$) between temperature and whitefly population build up in tomato field. The relationship between relative humidity and whitefly population build up in the field was found significant but negatively correlated ($y = - 0.0321x^2 + 4.5518x - 159.44$ ($R^2 = 0.6769$). The increase of whitefly population in the field was positively correlated with the spread of TYLCV in the tomato field ($y = - 0.0002x^2 + 0.0297x + 1.0626$ & $R^2 = 0.663$). The highest and lowest prevalence of TYLCV was recorded in BARI-T6 and BARI-T11, respectively. In all the varieties, virus prevalence was found higher at mid stage followed by late and early stage of infection.

Key words: Prevalence, TYLCV, whitefly.

INTRODUCTION

Tomato (*Lycopersicon esculentum* Miller) is one of the most important vegetable crops widely cultivated almost all over the world. As a processing crop it ranks first among the vegetables and a major source of vitamins and minerals (Shanmugavelu, 1989). It is one of the most popular vegetable in Bangladesh occupying an area of about 14338 ha, with a total production of about 97565 metric tons and average yield of 6.8 metric tons per ha (Anonymous, 2001). The yield is remarkably poor in comparison to world average of 27.8 metric tons per ha (Anonymous, 1997). Among the major constraints of tomato cultivation, whitefly (*Bemisia tabaci*) transmitted *Tomato yellow leaf curl virus* (TYLCV) is considered to be the most important one in respect of prevalence, severity and damage to the crop in all tomato growing areas in the world (Kalloo, 1991). Over 70 plant viruses are transmitted by whiteflies. Most of these, and all hitherto known whitefly-borne tomato viruses, are transmitted by *B. tabaci* (Duffus, 1987). The whitefly transmitted TYLCV can

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cause up to 100% losses in tomato production in many countries viz. in the Middle East, Southwest Europe, Tropical Africa, Southeast Asia, and the Caribbean Islands (Czosnek and Laterrot, 1997). The virus is also highly damaging in Bangladesh which may reach even up to 100% depending on the varieties and stage of infection and distributed all over the country (Akanda and Rahman, 1993; Gupta, 2000). So the management of TYLCV is of immense important to reduce the crop loss and also to minimize the deterioration quality. Control of TYLCV in a particular region depends largely on the management of vector (*Bemisia tabaci*) population. So it needs in depth investigation on the relationship of whitefly population and prevalence of the virus on different tomato varieties. The present study was undertaken to find out the relationship of whitefly population with the prevalence of TYLCV on eight tomato varieties under field condition.

MATERIALS AND METHODS

The experiment was conducted at the experimental farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur during November 2001 to March 2002. Eight tomato varieties released by Bangladesh Agricultural Research Institute (BARI) namely BARI tomato 1 or Manik (BARI-T1), BARI tomato 2 or Ratan (BARI-T2), BARI tomato 4 (BARI-T4), BARI tomato 5 (BARI-T5), BARI tomato 6 or Apurba (BARI-T6), BARI tomato 7 or Chaity (BARI-T7), BARI tomato 11 (BARI-T11), and BARI tomato 12 (BARI-T12) were included in the study (Anonymous, 2005). Tomato seedlings of the eight varieties were raised separately in a well-drained open nursery bed. The experimental field was properly prepared and added recommended doses of manures and fertilizers (Rashid 1993). Nine seedlings of age 33 days each variety were transplanted in 2m×2m unit plot maintaining 70 cm row to row and 70 cm plant to plant distance. Intercultural operation like, irrigation, weeding etc. was done as and when necessary.

The plants were inspected every day morning to note the appearance and development of the symptoms of TYLCV starting from transplantation to last harvest. The tomato plants remained asymptomatic until last harvest was designated as healthy plants. The virus was identified on the basis of field symptoms as described by Akanda (1991), Alam (1995), and Gupta (2000). Whitefly was monitored by placing yellow traps in the field as suggested by Moericke (1957). Three yellow traps were placed in the experimental field to find out the whitefly population and spread of the virus from the date of transplanting to harvesting. Half of the yellow traps were filled with tap water and 2-3 drops of liquid trix were added to the water so that whiteflies could not fly after falling into the traps. The number of whiteflies fallen on the traps were counted every day between 9 to 10 AM up to the date of last harvesting. The water of the traps were changed every day after counting the trapped whiteflies. The relationship between the whitefly population and spread of TYLCV in the tomato field was also analyzed. The data on the prevalence of TYLCV was collected at three stages of the plant growth categorized as early (transplanting to first flowering), mid (first flowering to first fruiting) and late stage (first harvesting to last harvesting). The experiment was laid out in 8×3 factorial randomized complete block design (RCBD) with 4 replications. The analysis of the percentage data were done after arcsine transformation. The means of different parameters were compared by Duncan's multiple range test (DMRT) at 5% level of significance using MSTAT-C software.

RESULTS AND DISCUSSION

Prevalence of TYLCV infection

The results on prevalence of TYLCV infection at three growth stages (early, mid and late) of eight tomato varieties observed in the experimental field are presented in the Table 1 and Figure 1. In all the eight tomato varieties, prevalence of TYLCV infection was found significantly higher at mid stage as compared to late and early stage of plant growth. The maximum percent of TYLCV infected plants was recorded as 69% from BARI-T6 (Chaity) variety and BARI-T11 showed the minimum (42%). BARI-T4 and BARI-T7 (Apurba) showed the similar performance (64%) in respect of TYLCV prevalence and also the varieties BARI-T1and BARI-T2 (50%). The rest two varieties BARI-T5 and BARI-T12 showed 53% and 44% infected plants, respectively (Fig. 1). The percent non TYLCV infected plants varied from 31–58% depending on the tomato variety planted in the field during the study period.

Table 1. Prevalence of TYLCV on eight tomato varieties

Variety	Percentages of prevalence				
	Stages of plant growth*			Average	Healthy (%)
	Early	Mid	Late		
BARI-T_1 (Manik)	14 ghi	22 de	14 ghi	50	50
BARI-T_2 (Ratan)	11 ij	25 cd	14 ghi	50	50
BARI-T_4	14 ghi	31 ab	19 efg	64	36
BARI-T_5	14 ghi	28 bc	11 ij	53	47
BARI-T_6 (Chaity)	17 fgh	33 a	19 efg	69	31
BARI-T_7 (Apurba)	14 hi	33 a	17 efgh	64	36
BARI-T_{11}	14 ghi	20 ef	8 j	42	58
BARI-T_{12}	8 j	25 cd	11 ij	44	56

Data with same letters in row or column are not significantly different at 5% level by DMRT among the treatment means of tomato varieties, virus infection and infection interaction

The results of the present study indicated that tomato variety BARI-T11 performed better against the prevalence of TYLCV infection compared to the others under field condition. The prevalence of infection was found to be varied depending on the tomato varieties (42-69%) and stages of infection (8-33%). Almost such type of investigation on varietal performance against TYLCV prevalence in tomato field was obtained by Mazyad *et al*. (1979), Pilowsky *et al.* (1993), Gupta (2000), Azam (2001) and Paul (2002).

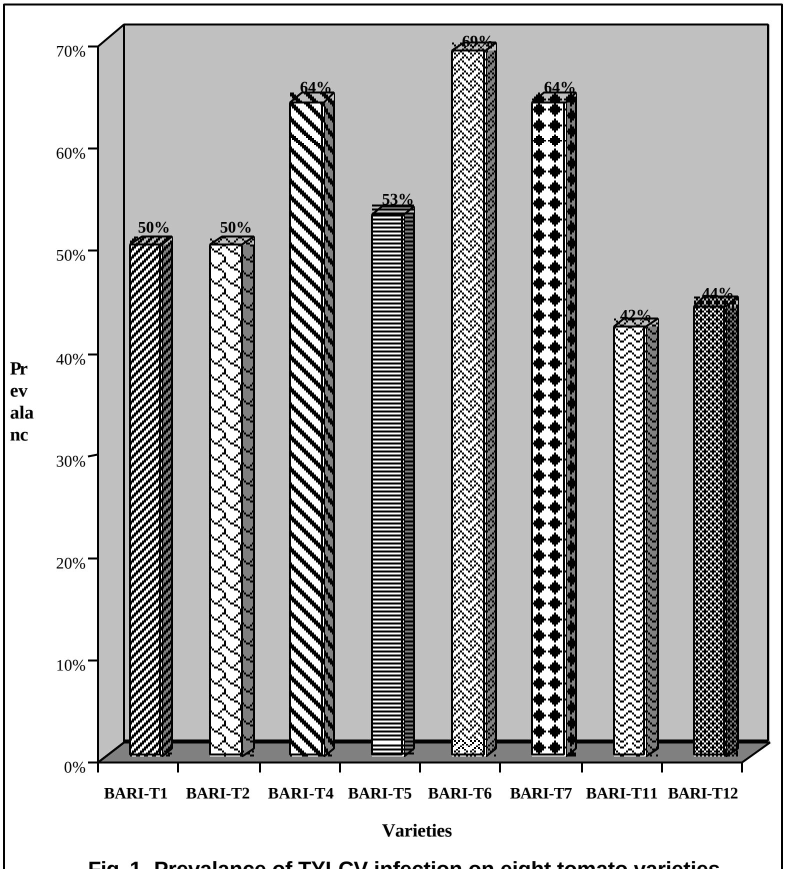

Fig. 1. Prevalance of TYLCV infection on eight tomato varieties

Spread of the virus in the field

Relationship of Temperature and Humidity with Whitefly population build-up in the field

Temperature

The average temperature in the tomato field was 19.23^{0}C when the experiment was started (08 to 21 December, 2001), which dropped down to 16.58^{0}C in the next consecutive 42 days and then increased to 29.19^{0}C in the following 56 days. Within this period, the whitefly population increased from 11 at the first 14 days (08 to 21 December, 2001) to 98 in the subsequent 28 days and then declined to 36 in the next fortnight possibly due to the rainfall with decreasing temperature in the field. Moreover, the population of whitefly further increased up to 102 during 4th to 6th fortnights then declined to 43 at the last fortnight (Fig. 2A). A quadratic polynomial relationship between temperature and whitefly population build up in tomato field was observed as it is indicated by the equation y = -0.0059x2 + 0.2826x - 1.5378 (R^2 = 0.0962) where the R^2 value was very low and the relationship was very weak (Fig. 2B). The equation revealed that the whitefly population was maximum i.e. 102 at 28.65 ^{0}C and beyond this temperature the population decreased at the rate of 0.0059 for per unit changing of temperature. Gupta (2000), Sultana (2001), Paul (2002), Haque (2002) and Parvin (2002) found significantly positive correlation of whitefly population build up in tomato field with temperature.

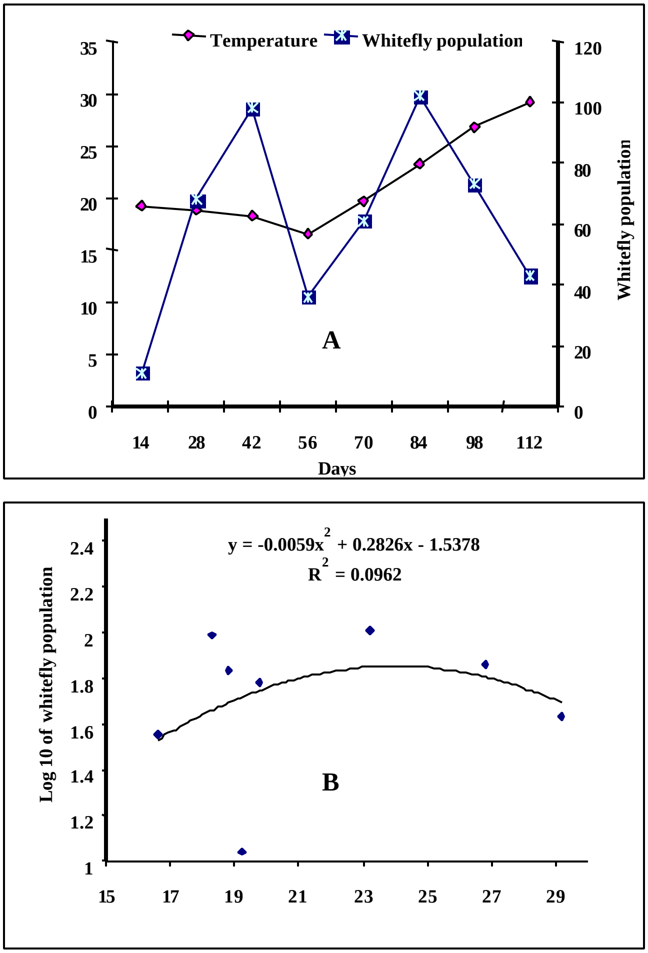

Fig. 2. **Whitefly population influenced by temperature (December 08, 2001 to March 29, 2002) (A) and relation between temperature and whitefly population (B) in the tomato field**

Relative Humidity

The relative humidity percentage in the tomato field during the experiment period varied from 66.93 to 76.08% (Fig. 3A). Number of whitefly gradually increased from initial 11 at the first 14 days to 98 at the 3rd 14 days and then declined to 36 in the 4th 14 days due to rainfall. After that whitefly population again gradually increased to 61 and 102 at the 5th and 6th 14 days, respectively. This was then gradually declined to 43 in the subsequent 28 days. In fig. 3B the equation y = -0.0321x2 + 4.5518x - 159.44 (R^2 = 0.6769) indicates a quadratic polynomial relationship between relative humidity and whitefly population buildup in the tomato field. The relationship was somewhat significant but showed a negative trend indicating the negative effect of relative humidity on the whitefly population buildup in the field. The whitefly population was maximum i.e. 102 at 73.14% relative humidity and beyond this relative humidity population decreased at the rate of 0.0321 for per unit changing of relative humidity. This may be due to rainfall. Although Gupta (2000), Sultana (2001), Paul (2002), Haque (2002) and Parvin (2002) stated that there was a positive correlation of whitefly population buildup in relation to relative humidity prevailing over the tomato field. The result of the present study contradicts the results of the previous workers, which need to reinvestigate with proper care for several years for clarification.

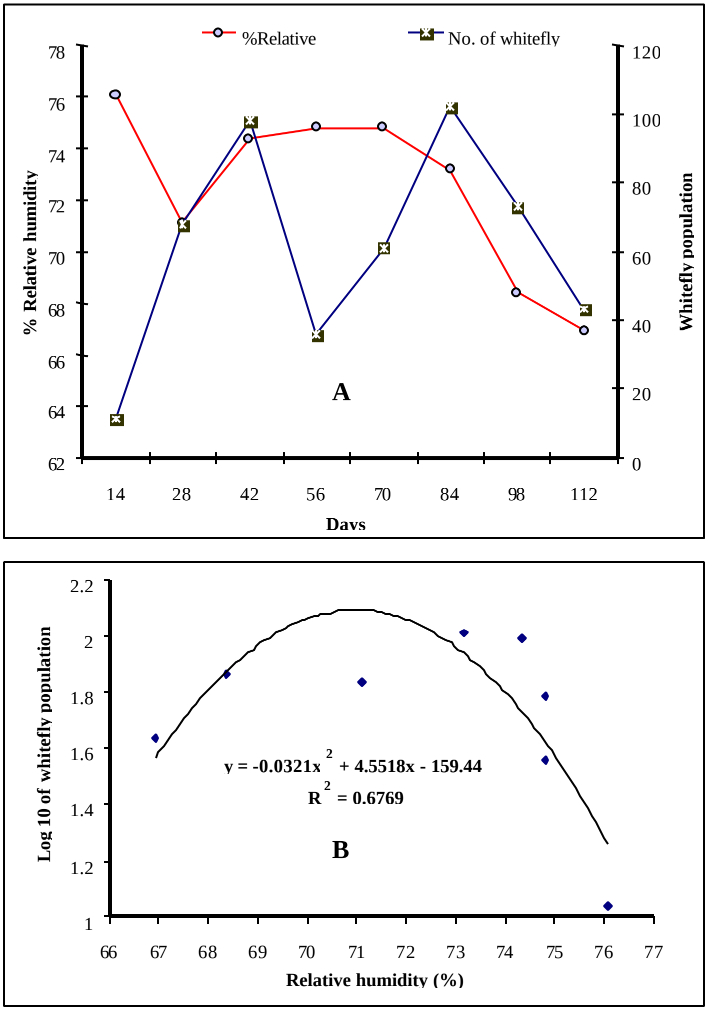

Fig. 3. Whitefly population influenced by percent relative humidity (December 08, 2001 to March 29, 2002) (A) and relation between percent relative humidity and whitefly population (B) in tomato field

Relationship between the whitefly populations build up and spread of TYLCV in the tomato field

The numbers of whitefly caught in the field in every 14 days are presented in the Fig. 4A. The results obtained in the present study demonstrated that the presence of increased number of whitefly increased the number of TYLCV infected plants in the tomato field with few exceptions, while the number of whitefly population gradually increased up to 98 and then decreased up to 36 this might be due to the rainfall. After that it started to increase and reached up to 102 but after that decreased again. This might be due to the maturity of the plant, which did not favour the whitefly. Whereas a steady increasing trend observed in respect of disease spread during the whole study period. This is due to increasing the population of viruliferous whitefly and continuous symptom expression of previously inoculated plants in the field.

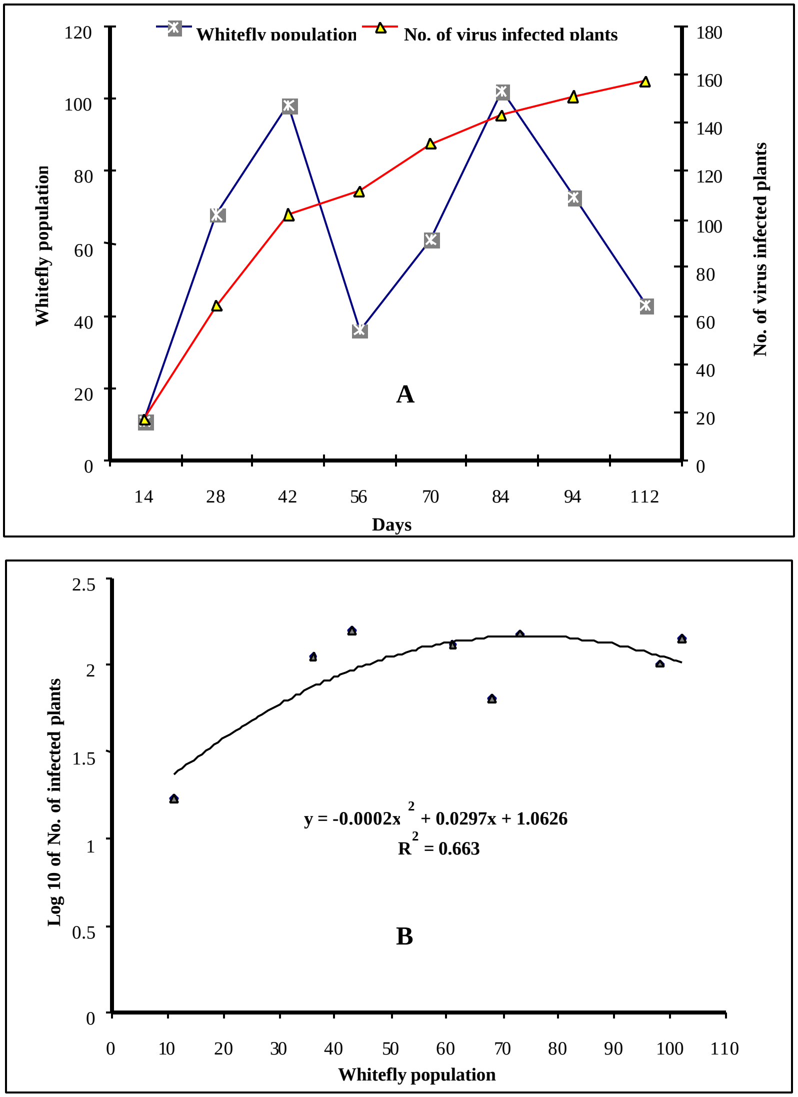

Fig. 4. Spread of TYLCV infection in tomato field in relation to whitefly population during December 08, 2001 to March 29, 2002 (A) and relationship between whitefly population and virus infection (B)

A quadratic polynomial relationship between whitefly population buildup and spread of TYLCV in the field was found as indicated by the equation: $Y= -0.0002x^2 + 0.0297x + 1.0626$ ($R^2 = 0.663$) where the R^2 value was high and the relationship was positive and strong. The R^2 value indicates that about 66.3% of the disease spread can be explained by the whitefly population. The equation also suggested that the number of TYLCV infected plants was the maximum i.e. 151 when whitefly population was 73 and beyond this population, the disease spread decreased at the rate of 0.0002 for per unit changing of whitefly population (Fig. 4B). Several authors (Mehta *et al*., 1994; Gupta, 2000; Paul, 2002 and Parvin, 2002) reported that increase of whitefly population is positively correlated with the spread of TYLCV in the field.

CONCLUSION

The results obtained in the study revealed that none of the eight tomato varieties had adequate level of tolerance against TYLCV though the prevalence varied from 42-69% depending on tomato varieties. Virus prevalence was found higher at mid stage followed by late and early stage of infection in all the varieties. The temperature and relative humidity were weakly related with the whitefly population build up in the field. However, the increase of whitefly population in the field was significantly correlated with spread of TYLCV.

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