Ann. Bangladesh Agric. (2017) 21 (1 & 2) : 89-97 ISSN 1025-482X (Print)
2521-5477 (Online)

SCREENING OF TOMATO GENOTYPES AGAINST TOMATO PURPLE VEIN VIRUS

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Abstract

Tomato Purple Vein Virus (TPVV) causes appreciable yield loss of tomato. The present experiment was conducted to evaluate the performance of sixteen tomato genotypes based on their growth and yield contributing characters against TPVV under field and inoculated conditions and to find out resistance source(s).The number of whitefly population ranged 6.8 to 47.2 and became minimum during January. However, there was an increasing trend with fluctuations from last week of February to second week of March. In inoculated condition, the minimum percent infection (46.0%) was recorded in hybrid Salamat. The maximum percent infection (100.00%) was found in Diamond, Mongal, Tropic green and Udayan. In field condition, the minimum percent infection was recorded in hybrid Salamat (12.0%) followed by BARI Tomato-9 (20.00%), Abhiruchi-6 (20.33%) and Abhiruchi-10 (23.67%). However, the maximum percent infection was found in Diamond (46.33%).The Fruit yield was considered an important parameter among all the characters which ranged 544.60 g to 1566 g per plant. The highest fruit yield was recorded in Abhiruchi-10 (1566 g/plant) and the lowest fruit yield was found in Tropic green (544.60 g/plant). The hybrid Salamat, Abhiruchi-6, Bankim, BARI tomato-2 and BARI tomato-3 were found to be promising genotypes. Therefore, these genotypes could be considered as new source of resistance/tolerant against the virus.

Keywords: Screening, tomato, genotype, TPVV, whitefly, resistance.

Introduction

Tomato (*Solanum lycopersicum)* is an important source of vitamin A and C. It contains 'Lycopene' an antioxidant that can protect free radical injury. The increasing trend of area under cultivation and production indicates its importance as a crop. Among the diseases, viruses are considered to be major limiting factors for tomato production. The incidence of different Geminiviruses namely *Tomato Yellow Leaf Curl Virus* (TYLCV), *Tomato Leaf Curl Virus* (TLCV) and *Tomato Purple Vein Virus* (TPVV) have been detected in Bangladesh (Akanda *et al*., 1991). Among these viruses TYLCV and TPVV are most damaging and distributed all over the country. TPVV has been reportedto cause 70-100% yield loss of tomato (Hossain and Akanda, 2003). So far, none of the genotypes cultivated in Bangladesh have found to have resistance or tolerance to TPVV (Akanda *et al.* 1999). Moreover, the prevalence of whitefly ensures the possibility of infection but vector-mediated control by chemical means is ineffective

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(Tzanetakis *et al*., 2013). Increasing demand of tomato is very encouraging and resistant genotypes could be a sustainable solution against the virus (Rahman *et al*., 2016 and Mansilla-Córdova *et al*., 2018). Therefore, the present study was conducted with a view to evaluate the performance of sixteen tomato genotypes to find out resistant sources through artificial inoculation and field performance.

Materials and Methods

Field evaluation

The field experiment was carried out at the Research and Development farm of Energy Pac Agro. Limited, Gazipur. A total of sixteen tomato genotypes namely Abhiruchi-06, Abhiruchi-10, Abhiruchi-11, Bankim, Chuanchu, Winner, Gautum, Mongal, BARI Tomato-2, BARI Tomato-3, BARI Tomato-9, Salamat, Tropic green, Udayan, Raksha and Diamond were used in the experiment. Seedlings of each genotypes were raised in a well-drained open nursery bed. The main field was prepared following standard method and recommended doses of manure and fertilizers. After final land preparation, field was divided into 80 equal plots (3 m × 2 m) maintaining plot to plot distance of 0.5 m and block to block distance of 1.0 m. Apparently healthy seedlings of twenty-five days were planted maintaining 70 cm plant to plant distances. All plants were checked every day from 9:00-10:00 to record incidence of TPVV and the infected plants which were identified based on visible symptoms of the disease as described by Akanda (1991). Leaf chlorophyll was determined by using SPAD machine (Minolta Model-502) at five days' interval from ten randomly selected plants per plot. Virus incidence was assessed based on number of plants infested per plot. The incidence of TPVV was expressed in percentage on the basis of total tomato plants checked using the formula shown below:

$$\% \text{ infected plants} = \frac{\text{number of infected plants}}{\text{Total number of plants}} \times 100$$

Whitefly population assessment and release in the nethouse

Whitefly populations were assessed for three-month period based on counting on five yellow water traps placed on different points of the experimental field as suggested and designed by Moericke (1957). The traps were placed in first week of Januar yand kept up to last week of March. The trapped vectors were counted from the trays every morning. For convenience, the data were summed as weekly data in the line graph. The water of the traps was changed regularly with detergent after counting the insects. A total of fifty whiteflies were caught from tomato fields of BSMRAU by sweep net, and released in the nethouse to ensure efficient inoculation of the virus particle into the susceptible genotypes of tomato.

Screening in nethouse condition

Inoculum preparation and artificial inoculation: TPVV isolate was collected from characteristic leaf symptoms of Abhiruchi-11 and maintained in *Nicotiana tabacum* for further mechanical inoculation in test plant (tomato seedling) in nethouse condition. Tomato seedlings were raisedin seed bed and then transplanted in earthen pot inside the nethouseat 2-3 leaf stage. Freshly harvested virus-infected leaves were grinded using a sterilized mortar and pestle with 0.05 M phosphate buffer at pH 7.2 (1:5 weight/

volume) containing 1% Na_2SO_4. The leaves were dusted with carborundum powder (silicon carbide, 400-600 mesh) to increases infection by providing minute wounds for the entry of virus particles. The inocula were gently rubbed phosphate buffer on to the leaves. Inoculated leaves were rinsed with water after inoculation. The healthy controls were rubbed with buffer and carborandum only (Green, 1984). The nethouse was sprayed every week with metasystoc® (Oxydemeton-methyl) at a rate of 45 mg L^{-1} of water to control aphids, whiteflies and thrips and fungicide Ridomil® (75% Metaxyl and 56% Mancozeb) was sprayed over plants at a rate of 2.5 kg ha^{-1} to protect from most common fungal diseases. The symptoms were recorded and disease incidence was calculated based on total number of plants checked.

The experiment was laid out in randomize complete block design with three replications. The data were analyzed statistically using MSTAT-C software. Mean separation was done by Fisher's LSD Test ($P= 0.05$).

Results and Discussion

Prevalence of whitefly in field

The number of whitefly population ranged from 6.8 to 47.2 during the study period. There was lower number of whitefly population during the early season and became the minimum in January. During January to mid-February whitefly population increased steadily as it could probably due to slow rise of temperature and sudden rainfall. However, there was a fluctuation of insect vector from last week of February to second week of March. Sudden rain influenced the prevalence. From this point onward whitefly started to increase to the highest number. Borah and Borodoloi (1998) suggested that simple correlation studies revealed a positive and significant association of number of whitefly population and temperature (Fig.1).

Incidence of TPVV under nethouse and field conditions

The characteristic disease symptoms of TPVV infected plants were recognized as the development of purple color in the veins of the leaf of infected tomato plants accompanied with severe stunting. The development of purple pigmentation in the leaf veins of infected tomato plants was recorded as the initial and unique characteristic of TPVV which never observed in TYLCV infected plants (Akanda, 1999).

In presence of whiteflies vector and sap inoculated condition, the minimum infection was recorded in hybrid Salamat (46.0%). The genotypes BARI Tomato-9, Abhiruchi-6, Abhiruchi-10, Abhiruchi-11, Gautum and Raksha showed a disease incidence ranging from 70.67 to 78.67%. However, the maximum percent (100.00%) infection was recorded in Diamond, Mongal, Tropic green and Udayan followed by Bankim, BARI Tomato-2, BARI Tomato-3, Chuanchu and Winner. The tomato genotypes Diamond, Tropic green, Udayan, Mongal and Bankim were found as susceptible genotypes against the TPVV both in field and inoculated condition. The genotype Salamat performed better under inoculated nethouse and field conditions. Also, Abhiruchi-6, Abhiruchi-10, BARI Tomato-9 exhibited significant level of resistance against the virus infection in both the conditions (Fig. 2).

Underfield condition, the minimum infection was recorded in hybrid Salamat (12.0%)

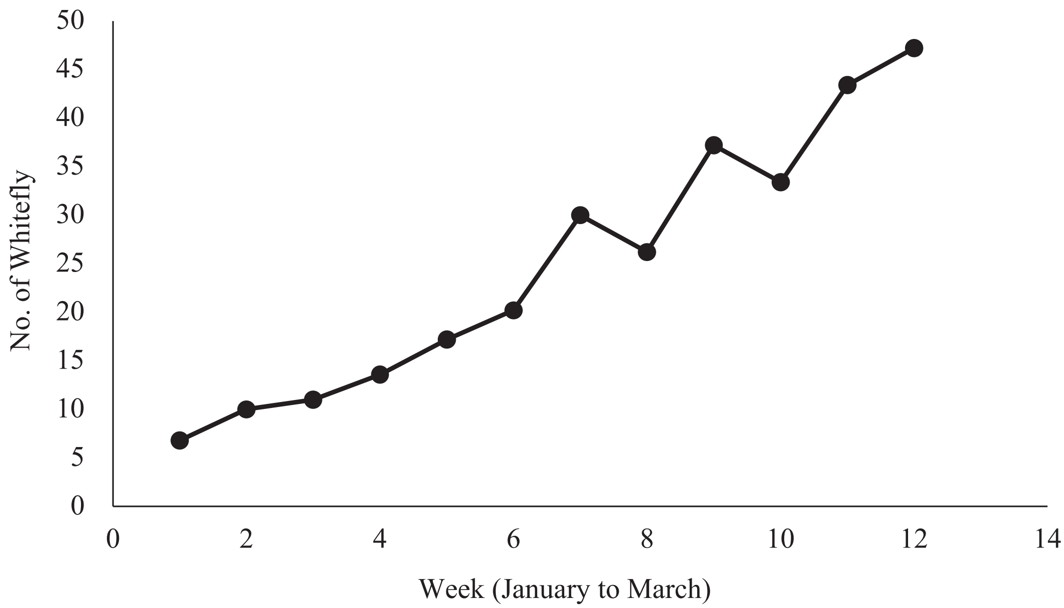

Fig. 1. Prevalence of whitefly in the field during January to March.

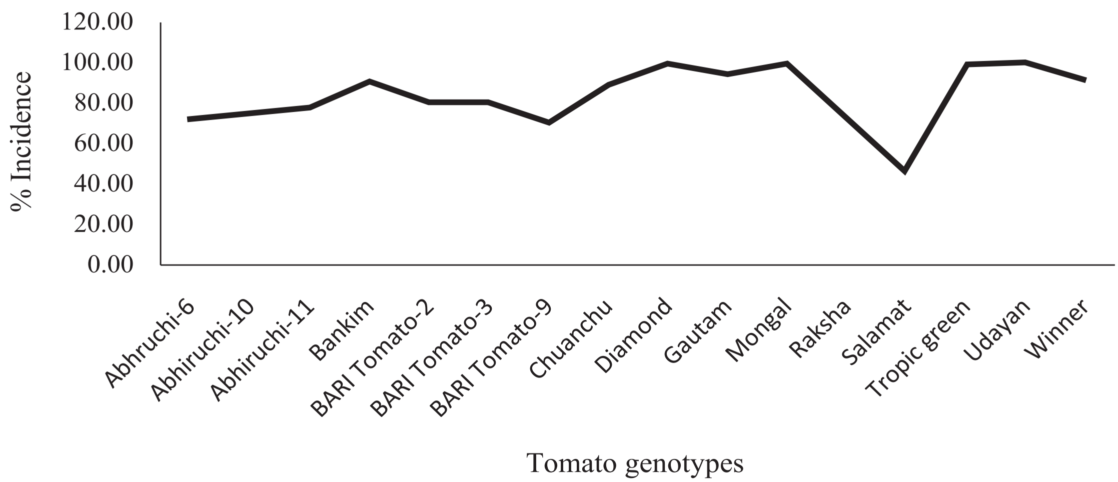

Fig. 2. Incidence of TPVV under inoculation conditionin nethouse.

followed by BARI Tomato-9 (20.00 %), Abhiruchi-6 (20.33 %) and Abhiruchi-10 (23.67 %). The genotypes Abhiruchi-11, Bankim, Chuanchu, Winner, Gautum, Mongal, BARI Tomato-2, BARI Tomato-3, Raksha and Diamond exhibited a disease incidence ranging from 27.33 to 35.67 %. However, the maximum percent infection was recorded in Diamond (46.33 %) followed by Tropic green (41.00 %) and Udayan (39.67 %). The percentage infection of TPVV ranged to a varying degree depending on the genotypes perhaps due to their inherent resistance and intensity of whitefly during the season (Fig. 3).

Plant height

The plant height was measured as the length of the tomato plant from the base of stem near soil line and up to the tip of the main stem. The infection caused significant (*P=0.05*) reduction in plant height of all sixteen tomato genotypes under field condition. The plant height ranged 28.53 to 95.10 cm. The highest plant height was recorded in Abhiruchi-11 which was statistically similar to Winner. The lowest height was found in Gautam which was statistically similar to Diamond and Mongal (Table l).

Leaf number

The infection caused significant reduction in number of leaves of all sixteen tomato genotypes. The number of leaves ranged 63.18 to 26.81 per plant. The highest leaf number was recorded in Abhiruchi-10and the lowest in Tropic green (Table l).

Branch number

The infection caused significant reduction in number of branch of all sixteen tomato genotypes over healthy plants. The number of branch ranged 9.580 to 3.407. The highest plant height was recorded in Abhiruchi-10 which was statistically similar to Salamat and Abhruchi-6. The lowest was found in Tropic green which was statistically similar to Chuanchu and Mongal (Table l).

Fresh shoot weight

The infection caused significant reduction in fresh shoot weight of all sixteen tomato genotypes over healthy plants. The fresh shoot weight ranged 545.3 to180.4 g. The highest plant height was recorded in Abhiruchi-10. The lowest was found in Tropic green followed by Chuanchu, Mongal, Udayan and Winner (Table l).

Fresh root weight

The infection caused significant reduction in fresh root weight of all sixteen tomato

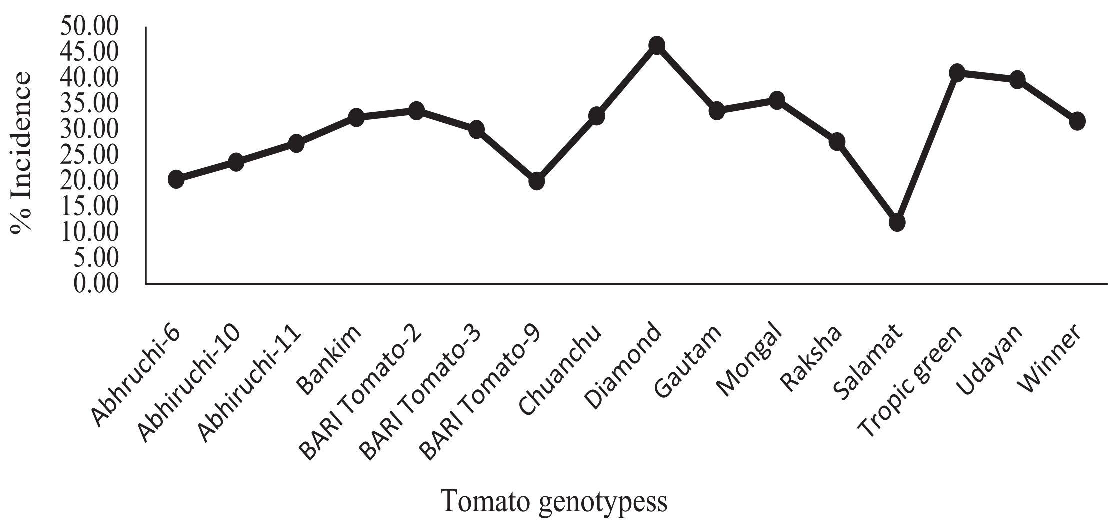

Fig. 3. Incidence of TPVV under field condition.

Table 1. Performance of different growth parameters due to TPVV infection

Tomato Genotypes	Plant height (cm)	Number of leaves/plant	Number of branch/plant	Fresh shoot weight (g)	Fresh root weight (g)	SPAD value
Abhruchi-6	46.92ef	55.70b	9.130ab	321.3c	47.55c	42.29b
Abhiruchi-10	70.61b	63.18a	9.580a	545.3a	57.87a	49.50a
Abhiruchi-11	95.10a	42.84cd	7.350e	282.8cd	32.22 ef	36.09d-f
Bankim	54.87de	52.08b	8.413bc	308.4c	44.37cd	38.84b-d
Chuanchu	69.83bc	34.15fg	4.530i	200.0fg	20.59gh	28.32h
Diamond	36.25gh	38.06d-f	6.147fg	232.7ef	27.94f	31.74f-h
Gautam	28.53h	38.77c-f	6.193fg	232.7ef	29.33f	32.97e-g
Mongal	32.66gh	31.20g	4.437i	205.6e-g	19.99gh	28.39h
BARI Tomato-2	56.94d	42.94c	8.133cd	293.3cd	41.20de	36.04d-f
BARI Tomato-3	55.00de	42.79cd	7.383de	287.8cd	37.74e	36.04d-f
BARI Tomato-9	58.79 d	40.62c-e	7.027ef	253.0de	29.81f	34.99d-g
Raksha	40.57fg	41.32cd	6.267fg	250.4de	29.42f	35.06d-g
Salamat	61.81cd	55.41b	9.470a	395.1b	53.20b	41.13bc
Tropic green	67.11bc	26.81h	3.407j	180.4g	17.35h	20.37i
Udayan	48.38ef	36.27ef	5.177hi	213.4e-g	22.69g	31.25gh
Winner	94.35a	35.80f	5.547gh	216.4e-g	23.46g	31.30gh

genotypes over healthy plants. The fresh root weight ranged 57.87 to17.35g. The highest root weight was recorded in Abhiruchi-10 and the lowest was found in Tropic green (Table l).

Chlorophyll content (SPAD value)

The infection caused significant reduction in Chlorophyll content (SPAD value) of all sixteen tomato genotypes over healthy plants. The chlorophyll content (SPAD value) ranged 20.00 to 49.50. The highest SPAD was recorded in Abhiruchi-10 and the lowest was found in Tropic green (Table l). Alam *et al*. (1994) have reported that incidence of TPVV affected cellular components and Chlorophyll, Beta-carotene and Phosphorus contents were reduced due to infection by the viruses.

Number of bunch

The infection caused significant reduction in number of bunch per plant of all sixteen tomato genotypes over healthy plants under field condition. The number of Bunch ranged 22.93 to 7.963. The highest number of bunch was recorded in Abhiruchi-10 and the lowest was found in Tropic green (Table 2).

Number of flower

The infection caused significant reduction in number of flower per plant of all sixteen tomato genotypes over healthy plants under field condition. The number of flower ranged 92.21 to45.74. The highest number of flower was recorded in Abhiruchi-10. The lowest was found in Tropic green which was statistically similar to Chuanchu and Mongol (Table 2).

Number of fruit

The infection caused significant reduction in number of fruit per plant of all sixteen tomato genotypes over healthy plants under field condition. The number of fruitranged17.10 to 6.677 g. The highest number of fruit was recorded in Abhiruchi-10 which was statistically similar to Abhhiruchi-6 and Salamat. The lowest was found in Tropic green which was statistically similar to Chuanchu, Diamond, Mongol and Udayan (Table 2).

Fruit length

The virus infection caused significant reduction in fruit length of all sixteen tomato genotypes over healthy plants. The fruit length ranged 5.68 to 1.99 cm. The highest fruit length was recorded in Abhiruchi-10. The lowest was found in Tropic green which was statistically similar to Chuanchu, Mongol, Udayan and Winner (Table 2).

Fruit girth

The virus infection caused significant reduction in fruit girth of all sixteen tomato genotypes over healthy plants under field condition. The fruit girth ranged 18.33 to 4.07 cm The highest fruit girth was recorded in Abhiruchi-10. The lowest fruit girth was found in Tropic green which was statistically similar to Mongol (Table 2).

Fruit yield

TPVV infection caused significant reduction in fruit yield per plant of all sixteen tomato genotypes over healthy plants under field condition. The fruit yield ranged 1566.00 to 544.60 g. The highest fruit yield was recorded

Table 2. Performance of different yield contributing parameters and fruit yield of sixteen tomato genotypes due to TPVV infection

Tomato Genotypes	Number of bunch/plant	Number of flowers/plant	Number of fruits/plant	Fruit length (cm)	Fruit girth (cm)	Fruit yield (g)
Abhruchi-6	18.17b	76.22bc	15.85a	4.810b	12.44c	1337.00b
Abhiruchi-10	22.93a	92.21a	17.10a	5.680a	18.33a	1566.00a
Abhiruchi-11	15.41c-e	68.87c-e	12.44bc	4.210b-e	8.620d-f	1044.00de
Bankim	17.11bc	72.57b-d	13.64b	4.237b-e	9.840d	1200.00c
Chuanchu	11.07g	52.36fg	7.967fg	2.253g	6.003i	716.50hi
Diamond	14.29d-f	63.11e	8.517e-g	3.470f	7.330f-i	841.70f-h
Gautam	14.41de	65.01de	9.527ef	3.537f	7.740f-h	841.60f-h
Mongal	10.08g	52.17fg	8.437e-g	2.297g	4.673j	698.00i
BARI Tomato-2	16.00cd	71.14c-e	12.58bc	4.503b-d	9.700d	1139.00cd
BARI Tomato-3	15.81cd	70.63c-e	12.36bc	4.063c-f	9.113de	1042.00de
BARI Tomato-9	15.29c-e	67.56de	11.48cd	3.787ef	8.297e-g	933.80ef
Raksha	15.12c-e	69.73c-e	10.39de	3.983d-f	7.490f-h	870.40fg
Salamat	18.79b	79.73b	16.27a	4.667bc	15.64b	1404.00b
Tropic green	7.963h	45.74g	6.677g	1.993g	4.077j	544.60j
Udayan	12.18fg	54.66f	8.670e-g	2.543g	6.583hi	779.80g-i
Winner	13.31ef	54.34f	8.803ef	2.613g	7.157g-i	769.40g-i

in Abhiruchi-10 and the lowest fruit yield was found in Tropic green (Table 2).

Many authors have reported that the tomato viruses are the major limiting factors affecting health and yield of tomato during field, glass-house and nethouse conditions (Hossain *et al*., 2015; Moriones *et al*., 2017; Tamilnayagan *et al*., 2017; Ullah *et al*., 2017). Moreover, the prevalence of insect vector efficiently transmits viruses and severely affect the production system (Lepidot, 2007). The resistant genotypes were found to act as natural barrier and disfavour virus incidence even under field conditions (Friedmann *et al*., 1998; Ray *et al*., 2017).

Conclusion

The results of the present study reveal that a numbers of tomato genotypes exhibited appreciable withstanding capacity against TPVV infection under field and inoculated conditions. Percent incidence was always higher in inoculated plants than control. The genotypes showing susceptibility in inoculation conditions were also found highly susceptible in field conditions. Based on performance of the genotypes in both the conditions Salamat, Abhiruchi-6, Abhiruchi-10 and Bankim exhibited a significant level of resistance. Therefore, these tomato genotypes may be suggested as new sources of resistance against the virus.

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