IMPACT OF *TOMATO SPOTTED WILT VIRUS (TSWV)* ON GROWTH CONTRIBUTING CHARACTERS OF EIGHT TOMATO VARIETIES UNDER FIELD CONDITION

A. A. FAROOQ[1] AND A. M. AKANDA[2]

[1]MS Student, [2]Professor, Plant Pathology Division, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur-1706, Bangladesh

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ABSTRACT

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An attempt was made to evaluate the performance of eight tomato varieties namely BARI-T1 (Manik), BARI-T2 (Ratan), BARI-T3, BARI-T7 (Apurba), BARI-T8 (Shila), BARI-T9 (Lalima), BINA-T1 and BINA-T2 against *Tomato spotted wilt virus* (TSWV) under field condition. The study was conducted at the experimental farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur during November 2005 to March 2006. Irrespective of tomato varieties and stages of infections, TSWV significantly (p=0.05) reduced the growth contributing characters of tomato plants as compared to healthy ones. Significantly higher percent of reduction to all the selected eight growth contributing parameters was observed when plants were infected with TSWV at early stage of infection as compared to mid and late stages. In consideration of growth contributing characters BARI-T9 seemed to perform better in comparison to other varieties when infected with TSWV.

Key ward: *Tomato Spotted Wilt Virus*, impact, growth contributing characters

INTRODUCTION

Tomato spotted wilt virus (TSWV), transmitted by the thrips (*Frankliniella occidentalis*) is one of the most devastating viral pathogens appeared as a dramatically increasing threat to tomato causing tremendous yield loss throughout the tropics and subtropics. Diseases attributed to TSWV were first reported in Australia in 1915 (Best *et al*.1968). The spheroidal particles of TSWV are of 80-100 nm in diameter (Avila *et al*. 1991). TSWV is under genus *Tospovirus* of the family *Bunyaviridae* (German *et al*.1992, Murphy *et al*. 1995). TSWV has a host range spanning several hundred species in both monocotyledonous and dicotyledonous plants which include ornamentals and tomato (Moyer *et al*.1999, Tisserat, 2005). TSWV can infect 35-plant families including the Solanaceae, Asteraceae, Leguminaceae, Brassicaceae, and Bromiliaceae (Momol and Pernezny 2006).TSWV is transmitted from plant to plant by nine species of thrips (Tsuda, 1999, Mound, 1996). Thrips are less than one-quarter inch in length, light green to brown, and are extremely difficult to find on the plants (Tisserat 2005). TSWV is of worldwide importance (Peters *et al*. 1998). This virus is damaging to all floral crops and currently causes the most important disease of these hosts in the USA as well as in temperate and subtropical regions of the world (Pfleger *et al*. 1989, Natalie 2005). Severe yield losses associated with TSWV have been reported in tomato, peanut, tobacco, pepper and potato as well as in some ornamental crops (Culbreath *et al*. 2006, Diffie *et al*. 2006). Although most insecticides have little effect on spotted wilt incidence, use of phorate (Thimet or Phorate) in-furrow at planting has shown consistent suppression of spotted wilt. It has also been found that use of classic herbicide tends to increase severity of spotted wilt (Culbreat *et al*. 2006). Controlling weeds, avoiding contaminated host plants near the vegetable crop, and eliminating thrips in greenhouses and solariums are the best way to manage this problem. Sprays to control thrips have not been successful, probably because viruliferous thrips are constantly being blown into fields from external virus reservoirs (Swift 2006). Cultivar choice has been the most consistent way to suppress TSWV epidemics. In Bangladesh, 16 different viruses including TSWV have so far been recorded (Akanda and Rahman 1993, Akanda *et al*. 1994).But a depth studies on TSWV in Bangladesh have not yet been done. For boost-up the production of tomato, the management of a damaging virus like TSWV is immensely important. Moreover, the cultivation of resistant or tolerant varieties is eco-friendly and effective method of disease management. For the purpose a depth study on different aspects of TSWV is required. The present study illustrated the impact of TSWV on different growth contributing characters with a view to determine the status of eight tomato varieties against the virus.

MATERIALS AND METHODS

The field experiment was conducted at the research farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur during November 2005 to March 2006. The soil of the experimental field belongs to Salna series under the Agroecological Zone (AEZ)-28: Madhupur Tract. The texture of the soil was silty clay in surface layer and silty clay loam in subsurface (Rahman *et al*. 1998). The pH of the soil was 6 to 6.5.Eight tomato varieties namely BARI Tomato-1/Manik(BARI-T1),BARI Tomato-2/Ratan(BARI-T2),BARI Tomato-3(BARI-T3), BARI Tomato-7/Apurba(BARI-T7), BARI Tomato-8/Shila(BARI-T8), BARI Tomato-9/

Lalima (BARI- T9), BINA Tomato-1(BINA-T1) and BINA Tomato-2(BINA-T2)were used in the experiment. The seeds of these tomato varieties were collected from Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur and Plant pathology Division, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh. After well prepared of the nursery bed the seeds of eight tomato varieties were sown on November 17, 2005. Proper care was taken to ensure good and healthy seedling development. The experimental field was ploughed and leveled to have a good tilth on December 2, 2005. Fertilizer dose was used as N-200 (applied in two splits, one at 21 and other at 35 days after transplanting), P_2O_5-100, K_2O-150, S-20 and B-2 kg/ha as suggested by Rahman *et al*. (1998). Cow dung (5 t/ha) and all the fertilizers except urea were applied during final land preparation. The experiment was laid out following 8x2x3 factorial in Randomized Complete Block Design (RCBD) with 4 replications. The seedlings of eight tomato varieties grown in open nursery bed were carefully uprooted and transplanted in the main field on December 17, 2005. Forty-eight seedlings of each variety were transplanted in 3mx10m unit plot maintaining 70x70cm^2 spacing. Intercultural operations were done as and when required. *Tomato spotted wilt virus* (TSWV) was identified on the basis of field symptoms as described by Tisserat (2005), Natalie (2005), Momol and Pernezny (2006), Swift (2006) and Single-Stranded Conformational Polymorphism (SSCP). The data on the growth characters of tomato plants were collected at three stages of the plant growth as early (transplanting to first flowering), mid (first flowering to first fruiting) and late stage (first harvesting to last harvesting).To fiend out the affect of TSWV infection on different growth contributing characters of tomato, data were noted at early, mid and late stages of the crop as described earlier. The selected growth contributing characters were i) plant height (cm), ii) no. of branches/plant, iii) plant canopy (cm^2), iv) fresh shoot weight (g/plant), v) dry shoot weight (g/plant), vi) root length (cm), vii) fresh root weight (g/plant) and viii) dry root weight (g/plant). The data were analyzed statistically using the analysis of variance (ANOVA) of MSTATC software for proper interpretation. Incase of growth data the mean values were compared by Duncan's multiple range test (DMRT) at 5% level of significance. Yield data were collected for the correlation regression between percent reductions of plant growth contributing characters and percent reduction of yield due to TSWV infection. Percent reduction of the growth contributing characters was calculated following the under mentioned formula:

Reduction percentage, $P = \frac{A\text{-}A_1}{A} \times 100$

Where,

P = Reduction percentage of growth contributing character

A = Any parameter (growth contributing character) of healthy plants

A_1 = Any parameter (growth contributing character) of infected plants

All the parameters expressed per plant basis unless it is otherwise stated.

RESLTS AND DISCUSSION

Evaluation of growth contributing characters of tomato varieties under TSWV infection

Plant height (cm)

TSWV infection caused significant (p=0.05) plant height reduction in all the eight tomato varieties compared to healthy plants at early, mid and late stages of infection (Table 1). The lowest height was found in plants infected at early stage as compared to mid and late stages. All the eight varieties showed statistically significant differences in plant height at the different stages of infection except BARI-T1, which produced statistically similar plant height at the mid and late stage of infection. Moreover, all varieties showed significant difference in healthy and different stages of infection accept BARI-T8 and BARI-T9, which showed statistically similar height between healthy and late infected plants (Table 1). Significant reduction of plant height was observed at early stage of infection in all the cases (50-67%) while mid and late stage infection caused less reduction as compared to the early (24-46% and 6-17%), depending on the tomato varieties. The highest reduction of plant height (67%) due to early stage of infection was recorded in BINA-T2 and the lowest (6%) reduction due to late stage of infection was found in BARI-T9.

Table 1. Effect of TSWV infection on plant height (cm) at early, mid and late stages of eight tomato varieties

Varieties	Plant height (cm)			
	Stages of appearance of TSWV infection in plants			
	Early	Mid	Late	Healthy
BARI-T1 (Manik)	35.16lm	52.31j	76.34fg	83.14d-f
BARI-T2 (Ratan)	37.51l	66.49i	89.11c-e	107.60b
BARI-T3	36.97l	63.21i	78.15f	91.73c
BARI-T7	47.38jk	80.73f	108.10b	126.80a
BARI-T8	40.66kl	62.02i	68.85g-i	81.96ef
BARI-T9	28.52m	54.83j	74.88f-h	79.69f
BINA-T1	53.68j	90.01cd	108.00b	127.10a
BINA-T2	41.32kl	68.36hi	112.60b	126.75a

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

Number of branches per plant

The number of branches per plant produced by healthy plants was significantly higher compared to TSWV infected plants in all the varieties at early, mid and late stages of infection (Table 2). A significant (p=0.05) difference in the number of branches per plant were observed in all the three stages of TSWV infection among the varieties with few exception. The results suggested that the reduction of branch number per plant was higher in early stage of infection followed by mid and late stage in all cases. The highest reduction of branches per plant was 69% in BARI-T1 at early infected stage and the lowest was 22% in BARI-T7 at late infected stage. The reduction of branch number in all the varieties ranged from 53-69% at early, 35-48% at mid and 18-28% at late infected stage.

Table 2. Effect of TSWV infection on branch number per plant at early, mid and late stages of eight tomato varieties

Varieties	Number of branches per plant			
	Stages of appearance of TSWV infection in plants			
	Early	Mid	Late	Healthy
BARI-T1 (Manik)	4.50n	7.50ij	10.50c-e	14.50a
BARI-T2 (Ratan)	5.00mn	6.75i-l	9.75ef	12.75b
BARI-T3	4.00n	7.25ij	9.25e-h	11.75b-d
BARI-T7	4.25n	7.00i-k	10.25de	12.50b
BARI-T8	5.00mn	8.00g-j	9.75ef	12.50b
BARI-T9	5.50k-n	9.50e-g	12.00bc	15.50a
BINA-T1	5.25l-n	7.75h-j	9.50e-g	12.00bc
BINA-T2	5.00mn	6.50j-m	8.25f-i	10.75c-e

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

Plant canopy (cm^2)

TSWV infection caused significant (p=0.05) plant canopy reduction in all the eight tomato varieties compared to healthy plants at early, mid and late stages of infection (Table 3). The lowest canopy was found in plants infected at early stage compared to mid and late stage and healthy. All the eight varieties showed statistically significant differences in plant canopy at the different stages of infection except BARI-T1. BARI-T8 and BARI-T9 showed statistically similar canopy between healthy and late infected plants. In all the cases early infection caused higher reduction of canopy per plant followed by mid and late infection. Maximum canopy reduction (60%) was found in BINA-T2 at early stage of infection where BARI-T1 showed the minimum (50%). Reduction at mid and late stage infected plants varied from 20-43% and 4-15%, respectively, depending on the tomato varieties.

Table 3. Effect of TSWV infection on canopy (cm^2/plant) at early, mid and late stages of eight tomato varieties

Varieties	Plant canopy (cm2/plant)			
	Stages of appearance of TSWV infection in plants			
	Early	Mid	Late	Healthy
BARI-T1 (Manik)	1218.22op	1648.89k-m	2252.33f-i	2423.12c-f
BARI-T2 (Ratan)	1277.28n-p	1986.54ij	2572.98c-e	3037.39b
BARI-T3	1263.50n-p	1922.55jk	2297.86e-h	2638.71c
BARI-T7	1525.10l-n	2362.58c-f	3049.69b	3519.74a
BARI-T8	1345.45no	1881.95jk	2064.06g-j	2393.34c-f
BARI-T9	1051.36p	1712.14kl	2240.76f-i	2336.49d-g
BINA-T1	1683.35k-m	2595.64cd	3047.23b	3527.13a
BINA-T2	1421.25m-o	2030.35h-j	3212.12b	3580.37a

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

Fresh and dry shoot weight (g/plant)

The results of fresh shoot weight of healthy and infected plants are presented in Table 4. The fresh shoot weight of healthy plants was significantly (p=0.05) higher as compared to early, mid and late stage infected plants except in BINA-T2 which was statistically similar with healthy at late infected stage. A significant reduction in the fresh shoot weight of all the eight varieties was observed at the early infected stage compared to mid and late stage. Results on the average of all stage-infected plants are presented in Table 4. Significantly higher fresh shoot weight was recorded in healthy plants of all the eight varieties as compared to TSWV infected plants. Similarly, the dry shoot weight of healthy plants was significantly higher than that of early, mid and late stage infected plants in all the cases except BARI-T3 and BARI-T9 varieties, which showed statistically similar dry shoot weight at late infected stage (Table 5). Early stage infected plants showed higher reduction in both fresh and dry shoot weight which ranged from 60-70% and 58-77%, respectively as compared to mid (34-49% in fresh and 36-51% dry shoot weight) and late infected plants (9-24% fresh and 8-30% dry shoot weight) depending on tomato varieties.

Table 4. Effect of TSWV infection on fresh shoot weight at early, mid and late stages of eight tomato varieties

Varieties	Fresh shoot weight (g/plant)			
	Stages of appearance of TSWV infection in plants			
	Early	Mid	Late	Healthy
BARI-T1 (Manik)	68.60l-n	105.50ij	153.60gh	201.40de
BARI-T2 (Ratan)	78.37k-m	122.50i	215.80d	241.60c
BARI-T3	66.57l-n	130.40hi	191.20de	212.20de
BARI-T7	110.40ij	215.20d	335.70b	373.50a
BARI-T8	55.47mn	87.93j-l	150.30gh	163.50g
BARI-T9	66.74l-n	124.20i	167.10fg	189.50ef
BINA-T1	95.28jk	156.90g	216.50d	259.40c
BINA-T2	49.10n	77.57k-m	111.80ij	122.90i

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

Table 5. Effect of TSWV infection on dry shoot weight at early, mid and late stages of eight tomato varieties

Varieties	Dry shoot weight (g/plant)			
	Stages of appearance of TSWV infection in plants			
	Early	Mid	Late	Healthy
BARI-T1 (Manik)	27.39o-r	47.66k-m	61.20ij	87.20d
BARI-T2 (Ratan)	23.52qr	49.41k-m	76.00e-g	101.30c
BARI-T3	33.64n-q	43.36l-n	63.21ij	80.74d-f
BARI-T7	36.92no	74.77f-h	85.06de	117.20b
BARI-T8	25.48p-r	40.18mn	54.00j-l	65.32hi
BARI-T9	21.95r	35.45n-p	61.71ij	67.05g-i
BINA-T1	44.15l-n	86.29d	117.60b	139.20a
BINA-T2	23.32qr	43.85l-n	54.66jk	74.28f-h

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

Root length (cm)

The effect of TSWV infection on the root length of tomato plants are summarized in Table 6. Healthy plants produced significantly (p=0.05) higher root length compared to early, mid and late sage infected plants in all tomato varieties except BARI-T8 and BARI-T9 in late stage. The lowest root length was found in early stage infected plants which statistically differed with mid and late stage infected plants in all cases. The percent reduction of root length was found higher in early-infected plants compared to mid and late stage infection. The ranges of root length reduction varied among the stages of infection which were 52-68%, 30-44% and 11-30% at early, mid and late stages of infection, respectively, depending on tomato varieties.

Table 6. Effect of TSWV infection on root length at early, mid and late stages of eight tomato varieties

Varieties	Root length (cm/plant)			
	Stages of appearance of TSWV infection in plants			
	Early	Mid	Late	Healthy
BARI-T1 (Manik)	8.47m	18.03ij	20.81hi	25.72ef
BARI-T2 (Ratan)	10.11m	18.13ij	22.52gh	28.33de
BARI-T3	13.33l	15.39kl	19.06ij	27.52de
BARI-T7	15.17kl	21.97gh	28.64d	23.21f-h
BARI-T8	10.83m	17.10jk	24.14fg	27.42de
BARI-T9	10.19m	15.29kl	20.73hi	23.64fg
BINA-T1	18.28ij	26.93de	35.50b	42.16a
BINA-T2	15.04kl	18.36ij	27.12de	31.43c

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

Fresh and dry root weight (g/plant)

The effects of TSWV infection on fresh and dry weight of root are presented in Table 7 and Table 8. Both the fresh and dry weight of root decreased significantly (p=0.05) at early, mid and late infected plants compared to healthy in all the varieties with few exception. Late infected BARI-T9 showed statistically similar fresh and dry weight with their respective healthy plants. There was significant differences (P=0.05) in the fresh and dry weights of early, mid and late infected plants. In both cases higher reduction was observed in early stage of infection in all the eight tomato varieties compared to mid and late stages of infection. The reduction of fresh root weight of early, mid and late infected plants varied from 50-66%, 32-43% and 11-25% whereas dry root weight varied 56-73%, 23-50% and 12-22%, respectively, depending on tomato varieties.

Table 7. Effect of TSWV infection on fresh root weight at early, mid and late stages of eight tomato varieties

Varieties	Fresh root weight (g/plant)			
	Stages of appearance of TSWV infection in plants			
	Early	Mid	Late	Healthy
BARI-T1 (Manik)	17.52j-l	21.02h-j	27.52ef	36.89c
BARI-T2 (Ratan)	11.08n	29.06i-k	27.78ef	32.89d
BARI-T3	14.96lm	19.03i-k	26.54ef	32.66d
BARI-T7	20.71h-j	33.49cd	42.78b	52.56a
BARI-T8	15.61k-m	22.74gh	29.43e	35.37cd
BARI-T9	12.33mn	16.56kl	21.93g-i	24.67fg
BINA-T1	21.07h-j	29.11e	36.46c	44.16b
BINA-T2	18.11j-l	28.57e	34.92cd	42.15b

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

Table 8. Effect of TSWV infection on dry root weight at early, mid and late stages of eight tomato varieties

Varieties	Dry root weight (g/plant)			
	Stages of appearance of TSWV infection in plants			
	Early	Mid	Late	Healthy
BARI-T1 (Manik)	5.88l	8.89jk	13.74cd	16.00b
BARI-T2 (Ratan)	4.26m	8.87jk	11.83e-g	14.30c
BARI-T3	5.93l	9.95h-j	11.20f-h	13.86cd
BARI-T7	5.34lm	10.25h-j	16.34b	19.46a
BARI-T8	6.59l	10.60g-i	13.57cd	15.70b
BARI-T9	4.24m	7.97k	10.93gh	12.66de
BINA-T1	6.21l	9.85g-j	12.48d-f	14.22c
BINA-T2	5.17lm	9.14jk	9.26i-k	11.81e-g

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

Fruit yield (g/plant)

The effect of TSWV infection on the fruit yield of eight tomato varieties at the three different stages of infection as compared to healthy plants is noted in Table 9. In all the cases, healthy plants produced significantly (p=0.05) higher fruit yield compared to infected plants. Among the three infected stages, significantly higher yield was observed at late stage infected plants followed by mid and early. The lowest yield was recorded in BARI-T7 at early infection, which was statistically identical with other varieties infected at early stage except BARI-T9. BARI-T9 gave the highest yield at all the stages of infection as compared to rest of the varieties except BARI-T8 at mid and BARI-T3 & BARI-T8 at late stage infection. The lowest yield at mid and late stage infection was noted from BARI-T7 and BINA-T2, respectively, and they were statistically identical with each other at both the stages. The highest fruit yield reduction was observed due to early infection (78-88%) followed by mid (34-51%) and late infection (11-29%) in all the varieties. However, the early infection caused higher reduction of fruit yield as compared to mid and late infection.

Table 9. Effect of TSWV infection on fruit yield (g/plant) at early, mid and late stages of eight tomato varieties

Varieties	Fruit yield (g/plant)			
	Stages of appearance of TSWV infection in plants			
	Early	Mid	Late	Healthy
BARI-T1 (Manik)	568.55kl	2046.98h	2844.21d	4006.77ab
BARI-T2 (Ratan)	458.15kl	1627.05i	2162.13gh	2942.24d
BARI-T3	512.79kl	2479.40e-g	3541.97c	3980.19ab
BARI-T7	420.18l	1014.55j	1533.70i	2073.11h
BARI-T8	481.43kl	2621.50d-f	3463.66c	4130.46a
BARI-T9	802.62jk	2837.35d	3706.85bc	4300.16a
BINA-T1	589.23kl	1531.25i	2331.18f-h	2790.14de
BINA-T2	459.38kl	1115.98j	1628.03i	2089.04h

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

Impact of reduction of growth contributing characters due to TSWV infection on yield of tomato

The correlation regression between percent reductions of plant growth contributing characters and percent reduction of yield due to TSWV infection are presented in the Figure 1(A-H). In case of growth contributing characters the results revealed that percent reduction of all selected growth contributing characters like plant height, number of branches per plant, plant canopy, fresh shoot weight, dry shoot weight, root length, fresh root weight and dry root weight per plant had highly positive and significant correlation with percent yield reduction of tomato due to TSWV infection at early, mid and late stage of infection. It indicates that with the increase of percent reduction of any growth contributing character due to TSWV infection at any stage percent reduction of yield of tomato also increased.

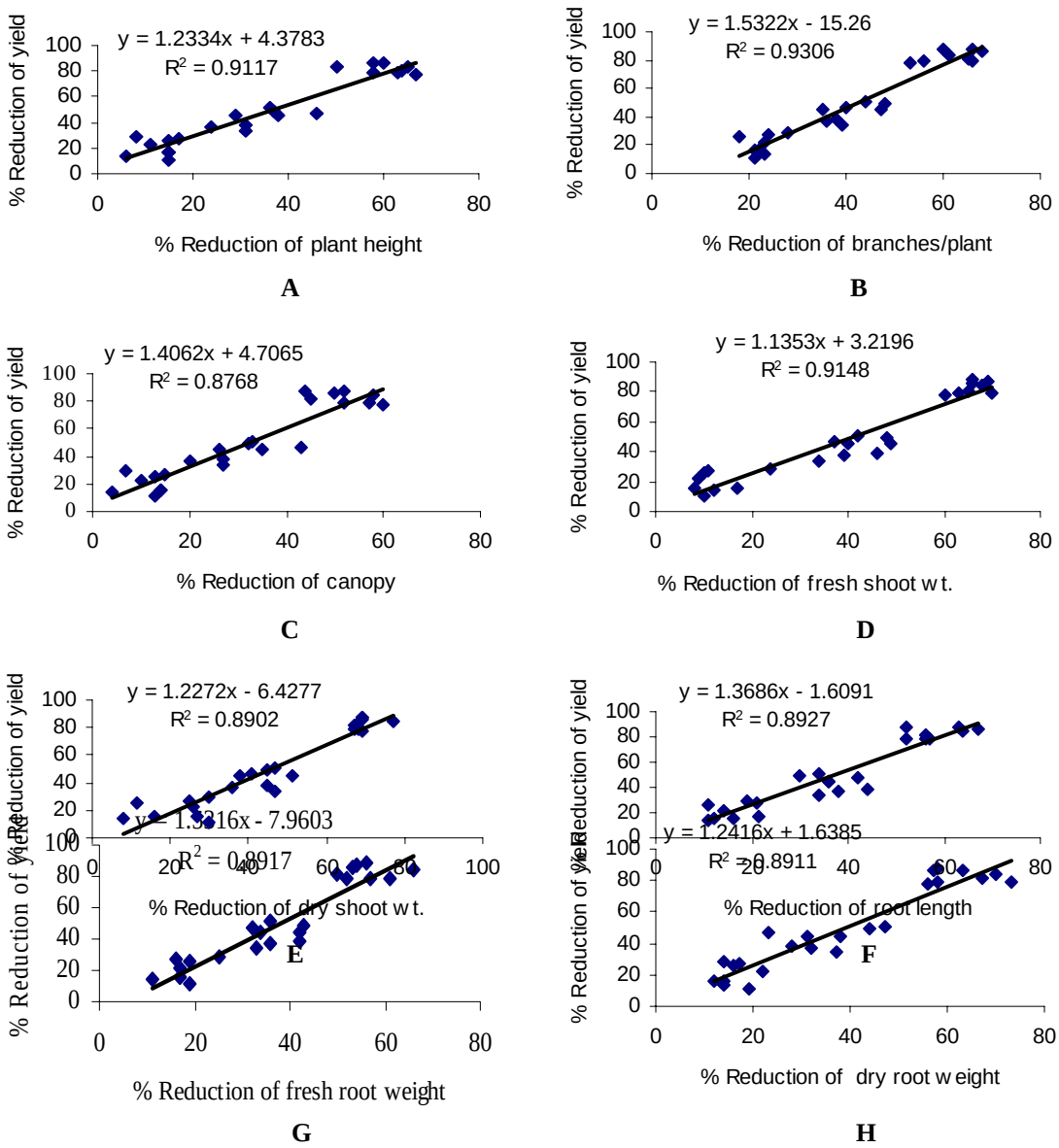

Figure 01. Correlation regression between percent reduction of(A) plant height, (B) no. of branch per plant, (C) plant canopy, (D) fresh shoot weight (E) dry shoot weight, (F) root length, (G) fresh root weight, (H) dry root weight and percent reduction of yield at early, mid and late stages of eight tomato varieties.

Status of eight tomato varieties in respect of TSWV infection

The overall effect of TSWV on all selected growth contributing characters are accommodates in the Table 10. The Table illustrates the status of the all eight varieties in respect of TSWV infection. It seemed that, none of the eight tomato varieties had promissory level of resistance or tolerance against TSWV infection though BARI-T9 performed better compared to others. All the parameters of tomato plants studied under the present investigation were found to be affected due to TSWV infection at different stages as compared to healthy. In all cases early stage infection caused severe reduction of plant growth contributing characters of all the eight tomato varieties. The extent of damage in different growth contributing characters as well as yield was largely dependent upon the stages of infection and tomato varieties. The similar findings were also noted by Greenough *et al.* (1990), Tomassoli and Barba (1994), Swift (2006), Culbreath (2006). In almost all cases, they reported that the damage due to TSWV infection largely depend on tomato varieties.

Table 10. Status of eight tomato varieties in respect to TSWV prevalence and impact of virus infection on growth contributing characters in the field

Status of the tomato varieties1									
Varieties	Rank on the basis of growth contributing characters2								Rank
	Ph	Nb	Cp	Fsw	Dsw	Rl	Frw	Drw	
BARI-T1	3	8	4	8	7	7	6	6	7
BARI-T2	7	7	7	7	8	8	7	7	8
BARI-T3	5	4	3	3	4	4	8	3	5
BARI-T7	6	6	6	6	5	5	5	8	6
BARI-T8	1	2	2	4	4	1	4	4	2
BARI-T9	2	5	1	2	1	2	1	5	1
BINA-T1	4	1	5	5	2	3	2	2	3
BINA-T2	8	3	8	1	3	6	3	1	4

[1]Best ranked by which was followed by 2-8; [2]Ph (plant height), Nb (branch/plant), Cp (canopy/plant), Fsw (fresh shoot wt.), Dsw (dry shoot weight), Rl (root length), Frw (fresh root wt.), Drw (dry root wt.).

CONCLUSION

The results of the effect on eight growth contributing characters viz. plant height per plant, number of branches per plant, canopy per plant, fresh and dry shoot weight per plant, root length, fresh and dry root weight per plant demonstrated that the virus caused significant reduction of all the parameters compared to healthy in all the eight tomato varieties. In all the cases, early stage infection significantly reduced all the parameters followed by mid and late stage infection. The differences so far recorded in respect to the reduction of all growth contributing characters were influenced by the stage of infection and tomato varieties, whereas the effect of stages of infection had more pronounced compared to healthy. The correlation and regression analysis revealed that the percent reduction of growth contributing characters due to TSWV infection had pronounced effect on percent yield reduction of tomato as strongly positive and significant effect was observed in all cases. The results of the study on all growth contributing characters suggested that, none of the eight tomato varieties had impressive level of tolerance against TSWV infection. Although BARI-T9 performed better as compared to other tomato varieties on consideration of growth contributing characters.

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