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Comparative study of effect of TYLCV and Septoria blight on F_3 tomato lines

Mehboob Ahmad[1*], Zishan Gul[1], Mazhar Iqbal[1], Bilal Ahmad Khan[1], Zaheer Ullah khan[1], Muhammad Shahid[2], Adil Rehman[2]

[1]*Hazara Agricultural Research Station Abbottabad, Pakistan*

[2]*Agricultural Research Station Baffa,Mansehra, Pakistan*

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Abstract

The project was undertaken to compare the effect of TYLCV and Septoria blight infection on F3 population of tomato (*Solanum Lycopercicum* L) lines in order to find which of two diseases is more destructive and to screen resistant F3 lines. The research was conducted at Hazara agricultural research station Abbottabad during August-December 2015.Variablity data indicates that CV(co-efficient of variation) was highest for yield/plant(123.72%) followed by No of fruits/plant while lowest CV was noted for TYLCV severity and incidence. Minimum range for all the parameters was 0 while, maximum range for TYLCV and septoria blight severity was recorded to be 5.Maximum range for TYLCV and septoria blight incidence was noted to be 100. Maximum range of yield/plant,fruit weight and number of fruits was found to be 650,70, and 9,respectively.Negative value of correlation was found between TYLCV severity and incidence to yield and yield components. Data collected on TYLCV severity and incidence exhibits that the disease has caused reduction in yield and No of fruits to zero in some lines i.e L4,L6,L11,L12 and L13 while Septoria blight severity and incidence results shows that the disease has moderate effect on yield i.e in L5 and L14,inspite of highest disease severity (5), yield/plant was recorded as 166.5grams and 180 grams.

* **Corresponding Author:** Mehboob Ahmad ✉ mehboob05pbg@yahoo.co.uk

Introduction

Tomato is the one of the most important vegetable crop of the world after potato. It faces certain bio and a-bio stresses due to which its yield is reduced. Tomato is susceptible to over 200 diseases caused by pathogenic fungi, bacteria, viruses and nematodes (Lukyanenko ,1991) . Fungal and viral diseases are two major factors responsible for reducing its yield. Among the viruses affecting tomato, tomato yellow leaf curl virus devastates crop not only in Pakistan but all over the world. It belongs to genus *Begomovirus*, family *Geminiviridae* and is transmitted by the whitefly *Bemisia tabaci* (Köklü *et al.*, 2006; Barbieri1 *et al* ., 2010; Le., 2015). It is a DNA virus with 2.7-2.8 kb genome size (Delatte *et al*. 2005).Plants infected with TYLCV may be observed with stunted small upward cupping or curling leaves crumpling with strong yellowing at the edges and in between the veins. Early stage infection in plants may lead total failure in yield and severely stunted growth while infection at lateral stage may cause stunting of growth, abnormal erect or upright growth and a bushy appearance (Green and Kalloo,1994).

Among the fungal diseases of tomato, septoria leaf spot (*Septoria lycopersici* Speg.) is one of the most destructive diseases. Under favourable environmental conditions i.e during high rain falls it acts by complete defoliation, consequently, crop is lost significantly (Delahaut and Stevenson, 2004)**.**The symptoms of this disease are circular to elliptical lesions, with a dark-gray center, surrounded by a yellow halo, particularly on older leaves. (Blum, 2000). Parker *et al.* (2000) reported that tomato plants were highly susceptible to disease attack in the field at all stages of their growth and the disease could be highly destructive in wet and warm climate. Although the causal fungus (*Septoria lycopersici*) will not directly infect fruits, losses are due to defoliation leading to fruit maturity failure and sunscald injury (watt.2000).

Previously, work has been done on screening of tomato cultivars and accessions against septoria leaf spot and TYLCV diseases.Gul *et al.*(2016) screened tomato lines against septoria blight and studied their effect on yield,fruit size and fruit weight.Tu and Poysa (1990) used brushing method for inoculation of tomato seedling for screening against septoria blight at early stage.Zhengxing (1999) tested 13 varieties of tomato from different ecological regions for TYLCV resistance and screened the TYLCV resistant varieties with best horticultural features.

Osei *et al.* (2012) conducted study on 30 lines of tomato for TYLCV resistant and found 23 lines susceptible to the pathogen.Kaya and Tanyolac (2009) screened F3 tomato lines resistant to TYLCV by using molecular markers.

Past studies were conducted for screening of single pathogen in tomato cultivars or lines. The screening for one pathogen may not lessen the risk of infection by other pathogen. Therefore, our study was conducted with aim to screen for viral and fungal pathogens in the same population simultaneously. Very few efforts were made in selection for resistance to the pathogen of fungal and viral diseases in breeding lines like F2 or F3 lines. Keeping in view these deficiencies our research was initiated to screen for the pathogens in F3 generations and after selecting the plants having combine resistance for both the pathogens i.e fungal and viral ,to proceed to the next breeding generation i.e F4 to F8.It is expected that the lines selected for the pathogen resistance in F3 stage may segregate into highly resistant and moderate resistant lines in F4 generation; however, there may be less chances of observing susceptible lines in the next generation. The aim will be achieved in F8 generation where we would be able to develop high yielding variety, resistant to abiotic stress.

Materials and methods

Field layout and breeding work

The research was conducted at Hazara agricultural Research station Abbottabad from the year 2013 to 2015.In the year 2013,Crosses were made between two varieties of distinct characteristics: VCT1 a pear fruit shaped variety was used as tester and

Continental ,a round fruit shaped variety was used as line.F1 seed was obtained from the crosses and was sown in 2014 as F1 generation.F2 seed was collected from F1 generation.F2 generation plants were sown in January 2015 and 15 lines were selected according to desirable characteristics. Selected F3 lines were sown in July 2015 and were transplanted in the field after 45 days. Plant to plant distance was kept 50cm and row to row distance was maintained 100cm. The data was collected for diseases and yield during the months October, November and December. The period mentioned is favorable for septoria and viral diseases at the field .White fly, the vector of TYLCV was also found in the field. Data on the parameters disease severity, disease incidence, No of fruits/plant, fruit weight and yield/plant were recorded on each line.

Disease data

Severity of the two diseases was scored from the same population in different time intervals under natural inoculums using a scale of 0 to 5, where 0 = no disease and 5 = complete development of disease on a plant as suggested by Joshi (2011), according to Table-1.

Statistical analysis

Data were analyzed using the software statistix-8.1.Means, variance, CV (coefficient of variance) were calculated by using descriptive statistics. Correlation was also found using the same soft-ware.

Results and discussion

Variability

Values of means, variance ,CV(co-efficient of variation), maximum and minimum range for F3 lines are shown in Table 2.Highest variance was noted for yield/plant and lowest variance was calculated for TYLCV severity. Highest value (123.72%) of CV was noted in yield/plant followed by No of fruits/plant(108.18%). Other parameters like septoria blight severity, septoria blight incidence also showed CV value more than 80%.Lowest value of CV was noted for TYLC severity and incidence i.e 56.46% and 41.43%.Higher values of CV and variance indicates that the character is more variable than other traits and the segregation in F3 exists due to additive gene action while lowest value of CV and variance shows that the segregation is low for the trait due to dominant or partial dominant gene action.

Table 1. Disease severity scoring.

Scale	Disease severity	Description	
		Septoria blight	TYLCV
0	0.0%	Leaves free from leave spot	Leaves having normal shape and color
1	0-5%	0-5% leaves area infected and covered by spot.	Leaves very slightly de-shaped and discolored
2	6-20%	6-20% leaves area infected and covered by spots	6-20% leaves area de-shaped and discolored
3	21-40%	21-40% leaves area infected and covered by spots	21-40% leaves area de-shaped and discolored
4	41-70%	41-70% leaves area infected and covered by spots	41-70% leaves area de-shaped and discolored
5	>70%	>71% leaves area covered by spot	Total area of leaves de-shaped (cup-shaped) and discolored(pale-green)

Correlation

Correlation among the yield components and diseases is shown in Table 3.Yield/plant, No of fruits/plant and fruit weight are negatively correlated to TYLCV severity and TYLCV incidence. Consuegra *et al.*, (2015) has also found the negative correlation of TYLCV severity to No of fruits/plant and yield/plant, which confirms our findings.TYLCV causes the suppression of fertilization in flowers and flowers cannot develop into fruits and are shed, which results in the reduction in number of fruit and consequently the yield.

Positive correlation was found between yield components, Septoria blight severity and incidence. Septoria blight does not directly affect the flowering or formation of fruits.It acts indirectly by reducing the photosynthesis process by causing infection in leaves.

So number of fruits are not reduced by this disease and hence yield is also not affected to a great extent as affected by TYLCV. There is also negative correlation among TYLCV severity, incidence and Septoria blight severity, incidence. This indicates that there is no linkage between resistant genes of TYLCV and Septoria blight and both type of genes segregate independent of one another. The result indicates that TYLCV has greatly affected yield and yield components while Septoria blight has not affected yield and yield components significantly.

Table 2. Mean, variance, CV, minimum and maximum range for TYLCV severity, TYLC incidence, Septoria blight severity, Septoria blight incidence, No of fruits/plant, Fruit weight and Yield/plant.

	TYLC severity	TYLC incidence	Septoria blight severity	Septoria blight incidence	No of fruits/plant	Fruit weight	Yield/plant
Mean	3.4000	84.000	1.8000	51.333	3.2013	33.083	171.92
Variance	3.6857	1211.4	3.1714	2169.5	11.994	832.34	45242
C.V.	56.465	41.435	98.936	90.737	108.18	87.205	123.72
Minimum	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 3. Correalation among TYLCV severity, TYLCV incidence, Septoria blight severity, Septoria blight incidence, Fruit weight ,No of fruits/plant and yield/plant.

	Yield/pla	Nof	FR wt	Sep inc	Sep sev	TYLC incidence
Tylc sev	-0.8496	-0.9575	-0.6042	-0.4857	-0.7897	0.6799
Tylc inc	-0.8197	-0.6832	-0.5413	-0.0300	-0.3319	
Sep sev	0.4641	0.6829	0.2457	0.6493		
Sep inc	0.2735	0.4207	0.0459			
Frt wt	0.7858	0.7078				
nof	0.9218					

Disease severity ,incidence and yield components means

The results in the Table.4 indicate that among all the 15 F3 lines, L2 line showed complete resistance to TYLCV with 0 values for severity and 0% incidence on disease scale. It may be due to action of 2-3 recessive additive genes in the line as suggested by Vidavsky and Czosnek (1998) in their study. L2 selected from F2 may consist of homozygous recessive genes for resistance which exhibited additive gene action in F3 generation. The line exhibited highest values for number of fruits/plant (9), fruit weight (70 gram) and yield/plant (630 grams) among all the lines. The lines L1,L4,L6,L7,L11,L12,L13 and L15 showed highest value of disease severity i.e 5 and disease incidence i.e 100% to TYLCV and the lowest or comparatively lowest yield/plant and lower number of fruits/plant were recorded in the same lines i.e 0 gram/plant and 0 numbers of fruits/plant were recorded in lines L4,L6,L11,L12,L13 followed by 15gram/plant yield in line L7, 50gram/plant yield in L15 and only 1 fruit/plant was recorded in the 3 lines. Lapitop *et al.* (1997) has also reported 100% yield loss due to TYLCV infection in his study. However 100% disease incidence without highest value of disease severity has not severely affected the yield as was noted in lines L3 and L9.It is clear from the result that TYLCV is responsible for reducing the yield to zero or affected plants produced very few fruits. Schuster and Stansly,(1996) has also mentioned in their report that infected plants have stunted growth and flower abortion which reduces the number of fruits to zero. Highest fruit weight reduction has been noted in L7 i.e 15gram and moderate fruit weight reduction has been noted in L1 i.e 60gram and L15 i.e 50gram.The result indicates that weight may be highly or moderately affected by the TYLCV disease .Thus TYLCV reduces plant yield mostly by reducing the number of fruits/plant and by decreasing the weight/fruit to some extent. Akram *et al.*, (2014) also reported the reduction in fruit weight due to TYLCV infection.

Highest value of septoria blight severity i.e 5 was recorded in lines L5 with 166.5g yield/plant and 7 number of fruits/plant followed by L8 in which septoria blight severity was estimated to be 4 and yield/plant and number of fruits/plant was calculated as 530.6 gram and 7 fruits/plant, respectively.5 of the 15 lines showed complete resistance to septoria leaf spot that is 0 severity with 0 % incidence. Complete resistance may be due to action of single dominant gene in the lines as reported by Joshey (2011) in his research.

Table 4. TYLCV severity, TYLCV incidence, Septoria blight severity, Septoria blight incidence, Number of fruits/plant (NOF), Fruit weight (Wt), Yield/plant (yld/pl).

L. No	TYLC sev	TYLC inc	Sp.sev	sp.inc	NOF	Wt(grams)	yld/pl(grams)
1	5	100	0	0	1	60	90
2	0	0	2	100	9	70	630
3	2	100	3	100	7	60	420
4	5	100	0	0	0	0	0
5	1	80	5	100	7	25	166.5
6	5	100	0	0	0	0	0
7	5	100	1	50	1	15	15
8	1	0	4	0	7	70	530.6
9	3	100	2	70	3	63.75	191.25
10	3	80	1	50	6	52.5	341.25
11	5	100	2	100	0	0	0
12	5	100	0	0	0	0	0
13	5	100	2	100	0	0	0
14	1	100	5	100	6	30	180
15	5	100	0	0	1	50	50

The results indicate that septoria blight has not as much effect on yield/plant as TYLCV. Number of fruits/plant is also not affected by the disease. Our results match with the study of Franciss *et al.,* (1992) who also found moderate yield loss due to septoria blight effect. The lines L1,L4 and L6 showed 0 severity to septoria blight disease, however, they showed lower yield due to TYLCV effect.

Conclusion

It has been found from the above study that viral disease TYLCV is the main factor responsible for 100% yield loss as compared to septoria blight which has moderate effect on yield. Therefore serious attention should be given to screen resistant lines from F2 and F3 generations against TYLCV disease as well as fungal diseeases.

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