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Screening of Native and Exotic Tomato Germplasm for Their Susceptibility to Tomato Yellow Leaf Curl Virus and its Effect on Their Agro-Economic Performance Under Field Conditions

Waheed Akram[1*], Tehmina Anjum[1], Sana Hanif[1], Sabin Fatima[1], AsrarMahboob[2], Asmat Ali Javed[3]
[1]Institute of Agricultural Sciences, University of the Punjab, Lahore, Pakistan
[2]Assistant Agronomist, Maize and Millets Research Institute, Yousafwala, Sahiwal, Pakistan
[3]Assistant Agronomist, Agronomic Research Station, Farooq Abad, Pakistan

***Corresponding Author**
Name: Waheed Akram
Email: meher_waheed@yahoo.com

Abstract: Native and exotic tomato germplasm was screened for their performance against tomato leaf curl virus. Whole experiment was conducted in author's agriculture field under natural disease epidemic conditions. Fifteen tomato accessions along with five verities were used in this investigation. The effect of disease in percent plants infection was observed at different intervals. Reduction in performance of tomato plants under attack of this disease as also found out. None of the tomato entry was found to be 100 percent resistant against viral attack. But tomato accession "0017862" was found to be somewhat resistant as compared to other to tomato entries with minimum disease incidence when data was recorded at 60 day after transplantation. In the same way "Apple red" verity bearded maximum reduction in fruit bearing under attack of this viral disease, where minimum effect on fruit bearing was seen in accession "0017872" when comparison was made with healthy plants of same entry. Maximum reduction in fruit size was seen in diseased plants of entry "0017870" as compared to healthy plants of the same entry. Fruit size was least effected in entry "0017872" under the attack of tomato leaf curl virus.
Keywords: Tomato, Tomato Yellow Leaf Curl Virus, White Fly, Disease Index.

INTRODUCTION

Vegetables are a valuable source of minerals and vitamins. Huge area comes under tomato (*Solanumlycopersicon* L.) cultivation in the whole world as compared to any other vegetable crop [1]. Vegetable production in Pakistan has increased in the past decade due to growing demand [2]. Tomato is an important economical crop. This crop is routinely affected by biotic disorders. Fresh local tomatoes are one of the most popular items of vegetable markets. There are several biotic disorders affecting tomato growth and yield. These include disease caused by fungi, bacteria and viral pathogens. Among foliar diseases of tomato, Tomato leaf curl diease caused by Tomato yellow leaf curl virus (TYLCV) is a destructive and economical important diseases occurring throuthout tomato growing areas in the world [3, 4, 5, 6].

TYLCVbelong to Geminiviridae and has small geminate particles [5, 6, 7] . All plantings are affected by TYLCV, even those grown under protection (greenhouses and high tunnels) and in small home gardens. Tomato leaf curl disease in an important foliar disease of tomato effecting tomato fields throughout the world (AVRDC). It can severely infect tomato fields at all stages. The losses due to tomato leaf curl virus can reach up to 93.3% at early stages of the crop. The economic losses caused by this virus have made it of immense importance throughout the world. When symptoms have started developing in the fields, it is impossible to wipe awayits attack. This virus is vector transmitted. White fly is responsible for transmission of this virus in tomato plants [8, 9]. Around 7 million hectares of crop plants in 40 countries are subjected to begomovirus attack by TYLCV or by mixed infections in 15 of those countries [10].

Un-wise uses of insecticides to kill white fly have made this incest resistant [11]. Thus because of limited effectiveness of management strategies, use of resistant genotypes is most suited option. Because of evolution of new viral isolates that overcome the existing resistant germplasm, it is of prime importance to continue searching for new resistant verities. The potential benefits of viral resistant germplasm are great, because it is the most economical and environmentally safe strategy. The goals of this study were to screen tomato varieties and accession with resistance to tomato leaf curl virus for their susceptibility to naturally-occurring diseases and to evaluate its effects on yield and performance of different tomato genotypes under investigations.

MATERIALS AND METHODS

The replicated experiment was set up according to an experimental design with four randomized blocks with two rows of hundred plants per genotype per block. Experiment was conducted in the agriculture fields at district Kasur of Punjab Province. Total of 0.2 acre area was used for this experiment with sub plots made under main plots according to experimental layout. The individual plot size was 20 m^2 with two bed made per plot. One hundred plants were sown of each accession at distance PxP distance of 1.5 feet. All the experimental plots were of equalsize and geometry. All these accessions were seeded in the nursery and three weeks old seedlings were transplanted in the experimental plots in the Rabi season of 2011 and 2012. NPK 20:30:30 kg/ha was applied as basal dose during field preparation and additional dose of nitrogen 60 kg/ha was applied as top dressing in two equal splits at 25 and 50 days after transplanting. In addition, High yield, a micronutrient was applied as foliar application at 25days after transplanting. Irrigation was applied as and when necessary. Data regarding to yellow leaf curl virus was recorded on different days after transplantation. Percentage disease incidence was recorded for each accession.

The observations on days to flowering, days to first fruit harvest, number of clusters/plant, number of fruits/cluster, fruit set %, marketable fruit yield, non-marketable fruit yield and plant stand(survivability) at harvest were collected.Fruit characteristics were assessed of resistant verities and represented in table. Ripen tomato fruits were harvested to assess fruit characteristics. Difference in yield of diseased and healthy plants of same genotype was also observed to denote losses in the yield because of fungal attack.

RESULTS AND DISCUSSIONS

The incidence of tomato leaf curl virus on different genotypes was significantly different. Incidence of disease was increased on genotypes with the passage of time. At 60 days after transplantation, disease incidence was greater as compared to the 30 and 40 days after transplantation when data was recorded for incidence of viral attack (Table 1).Maximum disease incidence was recorded in case of genotype ‘0017866’ whereas least viral attack was observed on tomato genotype ‘006232’. No genotype was found totally resistant against viral attack (Table 1). In case of genotype ‘0017870’ no plant was found to be infected with viral attack at 30 DAP where as it showed a rapid incidence at 45 and 60 DAP (Table 1). All the verities were susceptible to viral attack. Like accession ‘0017873’ maximum disease incidence was observed on tomato verity ‘Rio Grande’(Table 1). Fifty nine percent plants were infected with virus at 60 DAP in this case. Whereas in case of variety ‘Valentine Red’, nearly half the plants were infected with virus (Table 1).

There was a pronounced difference in the yield losses when comparisons were made between healthy and diseased plants of the same genotypes (Table 2, 3). Not only reduction in the total fruit set was observed, but also weight of individual fruit was reduced in case of viral infected plants. The lowest yield reduction was observed in case of tomato accession ‘0017872’ (Table 3). Here only 06% yield reduction was observed in case of total number of fruit per plants. Tomato accessions ‘0017862’, ‘0017868’, ‘017856’, and ‘0017866’also performed batter (Table 3). These exhibited yield reduction of 12, 16, 17, 18 % respectively. In case of verities, minimum yield reduction of 08% was recorded in case of variety ‘Rio Grande’. So this was the best performing verity under viral attack (Table 3).

This nasty virus also disturbed the fruit size and a significant reduction in size of fruit was recorded (Table 3). Maximum reduction in fruit size was observed in case of genotype ‘017856’, whereas minimum reduction in size of fruit was recorded in case of genotype ‘0017858’(Table 3). In the same way only 6% reduction in fruit size was observed in ‘Rio Grande’and ‘Valentine Red’ verities. Valentine Red’ showed maximum reduction in fruit size under viral attack (Table 3).

Host genetic resistance is considered the most effective method for management of plant disease. The finding of this research work therefore represents the precarious conditions of tomato in Pakistan. None of the tomato germplasm was found to be completely resistant to tomato wilt virus. These results are also in accordance with the early researches which report the widespread occurrence of tomato leaf curl virus disease on agriculture fields throughout the vegetable growing areas of Pakistan.

Disease resistant genotypes are considered the most effective approach for management of diseases [12]. Resistant verities can be developed when sufficient genetic variation is available [13]. Nature has blessed plants with resistance genes. These are evolved to respond against numerous plant diseases by expressing themselves in specific ways. The incorporation of resistance genes in susceptible verities is now a common practice [14].Breeding for resistance in cultivated tomato varieties is the best approach to controlling viral disease [1, 15].

Some tomato verities have been developed that carry resistance genes from different plant sources in the world, but these are not suitable for cultivation because of some faults in their exploitations [16]. Developing resistant tomato verities by conventional breeding methods is a time consuming technique. Sometime genetic shift in pathogen populations makes previously resistant verity susceptible on [15, 17, 18]. Therefore we are needed to carry on a continuous search for resistant verities against pathogens.

Cultivation of any specific verity of a vegetable also takes into account consumers preferences. Rio Grande is a popular hybrid tomato verity in Pakistan because of its yield and fruit quality. All the verities used in this study are preferred by vegetable grower because of their yield and fruit quality. But this is also susceptible to viral attack.

Table 1: Incidences of leaf curl virus diseases on tomato genotypes under field conditions

Genotypes	Leaf curl virus incidence (%)		
	30 DAP	45 DAP	60 DAP
006231	21bc	28cd	35e-g
006232	13ef	15j	22k
006234	10fg	19hi	31hi
017856	18b-d	22fg	46cd
0017858	16cd	21fg	53bc
001860	23b	31bc	40ef
0017862	09fg	11k	19kl
0017863	17cd	24d-f	37fg
0017865	06h	19hi	33h
0017866	27a	30b-d	57ab
0017867	03i	05l	11m
0017868	15de	26de	41ef
0017870	00j	12jk	29ij
0017872	12 ef	20 f-h	50bc
0017873	20bc	33b	61a
Apple red	14d-f	29cd	49b-d
Blue moon	16cd	26de	57ab
Red samba	17cd	28 cd	59a
Rio Grand	11f	32bc	41e
Valentine red	24ab	39a	46cd

Table 2: Performance of tomato varieties on flowering days, first harvest days and fruit set under field conditions:

Genotypes	Days to flowering from transplanting	Days to first harvest from transplanting	Fruit set, %
006231	31 d-f	63 fg	87 bc
006232	29 ef	67 c-e	81 e-g
006234	34 de	75 b	73 jk
017856	39 ab	69 cd	92 ab
0017858	36 cd	57 ij	84 de
001860	42 a	79 a	77 h-j
0017862	35 c-e	64 f	91 ab
0017863	26 e-g	63 fg	84 de
0017865	33 de	69 cd	79 gh
0017866	37 bc	71 bc	84 de
0017867	28 fg	60 g-i	89 a-c
0017868	36 cd	79 a	83 d-f
0017870	24 gh	62 g	88 bc
0017872	41 a	69 cd	73 jk
0017873	36 cd	75 b	86 b-d
Apple red	37 b-d	59 hi	72 j-l
Blue Moon	43 a	63 e-g	76 ij
Red Samba	29 ef	61 gh	94 a
Rio Grand	37 bc	67 c-e	87 bc
Valentine Red	36 c	57 ij	79 gh

Table 3: Effect of leaf curl disease on performance of tomato

Genotypes	No of fruits per plant			Weight of individual fruit		
	Healthy	Diseased	% Loss	Healthy	Diseased	% Loss
006231	13.68	10.50	23.2 ef	36.01	34.19	05.63 ij
006232	11.29	08.30	26.48 de	53.76	41.07	03.77 i-k
006234	17.56	11.45	34.79 b-d	67.39	58.52	13.43 ef
017856	23.62	19.51	17.40 gh	43.40	29.81	32.55 b
0017858	26.98	15.42	42.84 b	37.19	36.52	02.71 kl
001860	15.57	11.72	24.72 ef	56.05	41.21	26.78 bc
0017862	11.03	10.89	12.69 hi	108.44	96.71	11.13 e-g
0017863	29.46	19.39	34.18 b-d	67.73	49.60	17.93 cd
0017865	21.65	14.56	32.74 bc	73.09	51.57	30.13 b
0017866	16.80	13.65	18.53 f-h	98.22	82.97	16.32 c-e
0017867	31.49	22.70	27.91 c-e	61.18	55.48	09.83 fg
0017868	25.09	20.96	16.46 h	56.34	51.32	08.92 gh
0017870	19.82	10.67	45.73 ab	39.27	17.28	56.41 a
0017872	27.20	25.44	06.38 jk	72.55	70.87	02.71 kl
0017873	13.66	09.76	28.50 cd	41.49	34.73	17.07 cd
Apple red	24.97	11.59	53.58 a	49.40	41.65	16.32 c-e
Blue Moon	21.48	15.03	30.27 b-d	86.72	73.03	15.11 de
Red Samba	30.05	28.35	08.10 j	47.96	44.80	06.38 ij
Rio Grand	26.91	20.07	25.41 d-f	58.22	43.19	25.86 b-d
Valentine Red	22.36	17.75	20.61 fg	63.38	57.28	09.53g

Table 4.Characteristics of late blight resistant varieties compared to Mt Fresh from evaluations done by Vegetable Program staff

Accessions	Fruit Color	Fruit Shape	Fruit size	External Defects	Smell	Firmness
006231	Red	Plum	Small	No	Yes	Soft
006232	Red	Round	Medium	No	No	Firm
006234	Scarlet red	Round	Medium	No	No	Firm
017856	Bright red	Plum	Small	No	Yes	Firm
0017858	Greenish red	Round	Medium	No	No	Firm
001860	Red	Plum	Medium	No	No	Firm
0017862	Red	Round	Big	N	No	Soft
0017863	Pinkish red	Plum	Medium	Cracks	No	Firm
0017865	Bright red	Round	Medium	No	Yes	Firm
0017866	Red	Plum	Big	Cracks	Yes	Firm
0017867	Pale red	Round	Medium	No	No	Firm
0017868	Bright red	Plum	Small	No	No	Firm
0017870	Dull red	Round	Small	No	No	Soft
0017872	Red	Round	Medium	No	No	Firm
0017873	Bright red	Plum	Small	No	No	Soft
Apple red	Pale red	Round	Small	No	Yes	Firm
Blue Moon	Red	Round	Big	Cracks	No	Firm
Red Samba	Red	Plum	Small	No	No	Soft
Rio Grand	Red	Plum	Medium	No	No	Soft
Valentine Red	Bright red	Round	Big	No	yes	Firm

CONCLUSION

Tomato production in Pakistan is greatly affected by biotic factors. This field study indicated that no tomato germplasm was resistant against tomato leaf curl virus. But accessions as and verity is somewhat resistant against this tomato leaf curl virus. Accessions and verities such as can tolerate this viral attack by showing minimum losses in fruit number and size. Development and introduction of tomato germplasm

either resistant or tolerant to tomato leaf curl virus is highly necessary.

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