Screening and Evaluation of Tomato (*Solanum lycopersicum*L.) Genotypes for Tolerance to Tomato Yellow Leaf Curl Virus (TYLCV) Disease under Field Condition

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Abstract

Tomato yellow leaf curl virus (TYLCV) disease is transmitted by the whitefly (*Bemisia tabaci)* is one of the most serious diseases of tomato in the Sudan.The disease incidence can reach 100% resulting in total loss of the yield. Thirty tomato genotypes from different sources were tested for tolerance to this disease and evaluated for some plant and yield traits included plant height, number of primary branches, days to 50%flowering, number of flowers per inflorescence, number of fruits per cluster, fruit set, fruit weight, fruit shape and fruit firmness. The experiments were conducted during three seasons included summer (2006), winter (2006/2007) and summer (2007) at El Hudeiba Research Station, Agricultural research Corporation - Sudan. Two breeding lines named Multichiltylc-95-Jo-C2 and Pimpertylc-J-13 were selected as tolerant to TYLCV disease during winter and summer seasons whereas the other lines were found tolerant to this disease during the winter season and susceptible in the summer. Although, Multichiltylc-95-Jo-C2 and Pimpertylc-J-13 showed tolerant to the disease they did not set any fruit during the summer season.

Key words: tomato, TYLCV, screening, tolerant, summer, winter

Introduction

Several fungal, bacterial and viral diseases have directly hampered the cultivation of tomato in eastern and southern Africa (AVRDC report, 1995).The most serious disease of tomato throughout the Mediterranean region, the Middle-East and tropical region of Africa and Asia is tomato yellow leaf curl virus (TYLCV) that is caused by a geminivirus transmitted by the whitefly, *Bemisia tabaci* (Kasrawi, 1991). Yassin (1975) reported that TYLCV was endemic throughout the Sudan with epidemic often reaching 100% and disease incidence was greater during the summer and autumn seasons than during winter. The genetic approach of breeding tomato resistant to TYLCV is the long term solution to the problem. The first stage in breeding for TYLCV resistance is to screen *Solanum*accessions for resistance to TYLCV (Kasrawi, 1988). In view of that the present study aimed at screening *Solanum lycopersicum* genotypes for tolerance to TYLCV disease under winter and summer field conditions to identify sources of resistance to this disease.

Materials and Methods

Genotypes used in this study included 29 breeding lines received from different sources and one cultivar susceptible to TYLCV disease as check (table1).The experiment was conducted at El Hudeiba Research Station, Agricultural Research Corporation – Sudan.The genotypes were grown in a Randomized Complete Block Design (RCBD) with three replications. Plot size was 5 x 3.6 meters with spacing of 0.5 meter between plants and 20 individual plants per plot. The experiments were conducted in three different seasons. The first experiment was conducted in summer season (February - June, 2006). Second experiment was conducted in winter season (November 2006 - March 2007). Third experiment was conducted in summer season (June - October, 2007). Plants were grown in infected field naturally infested by *B. tabaci*. Individual plants were inspected for TYLCV disease symptoms every week in the three experiments. At the end of the experiments disease severity and incidence

were recorded.TYLCV disease severity was scored on a 1-3 scale as described by Kasrawi (1989) as follows

1 = no observed symptom (resistant).

2 =mild symptoms which are not affecting or slightly affecting the plant growth habit (tolerant).

3 = severe symptoms include leaf size reduction, leaf curling, between veins yellowing and plant stunting (susceptible).

TYLCVdisease incidence was computed using the formula developed by James (1983):

TYLCV disease incidence =(Number of diseased plants / Total number of plants) x 100%.

Many phenotypic characteristics of plant such as plant height, number of primary branches, days to 50%flowering, number of flowers per inflorescence, fruit and yield traits including number of fruits per cluster, fruit set, fruit weight, fruit shape and fruit firmness were evaluated. Data were subjected to analysis of variance by using MSTAT version 9 software.

Table 1: Genotypes Screened for tolerance to tomato yellow leaf curl virus disease during summer and winter seasons (2006 -2008)

Genotype	Origin
LO 0181	AVRDC
LO 3982	AVRDC
LO 3693	AVRDC
LO 3690	AVRDC
LO 3969	AVRDC
LO 4361	AVRDC
LO 0232	AVRDC
LO 2991	AVRDC
LO 0142	AVRDC
LO 3570	AVRDC
LO 0180	AVRDC
LO 3716	AVRDC
LO 2909	AVRDC
LO 0099	AVRDC
LO 1076	AVRDC
LO 0226	AVRDC
Multichiltylc-95-Jo-C2	INRA
Pimpertylc-J-13	INRA
Chiltylc-94-6-c1	INRA
Chiltylc-94-3-B-51L	INRA
Tyking-3-2	INRA
Tyking-3-3	INRA
Destina-10-1	INRA
Destina-10-2	INRA
HSD 4420	ARC
HSD 5031	ARC
HSD 5034	ARC
HSD 4422	ARC
HSD 4423	ARC
Peto 86 P.S.	Seed Shop

Key: AVRDC= Asian Vegetable Research and Development Center at Taiwan
INRA=National Institute for Agricultural Research at France.
NIPHE= National Institute for Promotion of Horticultural Exports at University of Gezira, Sudan.
ARC=Agricultural Research Corporation - Sudan.

Results and Discussion

Results of the first experiment showed that TYLCV disease incidence was 100% in all genotypes and the disease severity was rated 3 (susceptible) for all genotypes except two lines named Multichiltylc-95-J0-C2 and Pimpertylc-J-13 which were rated as tolerant to TYLCV (Table2). These results indicated that none of the27genotypeswere tolerant to TYLCV disease under summer conditions. This may be due to the fact that TYLCV disease incidence was higher during the hot months of the year than the cooler ones, and high temperatures prevailed during that summer season which ranged between 33.4^0 and 38.2^0C might increase vulnerability of those lines to the virus attack. Infection of the genotypes received from AVRDC as tolerant to this disease also might be due to the fact that TYLCV disease from South and East Asia (Thailand and China) was determined as a geminivirus with a bipartite genome (Czosnek and Laterrot, 1997). In other words those breeding lines were originally bred for tolerance to TYLCV – Thailand strain which is different from the one that prevails in the tropics, which is TYLCV with a monopartite genome (Navas-Castillo *et al.,* 1999).These results were supported by the results of Azizi (2008) which showed that many tomato accessions which were reported in earlier studies as tolerant to TYLCV at AVRDC were found susceptible in Iran.

In the second experiment when maximum temperature ranged between 33.6°C and 35.7°C, all genotypes received from INRA, NIPHE, AVRDC showed no TYLCV symptoms and only mild symptoms appeared on the genotypes from ARC and the checkcultivars (Table 3).The results indicated that screening for resistance to TYLCV during the winter season under field condition only may be misleading, because the check cultivars were already known to be highly susceptible to TYLCV disease but they did not show any symptoms. On the other hand, the genotypes showed significant differences among different tested plant and fruit traits (Table 4).

In the third experiment when maximum temperatures ranged between 40°C and 42°C, the incidence of TYLCV among all genotypes was 100% and the disease severity was rated 3 (susceptible)except for the twolines Multichiltylc-95-Jo-C2 and Pimpertylc-J-13 which showed only mild symptoms i.e. tolerant(Table 5). The plant height, number of branches in the main stem and the number of flowers perinflorescence were highly reduced compared to those in the winter season, whereas the fruit set was almost nil (Table6). Results showed that all genotypes, except Multichiltylc-95-Jo-C2 and Pimpertylc-J-13were susceptible to TYLCV disease during summer season and this indicated thatsummerhigh temperatures resulted in increasing vulnerability of tomato plants to the virus attack and adversely affects the vegetative growth and reproductive processesand ultimately inhibits fruit set. These results agreed with the results of AbdElbaki(1991).In the summer season Multichiltylc-95-Jo-C2 showed mild symptoms, but its plant vigor was reduced and few flowers were produced and abscised resulted in no fruit set. The selection of this line as tolerant to TYLCV disease agreed with the findings of Giordano *et al*(1995) who tested several accessions of *Solanum* for resistance to TYLCV in Brazil and found that Multichiltylc-95-Jo-C2 was one of the resistant genotypes. On the other hand, Pimpertylc-J-13 showed only mild symptoms, but its plant vigor was reduced compared to the winter season and few flowers were produced and abscised resulted in no fruit set. The selection of this line as tolerant to TYLCV agreed with the findings ofLaterrot and Moretti (1996) which showed that the population with introgressions from *S. pimpinellifolium* and *S. peruvianum* known as Pimpertylc-J-13 was the most tolerant to TYLCV among three populations tested in Jordan.

Results suggested that tolerance to TYLCV is independent of tolerance to high temperatures stress. Moreover, these results are in agreement with those of Vidavski

(2008) who reported that in the most resistant hybrid between the lines 72-PER from *S. peruvianum* and the line HAB from *S. habroch*aites, the decreaseof yield was 45%, although the plants were almost symptomless.

Conclusion

Regarding the tested genotypes, the introgression lines Multichiltylc-95-Jo-C2 and Pimpertylc-J-13 are the most reliable sources of tolerance to TYLCV during winter and summer conditions in the Sudan.

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Table 2: Tomato yellow leaf curl virus(TYLCV) disease incidence and severity on tomato genotypes evaluated during the summer season (February- June 2006)

Genotype	TYLCV incidence %	TYLCV severity rating
LO 0181	100	3
LO 3982	100	3
LO 3693	100	3
LO 3690	100	3
LO 3969	100	3
LO 4361	100	3
LO 0232	100	3
LO 2991	100	3
LO 0142	100	3
LO 3570	100	3
LO 0180	100	3
LO 3716	100	3
LO 2909	100	3
LO 0099	100	3
LO 1076	100	3
LO 0226	100	3
Multichiltylc-95-Jo-C2	100	2
Pimpertylc-J-13	100	2
Chiltylc-94-6-c1	100	3
Chiltylc-94-3-B-51L	100	3
Tyking-3-2	100	3
Tyking-3-3	100	3
Destina-10-1	100	3
Destina-10-2	100	3
HSD 4420	100	3
HSD 5031	100	3
HSD 5034	100	3
HSD 4422	100	3
HSD 4423	100	3
Peto 86 P.S.	100	3

Key: 3= Susceptible, 2 = Tolerant

Table3:Tomato yellow leaf curl virus (TYLCV) disease incidence and severity on tomato genotypes evaluated during the winter season (November 2006-March 2007)

Genotype	TYLCV incidence %	TYLCV severity rating
LO 0181	0	1
LO 3982	0	1
LO 3693	0	1
LO 3690	0	1
LO 3969	0	1
LO 4361	0	1
LO 0232	0	1
LO 2991	0	1
LO 0142	0	1
LO 3570	0	1
LO 0180	0	1
LO 3716	0	1
LO 2909	0	1
LO 0099	0	1
LO 1076	0	1
LO 0226	0	1
Multichiltylc-95-Jo-C2	0	1
Pimpertylc-J-13	0	1
Chiltylc-94-6-c1	0	1
Chiltylc-94-3-B-51L	0	1
Tyking-3-2	0	1
Tyking-3-3	0	1

Destina-10-1	0	1
Destina-10-2	0	1
HSD 4420	100	2
HSD 5031	100	2
HSD 5034	100	2
HSD 4422	100	2
HSD 4423	100	2
Peto 86 P.S.	100	2

Key: 2 = Tolerant, 1 = Resistant

Table 4: Evaluation of phenotypic characteristics of plant, fruit and yield traits of tomato Genotypes screened for tolerance to tomato yellow leaf curl virus (TYLCV) disease during The Winter season (November 2006-March 2007)

Genotype	Mean fruit yield /plant (kg)	fruit wt. (g)	Mean plant height (cm)	Mean no. of primary branches	Mean no. of flowers/ inflorescenc	Days to 50% of plants flowering	No. of fruits /cluster	Fruit shape
LO 0181	0.42	4.1	168.3	14	6	57	5	Round
LO 3982	1.0	7.3	151.6	15	7	55	6	Round
LO 3693	0.95	16	143.6	13	8	55	6	Round
LO 3690	1.1	3.2	131.3	16	7	57	6	Round
LO 3969	0.93	6.1	48	9	6	57	5	Round
LO 4361	1.2	8.1	68.6	7	7	56	7	Round
LO 0232	1.2	4.2	99.6	7	6	55	5	Round
LO 2991	0.98	6.3	112.3	8	6	56	5	Round
LO 0142	1.3	5.5	123.5	8	7	56	5	Round
LO 3570	1.2	9.2	134.4	8	6	55	5	Round
LO 0180	0.99	6.6	113.8	7	6	55	5	Round
LO 3716	1.1	10	156.2	12	7	56	6	Round
LO 2909	1.2	3.3	134.6	14	8	55	6	Round
LO 0099	0.94	7.4	112.7	12	6	56	5	Round
LO 1076	1.2	8.2	167.4	15	6	58	5	Round
LO 0226	1.1	9.4	156.3	15	7	55	5	Round
Multichiltylc-95-J0-C2	2.3	89	62.6	6	5	50	4	Round
Pimpertylc-J-13	1.3	70	143.3	11	5	55	4	Round
Chiltylc-94-6-c1	1.4	82.5	80	15	5	58	4	Round
Chiltylc-94-3-B-51L	2.8	93.3	110	11	5	57	4	Round
Tyking-3-2	1.5	66	72.6	10	5	57	7	Heart
Tyking-3-3	1.2	60.3	63	10	5	59	6	Round
Destina-10-1	1.3	115	75	10	6	58	5	Oval
Destina-10-2	1.8	117	80	10	5	52	5	Oval
HSD 4420	1.54	114.3	78.6	8	6	55	5	Round
HSD 5031	1.6	122.3	123	10	5	52	4	Round
HSD 5034	1.6	120.3	140.3	10	5	45	4	Round
HSD 4422	1.5	133.3	150.3	10	5	57	4	Round
HSD 4423	1.6	126.3	120.3	10	5	56	4	Round
Peto 86 P.S.	1.5	108.3	72	7	6	55	5	Oval
SE±	**0.27**	**6.70**	**3.56**	**0.77**	**0.35**	**1.16**	**0.33**	
CV%	**29.80**	**13.50**	**5.70**	**3.20**	**10.55**	**3.70**	**12.40**	
Significance level	**	**	**	**	**	**	**	

Table 5: Tomato yellow leaf curl virus (TYLCV) disease incidence and severity on tomato genotypes evaluated during the summer season (June- October 2007)

Genotype	TYLCV incidence %	TYLCV severity rating
LO 0181	100	3
LO 3982	100	3
LO 3693	100	3
LO 3690	100	3
LO 3969	100	3
LO 4361	100	3
LO 0232	100	3
LO 2991	100	3
LO 0142	100	3
LO 3570	100	3
LO 0180	100	3
LO 3716	100	3
LO 2909	100	3
LO 0099	100	3
LO 1076	100	3
LO 0226	100	3
Multichiltylc-95-Jo-C2	100	2
Pimpertylc-J-13	100	2
Chiltylc-94-6-c1	100	3
Chiltylc-94-3-B-51L	100	3
Tyking-3-2	100	3
Tyking-3-3	100	3
Destina-10-1	100	3
Destina-10-2	100	3
HSD 4420	100	3
HSD 5031	100	3
HSD 5034	100	3
HSD 4422	100	3
HSD 4423	100	3
Peto 86 P.S.	100	3

Key: 3 = Susceptible, 2 = Tolerant

Table 6: Evaluation of phenotypic characteristics of plant, fruit and yield traits of genotypes screened for resistance to tomato yellow leaf curl virus (TYLCV) disease during the summer season(June-October 2007)

Genotype	Mean No. of Fruits/plant	Mean plant height(cm)	Mean No. of branches/plant	Mean No. of flowers/cluster
LO 0181	0	16	14	0
LO 3982	0	15	15	0
LO 3693	0	40	13	0
LO 3690	0	14	16	0
LO 3969	0	15	9	0
LO 4361	0	25	7	0
LO 0232	0	30	13	0
LO 2991	0	14	16	0
LO 0142	0	15	9	0
LO 3570	0	35	7	0
LO 0180	0	28	10	0
LO 3716	0	37	10	0
LO 2909	0	37	11	0

LO 0099	0	32	10	0
LO 1076	0	29	10	0
LO 0226	0	57	7	0
Multichiltylc-95-J0-C2	0	36	6	6
Pimpertylc-J-13	0	41	11	5
Chiltylc-94-6-c1	2	35	15	6
Chiltylc-94-3-B-51L	0	60	11	4
Tyking-3-2	0	38	10	2
Tyking-3-3	0	37	10	2
Destina-10-1	0	40	10	4
Destina-10-2	0	25	10	1
HSD 4420	0	32	8	0
HSD 5031	0	34	10	0
HSD 5034	0	27	10	0
HSD 4422	0	32	10	0
HSD 4423	0	31	10	0
Peto 86 P.S.	0	23	7	0
SE±		**0.46**	**0.34**	
CV%		**2.5**	**5.7**	
Significance level		**	**	