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EVALUATION OF RESISTANCE FOR TOMATO YELLOW LEAF CURLVIRUS IN SOME TOMATO HYBRID CULTIVARS

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ABSTRACT

Widely distributed epidemics of tomato yellow leaf curl virus (TYLCV), in tomatoes (*Lycopersicon esculentum* Mill.), were recorded in different parts of the world. The disease is transmitted by the whitefly *Bemisia tabaci* Genn. from and to susceptible tomato cultivars, and causes serious yield losses.

This study aimed to develop alternative management practices to prevent annual damage from the disease through research on genetic control.

Two field experiments (1994/95,1995/96) were carried out in Hamranyia Agriculture Research Station (UAE) to evaluate resistance for TYLCV. Twelve hybrid tomato cultivars were tested and compared with two control treatments of the highly susceptible cultivar (ACE 55). One control treatment was covered with non-woven Agric. Fleece as mechanical control. Results indicated that the highest resistance was obtained with the mechanical resistant treatment, followed by the highly resistant cultivars tested E445, DRW 8001, Saria, DRW 8006, DRW 8003, W 322 F1, DRW 8009, and DRW 8005. The moderately resistant group included E446 and DRW 004, and the lowest resistant cultivars were 146-92 and Antares. The weight of marketable fruits was strongly related to resistance for TYLCV of evaluated cultivars.

Key words: *hybrid cultivars, resistance, tomato, tomato yellow leaf curl virus.*

1.INTRODUCTION

Tomato *(Lycopersicon esculentum Mill.)* yellow leaf curl virus (TYLCV) is a limiting factor for successful tomato production. The recent geographical distribution indicated that the disease spreads in many countries in Africa, Asia and Australia. The disease is one of the serious viral diseases in tomato fields, it can be easily transmitted and is spread primarily by a (biological) vector, an insect; sweet potato or tobacco whitefly *Bemisia tabaci* Genn. [Aleyrodidae, Hamoptera], (Gerling 1990).

Widely spread epidemics of tomato yellow leaf curl virus in the field and greenhouse tomatoes occur in most areas growing in U.A.E.tomatoes. The disease incidence ranged from 1 to 100% in open field and fresh market fruit production houses. Tomato is the first crop in open field and the main crop in plastic houses in U.A.E. The cultivated area reaches about 88631.0 Donum, and the total yield is estimated at 744531 tons (Annual Statistical Bulletin for year 1997 M.A.&F.).

Regional reports (Pilowsky and Cohen, 1974;EL-Hamady *et al.*, 1976; Abu Gharbiah *et al.*, 1978; Hassan *et al.*, 1982, 1984., and Kasrawi *et al.*, 1988) and in India (Nariani and Vasudeva, 1963) indicated that the disease results from a lack of resistance to the virus in commercial tomato cultivars, and causes severe losses in production. Varma and Poonam, (1980), reported about resistance, (slight susceptibility) in tomato line EC 104395 in India. Also tolerance to TYLCV was reported in *L.piminellifolium* accession LA 121, which is susceptible to virus infection by insect vector supporting virus multiplication, but shows very slight symptoms or none (Pilowsky and Cohen, 1974; Makkouk 1978; Hassan *et al.*, 1982; Mazyad *et al.*, 1982; and Kasrawi *et al.*, 1988).

Good tolerance of different *L.pimpinellifolium* accessions (LA 121, LA 1582, and selection of LA 1478 and Hirsute_INRA) was reported to be controlled by dominant (Geneif, 1984; Yassin, 1987; Kasrawi, 1989) gene in some new hybrid cultivars, as genetic control for TYLCV disease. Under field conditions of H.A.R.S. on the other hand, development of a sustainable approach to TYLCV management, through screening for tomato host plant resistance, is needed. The present study is concerned with twelve tested hybrid cultivars of tomato.

2. MATERIALS AND METHODS

Symptomatological studies were performed with tomato (*Lycopersicon esculentum* Mill.) leaf curl virus (TYLCV) disease.The experiments were carried out on the research plots of the field of Hamranyia Agriculture Researchs Station (H.A.R.S.), at Ras Al Khaima Emirate, U.A.E. The research within two successive seasons 1994/95, 95/96 (October to May) included twelve tomato hybrid cultivars and two control treatments (Table1), through a simple lattice design, with three replications. The plot (replicate) size was $20m^2$ ($10\times 2m$) with 1.5m between rows. Plots were covered with mulch, (black polyethylene sheets) 10×2m. Twenty-control holes corresponding to water dripper of irrigation lines, were applied for each plot.

2.1.Planting

Seedlings of tomato cultivars tested, free from TYLCV were grown as described by Al-Musa(1982) and transplanted on November 15, 1994 and November 13, 1995.Seedlings were spaced at 50cm in mulch holes.

2.2.Treatments

The experiments contained fourteen treatments, twelve hybrid cultivars tested and two control of highly susceptible cultivar "ACE 55".Three replicates of each treatment were used .Each replicate included 20 growing seedlings. Irrigation rates and fertilizers were applied as recommended for tomato. Replicates of control(2) were covered by agricultural sheets (non-woven Agric. fleece) [Agril 17].

2.3. TYLCV Evaluation

Incidence of TYLCV in infected plants was determined visually, at 2 weeks intervals, starting 30 days after transplanting. The number of infected plants in proportion to the total number of plants in each replicate was counted. Severity incidence of TYLCV in each plant was recorded, and the disease severity rate (D.S.R) for each replicate was calculated according to the following formula (Chastanger and Ogawa, 1979).

$$D.S.R = \frac{S \times I}{N}$$,where

S = Average of severity infection. I = Infected plant number.
N = Replicated plant number.

The severity of symptoms were classified on a 6 point rating scale, representing a TYLCV incidence. In the same time,(+) evaluating according to Morales, *et al.*, (1990) was measured in corresponding to the rating scale, both infection determinations are shown in Table (2), under the TYLCV disease severity index.

Table (1): Hybrid cultivars of tomato evaluated for TYLCV resistance during 1994/95 & 95/96.

No.	Treatments "Cultivars"	Company	Remarks
1	DRE 8001	Deruter	
2	DRE 8003	//	
3	DRW 8004	//	
4	DRW 8005	//	
5	DRW 8006	//	
6	DRW 8009	//	
7	W 3221. F1	//	
8	14 6-92	Sluis & Groot	
9	E445	Sandos seed	
10	E446	//	
11	Saria	Peto seed	
12	Antares	Dachen feldt	
13	Ace 55	Asgrow	Control (1)
14	Ace 55	Asgrow	Control (2) covered

(1): Ace 55. highly susceptibile cultivar, used as a control.

(2):Ace 55. This treatment is a blank or control, and planted under"Agril 17".

Table (2): The reaction classification used as severity index [(+) evaluation and rating scale] of TYLCV symptoms, developed in tested tomato hybrid cultivars.

Reaction class	*Severity index*	
	(+) Evaluation	***Rating scale***
No infection	—	0
Resistant	–	0 – 1
Modrately resistant	+	1 – 2
Modrately susceptible	+ +	2 – 3
Susceptible	+ + +	3 – 4
Highly susceptible	+ + + +	4 – 5

3.RESULTS

Evaluation of tested tomato hybrid cultivars, for TYLCV depended on morphological characteristic of viruliferous foliage symptoms of natural infection in the field. Typical symptoms of TYLCV disease of natural infection were obtained at 35 days old of susceptible cultivars under H.A.R.S. during two successive seasons,1994/95 and 95/96.

3.1. Symptoms

Tomato leaf curl virus, caused a range of symptoms that include five stages, described as follows under domestic condition of U.A.E., during winter and spring. It was noticed that the symptoms increased gradually in occurrence and severity during these five stages, within the vegetative growth.

3.1.1. Leaf yellowing: The earliest symptoms to observe was marginal leaf yellowing of the newest leaves (more than two or three leaves).

3.1.2. Leaf curl (upward): Leaf curl was expressed first at the top of the plant , sometimes leaves with mild cupping.

3.1.3. Leaflet size reduction: These are the more dramatic symptoms, when the reduction of leaf size is distinguished, and increased during the period of active vegetative growth. This is the beginning of symptoms due to plant age.

3.1.4. Stem and branch stunting: The plant vigor in this stage starts to breakdown, when viral infection causes stem and branch stunting. The plant foliage appear smallers in comparison with healthy ones.

3.1.5.Flower drop: This is the last stage when disease causes prolonged flower abortion, and fruit setting. Therefore, this symptom is more indicative of TYLCV disease.

As strategic observations were recorded during the two evaluated seasons; that, not all the above symptoms exist at the same time on the infected hybrid plants, except those of control "uncovered treatment",when almost all symptoms, especially, leaf cupping, reduction in leaf size,stunting and flower drop could be observed.

Table (3):Severity index (D.S.R.) of TYLCV disease incidence in different treatments "cultivars", within two growing seasons of (1994/95) and (95/96) at H.A.R.S.

Treat No.	Treatments "Cultivars"	D.S.R.[(a)]		Average of D.S.R.	Remark
		94 / 94*	95 / 96*		
1	DRW 8001	1.56	0.52	1.04	
2	DRW 8003	1.66	0.71	1.18	
3	DRW 8004	3.03	1.24	2.13	
4	DRW 8005	3.00	0.24	1.62	
5	DRW 8006	1.46	0.82	1.14	
6	DRW 8009	1.97	0.65	1.31	
7	W 3221 F.1	1.60	0.93	1.26	
8	146 –92	4.09	1.97	3.03	
9	E 445	1.15	0.16	0.65	
10	E 446	2.75	1.66	2.20	
11	Saria	1.32	0.83	1.07	
12	Antares	4.71	2.53	3.62	
13	Ace 55	5.00	4.70	4.85	Control (1)
14	Ace 55	0.00	0.00	0.00	Covered control (2)
	L.S.D. at 5%			1.46	

(a). According to a 0-5 rating scale. *. Average of D.S.R. of three replicates.

'able (4): Descending arrangement of incidence of tomato yellow leaf curl virus on different cultivars tested from severity index at H.A.R.S. during 1994/95 and 95/96 growing seasons.

Treat No.	Cultivars	Severity Index		Descending arrangement	Remark
		Average of D.S.R.	(+) Evaluation		
1	Ace 55	0.00	—	—	Control (2)
2	E 445	0.65	—	1	
3	DRW 8001	1.04	+	2	
4	Saria	1.07	+	3	
5	DRW 8006	1.14	+	4	
6	DRW 8003	1.18	+	5	
7	W 3224 F.1	1.26	+	6	
8	DRW 8009	1.31	+	7	
9	DRW 8005	1.62	+	8	
10	E 446	2.20	++	9	
11	DRW 8004	2.63	++	10	
12	146-92	3.03	+++	11	
13	Antares	3.62	+++	12	
14	Ace 55	5.00	++++	—	Control (1)

Values of TYLCV resistance, as disease severity rate (D.S.R.), for twelve tomato hybrid cultivars, are presented in Table3. Values of D.S.R. and (+) evaluation category, as severity index were arranged descendingly for the same cultivars, as illustrated in Table (4).
It is clear from D.S.R. data, that large differences in viral infection levels were present among the cultivars studied, in the two growing experimental years 1994/95 and 1995/96. Table(3)shows that the second year showed rather poor seasonal infection as compared with first year.

The statistical analysis revealed positive significant differences among the resistance cultivars for TYLCV, also between these cultivars and both treatments of control(1) and control (2). Control treatments were highly susceptible cultivar (ACE 55) where as studied cultivars have resistance against TYLCV.

Furthermore, none of the cultivars tested have the same resistance level of the mechanical protected covered treatment of control (2), which was significantly the highest treatment with control (1), then no viral symptoms of TYLCV was recorded.

On the other hand, Table(3) shows that the maximum resistance was obtained with E445 cultivar. Data indicated that the resistant score as D.S.R. ranged between 0-1 (-) highly significant differences for both seasons. The estimates was 1.15 (1994/95) and 0.16 (1995/96) with 0.65 as average in comparing with control (1), which was 5.00 (94/95) and 4.70 (95/96) with 4.85 as average, while L.S.D. value was 1.46 at 5%, respectively.

Moreover , results in Tables(3) and(4), indicate that the cultivars can be classified into three classes, based on the severity index recorded.

3.2. Cultivar classification

3.2.1. First class

This class includes the cultivars that have an average resistance score as D.S.R. ranging between 1-2 (+), showing the highly resistance and higher significant differences achieved in the class cultivars data, as compared with control (1). The best one having the largest resistance of the eight cultivars placed in this class during the two seasons was, DRW 8001, with an average 1.04, followed by SARIA, 1.07; DRW 8006, 1.14; DRW 8003, 1.18; W 3224 F.1, 1.26; DRW 8009, 1.31 and DRW 8005, 1.62. when compared with control (1).

3.2.2. Second class

Cultivars associated with the second class, contains only the two moderately resistant treatments.The average D.S.R. ranged between 2-3(++).Relatively high significant difference was noticed with the two cultivars,E 446,2.20 and DRW 8004, 2.63 as compared with control (1).

3.2.3. Third class

The lowest resistant cultivars in this class, where their D.S.R. average, ranged between 3-4 (+++) more susceptible, two cultivars take place as the last resistant treatment. It is the least different compared with control(1). The cultivars of this class are 146-92, 3.03 and Antares, 3.62.

Table (5): Average weight (Kg) of marketable tomato fruits per plant, produced from different TYLCV resistant cultivars, during two seasons (1994/95 & 95/96) at H.A.R.S.

Treat No.	Cultivars	Average weight of marketable fruits, Kg/plant		Average K.g. per/plant	Remarks
		94 / 95*	95 / 96*		
1	DRW 8001	2.91	9.13	6.02	
2	DRW 8003	3.47	8.08	5.77	
3	DRW 8004	5.57	10.78	8.17	
4	DRW 8005	3.36	9.28	6.32	
5	DRW 8006	2.93	11.88	7.39	
6	DRW 8009	4.04	9.04	6.54	
7	W 3224 F.1	2.56	8.53	5.54	
8	146-92	2.45	10.40	6.37	
9	E 445	2.72	10.43	6.57	
10	E 446	1.74	8.68	5.21	
11	Saria	2.23	8.02	5.12	
12	Antares	1.24	2.41	1.82	
13	ACE55 (control1)	0.05	1.89	0.97	
14	ACE55 (control2)	5.09	13.09	9.09	Covered

* Average yield Kg. Obtained from three replicates, each includes 20 plants. (60 plants).

Data of tomato marketable fruit yields (Kg. per plant) and their average for the two successive seasons of the studied tomato hybrid cultivars, as compared with ACE55 cultivar used in both control treatments are summarized in Table(5). Tables (3) and (5) show the relationship between cultivars against TYLCV disease and the fruit yield throughout two successive growing seasons.

Generally, there are relatively positive correlations between the tolerance traits and fruit weight per plant in the cultivars tested except DRW 8004 and 146-92.

The highest yielding treatment was the protected covered control (2), as the average weight of tomato fruits per plant, within the two seasons was 9.09Kg, followed by DRW 8004 (8.17Kg.), DRW 8006 (7.39Kg.), E 445 (6.57Kg.), DRW 8009 (6.54Kg.), 146-92 (6.37Kg.)and DRW 8001 (6.02Kg.).

The cultivars with an average yield of less than 6.0Kg were DRW 8003 (5.77Kg.), W 3224F.1, (5.54Kg.), E446 (5.21Kg.) and Saria, (5.12Kg.), whilst the lowest average yield was probably placed with only the cultivar Antares, (1.82Kg.) as compared with control (1) (0.97Kg.), as shown in Table (5).

4. DISCUSSION

Under the conditions of Hamranyia Agriculture Research Station (H.A.R.S.), planting twelve hybrid tomato cultivars, under the same environment, demonstrated variability in the tolerance trait of TYLCV disease.

Meteorological data for the test site are presented in Table (6). The high resistance of a genetic nature in the hybrid tomato cultivars in the second season (1995/96), was more than in the first (1994/95), This may be due to the environmental stress on the activity of the insect vector, caused by the low temperature, and high relative humidity (R.H.) during the rainy season 1995/96. This agrees with Nitazany (1975), who indicated that the outbreaks of TYLCV always follow months with a mean relative humidity <60% and mean maximum temperature of 30 ˚c. Also, it may be due to the stress of climatic change effects on the resistance gene derived from the wild parents. As Mazyad *et al.,* (1982) indicated that the *L.peruvianum* controlled only insect "white fly" transmitted with some resistance for TYLCV virus reproduction.

The resistance frequency was high in 94/95, under good climate which confirmed Makkouk (1978) and Makkouk and Laterrot (1983), they indicated that insect vector populations are large in late summer when sowings are made for autumn tomato crops.

The O level treatment (control 2), which was mechanically protected by agril cover, was the least infected treatment as compared with control(1) treatment. Eric and Durazo (1985) proved the effectiveness of spun-bonded polyestar (SBP) as floating row cover material in preventing virus disease during the critical time of cucurbit production. Also, Nameth *et al.*, (1986) reported that two of the most common methods used to protect cucurbits from aphids, have been effective" Aluminum foil" mulches, and oil sprays. Significant differences of resistance values among the studied cultivars for each season indicate the importance of tolerance gene effects in these cultivars, in addition to the variability of gene heritability from the wild parents. Pilowsky and Cohen (1974), stated that to TYLCV tolerance derived from *L.pimpinellifolium* is controlled by a single incompletely dominant gene.

Hassan *et al.*, (1984), indicated that TYLCV tolerance in *L.pimpinellifolium* is incompletely dominant and offered only resistance between 44-85%. Ultimately, Makkouk and Laterrot (1983), reported that the incorporation of genes for TYLCV tolerance from both *L.peruvianum* and *L.pimpinellifolium* may be more beneficial.

The abovementioned observations explain the results in the tomato cultivars tested during the same growing season and also within the two experimental seasons for the same cultivars. It also indicate that the TYLCV resistance is highly altered by change of environmental conditions and parents source and may react with other unkown factors. This is more clear with cultivars DRW 8004 and 146-92, which lost the positive relation between the fruit weight yield and TYLCV resistance during the two growing seasons.

In the present study, the cultivar E445 showed the highest resistance against TYLCV disease, followed with the first group of cultivars with significant differences as compared with control(1). The low variability of genetic control of these cultivars may be due to the potential sources of resistance to TYLCV, which are the best possibilities for improved the resistance or control the environmental variability and / or both (Makkouk and Laterrot, 1983).

The second group of cultivars respectively, showed moderate resistance or moderate susceptibility with significant differences. These cultivars were the least resistant or the more susceptible to TYLCV infection when compared with control(1).

The tomato fruit yields, in the tested cultivars were reflected in the frequency of resistance for TYLCV.In most cultivars, the relation was positive between TYLCV resistance and weight yield.

The highest yield was E 445, followed with the first group cultivars in comparison with control (1). Therefore, the mechanical control treatment (2), was the first in yield production compared with control (1) and the twelve studied cultivars.

A moderate yield was obtained in the second group and the lowest yield from the more susceptible cultivars in the third group, as compared with the control (1). Makkouk and Laterrot (1983), reported that losses due to TYLCV reach 50-75% in many regions, making tomato production during the autumn unprofitable.

Table (6): Environmental conditions during the two successive growing tomato seasons (1994/95 and 1995/96) at Hamranyia Agriculture Research Station (H.A.R.S.).*

Growing season Nov. to May	Rains		Average of		
	Rains day	Rain fall (mm.)	Relative humidity (R.H.%)	Temperature (c°)	
1994 / 95	7	79.0	41.6 66.0	12.5 29.3	Min Max
1995 / 96	25	459.3	50.4 90.9	17.4 24.8	Min Max

* (C.F.) Annual statistical abstract. Ministry of Planning. (20, 21, 22) Issues – 1995-1997.

CONCLUSION

* Over the past 50 years many attempts have been made to reduce incidence or control and/or manage TYLCV disease. Most methods have been targeted to control the insect vector whitefly "*Bemissia tabaci*" Genn, with chemical and mechanical applications and cultural practices.Currently, the genetic control through crossing is considered the only outlet to this difficult disease.
* TYLCV resistance in the studied tomato cultivars appeared to be of high genetic penetrance in some hybrids and was positively associated with fruit yield.

* The relationship between the TYLCV genetic tolerance and environmental conditions requires more research.
* The performance of TYLCV resistance trait in different cultivars indicates that the genetic control depends upon the transfer of a single incompletely dominant gene from the wild parents, which is insufficient for TYLCV control.

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تقييم مقاومة بعض هجن الطماطم للإصابة بمرض الاصفرار والتفاف الأوراق الفيرسي

صلاح عبد المنعم حسين - منصور إبراهيم منصور

المنطقة الزراعية الشمالية – محطة أبحاث الحمرانية الزراعية
وزارة الزراعة والثروة السمكية –دولة الإمارات العربية المتحدة

ملخص

أجريت دراسة لتقييم ومقارنة أثنى عشر صنفاً من هجن الطماطم لمقاومة مرض إصفرار والتفاف الأوراق الفيرسي "TYLCV" خلال موسمي الزراعة "أكتوبر – مايو" لعامي ١٩٩٤/٩٥، ١٩٩٥/٩٦. بمحطة الأبحاث الزراعية بالحمرانية (H.A.R.S) برأس الخيمة – بدولة الإمارات العربية المتحدة.

وأعتمد في التقييم على الأعراض المرضية الحقلية بالمقارنة مع صنف الطماطم "Ace 55" الشديد القابلية للإصابة في معاملتين أحدهما مغطاة بالنسيج الزراعي "Agril" كمقارنة للمقاومة الميكانيكية ضد الناقل الحشري " الذبابة البيضاء "*Bemisia tabaci* Genn. ".

وقد أظهرت النتائج تفوق معاملة المقاومة الميكانيكية على كل المعاملات. كما أن أفضل الأصناف المختبرة في مقاومة المرض كان الصنف E 445 يليه الأصناف, DRW8003, DRW8006, Saria, DRW8001, DRW8009 , W3224 F1 وأخيراً DRW8005. كمجموعة أولى ذات مقاومة عالية وفارق معنوي كبير عن معاملة المقارنة. يلي ذلك أصناف المجموعة الثانية المتوسطة المقاومة وذات الفارق المعنوي المتوسط عن المقارنة وتضم الأصناف E 446, DRW 8004 وأخيراً مجموعة الأصناف ذات القابلية الأكثر للإصابة والمقاومة الأقل وذات الفارق المعنوي القليل عن المقارنة وضمت الأصناف Antares,146-92.

وقد كانت نتائج متوسط المحصول للنبات الواحد إنعكاساً إيجابياً لنتائج القدرة الوراثية للمقاومة لهذه الأصناف. ويعتبر أهم ما أثبتته النتائج أن توريث جينات المقاومة المتنحية من الاباء البرية " لنبات الطماطم " إلى الأصناف التجارية أعطى مقاومة غير مستقرة خاصة بالنسبة لتغيرات الظروف البيئية كما ظهر بوضوح تذبذب قدرة توريث هذه الاباء لهذه الجينات للأصناف المختلفة وإن الاعتماد على المقاومة الوراثية للأصناف ضد مرض TYLCV ما زال يحتاج إلى المزيد من الأبحاث والدراسات.

المجلة العلمية لكلية الزراعة – جامعة القاهرة – المجلد (٥٢) العدد الرابع
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