

Inheritance of Resistance to Tomato Yellow Leaf Curl Virus (TYLCV) in *Lycopersicon pimpinellifolium*

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ABSTRACT

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The inheritance of resistance in *Lycopersicon pimpinellifolium* to tomato yellow leaf curl virus (TYLCV) was studied in progenies derived from crosses between the resistant parents *L. pimpinellifolium* Hirsute-INRA and LA 1478 and the susceptible parent *L. esculentum* 'Special Back'. Resistance appeared to be stable in these parents. Field-grown seedlings were subjected to natural infection with the tomato yellow leaf curl virus. Analysis of F₁, F₂, and backcross populations from crosses of *L. pimpinellifolium* with the susceptible cultivar revealed that resistance is controlled by a single dominant gene. It is suggested that the symbol *Tylc* be assigned for this gene in *L. pimpinellifolium*.

Additional keywords: disease resistance

Tomato yellow leaf curl virus (TYLCV), transmitted by the whitefly *Bemisia*

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tabaci Gennadius, is responsible for serious losses of tomato production in many countries of the Middle East. Although all tested tomato lines and cultivars were highly susceptible to TYLCV, resistance has been reported in *Lycopersicon pimpinellifolium* (L.) Mill., *L. hirsutum* Humb. and Bonpl., and *L. peruvianum* (L.) Mill. (3,5,6,8).

Studies on the inheritance of resistance of *L. pimpinellifolium* to TYLCV in different areas of the Middle East have produced variable results. Pilowsky and

Cohen (6) reported that resistance derived from LA 121 is controlled by a single gene with incomplete dominance, whereas Hassan et al (4) showed that resistance derived from LA 121 or LA 373 is quantitatively inherited with partially recessive gene action. Yassin (7) indicated that resistance in LA 1582 is conditioned by a single dominant gene.

The objective of this work was to determine the inheritance of resistance of *L. pimpinellifolium* Hirsute-INRA and LA 1478 to TYLCV in crosses with the susceptible commercial tomato cultivar Special Back.

MATERIALS AND METHODS

Plants that showed resistance (symptomless carriers) to TYLCV in a previous study (5), belonging to *L. pimpinellifolium* Hirsute-INRA and LA 1478, were used as resistant parents. The susceptible parent is a commercial tomato cultivar, Special Back. Seeds of *L. pimpinellifolium* Hirsute-INRA and LA 1478 were obtained from H. Laterrot (France) and from C. M. Rick (United States), respectively. Parents were selfed for two

generations and tested for TYLCV resistance before being used in crosses.

Interspecific crosses were made between susceptible and resistant parents to produce F₁ populations. F₁ hybrids were selfed and backcrossed to the susceptible parent to produce F₂ and BC₁ populations, respectively. In all crosses, resistant parents were used as the pollen parent. Plants of parents F₁, F₂, and BC₁ generations (Table 1) were evaluated for TYLCV resistance under field conditions at the Jordan University Experiment Station in the Jordan Valley.

In early September of 1987, 4-wk-old seedlings were transplanted to the field in rows 16 m long with between-row spacings of 75 cm and in-row spacings of 40 cm. All plants were subjected to natural infection. An ample supply of viruliferous whiteflies was ensured by growing two rows of tested tomato plants between two single rows of previously established TYLCV-infected plants of the susceptible parent. The number of tested plants in each generation is listed in Table 1.

A disease rating scale (0 = symptomless to 3 = severe symptoms) was used for evaluating TYLCV resistance. All plants rated "0" were considered equivalent to the resistant parent and were classified as resistant. Plants in the remaining ratings (1–3) were classed as susceptible. Individual seedlings were inspected for TYLCV resistance 3 wk after transplanting and were rated for the development of symptoms throughout the 20-wk growing season. Seven to 10 symptomless plants of each generation were back-indexed. Scions from symptomless plants were grafted onto healthy seedlings of the susceptible cultivar Special Back that were raised in insect-proof cages. Grafts were observed over a period of 5 wk for the development of TYLCV symptoms.

The chi-square test for goodness-of-fit was used to test hypothetical ratios for the inheritance of TYLCV resistance.

RESULTS AND DISCUSSION

The number of resistant and susceptible plants in parents F₁, F₂, and BC₁ of

different crosses is given in Table 1. Over a 2-wk period of field tests, all plants of TYLCV-resistant parents remained symptomless, whereas plants of the susceptible parent developed persistent, severe symptoms. These results are similar to those reported by Kasrawi et al (5), who screened the same material under plastic house conditions, indicating that resistance in these parents is stable.

All F₁ plants of the two crosses were resistant, and their performance in the field was similar to the resistant parent, indicating that inheritance of resistance in these parents is dominant. However, some F₁ plants developed very slight symptoms on some leaves at the seedling stage (5 wk after transplanting), giving the appearance of an intermediate resistance. These slight symptoms did not continue on younger leaves, and plants were completely symptomless at later stages (6–8 wk after transplanting). F₁ plants were vigorous, large, extremely floriferous, and had a high fruit set and yield. Check plants were stunted with yellow growing points, had curled leaflets, and were generally barren. Fruits of F₁ plants were round and similar to those of the resistant parents, but a little bigger. The observed transitory symptoms differ from those obtained by Pilowsky and Cohen (6), who reported that 8 wk after inoculation all F₁ plants were infected and were smaller in size with permanently downward-cupped leaflets that developed interveinal chlorosis. They did not report on the flowering and fruiting of these plants.

The two F₂ populations segregated in a ratio of 3 resistant:1 susceptible ($\chi^2 = 0.074$, $P = 0.79$ for the INRA cross, and $\chi^2 = 0.439$, $P = 0.51$ for the LA 1478 cross). All the susceptible plants had TYLCV scores of 2 or 3; no plants scored 1. These data are consistent with the hypothesis that TYLCV resistance exhibited by *L. pimpinellifolium* Hirsute-INRA and by LA 1478 is conditioned by a single dominant gene. The segregation ratio of 1 resistant:1 susceptible ($\chi^2 = 0.125$, $P = 0.73$, and $\chi^2 = 0.348$, $P = 0.57$ for the INRA and LA 1478 backcrosses, respectively) obtained in plants of the

BC₁ generations further supports the hypothesis that resistance to TYLCV is governed by a single dominant gene.

Back-indexing results revealed that all tested symptomless plants are carriers of the virus. The possibility of escape was virtually excluded because of the presence of sufficient numbers of viruliferous vector whiteflies, complete infection of susceptible parents, and sample back-indexing of progeny.

Pilowsky and Cohen (6) indicated that resistance derived from *L. pimpinellifolium* LA 121 is controlled by a single gene with incomplete dominance. Although there is disagreement on the type of gene action involved, my conclusion is similar in that resistance is controlled by a single gene. Results obtained from greenhouse pot experiments by observing leaf symptoms of young plants and employing a known inoculum source of TYLCV-infected *Datura stramonium* L. plants (6) may not represent the field-grown plants subjected to natural infection. Therefore, my results may provide a better determination of the inheritance of resistance to any complex of TYLCV strains that might be found under the natural field conditions. In addition, mature plant expression of TYLCV reactions would allow careful plant classification among segregating populations. The data presented in this paper confirm the findings of Yassin (7), but do not agree with the observations of Hassan et al (4), who found that resistance derived from *L. pimpinellifolium* LA 121 or LA 373 is controlled quantitatively with partially recessive gene action. The discrepancies in the data obtained in the different countries of the Middle East may have resulted from the differences in the tested accessions, environmental conditions where studies were conducted, and/or the existence of different strains of TYLCV. The method of inoculation with the virus may also affect the inheritance of resistance. For example, Findley et al (1) concluded that resistance to maize dwarf mosaic virus in a maize inbred is controlled by two dominant genes when progenies are mechanically inoculated, but only one dominant gene conditions resistance when progenies are aphid-inoculated.

The inheritance of TYLCV resistance should be useful in breeding programs attempting to transfer resistance from *L. pimpinellifolium* to adapted tomato cultivars. *L. pimpinellifolium* has a very close genetic relationship with cultivated *L. esculentum* Mill. and readily hybridizes with commercial cultivars. The only problem is the very small size of fruits of the wild type. However, Geneif (2) reported that gain in fruit size through backcrossing was rapid. It is suggested that the symbol *Tylc* (for tomato yellow leaf curl virus) be used for this single dominant gene in *L. pimpinellifolium*.

Table 1. Segregation of parents F₁, F₂, and BC₁ progenies for resistance to natural infection in the field in the Jordan Valley by tomato yellow leaf curl virus from crosses between *Lycopersicon esculentum* 'Special Back' (P₁) and *L. pimpinellifolium* Hirsute-INRA (P₂) and LA 1478 (P₃)

Generation	Parents or cross	Number of plants			Expected ratio	χ^2	P
		Total	Resistant	Susceptible			
P ₁	Special Back	198	...	198	...	...	...
P ₂	INRA	11	11	...	...	...	...
F ₁	P ₁ × P ₂	19	19	...	...	...	...
F ₂	F ₁ selfing	162	123	39	3:1	0.074	0.79
BC ₁	P ₁ × F ₁	32	17	15	1:1	0.125	0.73
P ₁	Special Back	198	...	198	...	...	...
P ₃	LA 1478	13	13	...	...	...	...
F ₁	P ₁ × P ₃	21	21
F ₂	F ₁ selfing	246	189	57	3:1	0.439	0.51
BC ₁	P ₁ × F ₁	46	25	21	1:1	0.348	0.57

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