Evaluation of Resistance to TSWV and Agronomic Behaviour of Some TSWV-Resistant Tomato Genotypes in Southern Italy

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Abstract

A two-year research was carried out in Ofanto valley (Basilicata region, southern Italy) in 2006-2007, for evaluating agronomic behaviour of new processing tomato genotypes resistant to *tomato spotted wilt virus* (TSWV) and ascertaining their effective resistance to the virus. Five TSWV-resistant genotypes (cultivars and lines) were compared in each year the TSWV susceptible cultivar 'Perfectpeel' was used as a control. Two transplant dates were adopted in both years: 1) mean-early and 2) mean-late. A split-plot design with 3 reps was followed in the two years. Yield and fruit quality were considered as agronomic traits. About virological aspects, field observations and laboratory analysis (ELISA, IME) were carried out during crop cycles. Phytoplasma infection frequency was also assessed for the same plants. The control cultivar 'Perfectpeel' resulted highly productive in both years that were however characterized by low incidence of virus infections; beside, among new genotypes 'Vespro' and 'Suerte' gave a good yield, while 'Candia' and 'Isi 23259' exhibited high fruit quality. Virological studies showed that the new processing tomato genotypes were indeed TSWV-resistant. Finally, phytoplasma infections had a dissimilar incidence among plants of the tested genotypes.

INTRODUCTION

The processing tomato is the most popular vegetable crop in the world. Italy has a leading position in Europe with more than half of the continent's production (Elia and Conversa, 2007). Among causes limiting cultivation of the *Solanacea*, diseases and, in particular, those of viral nature are very dangerous. Tomato is susceptible to many viruses, which, in simple or mixed infections may cause heavy damage to the crop. A survey in Brindisi province (south of Italy) showed that TSWV, among other viruses investigated (AMV, CMV, INSV, PVY, TSWV), was the one more spread in the studied area (Gallitelli et al., 2004). Furthermore, the risk exists that a resistance breaking strain (RB) of TSWV could spread in our country (Ciuffo et al., 2005). The research was therefore aimed at evaluating some new TSWV-resistant processing tomato genotypes to see if they could provide productive results comparable to those of agronomic reference cultivars remaining also TSWV-free.

MATERIALS AND METHODS

The experimental work took place in spring-summer periods of 2006 and 2007 in an area of Ofanto valley (Basilicata region) close to Experimental Farm "Gaudiano" of Lavello (PZ). Two transplant periods were considered in each year: 1) medium-early (11 May 2006 and 14 May 2007) and 2) medium-late (31 May 2006 and 29 May 2007). Five newly constituted TSWV-resistant tomato hybrids (F_1) were used (Table 1). 'Perfectpeel', lacking the gene Sw5 for resistance to TSWV, was used as a control. A split-plot experimental design with three replicates was followed. Leaf and berry samples, taken from the tomato plants under study with symptoms of viral infections were tested by

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DAS-ELISA and/or immune electron microscopy to verify if they were infected by one of the following viruses: CMV, TSWV, PVY, ToMV, TYLCV, PZSV, and EMDV. Plants with symptoms close resembling those caused by phytoplasmas, were subjected to diagnostic tests by polymerase chain reaction (PCR). In particular, DNA samples were extracted from leaf veins and petioles of these plants. For PCR, both universal primers P1/P7 (Schneider et al., 1995) and specific primers fStol/rStol, which amplify an approximately 620 base pair (bp) fragment of phytoplasmas belonging to stolbur group (Maixner et al., 1995), have been used. The following agronomic traits were recorded at harvest time: total and marketable yields, waste (%) and fruit quality (dry matter, soluble solids, pH juice, colour). All collected data were subjected to variance analysis (ANOVA) and mean values ($P \leq 0.05$) were separated by Fischer's Least Significant Difference Test (LSD).

RESULTS

As Table 1 shows, production levels of 2007 were significantly lower (-51% of marketable yield and -30% of total one) than those of 2006 because of unfavourable climate conditions, that were particularly hot and dry (data not shown). Moreover, agronomic traits were affected by transplantation time although lower differences were evidenced for quality parameters; the mid-late cycle determined an average increase of 13.1 t ha^{-1} (+17%) of the marketable yield. The tested genotypes appeared very significantly different for almost all agronomic traits. The control cultivar 'Perfectpeel' was the most productive (99.2 t ha^{-1} of marketable yield); beside, among new genotypes 'Vespro' and 'Suerte' gave the highest yields (93.4 and 91.7 t ha^{-1} of marketable fruits, respectively), while 'Meridio' and 'Candia' were the least productive. 'Candia' and 'Isi 23259' recorded high values of fruit quality traits (dry matter an soluble solids content). Results of virological investigation showed (for what concerns the first transplantation period of the first trial year) a low percentage of infected plants (average of 1%, data not shown) due, probably, to climatic conditions particularly unfavourable to vectors of viruses occurred during this period. Even the control was found free from virus attacks. In the second transplanting period of 2006 no virus infection was evidenced. PCR tests showed that all symptomatic plants tested were infected by phytoplasma of Stolbur. Spread of the phytoplasma was however low (0.4% on average) and no significant difference among genotypes and between the two periods of transplantation was observed. In the second trial year, percentage of plants infected by viruses was modest (Fig. 1). The viruses most frequently detected in symptomatic plants were TSWV, PZSV and EMDV. The first one was found only in plants belonging to the control and, reached a 4.2% infection rate with early transplantation and 0.4% in late cycle. Rare plants were found infected by CMV or ToMV. Plants percentages infected by phytoplasmas were statistically similar in the two period of transplantation, ranging around 1-7% (Fig. 1). The control 'Perfectpeel' and line 'Isi 23256' were the genotypes more infected in both crop cycles, with rates ranging between 2.4 and 3.2%. 'Candia' showed an incidence of Stolbur infection statistically similar to that of the above genotypes, in the second cultivation cycle.

DISCUSSION

The control cultivar 'Perfectpeel' confirmed its high productivity in both years that were characterized by low virus infections incidence. Among TSWV-resistant hybrids, 'Vespro' and 'Suerte' distinguished themselves for productivity, while 'Candia' and 'Isi 23259' showed high fruit quality. Results of ELISA or immune electron microscopy revealed TSWV presence, in percentages higher than those of other viruses detected, only in the plants used as control and lacking the resistance gene to the same virus. These results suggest that RB strain of TSWV is not yet present in the area where the trial was conducted and, therefore, at the moment, the use of TSWV-resistant cultivars seems to be a valuable tool for controlling the virus. TYLCV presence in plants tested was also excluded, although the pathogen has been reported in Puglia and in the same

Basilicata (Comes et al., 2006) along with B biotype of its vector *Bemisia tabaci*. The necrogenic strain of CMV, which caused considerable damage to tomato crop in almost all its growing areas in the past (Gallitelli et al., 1988; Rana et al., 1990), does not appear to be an alarming threat in contrast to PZSV, EMDV and Stolbur. Although these last three pathogens were only sporadically present in tomato fields of Basilicata in the past, they seem to have nowadays become, along with TSWV, more dangerous to the *Solanacea* in the same region.

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Tables

Table 1 Influence of transplant period on some yield ad qualitative traits of different processing tomato genotypes in two years.

Treatments	Yield				Fruit qualitative traits					
	Marketable (t ha^{-1})	Total (t ha^{-1})	Waste weight (%)	Mean weight (g)	Dry matter (%)	Soluble solids (°Brix)	Juice acidity (pH)	Colour chromatic coordiantes[2] a*	b*	L*
Years										
2006	113.2	145.3	22.0	58.7	6.5	5.1	4.44	27.7	20.8	36.8
2007	55.9	101.8	43.6	60.5	5.8	5.1	4.45	22.8	10.7	33.1
Significance[1]	**	**	**	n.s.	**	n.s.	n.s.	**	**	**
Transplant periods (T)										
Medium-early	78.1	109.6	30.6	57.8	6.3	5.0	4.44	25.7	16.0	35.3
Medium-late	91.1	137.5	35.1	61.4	6.0	5.1	4.45	24.7	15.6	34.5
Significance[1]	**	**	*	n.s.	**	n.s.	n.s.	*	n.s.	*
Genotypes (cv)										
Perfectpeel	99.2	137.1	29.2	56.9	6.1	4.8	4.37	23.5	15.4	35.7
Vespro	93.4	122.6	25.2	61.2	6.2	5.0	4.46	26.9	17.6	34.6
Meridio	73.3	111.8	36.2	64.1	5.8	4.9	4.51	25.6	15.4	34.5
Isi 23259	80.1	117.6	33.2	60.5	6.5	5.2	4.45	25.1	15.1	34.9
Suerte	91.7	125.4	28.1	54.0	6.0	5.0	4.45	24.5	15.8	35.5
Candia	69.7	126.9	45.1	60.8	6.5	5.6	4.42	25.7	15.3	34.5
Means	84.6	123.6	32.8	59.6	6.2	5.1	4.44	25.2	15.8	34.9
LSD 0.05 P	4.2	3.8	3.8	6.2	0.2	0.3	0.04	0.9	1.0	n.s.
Interactions[1]										
Y×T	n.s.	n.s.	n.s.	*	n.s.	n.s.	**	*	**	n.s.
Y×Cv	**	**	**	*	**	n.s.	**	**	*	**
T×Cv	**	n.s.	**	n.s.	**	*	**	**	n.s.	n.s.
Y×T×Cv	*	n.s.	n.s.	n.s.	**	n.s.	**	**	*	n.s.

[1] *=significance at P≤0.05; **=Significant at P≤0.01; n.s.=not significant.
[2] a*=red index; b*=yellow index; L*=brightness (Measurements made by a Minolta CR-300 chroma meter).

Figures

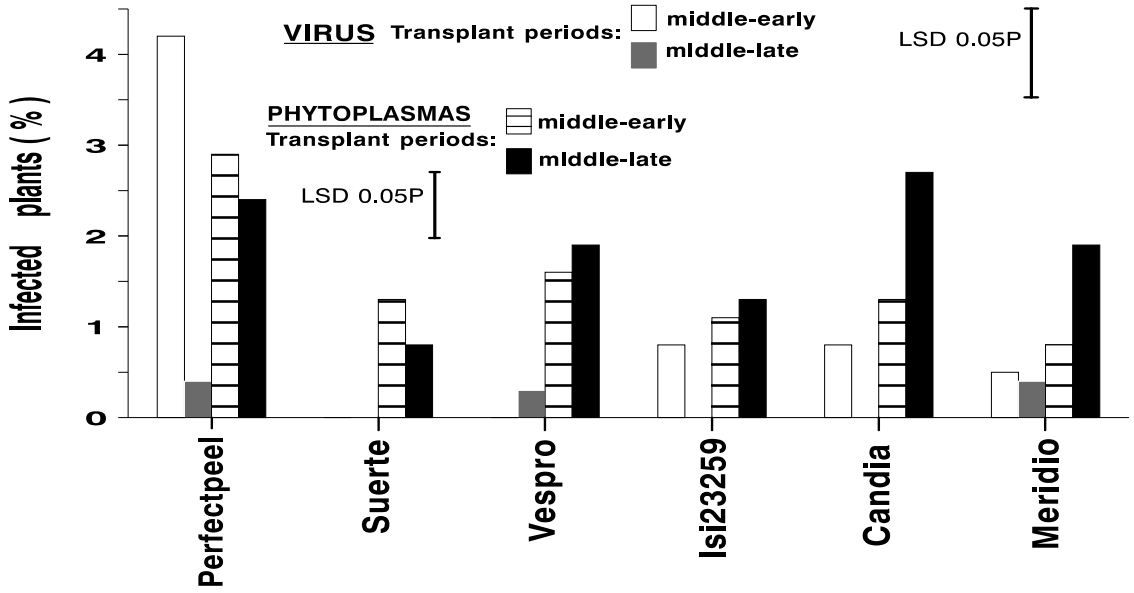

Fig. 1. Results of virologica and phytoplasma analysis conducted in 2007.