PALESTRA

INFECTION OF TOSPOVIRUSES IN PEPPER AND CONTROL BY RESISTANT PLANTS

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ABSTRACT

The tospoviruses Tomato spotted wilt virus (TS WV), Groundnut ringspot virus (GRSV), Tomato chlorotic spot virus (TCSV), Watermelon silver mottle virus (WSMV) and the new proposed species Capsicum chlorosis virus constitute a severe threat to Capsicum cultivation. Resistance to TSWV but not to other tospoviruses, based on a hypersensitive reaction, has been found only in accessions of C. chinense 'PI152225' and 'PI159236'. The resistance, carried by a dominant gene called Tsw, is broken at high temperatures and depends on plant age, with young plants more susceptible. The Tsw gene has been introduced into several commercial sweet and hot pepper cultivars with good agronomic performance. Resistance-breaking strains of TSWV systemically infecting the resistant plants have been found in the field. Future directions for search on resistance to tospoviruses in Capsicum are discussed.

Tospoviruses are a very dangerous threat to many crops. High infection rates have led to considerable economic losses in an increasing number of countries, so that tospoviruses are considered among the most destructive plant viruses (GERMAN et al., 1992). Severe damage of Capsicum spp. occurs worldwide (COLARICCIO et al., 1995; GITAS et al., 1998; LIMA et al., 2000; MOMOL et al., 2000; McMICHAEL et al., 2002; TAVELLA et al., 1997; Vaira et al., 1993). Plants are highly susceptible at all stages of development, showing severe symptoms, usually necrotic, on leaves and fruits.

The increasing problem of TSWV and other tospoviruses has stimulated a search for sources of genetic resistance, using conventional methods (CHO et al., 1996). Since genes for TSWV resistance are not known in C. annuum, breeding experiments have been carried out utilizing C. chinense Jacquin germoplasm from Amazonia (CHENG et al., 1989). BLACK et al., (1991) identified the accessions of C. chinense 'PI152225' and 'PI159236' as resistant to TSWV based on hypersensitive reaction (HR). BOITEUX (1995) confirmed that resistance was conferred in both accessions by a single dominant gene (Tsw) and Black et al., (1996) showed that resistance was governed by the same gene for both accessions.

The breaking of HR with PI152225 resulting in a systemic infection of TSWV occurred at high temperatures and depended also on the developmental stage of the plants at virus inoculation. When young plants were inoculated at the 2 true leaf stage and then grown continuously at 33°C, 20% of the plants reacted hypersensitively, whereas with plants inoculated at the 4 true leaf stage the proportion reached 45%. Progeny from self-pollinated plants, which maintained resistance even at 33°C, displayed a remarkable increase in HR to about 80%; so it was proposed that selection of parent plants resistant at high temperature regimes could be useful for breeding for resistance (ROGGERO et al., 1996). This finding was confirmed by ROSELLÓ et al., (1997), MOURY et al., (1998) and SOLER et al., (1998).

The complexity of the TSWV genome makes the recognition of new strains rather difficult (ADKINS, 2000). New TSWV strains can arise and be selected in the presence of resistant plants (QU et al., 1998) and the ability of this virus to replicate in its thrips vector may increase the opportunity for genomic diversification of its population (WIJKAMP, 1995). ROGGERO et al. (1999b) found two field pathotypes of TSWV which overcame the HR of a C. chinense 'PI152225' X C. annuum resistant hybrid. Two plants of this hybrid, grown in Liguria region (Italy) with good agronomic performance, showed typical systemic TSWV symptoms on apical leaves and fruits. The viruses isolated from the plants were recognized as TSWV strains by serological assays and were transmitted by F. occidentalis with high efficiency. They presented severe systemic symptoms in susceptible pepper and a high proportion (40-60%) of systemic infection in 'PI152225' and 'PI159236'. More recently, ROGGERO et al., (2002) reported again from Liguria that resistance to TSWV in commercial pepper cultivars grown under glass was seriously overcome. Two isolates (or pathotypes) were characterized and found
similar to other isolates in infecting a wide number of plants species and being transmitted with high efficiency by F. occidentalis. The isolates survived in experimental mixed infections with a non-resistance breaking isolate in susceptible pepper and 'PI152225' when inoculated at the same time, but cross protection in susceptible pepper acted against them. Other resistance-breaking strains were also found one year later in other crops (tomato, pepper and artichoke) close to infected resistant pepper plants. All commercial pepper cvs were systemically infected by these resistant-breaking strains under experimental conditions. TSWV strains overcoming resistance in tomato carrying the SW-5 gene were reported by Latham & Jones (1998), but these strains did not overcome the resistance of C. chinense. However, Roggero et al., (2002) found that resistant tomato cultivars were not susceptible to the TSWV resistance breaking strains isolated from pepper. This confirms that the Tsw gene in pepper and the Sw-5 gene in tomato have different characteristics, as also shown by molecular biology techniques (Jahn et al., 2000) and that resistant-breaking strains are highly specific.

Tsw is not effective against GRSV and TCSV (Boiteux & De Avila, 1994), Impatiens necrotic spot virus (Roggero et al., 1999b) and Capsicum chlorosis virus (McMichael et al., 2002). Green et al., (1996) evaluated the resistance of C. chinense resistant ‘PI’ accessions to WSMV and one line of ‘PI152225’ showed only local infection. No further search of resistance among Capsicum spp. has been reported for tospoviruses.

One can draw one major conclusion: further research is needed to reach the goal of a genetic control of tospovirus diseases in pepper. This is especially important for South America where GRSV and TCSV are prevalent, and Asia where WSMV is widespread. Livingstone et al., (1999) have published an improved genomic map of pepper, and Jahn et al., (2000) have compared the maps of the Tsw locus of C. chinense with that of the Sw-5 locus of tomato, while Grube et al., (2000) have analyzed in detail the loci of resistant genes for three members of the Solanaceae. This research stressed the potential use of comparative genome mapping in order to rapidly identify other genes showing similar function and specificity against other pathogens. Further search of resistance in Capsicum will thus include classical field and laboratory tests for susceptibility combined with new molecular techniques.

REFERENCES


Infection of tospoviruses in pepper and control by resistant plants.


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