REACTION OF AN INTERNATIONAL SET OF BACTERIAL WILT-RESISTANT TOMATOES TO A POPULATION OF *MELOIDOGYNE INCOGNITA* IN MARTINIQUE

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RESUMEN

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La capacidad hospedante de un grupo de 32 variedades y líneas de tomate reportados como resistentes al decaimiento bacteriano causada *por Ralstonia solanaceum* y de un cultivo sensible como referencia, fueron evaluados frente a una población de *Meloidogyne incognita* en Martinica. Los resultados del estudio mostraron que solo cuatro líneas (TBL-1, TBL-2, TBL-3 y TBL-4) fueron verdaderamente resistentes a *M. incognita*. Sin embargo, solo una variedad (BF-Okitsu101) presentó una ligera resistencia a *M. incognita* en estas condiciones, lo que resulta ser una característica interesante contra el decaimiento bacteriano.

Palabras claves: decaimiento bacteriano, *Lycopersicum esculentum, Meloidogyne incognita, Ralstonia solanacearum*, resistencia, sensibilidad, tomate.

Bacterial wilt of tomato, eggplant, and potato, caused by the phytopathogenic bacteria *Ralstonia solanacearum* (*ex Pseudomonas solanacearum* E. F. Smith) and known since 1896, can affect a wide variety of plants. Among these, tomato plants are particularly susceptible to this soil borne, vascular pathogen and the only effective way to control tomato bacterial wilt is the use of resistant varieties. Recently, root-knot nematodes (*Meloidogyne* spp.) were demonstrated to have a tremendous synergistic effect in increasing the bacterial wilt severity of bacterial wilt-resistant cultivars (Cadet *et al.*, 1989; Deberdt *et al.*, 1999).

A current objective of tomato breeders worldwide is to combine in some varieties useful horticultural features (e.g., fruit size, heat tolerance, plant determinism) and acceptable levels of resistance or tolerance to various pests and diseases (e.g., bacterial wilt, root-knot nematode, geminivirus, fungal pathogens). Two sources of resistance to bacterial wilt have been identified. A polygenic resistance with a quantitative resistance locus of major effect (20-50%) exists on tomato chromosome 6 (Danesh *et al.*, 1994). The source of these genes is *Lycopersicum esculentum* cv. *cerasiforme* which is often used as a resistant parent in the French West Indies (e.g., cultivar CRA 66). A source of dominant monogenic resistance, originating from *L. pimpinellifolium* (Hawaii 7997) is also used as a resistant parent (Prior *et al.*, 1993). Resistance to root-knot nematodes is conferred by a single gene Mi, also located on chromosome 6. This gene was introduced into commercial tomato cultivars from the wild species *L. peruvianum*, using embryo rescue of an interspecific cross of the wild species with *L. esculentum* (Smith, 1944). Numerous tomato breeding programs have long tried to create tomato cultivars carrying a stable resistance to bacterial wilt across locations. As part of these efforts, an

international set of 32 tomato cultivars and germplasm lines originating from 8 countries, and reportedly resistant to bacterial wilt, has been made available for testing worldwide in comparison with a susceptible check cultivar L-390 (Wang, 1994). The objective of the present study was to further evaluate this international set of bacterial wilt-resistant tomatoes against a population of root-knot nematode *Meloidogyne incognita* (Kofoid and White) Chitwood in Martinique.

The seeds of the 33 tomato cultivars and germplasm lines were evaluated against a population of *M. incognita* in a growth chamber using 1-month-old seedlings exhibiting vigorous growth. Seeds of each cultivar were sown in pasteurized soil and replanted after 15 days. Plants were grown singly in 237 cm^3 culture tubes made of PVC filled with pasteurized soil (steam-heated for 1 hr at 100°C). Soil was collected in Morne-Vert Martinique and was a volcanic hydrandept soil, pH 6.2, organic carbon 7.3%, cationic exchange capacity 10.3 meq/100g soil. There were 5 replications per cultivar. Treatments were arranged in a completely randomized design. Soil from each tube was watered twice a day and fertilized weekly with Hoagland's solution. The ambient temperature (night and day) in the growth chamber was 22-27°C ± 1°C at a 14h light photoperiod.

The inoculum source of *M. incognita*, confirmed by an esterase phenotype analysis (Esbenshade and Triantaphyllou, 1985), was established from a single egg-mass and increased in a greenhouse on the roots of tomato plants cv. Caraibo. For the resistance test, a suspension of ca. 1 000 juveniles freshly hatched (24-48h, Seinhorst, 1950) was poured into holes in the soil around the roots of the tomato plants in each culture tube one week after transplanting. Five weeks after inoculation, the tomato roots were gently washed free of soil, rated for galling on a 0-10 scale (Zeck, 1971) and nematodes were extracted from the roots in a mist chamber (Seinhorst, 1950). Nematode densities were expressed as nematode numbers per root system and per gram dry root weight. A reproductive factor (Rf = final number of eggs plus juveniles divided by initial inoculum) was calculated for each cultivar. An analysis of variance of the data was performed and means were separated by a Fisher'Protected LSD test at $P = 0.05$.

The cultivar Caraibo, susceptible to root-knot nematode and commonly used in the French West Indies, Martinique and Guadeloupe islands, was chosen as the susceptible nematode control reference. Cultivars and germplasm lines were assigned from susceptible to highly resistant based on the classification of Taylor (1971): susceptible = reproduction is not different from the susceptible control; slight resistance = reproduction is 25% to 50% of that on the susceptible control; moderate resistance = 10% to 25%; very resistant = 1% to 10%; highly resistant = < 1%.

Only 1 replicate of the cv. TBL-2 was found free of root-knot nematode. All other plants supported, to various degrees, reproduction by *M. incognita* (Table 1). The root-gall indices were relatively homogenous among the susceptible plants, ranging from 3.6 (germplasm line TML-114-48-5-N) to 5.8 (cv. Caravel and germplasm line CLN 65-349-D5-2-0). Only four germplasm lines, all belonging to the TBL group, were considered as highly resistant (Rf < 1) and very resistant (Rf = 1.5) to *M. incognita*. The cultivar BF-Okitsu 101 and the germplasm line CLN 1464-111-30-45 were considered as slightly resistant. It is interesting that there is no obvious relationship between root-gall indices, nematode numbers on the roots (J2/g roots) and reproductive factors. Some cul-

Table 1. Root-gall index, numbers of *Meloidogyne incognita* second stage juveniles (J2), nematode reproductive factor (Rf), and host status of 33 tomato lines and accession cultivars 35 days after soil infestation.

Tomato line[u]	Institute	Root-gall index[v]	J2 ($\times 10^3$)/ g root dw[w]	Rf[x]	Host Status[y]
TML-114-48-5-N spreading	IPP, Philippines	3.6[z] b	422 fgh	85.0 j	S
TML-46-N-12-N early NT	IPP, Philippines	4.2 bcd	314 defgh	80.8 ij	S
F7-80-465-10-Pink	IPP, Philippines	4.4 bcde	501 gh	76.5 hij	S
Kemir	LHRI, Indonesia	4.8 defg	453 fgh	74.9 ghij	S
Redlander	BRS, Australia	4.4 bcde	499 h	67.3 fghij	S
L-285	AVRDC, Taiwan	4.4 bcde	393 efgh	66.2 fghij	S
Caravel (CRA 90-30)	INRA, Guadeloupe	5.8 h	486 gh	61.8 efghij	S
Intan Putih	LHRI, Indonesia	5.2 efgh	621 h	57.4 defghi	S
MT-1	PPS, MARDI, Malaysia	4.8 defg	304 defgh	57.2 defghi	S
R-3034-3-10-N-UG	IPP, Philippines	4.4 bcde	423 fgh	57.1 defghi	S
Hawaii 7996	Univ. Florida, USA	5.0 defgh	297 defgh	54.7 defgh	S
Ranti	LHRI, Indonesia	5.6 gh	521 fgh	54.5 defgh	S
CRA 66	INRA, Guadeloupe	4.4 bcde	259 defgh	52.9 defgh	S
CL 5915-93-D4-1-0	AVRDC, Taiwan	5.0 defgh	408 defgh	52.4 defgh	S
Caraibo	INRA, Guadeloupe	5.4 fgh	537 gh	52.4 defgh	S
BRS-1	BRS, Australia	5.4 fgh	368 defgh	52.1 defgh	S
MT-11	PPS, MARDI, Malaysia	5.0 defgh	520 gh	51.9 defgh	S
GA 219 (PI 126408)	Univ. Florida, USA	5.6 gh	530 h	50.2 defg	S
GA 1565 (PI 263722)	Univ. Florida, USA	4.8 defg	462 fgh	47.9 cdef	S
Hawaii 7997	Univ. Florida, USA	4.2 bcd	236 defgh	47.7 cdef	S
CLN 65-349-D5-2-0	AVRDC, Taiwan	5.8 h	346 defgh	46.3 cdef	S
CLN 1463-160-40-60	AVRDC, Taiwan	5.4 fgh	294 defgh	44.6 bcdef	S
GA 1405 (PI 251323)	Univ. Florida, USA	5.0 defgh	304 defgh	43.3 bcdef	S
L-390	AVRDC, Taiwan	5.6 gh	216 def	42.1 bcdef	S
Hawai 7998	Univ. Florida, USA	4.6 cdef	146 de	38.9 bcde	S
Fla 7421	Univ. Florida, USA	5.4 fgh	532 h	38.0 bcde	S
Rodade	BRS, Australia	4.6 cdef	192 defg	35.0 bcd	S
CLN 1464-111-30-45	AVRDC, Taiwan	5.2 efgh	155 d	24.1 abc	SR
BF-Okitsu 101	NRIV, Japan	3.8 bc	175 d	20.4 ab	SR
TBL-1	NRIV, Japan	1.0 a	9 c	1.5 a	VR

Table 1. (Continued) Root-gall index, numbers of *Meloidogyne incognita* second stage juveniles (J2), nematode reproductive factor (Rf), and host status of 33 tomato lines and accession cultivars 35 days after soil infestation.

Tomato line[u]	Institute	Root-gall index[v]	J2 ($\times 10^3$)/ g root dw[w]	Rf[x]	Host Status[y]
TBL-3	NRIV, Japan	1.0 a	4 b	0.5 a	HR
TBL-4	NRIV, Japan	1.6 a	3 bc	0.4 a	HR
TBL-2	NRIV, Japan	0.8 a	5 a	0.4 a	HR

[u]International set of resistance sources in tomato to bacterial wilt (Wang, 1994).
[v]Galls of root-knot nematodes were rated on 0-10 scale (Zeck, 1971).
[w]Numbers of second stage juveniles per g root dry weight.
[x]Reproductive factor = final population divided by initial population.
[y]S = susceptible; SR = slight resistance; MR = moderate resistance; VR = very resistant; HR = highly resistant (Taylor, 1971).
[z]Values are the mean of 5 replicates; means followed by the same letter do not differ ($P = 0.05$) according to Fisher's Protected LSD test.

tivars exhibited a high root-gall index while supporting relatively fewer nematodes and conversely. Fourteen cultivars and germplasm lines, including cv. CRA-66 and cv. Hawaii 7996 commonly used in the breeding programs against bacterial wilt, were as susceptible as the control cultivar Caraibo to this population of *M. incognita*.

According to Dr. Tatemi from the National Research Institute of Vegetables, Japan (pers.com.), the observed nematode resistances of the germplasm lines TBL are likely inherited as the Mi gene from the parent line NFR-2 through FV-12. In Japan, these TBL germplasm lines showed strong resistance to bacterial wilt in open field tests (Tatemi, pers. comm.).

The result of the worldwide evaluation of the international set of resistance sources to bacterial wilt in tomato showed 9 entries with a good comparative stability, based on a plant survival percentage > 90% (Wang *et al.*, 1997). All of these entries were found in this study to be very susceptible to the root-knot nematode, except the cv. BF-Okitsu 101, a common tomato rootstock in Japan, which exhibited a slight resistance to this population of *M. incognita*. This result should be confirmed with other root-knot nematode populations before the cultivar is considered as a possible candidate by plant breeders.

Based on the synergistic effect of root-knot nematodes on bacterial wilt of tomato, and on the difficulty of introgressing both the Mi gene and the polygenic resistance to bacterial wilt into the same tomato cultivar without impairing the stability of the resistance to bacterial wilt (Sidhu, 1984; Nirmalavedi and Tikoo, 1993; Deberdt *et al.*, 1999), further research should be undertaken to understand the close relationship of resistance genes on tomato chromosome 6. A need also exists to find new compatible resistance sources to both bacterial wilt and root-knot nematodes.

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