Reaction of Muskmelon Germ Plasm to Inoculation with *Fusarium oxysporum* f. sp. *melonis* Race 2

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ABSTRACT

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Of 152 entries of muskmelon (*Cucumis melo*) germ plasm tested in the greenhouse for resistance to *Fusarium oxysporum* f. sp. *melonis* race 2, 18 cultivars had intermediate resistance (12–71% seedlings resistant) and 32 were highly resistant (81–100% seedlings resistant). Resistance was found in four botanical subspecies of *C. melo*, var. *reticulatus*, var. *inodorus*, var. *chito*, and var. *flexuosus*. The inheritance of wilt resistance is discussed.

Fusarium wilt of muskmelon (*Cucumis melo* L.), caused by *Fusarium oxysporum* Schlecht. f. sp. *melonis* Snyd. & Hans., was first reported in the United States from New York and Minnesota in the 1930s (3,4). In California, the disease was reported in 1940 from Los Angeles and Riverside counties on the cultivar Honey Dew and a casaba type cultivar (10). Subsequently, it was reported in Riverside County in 1976 (8). In 1976, a planting of muskmelons, cultivar Powdery Mildew Resistant 45, was severely affected with Fusarium wilt in the major production area of Fresno County in the San Joaquin Valley (6). Since 1975, the muskmelon acreage in the San Joaquin Valley with severe losses from this disease has increased annually. In 1980, the disease was found in Merced and Stanislaus counties, two muskmelon-production areas north of Fresno County. Thus, the Fusarium wilt pathogen appears to be well established in the San Joaquin Valley and is a serious threat to this major muskmelon-production area (about 13,000 ha grown annually).

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An extensive muskmelon-breeding program was initiated in 1970 at the University of California, Davis, to develop cultivars adapted to mechanical harvesting and resistant to diseases occurring in California. Because of the threat from Fusarium wilt, resistance was sought for incorporation into "western shipping-type" germ plasm. The purpose of this article is to report 1) on the evaluation of selected muskmelon germ plasm for resistance to Fusarium wilt through artificial inoculation under greenhouse conditions, 2) the relative level of resistance in the germ plasm tested, and 3) information concerning the inheritance of Fusarium wilt resistance.

MATERIALS AND METHODS

One hundred twenty-seven cultivars in four botanical subspecies of *C. melo*, var. *reticulatus* Naud., var. *inodorus* Naud., var. *chito* Naud., and var. *flexuosus* Naud., were tested for reaction to *F. oxysporum* f. sp. *melonis* race 2. Evaluation of germ plasm for resistance extended over a 2-yr period and represents 19 tests. About eight or nine seedlings of an entry were inoculated in a given test (Table 1) and about 17 seedlings of an entry of the progenies from selfed resistant plants (Table 2). Each entry occurred in at least two tests. Three differential cultivars, Charentais T, Doublon, and CM 17-187, and two susceptible cultivars, S.J. 45, and Top Mark, were included in each test to ensure that there was no change in pathogen virulence or in race for each test conducted. The reactions of S.J. 45 and Top Mark were more typical of susceptible U.S. cultivars than those of Charentais T or CM 17-187. Thus, cultivars S.J. 45 and Top Mark served as reference points for the reaction of U.S. germ plasm.

Field isolates of *F. oxysporum* f. sp. *melonis*, FY-2 and FY-4 (6), obtained from wilted muskmelon plants in the San Joaquin Valley, were single-spored and cultures were stored in autoclaved soil. These isolates were previously classified as race 4 (6) according to Banihashemi and de Zeeuw (2), but according to the new race nomenclature proposed by Risser et al (15), these isolates have been classified as race 2. The inoculum consisted of a mixture of macroconidia and microconidia (10^6 spores per milliliter) prepared from acidified potato-dextrose agar (APDA) cultures grown for 7–10 days at room temperature and room light.

Seeds of muskmelon cultivars, treated with 5% calcium hypochlorite solution for 5 min, were planted in autoclaved vermiculite (seedling pots). After about 10 days, plants in the cotyledon to first-true-leaf stage were removed from the seedling pots and the roots were washed in tap water, pruned to about 2.5 cm, and dipped for 1 min in the inoculum suspension. The inoculated seedlings were transplanted into cell-type plastic growing trays (one plant per cell) filled with a sterilized potting mix of peat and vermiculite (1:1) and placed in a greenhouse at 20–27 C. Control plant roots were pruned to about 2.5 cm and dipped in tap water only.

Plants were examined periodically and the number of yellowed, necrotic, wilted, or dead seedlings was recorded. Final assessments of the wilt reaction were made 28 days after inoculation. Plants free of external wilt symptoms were considered resistant. At the end of a test, selected resistant plants were transplanted into 10-L pots and grown to maturity for either self- or cross-pollinations. Plants free of external wilt symptoms that were not saved for genetic studies were cut to determine the extent of vascular discoloration, and a representative number of surviving plants with external symptoms was examined for vascular discoloration at the end of each test.

Throughout the investigation, a representative number of plants was selected and tissue pieces were plated on APDA. The cultivars were placed in three reaction classes: susceptible if no seedlings were resistant, intermediate if one plant was resistant but less than 80% were resistant, and highly resistant if more than 80% were resistant.

RESULTS

Symptoms were evident in susceptible plants as early as 7 days after inoculation and plants of susceptible cultivars were usually killed within 10 to 12 days. Of 1,142 seedlings without external wilt symptoms that were cut to determine the extent of vascular discoloration, 20 had slight discoloration extending a short distance up the hypocotyl. Vascular discoloration in a random sample of seedlings with external wilt symptoms ranged from none to severe. There appeared to be no clear relationship between the severity of external symptoms in surviving plants and the extent and degree of internal vascular discoloration. These observations are in agreement with Armstrong and Armstrong (1) that vascular discoloration is a questionable standard for judging susceptibility to wilt in a seedling test.

Typical *F. oxysporum* cultures were isolated from a representative number of plants with and without external symptoms. Pathogenicity was verified from a random selection from these isolates. Five cultivars released as Fusarium wilt-resistant were classified in our tests as susceptible: Don Juan Hybrid, Earlisweet Hybrid, Gold Star Hybrid, Summet Hybrid, and Super Market Hybrid (Table 1).

Cultivars released as Fusarium wilt-resistant but placed in our intermediate-resistance class were Burpee Hybrid, Delicious 51, Harvest Queen, Honey Rock, Iroquois, Minnesota Honey, Minnesota Midget, and Spartan Rock. Several cultivars not designated Fusarium wilt-resistant when released were classified as having intermediate resistance: De Cavillon, Golden Honey Moon, Honey Dew Orange Flesh, Honey Dew Bush, Honey Dew-Olivers Pearl Cluster, Morgan, Santa Claus Casaba, Smith's Perfect, and Sweet Granite (Table 1).

Eight cultivars released as Fusarium

Table 1. Reaction of muskmelon (*Cucumis melo*) cultivars to artificial inoculation with *Fusarium oxysporum* f. sp. *melonis* race 2 under greenhouse conditions

		Seedlings		Seedling reaction		
Cultivar	Source[a]	Total tested (no.)	Inoculation tests[b] (no.)	Resistant (%)	Diseased (%)	Dead (%)
Amarelo	A	17	2	53	12	35
Banana	NK	17	2	0	0	100
Big River Bush	TAM	17	2	0	0	100
Bellegrade	N	15	2	87	13	0
Burpee Hybrid	B	34	4	32	44	24
Campo	USDA	17	2	0	18	82
Chaca Hybrid	N	17	2	100	0	0
Chando Hybrid	A	34	4	97	3	0
Charantais Improved	S	34	4	0	15	85
Charentais T Cal. sib.	UCD	92	11	0	0	100
Classic Hybrid	G	17	2	0	18	82
CM 17-187	INRA	17	2	0	0	100
CM 17-187 Cal. sib.	UCD	94	11	0	0	100
Crane Melon	UCD	17	2	0	0	100
Crenshaw	A	43	5	84	16	0
Crenshaw	NK	32	4	84	16	0
De Cavillon	N	16	2	69	31	0
Delicious 51	H	34	4	35	28	27
Delicious 51	NK	34	4	30	35	35
Delicious 51	S	32	4	28	3	69
Dark Green Spanish	D	17	2	82	18	0
Doney Melon	N	17	2	100	0	0
Doublon	INRA	17	2	100	0	0
Doublon Cal. sib.	UCD	94	11	100	0	0
Don Juan Hybrid	A	34	4	0	24	76
Earlisweet Hybrid	S	17	2	0	59	41
Earl's Favorite	FM	25	3	88	12	0
Early Dawn Hybrid	H	34	4	97	3	0
Edisto	A	17	2	0	0	100
Edisto	NK	17	2	0	6	94
Edisto 47	NK	33	4	0	9	91
Edisto 47	M	34	4	0	18	82
Edisto 47	USDA	17	2	0	6	94
Eureka	NK	34	4	0	82	18
Far North	F	34	4	0	29	71
Galia Hybrid	HA	17	2	0	0	100
Giant Perfection	G	17	2	0	0	100
Gold Star Hybrid	H	17	2	0	6	94
Golden Ananas	B	17	2	0	6	94
Golden Beauty Casaba	NK	16	2	0	0	100
Golden Beauty Casaba	M	17	2	0	0	100
Golden Crenshaw	M	34	4	84	16	0
Golden Crispy	F	17	2	0	18	82
Golden Honey Moon	W	33	4	70	24	6
Golden Perfection	W	17	2	0	0	100
Granite State	P	17	2	18	35	47
Gusto 45	A	184	11	0	0	100
Hales Best	NK	17	2	0	0	100
Hales Best 36	NK	17	2	0	0	100
Hales Best 36	M	17	2	0	0	100
Harden Bush	USDA	17	2	0	0	100
Harmony Hybrid	A	17	2	0	6	94
Harper Hybrid	H	17	2	23	18	59
Harper Hybrid	S	17	2	12	6	82
Harvest Queen	A	24	2	50	42	8
Harvest Queen	NK	34	4	47	35	18
Harvest Queen	W	33	4	30	49	21
Heart of Gold	NK	17	2	0	12	88
Honey Dew	A	50	6	84	16	0
Honey Dew	NK	34	4	79	21	0
Honey Dew	M	34	4	82	18	0
Honey Dew Bush	UCD	25	3	56	44	0
Honey Dew Olivers—Pearl Cluster (Bush)	G	17	2	47	35	18
Honey Dew Orange Flesh	NK	32	4	47	37	16
Honey Gold No. 9	N	16	2	81	19	0
Honeydrip Hybrid	P	14	2	93	7	0
Honeyloupe	UCD	50	6	86	14	0
Honey Rock	G	33	4	18	27	55
Imperial 45 ECS	NK	17	2	0	0	100
Imperial 45-S12	NK	17	2	0	0	100
Improved PMR-45	M	17	2	0	0	100
Iroquois	H	51	6	35	49	16
Iroquois	S	50	6	30	44	26
Israel-Ogon	W	17	2	0	29	71
Jacumba	USDA	16	2	0	37	63
Juan Canari	M	34	4	82	18	0
Jumbo's Hales Best	A	17	2	0	0	100
Kangold	W	17	2	0	0	100
Kazakh Honey Dew	G	17	2	0	0	100
King Henry	NK	17	2	0	0	100

(continued on next page)

Table 1. *(continued from preceding page)*

Cultivar	Source[a]	Seedlings: Total tested (no.)	Seedlings: Inoculation tests[b] (no.)	Seedling reaction: Resistant (%)	Seedling reaction: Diseased (%)	Seedling reaction: Dead (%)
Kolhoznica	UCD	17	2	0	6	94
Luscious Hybrid	P	17	2	0	6	94
Mainstream	USDA	34	4	0	0	100
Makdimon Hybrid	HA	17	2	100	0	0
Mashad Melon No. 1	UCD	17	2	100	0	0
Mashad Melon No. 2	UCD	16	2	100	0	0
Minnesota Hybrid 16	F	17	2	0	65	35
Minnesota Hybrid 26	F	17	2	0	24	76
Minnesota Honey	F	34	4	70	18	12
Minnesota Honey Mist	F	16	2	0	0	100
Minnesota Midget	F	34	4	62	18	20
Morgan	M	34	4	59	12	29
Noy 50	ARO	17	2	82	18	0
Ogon 9	INRA	34	4	0	0	100
Old Time Tennessee	W	17	2	0	6	94
Oval Chaca Hybrid	P	16	2	94	6	0
Perfected Perfecto	W	17	2	0	0	100
Perfection	S	17	2	0	0	100
Perlita	A	51	6	82	6	12
Perlita	NK	34	4	76	6	18
Perlita	M	50	6	78	8	14
Perlita Bush	UCD	26	3	81	19	0
Persian Small	A	51	6	98	2	0
Persian Small	M	34	4	97	3	0
Planter's Jumbo	A	17	2	0	0	100
PMR 5	USDA	17	2	0	0	100
PMR 6	USDA	17	2	0	0	100
Pollock Rocky Ford	W	17	2	0	0	100
Pride of Wisconsin	F	17	2	0	35	65
Rocky Ford	G	17	2	0	0	100
Rocky Ford	W	17	2	0	0	100
Santa Claus Casaba	NK	17	2	42	29	29
Saticoy Hybrid	H	34	4	97	3	0
Saticoy Hybrid	S	34	4	100	0	0
Saticoy Hybrid	PS	34	4	100	0	0
Schoon's Hard Shell	NK	17	2	0	12	18
Sharon Hybrid	HA	17	2	94	6	0
Shipmaster	NK	17	2	0	0	100
Sierra Gold	NK	17	2	0	12	88
S.J. 45	A	86	11	0	0	100
Smith's Perfect	A	34	4	71	12	18
Smith's Perfect	NK	34	4	66	0	34
Snake Melon	B	26	3	77	8	15
Snake Melon	NK	32	4	81	3	16
SR-59	A	17	2	0	0	100
SR-59	NK	17	2	0	0	100
SR-91	FM	30	4	0	0	100
SR-91 Bush	UCD	17	2	0	0	100
Star-Trek Hybrid	H	17	2	0	24	76
Sugar Salmon	S	17	2	0	0	100
Spartan Rock	NK	51	6	16	12	72
Summet Hybrid	A	16	2	0	81	19
Sungold Casaba	F	17	2	94	6	0
Super Market Hybrid	H	17	2	0	6	94
Sweet Granite	F	17	2	59	0	41
TAM Dew	D	17	2	88	12	0
TAM Dew Improved	M	34	4	91	9	0
TAM Uvalde	NK	17	2	0	0	100
TAM Uvalde	W	17	2	0	0	100
Texas Resistant No. 1	W	17	2	0	0	100
Top Mark	A	84	11	0	0	100
Top Mark	NK	17	2	0	0	100
Top Mark	W	17	2	0	0	100
Top Net	M	26	3	0	0	100
Top Score	PS	17	2	0	0	100
Turkey	W	17	2	0	6	94
Valley Gold	M	50	6	98	2	0
Vine Peach Mango Melon	N	34	4	82	18	0
Westside	UCD	25	3	0	0	100
Yellow Canary	D	34	4	82	18	0

[a] Seed sources: A = Asgrow Seed Co.; ARO = Agriculture Research Organization, Israel; B = Burpee Seed Co.; D = Dessert Seed Co.; F = Farmer Seed Co.; FM = Ferry-Morse Seed Co.; G = Gurney Seed Co.; H = Harris Seed Co.; HA = Hazera Seed Co., Israel; INRA = Institut National Recherche Argonomique, France; M = Moran Seed Co.; N = Nichols Seed Co.; NK = Northrup-King Seed Co.; P = Park Seed Co.; PS = Petoseed Co.; S = Stokes Seed Co.; TAM = Texas A&M University; UCD = University of California, Davis; USDA = U.S. Department of Agriculture; and W = Willhite Seed Co.

[b] Utilizing eight or nine seedlings.

wilt-resistant were classified as highly resistant: Chaca Hybrid, Chando Hybrid, Doublon, Early Dawn Hybrid, Early Dew Hybrid, Makdimon Hybrid, Oval Chaca Hybrid, and Saticoy Hybrid. Twenty-three other cultivars not designated Fusarium wilt-resistant when released were also classified as highly resistant: Bellegrade, Crenshaw, Dark Green Spanish, Doney Melon, Earl's Favorite, Golden Crenshaw, Honeyloupe, Honeydrip Hybrid, Honey Gold No. 9, Juan Canari, Mashad Melon No. 1, Mashad Melon No. 2, Noy 50, Perlita, Perlita Bush, Persian Small, Sharon Hybrid, Snake Melon, Sungold Casaba, TAM Dew, Valley Gold, Vine Peach Mango Melon, and Yellow Canary (Table 1).

The cultivar Perlita, *C. melo* var. *reticulatus*, and the Snake Melon (Serpent Melon or Armenian cucumber), *C. melo* var. *flexuosus*, ranged from 76 to 82% resistant, but 12–18% were killed by race 2 (Table 1). The progenies from resistant self-pollinated mother plants of Perlita and Snake Melon were highly resistant (88–100% resistant) and no seedlings were killed by race 2 during the test period (Table 2). This suggests that the original seed sources (Table 1) were segregating for resistance.

Progenies from 19 resistant selfed mother plants representing 12 cultivars in the high resistance class had about the same level of Fusarium wilt-resistance as in the original seed lots tested. These data suggest that the cultivars Crenshaw, Dark Green Spanish, Doney Melon, Earl's Favorite, Golden Crenshaw, Honey Dew, Honeyloupe, Juan Canari, Mashad Melon No. 1, Persian Small, TAM Dew, and Valley Gold had homogeneous resistance to race 2 (Table 2). No consistent or significant increases in the level of Fusarium wilt-resistance over the original seed lots were found in the progenies of 14 resistant selfed mother plants representing nine cultivars in the intermediate resistance class (Table 2). It appears that the progenies from Fusarium wilt-resistant plants of Delicious 51, Granite State, Harvest Queen, Iroquiois, Minnesota Honey, Minnesota Midget, Morgan, Smith's Perfect and Spartan Rock had homogeneous resistance. This intermediate level of Fusarium wilt-resistance, however, is overcome in some plants at high concentrations of inoculum (10^6 conidia per milliliter).

Progenies from eight Fusarium wilt-resistant selfed mother plants representing five hybrid cultivars in the high resistance class segregated for resistance (Table 2). Genetic analyses for a limited F_2 population of the hybrid cultivars Chaca, Chando, Early Dawn, Oval Chaca, and Saticoy indicate that these hybrids are homogeneous for Fusarium wilt-resistance and that a single dominant gene in the host confers wilt-resistance.

DISCUSSION

The inoculation method used gave consistent and reproducible results. This is clearly shown by the reaction of the differential cultivars and the reference (wilt-susceptible) cultivars S.J. 45 and Top Mark. A total of 242 seedlings of resistant Doublon were tested and none were susceptible to Fusarium wilt. The differential cultivars susceptible to race 2, Charentais T and CM 17-187, and the known susceptible cultivars S.J. 45 and Top Mark comprise a combined total of 930 seedlings tested and none were Fusarium wilt-resistant. The reaction of these known susceptible cultivars indicate that few, if any, susceptible seedlings would have escaped detection in our testing procedures. It should also be noted that when two or more sources of the same cultivar were tested, the reactions were in reasonable agreement. The relatively high inoculum concentration used, however, may have prevented detection of low levels of resistance. The relationship of wilt severity to inoculum concentration has been reported (2,5,17) and Douglas (5) suggested that a range of inoculum concentration should be used in testing new breeding material.

The germ plasm we evaluated ranged from highly resistant to susceptible to Fusarium wilt. Just how broad this genetic base is for resistance to race 2 is not known. Risser et al (14,16) reported two race-specific dominant genes for host resistance: *Fom 1* in cultivar Doublon and *Fom 2* in cultivar CM 17-187. Gene *Fom 1* confers resistance to races 0 and 2 and *Fom 2* confers resistance to races 0 and 1.

In our search for Fusarium wilt-resistance in a western shipping-type muskmelon, a single dominant gene for resistance was found in the cultivar Perlita (*unpublished*). This gene also confers resistance to races 0 and 2. Allelism tests made by crossing homozygous wilt-resistant Perlita with homozygous wilt-resistant Doublon indicated two different dominant genes for Fusarium wilt-resistance that are independently inherited.

Leach and Currence (7) tested numerous cultivars of muskmelons on naturally infested soil in the field in Minnesota and found some resistant plants in Casaba, Honey Ball, Honey Dew, and a Persian type cultivar. Many of the Fusarium wilt-resistant cultivars receive their genetic resistance from a chance hybrid between a resistant Honey Dew plant and Bender-like susceptible cultivar or from selections from this hybrid: Minnesota 73-33 and 10-38, Plant Breeding No. 12, and Plant Breeding No. 13 (4,9,13).

Cultivars tested for resistance to race 2 of the *Fusarium* pathogen (Table 1) and reported to have the Minnesota source of resistance are Delicious 51, Harper Hybrid, Harvest Queen, Honey Rock FR, Iroquois, Minnesota Honey, Minnesota Midget, Spartan Rock, and Sweet Granite (4,7,8,11–13). These cultivars ranged from 12 to 70% resistant in our study and were placed in the intermediate-resistance class.

Inheritance of Fusarium wilt resistance in muskmelon studies by Mortensen (12) using the Minnesota source of resistance (Delicous 51, Iroquois, and Plant Breeding No. 13) indicated that there is a single major dominant gene for resistance (race not reported). He also suggested that plants recessive for this gene may be Fusarium wilt-resistant if they are dominant for two other complementary genes.

Several facts established by this investigation merit further discussion because they are of general significance to pathologists. Race reactions of the San Joaquin Valley isolates (6) were similar to those of Michigan isolates studied by Banihashemi and de Zeeuw (2). Neither Michigan nor San Joaquin Valley isolates produced symptoms on the cultivar Doublon but caused wilt and death of Charentais T, Ogon No. 9, and CM 17-187, the expected reaction for race 2 on the differential cultivars of Risser et al (14–16). Leary and Wilbur (8)

Table 2. Reaction of muskmelon progenies from self-pollinated resistant plants to artificial inoculation with *Fusarium oxysporum* f. sp. *melonis* race 2 under greenhouse conditions

Fusarium wilt reaction class and cultivar	Source[a]	Seedlings: Total tested (no.)	Seedlings: Inoculation tests[b] (no.)	Seedling reaction: Resistant (%)	Seedling reaction: Diseased (%)	Seedling reaction: Dead (%)
High resistance class						
Chaca Hybrid	N	33	2	82	0	18
Chando Hybrid	A	34	2	68	0	32
Crenshaw	A	34	2	82	18	0
Crenshaw	NK	34	2	88	12	0
D. G. Spanish	D	31	2	84	16	0
D. G. Spanish	D	26	2	92	8	0
Doney Melon	N	34	2	100	0	0
Doney Melon	N	33	2	100	0	0
Earl's Favorite	FM	34	2	85	15	0
Early Dawn Hybrid	H	34	2	79	0	21
Early Dawn Hybrid	H	31	2	84	0	16
Golden Crenshaw	M	31	2	84	16	0
Honey Dew	A	34	2	85	15	0
Honey Dew	M	33	2	94	6	0
Honeyloupe	UCD	34	2	82	18	0
Juan Canari	M	32	2	94	6	0
Juan Canari	M	34	2	88	12	0
Mashad Melon No. 1	UCD	30	2	100	0	0
Oval Chaca Hybrid	P	34	2	85	0	15
Oval Chaca Hybrid	P	34	2	68	0	32
Perlita	A	34	2	94	6	0
Perlita	A	33	2	100	0	0
Perlita	M	33	2	91	9	0
Perlita	NK	34	2	100	0	0
Persian Small	A	34	2	100	0	0
Persian Small	M	34	2	97	3	0
Saticoy Hybrid	H	34	2	71	0	29
Saticoy Hybrid	PS	34	2	65	0	35
Snake Melon	B	34	2	88	12	0
Snake Melon	NK	34	2	91	9	0
TAM Dew Improved	M	33	2	88	12	0
Valley Gold	M	34	2	100	0	0
Valley Gold	M	34	2	100	0	0
Intermediate resistance class						
Delicious 51	H	33	2	34	48	18
Delicious 51	NK	28	2	43	32	25
Granite State	P	34	2	24	29	47
Harvest Queen	A	34	2	44	32	24
Harvest Queen	NK	34	2	38	47	15
Iroquois	H	34	2	38	47	15
Iroquois	S	33	2	30	58	12
Minnesota Honey	F	34	2	59	26	15
Minnesota Midget	F	34	2	44	50	6
Morgan	M	34	2	53	27	20
Morgan	M	34	2	47	32	21
Smith's Perfect	A	34	2	65	12	23
Smith's Perfect	NK	30	2	57	17	26
Spartan Rock	NK	34	2	23	30	47
Differential cultivars (Fusarium wilt susceptible and resistant)						
Charentais T Cal. sib.	UCD	132	8	0	0	100
CM 17-187 Cal. sib.	UCD	127	8	0	0	100
Doublon Cal. sib.	UCD	135	8	100	0	0
Reference cultivars (typical of susceptible U.S. cultivars)						
S.J. 45	A	130	8	0	0	100
Top Mark	A	134	8	0	0	100

[a] Seed sources: A = Asgrow Seed Co.; ARO = Agriculture Research Organization, Israel; B = Burpee Seed Co.; D = Dessert Seed Co.; F = Farmer Seed Co.; FM = Ferry-Morse Seed Co.; G = Gurney Seed Co.; H = Harris Seed Co.; HA = Hazera Seed Co., Israel; INRA = Institut National Recherche Argonomique, France; M = Moran Seed Co.; N = Nichols Seed Co.; NK = Northrup-King Seed Co.; P = Park Seed Co.; PS = Petoseed Co.; S = Stokes Seed Co.; TAM = Texas A&M University; UCD = University of California, Davis; USDA = U.S. Department of Agriculture; and W = Willhite Seed Co.

[b] Utilizing 17 seedlings.

reported two races occurring in Riverside County, CA. The differential cultivars' wilt responses to their isolate X-38 were CM 17-187 resistant and Charentais T and Doublon susceptible, and to their isolate X-22, CM 17-187, Charentais T, and Doublon were susceptible, indicating race 1 and race 1-2, respectively (designation of Risser et al [16]).

In contrast, Armstrong and Armstrong (1) tested isolates from Canada and the United States (Michigan, Minnesota, North Carolina, Washington, and Wisconsin) and reported Doublon, Ogon No. 9, CM 17-187 as Fusarium wilt-resistant and Charentais T as susceptible. They also reported that Edisto 47 was resistant (we found it susceptible) and that Makdimon Hybrid was susceptible (we found it resistant). These contradictions are significant, and we do not believe they can all be accounted for by differences in methods and environmental conditions. Thus, there appears to be evidence for occurrence of several races of this pathogen in North America.

Studies are now under way to identify the mode of inheritance of Fusarium wilt resistance in the germ plasm reported in this study, to determine the genetic relationship among the sources of resistance, and to incorporate this resistance into a shipping-type cultivar for production in California.

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