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Research Note

Evaluation of Muskmelon Germplasm for Resistance to Fusarium Wilt

E. R. Champaco, R. D. Martyn and M. E. Miller[1]

Department of Plant Pathology and Microbiology Texas A&M University College Station, TX 77843

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ABSTRACT

Twenty five muskmelon *(Cucumis melo* L.) cultigens (named varieties and breeding lines) were root-dipped inoculated with four races of *Fusarium oxysporum* f. sp. *melonis* over a two year period and evaluated for resistance. Breeding line 'MR-1' was resistant to *F. o.* f. sp. *melonis* races 0, 1, and 2, as reported by others, but susceptible to race 1,2w. Six varieties were resistant to both race 0 and race 2 of *F. o.* f. sp. *melonis.* None of the varieties or breeding lines tested were resistant to race 1 or 1,2w. Of the four known races of *F. o.* f. sp. *melonis*, only race O has been reported in Texas.

RESUMEN

Veinticinco cultivares de melón (*Cucumis melo* L.) que incluyeron variedades de nombre y lineas mejoradas fueron inoculadas mediante inmersión de raiz con cuatro razas de *Fusarium oxysporum* f. sp. *melonis* por un período de dos años y se evaluó su resistencia. La linea mejorada 'MR-1' fué resistente a las razas 0, 1 y 2 de *F. o.* f. sp. *melonis*, como ha sido reportado por otros autores, pero fué susceptible a la raza 1,2w. Seis variedades fueron resistentes a las razas 0 y 2 de *F. o.* f. sp. *melonis.* Ninguna de las variedades o lineas mejoradas probadas fueron resistentes a las razas 1 o 1,2w. De las cuatro razas conocidas de *F. o.* f. sp. *melonis*, solo la raza 0 ha sido reportada en Texas.

Fusarium wilt *(Fusarium oxysporum* (Schlechtend: Fr.) W. C. Snyder & H. N. Hans. f. sp. *melonis* (Leach & Curr.) of muskmelon (*Cucumis melo* L.) can have serious negative impact on production. The disease was first reported in 1930 in New York (Chupp, 1939) and in 1931 in Minnesota (Leach and Currence, 1938). It is now widespread throughout many of the muskmelon producing regions of the world, including the United States, France, Israel, and Canada. There are currently four described races of *F. o.* f. sp. *melonis* (Risser et al., 1976): race 0, 1, 2, and 1,2. Race 1,2 is further subdivided into 1,2y (yellows strain) and 1,2w (wilt strain). These races are designated on their ability to overcome wilt resistance genes in muskmelon host differentials. Risser et al. (1976) have identified two wilt resistance genes in muskmelon: Fom-1 in 'Doublon' and 'Perlita FR' and Fom-2 in '1088 CM 17-187'. 'Perlita' was released as a powdery and downy mildew resistant muskmelon (Correa, 1964), but it also has resistance to *F. o. melonis* race 0 and 2 (Zink, 1991), and, until recently, was grown extensively in South Texas. Race 0 of *F. o. f. sp. melonis* is pathogenic to cultivars lacking both wilt resistance genes (e.g. 'Topmark'). Thus, Fom-1 confers resistance to *F. o.* f. sp. *melonis* race 0 and 2, and Fom-2 confers resistance to races 0 and 1. Race 1,2 overcomes both these resistance genes.

In 1986, muskmelon producers in South Texas suffered high economic losses due to the occurrence of a root rot/vine decline disease new to Texas and locally referred to as root rot (Champaco et al., 1988 and Champaco, 1990). The disease has persisted through the 1992 season. The incidence and severety of root rot appeared to be associated with plant maturation and wet, clay soils. Symptoms included leaf yellowing and die-back of of the crown leaves, a cortical rot of the taproot and lateral roots, and discoloration of the vascular system in the roots and crown. The disease has some symptoms similar to both Fusarium wilt and Fusarium crown and foot rot (*Fusarium solani* f. sp. *cucurbitae*) of squash.

Additionally, in 1987, Fusarium wilt of muskmelon was reported for the first time in Texas (Martyn et al., 1987). Although the etiology of this root-rot/vine decline disease had not been determined, its occurrence in the Lower Rio Grande Valley, combined with the recent discovery of *F. o.* f sp. *melonis*, and an increase in use of susceptible hybrid muskmelon varieties in the Lower Rio Grande Valley were the impetus for this study.

Identification of resistance genes and the development of varieties with resistance to Fusarium wilt is important for establishing effective control of this disease. The selection and improvement of two muskmelon breeding lines from 'PI-124111' has had considerable interest to those associated with muskmelon breeding. Cohen and Eyal (1987) released 'PI-124111F' in Israel and 'MR-1' was released in the United States by Thomas (1986). Both lines have reported resistance to powdery mildew, downy mildew, and to races 0, 1, and 2 of *F. o.* f. sp. *melonis*. Information, however, on the disease response of 'MR-1' to race 1, 2 of *F. o.* f. sp. *melonis* was lacking. Subsequently, 'MR-1' was shown to be susceptible to race 1,2 of *F. o.* f. sp. *melonis* by Champaco et al. (1989) and Zink and Thomas (1989). Although race 1,2 has not been reported in the United States, information on the disease reaction of 'MR-1' to this race is of considerable importance to the development of resistant cultivars.

The purpose of this present investigation was to evaluate the disease reaction of 21 muskmelon cultivars and hybrids (cultigens), many of which are grown in the Rio Grande Valley of Texas, and the breeding line 'MR-1' to the four races of *F. o.* f. sp. *melonis*.

[1] Texas Agricultural Experiment Station, Texas A&M University, 2415 East Highway 83, Weslaco, Texas 78596

MATERIALS AND METHODS

The Fusarium strains used were obtained from the stock collection maintained at the Fusarium Lab at Texas A&M University. The isolates of *F. o.* f. sp. *melonis* race O originated from Maryland (E.M. Dutky, University of Maryland, College Park, MD) and Texas (R. D. Martyn, College Station, TX). Race 1 was also from Maryland and race 2 was obtained from T. R. Gordon, University of California, Berkeley, CA. Race 1,2w originated from France and was obtained from D. Netzer, The Volcani Center, Bet Dasan, Israel. All isolates were imported under one or more of the following USDA, APHIS, PPQ permits: 2/82, 1/83, 5/87, 2/90, 900549. Each isolate was maintained as single-spored cultures in sterile soil. Muskmelon seeds of the varieties were obtained from commercial seed companies. The host differentials, 'Doublon', '1088 CM 17-187', and 'Perlita FR' were obtained from F. Zink (University of California, Davis, CA). Breeding line 'MR-1' was obtained from C. Thomas (USDA ARS, Charleston, SC).

Inoculum of each pathogen was increased by placing several granules of soil culture in 50 ml of a Fusarium mineral salts liquid medium (Esposito and Fletcher, 1961) in a 250 ml Erlenmeyer flask, and incubating on a rotary shaker at 100 rpm and 25± 2 C under continuous fluorescent light (860 μE/m²/sec) for 3-4 days. After incubation, they were filtered through eight layers of sterile cheesecloth and the microconidial suspension adjusted to 1×10^6 microconidia/ml.

Muskmelon seeds were surface-disinfested in 10% bleach (0.525% NaOCl) for 60 sec, rinsed in sterile distilled water, and planted in seeding flats containing a 4:4:1 (v:v:v) potting mixture of vermiculite:perlite:peat moss. At emergence of the first true leaves (approximately 10 days), seedlings were uprooted, gently washed under running water to remove surrounding potting mixture, root-dipped in the respective inoculum or water for 20-30 sec, and transplanted into 15-cm-dia pots (1,700 cm³) containing a 8:2:2:1 mixture of pasteurized sand:vermiculite:perlite:peat moss. Depending on the number of available seedlings, there were 2, 3, or 4 seedlings per pot, and 3 or 4 replications of each treatment. Observations were made at 1-2 day intervals and percent dead plants recorded. Incolulated seedlings were maintained for 3 weeks. The data presented in Table 1 are the combined data of four experiments performed over a 2-year period. Each entry was tested at least twice and some were tested three times. Data collected were transformed using an arcsine transformation and weighted prior to analysis of variance. Means were separated using Fisher's LSD test ($a = 0.05$).

RESULTS AND DISCUSSION

The race differentials ('Doublon', '1088 CM 17-187', and 'Perlita') were resistant to both strains of race O of *F. o.* f. sp. *melonis*, as reported, while the standard universal suscept 'Topmark' was susceptible (Table 1). Percent dead plants among susceptible cultivars inoculated with both isolates of race O ranged from 42 to 100%. Despite this variation in range, the general

Table 1. Disease reaction of muskmelon cultigens to race 0, 1, 2, and 1,2w of *Fusarium oxysporum* f. sp. *melonis*.

	Percent Dead Plants				
	Fusarium oxysporum f. sp. *melonis*				
Cultigen	Race 0 (Maryland)	Race 0 (Texas)	Race 1 (Maryland)	Race 2 (California)	Race 1, 2w (France)
Topmark	96 a	100 a	75 b	100 a	100 a
Doublon	0 b	0 e	68 b	0 e	100 a
1088 CM 17-187	0 b	0 e	0 c	96 a	100 a
Perlita FR	0 b	0 e	71 b	0 e	——
Perlita	——	0 e	81 b	0 e	100 a
MR-1	0 b	0 e	8 c	0 e	100 a
Aragon	94 a	96 a	96 a	100 a	75 bc
Challenger	100 a	96 a	82 a	100 a	100 a
Easy Rider	——	0 e	81 b	0 e	100 a
Explorer	——	92 a	100 a	72 abc	75 bc
FMX 47	——	100 a	94 a	44 cd	81 ab
Grande Gold	94 a	67 b	100 a	88 abc	100 a
Hiline	0 b	0 e	98 a	0 e	95 a
HMX 5601	——	33 cde	100 a	0 e	100 a
Hymark	100 a	42 bcd	90 ab	76 abc	69 cd
Laguna	0 b	4 e	100 a	6 e	94 a
Magnum 45	100 b	98 a	98 a	74 abc	75 bc
Mission	100 b	100 a	100 a	84 abc	44 d
Perlita 45	——	44 bcd	94 a	19 de	100 a
PSX 1983	0 b	0 e	96 a	0 e	100 a
PSX 2083	12 b	0 e	92 a	0 e	100 a
Sunshine	95 a	100 ab	95 a	58 cd	100 a
Topflight	100 a	88 a	93 a	92 ab	100 a
XPH 5363	100 a	——	100 a	81 abc	100 a
XPH 5364	100 a	96 a	97 a	93 ab	81 ab

Means followed by the same letters down a column are not significantly different based on Fisher's LSD TEST ($a = 0.05$) (——) Not included in test

trend exhibited by the cultivars and wilt differentials inoculated with either strain were similar. Eight cultivars ('Aragon', 'Challenger', 'Grande Gold', 'Magnum 45', 'Mission', 'Sunshine', 'Topflight', and 'XPH 5364') were susceptible to both strains. 'XPH 5363' was not tested against the Texas isolate of race O; however, it was susceptible to the Maryland isolate of race O. 'Hymark' appeared to be more resistant to the Texas race O isolate than to the Maryland race O isolate (Table 1). '1088 CM 17-187' and 'MR-1' were the only lines that exhibited significant resistance to race 1 of *F. o* f sp. *melonis* (Table 1). Statistically significant differences were observed among the remaining 21 cultigens, but the percent dead plants ranged from 68 to 100 and were not considered biologically significant.

In contrast to race 1, 'Doublon', 'Perlita FR', and 'Perlita' were resistant to race 2 of *F. o.* f. sp. *melonis*, whereas '1088 CM 17-187' and 'Topmark' were susceptible (Table 1). Six other cultigens also had a high level of resistance to race 2. These were 'Easy Rider', 'Hiline', 'HMX 5601', 'Laguna', 'PSX 1983' and 'PSX 2083'. All cultigens tested were susceptible to the French isolate of race 1,2w. 'Mission' appears to show some resistance to race 1,2w with only 44% dead plants (Table 1); however, this is an anomaly. The data reported are the average from several combined tests conducted over a 2-year period. In two of those tests, 'Mission' was severely affected and showed no resistance to race 1,2w, while in another test, the plants were affected very little. This is presumed to be the result of ineffective inoculum in those pots, perhaps induced by different environmental conditions at the time. Therefore, it is our opinion that 'Mission' does not express resistance to race 1,2w.

Zink et al. (1993) evaluated the disease reaction of 127 muskmelon cultivars to race 2 of *F. o* f. sp. *melonis* under greenhouse conditions. However, their study was performed in 1983 and many of the newer hybrids currently grown in Texas were not included. A more recent screening test conducted under field conditions over a 3 year period was reported by Ng and Kantzes (1989). Included in their study were more than 50 muskmelon varieties planted in a field known to be infested with both race 1 and race 2 of *F. o* f. sp. *melonis*. The results were based on plant survival ratings due to the combined effects of race 1 and race 2, but failed to identify the disease reaction of varieties to either race 1 or race 2 individually.

The results of our experiments confirm the findings of Zink and Thomas (1989) that breeding line 'MR-1' has high levels of resistance to *F. o.* f. sp. *melonis* races O, 1, and 2. 'MR-1', however, is highly susceptible to race 1,2w. The advantage of this breeding line is that it is the only breeding line other than 'PI-124111F' (Cohen and Eyal, 1987) with resistance to race 0, 1, and 2 of *F. o* f. sp. *melonis*. An additional advantage of 'MR-1' is its high level of resistance to powdery mildew and downy mildew (Thomas, 1986) and to *Alternaria cucumerina* (Thomas, et al., 1990).

When this study was conducted, the causal agent of the new root rot/vine decline disease was still unknown. However, evaluation of 12 muskmelon cultivars for vine decline symptoms planted in replicated field trials at four locations in the LRGV consistently showed that cultivars 'Mission' and 'Magnum 45' were the most severely diseased (Champaco, et al., 1988). These two cultivars also were used in this study and were susceptible to all races of *F. oxysporum* f. sp. *melonis*. Subsequently, *Monosporascus cannonballus* was shown to be a primary causal agent of a root rot/vine decline disease of muskmelons in the LRGV (Mertely, et al., 1991). 'Mission' and 'Magnum 45' also are susceptible to this fungus (Mertely, et al, in press). It is possible that the extreme severity of root rot/vine decline observed in some cultivars and at certain locations is the result of a disease complex, ie. two or more pathogens infecting the plant at the same time.

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