

A NEW PHYSIOLOGIC RACE (RACE 4) OF *FUSARIUM*  
*OXYSPORUM* F. SP. *MELONIS*<sup>1</sup>

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ABSTRACT

Based on the differential hosts of Risser & Mas, two distinct physiologic races, race 2 and a new race 4 of *Fusarium oxysporum* f. sp. *melonis* (Leach & Currence) Snyder & Hansen were indentified among Iranian and North American isolates, respectively. The Iranian isolate was capable of infecting the resistant muskmelon variety Persian Small Type whereas the North American isolates failed to infect it. One of the U.S. isolates identified as race 4 is a type common in Michigan. Several of the U.S. and Canadian isolates appeared to be similar to Michigan isolates.

Inoculum concentration was found to be important in relation to intensity of disease caused by both races on 6 muskmelon varieties.

INTRODUCTION

There have been conflicting reports on races of *Fusarium oxysporum* f. sp. *melonis* (Leach and Currence) Snyder & Hanson. Miller (4,5) stated that the muskmelon wilt fungus exists in nature as a "wild type" characterized by abundant aerial mycelium when first cultured. Cultural mutants with less aerial mycelium and lowered pathogenicity tend to displace the "wild type". But Reid (6), comparing soil cultures of the organism that he considered to be stable, found 9 macroscopically different types or cultural races that

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also differed in relative degree of pathogenicity. McKeen and Wensley (3) nevertheless preferred the concept of a "wild type" maintaining that mutants could be produced in sterile soil cultures such as Reid (6) depended on. Other features of morphology and growth other than the "wild type" were too readily variable to be evaluated objectively for race determination. Although Reid (7) found that differences in disease in different situations were best explained by races, Wensley and McKeen (10) concluded that population density was the controlling mechanism. Welty (9) obtained 17 isolates that differed in degree of virulence but could ascribe no race specific pathologic specialization. Recently, however, Risser and Mas (8) reported the existence of 3 distinct physiologic races of f. sp. *melonis* in France based on specific virulence toward a set of 4 differential host varieties.

In the present work attempts were made to compare pathogenicity of several North American and Iranian isolates of f. sp. *melonis* in muskmelon (*Cucumis melo* L.) varieties and to find whether distinct physiologic races exist among them. At the same time the relationship of inoculum level to disease produced by these isolates was studied. An abstract of this work has appeared earlier (1).

### MATERIALS AND METHODS

Michigan (M-4 & M-21) and Iranian (I-17) isolates were obtained from wilted melon plants and the single-spored sporodochial forms were stored in autoclaved soil. Isolates from Minnesota (supplied by Dr. C.J. Eide), Wisconsin and Ontario (obtained from Dr. G.M. Armstrong) were single-spored and maintained on PDA. Inocula were obtained by centrifuging and washing conidia from 3-day shake cultures. The conidia were washed 3 times with distilled water and their concentrations determined with a haemocytometer. Risser and Mas (8) differential varieties; Charentais T., Doublon, Ogon No. 9, and C.M. 17.187 (seeds supplied by Dr. G. Risser), and some Iranian and American melon varieties (Table 1) were used. Melon seedlings were grown in autoclaved vermiculite for 2 weeks, root-dipped in adjusted inoculum, transplanted into steam-sterilized soil and grown in the greenhouse at 25-30 C. Five to 10 seedlings were used for each isolate or inoculum level. Plants were examined daily and the number of yellowed, wilted or dead seedlings recorded during a 30 day test period. Plants that died following chlorosis or wilt during the test period were rated susceptible. Survivors with no symptoms of infection were considered resistant.

Table 1. American and Iranian muskmelon varieties used for race inoculation and inoculum concentration of *Fusarium oxysporum* f.sp. *melonis*.

Variety Number	Variety Name	Source
1	Rocky Ford	U.S.
2	Harvest Queen	" "
3	Honey Dew	" "
4	Smith's Perfect	" "
5	Persian Small Type	" "
6	P-1 (Kadkhoda Hosseinie Sabz)	Iran
7	P-3 (Baba-Kharman Darreh-Gas)	" "
8	P-6 (Shakhteh Mashad)	" "
9	P-5 (Kadkhoda Hosseini Zard)	" "
10	P-2 (Langrood)	" "
11	Spartan Rock	U.S.
12	Hales Best Jumbo	" "
13	Burpee Hybrid	" "
14	Pride of Wisconsin	" "
15	Schoon's Hard Shell	" "
16	Delicious 51	" "
17	Casaba	" "
18	Hearts of Gold	" "
19	Milwaukee Market	" "
20	Honey Rock	" "

## RESULTS AND DISCUSSION

Although the Iranian isolate caused typical chlorosis, wilt, and death of the variety Persian Small Type and 5 Iranian varieties, the North American isolates used in this work did not (Table 2). Inoculations of Iranian and Michigan isolates on differential varieties of Risser and Mas indicated that the Iranian isolate was similar or identical to race 2 (8). The Michigan isolates, on the other hand, differed from all three races in pathogenicity on the differential varieties and were considered to be of a new race (Race 4) of *F. oxysporum* f. sp. *melonis* according to Risser and Mas' classification (8). All of the North American isolates tested failed to infect the variety Persian Small Type and probably belonged to race 4. Since we did not have access to the actual isolates used by Risser and Mas, reactions of differential hosts used by the authors to the original 3 races are not known. Further investigations with additional differential hosts are needed to show if the Iranian isolate is identical to race 2 or not.

All 20 American and Iranian melon varieties (Table 1) used were susceptible to the Iranian isolate (I-17) at inoculum concentrations of  $10^6$  conidia/ml. Partial resistance was evident in some Iranian varieties such as P-1, P-2 and P-3 (Fig. 1-A). All of the Iranian varieties (P-1,2,3,5,6) and 2 American varieties (Persian Small Type and Smith's Perfect) were highly resistant to Michigan isolates (M-4 and M-21). Spartan Rock wilted when inoculated with Michigan isolates but only 10-20% of the plants died (Fig. 1-A).

Reactions of a differential group of 6 varieties (Fig. 1-B) to Michigan (M-4) and Iranian (I-17) isolates of f. sp. *melonis* indicated that the Iranian isolate could infect all varieties at  $10^4$  conidia/ml. High inoculum concentrations of the Michigan isolate were required to infect 3 of the varieties, Nos. 1,2 and 3 (Fig. 1-B). Stem reisolations of Michigan isolate could only be made from resistant varieties P-1 and Smith's Perfect (Nos. 4 and 6) where inoculum at  $10^7$  conidia/ml or higher was used. This isolate could not be recovered from Persian Small Type (No. 5) at any rate.

Inoculum concentrations thus proved to have an important influence on disease expression and our results agree with those obtained by Douglas (2). The Michigan isolate required a higher level of inoculum than did the Iranian isolate to produce a given level of disease on melon varieties otherwise equally susceptible to both races. This may be an important factor in breeding programs in which physiologic races are to be considered.

Previous lack of evidence for host specific physiologic specialization in the musk-

Table 2. Reaction of muskmelon varieties to isolates of *Fusarium oxysporum* f. sp. *melonis* and comparison to the race reactions of Risser and Mas differential varieties.

Variety	Source of Isolate Tested					Race reaction after Risser & Mas (8)		
	Iran	Mich.	Wis.	Minn.	Canada	Race 1	Race 2	Race 3
Persian Small Type	S	R	R	R	R	--	--	--
P-1	S	R	R	R	R	--	--	--
P-2	S	R	R	R	R	--	--	--
P-3	S	R	R	R	R	--	--	--
P-5	S	R	R	R	R	--	--	--
P-6	S	R	R	R	R	--	--	--
Iroquois	S	S	S	S	S	--	--	--
Charentais T.	S	S	--	--	--	S	S	S
Doublon	S	R	--	--	--	R	S	S
Ogon No. 9	R	S	--	--	--	R	R	S
C.M. 17. 187	R	S	--	--	--	R	R	S

S= susceptible (plant died in the test period of 30 days)

R= resistant

-- = Not tested

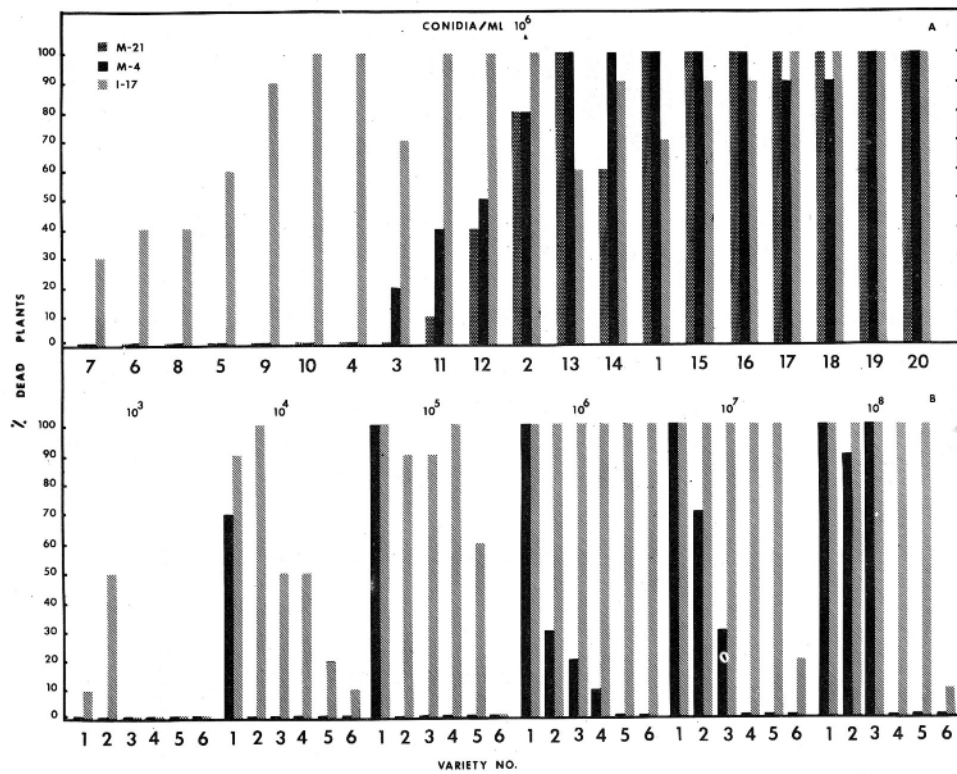


Fig. 1. (A) Relative susceptibility of 20 muskmelon varieties to Iranian(I-17) and Michigan (M-4 and M-21) isolates of *Fusarium oxysporum* f. sp. *melonis* after root dip inoculation in  $10^6$  conidia/ml. (B) Influence of inoculum concentration (conidia/ml) on disease reaction of 6 muskmelon varieties inoculated with Iranian isolate (I-17) and Michigan isolate (M-4) of *F. oxysporum* f. sp. *melonis*. Percent dead plants 30 days after inoculation.

melon wilt *Fusarium* probably resulted from a relative homogeneity of North American forms. Isolates of race 4 differ quantitatively from each other and include many cultural differences but appear to have rather clear qualitative difference from races described by Risser and Mas (8).

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