

Races of *Fusarium oxysporum* f. sp. *ciceri*

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ABSTRACT

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Based on the differential reaction of 10 chickpea cultivars to pathogenic isolates of *Fusarium oxysporum* f. sp. *ciceri*, the existence of at least four races of the fungus has been demonstrated. It is suggested that these be called races 1, 2, 3, and 4.

Wilt of chickpea (*Cicer arietinum* L.), caused by *Fusarium oxysporum* Schlecht. emend. Snyd. & Hans. f. sp. *ciceri* (Padwick) Snyd. & Hans., was first

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described by Padwick (6) in 1940. It has since been reported from several countries (4). Resistance to this pathogen has been found (5); it is the result of a single recessive gene factor in the host (Jagdish Kumar, ICRISAT, *personal communication*). No evidence in the literature on the existence of races has been provided so far. In the multi-locational tests of lines resistant to the pathogen conducted by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), several lines were found susceptible to the pathogen at

some locations (2,3). This indicated the probable existence of physiologic races. This paper provides evidence of the existence of at least four races of *F. oxysporum* f. sp. *ciceri*.

MATERIALS AND METHODS

Acquisition of *Fusarium* isolates and inoculum production. Test isolates were obtained from diseased specimens collected from Jabalpur in central India and from Hissar, Gurdaspur, and Kanpur in northern India. An isolate from ICRISAT Center (Hyderabad) was also included.

All cultures of the isolates were derived from single macroconidia on 2% water agar and increased on fresh potato-dextrose agar on laboratory benches (7). Only colonies representative of the wild type were maintained in sand tubes (2 ml of conidial suspension placed on 10 g of

Table 1. Reaction of chickpea cultivars to five isolates of *Fusarium oxysporum* f. sp. *ciceri*^a

Cultivar	Reaction to isolate from ^b																			
	Hyderabad				Kanpur				Gurdaspur				Hissar				Jabalpur			
	1	2	3	4 ^c	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
JG-62	S	S	S	S	S	S	S	S	M	M	M	M	S	S	S	S	S	S	S	S
C-104	S	S	S	S	S	S	S	S	R	R	R	R	S	S	S	S	S	S	S	S
JG-74	R	R	R	R	S	M	S	M	R	R	R	R	R	R	R	R	R	R	R	R
CPS-1	R	R	R	R	S	S	S	S	S	S	S	S	M	M	M	M	S	M	M	M
BG-212	R	R	R	R	S	S	S	S	M	M	M	M	M	M	M	M	M	M	M	M
WR-315	R	R	R	R	R	R	R	R	S	M	M	M	R	R	R	R	R	R	R	R
Annigeri	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Chafa	S	S	S	S	S	S	S	S	S	M	M	M	S	S	S	S	S	S	S	S
L-550	S	S	S	S	S	S	S	S	M	M	M	M	S	S	S	S	S	S	S	S
850-3/27	S	S	S	S	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M

^a Readings were taken 40 days after inoculation. (Seedlings were transplanted into pathogen-infested soil in pots and maintained on a greenhouse bench at 25–30 C.)

^b R = Resistant (0–20% wilt), M = moderately susceptible (21–50% wilt), and S = susceptible ($\geq 51\%$ wilt) to the pathogen. Number of seedlings of each cultivar varied from 20 to 25 in different replicates.

^c The numbers 1–4 represent the four replicates carried out with each isolate.

autoclaved, fine riverbed sand in a glass tube and stored at 5 C.)

To produce inoculum of each test isolate, a small amount of infested sand from the sand tube was sprinkled on a potato-dextrose agar plate, and a resulting colony that appeared representative of the original type for each isolate was selected. After a 7-day incubation period (25 C), a small agar plug was cut from the margin of the colony, removed with a cork borer, and placed on 100 g of sand-maize meal in a 250-ml flask. The inoculated flasks were incubated for 14 days at 25 C. One hundred grams of inoculum (sand-maize meal) was mixed thoroughly with 2 kg of autoclaved soil (black Vertisol) and riverbed sand mixture (1:1) in a 15-cm plastic pot. Before use, pots were washed in running water, dipped for 5 min in 5% copper sulfate solution, rinsed in sterilized water, and then air-dried. The fungus was allowed to become established in the infested soil mixture for 4 days before the transplanting of seedlings. The level of inoculum that this method gave was just sufficient to produce 100% mortality in a chickpea cultivar such as JG-62, which is highly susceptible to the pathogen, within 20 days.

Seed source and planting procedure.

For all tests, seed of 10 cultivars was obtained from ICRISAT's Germplasm Resources Unit, which maintains the collection of world germ plasm of chickpea. These cultivars were chosen on the basis of resistant/susceptible reactions to the pathogen found at the different locations. For example, four of these cultivars (BG-212, JG-74, CPS-1, and WR-315) were found resistant to *F. oxysporum* f. sp. *ciceri* at ICRISAT Center (5), and the remaining six were susceptible. Seed of each test cultivar was surface disinfected by immersion in a

2.5% solution of sodium hypochlorite for 2–3 min before planting in autoclaved (120 C, 2 hr), fine riverbed sand in polythene bags.

Inoculations were accomplished by transplanting five 7-day-old seedlings into each pot of culture-infested soil. Uninoculated checks were kept for each cultivar. Seedlings were maintained on greenhouse benches for 40 days. Greenhouse temperatures were in the range of 25–30 C during the course of this study. The control cultivar JG-62 (susceptible to *F. oxysporum* f. sp. *ciceri*) usually died within 20 days. Wilt symptoms consisted of stunting, drooping of leaves, and usually death of the plants.

RESULTS

In tests repeated four times with five isolates of *F. oxysporum* f. sp. *ciceri* and 10 chickpea cultivars, consistent differences in resistance and susceptibility to the pathogen were observed (Table 1). Cultivar C-104 was resistant to the Gurdaspur isolate but not to the other four. Cultivar JG-74 was resistant to all isolates except the Kanpur one. Cultivars CPS-1 and BG-212 were resistant only to the ICRISAT Center (Hyderabad) isolate, but both were moderately susceptible to the Hissar and Jabalpur isolates. Cultivar WR-315 was resistant to all isolates except the Gurdaspur one. The other cultivars (Annigeri, Chafa, L-550, and 850-3/27) had little or no resistance to the pathogen, reacting more or less like the JG-62 control.

DISCUSSION

For race classification we have followed the criterion of using the resistance/susceptibility reaction of the host cultivar to the pathogen (1). A critical analysis of the data presented (Table 1) suggests the existence of four

racers. The Hyderabad isolate, which is distinguished from other isolates by using cv. CPS-1 and BG-212 (resistant to the pathogen), constitutes one race. The Kanpur isolate is distinguished by using cv. WR-315 (resistant to the pathogen) and JG-74 (susceptible) and the Gurdaspur isolate by using cv. C-104 and JG-74 (resistant to the pathogen). The Hissar and Jabalpur isolates are distinguished by using cv. CPS-1 (moderately susceptible to the pathogen).

We propose to call the ICRISAT Center (Hyderabad) isolate race 1, the Kanpur isolate race 2, the Gurdaspur isolate race 3, and the Hissar and Jabalpur isolates race 4 (Table 1).

We have been operating an international, multilocation, wilt-resistant nursery annually since 1976. The 1977–1978 and 1978–1979 nurseries included all of the 10 cultivars, and their reactions at all five locations were similar to those given in Table 1. The only exception was that of cv. BG-212. During a 2-yr trial at Jabalpur in a field infested with *F. oxysporum* f. sp. *ciceri* and root rot fungi, BG-212 was reported to be susceptible to the pathogen in the first year. In the next year, however, BG-212 showed less than 10% mortality (resistant reaction to the pathogen).

The reactions of most of the 10 lines tested at San Luis Obispo in California (J. C. Phillips, *personal communication*) were similar to those at ICRISAT Center, indicating that the most prevalent race in California is probably race 1.

Cultures of the four races (isolates) are being maintained at ICRISAT and have also been deposited with the culture collections at the Indian Agricultural Research Institute, New Delhi, and Commonwealth Mycological Institute, U.K.

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