

# Screening of world chickpea germplasm for resistance to fusarium wilt<sup>1</sup>

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## ABSTRACT

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Over 13 500 chickpea (*Cicer arietinum* L.) germplasm accessions from 40 countries were evaluated for resistance to race 1 of *Fusarium oxysporum* f.sp. *ciceri* at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, India. One hundred and sixty accessions were found resistant through field and pot screenings. Many of these resistant accessions originated from India and Iran. One hundred and fifty wilt-resistant lines were desi types as against ten kabuli types.

## INTRODUCTION

Chickpea wilt, caused by *Fusarium oxysporum* Schl. emend. Snyder and Hans. f.sp. *ciceri* (Padwick) Snyder and Hans (*Foc*) is widespread in Bangladesh, Ethiopia, India, Mexico, Myanmar, Pakistan, Spain, Tunisia and USA (Nene et al., 1989a). At least seven races of *Foc* are reported from almost all the chickpea-growing regions in the world (Haware et al., 1990). Race 1 is widespread in India. The pathogen is seed-borne and persists in soil in the absence of chickpea for more than 6 years and causes considerable yield losses (Haware et al., 1986). Therefore, use of resistant cultivars would be the best method to manage this disease. At the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, India, large-scale systematic screening of chickpea germplasm was initiated in 1976 (Nene and Haware, 1980). The purpose of the screening was to identify additional sources of resistance to this important disease of desi (seed colour: brown, yellow, black and green) and kabuli (seed colour: beige) chickpea, to make them

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available to breeders for use in chickpea improvement programmes, and to share them with ICRISAT cooperators all over the world. Over 13 500 germplasm accessions collected from 40 countries were screened for resistance to fusarium wilt (race 1) during 1976–1985 and this article reports our findings.

## MATERIALS AND METHODS

*Field screening.* A uniform disease nursery was developed in 2 years in 4 ha of deep black soil (Vertisol) by incorporating chopped wilted plants and growing the susceptible cultivar, JG 62 (Nene et al., 1981). Since 1976, the wilt nursery has been used to screen germplasm accessions and breeding materials. While screening germplasm, every third row was sown to JG 62 so that the performance of test lines could be evaluated and at the same time fungus inoculum maintained in the plot. The world collection of chickpea germplasm accessions maintained by the ICRISAT gene bank was screened from 1976 to 1985. Sowing was done in mid-October and harvesting in February. For initial evaluation of germplasm accessions, 40 seeds per accession were sown in a single row, 4-m long and 60-cm apart. Data on wilt incidence were recorded twice, 30 days after sowing and 7 days before harvest. Seeds of promising lines which showed less than 20% mortality in the first year of screening were harvested from healthy plants and these lines were planted in the wilt nursery next season in two replications, along with new germplasm accessions. Promising lines were critically evaluated and lines that showed less than 10% mortality in the field were selected. These selections were further screened in the wilt nursery and in pots to confirm their resistance.

*Pot screening.* Germplasm selections that were identified as resistant to wilt in field screening were screened in pots in screenhouses. The potting medium was prepared according to the method of Nene and Haware (1980). Inoculum was prepared from a single-spore culture of *Fusarium oxysporum* f.sp. *ciceri* race 1. The inoculum was multiplied for 20 days on 100 g of 9:1 sand-maize meal medium in 250-ml conical flasks at 25°C. The fungus on medium from five flasks was added to one pot (30 cm) containing 10 kg of autoclaved sand-soil (Vertisol) mixture (1:1). The inoculum was thoroughly mixed in the pots and ten seeds of susceptible cultivar JG 62 were sown in each pot. JG 62 normally showed wilting within 15 to 20 days after sowing. Wilted plants were incorporated into the same pot. These pots were then used for evaluating germplasm accessions that appeared promising in the field.

## RESULTS AND DISCUSSION

During 1976 through 1985, more than 13 500 germplasm accessions available at the ICRISAT gene bank were screened in the disease nursery. Only

TABLE 1

Some characteristics of chickpea lines resistant to fusarium wilt evaluated at ICRISAT Center, 1976-85

S.No.	IC No.	Origin	Flower colour <sup>a</sup>	Seed colour	Size <sup>b</sup>
1	11311	India	P	Brown	12.9
2	11312	India	P	Brown	15.9
3	11313	India	P	Yellow	14.2
4	11314	India	P	Brown	16.3
5	11315	India	P	Brown	12.9
6	11316	India	P	Yellow	16.4
7	11317	India	P	Brown	19.3
8	11318	India	P	Brown	17.7
9	11319	India	P	Brown	14.5
10	11320	India	P	Brown	14.8
11	11321	Iran	P	Brown	17.4
12	11322	India	P	Brown	13.6
13	11323	India	P	Brown	15.4
14	11324	India	P	Brown	14.3
15	12233	India	P	Brown	13.4
16	12234	India	P	Yellow	17.8
17	12235	India	P	Brown	15.0
18	12236	India	P	Brown	18.9
19	12237	India	P	Yellow	14.1
20	12238	India	P	Brown	11.8
21	12239	India	P	Brown	13.3
22	12240	India	P	Yellow	18.0
23	12241	Mexico	P	Yellow	13.6
24	12242	Mexico	P	Yellow	12.9
25	12243	Mexico	P	Brown	11.2
26	12244	Iran	P	Yellow	15.1
27	12245	Iran	P	Yellow	11.7
28	12246	Iran	P	Yellow	19.2
29	12247	Iran	P	Brown	15.5
30	12248	Iran	P	Brown	16.8
31	12249	India	P	Yellow	18.4
32	12250	Iran	P	Yellow	19.6
33	12251	India	P	Yellow	15.0
34	12252	India	P	Yellow	13.2
35	12253	India	P	Yellow	13.7
36	12254	Iran	P	Yellow	13.5
37	12255	Iran	P	Yellow	14.6
38	12256	India	P	Yellow	12.9
39	12257	India	P	Brown	19.9
40	12258	India	P	Brown	12.4
41	12259	India	P	Yellow	13.8
42	12267	India	P	Brown	19.0
43	12268	India	P	Brown	15.2
44	12269	India	P	Brown	15.1
45	12270	Iran	P	Yellow	11.5
46	12271	Iran	P	Yellow	14.2
47	12272	Iran	P	Brown	14.0

TABLE 1 (Continued)

S.No.	IC No.	Origin	Flower colour <sup>a</sup>	Seed colour	Size <sup>b</sup>
48	12273	Iran	P	Yellow	14.0
49	12274	Iran	P	Brown	14.4
50	12275	India	P	Brown	15.7
51	12428	India	W	Beige	18.1
52	12429	Mexico	W	Beige	13.8
53	12430	Spain	W	Beige	13.1
54	12431	India	W	Orange	15.0
55	12432	Ethiopia	W	Beige	24.2
56	12433	Ethiopia	W	Beige	13.3
57	12434	Ethiopia	W	Beige	18.9
58	12435	India	W	Beige	14.8
59	12437	India	P	Brown	13.2
60	12440	India	P	Yellow	14.4
61	12444	India	P	Brown	17.1
62	12450	India	P	Orange	13.1
63	12452	India	P	Yellow	12.9
64	12454	India	P	Yellow	11.0
65	12460	India	P	Yellow	13.3
66	12467	India	P	Yellow	13.3
67	12470	India	P	Brown	13.2
68	12471	India	P	Yellow	13.3
69	12472	India	P	Yellow	12.3
70	14364	India	P	Brown	11.8
71	14365	India	P	Yellow	10.5
72	14366	India	P	Brown	13.4
73	14367	India	P	Brown	16.7
74	14368	India	P	Brown	16.8
75	14369	India	P	Yellow	14.2
76	14370	India	P	Brown	15.6
77	14371	India	P	Brown	11.9
78	14372	India	P	Brown	15.0
79	14373	India	P	Brown	11.7
80	14374	India	P	Brown	11.8
81	14375	India	P	Brown	13.2
82	14376	India	P	Brown	10.3
83	14377	India	P	Brown	11.6
84	14378	India	P	Brown	12.3
85	14379	India	P	Brown	11.8
86	14380	India	P	Brown	11.9
87	14381	India	P	Yellow	11.7
88	14382	India	P	Yellow	14.0
89	14383	India	P	Brown	11.6
90	14384	Iran	P	Brown	10.8
91	14385	Iran	P	Brown	13.4
92	14386	Iran	P	Brown	13.6
93	14387	Iran	P	Brown	11.4
94	14388	Iran	P	Brown	13.2
95	14389	Iran	P	Brown	13.0

S.No.	IC No.	Origin	Flower colour <sup>a</sup>	Seed colour	Size <sup>b</sup>
96	14390	Iran	P	Brown	14.8
97	14391	Iran	P	Brown	12.4
98	14392	Cyprus	P	Yellow	11.1
99	14393	Iran	P	Yellow	17.6
100	14394	Iran	P	Brown	10.8
101	14395	Iran	P	Yellow	14.8
102	14396	India	P	Yellow	16.3
103	14397	India	P	Yellow	15.6
104	14398	Iran	P	Brown	16.7
105	14399	Iran	P	Brown	14.6
106	14400	Iran	P	Brown	15.7
107	14401	Turkey	P	Black	10.3
108	14402	Turkey	P	Yellow	15.0
109	14403	India	P	Brown	10.9
110	14404	Iran	P	Yellow	12.3
111	14405	Iran	P	Yellow	13.8
112	14406	India	P	Green	13.9
113	14407	Mexico	P	Brown	12.0
114	14408	India	P	Brown	17.4
115	14409	Iran	P	Brown	13.6
116	14410	Iran	P	Brown	11.1
117	14411	Iran	P	Yellow	12.9
118	14412	Iran	P	Yellow	10.4
119	14413	Iran	P	Yellow	13.8
120	14414	Iran	P	Brown	15.9
121	14415	Iran	P	Yellow	13.8
122	14416	Iran	P	Brown	13.1
123	14417	India	P	Brown	13.8
124	14418	India	P	Brown	10.6
125	14419	India	P	Green	15.5
126	14420	India	P	Yellow	14.6
127	14421	Iran	P	Yellow	12.6
128	14422	Iran	P	Yellow	13.1
129	14423	Iran	P	Yellow	12.8
130	14424	Iran	P	Yellow	12.2
131	14425	Iran	P	Yellow	12.3
132	14426	Iran	P	Yellow	12.6
133	14427	Iran	P	Yellow	18.2
134	14428	India	P	Brown	13.0
135	14429	India	P	Yellow	14.7
136	14430	India	P	Yellow	18.4
137	14431	India	P	Yellow	15.7
138	14432	India	P	Yellow	13.6
139	14433	India	P	Yellow	12.8
140	14434	India	P	Yellow	12.7
141	14435	India	P	Yellow	11.4
142	14436	India	P	Yellow	15.9
143	14437	India	P	Brown	11.7
144	14438	India	P	Yellow	13.1
145	14439	India	P	Yellow	12.4

TABLE 1 (Continued)

S.No.	IC No.	Origin	Flower colour <sup>a</sup>	Seed colour	Size <sup>b</sup>
146	14440	India	P	Brown	11.4
147	14441	India	P	Brown	13.3
148	14442	India	P	Brown	12.2
149	14443	Iran	P	Yellow	15.7
150	14444	Pakistan	P	Brown	11.8
151	14445	India	W	Beige	11.7
152	14446	India	P	Yellow	16.0
153	14447	India	P	Brown	18.1
154	14448	Iran	P	Brown	12.2
155	14449	Iran	P	Yellow	13.5
156	14450	India	P	Yellow	15.6
157	14451	India	W	Brown	17.6
158	14452	India	W	Beige	19.2
159	14453	India	P	Beige	15.4
160	14454	India	P	Green	15.4

<sup>a</sup>P = Pink, W = White.

<sup>b</sup>100-seed mass (g).

TABLE 2

Distribution of germplasm accessions resistant to fusarium wilt, ICRISAT Center, 1976-85

Country of origin	Accessions screened	Accessions found resistant	Frequency (%)
Cyprus	44	1	2.2
Ethiopia	733	3	0.40
India	5750	96	1.66
Iran	4670	51	1.09
Mexico	364	5	1.37
Pakistan	150	1	0.66
Spain	110	1	0.99
Turkey	440	2	0.45
Other countries	1739	0	0.0

race 1 of chickpea wilt, *F. oxysporum* f.sp. *ciceri*, is prevalent in the disease nursery at ICRISAT Center (Haware and Nene, 1982). Susceptible control (JG 62) was killed uniformly throughout the field and there was no variability in inoculum distribution in the field. The purpose of pot screening was to confirm the resistance of lines identified resistant in the field screening. Three field screenings and two pot screenings confirmed the resistance of 160 lines to race 1. The resistant accessions are listed in Table 1 together with some details of their identity, country of origin, seed and flower colour, and seed size. Earlier, only ICC 11322 (WR 315) was reported resistant to wilt (Singh et al., 1974). Later, 14 chickpea lines were reported resistant to fusarium wilt

through systematic screening at ICRISAT Center (Nene and Haware, 1980). It may be pointed out that wilt-resistant lines often showed some mortality in the field due to the presence of other soil-borne pathogens [particularly *Rhizoctonia bataticola* (Taub.) Butler, *F. solani* (Mart.) Sacc. and *Sclerotium rolfsii* Sacc.]. However, these 160 lines showed no mortality in pot screening where only the wilt pathogen was present. Many of these lines are used extensively in the chickpea improvement programme at ICRISAT and in national programmes. The screening also shows that genetic resistance to fusarium wilt is adequately available in chickpea and can be used effectively for disease control. Some of these lines are multiple-disease resistant (Nene, 1988).

At least six races of *F. oxysporum* f.sp. *ciceri* have been reported so far, four in India (Haware and Nene, 1982) and two in Spain (Jimenez-Diaz et al., 1989). Race 1 is common in central and race 2 in northern India. Races 3 and 4 appear to be location specific in Punjab and Haryana states of India. In spite of the existence of races, it has not been difficult to identify broad-based and stable resistance in many chickpea lines such as ICC 11322, 14424 and 14433, which were identified as resistant to race 1, through multilocation testing (Nene et al., 1989b).

In the present study, germplasm accessions collected from 40 countries were screened. However, the resistant sources identified in the germplasm accessions were collected from eight countries; i.e., Cyprus (1), Ethiopia (3), India (96), Iran (51), Mexico (5), Pakistan (1), Spain (1) and Turkey (2) (Table 2). Many resistant sources originated in India and this is not surprising considering the antiquity of the crop and disease prevalence in most parts of the country. India is one of the centers of chickpea diversity (Vavilov, 1926) where a predominance of the desi type occurs. Only 11 wilt-resistant lines had white flowers as against 149 with pink flowers. Many resistant lines (150) were found among desi types whereas few occurred in the kabuli types (10).

The resistant selections identified are maintained in ICRISAT's Genetic Resources Unit and are available on request.

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