Safflower Germ Plasm Resistant to Fusarium Wilt

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ABSTRACT

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Selections from 14 safflower introductions were resistant to race 4 of *Fusarium oxysporum* f. sp. *carthami*. Five other selections were of value for breeding. Use of a spore inoculum in screening tests enhanced selection of resistant plants.

Fusarium wilt, caused by *Fusarium oxysporum* f. sp. *carthami* Klis. & Hous. (3), was recognized as a disease of safflower (*Carthamus tinctorius* L.) in California in 1962 (2) and in India in 1975 (6). Safflower cultivars available for commercial planting in 1962 were susceptible and hence contributed to widespread development of the disease. Several safflower introductions screened in a field test in 1967 and 1968 (5) were highly resistant to wilt; others showed a variable reaction which suggested the existence of pathogenic races. Tests with selected safflower introductions and cultivars distinguished three pathogenic races in 1970 (4) among isolates collected from diseased plants. Several introductions were resistant to the three races, and commercial breeders used the germ plasm to incorporate resistant genes into cultivars and breeding lines.

In 1973 an increase in wilt incidence in cultivars with good field resistance was attributed to a fourth pathogenic race (1). Several sources of resistance to races 1, 2, and 3, including UC41, a selection from PI304,447, were susceptible to race 4 in greenhouse tests. Surviving plants of several introductions were considered possible sources of resistant germ plasm. The objective of this study was to identify germ plasm resistant to *Fusarium* race 4.

MATERIALS AND METHODS

Nineteen safflower introductions were evaluated for resistance to *F. oxysporum* f. sp. *carthami* race 4. Ten had been screened for resistance to Fusarium wilt in previous tests (1,4), and nine were selected on the basis of their resistance to wilt in the field (5). Seeds planted were originally from open-pollinated plants that were resistant in the field to races 1, 2, and 3. UC41 was used as a susceptible check.

Inoculum consisting of autoclaved wheat grain (4) infested with a race 4 isolate was mixed with autoclaved soil (1.5 g/100 g of soil) and placed in galvanized metal flats. Single rows of 12–15 seeds were planted in three flats for each introduction in three experiments. UC41 was planted in each flat. Plant counts were made at emergence and 4–5 wk later, and the plants were observed for symptoms up to the bud stage. Seeds were harvested from surviving healthy plants and planted in subsequent tests.

High mortality rates prompted a change in the inoculum from infested grain to a suspension of micro- and macroconidia from 14-day-old cultures

Table 1. Reactions of safflower introductions and selections of introductions to *Fusarium oxysporum* f. sp. *carthami* race 4, their leaf spininess and oil value

Introduction	Selection	Spine index[a]	Oil (%)	Dead or diseased plants (%) from: Seed from introduction plants in field	Seed from selections in greenhouse
PI250,010	3992	1	29	0	0
PI250,538	4297	0	28	0	0
PI250,608	4305	0	31	0	0
PI250,079	4309	0	33	0	0
PI250,539	4298	0	30	4	0
PI306,596	4343	0	32	5	0
PI250,828	4046	1	33	7	0
PI250,827	4011	0	33	13	0
PI253,387	4258	0	29	22	0
PI251,398	4022	1	29	24	0
PI250,830	3133	1	27	31	0
PI209,288	3238	1	32	33	0
PI250,823	4043	0	30	40	0
PI250,523	3119	1	30	58	0
PI250,824	4009	0	34	28	5
PI251,462	4142	1	32	29	5
PI175,624	3478	1	35	19	5
PI250,007	4039	0	36	27	10
PI251,288	4308	0	28	24	16
PI304,447	UC41	0		100	

[a] 0 = spineless; 1 = spiny.

on autoclaved grain. Spores were washed from 126 g of grain inoculum (an amount of grain equivalent to that mixed in a flat of soil) with 160 ml of sterile distilled water and diluted with 160 ml of water to a concentration of 250,000 spores/ml. The inoculum level was selected on the basis of 100% mortality of UC41. Ten milliliters of spore suspension were pipetted into a furrow of each row before seeds were planted. Twelve to 15 seeds were planted per row and covered to a depth of 1 cm. A soil and sand mixture (1:1) was used as the planting base. Tests were conducted during seasons of high natural light with an ambient temperature ranging from 20 to 27 C.

RESULTS AND DISCUSSION

In tests where race 4 infested grain inoculum was mixed in soil, plant mortality among different introductions ranged from 50 to 100%. Plants were frequently killed before entire emergence. In subsequent tests using the same procedure and seed selected from surviving plants in the previous test, plant mortality of some introductions was reduced. Dead and diseased plants ranged from 15 to 80% of 50–100 plants per introduction. All UC41 plants in the tests were killed.

High plant mortality made it impossible to establish the value of the introductions as sources of resistance. When spores were used as inoculum, uniform and entire emergence of plants occurred. Susceptible plants began to wilt and die 7–10 days after emergence. Plants from the original seed of four introductions were resistant, but plant mortality among other introductions ranged from 4 to 58% and was 100% in UC41 (Table 1). In subsequent tests with seeds from surviving plants, selections from 14 introductions were resistant. All plants (50–100/selection) were symptomless to maturity. Five other introductions with a low percentage of dead plants are considered of value as sources of resistance to race 4.

Resistant plants obtained by selection and reselection in tests suggest genetic diversity of these introductions, which originate in the Middle East. Selections from introductions offer a genetic base from which plant breeders can select materials for incorporating resistant genes into cultivars and breeding lines. The low seed oil percentage of selections (Table 1) should not deter their use in breeding programs, since seed oil content can be increased through crosses with high-oil-yielding germ plasm. Development of cultivars with resistance to *F. oxysporum* f. sp. *carthami* race 4 and their use in commercial production should bring about control of the disease.

LITERATURE CITED

1. KLISIEWICZ, J. M. 1975. Race 4 of *Fusarium oxysporum* f. sp. *carthami*. Plant Dis. Rep. 59:712-714.
2. KLISIEWICZ, J. M., and B. R. HOUSTON. 1962. Fusarium wilt of safflower. Plant Dis. Rep. 46:748-749.
3. KLISIEWICZ, J. M., and B. R. HOUSTON. 1963. A new form of *Fusarium oxysporum*. Phytopathology 53:241.
4. KLISIEWICZ, J. M., and C. A. THOMAS. 1970. Race differentiation in *Fusarium oxysporum* f. sp. *carthami*. Phytopathology 60:1706.
5. KNOWLES, P. F., J. M. KLISIEWICZ, and A. B. HILL. 1968. Safflower introductions resistant to Fusarium wilt. Crop Sci. 8:626-637.
6. SINGH, A. K., D. K. CHAKRABARTI, and K. C. BASU CHOUDHARY. 1975. Two new diseases of safflower from India. Curr. Sci. 44:397-399.