Resistance of Interspecific Cotton Hybrids (*Gossypium hirsutum* × *G. barbadense* Containing *G. harknessii* Cytoplasm) to Fusarium Wilt

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ABSTRACT

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Analysis of progenies of crosses between the resistant cultivar Acala SJ-2 (*G. hirsutum*) and the susceptible cultivar Pima S-5 (*G. barbadense*) indicated that resistance to race 3 of *Fusarium oxysporum* f. sp. *vasinfectum* is controlled by a dominant gene. Crosses between breeding lines—male restorer and female (male sterile) parents, both on a background of *G. harknessii* cytoplasm—indicated that the resistance is not affected by the cytoplasm of the latter species. All but one of the five restorer lines tested with the *G. barbadense* genome were found susceptible to the fungus. Thus a close linkage of genes conferring resistance and restoration of fertility is ruled out. In addition, the resistance of such a restorer line enables us to obtain intraspecific as well as interspecific hybrids of cotton resistant to race 3 of the fungus.

An interspecific cotton hybrid (*Gossypium hirsutum* L. × *G. barbadense* L.) released in 1979 following development in New Mexico (1) yielded significantly more and was superior to Acala 1517-75 (*G. hirsutum*) in fiber quality. Commercial production of cotton hybrids without increased cultural costs became feasible with the introduction of *G. harknessii* L. as a source of both cytoplasmic male sterility (CMS) and restoration of fertility (restorer line-R) (5).

Production of cotton hybrids in Israel would be even more important if they were resistant to Fusarium wilt. This disease was reported here in 1974 (2); race 3 of the fungus *Fusarium oxysporum* f. sp. *vasinfectum* (Atk.) Snyd. & Hans. was the only one encountered (7). This race incited wilt in the cultivar Pima S-5 (*G. barbadense*), whereas the cultivar Acala SJ-2 (*G. hirsutum*) remained unaffected (7).

Consequently, in the course of breeding interspecific cotton hybrids (3), it became necessary to test the reactions of such hybrids to race 3 of the fungus and to establish the possible effect of *G. harknessii* cytoplasm and restorer gene on the resistance.

In our research, the male restorer parents were all of the Pima type (*G. barbadense*) and the female (male sterile) parents were all of Upland cotton (*G. hirsutum*) on a background of *G. harknessii* cytoplasm.

The first stage of our research was undertaken to determine the mode of inheritance of the resistance in cultivar Acala SJ-2 to race 3 of the fungus. A preliminary report has been published (6).

MATERIALS AND METHODS

The inoculum was derived from a culture of *F. oxysporum* f. sp. *vasinfectum* (Hf-10) isolated from a wilted cotton

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Table 1. Test for resistance to *Fusarium oxysporum* f. sp. *vasinfectum* (race 3) in progenies of crosses of resistant (R) cultivars of *Gossypium hirsutum* and susceptible (S) Pima S-5 (*G. barbadense*)

Parents and crosses	Number of plants tested	Expected ratio	Number of plants resistant:susceptible
Acala SJ-2 (A)	60	All R	60:0
Pima S-5 (P)	50	All S	0:50
F_1			
A × P	30	All R	30:0
Coker 310[a] × P	28	All R	28:0
GM-10[a] × P	29	All R	29:0
F_2			
A × P	106	3:1	77:29

[a] Cultivars of *G. hirsutum*.

Table 2. Reaction and segregation in progenies from crosses between cytoplasmic male sterility (CMS) and restorer lines (on a background of *Gossypium harknessii* cytoplasm) after inoculation with race 3 of *Fusarium oxysporum* f. sp. *vasinfectum*

Parents and crosses	Phenotypic segregation (R:S)	
	Expected ratio	Observed ratio
CMS lines		
A36 (Pima S-5)	?	0:29
A35 (Acala SJ-2)	?	21:0
A38 (S-1E)[a]	?	30:0
Restorer lines		
R-142 (GM-127)[a]	?	47:0
R-144 (P4-H-S-162)[a]	?	0:20
R-3-166[b]	?	0:37
R-181-1[c]	?	0:17
R-193-1[c]	?	0:18
F_1		
A35 × Pima S-5	All R	29:0
A35 × R-142	All R	34:0
A35 × R-144	All R	34:0
A35 × R-3-166	All R	34:0
A38 × R-142	All R	34:0
F_2		
A35 × R-142	?	48:0
A35 × R-144	?	27:5
A35 × R-3-166	?	27:6
A38 × R-142	?	43:0

[a] Obtained from D. D. Davis, New Mexico Agricultural Experiment Station, Las Cruces (1).
[b] Obtained from J. B. Weaver, Athens, GA (8).
[c] Local selected lines of backcrosses between Pima S-5 and Des-Haf-16 (4).

plant (Pima S-5) collected in the Esdraelon Valley. This isolate was previously defined as race 3 (7). Inoculum was obtained by growing the fungus on Czapek liquid medium for 7 days on a rotary shaker at 25 ± 1 C. Microconidia were harvested by centrifugation, and their concentration was adjusted to 2×10^6 conidia per milliliter with tap water. Seven- to 9-day-old seedlings of the tested cotton cultivars and breeding material were inoculated by root inoculation as described elsewhere (7).

The possible interference of breeding lines, on their reactions to the Fusarium wilt fungus—CMS lines as well as restorer lines (R) (containing *G. harknessii* cytoplasm), and their F_1 and F_2 progenies—was tested.

The following breeding lines were included: CMS lines—two local lines, A36 and A35, obtained by five backcrosses to Pima S-5 and Acala SJ-2, respectively; and A38 (S-1E), of *G. hirsutum* type obtained from Davis (1). Restorer lines (R)—two local lines, R-181-1 and R-193-1, obtained by four backcrosses of Pima S-5 to the breeding line Des-Haf-16 released by Meyer (4); and three R-lines obtained in the United States (R-142, R-144, and R-3-166).

Inoculated plants were transplanted into pots filled with heat-sterilized sandy loam soil and maintained in a greenhouse at 26 ± 1 C. Assessment of wilt symptoms was made 10 days after inoculation. After an additional week, the unwilted plants were transplanted and grown to maturity for either self- or cross-pollinations.

RESULTS AND DISCUSSION

Progenies from self-pollinated Pima S-5 (P) plants were found 100% susceptible; such progenies from Acala SJ-2 (A) plants did not show any wilt symptoms. The latter cultivar, as well as two additional cultivars of *G. hirsutum* (Coker 310 and GM-10), were crossed with the susceptible P. None of these F_1 progenies wilted (Table 1).

Inheritance of resistance was tested and the segregation observed in the F_2 generation of the cross A × P (with A as the female parent) suggested simple inheritance of the disease reaction. The 3:1 ratio (resistant:susceptible) indicated a single dominant gene (Table 1).

Line A36 (backcrossed to Pima S-5) was found susceptible; the other two lines were resistant (Table 2). Of the five R-lines of the *G. barbadense* genome only one, R-142, was found resistant (Table 2).

The F_1 progenies of A35 and A38 crossed to Pima S-5 or to R-lines were found resistant (Table 2). The reactions of the F_2 progenies were determined by the R-lines used in the F_1 crosses. The resistant R-142 line gave only resistant progenies, whereas the other two (R-144 and R-3-166) segregated in a 3:1 ratio (resistant:susceptible).

In conclusion, the data obtained in our investigation indicate 1) that a single dominant gene confers resistance to race 3 of the cotton Fusarium wilt; 2) the use of *G. harknessii* cytoplasm does not affect the resistance to this race of the fungus; 3) Pima S-5 remains susceptible to this race even in breeding lines containing the cytoplasm of *G. harknessii*; 4) the susceptible reaction to this race of the fungus of two R-lines, and the resistance of one such R-line, rule out a close linkage of genes conferring resistance to the fungus and restoration of fertility; and 5) the fact that R-142 was found resistant should not be overlooked. This enables production of intraspecific as well as interspecific hybrids of *G. barbadense* resistant to race 3 of Fusarium wilt of cotton.

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