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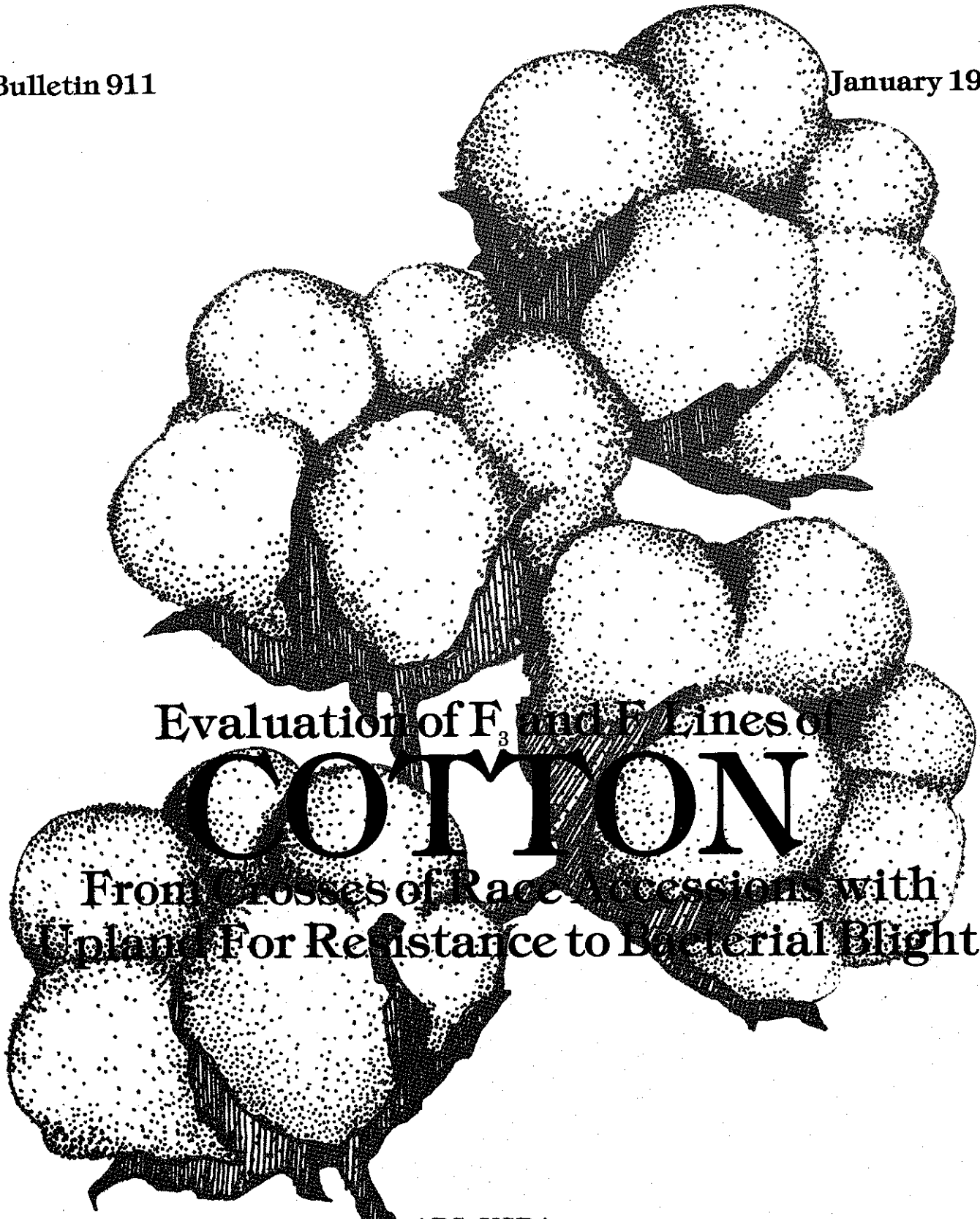

Evaluation of F_3 and F_4 Lines of COTTON From Crosses of Race Accessions with Upland For Resistance to Bacterial Blight

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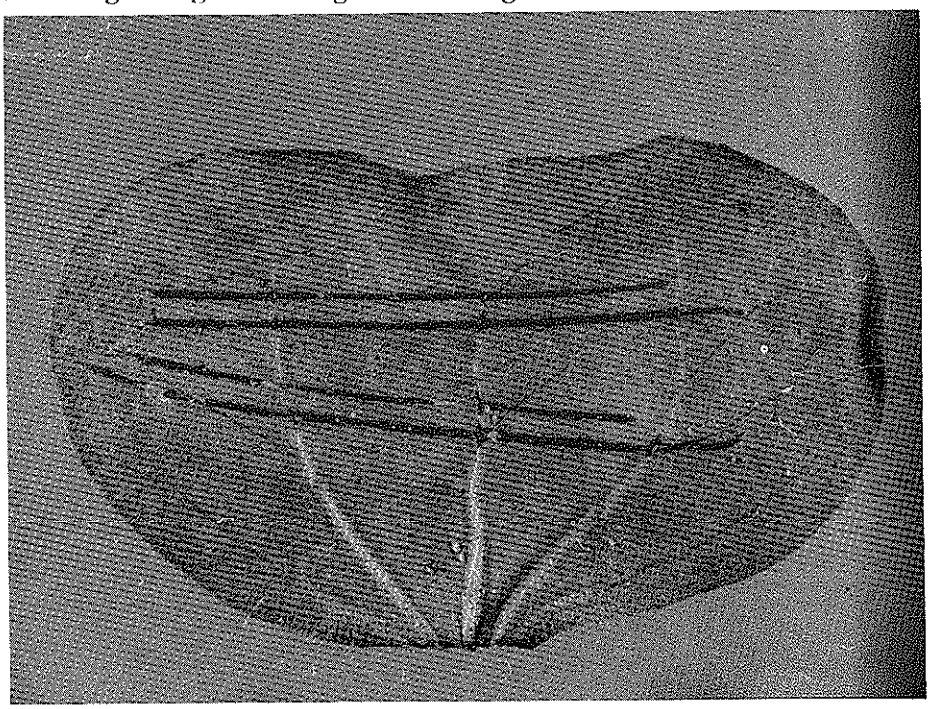
Eighty one lines of cotton, *Gossypium hirsutum* L., containing germplasm from 54 primitive accessions in the race collection have been released (Jenkins et al, 1979). The primitive accessions were originally crossed as males with either 'Deltapine 16' (DPL-16) and/or Lubbock Dwarf. The procedure for developing the flowering lines and maintaining genetic diversity was presented by McCarty el al, 1979. Also, sixteen additional lines with Fusarium wilt resistance have been released (Jenkins et al, 1979).

In 1978 and 1979, 82 cotton lines involving 54 race accessions, 10 BC_2F_5 lines and 119 F_3 race lines were evaluated for bacterial blight (*Xanthomonas malvacearum* (E.F. SM)) resistance in greenhouse tests. The bacterial blight inoculum consisted of a mixture of Races 1, 2, 7, 10 and 18 in equal volumetric portions. Before mixing each race, inoculum was standardized to equivalent bacterial density (ca 4 x 10″ viable cells/ml) based upon colorimeter reading (Mahill et al, 1978). The experimental designs were randomized complete blocks replicated four times.

The lower epidermis of seedling cotyledons was inoculated when most of the tissues were fully expanded (10-13 days after planting). Speed Ball #B-6 pens with the prongs 1.5 mm apart were used to inoculate the cotyledons. Visual blight ratings were recorded following maximum disease reactions, which occurred from nine to 13 days after inoculation (Mahill et al, 1978). A mean of the blight readings of six to ten plants per entry per replication was used as a disease grade for each experimental observation. The check cultivars used were 'Deltapine 61,' 'Stoneville 213' and GN-6-76. The disease grading scale is given in Table 1 (Mahill et al, 1978). Resistant and susceptible extremes of the grading scale are shown in Figure 1.



RESISTANT (Grade 2) ⇦ SUSCEPTIBLE (Grade 9) ⇨

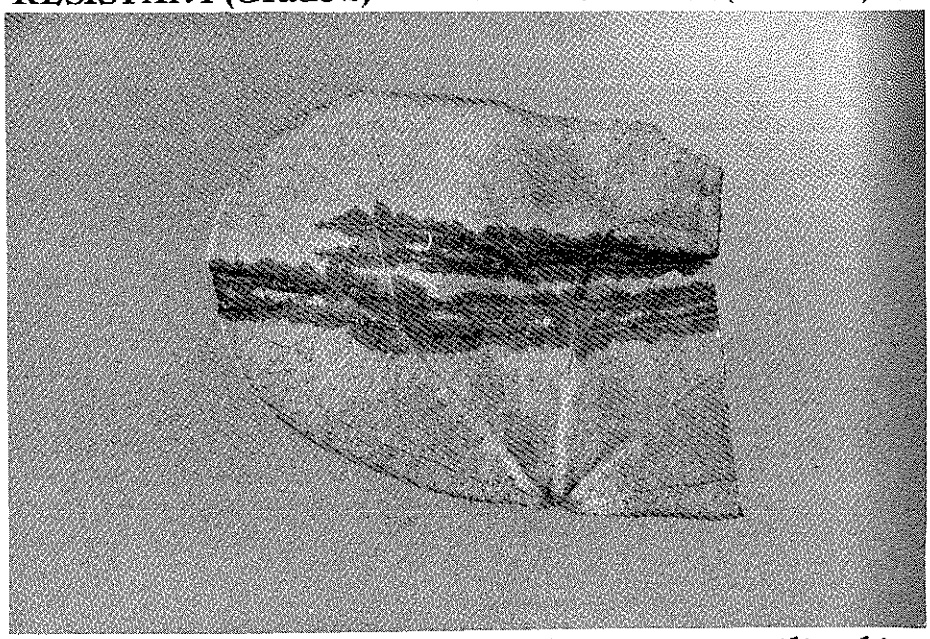


Figure 1. Resistant and susceptible extremes outlined in Table 1.

Table 1. Bacterial blight disease grading system used in greenhouse experiments with cotton.1/

Resistance Level	Disease Grade	Description of affected tissues
Susceptible	9	Completely susceptible - excessive water soaking of tissue and lesions are spreading.
	8	Solid water soaking of tissue and spreading well.
	7	Solid water soaking of tissue, definitely outside the scratch marks with little or no spreading.
Intermediate	6	Solid water soaking, but only occasional spreading outside the scratch marks.
	5	Water soaking of tissues in the scratch marks.
	4	Very slight signs of water soaking of tissues.
Resistant	3	Tissue darkening with no signs of water-soaked tissue.
	2	Tissue brown with no signs of water-soaked tissue.
	1	Completely resistant - tissue is white or gray resembling scar tissue from the scratch.

1/ Mahill et al., 1978.

Evaluations of the 82 F_4 and 10 BC_2F_5 cotton lines (Table 2) showed that 11 lines were equal to and 30 lines were non-significantly less susceptible than Stoneville 213. Race stock lines with Lubbock Dwarf as female parent apparently were intermediate while their counterparts with DPL-16 as female parent were susceptible. In the F_3 lines (Table 3), resistance higher than that of DPL-61 or Stoneville 213 was not observed. In general, the blight grades for all the cotton lines formed a normal distribution around the commercial checks. This distribution indicates that the converted race stock lines of cotton exhibit minor gene effects and are near the same level as the commercial checks. Genes no more effective than the known minor genes probably are involved. However, it is generally well known that major genes are not effective unless combined with compatible and complementary minor-modifier genes (Bird, L. S., personal communication). The identification of minor-modifier genes could complement known major genes.

The technique of mixed inoculum of *X. malvacearum* races used in this study was considered to be the reason for no more than intermediate grades. However, the presence of single genes that may be effective against single races of the pathogen cannot be ruled out. The best cotton lines reported herein may exhibit resistance to specific races.

Numerous primitive race accessions from diverse geographic origins were progenitors of the F_3 and F_4 cotton lines evaluated. Most were from Guerrero, Chiapas, and Oaxaco, Mexico, and Guatemala (Table 4). A high percentage of the lines originating from Chiapas and Oaxaca were intermediate in resistance to bacterial blight. A few lines from Hopi N. Mex. 1239, Hopi Mb-14-1-3, Belize, and from the Bahamas were more resistant than lines from other areas.

Predominately, the cotton lines had latifolium, punctatum, and morrilli race backgrounds (Table 5), and a large number of these were intermediate in resistance. A mean blight grade for morrilli of 6.3 (intermediate resistance) indicated a possible source of resistance in this cotton race.

Resistance to bacterial blight in this study was not associated with any cotton race or geographic origin. An increase in susceptibility over the upland parent apparently occurred in a few of the flowering lines. Cotton breeders should be aware of this response when using these exotic lines.

Our results tend to confirm previous research on bacterial blight (R. L. Knight, et al, 1950). According to Knight, the center of variability for the *G. hirsutum* species is in Central America. However, both Central and South America were poor areas for isolating cotton lines resistant to blackarm (bacterial blight). New-World strains of punctatum derived from Florida and the Bahamas showed resistance. In the data reported herein, two cotton lines from the Bahamas (Table 4) were intermediate in resistance.

Table 2. Bacterial blight resistance of the F_4 generation of 82 lines of cotton, Gossypium hirsutum L. (containing germplasm from 54 primitive races of cotton), and 10 BC_2F_5 lines of cotton.

Line[1]	Female parent[2]	Race[3]	Site of original collection[4]	Mean blight grades[5]					Disease evaluation rating[6]
				Test 1	Test 2	Test 3	Test 4	$\bar{X}$	
JPM-781-3-1	1	1	1		6.61 a-e	6.93 a-d		6.8	S
786-11-1	1	6	5	6.34 ab		6.77	6.39 a-c	6.5	S
786-11-2	2	6	5	5.81 b		5.99 b-j	5.78 a-d	5.9	I
782-25-1	1	2	3			6.73 a-g		6.7	S
782-26-1	1	2	3	7.51 ab		6.40 a-i		7.0	S
782-26-2	2	2	3	7.02 ab		5.96 d-j	6.07 a-d	6.4	I
781-59-1	1	1	3		7.29 a	6.65 a-h		7.0	S
781-66-1	1	1	3		6.73 a-d	6.45 a-i		6.6	S
781-66-3[7]		1	3			6.18 a-j	6.16 a-c	6.2	I
781-69-1	1	1	4		6.34 a-g	6.64 a-h		6.5	S
781-69-3[7]		1	4			6.92 a-d		6.9	S
781-75-1	1	1	4		6.64 a-e	6.87 a-e		6.8	S
781-75-3[7]		1	4			6.21 a-j		6.2	I
781-78-1	1	1	4		6.35 a-g	5.86 f-j	5.91 a-d	6.1	I
781-84-1	1	1	4		6.11 a-g	6.47 a-i		6.3	I
781-84-3[7]		1	4			5.93 e-j	5.78 a-d	5.9	I
781-87-1[7]		1	4			6.41 a-i		6.4	I
781-88-1	1	1	4		6.91 a-c	6.53 a-i		6.7	S
781-88-3[7]		1	4			6.28		6.3	I
782-94-1	1	2	4	7.60 ab		6.74 a-f		7.2	S
782-94-2	2	2	4	6.48 ab		6.19 a-j	6.11 a-d	6.3	I
781-100-1[7]		1	4			6.30 a-j		6.3	I
781-103-1	1	1	4		6.91 a-c	6.96 ab		6.9	S

(Continued)

Table 2. (Continued)

Line[1]	Female parent[2]	Race[3]	Site of original collection[4]	Mean blight grades[5] Test 1	Test 2	Test 3	Test 4	$\bar{X}$	Disease evaluation rating[6]
781-106-1	1	1	4		6.54 a-f	6.63 a-i		6.6	S
781-109-1	1	1	5		7.22 a	6.76 a-e		7.0	S
781-113-1	1	1	4		6.90 a-c	6.60		6.8	S
781-113-3[7]		1	4			5.93 e-j	5.96 a-d	5.9	I
781-118-1	1	1	4		6.50 a-f	6.78 a-f		6.6	S
781-158-1[7]		1	4			6.33 a-j		6.3	I
781-159-1	1	1	5		6.99 ab	6.65 a-h		6.8	S
781-185-1	1	1	4	7.13 ab		6.61 a-i		6.9	S
781-185-2	2	1	4	6.21 ab		5.98 c-j	5.51 b-d	5.9	I
786-194-1	1	6	5	6.62 ab		6.29 a-j	5.70 a-d	6.2	I
786-194-2	2	6	5	6.72 ab		5.89 f-j	6.05 a-d	6.2	I
781-195-1[7]		1	6			6.33 a-j		6.3	I
781-201-1	1	1	4		6.35 a-g	6.38 a-i		6.4	I
781-209-1	1	1	4		6.50 a-f	6.48 a-i		6.5	S
781-223-1	1	1	4		7.31 a	6.66 a-h		7.0	S
788-267-1	1	8	5	7.17 ab		6.30 a-j		6.7	S
786-292-1	1	6	5	7.41 ab		6.82 a-f		7.1	S
786-292-2	2	6	5	5.99 ab		6.39 a-i	5.73 a-d	6.0	I
786-295-1	1	6	5	7.73 a		6.54 a-i		7.1	S
786-295-2	2	6	5	6.08 ab		6.01 b-j	5.78 a-d	6.0	I
786-297-1	1	6	5	7.24 ab				7.2	S
786-297-2	2	6	5	6.29 ab		6.06 a-j	5.45 b-d	5.9	I
784-326-1	1	4	1	7.52 ab		6.60 a-i		7.1	S
784-336-1	1	4	1	7.30 ab		6.95 a-c		7.1	S
784-336-2	2	4	1		6.17 a-g	5.68 ij	5.62 b-d	5.8	I
788-339-1	1	8	1	7.17 ab		6.05 a-j	5.78 a-d	6.3	I
788-339-2	2	8	1		5.18 d-j	6.30 a-j	5.29 b-d	5.6	I
784-347-2	2	4	1		6.45 a-f	6.54 a-i		6.5	S
788-404-1	1	8	11	7.44 ab		6.62 a-i		7.0	S
788-404-2	2	8	11		5.57 b-g	5.68 ij	5.50 b-d	5.6	I
788-459-1	1	8	9	7.11 ab		6.22 a-j		6.7	S
788-459-2	2	8	9		5.18 d-g	6.40 a-i	5.64 b-d	5.7	I
785-461-1	1	5	5			6.43		6.4	I
782-488-1	1	2	8			6.34		6.3	I
782-495-1	1	2	9			6.64 a-h		6.6	S
782-495-3		2	9			6.26 a-j		6.3	I
788-679-1	1	8	9	7.59 ab		6.90 a-e		7.2	S
788-679-2	2	8	9		5.82 a-g	5.96 d-j	5.64 b-d	5.8	I
788-725-1	1	8	14	7.23 ab		6.65 a-h		6.9	S
788-730-1	1	8	7	7.42 ab		6.59 a-i		7.0	S
788-730-2	2	8	7		6.53 a-f	6.45 a-i		6.5	S
788-732-1	1	8	7	7.38 ab		6.68 a-h		7.0	S
788-732-2	2	8	7		5.80 a-g	6.16 a-j	4.98 d	5.6	I
788-759-1	1	8	12	7.36 ab		6.35 a-i		6.9	S
788-759-2	2	8	12		5.97 a-g	6.63		6.3	I
788-763-1	1	8	13	6.97 ab		6.68 a-h		6.8	S
788-763-2	2	8	13		5.85 a-g	6.38 a-i		6.1	I
788-764-1	1	8	13	7.39 ab		7.03 a		7.2	S
788-766-1	1	8	14	6.63 ab		6.13 a-j	6.00 a-d	6.3	I
788-766-2	2	8	14		5.75 a-g	5.76 g-j	5.63 b-d	5.7	I
788-786-1	1	8	14	7.16 ab		6.43 a-i		6.8	S
788-786-2	2	8	14		6.30 a-g	5.65 ij	5.80 a-d	5.9	I
788-790-1	1	8	14	7.23 ab		6.50 a-i		6.9	S
788-790-2	2	8	14		5.08 e-g	6.00 b-j	5.33 b-d	5.5	I

(Continued)

Table 2. (Continued)

Line[1]	Female parent[2]	Race[3]	Site of original collection[4]	Mean blight grades[5] Test 1	Test 2	Test 3	Test 4	$\bar{X}$	Disease evaluation rating[6]
788-805-1	1	8	15	6.26		6.20 a-j	6.27 a-c	6.2	I
788-805-2	2	8	15		4.98 fg	6.09 a-j	5.73 a-d	5.6	I
782-1045-2	2	2	9		6.50 a-f	6.13 a-j	5.93 a-d	6.2	I
788-1134-1	1	8	12	6.88 ab		6.34 a-i	6.06 a-d	6.4	I
788-1134-2	2	8	12		5.83 a-g	5.99 b-j	5.83 a-d	5.9	I
788-1149-1	1	8	9	7.05 ab		6.63 a-i		6.8	S
788-1149-2	2	8	9		4.87 g	5.42 j	5.26 b-d	5.2	I
788-1159-1	1	8	9	7.30 ab		6.66 a-h		7.0	S
788-1159-2	2	8	9		5.36 c-g	5.73 h-j	5.23 cd	5.4	I
788-1167-1	1	8	9	6.88 ab		6.10 a-j	6.25 a-c	6.4	I
788-1167-2	2	8	9		6.46 a-f	5.85 f-j	6.42 ab	6.2	I
788-1177-1	1	8	9	6.87 ab			6.79 a	6.8	S
788-1177-2	2	8	9		6.45 a-f		6.00 a-d	6.2	I
788-1180-1	1	8	9	7.08 ab			6.36 a-c	6.7	S
788-1180-2	2	8	9		6.74 a-d		6.14 a-c	6.4	I
DPL check				6.94 ab	6.27 a-g	6.53 a-i	6.00 a-d	6.4	I
STV 213 check				7.28 ab	5.80 a-g	6.10 a-j	5.87 a-d	6.3	I
GN-6-76 Resistant check						2.74 k	2.93 e	2.8	R

1/JPM-781-3-1: JPM = originators; 78 = year of germplasm release; 1 through 8 = race designation (1 = latifolium, 2 = punctatum, 4 = palmari, 5 = richmondi, 6 = morrilli, 8 = unclassified); 3 = accession number in ARS catalogue ARS-H-2, October 1974, the regional collection of Gossypium germplasm; 1 through 3 = serial release number from crosses involving this particular accession.

2/Female parent 1 was DPL-16; female parent 2 was Lubbock Dwarf.

3/Race Code 1 = latifolium; 2 = punctatum; 4 = palmari; 5 = richmondi; 6 = morrilli; 8 = unclassified.

4/Site of original collection of primitive races used in initial crosses: 1 = Guerrero, Mex; 3 = Chiapas, Mex; 4 = Guatemata; 5 = Oaxaca, Mex; 6 = El Salvador; 7 = Mexico; 8 = Yucatan, Mex; 9 = unknown; 11 = Hopi N. Mex. 1239; 12 = Veracruz, Mex; 13 = San Luis P. Mex.; 14 = Belize; 15 = Bahama Island.

5/Individual plants initially graded on a 1-9 scale (Table 1). Any 2 means within a test followed by the same letter are not significantly different based on Newman-Keul's Test.

6/Bacterial Blight Evaluation Rating, R = resistant (1.0-3.4), I = intermediate resistance (3.5-6.4), S = susceptible (6.5-9.0).

7/ BC_2F_5 (DPL-16 backcross parent) lines of cotton.

Table 3. Bacterial blight resistance of 119 F_3 lines from crosses of race stocks with Upland.

Race accession in cross	Race[1/]	Site of original collection[2/]	Mean blight grade[3/]	Disease evaluation rating[4/]
T-2	1	1	6.1 b-e	I
T-4	1	1	6.8 a-c*	S
T-6	1	2	6.0 c-e	I
T-7	1	2	6.5 a-e	S
T-16	1	3	6.9 a-c*	S
T-17	1	3	7.2 a*	S
T-21	1	3	6.3 a-e	I
T-22	1	3	6.2 b-e	I
T-24	1	9	6.1 b-e	I
T-30	1	3	6.6 a-e	S
T-31	1	3	6.7 a-d	S
T-33	1	3	6.7 a-d	S
T-34	1	3	6.1 b-e	I
T-35	1	3	6.9 a-c*	S
T-36	1	3	5.9 de	I
T-37	1	3	6.8 a-c*	S
T-38	1	3	6.5 a-e	S
T-39	1	3	6.2 a-e	I
T-40	1	3	6.9 a-c*	S
T-43	1	3	6.2 a-e	I
T-48	1	3	6.2 a-e	I

(Continued)

Table 3. (Continued)

Race accession in cross	Race[1]	Site of original collection[2]	Mean blight grade[3]	Disease evaluation rating[4]
T-50	1	3	6.6 a-e	S
T-56	1	3	6.3 a-e	I
T-57	1	3	6.0 b-e	I
T-58	1	3	6.3 a-e	I
T-60	1	3	6.4 a-e	I
T-61	1	3	6.7 a-d	S
T-62	1	3	6.4 a-e	I
T-63	1	3	6.3 a-e	I
T-64	1	3	5.8 de	I
T-65	1	3	6.0 b-e	I
T-67	1	3	6.4 a-e	I
T-68	1	4	6.2 b-e	I
T-71	1	4	6.5 a-e	S
T-72	1	4	6.4 a-e	I
T-73	1	4	6.5 a-e	S
T-74	1	4	6.3 a-e	I
T-77	1	4	6.4 a-e	I
T-79	1	4	7.0 ab*	S
GN-6-76 Resistant CK			2.7 f	R
DPL-61 CK			5.8 de	I
ST213 CK			5.7 e	I

(Continued)

Table 3. (Continued)

Race accession in cross	Race[1/]	Site of original collection[2/]	Mean blight grade[3/]	Disease evaluation rating[4/]
T-82	1	4	6.5 a-d	S
T-83	1	4	7.2 a-d	S
T-85	1	4	6.2 a-d	I
T-89	1	4	6.3 a-d	I
T-90	1	4	6.6 a-d	S
T-93	1	4	5.9 b-d	I
T-97	1	4	6.6 a-d	S
T-98	1	4	6.1 a-d	S
T-101	1	4	6.2 a-d	I
T-103	1	4	6.8 a-d	S
T-108	1	5	6.8 a-d	S
T-109	1	5	6.7 a-d	S
T-112	1	4	6.9 a-d	S
T-117	1	5	7.2 a-d	S
T-123	1	4	6.6 a-d	S
T-148	1	5	6.4 a-d	I
T-154	1	4	6.4 a-d	I
T-155	1	4	7.4 a-c	S
T-156	1	4	7.5 ab*	S
T-157	1	4	7.0 a-d	S
T-161	1	1	6.0 a-d	S
T-162	1	4	7.0 a-d	S

(Continued)

Table 3. (Continued)

Race accession in cross	Race[1/]	Site of original collection[2/]	Mean blight grade[3/]	Disease evaluation rating[4/]
T-164	1	4	6.1 a-d	I
T-170	1	4	7.0 a-d	S
T-173	1	4	6.5 a-d	S
T-177	1	4	6.6 a-d	S
T-178	1	4	6.4 a-d	I
T-180	1	4	7.1 a-d	S
T-182	1	1	6.9 a-d	S
T-183	1	1	6.6 a-d	S
T-188	1	4	6.8 a-d	S
T-197	1	4	6.5 a-d	S
T-199	1	4	6.8 a-d	S
T-205	1	1	6.7 a-d	S
T-206	1	1	6.7 a-d	S
T-208	1	4	6.3 a-d	I
T-212	1	5	7.2 a-d	S
T-213	1	6	6.5 a-d	S
T-214	1	6	6.3 a-d	I
T-215	1	6	7.0 a-d	S
T-216	1	6	6.8 a-d	S
T-217	1	4	6.3 a-d	I
T-218	1	4	6.7 a-d	S
T-221	1	4	7.2 a-d	S

(Continued)

Table 3. (Continued)

Race accession in cross	Race[1]	Site of original collection[2]	Mean blight grade[3]	Disease evaluation rating[4]
T-222	1	4	7.2 a-d	S
T-224	1	5	7.4 a-d	S
T-225	1	1	6.5 a-d	S
T-226	1	1	7.0 a-d	S
T-227	1	6	7.0 a-d	S
T-223	1	4	7.0 a-d	S
T-234	1	6	7.1 a-d	S
T-235	1	6	7.3 a-d	S
T-236	1	4	6.7 a-d	S
T-237	1	4	7.0 a-d	S
T-238	1	4	6.8 a-d	S
T-240	1	4	6.5 a-d	S
T-242	1	4	6.8 a-d	S
T-244	1	5	5.5 d	I
T-245	1	1	6.9 a-d	S
T-247	1	4	6.5 a-d	S
T-294	1	5	6.0 a-d	I
T-378	1	5	6.1 a-d	I
T-497	1	3	7.0 a-d	S
T-503	1	7	6.5 a-d	S
T-27	2	3	6.8 a-d	S
T-29	2	3	6.0 a-d	I

(Continued)

Table 3. (Continued)

Race accession in cross	Race[1/]	Site of original collection[2/]	Mean blight grade[3/]	Disease evaluation rating[4/]
T-45	2	3	6.7 a-d	S
T-165	2	4	6.5 a-d	S
T-251	2	4	6.5 a-d	S
T-488	2	8	6.4 a-d	I
T-10	8	5	7.1 a-d	S
T-32	8	9	6.6 a-d	S
T-149	8	4	6.8 a-d	S
T-150	8	6	6.7 a-d	S
T-151	8	4	6.9 a-d	S
T-399	8	10	6.1 a-d	I
T-404	8	11	6.4 a-d	I
T-459	8	9	7.2 a-d	S
T-570	8	9	7.7 a*	S
T-595	8	9	7.0 a-d	S
GN-6-76 Resistant Check			3.2 e	R
DPL-61 Check			5.9 a-d	I
ST213 Check			5.6 cd	I

* Significantly more susceptible than ST213.

1/ Race designation: 1 = latifolium; 2 = punctatum; 8 = unclassified.

(Continued)

(Continued)

2/ Site of original collection of primitive races used in initial crosses: 1 = Guerrero, Mex.; 2 - Pueblo, Mex.; 3 = Chiapas, Mex.; 4 = Guatemala; 5 = Oaxaca, Mex.; 6 = El Salvador; 7 = Mexico; 8 = Yucatan, Mex.; 9 = Unknown; 10 = Hopi M6-14-1-3; 11 = Hopi N. Mex. 1239.

3/ Individual plants initially graded on a 1-9 scale (Table 1). Any 2 means within an experiment followed by the same letter are not significantly different based on Newman-Keul's test.

4/ Bacterial blight evaluation rating, R = resistant (1.0-3.4), I = intermediate resistance (3.5-6.4), S = susceptible (6.5-9.0).

Table 4. Bacterial blight resistance of F_3 and F_4 lines, number tested, number grading interemediate resistance, and mean grade, by site of original collection of race accession progenitor.

Site of orginal collection	No. tested	No. graded intermediate	Mean blight grade
Guerrero, Mex.	17	4	6.6
Pueblo, Mex.	2	1	6.3
Chiapas, Mex.	36	18	6.5
Guatemala	65	18	6.6
Oaxaca, Mex.	24	11	6.5
El Salvador	8	1	6.9
Mexico	5	1	6.5
Yucatan, Mex.	2	2	6.4

(Continued)

(Continued)

Site of orginal collection	No. tested	No. graded intermediate	Mean blight grade
Hopi N. Mex. 1239	3	2	6.2
Hopi Mb-14-1-3	1	1	6.1
Veracruz, Mex.	4	3	6.3
San Luis P. Mex.	3	1	6.7
Belize	7	4	6.2
Bahama Island	2	2	5.9
Unknown	22	11	6.5
TOTAL	201	80	

Source: Tables 2 and 3

Table 5. Bacterial blight resistance of F_3 and F_4 lines, number tested, number graded intermediate resistance, and mean grade, by race progenitor.

Race	No. tested	No. graded intermediate	Mean blight grade
latifolium	122	41	6.6
punctatum	15	7	6.5
palmeri	4	1	6.5
richmondi	1	1	6.4
morrilli	10	6	6.3
unclassified	49	24	6.4
Total	201	80	

Source: Tables 2 and 3

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