Evaluation of Twelve Upland Cotton Genotypes for Resistance to *Phymatotrichum omnivorum*

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ABSTRACT

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Field plot studies were conducted in 1987 and 1988 to evaluate 12 upland cotton (*Gossypium hirsutum*) genotypes for relative susceptibility and lint yield production in the presence of *Phymatotrichum omnivorum*. Susceptibility differed among genotypes; MLB2BENH-1-85 generally had a low disease incidence, while C4HUGBEH-1-2-86 had the highest incidence. Differences also occurred among genotypes for lint yield, with CABUCD3H-1-86, BLLCABS-1-86, and C4HUGBEH-1-2-86 producing significantly more lint than Lankart LX571. Genotypes with less disease incidence and high lint yield production, combined with cultural practices for reducing the survival of *P. omnivorum*, should provide a beneficial approach for disease control.

Phymatotrichum root rot (PRR) caused by *Phymatotrichum omnivorum* (Shear) Duggar is a major constraint to production of upland cotton (*Gossypium hirsutum* L.) in the southwestern United States and Mexico (20). PRR generally has been controlled through a combination of cultural and crop management practices. Early investigators reported that fallowing (12), crop rotations (15, 17), deep plowing (6,14), and soil amendments (5,7,8) resulted in a reduction of disease incidence. Although these strategies produce beneficial results, severe losses often occur. More recent studies have emphasized the potential use of sodium chloride (10), anhydrous ammonia (18), and triazole fungicides (11,16) for control of PRR. Currently, the most effective and economical method for reducing yield losses attributable to PRR is the growing of fast-fruiting, early-maturing cultivars. Early literature reported that a shorter life cycle allowed a higher proportion of the potential yield to be obtained before the onset of disease (19).

Attempts of breeding for resistance to PRR have generally been disappointing because of the failure of identifying a significant source of genetic resistance. However, more recent reports have indicated that progress has been made in obtaining a moderate level of resistance (2–4) through indirect selection procedures (1). The objectives of these field experiments were to determine the relative susceptibility of 12 upland cotton genotypes to PRR and to evaluate the genotypes for lint yield in the presence of *P. omnivorum*.

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MATERIALS AND METHODS

Twelve upland cotton genotypes were evaluated for disease incidence and lint yield in the presence of *P. omnivorum.* With the exception of Lankart LX571, all genotypes were developed by breeding techniques of the multi-adversity resistance (MAR) cotton improvement program at Texas A&M University (1). Lankart LX571 is a commercial cultivar developed by conventional breeding methods. Genotypes were evaluated under field conditions in the 1987 and 1988 growing seasons. The experiments were conducted at the Blacklands Research Station, Temple, Texas. Soil type was a Houston black clay that is typically used for cotton production in central Texas. The plots were located in an area with a known history of PRR occurrence and similar inoculum density (3). This nursery is planted to cotton each year and no effort is made to reduce inoculum potential.

Experiments were designed as a randomized complete block with four replications. Plots were 9.1 m long × 0.7 m wide. Seed were planted with a cone planter and, following emergence, seedlings were thinned to 0.1 m apart. Planting dates were 8 April 1987 and 5 April 1988. Recommended production practices for cotton were followed each year, including land preparation, fertilization, and weed and insect control. Because of early season drought, a supplemental irrigation was applied 4 wk after planting in 1988.

Based on previous investigations (2,4), genotypes were evaluated for disease incidence at 4 and 5 wk after initial foliar symptoms. Disease incidence, which represented the percentage of dead plants for each genotype, was arcsine transformed as described by LeClerg et al (9) before analysis. Entire plots were hand-harvested at two dates in order to calculate lint yields and estimate earliness.

Data from each year were analyzed by analysis of variance. Following a significant *F* test ($P = 0.05$), a least significant difference (LSD) analysis was performed for mean separations. Correlation coefficients were obtained to determine the association of disease incidence and earliness with lint yield.

RESULTS AND DISCUSSION

Symptoms of foliar wilt were observed initially on 2 July 1987 and 15 June 1988. Mean disease incidence was generally higher in 1988 than in 1987 (Table 1). Differences in disease severity may have resulted from a lack of adequate rainfall, which could have suppressed disease development, in 1987 or the supplemental irrigation in 1988, which may have provided a more favorable environment for disease progression.

Significant differences ($P = 0.05$) in percentage of dead plants occurred among genotypes at 4 and 5 wk after initial symptom development in both 1987 and 1988. In 1987, MLB2BENH-1-85, BLLCABS-1-86, CABUCD3H-1-86, and OLBHUCA3S-1-86 had a lower percentage of dead plants than CDP37-HCIH-1-86 and C4HUGBEH-1-2-86 at week four. Significant differences also occurred at week five, where CABUCD-3H-1-86 and BLLCABS-1-86 had lower disease incidence than Tamcot CAB-CS, OC3HU2BNOS-1-85, C4HUGBEH-1-2-86, and CDP37HCIH-1-86.

With the exception of Tamcot CAB-CS, OC3HU2BNOS-1-85, and CDP37-HCIH-1-86, disease incidence was generally higher in 1988, as previously reported. At week four of 1988, MLB2-BENH-1-85, MACAOS-3-84, CAG8-CHUNS-1-2-86, Tamcot CAB-CS, and Lankart LX571 had lower disease incidence than did C4HUGBEH-1-2-86. A similar trend followed at week five, where MLB2BENH-1-85, MACAOS-3-84, CAG8CHUNS-1-2-86, and Tamcot CAB-CS had fewer plants killed than C4HUGBEH-1-2-86. Disease incidence for MLB2BENH-1-85 at week five also was significantly lower than for OLBHUCA3S-1-86. The results demonstrate that MLB2BENH-1-85 consistently was more resistant to PRR than C4HUGBEH-1-2-86, indicating that some genotypes are less susceptible to *P. omnivorum.*

Percy and Rush (13) found no evidence of host tolerance or rate-limiting resistance to PRR in cotton. This may have been because of the cotton genotypes they studied. Our studies showed that C4HUGBEH-1-2-86 consistently was the most susceptible genotype, followed by CDP37HCIH-1-86. MLB2BENH-1-85 appeared to have the most stable resistance to *P. omnivorum* of the 12 genotypes studied. No differences in disease incidence were observed between Tamcot CAB-CS and Lankart LX571, confirming the results of Percy and Rush (13).

Significant differences in lint yield ($P = 0.05$) were observed among genotypes in the presence of *P. omnivorum* for both 1987 and 1988 (Table 2). Replications were not significantly different for lint yield at either year. Mean lint yield of all genotypes differed between years; mean lint yield production in 1988 was 40 kg/ha^{-1} greater than for 1987.

Lint production ranged from 153 to 375 kg/ha^{-1} in 1987; yields of CABUCD3H-1-86, BLLCABS-1-86, C4HUGBEH-1-2-86, and CDP37HPIH-1-1-86 were significantly greater than MACAOS-3-84 and Lankart LX571. CABUCD3H-1-86 also produced higher yields than Tamcot CAB-CS, CAG8-CHUNS-1-2-86, CDP37HCIH-1-86, MLB2BENH-1-85, and OC3HU2-BNOS-1-85 in 1987. Likewise, genotypes differed for lint yield production in 1988. The lint yield obtained by CABUCD3H-

Table 1. Incidence (%) of Phymatotrichum root rot for 12 upland cotton genotypes 4 and 5 wk after initial symptom development

	DI[a] (week 4)		DI (week 5)	
Genotype	**1987**	**1988**	**1987**	**1988**
MLB2BENH-1-85	14.4[b]	22.0	30.7	33.5
BLLCABS-1-86	12.2	26.5	24.9	41.2
CABUCD3H-1-86	15.4	29.7	23.8	43.0
CDP37HPIH-1-1-86	19.7	26.5	30.9	40.0
MACAOS-3-84	22.6	26.1	36.3	38.4
CAG8CHUNS1-2-86	21.7	26.0	38.1	38.8
OLBHUCA3S-1-86	15.5	35.4	31.9	48.5
Tamcot CAB-CS	27.4	24.8	44.0	37.1
Lankart LX571	20.7	26.1	39.9	41.3
OC3HU2BNOS-1-85	27.7	26.4	45.7	41.6
CDP37HCIH-1-86	32.2	31.8	48.6	47.0
C4HUGBEH-1-2-86	32.1	40.8	46.7	54.2
Mean	21.8	28.5	36.8	42.0
LSD	16.2[c]	14.6	18.9	14.9
CV	35.3	27.1	26.5	19.9

[a]DI = disease incidence calculated as percentage of dead plants.
[b]Disease incidence data were arcsine square root transformed before analysis.
[c]Fisher's least square difference ($P = 0.05$) for comparing means of genotypes within columns.

Table 2. Mean lint yield of 12 upland cotton genotypes in soil naturally infested with *Phymatotrichum omnivorum*

	Lint yield (kg/ha^{-1})	
Genotype	**1987**	**1988**
CABUCD3H-1-86	375	450
BLLCABS-1-86	306	338
C4HUGBEH-1-2-86	299	331
CDP37HPIH-1-1-86	293	313
MLB2BENH-1-85	205	296
Tamcot CAB-CS	247	287
MACAOS-3-84	165	261
CDP37HCIH-1-86	211	260
OLBHUCA3S-1-86	269	258
OC3HU2BNOS-1-85	192	224
CAG8CHUNS-1-2-86	214	206
Lankart LX571	153	187
Mean	244	284
LSD	127[a]	133
CV	36.2	32.4

[a]Fisher's least significant difference ($P = 0.05$) for comparing means of genotypes within columns.

1-86 was significantly higher than that for all genotypes, except BLLCABS-1-86 and C4HUGBEN-1-2-86. Yields of BLLCABS-1-86 and C4HUGBEH-1-2-86 and C4HUGBEH-1-2-86. Yields of Lankart LX571. Lint yields were negatively correlated with disease incidence at 4 ($r = -0.50$, $P = 0.01$) and 5 ($r = -0.61$, $P = 0.01$) wk after the occurrence of initial symptoms, indicating that a delay in disease incidence within a genotype could result in higher yields.

One factor that may influence lint yields is earliness. Blank (5) demonstrated that earlier maturing genotypes produced significantly higher yields than later maturing genotypes. Streets (19) reported that the early maturity characteristic allows the plant to obtain satisfactory yields before the period of greatest disease incidence. However, our studies detected no significant correlation between earliness and lint yield, indicating that disease avoidance was not the major factor in reducing yield losses. The genotypes in these studies were classified as early to intermediate in maturity and were significantly earlier than the genotypes evaluated by Blank (5).

We found that genotypes vary in their degree of susceptibility and lint yield production in the presence of *P. omnivorum*. Based on disease incidence, MLB2BENH-1-85 appeared to be the least susceptible genotype. However, when compared to the other genotypes, MLB2BENH-1-85 did not produce one of the higher lint yields. CABUCD3H-1-86 obtained a significantly greater yield than seven of the genotypes in this study. Lint yields of BLLCABS-1-86 and C4HUGBEH-1-2-86 also were significantly higher than Lankart LX571. Thus, some genotypes may possess host tolerance to PRR. Identification of cotton germ plasm possessing resistance or host tolerance to *P. omnivorum* should provide a beneficial tool for cotton improvement breeding programs and, when combined with cultural practices, should result in reduced pathogen survival and higher lint yields.

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