Evaluation of Cotton Cultivar Susceptibility to Alternaria Leaf Spot

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ABSTRACT

Cotty, P. J. 1987. Evaluation of cotton cultivar susceptibility to Alternaria leaf spot. Plant Disease 71: 1082-1084.

The relative susceptibilities of several common Arizona cotton cultivars to *Alternaria macrospora* were evaluated in the greenhouse. *Gossypium hirsutum* cv. Deltapine Acala-90 was more susceptible than *G. hirsutum* cvs. Deltapine 61, Acala SJ-5, and McNair 235. *G. barbadense* cvs. Pima S-6 and Pima S-5 were more susceptible to *A. macrospora* than the *G. hirsutum* cultivars. Cotton acreage planted to cultivars with relatively high susceptibility to *A. macrospora* (Pima cotton and Deltapine Acala-90) has increased rapidly in recent years in Arizona, possibly contributing to increased frequency and severity of outbreaks of Alternaria leaf spot. Results indicate that lesion diameter is a useful measure of host susceptibility.

Alternaria leaf spot of cotton caused by *Alternaria macrospora* Zimm. occurs in most cotton-growing areas of the world. Although most cotton species are susceptible to this pathogen, the predominant species grown in the United States, *Gossypium hirsutum* L., is considered highly resistant (5). The high-quality, extra-long staple Pima cotton (*G. barbadense* L.), however, is highly susceptible. Alternaria leaf spot caused yield reductions of up to 25% in *G. barbadense* cv. Pima S-5 in Israel (2).

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Journal series paper 4400 of the Arizona Agricultural Experiment Station, Tucson.

Accepted for publication 10 July 1987 (submitted for electronic processing).

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During the current period of low overall cotton prices, the high-quality, extra-long staple Pima cotton has become increasingly favored by growers because of its relatively high per-acre value. As a consequence, more than 14% of Arizona's 205,000 ha of cotton was planted with Pima cotton in 1986 (3).

The occurrence of *A. macrospora* isolates in the United States with only very low virulence on cotton (8,10) and the general low estimated impact of this disease in Arizona (7) has suggested to some researchers that virulent *A. macrospora* strains may not occur in the United States (1). In 1982, 1983, and 1984, however, moderate to heavy levels of Alternaria leaf spot occurred in central and southeastern Arizona (6). Because the cultivar Pima S-6 was first released in 1983, many growers had their first experience with this cultivar during 1983 and 1984. The heavy disease pressure in those years led some growers to suspect that Pima S-6 was more susceptible to Alternaria leaf spot than its predecessor, Pima S-5.

High levels of disease also occurred in southeastern Arizona during the 1985 season, when some fields planted with *G. hirsutum* cv. Deltapine Acala-90 (DP 90) were affected. This was of immediate concern because *G. hirsutum* cultivars are generally considered highly resistant to this disease (5), and during the years 1984–1986, DP 90 was the most widely planted cotton cultivar in Arizona (3).

The purpose of this study was to determine under carefully controlled conditions the relative susceptibilities of the *G. barbadense* cultivars Pima S-5 and Pima S-6 to Alternaria leaf spot and to determine whether DP 90 is more susceptible than other *G. hirsutum* cultivars.

MATERIALS AND METHODS

Three isolates of *A. macrospora* were used in these studies: C-3 (ATCC 58174) from *G. barbadense* collected in Cochise County, Arizona, in 1982 (4); CB-1 from *G. barbadense* collected in Pinal County, Arizona, in 1984; and C-22 from *G. hirsutum* collected in Cochise County, Arizona, in 1985. Fungal isolates were maintained on a modified V-8 medium containing 5% V-8 juice (v/v) and 2% agar (w/v) at 27 C under 5,000 lux fluorescent light on a 12-hr diurnal cycle. The fungi sporulated abundantly under these conditions. For long-term storage, 3-mm-diameter agar plugs of sporulating cultures were maintained at room temperature in 25-ml vials containing 5

ml of sterile distilled water.

G. barbadense cvs. Pima S-5 and Pima S-6 and *G. hirsutum* cvs. DP 90, Deltapine 61 (DP 61), Acala SJ-5, and McNair 235 were grown in a greenhouse in 750-ml pots containing modified U.C. mix (6 pt of peat moss, 8 pt of sand, 1 pt of vermiculite plus 21 g of KNO_3, 21 g of K_2SO_4, 69 g of treble superphosphate, 311 g of domolite lime, 104 g of $CaCO_3$, and 10 g of $CuSO_4$ per cubic meter). Plants were fertilized with 50 ml of 2,000-ppm Miracle-Gro (Sterms Miracle-Gro Products, Inc., Port Washington, NY) every 8–10 days.

Thirty-five- to 40-day old plants at the five- to seven-leaf stage were sprayed to runoff with suspensions containing 2,500–3,500 conidia per milliliter in 0.01% Triton X-100 and were immediately placed in an unilluminated humidity chamber (RH 100%) maintained at 26–28 C (4,6). After 24 hr, plants were removed and placed on the greenhouse bench.

Plants were evaluated 6 days after inoculation. In each experiment, three plants of each cultivar were inoculated with one fungal isolate. Each fungal isolate was used in two experiments. Plants were maintained in randomized blocks throughout growth, inoculation, and postinoculation treatments.

In the initial three experiments, plants were subjectively ranked and numbered. (The most diseased plant in each experiment was assigned the number 1.) Similarly affected plants were placed in groups and visually rated from 6 (little disease) to 1 (severe disease). Leaves were then excised and photocopied and leaf surface areas were determined by digital image analysis at a later date. The lesions on each leaf were counted and the diameter of each lesion on the second oldest leaf of each plant measured. Lesions 0–1 mm in diameter were counted as 0.5 mm, those 1–2 mm in diameter were counted as 1.5 mm, etc. Because lesion size proved to be a reliable and objective criterion, it was the only criterion used to compare cultivar resistance in the final three experiments.

RESULTS

Lesion diameter was the most useful criterion for evaluating host susceptibility because it was objective, simple, and permitted rapid separation of resistant cultivars. Although using the number of lesions per square centimeter typically produced the same ranked order of cultivars as lesion diameter, the technique was more time consuming and did not permit adequate statistical separation of cultivars (Table 1).

The average lesion diameter on DP 90 was consistently greater than on the other *G. hirsutum* cultivars, and the average lesion diameter on the *G. barbadense* cv. Pima S-5 was consistently greater than that on S-6 (Fig. 1). These differences, however, were not always statistically significant in individual experiments. Figure 1 summarizes the results of five experiments. To compare cultivar resistance among several experiments, lesion diameters are expressed relative to that of Pima S-5, which was the most susceptible cultivar.

As previously reported (2), lesions were not evident until 2–3 days after inoculation. Lesion appearance differed on *G. hirsutum* and *G. barbadense*. Lesions on *G. barbadense* were surrounded by a ring of red-stained cells up to 2 mm wide. On *G. hirsutum*, rings of red-stained cells did not form; however, a yellow chlorotic halo was occasionally

Table 1. Evaluation of cotton cultivar resistance to *Alternaria macrospora* isolate CB1 with four criteria

	Disease severity[v]			
Cultivar	Rank[w]	Rating[x]	Lesion diameter[y] (mm)	Lesions/cm²[z] (no.)
Pima S-5	2.0 a	1.0 a	1.46 a	2.01 a
Pima S-6	5.3 ab	2.0 ab	1.24 ab	1.61 a
Deltapine Acala-90	7.7 bc	2.3 bc	0.99 b	1.26 ab
Acala SJ-5	12.3 cd	4.0 cd	0.71 c	0.84 abc
McNair 235	14.3 d	5.3 d	0.67 c	0.64 bc
Deltapine 61	15.3 d	6.0 d	0.67 c	0.42 c

[v] Numbers within a column followed by the same letter are not significantly different ($P = 0.05$) by the Student-Newman-Keuls test for multiple comparison of means. Results of a single experiment are presented. The test was performed three times with similar results.
[w] Plants were ranked most diseased (1) to least diseased (18).
[x] Plants with similar disease severity were placed in groups and assigned values 6 (low disease severity) to 1 (high disease severity).
[y] Lesions on the second oldest leaf of each plant were measured after 6 days.
[z] Number of lesions per square centimeter of the total leaf surface area of each plant.

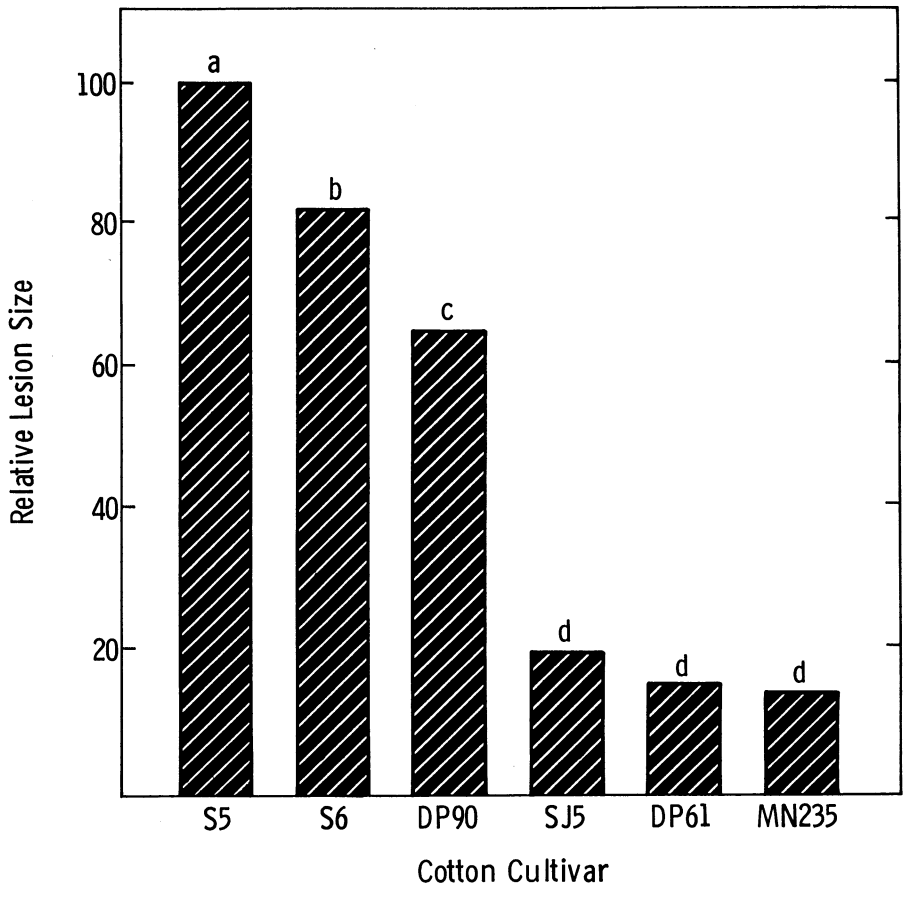

Fig. 1. Differences in resistance to *Alternaria macrospora* among six cotton cultivars as measured by lesion diameter. Diameters are expressed relative to the most susceptible cultivar, Pima S-5. Values are averages of five experiments, each replicated three times. Bars with the same letter are not significantly different ($P = 0.05$) according to the Student-Newman-Keuls test for multiple comparison of means.

evident.

Results of tests with each of the three isolates were similar. Isolates maintained for up to 3 yr in sterile distilled water retained their virulence.

DISCUSSION

Lesion diameter is an objective and quantitative measure of relative host resistance that is useful in evaluating host susceptibility to *A. macrospora*. Apparently, restriction of lesion expansion is an important factor in host resistance to this pathogen.

DP 90 is more susceptible to *A. macrospora* than other *G. hirsutum* cultivars tested. *G. hirsutum* is generally considered highly resistant to *A. macrospora*, whereas *G. barbadense* is considered highly susceptible (2,5). This is the first report of a quantitative difference in susceptibility among cultivars of either species.

DP 90 was introduced in 1982 and has rapidly become the most widely planted cotton cultivar in Arizona, constituting more than 40% of the cotton acreage (9). During this same period the percentage of Arizona cotton acreage planted to the highly susceptible Pima cotton (S-5 and S-6) steadily increased while the acreage of the highly resistant cultivar DP 61 decreased (9). This restructuring of Arizona's cotton acreage toward more susceptible cultivars may have influenced the frequency and severity of Alternaria leaf spot epidemics. This speculation agrees with the previous suggestion (1) that Alternaria leaf spot of cotton has been of little importance in the United States because of the small acreage cropped to sensitive cultivars.

The absence of virulent isolates of the pathogen has also been suggested as an explanation of the unimportance of this disease in the United States (1). However, the occurrence of widespread outbreaks of Alternaria leaf spot in Arizona during 1982–1984 (6) and results of the current study that identified highly virulent isolates from Arizona cotton indicate that this suggestion is incorrect.

Pima S-6 is the predominant *G. barbadense* cultivar currently planted in Arizona. The percentage of Pima cotton planted in the very hot, low-elevation areas of Arizona has increased since S-6 was introduced in 1983 because S-6 has greater heat resistance than S-5. However, because the first experience of many growers with S-6 was during 1983 and 1984, years in which high levels of leaf spot occurred (6), the impression developed that S-6 was more susceptible to *A. macrospora* than S-5. The results presented here indicate that this is not the case.

ACKNOWLEDGMENT

I wish to thank J. P. Evans for assistance with the video image analysis.

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