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Yield, Earliness, and Fiber Properties of Cotton Carrying Combined Traits for Pink Bollworm Resistance

F. Douglas Wilson*

ABSTRACT

The nectariless (N) and okra-leaf (L) traits confer low levels of resistance in cotton, *Gossypium hirsutum* L., to pink bollworm (PBW), *Pectinophora gossypiella* (Saunders). The semi-smoothleaf (SS) trait reduces the amount of leaf trash in mechanically harvested seed-cotton. The main objective of this study was to compare NL (or NSSL) isolines with N (or NSS) isolines and with check cultivars for resistance to PBW, lint yield, earliness, and fiber properties. The experiments were grown at three locations: Tempe, AZ; Maricopa, AZ; and Brawley, CA. In three experiments grown without the use of insecticide, two of the six NL (or NSSL) isolines (DES 56NL and DES 24NSSL) had significantly less seed damage caused by PBW, did not yield significantly less lint, were significantly earlier, and had deficient to comparable fiber properties when compared with the N counterpart isolines. The Stoneville 825 NL isoline yielded significantly more lint and had fiber properties comparable to the N isoline, but was not earlier and did not have less seed damage. All N, NL, NSS, and NSSL lines that were compared with nectaried, regular-leaf cultivars sustained less seed damage, and most were equal in lint yield and earliness. In a fourth, insecticide-treated experiment, DES 56NL required fewer insecticide applications, had significantly less seed damage, and was earlier maturing than the nectaried, regular-leaf 'Deltapine 61' (DPL-61) at two locations, and yielded more lint at one location. Fiber of DES 56NL was shorter, weaker, and coarser, but had elongation strength equal to that of DPL-61. In three of the four experiments, some year × cotton and location × cotton interaction effects were significant. Thus, in spite of some deficiencies in properties and performance, cotton germplasm lines are becoming available that combine PBW resistance with yield potential, earliness, and fiber properties that approach or equal those traits in cultivars.

A MAJOR OBJECTIVE in breeding cotton for resistance to pink bollworm (PBW) is to determine whether lines that carry combined resistance traits sustain less insect damage than those that carry single traits. Factorial analysis of a set of isolines showed that nectariless (N) or okra leaf (L) in a PBW-resistant genetic background increased the level of resistance above that conferred by the genetic background alone (13). However, combining N and L in the resistant background did not increase the level of resistance above that shown by N or L alone. The analysis also showed that smoothleaf (S) did not change the level of resistance appreciably, a result that was at variance with an early observation (17), but agreed with later ones (14). Those results (13, 14, 17) led to examination of the effects of genetic background and of an alternate source of smoothleaf (SS = semi-smoothleaf) on relative PBW resistance (the semi-smoothleaf trait reduces the amount of leaf trash in mechanically harvested seedcotton). The main objective of this study was to compare NL (or NSSL) isolines with N (or NSS) isolines; and with check cultivars for resistance to PBW, lint yield, earliness, and fiber properties. A secondary objective was to assess the importance of resistance trait × environment and resistance trait × genetic background interactions.

USDA-ARS, Western Cotton Res. Lab., 4135 E. Broadway, Phoenix, AZ 85040. Contribution from USDA-ARS, in cooperation with the Arizona Agric. Exp. Stn. Received 27 Nov. 1987. *Corresponding author.

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MATERIALS AND METHODS

Experiment 1. Four cultivars and six germplasm lines were evaluated in field plots in Arizona in 1983, 1984, and 1985. 'DES 24' and 'DES 56' have nectaries, hirsute leaves, and a regular leaf shape (1,2). Deltapine 61 (DPL-61) has nectaries and 'Deltapine NSL' (DPL-N) is nectariless (N, conditioned by ne_1, ne_2); both have the semi-smoothleaf trait (SS, conditioned by t_3) and a regular leaf shape. The nectariless germplasm lines DES 24N, DES 24NSS, and DES 56N were developed by W.R. Meredith, Jr., USDA-ARS, Stoneville, MS. The okra-leaf (L, conditioned by L_2^o), lines DES 24NL, DES 24NSSL, and DES 56NL were developed by crossing the DES 24N, DES 24NSS, and DES 56N parents to La-Okra-2 (7), followed by selection of okra-leaf plants in a segregating population of ca. 80 to 90 plants and backcrossing to the appropriate DES parent. Selection was not practiced for other traits. Okra-leaf isolines in other backgrounds (Exp. 3 and 4) were developed in a similar manner. The NL and NSSL lines in DES background were BC_3 in Exp. 1 in all 3 yr. The BC_5 generation of these lines were registered as WC-10NL (DES 24NL), WC-11NSSL (DES 24NSSL), and WC-12NL (DES 56NL) (12). For simplicity the N, NL, NSS, and NSSL lines from all four experiments are designated as isolines in this study, but are more appropriately called near-isolines because they are only BC_3 or BC_4 generations.

Experiment 1 was planted at the Arizona State University Farm Laboratory (ASU) in 1983 and 1984. Soil type is a Contine clay loam (fine, mixed, hyperthermic Typic Haplargid). In 1985, this experiment was planted at the University of Arizona Maricopa Agricultural Center (MAC). Soil type is a Denure sandy clay loam (coarse-loamy, mixed, hyperthermic Typic Camborthid).

At both locations, plot size was 20 rows × 18 m, with rows spaced 1-m apart. Plots were arranged in four randomized complete blocks. Cultural practices were standard for the area except that no insecticides were applied. Plants in rows 9 and 11 of each plot were hand thinned to a uniform spacing of 30 cm. Seedcotton was hand harvested once a week from 10 plants of one thinned row per plot, beginning in late August when bolls started to open, until late September, with a final harvest in late October or early November. A 6-m section of the other thinned row of each plot was hand harvested at the end of the season for a yield estimate. Data from the 10-plant plots were lost from one replication in 1984, so combined analyses are based on three replications per season. Data from the 6-m section were based on four replications.

Seedcotton samples were weighed and ginned and lint and seed samples were weighed to calculate various agronomic properties. Seed samples were X-rayed to determine the percentage of seeds damaged by PBW (15). Fiber properties were determined at the USDA-ARS fiber testing laboratory, Phoenix, AZ.

Experiment 2. The germplasm line with the lowest PBW damage in Exp. 1, DES 56NL, and the check cultivar, DPL-61, were grown at MAC and at the USDA-ARS Imperial Valley Conservation Research Center (IV), Brawley, CA in 1986. Soil type at IV is Holtville silty clay (clayey over loamy, montmorillonitic, hyperthermic Typic Torrifluvent). Plot size was 48 rows by 165 m (0.8 ha); rows were spaced 1-m apart. Plots were arranged in five randomized complete blocks. Cultural practices were standard for each area. Samples of 25 bolls per plot were taken twice a week and checked for PBW eggs. The action level for insecticide application of the bolls having PBW eggs was 17% at MAC and 8% at IV. These percentages equate to 10 and 5%, respectively, for boll infestation based upon number of larvae per boll (5). For PBW control, DPL-61 plots at MAC were sprayed three times (30 August, 6, 20 September), and DES 56NL plots were sprayed twice (30 August, 6 September). At IV, DPL-61 plots were sprayed nine times (5, 17, 26, and 31 July; 9, 15, 22, and 30 August; 6 September) and DES 56NL plots were sprayed six times (31 July; 9, 15, 22, and 30 August; and 6 September).

Plot harvesting, and agronomic and fiber sample processing were done in the same way as for Exp. 1, except that two unthinned (ca. 13 plants per m) rows 15-m long were machine harvested 23 October for a yield estimate at MAC and four unthinned rows per main plot, each 4-m long (16 m of row per plot) were hand harvested 25 September for a yield estimate at IV. In addition, a long warm fall caused additional bolls to open, which were hand picked 14 November from the 10-plant plots at MACT.

Experiment 3. 'Stoneville 825' (N, hirsute, regular leaf shape) and 'Gumbo 500' (nectaried, hirsute, L, 8) were used as check cultivars. Three NL and one NSS germplasm lines were developed by backcrossing into nectariless Stoneville backgrounds (Stoneville 825, 8701N, and 8737N). La-Okra-2 was the L source and DES 24-8ne (9) was the SS source for the germplasm lines. The four lines (BC_3 in 1985 and BC_4 in 1986), and the two cultivars were grown at MAC.

Plot size was 8 rows × 18 m; rows were spaced 1-m apart. Plots were arranged in four randomized complete blocks. Cultural practices were standard except that no insecticides were applied. Plot harvesting and sample processing were the same as in Exp. 1 for the stratified harvest data, except that plots were harvested biweekly instead of weekly. Two unthinned rows (ca. 13 plants per m) per plot, 15-m long, were harvested 31 October 1985 and 25 October 1986 for yield estimates.

Experiment 4. Stoneville 825 and Gumbo 500, used as checks, and six germplasm lines (developed by backcrossing into 7203-14-104 background) were grown at MAC in 1986. The N and L germplasm lines were BC_3 and the NL, SS, NSS, and NSSL lines were BC_4. The 7203-14-104 line, developed by W. D. Fisher, Arizona Agricultural Experiment Station, has some field resistance to PBW (16). DES 24-8ne was the N and SS source, and La-Okra-2 was the L source. Plot size, experimental design, harvesting, and processing procedures were the same as for Exp. 3, except that earliness is expressed as cumulative lint yield at second harvest.

Data Analysis. For all four randomized complete block experiments, data were analyzed by analysis of variance methods. The *F*-tests were conducted assuming lines and years as fixed effects. Means were compared with the use of the Fisher's LSD test (4).

RESULTS

In Exp. 1, seasonal seed-damage means were consistent over the 3 yr (no significant interactions were detected), so only the 3-yr means are presented (Table 1). The DES 24NSSL and DES 56NL isolines sustained significantly less seed damage than did the respective N isolines (DES 24NSS and DES 56N), but DES 24NL did not differ significantly from DES 24N. All N, NL, NSS, and NSSL lines had significantly less seed damage than did the nectaried, regular-leaf shape cultivars DES 24, DES 56 (hirsute leaf), and DPL-61 (semi-smoothleaf).

Three-year mean lint yields of the NL isolines did not differ significantly from those of their respective N isolines. Only DES 24NSSL yielded significantly less lint than DES 56 and DPL-61. However, DES 24, DES 24NSS, and DES 24NSSL yielded less lint than DPL-N. All three sets of N (or NSS) isolines in DES 24 and DES 56 backgrounds showed yield inconsistencies over the 3 yr, when compared to the recurrent parents. For example, DES 56N lint yields were 106, 107, and 83% of those of DES 56; and DES 56NL lint yields were 102, 118, and 106% of those of DES 56. In 1983, DES 56 and four germplasm lines yielded significantly more lint than DPL-61 and DPL-N. In 1984 and 1985, however, none of the germplasm lines or DES cultivars yielded more than the DPL checks. The relatively sparse plant spacing (30 cm) within the row may have reduced the advantage of the open canopy of the okra-leaf cottons (J.E. Jones, 1985, personal communication). The yield rows were relatively short (6 m) and may not have been representative of yields from a larger area. On the other hand, the yield rows were selected for stand height uniformity and, therefore, should have measured yield potentials adequately.

The DES 24NSSL and DES 56NL lines were significantly earlier (percent cumulative lint yield/total lint yield at third harvest) than the respective NSS and N lines, but DES 24NL and DES 24N did not differ

Table 1. Seed damage, lint yield, and cumulative lint yield at third harvest in check cultivars and in nectariless (N), okra leaf (L), and semi-smoothleaf (SS) germplasm lines grown at Tempe, AZ without insecticide.

Cotton	Seed damage 3-yr mean	Lint yield				Cumulative lint yield, third harvest			
		1983	1984	1985	3-yr mean	1983	1984	1985	3-yr mean
	%	kg ha^{-1}				% of total yield			
DES 24	37.6a†	772d	762a-c	1055b-d	863b-d	88.5a-c	66.3bc	77.2a-c	77.3bc
DES 24N	24.8bc	908bc	716bc	1042b-d	889a-d	95.1ab	72.2a-c	75.3a-c	80.9a-c
DES 24NL	26.1bc	1018ab	760a-c	1107bc	962ab	84.9bc	77.8ab	67.0c	76.6c
DES 24NSS	27.6b	744d	732a-c	975b-d	817cd	90.0ab	56.2cd	84.5ab	76.9c
DES 24 NSSL	20.2cd	967ab	509d	846d	773d	90.1ab	80.3ab	85.0ab	85.1ab
DES 56	38.4a	998ab	731a-c	1091bc	940ab	95.8a	64.5bc	90.2a	83.5a-c
DES 56N	26.3bc	1056a	778a-c	906cd	913a-c	90.1ab	71.4a-c	67.1c	76.2cd
DES 56NL	17.3d	1019ab	628cd	1139ab	929a-c	89.3ab	87.1a	88.9ab	88.4a
Deltapine 61	37.4a	797cd	879ab	1119ab	932a-c	80.0c	45.0de	79.2a-c	68.1d
Deltapine N	29.6b	753d	896a	1327a	992a	59.6d	35.7e	74.8bc	56.7e
Mean	28.5	903B	739C	1061A	901	86.3A	65.7B	78.9A	77.0
CV, %	24.5	16	17	14	16	7.1	16.3	12.9	11.5

Analysis of variance

Source	df	Mean square		
Years (Y)	1	685.8*	3838.3**‡	3295.4**
Reps/Y	6§	82.9	45.9	160.0
Cottons (C)	9	480.6**	199.5*	746.3**
Y × C	18	49.0	241.7**	277.0**
Error	54§	43.1	77.4	79.0

*,**Differences are significant at the 0.05 or 0.01 levels of probability, respectively, according to an *F* test.
† Means with lower-case letter(s) in common (within a column), or with capital letters in common (within a row), are not significantly different at the 0.05 level of probability, according to the Fisher LSD test (4).
‡ Original mean square × 10^{-2}.
§ For lint yield, df = 9, 81 for Reps/Y and error, respectively.

significantly in earliness. Three year earliness means were significantly higher for the two DES cultivars and for all six germplasm lines (except DES 56N) than for the DPL check cultivars. Earliness was also inconsistent over years. All three NL isolines, in comparison with N isolines, were inconsistent for earliness. In 1983, all but one DES cultivar and one germplasm line; and in 1984, all but one germplasm line were significantly earlier than DPL-61; but in 1985, none were significantly earlier. Differences in earliness were not attributable to differences in planting date because the experiments were planted on approximately the same date each year.

In Exp. 2, seasonal seed damage was significantly lower for DES 56NL than for DPl-61 at both locations, in spite of the fact that both cotton lines had been treated with insecticide to control PBW (Table 2). The first insecticide application was 26 d later on DES 56NL than on DPL-61 (31 July vs. 5 July, respectively) at IV, where PBW populations were much higher than at MAC (first insecticide application was 30 August on both cotton lines at MAC). The number of insecticide applications was 33% lower on DES 56NL than on DPL-61 at both locations.

At MAC, DES 56NL yielded significantly more lint than DPL-61 (54% more by mid-October; 22% more by mid-November), but at IV lint yields were not significantly different. This result led to a significant location × cotton interaction effect (analysis not shown). Location mean lint yields were not significantly different. DES 56NL was significantly earlier than DPL-61 at both locations, but the difference was much greater at MAC, resulting in a location × cotton interaction effect (analysis not shown). The entire crop was significantly earlier at IV than at MAC.

In Exp. 3, seed damage and lint yields were consistent over the 2 yr (Table 3). None of the germplasm lines in Stoneville background, or the N and L checks, differed significantly in the amount of seed damage. Both St 825NSS and St 825NL yielded significantly more lint (13 and 14% more, respectively) than did the N and L checks. Averaged over the 2 yr, none of the germplasm lines were significantly earlier than the checks. In 1985, St 825NSS was significantly earlier, but in 1986 was significantly later than the other germplasm lines, leading to a significant Y × C interaction effect. The reason for this discrepancy is not known.

In Exp. 4, the 7203-14-104NL isoline did not have significantly less seed damage than the N and L isolines, but did have significantly less seed damage than the two checks (Table 4). The NSSL isoline did not have less seed damage than any other isoline except SS, nor less than the checks. Lint yield of 7203-14-104L was significantly higher than yields of all other isolines except for N, but not significantly higher than yields of the checks. The 7203-14-104L isoline was significantly earlier than the N, NSS, and NSSL isolines and the N check, but not earlier than the NL and SS isolines and the L check.

In the four experiments, fiber properties were obtained for all cultivars and germplasm lines. However, only the comparisons are presented for the lines that were selected for low PBW damage or high yield with the check cultivars (Table 5). In Exp. 1 and 2, DES 56NL had significantly shorter and weaker fiber, and in Exp. 1 it also had higher elongation and coarser fiber than did DPL-61. In Exp. 3, fiber properties of the three germplasm lines were comparable to those of the check, ST 825, except that St 8737NL had coarser fiber. In Exp. 4, 7203-14-104L had shorter, weaker, and coarser fiber than both the N and L checks. On the other hand, fiber properties of 7203–14–104NL compared favorably with those of St 825, but the fiber was shorter and coarser than that of Gumbo 500.

DISCUSSION

Nectariless (N) cotton lines have found a permanent place in our breeding program because they consistently show resistance to PBW. Also, N usually has no negative effect on other traits. For example, in this study DES 24N and DES 56N had 21 to 34% less seed damage than the respective nectaried cultivars, but did not differ significantly in lint yield, earliness, or fiber properties (except that DES 56N had slightly shorter fiber than DES 56).

Table 2. Seed damage, lint yield, and cumulative lint yield at third harvest in a nectariless okra leaf (NL) germplasm line and nectaried regular leaf check cultivar under partial PBW control in 1986.

Location†	Cotton	Insecticide treatments	Seed damage	Lint yield‡	Cumulative lint yield, third harvest
		no.	%	kg ha^{-1}	% of total yield
MAC	DPL-61	3	8.2b*	1082c	17.8c
MAC	DES 56NL	2	4.7c	1665a	77.3b
IV	DPL-61	9	12.7a	1448b	79.9b
IV	DES 56NL	6	6.7bc	1372b	93.2a
CV, %			28.4	13	7.3
Location Mean					
MAC			6.4B	1373A	46.7B
IV			9.6A	1410A	86.5A

* Cotton means with lower case letter(s) in common, or location means with capital letter(s) in common, are not significantly different at the 0.05 level of probability, according to the Fisher LSD test (4).
† MAC = Maricopa, AZ; IV = Brawley, CA.
‡ Yields at MAC are based on machine-picked samples on 23 October; hand picking on 14 November gave final yield estimates of 1370 and 1673 kg ha^{-1} for DPL-61 and DES 56NL, respectively, a difference of 22%.

Table 3. Seed damage, lint yield, and cumulative lint yield at second harvest in Stoneville 825 (N check), Gumbo 500 (L check), and in four germplasm lines grown at MAC without insecticide.

Cotton	Seed damage 2-yr mean	Lint yield 2-yr mean	Cumulative lint yield, second harvest 1985	1986	2-yr mean
	%	kg ha^{-1}	% of total yield		
Stoneville 825(N)	19.5a†	1550b	47.2b	69.1bc	58.2a
Gumbo 500(L)	19.2a	1518bc	53.7b	79.7a	66.7a
Stoneville 825NSS	20.1a	1758a	66.0a	59.3c	62.7a
Stoneville 825NL	17.5a	1766a	46.9b	76.5ab	61.7a
Stoneville 8701NL	18.2a	1356c	54.4b	75.6ab	65.0a
Stoneville 8738NL	19.2a	1688ab	52.4b	75.8a	64.1a
Mean	18.9	1606	53.4	72.7	63.1
CV, %	20.9	11	15.3	9.0	11.8

Analysis of variance

Source	df	Mean Square		
Years (Y)	1	162.4	907.4‡	1247.5*
Reps/Y	6	121.3**	417.1	88.9**
Cottons (C)	5	7.3	2063.4**	23.3
Y × C	5	26.6	292.4	79.5**
Error	30	15.6	287.7	20.9

*,** Differences are significant at the 0.05 and 0.01 level of probability, respectively, according to an F test.
† Means with letter(s) in common (within a column) are not significantly different at the 0.05 level of probability, according to the Fisher LSD test (4).
‡ Mean squares = original mean squares × 10^{-2}.

The nectariless, okra-leaf (NL) isolines would be expected to have less seed damage than the N or L isolines because N and L presumably act independently. However, only two of the six NL isolines in this study had significantly lower seed damage than the respective N isolines (although three of the other four showed a similar trend). Also, in an earlier study, AET-5NL did not have lower seed damage than AET-5N or AET-5L (13). In fact, L has given inconsistent results, showing lower seed damage than the checks in some genetic backgrounds, but not in others (11, 13, 14). A decision to use NL rather than N alone to impart resistance to PBW will have to be made on an individual basis.

It is encouraging that some NL isolines yielded as much or more lint and were earlier than the comparable N isolines. In previous tests in Arizona, L lines had yielded significantly less lint and generally had not been significantly earlier than regular-leaf lines (11, 13, 14). The performance of the NL isolines was also encouraging because there has been some doubt about the efficacy of using backcross methods to transfer L into improved germplasm (10). The L trait also has certain other advantages, notably resistance to bandedwinged whitefly, *Trialeurodes abutilonea* (Haldeman); to larvae of boll weevil, *Anthonomus grandis* Boheman, in shed squares; and to boll rot (7, 8). The okra-leaf trait also may allow better penetration of spray into the plant canopy (6).

Transferring the semi-smoothleaf (SS) trait into N and NL germplasm apparently had little effect on PBW resistance. The effect of SS on yield and earliness varied, but St 825NSS yielded significantly more lint than ST 825 and was not significantly later. The SS trait, even though not resistant to PBW, is valuable because it reduces the amount of leaf and bract trash in mechanically harvested cotton, and because it supports lower populations of sweetpotato whitefly, *Bemisia tabaci* (Genn.) (3).

Inconsistencies in isolines and genetic backgrounds were not uncommon in these experiments. For example, NL isolines, when compared with N isolines in four genetic backgrounds (DES 24, DES 56, Stoneville 825, 7203–14–104), had 64 to 105% as much seed damage, yielded 96 to 114% as much lint, and varied from 95 to 116% in earliness.

Seed damage percentages and yield differences were not related in any obvious way. For example, in Exp. 1, DES 56NL had only 45% as much seed damage as

Table 4. Seed damage, lint yield, and cumulative lint yield at second harvest in N and L check cultivars and six germplasm lines grown at MAC, 1986, without insecticide.

Cotton	Seed damage	Lint yield	Cumulative lint yield, second harvest
	%	kg ha^{-1}	% of total yield
Stoneville 825(N)	18.6ab*	1625ab	69.1bc
Gumbo 500(L)	19.0ab	1596ab	79.7ab
7203-14-104N	15.0a-c	1577a-c	69.9bc
7203-14-104L	10.5c	1711a	84.2a
7203-14-104NL	9.6c	1516b-d	75.2ab
7203-14-104SS	21.0a	1394cd	71.4a-c
7203-14-104NSS	15.5a-c	1503b-d	61.5c
7203-14-104NSSL	13.9bc	1383d	70.6bc
Mean	15.4	1538	72.7
CV (%)	26.7	10	10.5

* Means with letter(s) in common (within a column) are not significantly different at the 0.05 level of probability, according to the Fisher LSD test

DES 56, but yielded about the same amount of lint. This result could be interpreted to mean that the yield potential of DES 56 would be higher than that of DES 56NL when PBW is controlled. However, a definitive comparison could be made only if data were available from both sprayed and unsprayed plots.

From a practical standpoint, comparisons between the resistant lines and currently grown cultivars are of considerable importance because those cultivars represent the standards by which new germplasm is measured. The DES 56NL germplasm line was the most promising one among the DES N and NL series when compared to DPL-61 in plots not treated with insecticide (Exp. 1) because it had significantly less seed damage, was significantly earlier, and yielded as much lint.

In insecticide-treated plots, DES 56NL, when compared with DPl-61, required 33% less insecticide (and a 4-wk delay of the first insecticide application at IV), had less seed damage, and yielded as much lint at one location and significantly more at the other location. This line was remarkably early maturing when compared with DPL-61, especially at MAC. For example, DES 56NL achieved a yield of 1000 kg ha^{-1} by 1 September at MAC and 19 August at IV, whereas DPl-61 did not attain this yield level until 20 September at MAC (20 d later) and 24 August at IV (5 d later). At MAC, DES 56NL yielded virtually no seedcotton after mid-October, whereas DPL-61 increased yield by 11% between mid-October and mid-November. The sharp cutout of DES 56NL at MAC, along with early harvest and stalk destruction, could reduce overwintering PW populations significantly.

In the Stoneville (St) and 7203-14-104 series of germplasm lines, St 825NL and St 825NSS were the most promising ones, when compared with the cultivars, because they yielded significantly more lint and exhibited comparable fiber quality.

It is important to assess the effects of the year × cotton and location × cotton interactions on the consistency of performance of germplasm lines, particularly those selected for future study or release. For example, in Exp. 1 and 2, DES 56NL had less seed damage and was earlier, but varied in lint yield in comparison with DPL-61. In Exp. 3, ST 825NSS was significantly earlier than the other cotton lines in 1985, but significantly later than most in 1986, whereas St 825NL performed consistently both years. These results emphasize the importance of continued testing.

In spite of certain deficiencies and inconsistencies, it is evident that germplasm lines are becoming available that combine significant levels of resistance to PBW with yield potentials, earliness, and fiber properties that approach or equal those traits in current cultivars.

Table 5. Fiber properties in selected cultivars and germplasm lines.

Experiment no. and cultivar or line	Fiber length 2.5%	Fiber length 50%	Fiber strength	Fiber elongation	Micronaire
	mm	mm	kN m kb^{-1}	%	
Exp. 1					
Deltapine 61	29.4a*	12.4ab	202.9a	8.5c	4.14b
DES 24NL	27.8c	12.5ab	204.7a	8.9c	4.41a
DES 56NL	25.6d	12.1b	181.7b	9.6b	4.46a
DES 24NSSL	28.6b	12.8a	208.1a	11.2a	4.06b
CV, %	2.5	5.3	6.6	5.3	7.40
Exp. 2					
Deltapine 61	27.7a	11.4a	199.2a	8.7a	4.05a
DES 56NL	25.4b	11.2a	180.2b	8.9a	4.25a
CV, %	2.3	4.9	4.8	3.8	5.33
Exp. 3					
Stoneville 825	27.1a	11.3a	195.0ab	8.6a	4.22b
Stoneville 825NL	27.1a	11.3a	192.5b	8.8a	4.28b
Stoneville 825NSS	27.3a	11.5a	189.1b	8.6a	4.13b
Stoneville 8737NL	27.5a	11.9a	202.0a	8.8a	4.63a
CV, %	1.6	5.4	4.3	4.0	4.36
Exp. 4					
Stoneville 825	27.0ab	11.2a	203.8a	9.0b	4.44b
Gumbo 500	27.6a	11.4a	212.6a	9.8a	4.03c
7230-14-104L	25.5c	10.5b	185.9b	8.7b	4.74a
7203-14-104NL	26.2bc	10.9ab	203.3a	9.7a	4.64ab
CV, %	2.5	4.4	5.3	3.6	3.85

* Means with letter(s) in common (within a column and within an experiment) are not significantly different at the 0.05 level of probability, according to the Fisher LSD test (4).

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