# TEN PEE DEE GERMPLASM LINES OF UPLAND COTTON WITH HIGH YIELD POTENTIAL, VARIABLE MATURITY, AND EXCELLENT FIBER AND SPINNING PROPERTIES

**O. Lloyd May**
**USDA-ARS and Clemson Univ.**
**Florence, SC**

## Abstract

Ten cotton germplasm lines, PD-3-14, PD 93030, PD 93034, PD 93057, PD 93007, PD 93043, PD 93046, PD 93009, PD 93019, and PD 93021, combining high yield potential, excellent fiber quality, and variable maturity were released in 1995. This germplasm represents another level of improvement in lint yield and fiber quality over that of 'PD-3,' a southeastern USA cultivar with an unusual combination of high lint yield and excellent fiber and spinning properties. The germplasm line PD-3-14 was the result of a selection program to reduce the frequency of the frego bract trait in PD-3. In three years of evaluation in full-season tests, PD-3-14 outyielded PD-3 by an average of 7%. The yarn strength of PD-3-14 also averaged 2% higher than PD-3, with fiber strength, length, and micronaire being similar. The remaining nine germplasm lines were derived from a factorial mating design among Pee Dee germplasm lines. They were evaluated in full-season (8 May) and late-planted (10 June) tests. In full-season trials, PD 93030, PD 93034, and PD 93057 averaged 2%, 8%, and 10% higher lint yield, respectively, than PD-3. These lines also averaged 3-4% better yarn strength than PD-3. In late-planted trials, PD 93007, PD 93043, and PD 93046 are earlier maturing than PD-3, and averaged 20%, 27%, and 21%, respectively, better lint yield. Their yarn strength is similar to that of PD-3. PD 93009, PD 93019, and PD 93021 exhibit yield superiority over PD-3 when evaluated in both full-season and late-planted trials. Compared with PD-3, PD 93009, PD 93019, and PD 93021 averaged 12%, 8%, and 5%, respectively, higher yield. Fiber properties and yarn strength of PD 93009 and PD 93019 are similar to PD-3, while the yarn strength of PD 93021 averages 3% higher.

## Introduction

Culp et al. (1984) and Green and Culp (1990) reported success in the concurrent improvement in lint yield and fiber quality, an ongoing goal of the cooperative USDA-ARS/Clemson University cotton breeding program. The objective of this paper is to document germplasm released in 1995 that represents a new level of achievement in the simultaneous improvement of lint yield and fiber quality in cotton.

## Materials and Methods

The germplasm line PD-3-14 was derived from the bulk seed increase of a single non-frego bract plant selection made in breeder seed of the cultivar PD-3. In an isolated block of PD-3, C.C. Green and T.W. Culp chose desirable non-frego bract plants in an attempt to reduce the low frequency occurrence of frego bract in PD-3. These selections were increased and compared with production seed of PD-3 in a 4-replicate, randomized complete-block design (RCBD) at Florence, SC, in 1990. Plot size was two rows, 10.6 m long, with 96-cm row spacing. Lint yield, fiber properties (Starlab, Knoxville, TN; single-instrument tests), and yarn strength were determined. Selection number 14 was found to produce higher yield and yarn strength than PD-3 and was advanced for more extensive testing.

PD-3-14 was entered into the 1993 Regional High Quality Test conducted at nine locations from Texas to North Carolina. Each location of the test utilized a RCBD, but number of replicates and plot size were the choice of individual cooperators. Lint yield was determined at all locations, but fiber properties and yarn strength were measured at only seven locations. Fiber and yarn data were derived from boll samples picked prior to machine harvest, and all fiber tests were made by Starlab. PD-3-14 was also evaluated in the Georgia Strains Test at Tifton, Plains, and Midville. Lint yield and fiber data (single-instrument tests) were obtained. Deltapine 90 was common to the Regional High Quality and Georgia Strains Tests and was used as a check. PD-3-14 was also entered into the 1993 Regional Cotton Fusarium Wilt Nursery.

PD-3-14 and PD-3 were compared in nine trials in 1993 and 1994. PD-3-14 and PD-3 were compared for lint yield, fiber properties, and yarn strength in the South Carolina Advanced Cotton Variety Test in 1993 at Florence, and Blackville, SC. Each test consisted of a RCBD with eight replicates at Blackville and six replicates at Florence. Plot size was two rows, 10.6 m long with 96-cm row spacing. Fiber properties and yarn strength were measured on samples taken from plot yields (not boll samples), and all measurements were provided by the ARS Cotton Quality Research Station, Clemson, SC. PD-3-14 and PD-3 were also compared for lint yield, fiber properties, and yarn strength in 1994 on-station testing. Both were used as checks in four on-station trials of experimental F6 breeding lines. PD-3-14 and PD-3 were also entered into the Pee Dee Regional Test conducted at Tifton, GA; Jay, FL; and Florence, SC. All tests consisted of 4-6 replicate RCBD. Plot size at Florence was as described for the South Carolina Advanced Variety Tests and were one row, 10.6 m long, 96-cm spacing at Tifton, GA. Fiber and yarn data were obtained at Florence only and came from boll samples taken prior to machine harvest. All fiber measurements were made at Starlab.

## Derivation of PD 93007, PD 93009, PD 93019, PD 93021, PD 93030, PD 93034, PD 93043, PD 93046, and PD 93057

These nine germplasm lines derive from a study of breeding progress that could be expected from crossing Pee Dee lines that descend from over 40 yr of breeding for improved fiber properties. Parents of the crosses (pedigree

below) were randomly chosen from a set of 52 elite Pee Dee lines developed by T.W. Culp.

| | |
|---|---|
| PD 93030 | PD 5358/PD 5485 |
| | PD 5358='Delcot 311'/PD 6079 |
| | PD 5485='McNair 235'/FJA 347 |
| PD 93034 | PD 5285/PD 5485 |
| | PD 5285='DES 422'/PD 6044 |
| PD 93057 | PD 5265/PD 5485 |
| | PD 5265='McNair 220'/'Sealand 542' |
| PD 93007 | PD 5285/PD 5485 |
| PD 93043 | PD 5265/PD 5576 |
| | PD 5576='DeltaPine 41'/PD 3246 |
| PD 93046 | PD 5358/PD 5485 |
| | PD 5358='Delcot 311'/PD 6079 |
| PD 93009 | PD 5286/PD 5485 |
| | PD 5286='DES 422'/PD 6044 |
| PD 93019 | PD 5285/PD 5377 |
| | PD 5377='Delcot 311'/PD 6171 |
| PD 93021 | PD 5286/PD 5377 |

Details on the evaluation of the F2 and F3 populations can be found in May and Green (1994). About 345 F2:4 progeny rows from that study were evaluated for lint yield, fiber properties, and yarn strength in 1990 by C.C. Green. Based on lint yield and yarn strength, 100 F4 lines were advanced to F5 for further testing. Selected lines were evaluated in full-season (about 8 May planting) and late-planted (about 10 June) tests at the Pee Dee Research and Education Center in the F5, F6, and F7 generations in 1992, 1993, and 1994, respectively. Each test consisted of a 4-replicate RCBD with PD-3 as a check. Plot size was similar to that described for PD-3-14 on-station testing. Fiber properties and yarn strength were measured on fiber derived from boll samples picked prior to machine harvest. All fiber measurements were made by Starlab. Five of the germplasm lines were also evaluated in 1994 in the Pee Dee Regional Test conducted at Florence; Tifton, GA; and Jay, FL. This test can accommodate only a limited number of entries; thus not all nine germplasm lines could be evaluated. Plot size at Florence was as described for PD-3-14 testing while plot size was the choice of cooperators at Tifton, GA, and Jay, FL. Planting and harvest dates for the two tests were consistent with a full-season production system.

## Results and Discussion

The release of PD-3 (Culp et al., 1988) was a milestone in the effort to simultaneously improve lint yield and fiber properties. PD-3 possesses an unusual combination of high yield potential and desirable fiber and yarn strength. Until 1993, its last year of commercial production, PD-3 possessed the best combination of lint yield and fiber properties of cultivars grown in South Carolina (May et al., 1993).

The frego bract trait had been observed to occur at low frequency (<1%) in the initial years of commercial production of PD-3 (Green and Culp, 1988, unpub. data). In an attempt to reduce frego bract in PD-3, C.C. Green and T.W. Culp selected desirable non-frego bract plants in a block of breeder seed of PD-3. Subsequent evaluation of these selections indicated that they coincidentally identified a strain with improved lint yield and fiber quality. PD-3-14 outyielded PD-3 by an average of 7% in nine yield trials conducted in 1993 and 1994 (Table 1). An unusual finding was that the yarn strength of PD-3-14 was also slightly higher (about 2%) than that of PD-3 even though there were only small differences in fiber strength ($T_1$), length, and micronaire. Galling indices (Table 1) of PD-3 and PD-3-14 (Mueller and Starr, 1993, unpub. data) taken from plants evaluated at the Fusarium Wilt Nursery suggest that neither PD-3 nor PD-3-14 exhibit resistance to root-knot nematode (*Melodoigyne incognita*). Since seedling diseases were not controlled at the Fusarium Wilt Nursery prior to 1994 (J. Mueller, pers. comm.), it is difficult to assess the fusarium wilt (*Fusarium oxysporum* Schlect. and *Fusarium vasinfectum* (Atk.) Snyd. and Hans) resistance of PD-3-14 based on cumulative counts of wilted plants. Initial counts of wilted plants are taken in the Fusarium Wilt Nursery in June; thus the impact of seedling disease on final counts of wilted plants in pre-1994 data remains unknown. The number of trials where PD-3-14 was evaluated (21) in addition to their geographic span of the upland picker belt suggests that PD-3-14 is not highly susceptible to the fusarium wilt and should exhibit moderate resistance as that of PD-3.

Lint yield and fiber quality of PD-3-14 exceeded that of Deltapine 90, a popular southeastern USA cultivar, in the 1993 Regional High Quality (USDA, 1994) and Georgia Strains Tests (Table 2). Relative to Deltapine 90, lint yield of PD-3-14 averaged 3% higher, yarn strength averaged 13% higher, fiber strength averaged 8% higher, and micronaire averaged 5% lower. These data suggest that PD-3-14 should be useful as a source of excellent fiber quality in a germplasm with high yield potential.

The remaining nine germplasm lines possess desirable combinations of early or full-season maturity, high lint yield, and excellent fiber properties that should make them useful to breeders and geneticists.

Three germplasm lines, PD 93030, PD 93034, and PD 93057, were released based on their superior lint yield and fiber quality relative to those of PD-3 in full-season (mean planting date 8 May) production systems averaging 170 days (2594 heat units) from planting to harvest across 3 yr (Table 3). PD 93030 exhibits a small yield advantage over PD-3 (about 2%), but its yarn strength averages 4% higher. PD 93034 and PD 93057 averaged 8% and 10% higher yield, respectively, than PD-3 while also maintaining better yarn strength. Fiber strength ($T_1$), MIC, and 2.5% span length are similar between the three germplasm lines.

PD 93007, PD 93043, and PD 93046 were released for their combination of early maturity, high yield potential, and excellent fiber quality. They were evaluated in late-planted (average planting date 10 June) trials averaging 164 days (2296 heat units) from planting to harvest. All three germplasm lines are earlier maturing than PD-3, yet they possess similar excellent fiber quality (Table 4). These germplasm lines should be useful to breeders seeking to develop early-maturing, high-yielding genotypes that maintain good fiber quality. Based on data from South Carolina Variety Tests (May et al., 1993) and a potentially expanding acreage of cotton planted after wheat in South Carolina, there is a need for early-maturing cultivars that have good fiber quality.

The remaining germplasm lines, PD 93009, PD 93019, and PD 93021, were released for their yield advantage over PD-3 in both full-season and late-planted production systems. The germplasm lines also exhibit similar excellent fiber quality (Table 5). PD 93009 outyielded PD-3 in three full-season and three late-planted tests for an average yield advantage of 12%. PD 93019 outyielded PD-3 in six full-season and three late-planted tests for an overall yield advantage of 8%. PD 93021 outyielded PD-3 in five of six full-season tests and three late-planted tests for an average 6% yield increase. These germplasm lines should be useful as parents for the improvement of lint yield and fiber quality for both full-season and early-maturity production systems.

These ten germplasm lines represent a new level of achievement in the effort to simultaneously improve lint yield and fiber quality. They should provide breeders with a source of excellent fiber quality, particularly yarn strength, in germplasm with high yield. Three of the germplasm lines, PD 93009, PD 93043, and PD 93046, will be valuable in efforts to develop early-maturing cultivars without sacrificing fiber quality.

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Table 1. Comparison of lint yield, fiber traits, and root galling indices between PD-3 and PD-3-14.

| | Lint Yield† -lb/ac- | $T_1$‡ -cn/tex- | 2.5% Length -in- | MIC | Yarn Strength -mn/tex- | Gall Index# |
|---|---|---|---|---|---|---|
| PD-3 | 870 | 21.4 | 1.15 | 4.46 | 134.7 | 4.0 |
| PD-3-14 | 934 | 21.9 | 1.14 | 4.41 | 137.6 | 4.7† |

† 1993-1994 mean yield from 6 on-station and 3 off-station (Tifton, GA; Jay, FL; Blackville, SC).

‡ 1990, 1993, and 1994 means ($T_1$=fiber strength, 2.5% length, MIC, yarn strength) from 7 on-station and 2 off-station (Tifton, GA, and Blackville, SC) trials.

# 1-5 scale rated by nematologists J. Mueller and J. Starr.

Table 2. Comparison of lint yield and fiber properties between PD-3-14 and Deltapine 90.

| | Lint Yield† -lbs/ac- | $T_1$‡ -cn/tex- | 2.5% Length -in- | MIC | Yarn Strength -mn/tex- |
|---|---|---|---|---|---|
| PD-3-14 | 955 | 234 | 1.14 | 4.59 | 149 |
| Deltapine 90 | 927 | 213 | 1.12 | 4.86 | 131 |

† Mean over 12 trials, 9 from 1993 Regional High Quality and 3 from 1993 Georgia Strains Test.

‡ Mean from 1993 Regional High Quality Test (7 locations reported fiber data).

Table 3. Lint yield and fiber properties of PD 93030, PD 93034, and PD 93057 from their full-season performance.

| | Lint Yield -lbs/ac- | | $T_1$ -cn/tex- | | 2.5% Length -in- | | MIC | | Yarn Strength -mn/tex- | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | PD-3† | | PD-3 | | PD-3 | | PD-3 | | PD-3 |
| PD 93030 | 1021 | 998 | 22.0 | 21.3 | 1.18 | 1.18 | 4.80 | 4.93 | 146.6 | 140.6 |
| PD 93034 | 984 | 896 | 22.0 | 21.3 | 1.17 | 1.18 | 4.85 | 4.93 | 146.8 | 140.6 |
| PD 93057 | 990 | 890 | 21.7 | 21.7 | 1.23 | 1.21 | 4.93 | 4.90 | 145.9 | 142.3 |

†Comparison with PD-3 based on data from common trials.

Table 4. Lint yield and fiber properties of PD 93007, PD 93043, and PD 93046 from their performance over 3 yr in a late-planted production system.

| | Lint Yield -lbs/ac- | | $T_1$ -cn/tex- | | 2.5% Length -in- | | MIC | | Yarn Strength -mn/tex- | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | PD-3† | | PD-3 | | PD-3 | | PD-3 | | PD-3 |
| PD 93007 | 666 | 537 | 22.5 | 22.3 | 1.15 | 1.17 | 4.55 | 4.60 | 150.3 | 152.1 |
| PD 93043 | 718 | 563 | 22.0 | 22.4 | 1.18 | 1.15 | 4.50 | 4.57 | 151.9 | 152.1 |
| PD 93046 | 683 | 563 | 22.2 | 22.4 | 1.19 | 1.15 | 4.52 | 4.57 | 154.4 | 152.1 |

†Comparison with PD-3 based on data from common trials.

Table 5. Lint yield and fiber properties of PD 93009, PD 93019, and PD 93021 from 3 yr of full-season and late-planted tests.

| | Lint Yield -lbs/ac- | | $T_1$ -cn/tex- | | 2.5% Length -in- | | MIC | | Yarn Strength -mn/tex- | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | PD-3† | | PD-3 | | PD-3 | | PD-3 | | PD-3 |
| PD 93009 | 776 | 688 | 21.6 | 22.1 | 1.16 | 1.18 | 4.65 | 4.78 | 145 | 146 |
| PD 93019 | 929 | 859 | 22.1 | 22.1 | 1.16 | 1.18 | 4.72 | 4.78 | 145 | 146 |
| PD 93021 | 898 | 850 | 22.5 | 22.2 | 1.19 | 1.18 | 4.64 | 4.78 | 151 | 146 |

†Comparison with PD-3 based on data from common trials.