GERMPLASM

Registration of CRB 252, an Upland Cotton Germplasm Line with Improved Fiber Quality Traits

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ABSTRACT

The upland cotton (*Gossypium hirsutum* L.) germplasm line CRB 252 (Reg. No GP-925, PI 658596) was developed, evaluated, and jointly released in 2009 by the USDA-ARS, the Louisiana Agricultural Experiment Station, the Georgia Agricultural Experiment Station, and Cotton Incorporated. The purpose of the release was to provide a broadly adapted, high fiber-quality resource for facilitating fiber improvement efforts across the U.S. Cotton Belt. CRB 252 originated from the cross 'Suregrow 248'/'Phytogen 72'//'Stoneville 474'/'Acala Maxxa', followed by individual plant selection in the F2 and F3 generations at the low-desert location of Maricopa, AZ and F3.5 progeny selection at five locations distributed across the Cotton Belt. Evaluation of CRB 252 occurred in 13 location-year environments at Florence, SC; Blackville, SC; Tifton, GA; Plains, GA; Alexandria, LA; Maricopa, AZ; and Shafter, CA in 2007 and 2008. CRB 252 displayed fiber length and micronaire values superior to those of the high fiber-quality check cultivars Phytogen 72 and FM 958. The fiber strength and short-fiber content of CRB 252 was superior to those of FM 958. Lint yield of CRB 252 was superior to that of Phytogen 72 and did not differ from FM 958. CRB 252 is an excellent source of quality fiber, with acceptable yield potential that appears to be stable across production environments.

The upland cotton (*Gossypium hirsutum* L.) germplasm line CRB 252 (Reg. No. GP-925, PI 658596) was developed, evaluated, and jointly released in 2009 by the USDA-ARS, the Louisiana Agricultural Experiment Station, the Georgia Agricultural Experiment Station, and Cotton Incorporated. CRB 252 is the product of a cooperative breeding project, spanning the U.S. Cotton Belt, with the goal of developing broadly adapted, elite upland germplasm possessing improved fiber quality and heat tolerance. CRB 252 possesses superior fiber attributes and provides public and private breeders with a broadly adapted resource for the improvement of fiber quality.

CRB 252 derives from a double cross involving the cultivars 'Sure Grow 248' (SG 248; PVP 9700092), 'Phytogen 72' (PHY 72; PVP 200100115), 'Stoneville 474' (ST 474; PVP 9400152), and 'Acala Maxxa' (Maxxa; PVP 9000168). The parent cultivar SG 248 was developed from the cross of the strain Mo89–117 and the cultivar 'Deltapine 5415' (PVP 9100132), (Bowman et al., 2006). PHY 72 derives from the cross of the cultivar 'Acala Prema' (PVP8800171) and Acala 1517D (National Plant Germplasm System, 2009). ST 474 derives from the cross 'Stoneville 453'/'DES 119' and Maxxa derives from the cross T7538/S4959 (Bowman et al., 2006). SG 248 and ST 474 were selected as putatively heat-tolerant parents, based on their yield performance in the low desert in Arizona and on evaluations of their pollen fertility and fruit retention rates under heat stress. PHY 72 and Maxxa were selected as high fiber-quality parents based on their known fiber quality attributes. Crosses were made between putative heat-tolerant and high fiber-quality parents to create the two F_1 populations SG 248/PHY 72 F_1 and ST 474/Maxxa F_1, which were then crossed to produce the hybrid population SG 248/PHY 72//ST 474/Maxxa from which CRB 252 derives.

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Abbreviations: HVI, high volume instruments; UHM, upper half mean.

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Developments in spinning technology and higher international fiber quality standards have placed increasing demands on the U.S. cotton industry for fiber quality improvement. Resources for fiber improvement are available, but many of these resources have historically proven to have limited regional adaptation. The Acala (*G. hirsutum*) cottons, one such source, have historically demonstrated weak yield performance outside of their areas of adaptation in the American Far West and Southwest and heightened heat sensitivity under adverse conditions within the Southwest. More broadly adapted high fiber-quality resources would greatly facilitate fiber improvement efforts across the U.S. Cotton Belt. CRB 252 was developed to provide a more broadly adapted, improved fiber quality resource for the cotton breeding community.

Methods

CRB 252 was developed using pedigree selection and an early generation regional testing program. The F_1 population of the SG 248/PHY 72//ST 474/Maxxa hybrid was increased to produce F_2 seed in the Cotton Winter Nursery at Tecoman, Mexico, in the winter of 2003–2004. Individual plant selection was practiced in the F_2 and F_3 generations at the low-desert location of Maricopa, AZ in 2004 and 2005. Selection was conducted in two stages within each generation. The criterion for individual plant selection in the field was primarily for fruit retention and yield under a heat stress environment. In the second stage of selection, fiber from field-selected plants was analyzed using high volume instruments (HVI) in the Fiber Quality Laboratory of Cotton Incorporated, Cary, NC. Individuals with superior fiber-quality properties were selected and F_4 seed were planted in the Cotton Winter Nursery at Tecoman, Mexico, in the fall and winter of 2005–2006 for generation advancement and seed increase. A 50-boll sample was hand harvested from each $F_{3.4}$ progeny row at Tecoman, and its fiber was sent to Cotton Incorporated for fiber analyses. Initial progeny selection was conducted on the lines at Tecoman on the basis of fiber quality, and selected rows were bulk harvested for further evaluation.

In 2006, nonreplicated progeny tests of $F_{3.5}$ progeny lines were conducted at five locations for the purpose of identifying lines for replicated testing in 2007. Locations in 2006 included Florence, SC; Tifton, GA; St. Joseph, LA; Maricopa, AZ; and Shafter CA. Tests were conducted using augmented designs, with the check cultivars ‘Deltapine 393’ (DP 393), ‘Sure Grow 747’ (SG 747), ‘FiberMax 958’ (FM 958; PVP 200100208), and PHY 72 recurring throughout the tests. DP 393 and SG 747 were included as agronomic and yield performance checks and the cultivars FM 958 and PHY 72 were included as superior fiber-quality checks. Yield data and fiber samples were obtained from the locations, and fiber analyses were conducted by Cotton Incorporated. Progeny row data at individual sites were adjusted using the check cultivar means from the augmented design. Experimental error was estimated from the replicated checks and LSD mean separations conducted to identify superior progeny lines. From these tests, a set of lines were identified for replicated testing. CRB 252 was evaluated under the designation PX03203–25–2 in progeny selection and replicated testing.

Replicated testing of seven progeny lines was conducted in a total of 13 location-year environments at Florence, SC; Blackville, SC; Tifton, GA; Plains, GA; Alexandria, LA; Maricopa, AZ; and Shafter, CA in 2007 and 2008. Tests were arranged in an RCB design with four replications at all locations, with the exceptions of Plains and Tifton, GA in 2008, which had three replications. Standard production practices of the locale were followed in each test. All replicated tests included the commercial cultivars DP 393 and SG 747 as agronomic and yield performance checks and the cultivars FM 958 and PHY 72 as superior fiber-quality checks. Lint yields of test entries were determined by machine harvest of the two-row plots. Fiber quality, lint percent, and boll weight were determined from hand-harvested boll samples that were picked from all plots before machine harvesting. Fiber from plot samples was analyzed using HVI in the Fiber Quality Laboratory of Cotton Incorporated, Cary, NC. Measurements of boll weight were obtained from only five tests: Maricopa, AZ in 2007 and 2008, Alexandria, LA in 2007, Florence SC in 2008 and Blackville, SC in 2008. The fiber quality variables upper half mean (UHM) length, length uniformity, short fiber content, strength, elongation, and micronaire were obtained from eleven tests conducted at Maricopa, AZ; Shafter, CA; Alexandria, LA; Florence, SC; Blackville, SC; Tifton, GA; and Plains, GA in 2007 and 2008. Data were analyzed using analysis of variance and SAS v. 9.1 PROC GLM (SAS Institute, 2003). Means separation among genotypes was conducted using the Waller–Duncan *k*-ratio procedure (Ott, 1988).

Characteristics

CRB 252 displayed excellent fiber quality and a stable, acceptable yield potential across the 13 location-year tests (Tables 1 and 2). CRB 252 produced a UHM fiber length (31.3 mm) that was superior ($p < 0.05$) to that of the high fiber-quality check cultivars PHY 72 (30.3 mm) and FM 958 (29.3 mm), as well as of the agronomic and yield performance checks, DP 393 (29.0 mm) and SG 747 (28.6 mm). The fiber length uniformity of CRB 252 (84.1%) did not differ from that of the check cultivars, with the exception of FM 958 (83.3%), which was inferior to CRB 252. The fiber strength of CRB 252 (318 kN m kg^{-1}) was superior to that of DP 393, SG 747, and FM 958. PHY 72 produced a fiber strength that was slightly superior to CRB 252. The fiber elongation before break of CRB 252 (5.4%) was lower than for the check cultivars. Lower fiber elongation values may indicate a “brittle” fiber that is more prone to damage during ginning and processing. However, the short-fiber content (often resulting from fiber damage) of CRB 252 (7.0%) did not differ from that of PHY 72 or DP 393 and was superior (lower) than that of SG 747 and FM 958. The micronaire of CRB 252 (4.3) was lower than that of the check cultivars.

The lint yield of CRB 252 (1420 kg ha^{-1}) was lower ($p < 0.05$) than that of DP 393 (1632 kg ha^{-1}) and SG 747 (1593 kg ha^{-1}),

Table 1. Mean fiber properties of CRB 252 and check cultivars in 11 tests conducted at Florence, SC; Blackville, SC; Tifton, GA; Plains, GA; Alexandria, LA; Maricopa, AZ; and Shafter, CA in 2007 and 2008.†

Entry	Length UHM‡	Uniformity§	Short-fiber content¶	Strength#	Elongation††	Micronaire‡‡
	mm	%	%	kN m kg^{-1}	%	
CRB 252	31.3 a§§	84.1 b	7.0 cd	318 b	5.4 f	4.3 e
PHY 72	30.3 c	84.0 b	7.0 cd	323 a	6.3 c	4.6 c
DP 393	29.0 e	83.9 b	7.2 c	302 cd	7.2 a	4.8 b
SG 747	28.6 f	83.8 b	7.6 b	279 e	7.2 a	4.9 a
FM 958	29.3 e	83.3 c	7.9 a	304 cd	6.0 d	4.8 b

†Data extracted from larger, multiple-entry tests.

‡The average length of the longer 50% of the fibers sampled.

§Ratio between the mean length and upper-half mean length of fibers, expressed as percent.

¶The percentage of fibers in a sample (by weight) that are less than 12.7 mm (one-half inch) in length.

#Force required to break a bundle of fibers one tex unit in size (one tex unit is the weight in grams of 1000 m of fiber).

††Percent elongation of fibers before breaking.

‡‡Fiber fineness or maturity; determined by an airflow instrument that measures the air permeability of a constant mass of cotton fibers compressed to a fixed volume.

§§Values in a column not followed by the same letter are significantly different (*P* = 0.05). Means tests were performed on a larger, multiple-entry data set.

Table 2. Yield and yield component means of CRB 252 and check cultivars in 13 tests conducted at Florence, SC; Blackville, SC; Tifton, GA; Plains, GA; Alexandria, LA; Maricopa, AZ; and Shafter, CA in 2007 and 2008.†

Entry	Lint yield	Lint	Boll weight‡
	kg ha^{-1}	%	g
DP 393	1632 a§	41.2 a	5.0 bc
SG 747	1593 a	40.8 ab	5.2 ab
FM 958	1435 b	38.7 d	5.2 ab
CRB 252	1420 b	38.5 d	5.2 ab
PHY 72	1336 c	39.2 c	5.3 a

†Data extracted from larger, multiple entry tests.

‡Boll-weight data was obtained from only five tests: Maricopa, AZ in 2007 and 2008; Alexandria, LA in 2007; Florence SC in 2008; and Blackville, SC in 2008.

§Values in a column not followed by the same letter are significantly different (*P* = 0.05). Means tests were performed on a larger, multiple-entry data set.

equivalent to the yield of FM 958 (1435 kg ha^{-1}), and higher than that of PHY 72 (1336 kg ha^{-1}) (Table 2). At 38.5%, the lint percent of CRB 252 is lower than that of the check cultivars. CRB 252 did not differ from the check cultivars in boll weight.

The yield stability of CRB 252 across locations, relative to the check cultivars, can be seen in Table 3. CRB 252 did not differ significantly from the check cultivars in lint yield at the individual locations, with the exceptions of Florence, SC and Alexandria, LA. At the Florence, SC location, DP 393 produced higher yields than did CRB 252 and the fiber-quality check cultivars. At the Alexandria, LA location, the cultivars DP 393 and SG 747 produced higher yields than did the improved fiber quality checks and CRB 252. Overall, CRB 252 is an excellent source of fiber quality and acceptable yield potential that appears to be stable across production environments.

Availability

Small quantities of seed (25–50 g) are available to cotton breeders, geneticists, and other research personnel on written request to: R.G. Percy, USDA-ARS, Southern Plains Agricultural Research Center, 2881 F&B Road, College Station, TX 77845. Requests for seed from outside the USA must be accompanied by an import permit allowing entry into the requestor's country. The provider may not be able to certify that seed is free of certain insects or pathogens specified on import permits, and in such cases seed cannot be supplied. It is requested that appropriate recognition of the source be given when these germplasm lines contribute to the development of a new breeding line, hybrid, or cultivar. Genetic material of this release will be deposited in the National Plant Germplasm System, where it will be

Table 3. Average lint yields of CRB 252 and check cultivars in replicated tests at five locations during 2007 and 2008.†

Entry	Yield				
	Florence, SC	Tifton, GA	Alexandria, LA	Maricopa, AZ	Shafter, CA
	kg ha^{-1}				
DP 393	1434 a‡	1425 a	1255 a	1911 a	1976 a
SG 747	1335 ab	1365 ab	1326 a	1868 ab	1891 ab
CRB 252	1218 bc	1228 abc	866 cd	1742 a-d	1873 abc
FM 958	1216 bc	1203 abc	968 bc	1865 ab	1818 bcd
PHY 72	1063 c	1173 bc	780 de	1689 cd	1879 abc

†Data extracted from larger, multiple-entry tests.

‡Values in a column not followed by the same letter are significantly different (*P* = 0.05). Means tests were performed on a larger, multiple-entry data set.

available for research purposes, including development and commercialization of new cultivars.

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