

## Cultivar BRS 433FL B2RF: upland cotton with high-quality fiber, insect resistance and glyphosate tolerance for the Brazilian Savanna

Camilo de Lelis Morello<sup>1</sup>, Nelson Dias Suassuna<sup>1\*</sup>, Murilo Barros Pedrosa<sup>2</sup>, Paulo Augusto Vianna Barroso<sup>3</sup>, João Luís da Silva Filho<sup>1</sup>, Taís de Moraes Falleiro Suassuna<sup>1</sup>, Fabiano José Perina<sup>1</sup>, Valdinei Sofiatti<sup>1</sup>, Fernanda Oliveira da Cunha Magalhães<sup>1</sup> and Fernando Mendes Lamas<sup>4</sup>

**Abstract:** *Cultivar BRS 433FL B2RF is a high-quality fiber upland cotton with high lint yield potential and resistance to several diseases. The introgressed transgenic events Bollgard II® and Roundup Ready Flex® confer enhanced resistance to lepidopteran pests and tolerance to the herbicide glyphosate, respectively. Fiber length exceeds 32.5 mm and fiber strength 33 gf tex<sup>-1</sup>.*

**Keywords:** *Gossypium hirsutum*, glyphosate tolerance, insect resistance, fiber quality.

### INTRODUCTION

The major objectives of cotton breeding programs are to improve yield, pest resistance and fiber quality of cultivars capable of meeting synthetic fiber competition and suited for the new spinning technology (Morello et al. 2010, Smith et al. 2011, Morello et al. 2012). Thus, an enhanced fiber quality is essential for the competitiveness of cotton fiber in the textile industry. Moreover, along with conventional agronomic traits (Suassuna et al. 2020), commercial biotechnological traits must also be improved in tropical environments to reinforce the pest and weed management and raise the competitiveness of Brazilian cotton (Suassuna et al. 2018).

*Gossypium hirsutum* L. *latifolium* Hutch, also called upland cotton, accounts for over 90% of the cotton fiber global production. Since the 1990s, the cotton production area in the Brazilian cerrado (savanna) has expanded, mainly as a result of the breeding efforts to develop regionally adapted, high-yielding cultivars as well as improved management practices (Morello et al. 2015, Silva Neto et al. 2016, Barroso et al. 2017, Suassuna et al. 2018), which have made the Brazilian cotton internationally competitive. High pest pressure and weed competition occur in cerrado region (Salgado et al. 2002, Bentivenha et al. 2016), reducing the crop profitability. Therefore, the Embrapa's cotton breeding program focus on to develop high-yielding cotton cultivars with superior fiber quality and with transgenic insect resistance and herbicide tolerance, adapted to the Brazilian cerrado.

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**\*Corresponding author:**

E-mail: [nelson.suassuna@embrapa.br](mailto:nelson.suassuna@embrapa.br)

 ORCID: 0000-0001-7760-1232

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<sup>1</sup> Embrapa Algodão, C.P. 147, 58.428-095, Campina Grande, PB, Brazil

<sup>2</sup> Fundação Bahia, BR 020/242, km 50,7, 47.850-000, Luís Eduardo Magalhães, BA, Brazil

<sup>3</sup> Embrapa Monitoramento por Satélite, 13.070-115, Campinas, SP, Brazil

<sup>4</sup> Embrapa Agropecuária Oeste, C.P. 661, 79.804-970, Dourados, MS, Brazil

Commercial cotton cultivars with transgenic resistance to the main lepidopteran pests and tolerant to the herbicides are available in Brazil (Morello et al. 2015, Barroso et al. 2017, Suassuna et al. 2018, CTNBio 2019). The transgenic event MON 15985, commercially known as Bollgard II® (B2), produces the Bt proteins Cry1Ac and Cry2Ab. These two toxins are effective to control several lepidopteran pests of cotton. The transgenic cotton event MON 88913, commercially known as Roundup Ready Flex® (RF), contains a modified protein (CP4 EPSPS) that makes cotton RF plants tolerant to the herbicide glyphosate.

The Brazilian Agricultural Research Corporation (Embrapa) performs a national cotton breeding program. This program works along conventional lines as well as with multiple transgenic trait introgression to develop and release competitive cotton cultivars. The extensive program involves private partnerships to support financially and technically. During the development of cultivar BRS 433FL B2RF the program was supported by FUNDEAGRO and Fundação Bahia. The cultivar “BRS 433FL B2RF” (Reg. no. 36253) is the first long staple transgenic cotton cultivar developed in Brazil and its development is described. It is an excellent option for fiber suited for spinning of fine or very fine yarn and is a result of the current efforts to create new cotton lines and cultivars with a better fiber quality, good yield potential, transgenic insect-resistance and herbicide tolerance, adapted to the cultivation conditions of Brazil.

## GENETIC ORIGIN AND DEVELOPMENT

Cultivar BRS 433FL B2RF was developed by backcrossing BRS 336 (recurrent parent), followed by pedigree selection for the incorporation of the events MON 15985 (B2) and MON 88913 (RF). Cultivar BRS 336 [(Chaco 520 x BRS Itaúba) x Delta Opal] has an outstanding fiber quality, high fiber yield, is well-adapted to the climate of the savanna and semi-arid regions in central Brazil and resistant to bacterial blight (causal agent *Xanthomonas citri* subsp. *malvacearum*) and to cotton blue disease (causal agent *Cotton Leafroll Dwarf Virus*) (Morello et al. 2012). The donor, DP 164 B2RF {DP 565/3\*[DP 565 x (Cocker 312 RF x DP 50 B2)]} is a high-yielding cotton cultivar, in spite of the medium fiber length (2.5% SL = 29.5 mm) and medium fiber strength (28.5 gf tex<sup>-1</sup>) and is susceptible to bacterial blight and cotton blue disease virus. Cultivar BRS 433FL B2RF was originated from a hybridization of BRS 336 and DP 164 B2RF, followed by three backcrosses (BRS 336/4\*DP 164 B2RF). Initial cross was performed in 2011, and the crosses BC<sub>1</sub>, BC<sub>2</sub> and BC<sub>3</sub> from 2012 to 2013. Plants of BC<sub>3</sub>F<sub>1</sub> and BC<sub>3</sub>F<sub>2</sub> were selfed in controlled environment (nethouses). From BC<sub>3</sub>F<sub>3</sub> population were selected B2 and RF homozygous plants using a specific real-time PCR assay.

From these selected plants, 168 progeny rows (BC<sub>3</sub>F<sub>3,4</sub>) were tested in the 2013/2014 growing season. Cultivar BRS 433FL B2RF was derived from a F<sub>3,4</sub> progeny row (CNPV GO 2014 33 B2RF) after two successive single plant selections in the BC<sub>3</sub>F<sub>2</sub> and BC<sub>3</sub>F<sub>3</sub> generations. Individual plants were selected for fiber quality, lint yield, disease resistance (cotton blue disease and bacterial blight) and plant architecture (height, lodging tolerance, length of branches etc.). Progeny CNPV GO 2014 33 B2RF (F<sub>4</sub>) was grown in the second season of 2014 in a nethouse and evaluated in field tests at two locals as advanced breeding line (F<sub>5</sub>) in the 2014/2015 growing season. Seeds were multiplied on an irrigated experimental field in 2015 off-season in Ceará state. Thereafter, 12 trials (states of Bahia, Goiás, Maranhão, Piauí, Mato Grosso do Sul, and Mato Grosso) were carried out in the 2015/2016 growing season and 14 trials in Bahia, Goiás and Mato Grosso in the 2016/2017 and 2017/2018 growing seasons. Averaged across all 28 field tests, cv. BRS 433FL B2RF had a mean fiber length (UHML HVI) of 32.8 mm, fiber strength of 33.9 gf tex<sup>-1</sup> and micronaire index of 4.4.

## PERFORMANCE CHARACTERISTICS

Cultivar BRS 433FL B2RF has similar height and maturity as cv. BRS 336 when grown in São Desidério (lat 12° 05' 33" S, long 45° 48' 08" W, alt 776 m asl), BA. “BRS 433FL B2RF” grows to a medium/tall plant height (118 - 135 cm at maturity) when treated with 50 - 75 g ai of a plant growth regulator. “BRS 433FL B2RF” has trichomes on main stem and on the leaves. The leaves are normal-shaped and have glands and nectaries. Bracts have more than 12 lobes. Generally, the first fruiting branch is on the fifth node, and the plant has a pyramidal morphology. Flowers petals, anthers and pollen are cream-colored. Green fruits when completely developed are elliptical and generally have five and occasionally four locules. Open bolls resist shattering and are suitable for mechanical harvesting, but are not stormproof. The lint is white and the seeds have a white fuzz as well.

First flowers of the cultivar appear 55 to 60 days after emergence (DAE), and the first open boll appear at about 110 to 120 DAE (at 776 m asl). (Table 1). Under the evaluated environmental conditions and application of harvest-aid treatments, harvesting is possible between 165 and 180 DAE.

“BRS 433FL B2RF” is resistant to cotton blue disease, caused by *Cotton leafroll dwarf virus*- CLRDV and bacterial blight, caused by the bacterium *Xanthomonas citri* subsp. *malvacearum*. The cultivar is moderately susceptible to ramularia leaf spot, caused by the fungi *Ramulariopsis pseudoglycines*, and susceptible to ramulosis, caused by the fungi *Colletotrichum gossypii* var. *cephalosporioides* (Table 1). Foliar fungicide sprays are required in order to reduce losses due to ramularia leaf spot. Cotton blue disease and bacterial blight resistance were assessed in two independent field trials without control of the virus vector (*Aphis gossypii*). All evaluated plants showed no symptoms of bacterial blight. Likewise, no typical symptoms of cotton blue disease were recorded on evaluated plots. Additionally genotyping tests were performed with the molecular markers linked to resistance genes to cotton blue disease and bacterial blight, DC20027 and CIR 246, respectively (Xiao et al. 2010, Fang et al. 2010). Ramularia leaf spot was assessed on a 1 - 5 severity score scale based on the leaf lesion area, ranging from 1 ( resistant) to 5 (extremely susceptible) in two field trials without chemical control. Cotton ramulosis resistance was evaluated on artificially inoculated plants on controlled environment, using a methodology proposed by Cia et al. (2002).

**Table 1.** Agronomic traits and fiber quality of the cultivars BRS 433FL B2RF, BRS 336 (recurrent parent) and FM 980 GLT (check)

Traits	BRS 433FL B2RF	BRS 336 <sup>y</sup>	FM 980 GLT
First flower (DAE) <sup>*</sup>	55-60	60-65	60-65
First open boll (DAE) <sup>*</sup>	110-120	110-120	115-125
Boll weight (g) <sup>a</sup>	5.9	6.6	5.1
Fiber length (UHML) (mm) <sup>a</sup>	32.8	32.9-35.8	30.1
Uniformity index (ML/UHML - %) <sup>a</sup>	84.9	82.6-86.3	84.3
HVI strength (gf tex <sup>-1</sup> ) <sup>a</sup>	34.1	32.0-37.0	30.7
Micronaire reading <sup>a</sup>	4.4	4.0-4.9	4.6
Elongation (%) <sup>a</sup>	6.0	4.6-7.1	6.3
Reflectance – Rd (%) <sup>a</sup>	80.7	68.4-82.8	80.9
Yellowness (+ b) <sup>a</sup>	7.9	4.9-8.6	7.7
Short fiber index (%) <sup>a</sup>	6.0	4.6-7.3	7.0
Cotton leafroll dwarf virus (CLRDV) <sup>b</sup>	0.0	0.0	0.0
Atypical form of CLRDV <sup>cd</sup>	1.5	-	3.0
Ramularia leaf spot <sup>d</sup>	3.5	-	3.0
Bacterial blight <sup>d</sup>	1.0	1.0	1.0
Ramulosis <sup>e</sup>	0.36	1.0 <sup>f</sup>	0.57

<sup>\*</sup> Data recorded in São Desidério – BA (lat 12° 05' 33" S, long 45° 48' 08" W, alt 776 m asl).

<sup>y</sup> Values (maximum and minimum) of fiber quality traits. Data published by Morello et al. (2012).

<sup>a</sup> Means of 12 field trials in the 2015/2016 growing season, in several environments (States of Goiás, Bahia, Mato Grosso, Mato Grosso do Sul, Piauí, and Maranhão); <sup>b</sup> Incidence (%) of plants with cotton blue disease symptoms - data of two trials without control of the virus vector (*Aphis gossypii*), confirmed by SNP marker (Fang et al. 2010); <sup>c</sup> Symptoms of an atypical form of CLRDV, according to Silva et al (2015); <sup>d</sup> Disease severity (grades from 1 = resistant to 5 = highly susceptible) - data of two trials without fungicide application. Resistance to bacterial blight was confirmed by using SNP markers (Xiao et al. 2010); <sup>e</sup> Relative disease index, where 1.0 is resistant and 0 is susceptible (Cia et al. 2002) – data of plants artificially inoculated with *Colletotrichum gossypii* var. *cephalosporioides*; <sup>f</sup> Cotton cultivar IMA 1318 was used as a resistant/partial resistant check.

**Table 2.** T-test comparison of cottonseed yield – CY (kg ha<sup>-1</sup>), lint yield – LY (kg ha<sup>-1</sup>), lint percentage – LP (%), fiber length – Len (mm), and fiber strength – Str (gf tex<sup>-1</sup>) for cultivars BRS 433FL B2RF and FM 980 GLT (check) in the growing seasons 2014/2015 and 2015/2016

	2014/2015 <sup>1</sup>					2015/2016 <sup>2</sup>				
	CY	LY	LP	Len.	Str.	CY	LY	LP	Len.	Str.
Error	398048	67290	0.168	0.102	0.350	432539	79374	1.217	0.843	2.507
df	72	72	72	72	72	363	363	396	396	396
N	8	8	8	8	8	44	44	48	48	48
BRS 433	5047.5	1869.8	37.0	33.3	35.1	4295.2	1646.5	38.3	32.8	34.1
FM 980	5273.3	2356.5	45.1	30.3	32.1	3919.2	1731.0	44.2	30.1	30.7
T-value	-0.72	-3.75**	-39.79**	18.76**	10.15**	2.68**	-1.41	-26.49**	14.50**	10.24**

<sup>1</sup> Data of two field trials; <sup>2</sup> Data 12 field trials; \*\* Significant at 1%.

Paired t-tests were used to compare significant differences between “BRS 433FL B2RF” and checks in each growing season. In 2014/2015, cv. BRS 433FL B2RF had significantly longer fiber (33.3 mm) and stronger fibers (35.1 gf tex<sup>-1</sup>) than cv. FM 980 GLT (30.3 mm and 32.1 gf tex<sup>-1</sup>, respectively). There was no significant difference between cottonseed yield of the cultivars BRS 433FL B2RF (5047.5 kg ha<sup>-1</sup>) and FM 980 GLT (5273.3 kg ha<sup>-1</sup>). However, the lint yield of cv. FM 980 GLT was significantly higher due to the higher fiber percentage (Tables 2 and 4). In 2015/2016, cv. BRS 433FL B2RF had

**Table 3.** T-test comparison of cottonseed yield - CY (kg ha<sup>-1</sup>), lint yield - LY (kg ha<sup>-1</sup>), lint percentage - LP (%), fiber length - Len (mm), and fiber strength - Str (gf tex<sup>-1</sup>) for cultivars BRS 433FL B2RF and DP 1536 B2RF (check) in the growing seasons 2016/2017 and 2017/2018

	2016/2017 <sup>1</sup>					2017/2018 <sup>2</sup>				
	CY	LY	LP	Len	Str	CY	LY	LP	Len	Str
Error	547046	113054	0.963	0.836	3.277	516716	68855	1.0074	0.6501	2.9732
df	144	96	120	120	120	168	168	168	168	168
N	24	16	20	20	20	28	28	28	28	28
BRS 433	6894.3	2924.6	38.2	33.2	32.8	6428.8	2260	33.657	32.414	34.1
DP 1536	6498.0	3012.4	43.8	30.6	33.1	6362.6	2532	38.314	30.786	34.171
T-value	1.86	-0.74	-17.98**	8.85**	-0.63	0.34	-3.88**	-17.36**	7.56**	-0.15

<sup>1</sup> and <sup>2</sup> Data of seven field trials; \*\* Significant at 1%.

**Table 4.** Means of cottonseed yield - CY (kg ha<sup>-1</sup>), lint yield - LY (kg ha<sup>-1</sup>), lint percentage - LP (%), micronaire index - Mic, fiber length - Len (mm) and fiber strength - Str (gf tex<sup>-1</sup>) of the cultivars BRS 433FL B2RF and FM 980 GLT (check) in the growing seasons 2014/2015 and 2015/2016

Location	Cultivar	CY	LY	LP	Mic.	Len.	Str.
Luís Eduardo Magalhães - BA <sup>1</sup> Trial 1	FM 980 GLT	5979.0	2494.5	41.7	5.0	30.7	31.8
	BRS 433FL B2RF	5434.5	2032.5	37.3	3.9	33.1	34.8
Luís Eduardo Magalhães - BA <sup>1</sup> Trial 2	FM 980 GLT	4567.5	2218.5	48.5	4.2	29.9	32.4
	BRS 433FL B2RF	4660.5	1707.0	36.6	3.9	33.5	35.4
São Desidério - BA <sup>2</sup>	FM 980 GLT	3681.0	1576.5	42.9	4.5	29.6	28.8
	BRS 433FL B2RF	3618.0	1465.5	40.4	4.1	31.3	33.9
Luís Eduardo Magalhães - BA <sup>2</sup> Trial 1	FM 980 GLT	3451.5	1623.0	46.9	4.5	30.6	32.1
	BRS 433FL B2RF	4044.0	1528.5	37.9	4.2	33.8	35.0
Luís Eduardo Magalhães - BA <sup>2</sup> Trial 2	FM 980 GLT	4452.0	1801.5	40.4	5.0	32.9	31.2
	BRS 433FL B2RF	4602.0	1834.5	39.9	4.5	34.3	35.0
Riachão das Neves - BA <sup>2</sup>	FM 980 GLT	3418.5	1677.0	48.9	4.5	29.1	32.6
	BRS 433FL B2RF	6664.5	2683.5	40.2	4.8	33.0	38.2
Cristalina - GO <sup>2</sup>	FM 980 GLT	3774.0	1482.0	39.3	4.7	29.1	29.6
	BRS 433FL B2RF	4081.5	1515.0	37.1	4.2	31.3	33.7
Sorriso - MT <sup>2</sup>	FM 980 GLT	3898.5	1693.5	43.5	4.5	31.2	33.0
	BRS 433FL B2RF	3330.0	1176.0	35.2	4.2	33.8	35.0
Tasso Fragoso - MA <sup>2</sup>	FM 980 GLT	-	-	-	4.7	28.1	29.9
	BRS 433FL B2RF	-	-	-	5.1	31.8	34.0
Uruçuí - PI <sup>2</sup>	FM 980 GLT	2898.0	1417.5	48.8	4.7	29.6	30.7
	BRS 433FL B2RF	2991.0	1212.0	40.4	4.5	32.7	34.8
Campo Verde - MT <sup>2</sup>	FM 980 GLT	6294.0	2964.0	47.1	4.5	30.6	32.7
	BRS 433FL B2RF	5623.5	2008.5	35.7	4.2	33.5	33.5
Santo Antônio de Goiás - GO <sup>2</sup>	FM 980 GLT	5034.0	2005.5	39.8	4.7	30.5	31.8
	BRS 433FL B2RF	5556.0	2107.5	37.9	4.5	31.4	33.8
Chapadão do Sul - MS <sup>2</sup>	FM 980 GLT	2646.0	1059.0	40.2	4.2	28.6	25.2
	BRS 433FL B2RF	2856.0	1072.5	37.5	3.6	32.1	29.0
Sapezal - MT <sup>2</sup>	FM 980 GLT	3564.0	1741.5	48.9	4.8	30.7	31.3
	BRS 433FL B2RF	3880.5	1507.5	38.9	4.8	34.2	32.7
Mean	FM 980 GLT	4127.5	1731.0	44.2	4.6	30.1	30.7
	BRS 433FL B2RF	4410.9	1646.5	38.3	4.4	32.8	34.1

<sup>1</sup> 2014/2015 season; <sup>2</sup> 2015/2016 season.

longer (32.8 mm) and stronger fibers (34.1 gf tex<sup>-1</sup>) than cv. FM 980 GLT (30.1 mm and 30.7 gf tex<sup>-1</sup>, respectively). Cultivar BRS 433FL B2RF produced significantly more cottonseed than FM 980 GLT (4295.2 and 3919.2 kg ha<sup>-1</sup>, respectively); nevertheless, the cotton lint yield was not significantly different due to the higher fiber percentage of cv. FM 980 GLT (Table 2).

In the growing seasons 2016/2017 and 2017/2018, cv. BRS 433FL B2RF was compared with cv. DP 1536 B2RF with the same biotechnology traits and improved fiber quality. In 2016/2017, fiber length of cv. BRS 433FL B2RF was significantly longer (33.2 mm) than of cv. DP 1536 B2RF (30.6 mm). Both cultivars had a high fiber strength (Table 3), without significant differences for this trait. In this season, the overall yield means were higher than in the previous ones. Averaged across seven trials, cottonseed yield and lint yield of cv. BRS 433FL B2RF and DP 1536 B2RF were not significantly different (Table 3), although DP 1536 had a higher lint percentage. In the 2017/2018 growing season, fiber length was significantly higher in BRS 433FL B2RF (32.4 mm) than in DP 1536 B2RF (30.8 mm), while fiber strength was statistically the same again. There were no significant differences in cottonseed yield; however, due to the difference in lint percentage, the lint yield of cv. DP 1536 B2RF was higher (Tables 3 and 5). With a relatively low lint percentage, the cottonseed yield potential of cv. BRS 433FL B2RF is very high, enough to ensure high fiber productivity (Tables 3 and 5). On the other hand, high volume instrument (HVI) measurements consistently indicated superior physical properties for an upland cotton cultivar, e.g., mean micronaire reading of 4.4; fiber length (UHML) 32.8 mm and mean fiber strength

**Table 5.** Means of cottonseed yield - CY (kg ha<sup>-1</sup>), lint yield - LY (kg ha<sup>-1</sup>), lint percentage - LP (%), micronaire index - Mic, fiber length - Len (mm) and fiber strength - Str (gf tex<sup>-1</sup>) of the cultivars BRS 433FL B2RF and DP 1536 B2RF (check) in the growing seasons 2016/2017 and 2017/2018

Location	Cultivar	CY	LY	LP	Mic.	Len.	Str.
Luís Eduardo Magalhães - BA <sup>1</sup>	DP 1536 B2RF	6597.0	2944.5	44.6	5.1	29.7	31.5
	BRS 433FL B2RF	7657.5	2833.5	37.0	4.6	31.9	31.1
Barreiras - BA <sup>1</sup>	DP 1536 B2RF	-	-	42.8	4.8	30.7	34.8
	BRS 433FL B2RF	-	-	36.5	4.2	33.7	36.2
Riachão das Neves - BA <sup>1</sup>	DP 1536 B2RF	6706.5	2866.5	42.8	5.0	31.1	32.0
	BRS 433FL B2RF	8767.5	3436.5	39.1	4.9	33.7	32.6
São Desidério - BA <sup>1</sup>	DP 1536 B2RF	7380.0	3180.0	43.1	5.2	31.3	34.3
	BRS 433FL B2RF	8028.0	3102.0	38.6	5.0	34.1	31.3
Santo Antônio de Goiás - GO <sup>1</sup>	DP 1536 B2RF	6702.0	3058.5	45.6	4.8	30.3	33.1
	BRS 433FL B2RF	5853.0	2326.5	39.8	4.6	32.5	32.7
Campo Verde - MT <sup>1</sup>	DP 1536 B2RF	6118.5	-	-	-	-	-
	BRS 433FL B2RF	5848.5	-	-	-	-	-
Sorriso - MT <sup>1</sup>	DP 1536 B2RF	5484.0	-	-	-	-	-
	BRS 433FL B2RF	5211.0	-	-	-	-	-
Luís Eduardo Magalhães - BA <sup>2</sup>	DP 1536 B2RF	8284.5	3333.0	37.2	4.9	31.4	36.0
	BRS 433FL B2RF	7710.0	2763.0	32.9	4.6	34.3	34.8
Riachão das Neves - BA <sup>2</sup>	DP 1536 B2RF	7047.0	3096.0	40.9	4.8	30.1	34.0
	BRS 433FL B2RF	7642.5	2940.0	35.4	4.6	32.6	33.4
São Desidério - BA <sup>2</sup>	DP 1536 B2RF	6298.5	2640.0	38.9	5.1	30.8	34.6
	BRS 433FL B2RF	7134.0	2643.0	34.1	4.7	33.5	33.8
Santo Antônio de Goiás - GO <sup>2</sup>	DP 1536 B2RF	5973.0	2286.0	38.4	4.0	30.4	30.9
	BRS 433FL B2RF	5055.0	1791.0	35.5	4.0	31.4	34.9
Campo Verde - MT <sup>2</sup>	DP 1536 B2RF	5809.5	2176.5	37.4	4.3	30.4	34.1
	BRS 433FL B2RF	5682.0	1927.5	34	3.7	30.4	34.0
Sapezal - MT <sup>2</sup>	DP 1536 B2RF	5521.5	2065.5	37.5	4.1	31	34.5
	BRS 433FL B2RF	5616.0	1720.5	30.6	3.9	32	32.5
Sorriso - MT <sup>2</sup>	DP 1536 B2RF	5604.0	2124.0	37.9	4.7	31.4	35.1
	BRS 433FL B2RF	6162.0	2032.5	33.1	4.1	32.7	35.3
Mean	DP 1536 B2RF	6425.1	2706.4	40.6	4.7	30.7	33.7
	BRS 433FL B2RF	6643.6	2501.5	35.6	4.4	32.7	33.6

<sup>1</sup> 2016/2017 growing season; <sup>2</sup> 2017/2018 growing season.

33.9 gf tex<sup>1</sup>. This fiber quality is comparable to the obsolete low-yielding long staple cultivar BRS Acácia (Acala type) and the recurrent parent BRS 336 (Table 1).

The accepted base for upland cotton is a mean fiber length of 27.8 mm (Smith et al. 2011). Fiber length has long been considered one of the primary determinants of cotton quality. Staple length influences yarn strength and yarn uniformity. Individual fibers are converted to yarn by a series of techniques of twisting the fiber strands. Longer fibers can be twisted around each other more than shorter fibers. This layering reinforces the yarn, making it more resistant to breakage. Thus, yarn made from long is stronger than yarn made from short fibers. Fiber strength also affects the types of cotton products that can be made from yarn. Therefore, cv. BRS 433FL B2RF may be useful in the cotton industry, for the production of high-quality yarns and fabrics and would achieve high fiber prices. With regard to breeding, cv. BRS 433FL B2RF can be used in cotton breeding programs as a donor parent with high-quality fiber.

## SEED MAINTENANCE AND DISTRIBUTION

Cultivar BRS 433FL B2RF was registered by the Ministry of Agriculture, Livestock and Food Supply (no 36253). Foundation seed is produced by Embrapa and licenced seed companies are responsible for the certified seed production, together with Embrapa.

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