

## BRS 700FL B3RF: an outstanding fiber quality upland cotton cultivar with high seed cotton yield

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**Abstract:** BRS 700FL B3RF is an extra-long staple (ELS) upland cotton cultivar. It features exceptional fiber quality, with fiber length exceeding 33.0 mm and fiber strength above 32.5 gf tex<sup>-1</sup>. This cultivar includes transgenic events Bollgard<sup>®</sup> III and Roundup Ready Flex<sup>™</sup>, providing enhanced resistance to lepidopteran pests and tolerance to glyphosate.

**Keywords:** *Gossypium hirsutum*, transgenic insect resistance, glyphosate tolerance

### INTRODUCTION

Cotton (*Gossypium* spp.) is the most important natural fiber crop globally, with four species cultivated worldwide, though two are economically prominent: *Gossypium hirsutum* L. (Upland cotton), which accounts for over 90% of global production, and *G. barbadense* L. (Pima, Sea Island, Egyptian, or extra-long staple [ELS] cotton), representing about 5% of world fiber production (Fang 2018). Upland cotton generally yields more than Pima cotton, but Pima produces longer, stronger, finer, and more uniform fibers.


Fiber quality is critical to the spinning process. Different methods exist for spinning cotton fiber into yarn. Ring spinning (both conventional and compact) has dominated for decades, accounting for about 75% of global spinning capacity, while open-end rotor-spinning represents approximately 25% (Kelly et al. 2015). In recent years, air-jet (vortex) spinning has gained significant ground. A limitation of vortex spinning is its intolerance of shorter fibers. Thus, selecting cotton cultivars with longer fiber length can indirectly reduce the short fiber index, a key factor in improving fiber quality to meet the textile industry's growing demand for higher-quality fibers and increase cotton's competitiveness against synthetic fibers. Along with fiber quality, major objectives of cotton breeding programs include improving yield and pest resistance (Morello et al. 2010, Smith et al. 2011, Morello et al. 2020, Suassuna et al. 2021).

Crop Breeding and Applied Biotechnology  
24(4): e49552444, 2024  
Brazilian Society of Plant Breeding.  
Printed in Brazil  
<http://dx.doi.org/10.1590/1984-70332024v24n4c41>



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Received: 12 June 2024

Accepted: 04 August 2024

Published: 25 September 2024

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Empresa Brasileira de Pesquisa Agropecuária's (Embrapa) cotton breeding program has made significant progress in developing *Upland* cotton cultivars with superior fiber quality over recent decades. The first high-quality fiber cultivar, BRS Acácia, was an Acala-type cotton with excellent fiber quality but susceptibility to bacterial blight and cotton blue disease, limiting its cultivation in the Brazilian Savannah. In 2012, Embrapa released BRS 336, a cultivar with excellent fiber length and strength, and resistance to bacterial blight and cotton blue disease (Morello et al. 2012), well-suited to the Brazilian Savannah. However, in 2013, after *Helicoverpa armigera* became a major pest in Brazil, cotton producers demanded transgenic cultivars resistant to lepidopteran pests. Using BRS 336 as a recurrent parent, Embrapa developed BRS 433FL B2RF in 2020, the first transgenic *Upland* cotton cultivar with high-quality fiber (Morello et al. 2020). Both BRS 336 and BRS 433FL B2RF have fiber lengths exceeding 32.5 mm and fiber strength of 33 gf tex<sup>-1</sup>, though with a higher micronaire index, similar to medium staple cultivars.

Commercial transgenic cotton cultivars with resistance to lepidopteran pests and tolerance to herbicides are now available in Brazil (Morello et al. 2015, Suassuna et al. 2018, Belot et al. 2020, Suassuna et al. 2021). The transgenic events MON 15985 and COT 102, marketed as Bollgard® III (B3), produce the *Bt* proteins Cry1Ac, Cry2Ab, and VIP 3A, which are effective against several lepidopteran pests in cotton. Additionally, the transgenic cotton event MON 88913, marketed as Roundup Ready Flex® (RF), provides tolerance to the herbicide glyphosate through a modified protein (CP4 EPSPS).

The development of BRS 700FL B3RF was a collaboration between Embrapa and International Seed Technology (IST) Cotton Brasil Ltda., which partially supported Embrapa's breeding program. BRS 700FL B3RF (Reg. no. 55167) is the first high-quality fiber transgenic cotton cultivar developed in Brazil, featuring three insecticidal *Bt* proteins. It is an excellent option for producing fine or very fine yarn and represents the ongoing efforts to create new cotton lines and cultivars with enhanced fiber quality, good yield potential, transgenic pest resistance, and herbicide tolerance, particularly suited for the Brazilian Savannah.

## BREEDING METHODS

BRS 700FL B3RF (*Gossypium hirsutum* L.) was developed through backcrossing BRS 336 (recurrent parent) with a biotech trait donor, followed by pedigree selection to incorporate the transgenic events COT102, MON 15985, and MON 88913 (Bollgard® III Roundup Ready Flex™ - B3RF). BRS 336, an *Upland* cotton cultivar released in 2012, has outstanding fiber quality, is well-adapted to major cotton-growing regions in Brazil, and is resistant to bacterial blight (*Xanthomonas citri* subsp. *malvacearum*) and cotton blue disease (caused by Cotton Leafroll Dwarf Virus) (Morello et al. 2012). The donor of the biotech traits was identified as 11Q2223-B3R2-T1A2. BRS 700FL B3RF originated from a hybridization between BRS 336 and the B3RF donor, followed by four backcrosses. The initial cross was performed in 2015, with BC<sub>1</sub>, BC<sub>2</sub>, BC<sub>3</sub>, and BC<sub>4</sub> conducted from 2016 to 2017. Plants from the BC<sub>4</sub>F<sub>1</sub>, BC<sub>4</sub>F<sub>2</sub>, and BC<sub>4</sub>F<sub>3</sub> generations were selfed in a controlled environment and genotyped from 2018 to 2019 using specific qPCR assays. These generations were managed by Bayer (Monsanto) at their experimental unit in Juana Diaz, Puerto Rico, under controlled cultivation conditions. In 2020, Embrapa imported the seeds and grew them under controlled conditions (net houses), resulting in BC<sub>4</sub>F<sub>4</sub> seeds harvested from 19 progenies. Lint percentage and fiber quality were recorded, and 12 progenies were selected as breeding lines, including CNPA-CO-2019-2081-B3RF, which was advanced to the Value for Cultivation and Use (VCU) trials over the next three crop seasons.

A total of 15, 16, and 17 trials were conducted during the 2020/2021, 2021/2022, and 2022/2023 growing seasons, respectively, across the states of Bahia, Goiás, Mato Grosso do Sul, Mato Grosso, Minas Gerais, São Paulo, Paraná, Piauí, Maranhão, Ceará, and Paraíba. All experiments followed a randomized complete block design with four replications. The experimental plot consisted of four 5-meter-long rows, with row widths of 0.76 m or 0.90 m (in Mato Grosso), and a plant population of approximately 10 plants per meter. In each plot, 30 bolls were hand-harvested from the middle of the fruiting zone and ginned in a laboratory saw gin to determine lint percentage (LP%). Fiber properties, including fiber length (Len, mm), fiber strength (Str, gf tex<sup>-1</sup>), and micronaire index, were measured using an HVI instrument (Uster HVI 1000). The micronaire index reflects both the fineness and maturity of the fiber. Higher readings may indicate coarser or more mature fibers, while lower readings suggest finer or immature fibers (Hequet et al. 2006). To ensure accurate measurement of the fiber fineness, additional analysis was conducted using an Advanced Fiber Information System (AFIS) at the Fiber and Biopolymer Research Institute

at Texas Tech University. The AFIS provided detailed information on length and diameter distribution, trash and nep content, and measurements of fiber fineness and maturity. Plots were harvested (either manually or with a mechanical picker modified for plot harvest) to determine seed cotton yield (CY, kg ha<sup>-1</sup>) and lint yield (LY, kg ha<sup>-1</sup>). An analysis of variance (ANOVA) was conducted for each experiment, and means were grouped by using the Scott-Knott test.

## TRAITS AND PERFORMANCE

BRS 700FL B3RF is a medium to tall cotton cultivar with a pyramidal morphology. Plants reach a height of 120-145 cm at maturity when treated with 150-175 g of mepiquat chloride per hectare, applied in fractions throughout the season. Leaves are normally shaped, with nectaries and gossypol glands. Flower petals, anthers, and pollen are cream-colored. Fruits are elliptical, large (averaging 5.7 g), and typically have five locules, with some bolls occasionally having four. Both the lint and fuzz fibers are white. The open bolls are suitable for mechanical harvesting, although they are not stormproof.

When grown at 750-850 m above sea level (asl), the first flowers appear 54-60 days after emergence (DAE), with the first bolls opening around 124-126 DAE. BRS 700FL B3RF is a mid-season to late-maturing cultivar, with full boll maturation occurring between 175 and 185 DAE.

BRS 700FL B3RF is resistant to cotton blue disease, caused by the Cotton leafroll dwarf virus (CLRDV), and bacterial blight, caused by *Xanthomonas citri* subsp. *malvacearum*. However, BRS 700FL B3RF is susceptible to ramularia leaf spot (*Ramulariopsis pseudoglycines*), requiring foliar fungicide sprays to mitigate losses. Resistance to cotton blue disease and bacterial blight was assessed in two independent field trials without vector control, where all plants showed no symptoms of these diseases. Genotyping tests confirmed the presence of molecular markers associated with resistance to cotton blue disease (DC20027) and bacterial blight (CIR 246) (Fang et al. 2010, Xiao et al. 2010). Ramularia leaf spot severity was assessed on a 1-5 scale, where 1 represents resistance and 5 indicates high susceptibility.

BRS 700FL B3RF's agronomic performance was compared to TMG 44 B2RF, Brazil's most widely planted cotton cultivar in recent years. The Scott-Knott test was used to identify significant differences between the cultivars across individual field trials and joint analyses. During the 2020/2021 growing season, pooled data from 15 locations showed that BRS 700FL B3RF had significantly longer fibers (33.5 mm) and stronger fibers (32.8 gf tex<sup>-1</sup>) than TMG 44 B2RF (30.0 mm and 29.8 gf tex<sup>-1</sup>, respectively). BRS 700FL B3RF also produced more seed cotton (4867.2 kg ha<sup>-1</sup>) compared to TMG 44 B2RF (4777.1 kg ha<sup>-1</sup>). However, TMG 44 B2RF had a higher lint percentage (42.3%) and a significantly higher cotton lint yield (Table 1). BRS 700FL B3RF's highest seed cotton yield was recorded in Riachão das Neves, BA, with 8218.5 kg ha<sup>-1</sup>. In all 15 locations, BRS 700FL B3RF consistently produced longer fibers than TMG 44 B2RF (Table 2).

In the 2021/2022 growing season, comprising 16 trials, there were no significant differences between the seed cotton yields of BRS 700FL B3RF (4501.7 kg ha<sup>-1</sup>) and TMG 44 B2RF (4545.0 kg ha<sup>-1</sup>). However, TMG 44 B2RF had a higher lint yield due to its greater lint percentage. BRS 700FL B3RF consistently produced longer (33.7 mm) and stronger (33.4 gf tex<sup>-1</sup>) fibers compared to TMG 44 B2RF (Table 1). Despite irregular rainfall and resulting lower yields, the fiber quality

**Table 1.** Joint analysis of experiments carried out at various locations in three growing seasons. Means of BRS 700FL B3RF and TMG 44 B2RF cultivars for seed cotton yield (CY), lint percentage (LP), lint yield (LY), fiber length (LEN), fiber strength (STR), and Micronaire index (MIC) in 48 locations during the 2020/2021 (15 locals), 2021/2022 (16 locals), and 2022/2023 (17 locals) growing seasons

Season	Cultivar	CY (kg ha <sup>-1</sup> )	LP (%)	LY (kg ha <sup>-1</sup> )	LEN (mm)	STR (gf tex <sup>-1</sup> )	MIC
2020/ 21	BRS 700FL B3RF	4867.2*	36.9	1785.4	33.5*	32.8*	3.8
	TMG 44 B2RF	4777.1	42.3*	2018.7*	30.0	29.8	4.1*
2021/ 22	BRS 700FL B3RF	4501.7	37.6	1695.2	33.7*	33.4*	3.8
	TMG 44 B2RF	4545.0	43.3*	1974.4*	29.9	29.8	4.2*
2022/ 23	BRS 700FL B3RF	4806.6*	38.0	1931.1	33.6*	31.9*	3.7
	TMG 44 B2RF	4666.1	43.8*	2106.0*	29.9	29.1	4.2*

\* Pairs of treatment mean at each season, for each variable, followed by an asterisk indicate that the means differed by the Scott-Knott grouping test at a level of 5% probability in the respective original trials, with 20 (season 2020/2021) or 18 treatments and 4 replications.

of BRS 700FL B3RF remained superior across all locations, with the highest yields observed in Luís Eduardo Magalhães, BA, where supplementary irrigation was used (Table 3).

In the 2022/2023 season, consisting of 17 trials, BRS 700FL B3RF produced significantly more seed cotton (4806.6 kg ha<sup>-1</sup>) than TMG 44 B2RF (4666.1 kg ha<sup>-1</sup>). However, TMG 44 B2RF had a higher lint percentage (43.8%) and thus a higher cotton lint yield (Table 1). BRS 700FL B3RF again demonstrated superior fiber quality, with significantly longer fibers (33.6 mm) and stronger fibers (31.9 gf tex<sup>-1</sup>) than TMG 44 B2RF (Table 4).

Across all 48 field tests conducted over three seasons, BRS 700FL B3RF had an average fiber length (UHML HVI) of 33.6 mm, fiber strength of 32.7 gf tex<sup>-1</sup>, and a micronaire index of 3.8, all of which were significantly superior to TMG 44 B2RF. Despite producing seed cotton yields comparable to TMG 44 B2RF, the lower lint percentage of BRS 700FL B3RF resulted in 11.3% lower fiber productivity (Table 1). High-volume instrument (HVI) measurements consistently confirmed the superior physical properties of BRS 700FL B3RF, comparable to the obsolete, low-yielding extra-long staple (ELS) cultivar BRS Acácia (Acala type). When compared to its recurrent parent BRS 336, BRS 700FL B3RF exhibited similar fiber length and strength but had a lower micronaire index, indicating finer and/or more mature fibers.

**Table 2.** BRS 700FL B3RF and TMG 44 B2RF means of lint percentage (LP), seed cotton yield (CY) lint yield (LY), fiber length (LEN), fiber strength (STR), and micronaire index (MIC) in 15 trials carried out in the 2020/2021 growing season

Local <sup>#</sup>	Cultivar	LP (%)	CY (kg ha <sup>-1</sup> )	LY (kg ha <sup>-1</sup> )	LEN (mm)	STR (gf tex <sup>-1</sup> )	MIC
ALA	BRS 700FL B3RF	38.2	2357.5	901.6	34.1*	35.3	3.9
	TMG 44 B2RF	42.5*	2438.4	1040.5	31.3	35.0	4.1
BAR	BRS 700FL B3RF	41.4	4650.0	1922.1	33.1*	32.2	4.1
	TMG 44 B2RF	42.9*	5223.4	2248.6	30.7	31.9	4.3*
BUR	BRS 700FL B3RF	34.7	4515.5*	1568.5	31.6*	31.4*	3.4
	TMG 44 B2RF	41.4*	4083.7	1688.3*	27.5	26.6	3.4
CDS	BRS 700FL B3RF	36.6	4667.6	1714.0	33.4*	32.2*	3.7
	TMG 44 B2RF	42.3*	4582.3	1942.4	29.5	28.7	3.9
CMB	BRS 700FL B3RF	37.6	5341.2	2009.7	34.7*	34.2*	4.2
	TMG 44 B2RF	41.9*	5171.5	2166.4	31.2	31.6	4.5*
COR	BRS 700FL B3RF	36.1	6062.1	2189.6	34.9*	31.2*	4.1
	TMG 44 B2RF	43.8*	6305.3	2760.5*	30.9	29.4	4.4*
CPV	BRS 700FL B3RF	36.1	5182.3	1873.0	33.1*	32.3*	3.6
	TMG 44 B2RF	42.5*	5759.4*	2448.0*	29.8	28.9	3.9*
DEC	BRS 700FL B3RF	36.3	4484.7	1626.7	33.1*	32.3*	3.5
	TMG 44 B2RF	42.0*	5275.5*	2218.4*	30.0	28.0	3.9*
LEM	BRS 700FL B3RF	36.2	5728.5	2068.4	33.5*	31.9*	4.0
	TMG 44 B2RF	42.4*	6041.6*	2555.2*	30.0	30.2	4.5*
MVL	BRS 700FL B3RF	39.5	2440.9	964.6	35.0*	33.0	3.6
	TMG 44 B2RF	42.6*	1645.0	702.2	32.0	32.6	4.0*
RDN	BRS 700FL B3RF	36.3	8218.5	2976.9	33.8*	32.0*	3.8
	TMG 44 B2RF	42.4*	7030.3	2983.8	30.1	28.4	4.0*
SAG	BRS 700FL B3RF	36.1	6608.4	2391.0	32.5*	31.0*	3.6
	TMG 44 B2RF	41.1*	6762.8	2775.7*	28.9	28.2	4.2*
SDS	BRS 700FL B3RF	34.8	6525.0*	2274.7	33.0*	32.1*	3.7
	TMG 44 B2RF	40.9*	5711.3	2334.6*	29.1	28.5	3.6*
TOC	BRS 700FL B3RF	36.9	3503.3	1291.8	32.1*	36.1*	3.2
	TMG 44 B2RF	43.2*	3509.9	1512.2*	28.1	28.5	3.7*
VER	BRS 700FL B3RF	37.0	2722.2*	1007.5	34.1*	34.4*	4.2
	TMG 44 B2RF	42.7*	2116.4	904.0	31.2	30.6	4.8*

\* Pairs of treatment mean at each location, for each variable, followed by an asterisk indicate that the means differed by the Scott-Knott grouping test at a level of 5% probability in the respective original trials, with 20 treatments and 4 replications. # ALA=Alagoinha PB, BAR=Barbalha CE, BUR=Buritis MG, CDS=Chapadão do Sul MS, CMB=Cambará PR, COR= Correntina BA, CPV=Campo Verde MT, DEC=Decirolândia MT, LEM=Luis Eduardo Magalhães BA, MVL=Missão Velha CE, RDN=Riachão das Neves BA, SAG=Santo Antônio de Goiás GO, SDS=São Desidério BA, TOC=Tocantínia TO, and VER=Vera MT.

AFIS analysis further supported the quality of BRS 700FL B3RF, showing a lower number of neps per gram (below 100) and seed coat neps (below 10). The upper quartile length weighted (UQLw) was 35.0 mm, which is typically higher than UHML, confirming that BRS 700FL B3RF produces longer fibers than most Upland cotton cultivars on the market (Liu and Chang 2024). The short fiber content weighted (SFCw) was 7.0%, which is lower than typically measured in commercial cotton, reflecting the cultivar's longer fibers and higher strength, factors that contribute to improved spinning performance for yarn finer than 40 Ne or under air-jet spinning technology.

The fiber maturity ratio was 0.94, with an IFC of 5.3%, a fineness of 161 mtex, and a standard fineness of 171 mtex. The micronaire index of 3.8 reflects the presence of both fine and mature fibers, or possibly coarser and immature fibers (Hequet et al. 2006). AFIS data confirmed that BRS 700FL B3RF produces fine and mature fibers, which is advantageous for producing finer yarns in ring-spinning or air-jet spindle frames. Therefore, the BRS 700FL B3RF can be useful in the cotton industry to produce high quality yarns and fabrics and achieve higher fiber prices.

**Table 3.** BRS 700FL B3RF and TMG 44 B2RF means of lint percentage (LP), seed cotton yield (CY) lint yield (LY), fiber length (LEN), fiber strength (STR), and micronaire index (MIC) in 16 trials carried out in the 2021/2022 growing season

Local <sup>#</sup>	Cultivar	LP (%)	CY (kg ha <sup>-1</sup> )	LY (kg ha <sup>-1</sup> )	LEN (mm)	STR (gf tex <sup>-1</sup> )	MIC
ALA	BRS 700FL B3RF	36.6	4632.5	1694.4	34.5*	35.4*	3.7
	TMG 44 B2RF	40.9*	4871.6	1993.5	31.2	31.9	3.9
BAR	BRS 700FL B3RF	42.4	3376.3	1428.2	33.5*	36.1*	4.1
	TMG 44 B2RF	45.0*	2855.0	1288.5	30.3	32.8	4.7*
BUR	BRS 700FL B3RF	31.4	4883.2	1535.8	31.8*	27.3*	3.3
	TMG 44 B2RF	42.1*	4942.8	2072.8*	27.1	24.2	3.7*
CDS	BRS 700FL B3RF	36.1	4628.1	1671.2	34.2*	31.9*	3.3
	TMG 44 B2RF	42.2*	4776.0	2014.8*	30.2	28.9	3.5
CMB	BRS 700FL B3RF	40.2	3449.8	1387.5	34.0*	35.2*	4.5
	TMG 44 B2RF	44.2*	4090.5	1808.8	31.1	33.0	4.6
LEM	BRS 700FL B3RF	36.7	6242.1	2290.0	35.5*	32.8*	3.8
	TMG 44 B2RF	44.9*	7024.8*	3150.1*	30.3	29.2	4.4*
MVL	BRS 700FL B3RF	38.8	3090.9	1201.3*	32.9*	35.8	3.5
	TMG 44 B2RF	39.9	2611.6	1031.6	30.8	34.0	4.3*
PAL	BRS 700FL B3RF	38.5	4961.1	1915.1	32.8*	34.4*	3.8
	TMG 44 B2RF	44.1*	5426.6*	2393.2*	29.9	30.5	5.0*
PMA	BRS 700FL B3RF	36.5	5110.9*	1863.2	34.7*	32.0*	3.8
	TMG 44 B2RF	41.7*	4075.9	1701.2	29.7	27.0	4.1*
PRL	BRS 700FL B3RF	34.9	3174.8	1108.1	33.2*	33.1*	3.4
	TMG 44 B2RF	40.7*	3616.0*	1469.2*	30.0	30.0	3.5
RDN	BRS 700FL B3RF	38.3	6145.9	2354.3	34.2*	33.6*	3.7
	TMG 44 B2RF	44.3*	6131.5	2722.4	28.9	26.4	4.0
SAG	BRS 700FL B3RF	39.3	4781.3	1880.5	34.5*	33.2*	3.7
	TMG 44 B2RF	46.4*	4379.4	2030.0	30.2	30.4	4.0*
SDS	BRS 700FL B3RF	41.0	5135.5	2103.7	33.0*	34.8*	4.3
	TMG 44 B2RF	46.6*	4763.7	2231.9	28.9	29.9	4.7*
TOC	BRS 700FL B3RF	37.7	4153.0	1565.2	33.3*	32.4*	3.7
	TMG 44 B2RF	44.3*	4231.1	1874.2*	30.3	30.7	4.3*
VER	BRS 700FL B3RF	36.1	3967.8	1430.2	34.1*	32.6*	3.8
	TMG 44 B2RF	42.0*	4251.2	1784.8	29.5	28.9	4.6*
VIL	BRS 700FL B3RF		4294.5				
	TMG 44 B2RF		4437.3				

\* Pairs of treatment mean at each location, for each variable, followed by an asterisk indicate that the means differed by the Scott-Knott grouping test at a level of 5% probability in the respective original trials, with 18 treatments and 4 replications. <sup>#</sup>ALA=Alagoinha PB, BAR=Barbalha CE, BUR=Buritis MG, CDS=Chapadão do Sul MS, CMB=Cambará PR, LEM=Luis Eduardo Magalhães BA, MVL=Missão Velha CE, PAL=Palmas TO, PMA=Parapanema SP, PRL=Primavera do Leste MT, RDN=Riachão das Neves BA, SAG=Santo Antônio de Goiás GO, SDS=São Desidério BA, TOC=Tocantina TO, VER=Vera MT, and VIL=Viçosa RO.

**Table 4.** BRS 700FL B3RF and TMG 44 B2RF means of lint percentage (LP), seed cotton yield (CY) lint yield (LY), fiber length (LEN), fiber strength (STR), and micronaire index (MIC) in 17 trials carried out in the 2022/2023 growing season

Local <sup>#</sup>	Cultivar	LP (%)	CY (kg ha <sup>-1</sup> )	LY (kg ha <sup>-1</sup> )	LEN (mm)	STR (gf tex <sup>-1</sup> )	MIC
BAL	BRS 700FL B3RF	37.5	4942.3*	1865.2	34.9*	32.8*	4.0
	TMG 44 B2RF	45.4*	4550.6	2068.8	29.7	28.7	4.4*
BUR	BRS 700FL B3RF	37.5	4670.4	1754.3	32.5*	27.7*	4.0
	TMG 44 B2RF	42.8*	5244.0	2309.6	28.9	25.4	4.1
CDS	BRS 700FL B3RF	38.5	2046.2	789.1	33.3*	32.5*	4.2
	TMG 44 B2RF	46.7*	3350.9	1566.3	29.2	28.8	4.5
CMB	BRS 700FL B3RF	39.9	4727.4*	1885.6*	35.0*	32.2*	3.9
	TMG 44 B2RF	43.6*	3076.7	1343.8	31.8	31.0	3.9
CNP	BRS 700FL B3RF	37.2	3670.6	1363.3			
	TMG 44 B2RF	44.2*	3907.0	1731.6*			
LEM	BRS 700FL B3RF	39.8	5026.3	3315.8	34.3*	32.2*	4.2
	TMG 44 B2RF	43.1*	4373.4	2293.8	31.1	30.4	4.4*
PAL	BRS 700FL B3RF	37.1	4203.1	1560.3	31.1	34.7	3.5
	TMG 44 B2RF	43.9*	4316.4	1892.8	29.2	31.9	4.7*
PMA	BRS 700FL B3RF	31.4	4835.6	1528.6	33.1*	29.3*	2.7
	TMG 44 B2RF	38.2*	4474.4	1708.9	28.9	25.7	3.1*
PRL	BRS 700FL B3RF	35.7	4714.2*	1685.7	34.1*	31.2*	4.1
	TMG 44 B2RF	42.3*	3327.0	1409.6	30.0	28.0	4.3
RDN	BRS 700FL B3RF	40.1	8489.8	3402.0	35.1*	30.9*	3.7
	TMG 44 B2RF	45.6*	8565.9	3906.7*	31.0	27.5	4.3*
SAG	BRS 700FL B3RF	38.4	7993.4	3088.7	33.7*	29.5*	3.7
	TMG 44 B2RF	44.9*	8634.9	3873.0*	29.6	28.2	4.0*
SAG <sup>†</sup>	BRS 700FL B3RF	38.1	6736.1	2570.2	33.4*	31.0*	3.7
	TMG 44 B2RF	44.2*	7194.4	3179.3*	29.9	28.1	4.1*
SDS	BRS 700FL B3RF	39.0	4810.9	1878.7	34.8*	31.4*	3.6
	TMG 44 B2RF	43.2*	5440.0*	2350.6*	31.1	28.8	3.7
TER	BRS 700FL B3RF	38.4	1922.9	739.8	32.3*	35.9*	3.9
	TMG 44 B2RF	44.0*	1558.2	688.9	28.9	32.8	4.7*
TOC	BRS 700FL B3RF	40.6	4390.6	1785.4	33.3*	34.3*	3.4
	TMG 44 B2RF	44.2*	4074.5	1796.1	29.0	29.5	4.0*
VER	BRS 700FL B3RF	36.2	3584.0	1298.5	34.3*	32.9*	3.5
	TMG 44 B2RF	42.7*	3317.5	1418.7	30.2	29.9	4.0*
VIL	BRS 700FL B3RF		4315.4				
	TMG 44 B2RF		3853.8				

\* Pairs of treatment mean at each location, for each variable, followed by an asterisk indicate that the means differed by the Scott-Knott grouping test at a level of 5% probability in the respective original trials, with 18 treatments and 4 replications. <sup>†</sup>Late sowing trial. <sup>#</sup>BAL=Balsas MA, BUR=Buritis MG, CDS=Chapadão do Sul MS, CMB=Cambará PR, CNP=Campo Novo do Parecis MT, LEM=Luis Eduardo Magalhães BA, PAL=Palmas TO, PMA=Parapanema SP, PRL=Primavera do Leste MT, RDN=Riachão das Neves BA, SAG=Santo Antônio de Goiás GO, SDS=São Desidério BA, TER=Teresina TO, TOC=Tocantina TO, VER=Vera MT, and VIL=Vilhena RO.

## AVAILABILITY

Foundation seeds of BRS 700FL B3RF (registration number 55167) are produced by Embrapa. Commercial seeds are available for purchase from IST Cotton Brasil Ltda. Inquiries regarding seed availability for research or commercial purposes should be directed to the corresponding authors.

## ACKNOWLEDGEMENTS

Funding for this work was partially provided by grants from Embrapa and IST Cotton Brasil Ltda. The authors gratefully acknowledge the infrastructure and support of AGOPA's Fiber Laboratory. Special thanks to the supporting team: Gedeon Dias Lopes, Thiago Cândido do Nascimento Ribeiro, and Washington da Conceição Gonçalves.

## DATA AVAILABILITY

The datasets generated and/or analyzed during the current research are available from the corresponding author upon reasonable request.

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