

'BRS FS307' high-yielding common bean cultivar with mulatto grain for Northeastern Brazil

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Abstract: 'BRS FS307' is a common bean cultivar with mulatto grain developed for the Northeast of Brazil. Presents the following characteristics: cycle semi-early, yield potential of 4.145 kg ha⁻¹ and a mean yield of 2.703 kg ha⁻¹, i.e., 13.9% higher than that of the control cultivars (BRS Marfim and BRS Agreste).


Keywords: *Phaseolus vulgaris*, breeding, family farming.

INTRODUCTION

In Brazil, common bean (*Phaseolus vulgaris* L.) is one of the main agricultural crops (FAO 2019). In the North and Northeast regions, common bean is not only important in economic and agronomic aspects, but also because of its social role, for being cultivated on small farms for subsistence food production, contributing as a basic protein source to food security (Carvalho et al. 2016). Nevertheless, the generation and transfer of technology that could improve common bean production systems, in particular in these regions of Brazil, is precarious. Improved common bean cultivars with high yield, broad adaptation and lower sensitivity to biotic and abiotic stresses represent one of the most significant contributions to the efficiency of this productive sector (Souza et al. 2013). Currently, efforts of common bean breeding in the Northeast Region are being made by Embrapa Rice and Beans, Embrapa Coastal Tablelands and by the Agronomic Institute of Pernambuco (IPA), with activities in the states of Bahia, Sergipe, Alagoas and Pernambuco. With regard to the grain color and type as well as the culinary quality, the regional consumers are demanding. The Northeast is the only Brazilian region where the mulatto grain type is popular. The last mulatto grain cultivars released by Embrapa for the Northeast region were BRS Marfim, in 2002, and BRS Agreste, in 2009. The size and grain quality of cv. BRS FS307 exceed those of cv. BRS Marfim and it produces higher yields than cv. BRS Agreste. Normally, cultivars with this grain type are rather robust, for being adapted to the growth conditions of the region. Thus, during the development of new cultivars by the common bean breeding program of Embrapa Rice and Beans, efforts are being made to take regional demands into consideration.

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BREEDING METHODS

BRS FS307 was derived from a cross of the lines CNFM 8080 and BRS Marfim, in 2004, made at Embrapa Rice and Beans, in Santo Antônio de Goiás (GO). In 2004, the F_1 generation was sown in a greenhouse. In the winter season of 2005, F_2 bulk seed was sown on the field, in Santo Antônio de Goiás, GO. In the dry season of 2006, the F_3 generation was bulk-harvested in Ponta Grossa (PR), after selection for plant architecture and resistance to anthracnose, angular leaf spot, rust and common bacterial blight. In the rainy season of 2006, generation F_4 was bulk-harvested in Ponta Grossa and selected again for plant architecture and resistance to anthracnose, angular leaf spot, rust and common bacterial blight. In 2007, the F_5 generation was sown in Santo Antônio de Goiás in the winter, where individual plants were selected for plant architecture.

Also in 2007, the $F_{5,6}$ generation was sown in the rainy season in Ponta Grossa, where lines were selected for plant architecture and resistance to anthracnose, angular leaf spot, rust and common bacterial blight. In the rainy season of 2008, this line was evaluated in Ponta Grossa for plant architecture and resistance to the same common bean diseases. Thereafter, line CNFM 15642 was evaluated in replicated tests.

In 2010, CNFM 15642 was evaluated in a progeny test with 24 other lines and three controls (BRS Marfim, BRS Agreste and IAC Centauro) in a randomized block design with three replications and two 4-m row plots. The tests were planted in two environments: Ponta Grossa, in the dry season and Santo Antônio de Goiás, in the winter. During these trials, the grain yield, cycle, plant architecture, lodging tolerance and reaction to anthracnose and angular leaf spot were evaluated (Melo 2009).

In 2011, line CNFM 15642 was evaluated in a Preliminary Trial with 12 other lines and three controls (BRS Marfim, BRS Agreste and IAC Centauro), in a randomized block design with three replications and two 4-m row plots. The tests were conducted in four environments: Santo Antônio de Goiás (GO) in the winter; Ponta Grossa (PR) in the rainy and dry season; and Carira (SE) in the rainy season. The grain yield, cycle, plant architecture, lodging tolerance and disease reaction (anthracnose, common bacterial blight, powdery mildew and bacterial wilt) were evaluated.

A combined analysis of preliminary and progeny test data indicated line CNFM 15642 for the VCU (Value for Cultivation and Use) trials. In 2012, the line was multiplied to obtain enough seeds for the VCU tests.

From 2013 to 2015, line CNFM 15642 was evaluated in 22 trials with two control cultivars (BRS Marfim and BRS Agreste), in a randomized block design with three replications and four 4-m row plots, using the recommended technologies for the different environments and cultivation systems. During these trials, the grain yield, crop cycle, plant architecture, lodging tolerance and disease reaction were evaluated. Although the cultivar had its final tests completed in 2015, it cannot be launched this year. As it is a cultivar that is being recommended only for the Northeast region of Brazil, there was great difficulty in the production process of basic seeds and only in the year 2020 was a minimum quantity obtained for its launch.

In the final field trials, environment-specific ANOVAs for seed yield were performed and evaluated with the F-test. These individual analyses addressed the variation between the means and experimental precision of the evaluations in the different environments. The line effect was considered fixed, because the tested elite lines had already been selected for these traits in the preliminary tests and, consequently, no longer represented the original variability. The environmental effect was considered random, because the sampling locations where the field trials were performed represent the normal environmental conditions (locations, growing seasons and years) of common bean seed production in Brazil. Residual variances for the traits were considered non-homogeneous when the ratio between the highest and lowest variances in the individual analyses was $>7:1$, as suggested by Pimentel-Gomes (2009). In this case, the degrees of freedom of the mean error and genotype - environment (GE) interaction were adjusted as proposed by Cochran (1954). A combined analysis was performed for seed yield and the means were compared by the Scott-Knott test at 5% probability (Scott and Knott 1974).

GRAIN YIELD AND YIELD POTENTIAL

From 2013 to 2015, in 22 VCU trials in the rainy season, cultivar BRS FS307 (CNFM 15642) produced mean yields of 2.703 kg ha⁻¹ (Table 1) in Sergipe, Alagoas, Pernambuco and Bahia, exceeding the mean yield of the control cultivars

Table 1. Mean seed yield (kg ha⁻¹), agronomical characteristics and disease reactions of cultivar BRS FS307 compared to the control cultivars BRS Marfim and BRS Agreste in final field trials in the northeast of Brazil, from 2013 to 2015

Cultivar	YLD* (kg ha ⁻¹)	Grain size	Cycle	ARCH	AN	CBB	RU	ALS	CBMV	BGMV	FW	BW
BRS FS307	2.703 a	MG	SE	SU	MR	S	MR	S	R	S	MR	S
BRS Marfim	2.499 b	SG	SE	SU	MS	S	MR	MR	R	S	MR	S
BRS Agreste	2.320 b	SG	N	U	MS	S	MS	S	R	S	MS	S

YLD- Mean grain yield; MG- Medium grain size; SG- small grain size; N- Normal cycle; SE- Semi-early cycle; ARCH- Plant architecture; SE- Semi-upright architecture; U- Upright architecture; AN- Anthracnose (*Colletotrichum lindemutianum*); CBB- Common bacterial blight (*Xanthomonas axonopodis* pv. *phaseoli* and *Xanthomonas fuscans* pv. *fuscans*); RU – Rust (*Uromyces appendiculatus*); ALS- angular leaf spot (*Pseudocercospora griseola*); CBMV- Common bean mosaic virus; BGMV- Bean golden mosaic virus; FW-Fusarium wilt (*Fusarium oxysporum* f. sp. *phaseoli*); BW- Bacterial wilt (*Curtobacterium flaccumfaciens* pv. *flaccumfaciens*); R- Resistant; MR- Moderately resistant; MS- Moderately susceptible; S- Susceptible; * Means followed by the same letter are not significantly different by the Scott-Knott test at 5% probability.

(2.410 kg ha⁻¹) by 13.9 %. In each state separately, the yield was 9.0% higher in Bahia; 15.2% in Pernambuco; 12.9% in Sergipe; and 16.9% in Alagoas.

The yield potential of 'BRS FS307', averaged across the five trials in which it produced most, was 4.145 kg ha⁻¹. This estimate demonstrates the high genetic potential of the cultivar and that high yields can be achieved in favorable environments with good cultivation conditions.

ADDITIONAL IMPORTANT AGRONOMIC TRAITS

In terms of the technological and industrial quality traits, the grain color and size of cultivar BRS FS307 are regular and the mean 100-grain weight is 24g, exceeding that of cultivars BRS Marfim (22.8 g) (Del Peloso et al. 2002) and BRS Agreste (21g) (Melo et al. 2008). The mean cooking time of 'BRS FS307' is 43 min and the mean protein percentage 23%, which meets the standard for common bean.

Under artificial inoculation, cultivar BRS FS307 is resistant to common mosaic virus. In field evaluations, it was moderately resistant to anthracnose and fusarium wilt. However, it was susceptible to angular leaf spot, bacterial wilt, common bacterial blight and golden mosaic virus (Table 1).

Cultivar BRS FS307 has a semi-early cycle (75 - 84 days from emergence to physiological maturity). The plants have a semi-upright plant architecture, with indeterminate type II growth habit. Lodging tolerance is intermediate and the plants can be harvested mechanically and directly. The semi-early cycle, semi-upright plant architecture and adaptation to mechanical harvesting are important features for producers, for allowing an easy earlier harvesting, be it by hand or machine. The flowers are purple and the physiologically mature pods yellow. At harvest maturity, the pod color is straw yellow. The grains are mulatto, flat and kidney-shaped, not shiny.

The special features of cv. BRS FS307 are mulatto grain and higher yields than those of cultivars BRS Agreste (Melo et al. 2008) and BRS Marfim (Del Peloso et al. 2002), with superior grain quality and moderate resistance to anthracnose and fusarium wilt, which are regionally important diseases. Due to the longer post-harvest shelf-life than that of the common cultivars of the carioca group, cultivar BRS FS307 can be sold at a higher market price, generating higher income for small producers. The release of cultivar BRS FS307 is expected to expand the share of the mulatto grain group on the Brazilian market, to promote common bean cultivation in the Northeast and also to fulfill the mission of the Brazilian Agricultural Research Corporation (Embrapa), of providing technologies for family farming.

The common bean cultivar BRS FS307 with mulatto grain is recommended for the states of Bahia, Sergipe, Alagoas, Pernambuco, Paraíba, Rio Grande do Norte, Ceará and Piauí. It has a semi-early cycle, high yield potential and commercial grain quality, stable yield and is resistant to anthracnose and fusarium wilt.

SEED PRODUCTION

Cultivar BRS FS307 was registered (No. 38679) by the Ministry of Agriculture, Livestock and Food Supply (MAPA). Embrapa Rice and Beans, Embrapa Coastal Tablelands and Embrapa Secretariat for Innovation and Business are in charge of the basic seed production.

Table 2. Mean seed yield (kg ha⁻¹) of cultivar BRS FS307 at each test location, compared with the mean of the control cultivars BRS Marfim and BRS Agreste in final field trials in the northeast of Brazil

Locations	Year	BRS FS307	Control cultivars		Percentage of the mean yield of the control cultivars (%)
			BRS Marfim	BRS Agreste	
Paripiranga-BA	2013	3.412	3.091	2.795	115.9
Paripiranga-BA	2014	3.367	3.542	2.889	104.7
Paripiranga-BA	2015	3.418	2.992	3.441	106.3
Araripina-PE	2014	854	594	736	128.4
Arco Verde-PE	2013	4.409	3.850	3.375	122.0
Arco Verde-PE	2015	2.823	3.105	2.909	93.9
Belém de São Francisco-PE	2013	1.368	1.340	1.378	100.7
Belém de São Francisco-PE	2014	1.659	1.339	1.324	124.6
Belém de São Francisco-PE	2014	1.602	1.498	1.633	102.3
Belém de São Francisco-PE	2015	2.273	1.710	2.138	118.1
Caruaru-PE	2013	2.532	2.360	2.101	113.5
Caruaru-PE	2014	1.294	1.320	1.104	106.8
Caruaru-PE	2015	2.426	2.141	1.943	118.8
Petrolina-PE	2015	3.091	3.202	3.035	99.1
São João-PE	2014	2.114	1.762	1.105	147.5
São João-PE	2015	2.733	2.462	2.031	121.7
Carira-SE	2013	3.550	3.229	2.304	128.3
Carira-SE	2014	4.154	4.084	3.458	110.2
Carira-SE	2015	4.611	3.507	4.077	121.6
Frei Paulo-SE	2014	3.353	3.431	3.341	99.0
Frei Paulo-SE	2015	4.004	4.038	3.571	105.2
Santana do Ipanema-AL	2015	428	382	350	116.9
Overall mean		2.703	2.499	2.320	113.9

CONCLUSIONS

Common bean cultivar BRS FS307 is recommended for Northeastern Brazil and has a semi-early cycle, high yield potential and good commercial grain quality, yield stability, anthracnose resistance and fusarium wilt resistance.

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