



## BRS FS308: COMMON BEAN CULTIVAR WITH LIGHT RED KIDNEY BEANS, FOR EXPORT

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**Abstract:** BRS FS308 is a common bean cultivar with beans of the light red kidney commercial group for farmers interested in production for export. BRS FS308 has 100-seed weight of 55 grams, semi-early cycle, semi-upright plant architecture, good yield potential (3,001 kg ha<sup>-1</sup>), resistance to anthracnose, and moderate resistance to fusarium wilt. This cultivar is recommended for growing in the Central and South-Central regions of Brazil.

**Keywords:** *Phaseolus vulgaris*, plant breeding, andean origin.

### Introduction

Brazil is one the largest producers and consumers of common bean (*Phaseolus vulgaris* L.) (FAO, 2021), a food that is part of the basic diet of Brazilians. Brazilian common bean production in 2019 was 2.5 million tons (Embrapa Arroz e Feijão, 2021) on 1.7 million hectares, with mean yield of 1,520 kg ha<sup>-1</sup>.

Production and consumption are predominantly of smaller size beans of Mesoamerican origin; the *carioca* commercial group (small beans, elliptical, cream-colored with brown streaks, and 100-seed weight from 25 to 30g) represents approximately 70% of Brazilian production, and the black commercial group (small beans, elliptical, black, and 100-

seed weight from 20 to 25g) represents approximately 15%. However, there is demand for production of other commercial groups that have higher added value and that are also consumed domestically, such as *roxinho* (small beans, rounded, purple, and 100-seed weight from 20 to 25g); *rosinha* (small beans, elliptical, pinkish, and 100-seed weight from 20 to 25g); red (small beans, elliptical, red, and 100-seed weight from 20 to 25g); *mulatinho* (small beans, elliptical, cream-colored, and 100-seed weight from 20 to 25g); *rajado* (medium-sized beans, elongated reniform, cream-colored with reddish streaks, and 100-seed weight from 35 to 45g); and *jalo* (medium-sized beans, elongated reniform, yellowish, and 100-seed weight from 35 to 45g).

In addition, there is the possibility of bean production for export (Pereira et al., 2021). However, the carioca bean type is not consumed in great volume outside of Brazil. This is one of the factors that helps explain the wide variation in common bean prices in Brazil. When there is a production surplus, there is no possibility of exporting large volumes of this surplus, and when Brazilian domestic production declines, large volumes of this commercial group are not available to import. Among the commercial groups of greatest interest internationally are those of Andean origin, such as cranberry (large beans, rounded, cream-colored with reddish streaks, and 100-seed weight from 50 to 65g); sugar bean (large beans, elongated ovoid, cream-colored with reddish streaks, and 100-seed weight from 60 to 70g); white (large beans, elongated cylindrical, shiny white, and 100-seed weight from 46 to 70g); dark red kidney (DRK) (large beans, elongated reniform, dark purple, and 100-seed weight from 50 to 60g); light red kidney (LRK) (large beans, elongated reniform, reddish pink, and 100-seed weight from 50 to 60g); *calima* (large beans, elongated cylindrical, purple with cream-colored streaks, and 100-seed weight from 48 to 50g); and pinto (medium-sized beans, flattened ovoid, cream-colored with brown specks, and 100-seed weight from 35 to 45g).

Each one of these groups is produced and consumed in different regions of the world. The light red kidney group is primarily produced in Argentina, North America, Bolivia, and Belize, predominantly for export, especially to Europe (International Food Trader, 2015). Argentina exports around 13,500 metric tons of beans of this group annually. North America exports around 27,000 metric tons annually of the dark red kidney and light red kidney bean groups. Central America is also a producer and consumer of light red kidney beans.

Historically, beans of Andean origin were not prioritized by Brazilian breeding programs, given the preference for consumption of Mesoamerican beans. Thus, there are few cultivars available for these commercial groups. Recently, some breeding programs have directed

attention to Andean beans, seeking to obtain and identify lines that are better adapted to the edaphic and climatic conditions of Brazil (Gonçalves et al., 2010; Pereira et al., 2014).

In this regard, in recent years, new cultivars with bean commercial types that are consumed outside of Brazil were recommended for growing in Brazil: BRS Embaixador (Aidar et al., 2008a), with DKR beans; BRS Executivo (Aidar et al., 2008b), with sugar beans; BRSMG Realce (Melo et al., 2014), with rajado beans; BRS Ártico (Pereira et al., 2016), with white beans; IAC Nuance (Carbonell et al., 2020), with cranberry beans; IAC Tigre (Carbonel et al., 2020), with pinto beans; and IAC Boreal (Chiorato et al., 2008) and BRS FS305 (Pereira et al., 2021), with calima beans. However, cultivars have not yet been registered for the LRK group in Brazil.

## Breeding methods

BRS FS308 is a line (CF 250007) from the active germplasm bank (banco ativo de germoplasma - BAG) of Embrapa Arroz e Feijão (BGF 16251) with LRK type beans. This line was collected in São José do Norte, RS, Brazil, and was cataloged in BAG in 1973. Thus, the use of this traditional variety is characterized as access to the genetic patrimony with traditional knowledge of unidentifiable origin. The activities of access to the genetic patrimony related to this line were registered with the Ministry of the Environment (register A1EC2EA).

In 2008, a search was made in the active germplasm bank of Embrapa Arroz e Feijão and, by means of germplasm passport information, 200 accessions were identified with bean grain consumed in the foreign market (cranberry, sugar bean, calima, DRK, and LRK). Of these 200 accessions, 33 were identified as having bean grain within the suitable commercial standards. In 2009, these 33 lines were multiplied in the field in Santo Antônio de Goiás, GO, Brazil, and selection was made for grain type, resulting in the selection of 13 lines. Individual plants were obtained, which were later multiplied to obtain a larger volume of seeds.

From 2010 to 2014, the CF 250007 line was evaluated in Goiás, Distrito Federal, Minas Gerais, Espírito Santo, and Mato Grosso in the winter crop season, and in Paraná, Santa Catarina, and São Paulo in the rainy and dry crop seasons, for a total of 29 evaluation environments. The experiments were initially composed of 13 lines with LRK, DRK, sugar bean, and calima type bean grains and three check cultivars: BRS Embaixador (DRK), BRS Executivo (sugar bean), and BRS Radiante (rajado). After that, CF 250007 was once more evaluated in a new VCU trial formed by five lines selected in the previous step and five check cultivars: BRS Embaixador (DRK), BRS Executivo (sugar bean), BRS FS305 (calima), BRS Ártico (white), and IPR Garça (white). The experiments were conducted in 2015 and 2016 in the same states and seasons cited above, for a total of 27 other environments. A randomized block experimental design was used, with three replications and plots consisting of four 4-m rows, using the technological management practices recommended for the different environments and growing systems.

This line was extensively evaluated in the VCU trials through the following traits: grain yield, 100-seed weight, cooking time, and protein concentration. In addition, the following traits were evaluated using a scoring scale from 1 (totally favorable phenotype) to 9 (totally unfavorable phenotype) (Melo, 2009): plant architecture, resistance to lodging, and reaction to diseases – common bacterial blight (*Xanthomonas axonopodis* pv. *phaseoli*), bacterial wilt (*Curto bacterium flaccumfaciens* pv. *flaccumfaciens*), angular leaf spot (*Pseudocercospora griseola*), anthracnose (*Colletotrichum lindemutianum*), powdery mildew (*Erysiphe polygoni*), fusarium wilt (*Fusarium oxysporum* f. sp. *phaseoli*), and bean golden mosaic (BGMV).

Grain yield was measured in kg ha and corrected to 13% grain moisture. A 100-seed sample was removed for weighing to obtain the 100-seed weight of each plot. In some experiments, samples were removed to perform analyses of cooking time and protein percent. For

cooking time, the beans were soaked in distilled water at the proportion of 1:4 (w/v) at ambient temperature. After 16 hours, the water was eliminated and the beans were placed in a Mattson cooker. Cooking time was determined from the time the water boiled to the time at which the rods of the Mattson cooker penetrated 50%+1 bean grain. Protein concentration was analyzed using bean grain meal (beans ground in a ball mill), determining nitrogen content by the micro-Kjeldahl method.

### Grain yield and yield potential

Of the 56 experiments set up, 29 were harvested and achieved the standards of experimental quality necessary to be considered in the cultivar registration process in relation to yield data. These 29 VCU experiments were conducted from 2010 to 2016 in two of the regions for recommendation of common bean cultivars (Pereira et al., 2009): Region I (South-Central) (Paraná, Santa Catarina, and São Paulo) in the rainy and dry seasons, and in Region II (Central) (Goiás, Distrito Federal, Mato Grosso, Espírito Santo, and Minas Gerais) in the winter season. In these trials, the cultivar BRS FS308 had mean yield of 2006 kg ha<sup>-1</sup>, similar to that of BRS Embaixador and 16% superior to that of BRS Executivo (Table 1). Considering each one of the regions, BRS FS308 had higher yield in Region I, with 22% superiority to BRS Embaixador and 39% superiority to BRS Executivo. In Region II, BRS FS308 had yield 12% lower than BRS Embaixador and 9% higher than BRS Executivo.

The yield potential of BRS FS308, obtained from the mean of the five experiments in which this cultivar had the highest yields, was 3,001 kg ha<sup>-1</sup>. This estimate shows that the cultivar has high genetic potential and that if the environment is favorable and there are good growing conditions, high yields can be achieved.

### Other traits

In relation to the grain technological and industrial quality traits, the cultivar BRS FS308 has a mean 100-seed weight of 55 grams, similar to that of BRS Embaixador and lower than that of BRS Executivo (Table 2). The beans are of the

LRK type, with a long oblong reniform shape and intermediate shine. Mean cooking time of BRS FS308 is 32 minutes, similar to that of the check cultivars. The mean grain protein percentage of BRS FS308 was similar (22%) to that of BRS Executivo, and higher than that of BRS Embaixador.

In the field experiments, BRS FS308 proved to be resistant to anthracnose, moderately resistant to fusarium wilt, and moderately susceptible to powdery mildew (Table 3). However, it proved to be susceptible to bean golden mosaic virus, common bacterial blight,

angular leaf spot, root rots, and bacterial wilt.

BRS FS308 has a semi-early cycle (from 75 to 84 days, from emergence to physiological maturity), similar to that of the cultivar BRS Embaixador. The plants are shrublike, with a determinate growth habit. BRS FS308 has a semi-upright plant architecture, with shorter plants than those of BRS Embaixador; it has good resistance to lodging and is adapted to mechanical harvest, including direct harvest. Flowers are white, and at physiological maturity and at harvest, the pods are yellowish, with purple streaks.

**Table 1.** Grain yield of BRS FS308 compared to that of the check cultivars BRS Embaixador and BRS Executivo in the Value for Cultivation and Use trials by region of recommendation and sowing season, in 2010 to 2016.

Region	Season	BRS FS308 (kg ha <sup>-1</sup> )	BRS Embaixador (kg ha <sup>-1</sup> )	BRS Executivo (kg ha <sup>-1</sup> )	Number of environments
I	Rainy	1,684a	1,069b	1,201b	05
	Dry	1,415a	1,482a	1,024b	05
	Overall	1,550a	1,276b	1,113b	10
II	Winter	2,225b	2,517a	2,045c	19
<b>Overall</b>	-	<b>2,006a</b>	<b>2,120a</b>	<b>1,727b</b>	<b>29</b>

Region I - RS, SC, PR, MS, and SP; Region II - MG, ES, RJ, GO, DF, MT, TO, BA, and MA. Mean scores followed by the same letter in the rows do not differ statistically from each other according to the Scott-Knott method at 5% probability.

**Table 2.** Traits of the beans of the common bean cultivar BRS FS308 compared to those of the check cultivars BRS Embaixador and BRS Executivo.

Cultivar	CT (minutes)	PC (%)	100SW (g)
<b>BRS FS308</b>	32	21.8	<b>55</b>
<b>BRS Embaixador</b>	32	16.8	<b>56</b>
<b>BRS Executivo</b>	34	21.4	<b>65</b>

CT - cooking time; PC - protein concentration; 100SW - 100-seed weight.

**Table 3.** Agronomic traits and reaction to diseases of the cultivar BRS FS308 compared to the check cultivars BRS Embaixador and BRS Executivo.

Cultivar	Cycle	ARQ	AN	CBB	ALS	CM	GM	FOP	RR	BW	PM
<b>BRS FS308</b>	SE	Semi-upright	R	S	S	NA	S	MR	S	MS	MS
<b>BRS Embaixador</b>	SE	Upright	R	S	S	S	S	MR	S	S	S
<b>BRS Executivo</b>	N	Semi-upright	MS	S	S	S	S	MR	S	MS	MR

N- Normal; SE - semi-early; ARQ - plant architecture; AN - Anthracnose; CBB - common bacterial blight; ALS - angular leaf spot; CM - common mosaic; GM - golden mosaic; FOP - fusarium wilt; RR - root rots; BW - bacterial wilt; PM - powdery mildew; R - resistant; MR - moderately resistant; MS - moderately susceptible; S - susceptible; NA - information not available.

## Seed production

BRS FS308 was registered on 5 Aug. 2019 under number 41058 with the Brazilian Ministry of Agriculture (Ministério da Agricultura,

Pecuária e Abastecimento - MAPA). Production of basic seeds for availability to seed producers will be under the responsibility of Embrapa and of partners selected through public notices for technical cooperation.

## Conclusions

BRS FS308 is prominent for its semi-early cycle and LRK type bean grain. In addition, it is resistant to anthracnose and moderately resistant to fusarium wilt. Based on its performance, BRS FS308 was registered for Region I (Paraná, Santa Catarina, São Paulo, Rio Grande do Sul, and Mato Grosso do Sul) for the rainy and dry crop seasons, and for Region II (Goiás, Distrito Federal, Mato Grosso, Tocantins, Maranhão, Bahia, Espírito Santo, Rio de Janeiro, and Minas Gerais) for the winter crop season.

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