CROP BREEDING AND APPLIED BIOTECHNOLOGY

CULTIVAR RELEASE

BRS A705: an early-cycle, lodging-resistant irrigated rice cultivar with high yield

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Abstract: *BRS A705 is an early-maturing cultivar developed by Embrapa, recommended for irrigated cultivation. The plants have high tillering and moderate resistance to the main diseases. This cultivar has short stature, which confers a greater tolerance to lodging. It presents high yield and long and fine grains of excellent quality.*

Keywords: Oryza sativa *L., genetic breeding, grain quality*

INTRODUCTION

The development of low height irrigated rice genotypes is one of the greatest successes in the modern history of genetic breeding. Genotype IR-8, launched in 1966 by IRRI, was the precursor genotype that revolutionized world agriculture. This is because it presented a new plant architecture, having agronomic characteristics such as low height, high tillering, response to nitrogen fertilization without problems of plant lodging, and mainly high grain yield (Magalhães Jr. and Oliveira 2008). Genetic breedingin recent decades has provided significant increases in rice yield potential (Streck et al. 2018). However, the increase in yield, especially in early genotypes, requires greater attention in the search for a plant structure able to support the weight of this greater number of grains without plant lodging. Breeding programs have benefited from knowledge arising from related areas of science for the generation and selection of superior plants (Brito et al. 2021). This knowledge includes the observation of morphological characteristics such as leaf length, tillering capacity, length and number of roots; micromorphological characteristics such as stomatal density, stomatal opening width, leaf nerve density, and interneural distance; anatomical characteristics such as xylem and phloem caliber, aerenchyma and sclerenchy maformations; and finally physiological traits such as photosynthesis and transpiration rates, stomatal conductance, water use efficiency (Sharma et al. 2013), among others.

The Embrapa Genetic Rice Breeding Program has the challenge of developing cultivars that are highly adaptable and stable to the different environments in

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which they grow, and that simultaneously express high grain yield associated with adequate agronomic and industrial characteristics. Cultivar BRS A705 was developed with this objective, associating precocity, high yield, and lodging resistance.

PEDIGREE AND BREEDING METHOD

BRS A705 was developed from a simple cross, by artificial hybridization, involving inbreed lines BRA01016 (female parent) and CNAi10393 (male parent), carried out by Embrapa in 2004. Inbreed line BRA01016 (also coded as TF 390) comes from the Embrapa rice breeding program for tolerance to low temperatures, developed from a simple crossing

Table 1. Plant and grain traits of the new irrigated rice cultivar BRS A705 in comparation to cultivar BRS Pampa CL

Traits	**Cultivar**	
Plants*	**BRS A705**	**BRS Pampa CL**
Plant type	modern	modern
Initial vigor	early	early
Cycle (days from emergence to 50% flowering)	89	87
Maturation	120	118
Plant height (cm)	85	95
Stem length (cm)	65	75
Panicle length (cm)	24	23
Panicle exsertion	average	average
Leaf color	green	green
Flag leaf angle	erect	erect
Panicle type	intermediate	intermediate
Hairiness	present	present
Degraining	intermediate	intermediate
Lodging	resistant	moderately resistant
Tillering	high	high
Indirect iron toxicity	moderately resistant	moderately resistant
Leaf blast	moderately resistant	moderately resistant
Panicle blast	moderately resistant	moderately resistant
Grain staining	moderately resistant	moderately resistant
Herbicide resistance	susceptible	resistant
Grains *		
Class	long and thin	long and thin
Awn	absent	absent
Color of glumes	straw	straw
Color of the apiculus	white	white
Hairiness	present	present
Length with shell (mm)	9.61	9.80
Polished length (mm)	7.20	7.16
Width with shell	2.35	2.19
Polished width (mm)	2.17	2.00
Thickness with shell	2.04	1.95
Polished thickness(mm)	1.86	1.74
Polished length/width ratio (mm)	3.32	3.58
Thousand grain weight (g)	27.6	25.1
Total productivity (%)	70.5	68
Whole grains (%)	62.3	62
Amylose	high	high
Gelatinization temperature	low	low
Yield (t ha^{-1})**	10	10.2

* Susceptible to change depending on the characteristics of the environment in which it grows. ** Grains with husk and 13% moisture as observed in experiments conducted by Embrapa.

between the Chilean cultivar Diamante (source of tolerance) and line TF 375. Inbreed line CNAi10393 comes from *in vitro* somaclonal variation with the Colombian cultivar Metica 1 (source of blast resistance and modern plant architecture). Figure 1 shows the genealogy of cultivar BRS A705.

This cross was identified with code CNAx12967 and F1 seeds were multiplied in a screened nursery, in the second semester of 2004. The F2 generation was sown in Selection Nursery 1, in the 2005/06 season, for selection of individual plants within the segregating population. Moreover, F2:3 families were evaluated and selected in the Family Observation Test (EOF, in Portuguese), in the 2006/07 crop season. In the 2007/08 crop season, F2:4 families advanced in EOF bulk were evaluated in the Family Yield Test (ERF) in two locations: Alegrete and Capão do Leão, both in Rio Grande do Sul State (RS), Brazil. Based on the results of the joint analysis of these tests, family CNAx12967-B-2-B showed promise in terms of grain yield, precocity, lodging tolerance, disease resistance, and grain quality.

Within this F2:5 family, advanced in ERF bulk, nine individual plants were selected in the Selection Nursery 2 conducted in the 2008/09 season. The nine F5:6 inbreed lines were evaluated in the Line Observation Test (EOL), in the 2009/10

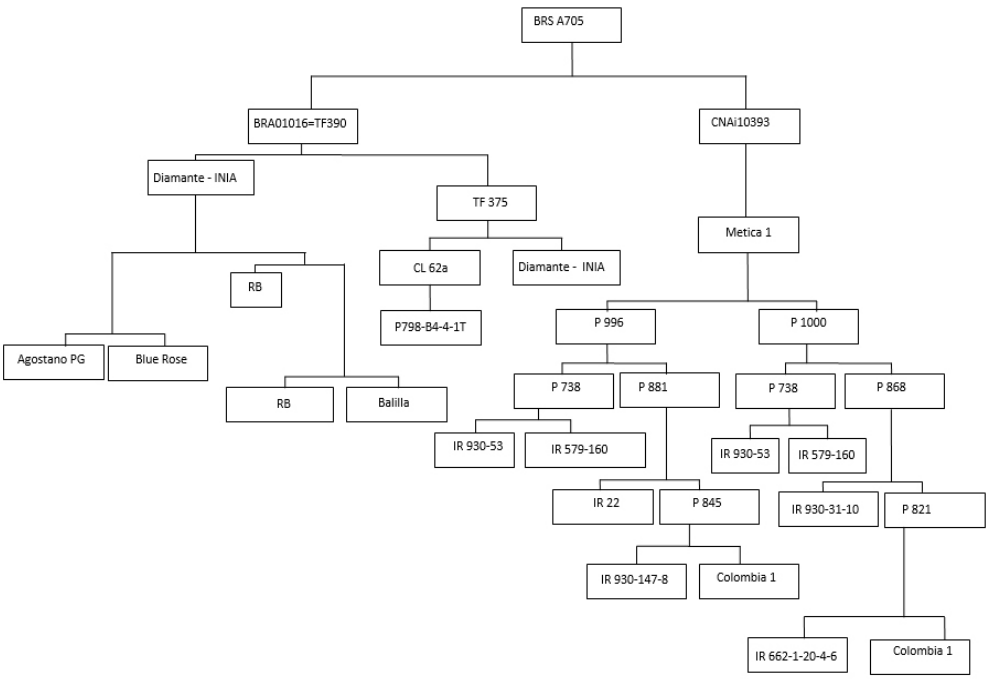

Figure 1. Genealogy of the irrigated rice cultivar BRS A705.

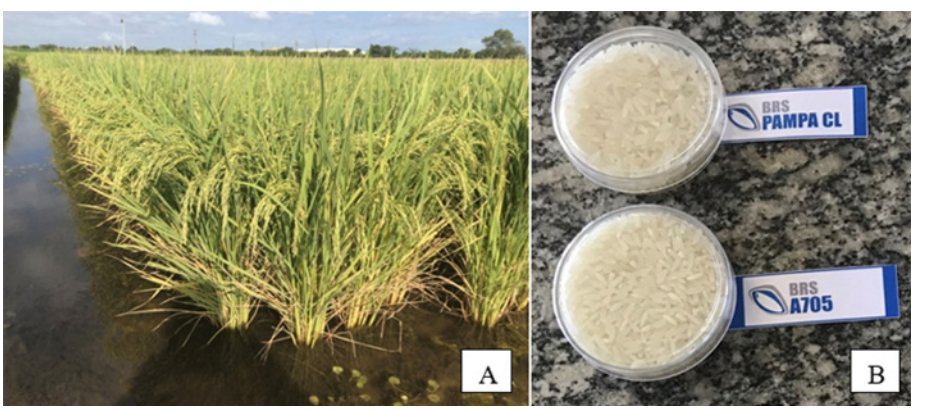

Figure 2. Image of BRS A705 cultivar plants in a seed production crop (A) and the grains compared with BRS Pampa CL (premium quality rice) (B).

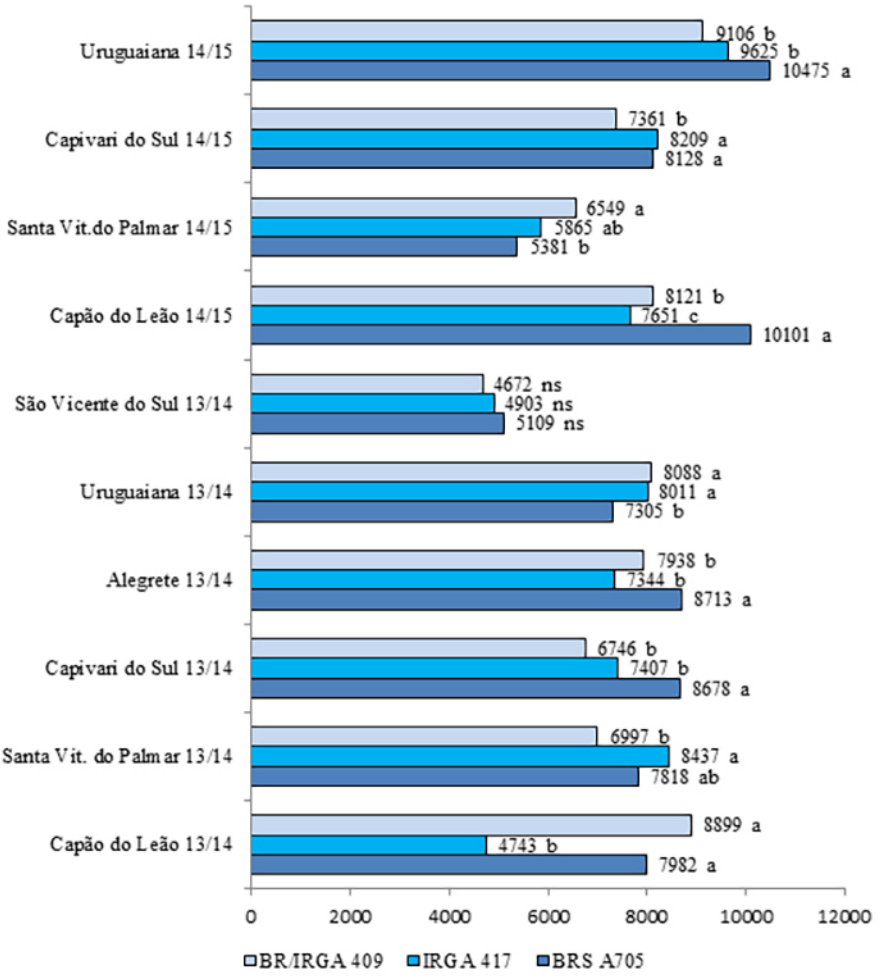

Figure 3. Yield of cultivar BRS A705 in Value of Cultivation and Use (VCU) experiments in relation to the control cultivars in the different rice growing regions of Rio Grande do Sul State. Anova performed separately per crop season; cultivars within each location compared by lsmeans (at p=0.05) in SAS statistical software.

season. Of these, CNAx12967-B-2-B-B-8 stood out, which was coded as AB10501 and included in the Preliminary Trials (EP) of the two subsequent crop seasons (2010/11 and 2011/12), in two locations: Alegrete and Capão do Leão. In the 2012/13 season, inbreed line AB10501 participated in the Regional Trials (ER) conducted in four locations in Rio Grande do Sul State (Alegrete, Capão do Leão, Santa Vitória do Palmar, and Uruguaiana).

In 2013/14 and 2014/15, inbreed line AB10501 was evaluated in Cultivation and Use Value (VCU) trials in Rio Grande do Sul State (Alegrete, Capão do Leão, Capivari do Sul, Santa Vitória do Palmar, São Vicente do Sul, and Uruguaiana). In this step, controls BR-IRGA 409 and IRGA 417 stood out in terms of grain yield. In subsequent crop seasons, the line participated in several observation units in RS, including demonstrative units and experimental crops, where it was tested both in the direct sowing system in dry soil and in a pre-germinated system.

PERFORMANCE CHARACTERISTICS

Table 1 shows the main characteristics of cultivar BRS A705 in relation to cultivar BRS Pampa CL (Magalhães Júnior et al. 2022). Cultivar BRS A705 shows agronomic patterns similar to those of cultivar BRS Pampa CL in terms of maturation cycle and disease reaction. The first presents excellent culinary and industrial quality of grains. Moreover, the high percentage of whole grains and the low percentage of total plastered area stand out. Their main difference is in plant

height, which makes cultivar BRS A705more tolerant to lodging. From the management point of view, it is noteworthy that cultivar BRS A705 is not resistant to imidazolinone herbicides, which are total herbicides. Therefore, selective herbicides normally registered for rice in cultivar BRS A 705 must be used.

Cultivar BRS A705 is a nearly maturing cultivar, with a cycle in Rio Grande do Sul State of around 120 days from emergence to grain maturation, which may vary according to different management conditions and cultivation environments. The plants are of the modern type, with hairy leaves and an erect flag leaf (Figure 2). It differs from the other cultivars due to its smaller plant height, being 5 to 10 centimeters shorter than several commercial cultivars, which confers greater tolerance to lodging. It has long and fine grains with a light hairy skin, without the presence of awns. Whole grain yield after processing is above 62%, and 1000 grains weight is 27.6 g (Figure 2). Regarding culinary standards, it has excellent quality, with a high apparent amylose content and low gelatinization temperature, providing soft and loose grains after cooking.

Cultivar BRS A705 was also evaluated for blast resistance at the Brazilian National Blast Nursery (VNB). The tests were conducted by a network of phytopathologists who are part of public rice breeding teams in Brazil. The maximum score received, on a scale of 0 to 9 (highest incidence), was 5, allowing the cultivar to be classified as moderately resistant to blast.

Regarding abiotic stresses, BRS A705 participated in the assessment of tolerance to iron toxicity conducted at the Terras Baixas Experimental Station of Embrapa Temperate Climate. The cultivar obtained an intermediate score (5) and was thus classified as moderately tolerant.

Figure 3 shows the yield of cultivar BRS A705 in the various environments where it was tested. The cultivar shows high yield when well-managed (above 10 tons per hectare). These results come from statistical analysis (ANOVA and Tukey Test), which demonstrate the reliability of results with a CV of 18.16%. The good results of the 2014/15 season in the cities of Capão do Leão and Uruguaiana stand out, in which cultivar BRS A705 reached an average yield of 10,101 kg ha^{-1} and 10,475 kg ha^{-1}, respectively.

BASIC SEED PRODUCTION

The irrigated rice cultivar BRS A705 can be used for cultivation in Rio Grande do Sul State, Brazil. Such cultivation can also extend to the states of Maranhão, Roraima, Tocantins, and Goiás, where the cultivar has shown tolerance to lodging even under high levels of nitrogen fertilization. The cultivar has high yield potential, with industrial and culinary quality of grains that meet the standards of the Brazilian market. It is registered with the Ministry of Agriculture and Supply (MAPA) under number 43669 of 05/19/2020 and definitive variety protection certificate number 20200199 of 04/06/2020. The cultivar is also characterized in detail for its positioning in the market, with seeds of genetic purity available. The 2022/23 crop will be the first commercial crop with seeds made available to grain producers.

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