

## BRS A701 CL: a new irrigated rice cultivar adapted to the clearfield® production system

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**Abstract:** A partnership program of Embrapa and BASF resulted in the development of a new irrigated rice cultivar adapted to the Clearfield® production system in Rio Grande do Sul. The cultivar is tolerant to the imidazolinone herbicide kifix®. In field trials in Rio Grande do Sul it produced a mean yield of 8394 kg ha<sup>-1</sup>.

**Key words:** *Oryza sativa* L., herbicide tolerant, grain yield, genetic improvement.

### INTRODUCTION

The presence of weeds in commercial rice fields, particularly that of weedy rice, limits grain yield and reduces the grain quality of the crop. This is a critical problem in Rio Grande do Sul, which accounts for 70% of the rice produced in Brazil (CONAB 2017). Since weedy rice and cultivated rice belong to the same species and are consequently physiologically very similar, the control of weedy rice on commercial fields is a great challenge in Brazil and other parts of the world (Rangel et al. 2010). The development of rice cultivars with tolerance to a broad herbicide spectrum is considered a strategy of great benefit to irrigated rice production in the country.

Based on the use of imidazolinone tolerant cultivars, the Clearfield (CL) Production System was introduced in Rio Grande do Sul during the 2003/2004 crop season. This system increased the efficiency of weed control and spontaneous weed rice growth in commercial fields. Nowadays, CL cultivars are planted on approximately 70% of the rice area in Rio Grande do Sul.

The objective of this study was to describe the methods used to obtain the new cultivar BRS A701 CL and its morphological and agronomic traits. This CL cultivar was the result of a scientific collaboration between Embrapa and BASF and is recommended for cultivation using the Clearfield Production System in Rio Grande do Sul.

### BREEDING METHOD

BRS A701 CL was derived from a backcross program based on a cross between the cultivars BRS 7 Taim (recurrent parent) and Cypress CL (donor parent). Cypress CL is a source of tolerance to herbicides of the imidazolinone group. The objective was to combine the desirable agronomic traits of BRS 7 Taim with

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broad-spectrum imidazolinone tolerance, expressed in Cypress CL. The backcross program was developed by Embrapa, in partnership with Basf, based on the methodology described by Rangel et al. (2010). The first cross was followed by three backcrosses (BC<sub>3</sub>) under controlled conditions in a greenhouse. In each segregating generation, seeds were sown in plastic trays and the seedlings sprayed with imidazolinone herbicide 20 days after germination. The herbicide solution consisted of 180 g ha<sup>-1</sup> kifix® herbicide, mixed with 0.5% v/v of the surfactant dash® (mineral oil). Herbicide-tolerant plants were selected 10 days after spraying, transplanted to pots and individually crossed with the recurrent parent at flowering. Progeny tests of herbicide-tolerant BC<sub>3</sub>F<sub>3</sub> plants were applied to identify lines homozygous for the tolerance allele.

Nine CL lines were selected and evaluated for herbicide tolerance and agronomic traits in the field during the 2008/2009 growing season in Goianira, GO. The field trial confirmed tolerance to kifix® and potential use in the Clearfield Production System of all nine CL lines. Field trials to assess the Value for Cultivation and Use (VCU trials) were performed in Rio Grande do Sul during the 2010/11 and 2011/12 growing seasons. Agronomic and grain quality traits were evaluated according to Pinheiro et al. (2009). These trials included nine CL lines and two check cultivars (BRS Pelota and BRS 7 Taim), of which the latter is also a parent cultivar. The analysis of herbicide tolerance and agronomic traits showed that the CL line AB10125 performed best, which was released for commercial use as BRS A701 CL. This new cultivar has several improved traits, including high yield, high grain quality and tolerance to the imidazolinone herbicides.

## PERFORMANCE CHARACTERISTICS

The mean yield of BRS A701 CL was 8394 kg ha<sup>-1</sup> in Rio Grande do Sul, not significantly different from the check cultivars BRS 7 Taim (8232 kg ha<sup>-1</sup>) and BRS Pelota (8108 kg ha<sup>-1</sup>) (Table 1). Cultivar BRS A701 CL has a median cycle (median anthesis = 89 days), similar to both check lines, while plant height (86 cm) is statistically different from BRS Pelota (91 cm), but similar to BRS 7 Taim (85 cm). The new cultivar is also tolerant to lodging (score= 3.0, mean of different locations and years) (Table 1). BRS A701 CL has a modern plant type, erect and glabrous leaves, a high number of tillers per plant, and strong and vigorous stems.

The grain cooking and industrial quality are important traits for the acceptability of a new cultivar. With regard to the standards of the rice industry, BRS A701 CL produces a mean of 72% of total milled grains and 67% of whole milled grains, which is considered very good in Rio Grande do Sul (Table 2). The grains are visually attractive and vitreous, and have a low percentage of chalky grains (2.37%) and good cooking quality traits (Table 2).

In relation to rice diseases (Table 2), BRS A701 CL proved resistant to leaf scald (*Monographella albescens*) and grain spot (caused by a complex of pathogens), and moderately

**Table 1.** Mean grain yield (YLD), mean number of days to flower (FLO), mean plant height (HT) and lodging score (LO) of the new cultivar BRS A701 CL and checks (BRS 7 Taim and BRS Pelota) during agronomic trials of Value for Cultivation and Use (VCU) in the 2010/2011 and 2011/2012 growing seasons, in Rio Grande do Sul

Cultivar	YLD <sup>1</sup> (kg ha <sup>-1</sup> )	FLO (days)	HGT (cm)	LOD <sup>2</sup> (1-9)
BRS A701 CL	8394 ab	89 ab	86 a	3
BRS 7 Taim	8232 a	91 a	85 a	1
BRS Pelota	8108 b	88 b	91 b	2
Mean	8080	90	89	
CV (%)	14.71	1.68	4.19	

<sup>1</sup> Data from eight trials, four in 2010/2011 and four in 2011/2012; <sup>2</sup> Lodging on a 1 to 9 score scale: 1 indicates absence of lodging, 9 completely lodged plants (Pinheiro et al. 2009). Means followed by the same letter are not significantly different at 5% probability by Dunnett's Test.

**Table 2.** Estimates of whole milled grain percentage (MQ), shattered grain (SG), total milled grain percentage (TG), chalkiness (GC), resistance to leaf scald (LSC), brown spot (BS) and grain spot (GS) of the new cultivar BRS A701 CL and checks (BRS 7 Taim and BRS Pelota) during agronomic trials of Value for Cultivation and Use (VCU) in the 2010/2011 and 2011/2012 growing seasons, in Rio Grande do Sul

Cultivar	MQ (%)	SG (%)	TG (%)	GC (%)	LSC <sup>1</sup>	BS <sup>1</sup>	GS <sup>1</sup>
BRS A701 CL	67.02	4.48	71.50	2.37	2	4	3
BRS 7 Taim	65.65	6.34	71.99	2.92	3	3	3
BRS Pelota	63.38	7.27	70.65	2.65	3	2	2

<sup>1</sup> Disease resistance on a 1 to 9 score scale: 1 indicates absence of symptoms, 9 indicates plants with symptoms on more than 50% of the leaf area (Pinheiro et al. 2009).

**Table 3.** Main morphological descriptors of rice cultivar BRS A701 CL, based on field evaluations in Goianira, GO, during the 2011/2012 and 2012/2013 growing seasons

Descriptor	Phenotype
Leaf color	Green
Angle of flag leaf	Erect
Leaf pubescence	Absent (glabrous leaves)
Leaf: auricle color	Light green
Leaf: ligule color	Absent to green
Stem length	Short (65 cm)
Panicle length	Median (21 cm)
Presence of awn	Absent or very short
Spiklets: glume color	Beige/Golden
Spiklets: apiculus	Yellow
Dehulled grain length	Long (7.08 mm)
1000-grain weight	24.1 to 25.5 g

resistant to brown spot disease (*Bipolaris oryzae*).

During the two-year agronomic trials of Value for Cultivation and Use (VCU), cultivar BRS A701 CL was approved for release in tests of distinctness, homogeneity, and stability (DHS), established by the Brazilian Ministry of Agriculture, Livestock and Supply (MAPA), to be registered and protected as a new cultivar. Some traits measured in the DHS trials are listed in Table 3.

The estimate of the similarity coefficient between BRS A701 CL and the recurrent parent BRS 7 Taim was 0.97 (Band coefficient; Lynch 1990). This estimate was based on DNA polymorphism analysis of 4,200 SNP markers using the Illumina DNA Biochip OSBR Embrapa, Brazil.

## SEED PRODUCTION

BRS A701 CL is registered in the National Register of Cultivars (RNC – MAPA), registry number 34.460 (RNC – MAPA). Foundation seed is produced by Embrapa Produtos e Mercado, in Capão do Leão/RS, in partnership with BASF. Genetically pure breeder seed was obtained based on DNA analysis. Total DNA from 100 BC<sub>3</sub>F<sub>4</sub> herbicide-tolerant progenies of line AB10125 and the recurrent parent (BRS 7 Taim) was extracted and all lines were genotyped with 4,200 SNP markers using the Illumina DNA Biochip OSBR, Embrapa, Brazil. The plants with the highest background recovery of the recurrent parent were selected for selfing and seed production. Seeds of 15 families with similarity to BRS 7 Taim exceeding 0.97 were harvested separately.

Seeds of these families were sown in plastic trays and the seedlings transplanted to the field for rigorous morphological and developmental inspection. Eleven families had very high uniformity and very similar SNP marker fingerprint. Seeds of these 11 families were harvested individually and approximately 2.0 kg of high quality seed (breeder seed) was obtained per family. A seed bulk of the 11 families was used to obtain breeder seed, underlying foundation seed production.

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