CROP BREEDING AND APPLIED BIOTECHNOLOGY

CULTIVAR RELEASE

BRS Pampeira: new irrigated rice cultivar with high yield potential

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Abstract: *BRS Pampeira is a rice cultivar developed by Embrapa, recommended for irrigated cultivation in Brazil. It shows modern architecture, with high tillering and tolerance to lodging. It stands out for its high yield potential, medium cycle and good grain quality.*

Key words*: Oryza sativa L., productivity, plant breeding.*

INTRODUCTION

Rice (*Oryza sativa* L.) is the basis of the diet and the main source of proteins and carbohydrates for more than half the world's population, its relative importance is even more evident in poor and developing countries (Lee et al. 2011).

Currently, the increase in yield is a major challenge for the genetic breeding of irrigated rice, because, in addition to the difficulties arising from the complexity of this trait, the improvement must meet the industrial and culinary standards on the Brazilian market. Thus, the global food security will continue to depend on the ability to sustain high production yields (Zeigler and Barclay 2008).

Embrapa's Irrigated Rice Breeding Program has the challenge to develop cultivars that have a high stability and adaptability to the different environments in which they were grown and that express high yield, associated with the appropriate agronomical and industrial characteristics.

In this sense, the rice cultivar BRS Pampeira was developed to meet a gap of medium maturity cultivars, with grain quality and high yield potential. Therefore, the goal is to present and agronomically describe the irrigated rice cultivar BRS Pampeira developed by Embrapa, recommended for cultivation under flood irrigation, initially for the state of Rio Grande do Sul, but with the perspective of adoption also throughout the Brazilian tropical region.

PEDIGREE AND BREEDING METHOD

The cultivar BRS Pampeira was originated through a cross single, having as female parent the cultivarIR-22, introduced from the International Rice Research Institute (IRRI), and, as male parent, the CNA 8502 line. The aim was to gather in this new cultivar good agronomical traits, such as better blast resistance,

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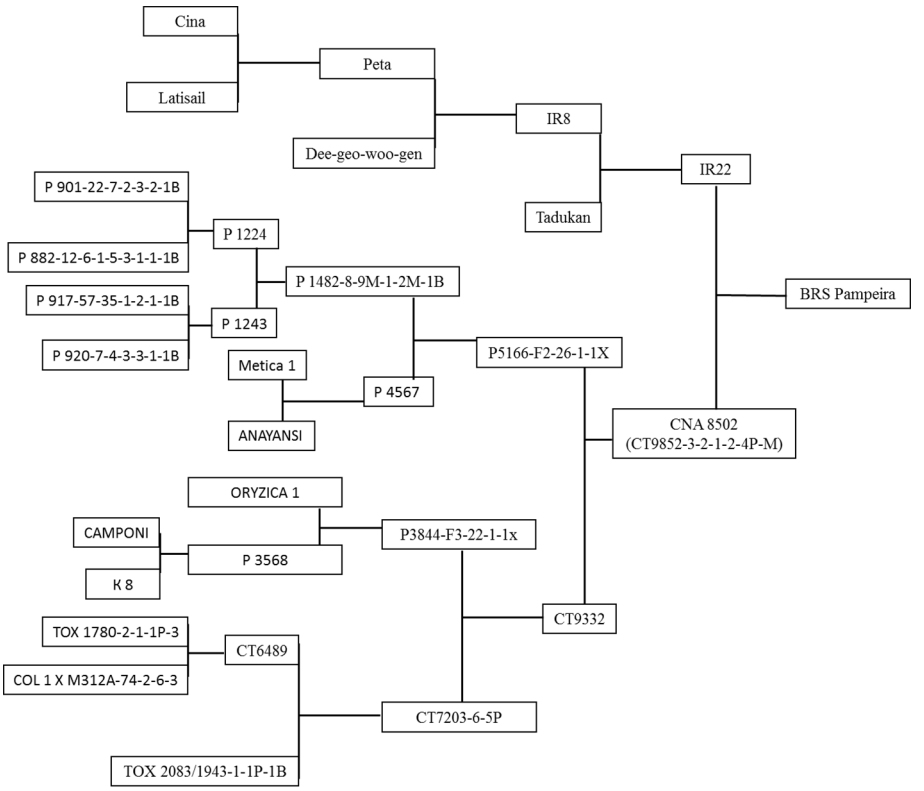

Figure 1. Genealogy of the irrigated rice cultivar BRS Pampeira.

hardiness, yield potential and grain quality (Figure 1).

In 2000, the cross between these parents was done, and it progenies were coded by the breeding program as CNAx8133. In the first half of 2001, in Goianira, in the state of Goiás (GO), after the multiplication of F_1 seeds, the F_2 generation was sown in the nursery 1 (SN1) for the selection of individual plants, resulting in the F_3 progenies. These progenies, in the 2001/2002 crop season, were evaluated in the Test of Observation of Families (EOF) in the city of Goianira. The progenies selected in this experiment ($F_{2:4}$) were re-evaluated in 2002/2003, in the Tropical Families Yield Test (ERFT) in the counties of Goianira (GO), Formoso do Araguaia (TO) and Boa Vista (RR).

In the pooled analysis of these trials, it was possible to identify the CNAx8133-B-4-B-B family, originated from the fourth plant selected in the 2001 field trial, producing in average 6,594 kg ha^{-1}, and considered to be promising with respect to the other features. This family was used as a source of lines in the VS2, in the year 2003/2004, when 15 plants were selected from its scope.

In Goianira, in the 2004/2005 growing season, its progenies ($F_{5:6}$) were evaluated in the Lines Assessment Test (EOL), where the line derived from the first selected plant in the former family stood up. So, in the following year, it was included in the preliminary test of irrigated rice yield in the tropical region (EPT), with the identification BRA051108. In this trial, its yield was similar to that of Metica 1, until then one of the most productive tropical cultivars, and presented low temperature of grain gelatinization, similar to the IR-22, one of the desired targets during the selection process.

The BRA051108 line, in the 2006/2007 crop season, was part of the Tropical Yield Regional Tests (ERT), held in five locations in the tropical region of Brazil (Formoso do Araguaia – Tocantins, Belém – Pará, Bragança – Pará, Salvaterra – Pará, Cantá – Roraima). In these field trials, the BRA051108 line showed good agronomic performance and yield.

In the crop seasons from 2007/2008 to 2012/2013, the BRA051108 was included on tests required by the Ministry of Agriculture, Livestock and Supply (MAPA) for the release of new cultivars, i.e., the tests of Value of Cultivation and Use

(VCU). These were conducted in all the irrigated rice-producing regions of Brazil. In the joint analysis of the VCU tests, the BRA051108 line reached higher yields than the controls BR IRGA 409, BRS 7 Taim and BRS Tropical. The BRA051108 has good quality grain, tolerance to lodging and to the major diseases of the culture (rice blast, leaf scald), in addition to high genetic potential for productivity. Thus, it is an excellent the new cultivar to be release and recommended for cultivation in the different rice-producing regions in Brazil.

PERFORMANCE CHARACTERISTICS

The cultivar BRS Pampeira has biological cycle around 133 days, from emergence to maturity in the Rio Grande do Sul state, being classified as medium cycle. The plants have modern-Philippine height, with hairy leaves and erect leaf flags. The average plant height is 91.5 cm, which can vary depending on the cultural management and the environmental conditions found in other states of Brazil. This cultivar has high tillering, strong stems and resistance to plant lodging (Table 1).

The grains are long and thin, vitreous, with low incidence of white center, the average 1000-grain weight being around 27 g. The hulls of the grains have straw yellow color is hairy and has no awns. The average panicle length is 23.9 cm. The industrial yield of grains, under normal conditions of environment and crop management, is higher than 62% whole polished grains, with a total yield of 68% (Table 2).

It has excellent cooking attributes compared to the best cultivars highlighted by the industry. In indirect tests of cooking quality, the grain has amylose content (AC) ranked as high and low gelatinization temperature (GT), as expected for a cultivar with good characteristics of cooking, giving loose and soft pattern after baking. These attributes found follow the line of the cultivar release obtained by Schiocchet et al. (2015), being a standard currently sought by irrigated rice breeding in Brazil.

As for the response to biotic stresses, BRS Pampeira shows a reaction ranging from intermediate to moderately resistant to rice blast (*Pyricularia grisea*) in the leaf and in the panicle. The level of resistance refers to what was observed in the

Table 1. Comparison of plant traits between the irrigated rice cultivars BRS Pampeira and BRS Pampa

Characteristics	Cultivars	
	BRS Pampeira	BRS Pampa
Plant type	modern	modern
Days to flowering*	103	88
Days to maturity**	133 (medium)	118 (precocious)
Plant height (cm)**	91.5	96
Culm length (cm)**	67.6	72
Panicle length (cm)**	23.9	24
Panicle exsertion*	medium	medium
Leaf colour	dark green	green
Flag leaf angle	erect	erect
Auricle colour	light green	light green
Ligule colour	colorless	colorless
Culm internode color	light green	light green
Anthocyanin colouration on the culms	absent	absent
Panicletype	intermediate	intermediate
Leaf blade pubescence	present	present
Dehiscence*	intermediate	intermediate
Lodging tolerance*	tolerant	tolerant
Tillering*	high	high
Iron indirectly toxicity**	moderate tolerance	moderate tolerance
Rice blast in leaf and panicle**	moderate resistant	moderate resistant
Stain grains**	moderate sensitive	moderate resistant

* Atypical plants may arise due to the occurrence of natural crosses.
** Can undergo changes depending on the characteristics of the environment in which it is grown.

Table 2. Comparison of grain-related characteristics between the irrigated rice cultivars BRS Pampeira and BRS Pampa

Grain characteristics	Cultivars	
	BRS Pampeira	**BRS Pampa**
Caryopsis shape*	spindle-shaped	spindle-shaped
Awns	absent	absent
Glumes colour	straw	straw
Colour of apiculus in flowering	white	white
Colour of apiculus in maturaty	white	white
Pubescence grain	present	present
Lengthof grain (mm)**	9.2	9.82
Widthof grain (mm)**	2.1	2.2
Thicknessof grain (mm) **	2	2
Length of caryopsis (mm)**	7.15	7.19
Width of caryopsis (mm)**	1.93	1.96
Thickness of caryopsis (mm)**	1.75	1.76
Length / width $^{-1}$ ratio (mm)*	3.4	3.59
1000-grain weight (g)**	27	25.6
Total income (%)**	68.2	68
Intact grain (%)****	62	62
Endosperm amylose content	high	high
Gelatinization temperature	low	low
Potential productivity (t ha^{-1})***	12	10

* Length/width (without shell) ratio
** Can be changed depending on the characteristics of the environment in which it is grown.
*** Grains in shell, 13% humidity, observed in experiments conducted by Embrapa.
**** Grains peeled and polished in a Suzuki test device..

average of the VCU tests and can undergo changes in view of the different races, which alter with changing environments (interaction between places and years). It also displays average resistance to scald and medium susceptibility to brown spot and grain stain.

In relation to abiotic stresses such as toxicity to excess of iron in the soil, the cultivar is classified as moderately tolerant. It has a slow initial development after emergence, characteristic of cultivars with longer cycles such as the IRGA 424.

The cultivar BRS Pampeira meets a demand of medium cycle cultivars tending to long cycle with high yield potential and grain quality, being an option to producers that use the cultivar IRGA 424 (3rd most sown cultivar in RS). It has shown high yield levels in the main rice-producing areas, especially in the west border of the RS state, where it showed an average yield of 14 t ha^{-1} in the city of Uruguaiana (Figure 2).

In studies of estimates of the phenotypic stability and adaptability parameters, by the coefficient and the regression deviations from the average yield of rice grains in ten different RS environments, consisting of five environments in two crop seasons, the cultivar BRS Pampeira presented specific adaptability to the favorable environments.

The yield of the cultivar BRS Pampeira in other states of Brazil, compared to the standard cultivars of irrigated rice for each region, is presented in Table 3. It can be observed the yield potential of the cultivar and its wide adaptation. In the homogeneity tests, the BRS Pampeira has shown to be uniform, without the presence of atypical plants, proving to be genetically stable.

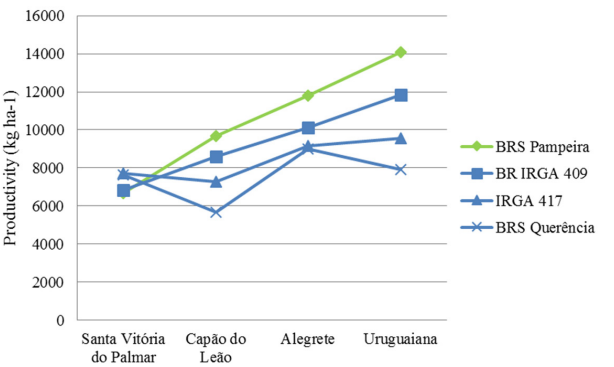

Figure 2. Yield of the cultivar BRS Pampeira compared with control cultivars at the VCU experiment, in the 2011/2012 and 2012/2013 season crops, in different regions of the RS state.

BASIC SEED PRODUCTION

The cultivar BRS Pampeira is registered in the National Register of Cultivars (RNC) and protected by the Ministry of Agriculture, Livestock and Supply (MAPA - Brazil). The Business Office of Capão do Leão, of Embrapa Products and Market is responsible for providing the basic seeds of the aforementioned cultivar.

Table 3. Yield assessment of the cultivar BRS Pampeira in kg ha^{-1} of paddy rice, at 13% humidity, for each location and year, in different regions of Brazil

Region	Year	County	Cultivars					
			BRS Pampeira	BRS Jaçanã	BR IRGA 409	BRS Tropical	BRS Fronteira	Average
Midwest	2007	Goianira, GO	7,263	6,989	5,965	.	.	6,477
	2008	Goianira, GO	10,437	8,620	7,018	.	.	7,819
	2009	Goianira, GO	11,244	7,976	.	8,945	.	8,461
		Miranda, MS	8,122	.	.	6,605	.	6,605
		Dourados, MS	7,566	.	.	8,558	.	8,558
		Rio Brilhante, MS	10,372	.	.	10,153	.	10,153
	2010	Goianira, GO	5,717	4,773	.	5,361	.	5,067
		Miranda, MS	7,198	6,545	.	4,676	.	5,611
		Dourados, MS	8,552	8,926	.	6,668	.	7,797
		Rio Brilhante, MS	7,298	5,231	.	6,270	.	5,751
North	2007	Formoso do Araguaia, TO	6,030	4,977	4,558	.	.	4,767
		Belém, PA	7,512	6,078	5,350	.	.	5,714
		Bragança, PA	5,645	5,208	3,048	.	.	4,128
		Salvaterra, PA	6,067	6,191	5,651	.	.	5,921
		Cantá, RR	8,171	8,257	7,367	.	.	7,813
	2008	Formoso do Araguaia, TO	7,492	6,160	6,565	.	.	6,346
		Lagoa da Confusão, TO	7,195	5,516	5,625	.	.	5,571
		Belém, PA	5,750	4,438	4,604	.	.	4,521
		Bragança, PA	5,481	7,331	7,323	.	.	7,327
		Salvaterra	4,702	4,699	3,302	.	.	4,001
		Cantá, RR	6,664	5,555	.	6,871	.	6,213
	2009	Formoso do Araguaia, TO	7,151	6,963	.	7,062	.	7,013
		Belterra, PA	9,707	8,500	.	9,148	.	8,824
		Cantá, RR	6,664	5,555	.	6,871	.	6,213
	2010	Formoso do Araguaia, TO	5,125	4,531	.	4,335	4,398	4,421
		Lagoa da Condusão, TO	7,047	8,797	.	6,422	9,047	8,089
		Belém, PA	8710	6588	.	5604	6666	6286
		Bragança, PA	3883	4500	.	3430	3726.	3885
Northeast	2008	Arari, MA	5,672	.	.	6,697	.	6,697
		Buriti dos Lopes, PI	8,861	.	.	8,518	.	8,518
		Teresina, PI	9,848	.	.	9,942	.	9,942
		Iguatu, CE	6,520	.	.	6,978	.	6,978
	2009	Arari, MA	8,668	.	.	8,488	.	8,488
		Buriti dos Lopes, PI	8,052	.	.	7,754	.	7,754
		Teresina, PI	11,708	.	.	11,399	.	11,399
	2010	Arari, MA	9,451	.	.	7,940	.	7,940
		Buriti dos Lopes, PI	10,513	.	.	9,156	.	9,156
		Teresina, PI	8,056	.	.	8,631	.	8,631
		Iguatu, CE	11,758	.	.	11,334	.	11,334
		Limoeiro do Norte, CE	10,986	.	.	10,624	.	10,624
	2012	Buriti dos Lopes, PI	6,340	6,282	.	7,020	5,734	6,345
		Teresina, PI	9,133	8,724	.	8,264	8,466	8,485
		Igreja Nova, AL	5,254	5,048	.	5,503	4,567	5,039

The sowing of the cultivar BRS Pampeira should follow the agricultural zoning for irrigated rice in Rio Grande do Sul and other states of the union. In the RS it is recommended that the sowing occurs respecting the cultivar cycle in interaction with the cultivation environment in such a way that the panicle differentiation occurs until early January or as close to that date as possible. In this case, it is recommended the early sowing season, which in the RS corresponds to the first half of October, so that it can express its maximum yield potential.

The cultivar BRS Pampeira is recommended for sowing in six rice-producing regions of the RS state, the west frontier being the preferred region, where it showed greater adaptability to the favorable environment. In registration with the Ministry of Agriculture, Livestock and Supply (MAPA), the cultivar was also recommended to the states of Goiás and Mato Grosso do Sul (midwest region); Tocantins, Pará and Roraima (north region); Maranhão, Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas and Sergipe (northeast region).

The density of suitable seeds (100% GC) should be about 60 seeds per linear meter (approximately 100 kg ha^{-1}) for the online system, to ensure a plant population from 200 to 300 plants per square meter (SOSBAI 2014). In the germination and seedling emergence tests performed at low temperatures, the cultivar showed intermediate response to cold.

The cultivar BRS Pampeira shows positive response to different levels of basic and coverage fertilization, without lodging of plants.

The harvest of this cultivar, aiming to minimize the natural abscission and prevent the grain breakage during the manufacturing process, should be performed when the grain moisture content is between 23% and 18%.

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