CROP BREEDING AND APPLIED BIOTECHNOLOGY

CULTIVAR RELEASE

BRS TR271 – a high grain yield and super-early wheat cultivar

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Abstract: *BRS TR271 is a new wheat cultivar released by Embrapa for Brazilian wheat-growing regions 1 and 2 of Rio Grande do Sul, Santa Catarina, and Paraná. It has high grain yield potential and a super-early cycle. It is widely adapted and is classified as bread wheat.*

Keywords: Triticum aestivum*, wheat-growing region, bread making*

INTRODUCTION

Wheat is the only agricultural commodity in which Brazil is not yet self-sufficient. Despite growth in production in recent years (CONAB 2022), Brazil has not reached the twelve to thirteen million tons per year needed to meet domestic demand. Brazilian wheat production for 2022 is estimated at over nine million tons.

Wheat breeding programs play a crucial role in ensuring that wheat production in Brazil continues to grow, delivering new improved cultivars with both higher grain yield potential and higher resistance/tolerance to the prevalent biotic and abiotic stress factors of the crop.

Woyann et al. (2019) estimated the genetic gain in yield obtained in wheat breeding programs in Brazil from 1984 to 2014 and concluded that yield improved by a factor of 33.9 kg ha^{-1} yr^{-1}, representing an annual increase of 1.28%. These values are in relative alignment with those obtained by other authors in different periods of analysis (Rodrigues et al. 2007, 1.54% from 1940 to 1992; Beche et al. 2014, 0.92% from 1940 to 2009; and Follmann et al. 2017, 2.86% from 2002 to 2013;). The genetic gains obtained in wheat breeding programs in Brazil have not yet reached stagnation, unlike the situation in other countries, as reported by Lo Valvo et al. (2018) in Argentina, Graybosch and Peterson (2010) in the United States, Matus et al. (2012) in Chile, and Brisson et al. (2010) in France.

The wheat breeding program of Embrapa began in 1974 and since then, more than 100 new cultivars have been released to farmers (Caierão et al. 2014). It is currently the most important public sector wheat improvement program in Brazil.

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BRS TR271 meets the Brazilian wheat market and productive sector expectations and represents an excellent option for producers in the southern region of the country. The objective of this paper is to present the main traits of this new bread wheat cultivar released by Embrapa.

BREEDING METHOD

BRS TR271 is derived from BRS Guamirim/WT 99172//BRS 331, a cross made in 2007 at Embrapa Trigo in Passo Fundo, RS. The F_1 generation was sown and bulk harvested in the greenhouse in 2008. Populations F_2 to F_6 were conducted under field conditions also in Passo Fundo, RS, from 2009 to 2013, sown under reduced seed density in plots consisting of three 3-meter rows, and selected through the genealogical method. In each generation, plants were selected with short height, high tillering capacity, and good performance when exposed to the main biotic and abiotic stresses of the crop through comparison to checks established at every group of 100 plots. Plants selected in the field were threshed in each generation, and grain was selected in the laboratory, keeping well-formed, healthy, and glassy-red kernels.

BRS TR271, derived from the selection period, has the selection history F101319-Z-0F-99F-1F-5F-1F. The plant selected in the F_6 generation was threshed and sown in Passo Fundo, RS, in 2014 (one 1-meter row) as part of a Pre-Observation Plot Collection. In 2015, the homozygous line was included in the Observation Plot Collection (six 6-meter rows) and grain yield began to be evaluated. The outstanding yield of this line in comparison to the checks led to its selection and it was named 'PF 150271'. In 2016 and 2017, 'PF 150271' was included in the preliminary line yield trials carried out locally (2016 - Passo Fundo, RS) and regionally (2017 - Passo Fundo, RS; Vacaria, RS: and São Luiz Gonzaga, RS). Value for Cultivation and Use (VCU) trials, required for registration with the Brazilian Ministry of Agriculture (MAPA), were conducted in 2018, 2019, and 2020.

PERFORMANCE AND AGRONOMIC PROFILE

The VCU trials were carried out from 2018 to 2020 in different locations in the three southernmost states of Brazil – Rio Grande do Sul, Santa Catarina, and Paraná (Table 1), representing Brazilian wheat-growing regions 1 and 2 (Brasil 2008).

The trials were arranged in a randomized complete block design with three replications. Each experimental unit consisted of six 6-meter rows spaced at 0.17 m, considering five square meters as harvest area for data collection. All crop practices, including fertilization and pest control, followed the technical recommendations for wheat and triticale cultivation in Brazil (Comissão 2022). Seeds were treated with Triadimenol + Imidacloprid prior to sowing. The agronomic traits analyzed in the VCU trials were grain yield, plant height, phenology (days from emergence to heading and from emergence to maturity), and plant response to biotic and abiotic stresses. In addition, the main technological quality parameters, including test weight and the 1000-seed weight, were analyzed at Embrapa Trigo. Analysis of variance

Table 1. Locations and years of evaluations of Value for Cultivation and Use (VCU) trials of cultivar BRS TR271 in wheat-growing regions 1 and 2 (Brasil 2008), including the states of Rio Grande do Sul (RS), Santa Catarina (SC), and Paraná (PR), from 2018 to 2020

Region/Location	State	Altitude (m)	Latitude	Longitude	No. of Trials		
					2018	2019	2020
Wheat-growing region 1					**5**	**4**	**4**
Campos Novos	SC	934	27°24'06''	51°13'33''	1	1	1
Guarapuava	PR	1098	25°23'43''	51°27'22''	1	1	1
Irati	PR	812	25°28'02''	50°39'04''	1	-	1
Passo Fundo	RS	687	28°15'46''	52°24'30''	2	2	1
Wheat-growing region 2					**5**	**5**	**9**
Chapecó	SC	674	27°05'47''	52°37'70''	1	1	1
Francisco Beltrão	PR	765	26°13'46''	52°40'18''	-	-	2
Pato Branco	PR	638	25°56'34''	52°59'47''	-	-	2
Santo Augusto	RS	528	27°51'03''	53°46'38''	1	1	1
São Borja	RS	123	28°39'38''	55°58'39''	1	1	1
São Luiz Gonzaga	RS	260	28°24'30''	54°57'41''	1	1	1
Três de Maio	RS	343	27°46'24''	54°14'37''	1	1	1

Table 2. Mean grain yield of BRS TR271 in relation to check varieties, considering the trial sites in wheat-growing regions 1 and 2 (Brasil 2008), evaluated in 2018, 2019, and 2020

Cultivar	2018	%[1]	2019	%[1]	2020	%[1]	Mean	%[1]
BRS TR271	5185 a	108.8	5239 a	101.6	5290 a	100.5	5238 a	103.5
Check 1 (C1)	4852 b	101.8	5387 a	104.5	5511 a	104.7	5250 a	103.7
Check 2 (C2)	4683 b	98.2	4923 ab	95.5	5011 a	95.3	4872 ab	96.3
C_M [2]	4767 b	100	5155 b	100	5261 a	100	5061 b	100

[1] grain yield percentage of BRS TR271 in relation to the average of the checks. [2] C_M – average of the two checks. Means followed by the same letter do not differ statistically according to Tukey's test ($p < 0.05$). C1 = 2018 (BRS Reponte); 2019 (BRS Reponte); 2020 (BRS Reponte). C2 = 2018 (TBIO Toruk); 2019 (TBIO Audaz); 2020 (TBIO Audaz).

was performed on the grain yield data, and means were compared by the Tukey Test at 5% probability.

Table 2 shows the mean grain yield data of BRS TR271 and the check varieties used for comparison over the years of evaluation. The new cultivar showed a mean grain yield of 5238 kg ha^{-1}, statistically different from the mean of the checks (C_M) according to Tukey's test, and a relative percentage of 103.5 in the same comparison. The mean grain yield obtained in the years 2018, 2019, and 2020 was 5185 kg ha^{-1}, 5239 kg ha^{-1}, and 5290 kg ha^{-1}, respectively, and was statistically different from the mean values of the checks (C_M) by Tukey's test (Table 2) – except for 2020. In comparison with BRS Reponte (Check 1), BRS TR271 has smaller plant height and better resistance to lodging, though it has slightly inferior grain yield (Table 2) – 5238 kg ha^{-1} for BRS TR271 and 5250 kg ha^{-1} for BRS Reponte.

The agronomic profile of BRS TR271 and its parent variety, BRS 331, is shown in Table 3. BRS TR271 has medium plant height and a super-early cycle (on average 72 days to heading and 123 days to maturity). It has an average test weight of 79.5 kg hL^{-1} and thousand-seed weight of 33.5 g. In regard to reaction to the main wheat abiotic stresses, BRS TR271 is characterized as moderately susceptible to frost in the vegetative stage and moderately resistant to toxic aluminum, shattering, and lodging. It has an intermediate response to pre-harvest sprouting. As for the main biotic stresses, it is moderately resistant to powdery mildew (*Blumeria graminis* f.sp. *tritici*), leaf rust (*Puccinia triticina*), scab (*Fusarium graminearum*), and wheat mosaic virus (WMV). It has an intermediate reaction to barley yellow dwarf virus (BYDV) and leaf spot (*Septoria tritici* and *Bipolaris sorokiniana*). BRS TR271 has greater tolerance/resistance to all biotic and abiotic stresses than its immediate parent variety, BRS 331, does (Table 3).

Table 3. Agronomic profile of BRS TR271 in comparison to wheat cultivar BRS 331

Agronomic trait	BRS TR271	BRS 331
Plant height (cm)	Medium	Medium
Cycle to heading (days)	Super-early	Super-early
Cycle to maturity (days)	Super-early	Super-early
Test weight (kg hL^{-1})	79.5	77.8
1000-seed weight (g)	33.5	29.8
Reaction to pre-harvest sprouting	MS/MR	S
Reaction to frost	MS	MS
Reaction to soil Al^{+++}	MR	S
Reaction to shattering	MR	MS
Reaction to lodging	MR	R
Reaction to powdery mildew	MR	MR
Reaction to tan spot	MR/MS	MS
Reaction to leaf rust	MR	S/MS
Reaction to scab	MR	MR
Reaction to BYDV	MS/S	MS
Reaction to WMV	MR	R

R = resistant; MR = moderately resistant; S = susceptible; MS = moderately susceptible. BYDV = Barley Yellow Dwarf Virus. WMV = Wheat Mosaic Virus.

Table 4. Physicochemical and rheological profile of BRS TR271 in wheat-growing regions (WGR) 1 and 2 (Brasil 2008)

Trait	WGR 1	WGR 2	Mean
Number of samples	10	12	22[1]
Gluten Strength (W × 10^{-4} Joules)	199	240	220
Tenacity/Extensibility ratio (P/L)	0.6	0.6	0.6
Elasticity Index	62.3	67.8	65.0
Extraction (%)	55.4	55.3	55.3
Falling Number (seconds)	336	291	313
Protein content (%)	15.0	14.2	14.6
Farinograph Stability Time (min)	11.1	16.2	13.6
Hardness (SKCS)[2]	77	75	76
Flour color			
Color L* Minolta[3]	92.5	92.9	92.7
Color b* Minolta[4]	12.8	12.5	12.6

[1] Sum. [2] SKCS = Single Kernel Characterization System. [3] Lightness (0: dark; 100: white). [4] Chromaticity (-60: blue; +60: yellow).

Twenty-two samples from VCU trials conducted from 2018 to 2020 were analyzed to evaluate the industrial quality of BRS TR271; ten samples represented wheat-growing region 1, and 12 represented wheat-growing region 2. The results are shown in Table 4. The mean values of the main quality parameters analyzed differ according to the region where the samples were obtained. The mean gluten strength

was 220 W × 10^{-4} J and the stability was 13.6 minutes, thus classifying BRS TR271 as a bread wheat cultivar (Brasil 2010). BRS TR271 has an excellent tenacity/extensibility ratio for bread making (mean values of 0.6), in addition to a good elasticity index (65.0), falling number (313 seconds), and protein content (14.6%). BRS TR271 is characterized as a very hard grain (average hardness index of 76), with flour color tending to yellow (Minolta parameters L* = 92.7 and b* = 12.6).

The molecular weight protein profile of BRS TR 271 is as follows: "GluA1: 2*"; "GluB1: 7+8"; "GluD1: 5+10", with a corresponding score of ten (Score 10).

OTHER TRAITS

BRS TR271 has upright flag leaves, with auricles that are predominantly heterogeneous in color. The top leaf node is wide to square shaped. This new cultivar is characterized by its oblong, awned, and clear spikes. The glume shoulder shape is predominantly high, and the glume tooth is classified as long (≥ 7 mm). The kernels of BRS TR271 are oval and red.

BRS TR271 is registered under number 49319 (18 Nov. 2021) and protected under number 20220022 (04 Feb. 2022) in MAPA (Ministério da Agricultura, Pecuária e Abastecimento).

BASIC SEED PRODUCTION

Embrapa Trigo (Rodovia BR 285, km 294, 99050-970, Passo Fundo, RS, Brazil) is authorized to license seed producers to produce, multiply, and sell protected varieties (law no. 9456/97) to grain farmers.

REFERENCES

Beche E, Genin G, Silva CL, Munaro LB and Marchese JA (2014) Genetic gain in yield and changes associated with physiological traits in Brazilian wheat during the 20th century. **European Journal of Agronomy 61**: 49-59.

Brasil – Ministério da Agricultura, Pecuária e Abastecimento (2008) Instrução normativa n° 58, de 19 de novembro de 2008. Regiões para a realização de ensaios de Valor de Cultivo e Uso (VCU) de trigo e o número mínimo de locais por região para a realização destes ensaios. **Diário Oficial [da] República Federativa do Brasil**. DOU, Brasília, Seção 1, p. 3.

Brasil – Ministério da Agricultura, Pecuária e Abastecimento (2010) Instrução normativa n° 38, de 30 de novembro de 2010. Regulamento técnico do trigo. **Diário Oficial [da] República Federativa do Brasil**, n. 229. DOU, Brasília, Seção 1, p. 2-4.

Brisson N, Gate P, Couache D, Charmet G, Oury FX and Huard F (2010) Why are wheat yields stagnating in Europe. A comprehensive data analysis for France. **Field Crops Research 119**: 201-212.

Caierão E, Scheeren PL, Só e Silva M and Castro RL (2014) History of wheat cultivars released by Embrapa in forty years of research. **Crop Breeding and Applied Biotechnology 14**: 216-223.

Comissão - Comissão Brasileira de Pesquisa de Trigo e Triticale (2022) **Informações técnicas para trigo e triticale – safra 2022**. Fundação ABC e Biotrigo Genética, Castro, 274p.

CONAB - Companhia Nacional de Abastecimento (2022) Acompanhamento da safra brasileira de grãos. Available at <https://www.conab.gov.br/info-agro/safras/graos/boletim-da-safra-de-graos>. Accessed on March 31, 2022.

Follmann DN, Cargnelutti FA, Lúcio AD, Souza VQ, Caraffa M and Wartha CA (2017) Genetic progress in homogeneous regions of wheat cultivation in Rio Grande do Sul State, Brazil. **Genetics and Molecular Research 16**: 72-81.

Graybosch RA and Peterson CJ (2010) Genetic improvement in winter wheat yields in the Great Plains of North America, 1959-2008. **Crop Science 50**: 1882-1890.

Lo Valvo PJ, Miralles DJ and Serrago RA (2018) Genetic progress in Argentine bread wheat varieties released between 1918 and 2011: Changes in physiological and numerical yield components. **Field Crops Research 221**: 314-321.

Matus I, Mellado M, Pinares M, Madariaga R and Del Pozo A (2012) Genetic progress in winter wheat cultivars released in Chile from 1920 to 2000. **Chilean Journal of Agricultural Research 72**: 303-308.

Rodrigues O, Lhamby JCB, Didonet AD and Marchese JA (2007) Fifty years of wheat breeding in southern Brazil: Yield improvement and associated changes. **Pesquisa Agropecuária Brasileira 42**: 817-825.

Woyann ADZ, Zanella R, Rosa, AC, Castro RL, Caierão E, Toigo, M, Storck L, Wu J and Benin G (2019) Genetic gain over 30 years of spring wheat breeding in Brazil. **Crop Science 59**: 2036-2045.