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## CULTIVAR RELEASE

### BRS Savanna: new six-rowed malting barley cultivar for irrigated crops in the Brazilian savanna

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**Abstract** – BRS Savanna, a cross between V. Morales x IF200113, is a spring and an early-maturing six-rowed barley, widely adapted to irrigated areas of the savanna, in Central Brazil. It presents production stability and the industrial quality, grain yield and lodging resistance are high. It is suitable for cultivation in the states of GO, MG and DF.

**Key words:** *Hordeum vulgare* L., plant breeding, cultivar description.

#### INTRODUCTION

Barley (*Hordeum vulgare* L.) is the fourth most important cereal crop in the world (FAOSTAT 2012). In 2011, grain yield in Brazil was 283.9 thousand tons in an area equal to 87.9 thousand hectares where the mean yield was 3.230 kg ha<sup>-1</sup> (CONAB 2012). Despite these numbers, Brazil is only the second largest importer in America and the twelfth importer worldwide (FAOSTAT 2012).

Traditionally, barley grown in Brazil is concentrated in the south of Brazil and recently, in small irrigated areas in São Paulo and Goiás (Amabile et al. 2007, CONAB 2012). Barley is an alternative crop for the irrigated system in the savanna, showing good adaptability to the edaphoclimatic conditions of this biome, low incidence of diseases, high yielding potential and effective use of water. From an industrial point of view, it shows clean seeds when grown in the savanna, nodormancy and it might be used as malt right after being harvested, avoiding long stocking periods to complete the maturation of grains (Amabile 2007).

In the Brazilian savanna, barley was first introduced as an irrigated winter crop in 1976, through a project elaborated by the Brazilian government named Plano Nacional de Auto-Suficiência de Cevada e Malte – PLANACEM (Amabile et al. 2007), with two basic goals: to meet the

internal demand of malt and provide the breeder in Central Brazil an alternative to diversify and integrate the irrigated crop, ensuring a more stable total yield (Amabile 2007). In order to obtain the malting barley, the improvement programs should meet the demands concerning the crop yield and it also requires genotypes that show a proper relation among the malting barley quality needed by the industry.

In 2002, Embrapa Cerrados established a partnership with the International Center for Agricultural Research in the Dry Areas (ICARDA) to evaluate several collections and genotypes, which goal was to generate technical subsidies to better develop the irrigated barley improvement in the savanna. The genotypes evaluated in this area were fundamental and convenient to continue the barley genetic improvement program, along with the strategy to increase the cereal yield.

Recent researches have shown that the savanna has the potential to meet the demands for barley grains, providing opportunities and offers to perform agricultural business including new commercial chances. The urgent challenge is to obtain cultivars showing better agronomical performance, industrial quality and adaptability to the irrigated systems which meet the industrial demands, in a way that will set barley as an agronomical and economical alternative for this region (Amabile et al. 2007).

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## CULTIVAR ORIGIN AND DEVELOPEMENT

BRS Savanna is a cross between genotypes V. Morales x IF200113 showing malting quality and lodging resistance. Figure 1 illustrates its genealogy. The crossing was performed in the winter of 2002 in the International Maize and Wheat Improvement Center (CIMMYT), in Cd. Obregon, Mexico. Generation F<sub>1</sub> was grown in the summer of 2002 at the research station CIMMYT in El Batan, Mexico. Populations F<sub>2</sub> and F<sub>3</sub> showed a bulk development, at stations CIMMYT, in Cd. Obregon and El Batan, respectively. On the other hand, Generation F<sub>4</sub> was introduced by Embrapa Cerrados, in Planaltina-DF and grown under irrigation in 2004, being submitted to a modified mass selection, where plants agronomically atypical were excluded and plants which were homogenous in relation to the cycle, height and the size of corn ear were selected.

From F<sub>5</sub> to F<sub>6</sub>, individuals were selected by using a genealogical method, where the selected cell line CPAC 20020098 was included in the competition essays in Luziânia (state of Goiás), Vianópolis (state of Goiás), Formosa (state of Goiás), Unaí (state of Minas Gerais), São Gotardo (state of Minas Gerais), Planaltina (Federal District) and Recanto das Emas (Federal District), in 2007 and also the first year of Value for Cultivation and Use. Because of the good agronomical performance observed, the lineage was evaluated in relation to the malting quality. In 2008 and 2009, CPAC 20020098 was included in the Value for Cultivation and Use trials in the second and third year, being properly registered at MAPA and equally evaluated in regards to the main malt quality parameters.

## PERFORMANCE

BRS Savanna is the second six-rowed cultivar recommended for the irrigated savanna and the first where the crossing came from an elite collection from Embrapa Cerrados being selected based on its agronomical and molecular traits as well as its malting quality. It shows stability in production and a mean performance higher than the control cultivar BRS 195, which was verified in 30 evaluations, including the VCU in Goiás, Minas Gerais and Federal District (from 2007 to 2009), observation units and intermediate, complementary and final evaluation trials in the Federal District (2010) (Table 1). Grain yield ranged from 4.726 kg ha<sup>-1</sup> to 8.659 kg ha<sup>-1</sup>, with an average of 5.908 kg ha<sup>-1</sup>, being 17.4% superior to the control cultivar (Table 1). The grain variety shows a commercial grade 1 higher than 82%, which average was 6.1% superior to witness BRS 195 (Table 1). The mean thousand grain weight was

45.7 g (ranging from 38.3 and 49.9 g), being superior to the control BRS 195 (42.3 g). Both BRS Savanna and BRS 195 do not show lodging in the sites and years evaluated.

BRS Savanna shows a malt industrial quality profile that meets most of the brewery industry specifications with a good extract yield, proper glassy percentage, soluble nitrogen, viscosity, friability and b-glucan content (Table 2). Throughout several evaluations, the mean protein content for BRS Savanna was 11.8% (Table 1). As for the resistance to diseases, it shows a moderate resistance to spot blotch (*Bipolaris sorokiniana* (Sacc.) Shoemaker) and crown rust (*Puccinia hordei*), but it is susceptible to torrice blast (*Magnaporthe grisea*) as all other irrigated barley cultivars in the savanna.

## OTHER TRAITS

BRS Savanna has a semi-erect juvenile growth habit. The flag leave is erect, short and the area is 22 cm<sup>2</sup>. The mean distance from the flag leave to the raquis is 8.37 cm and the average length of flag leaf sheath is 21.4 cm. The raquis shows a linear shape and has hairy lateral border. The rachilla is short and hairy. The coloration of the leaf auricles is absent and the tips might show anthocyanin. The barley ear is long (mean length = 9.27 cm), six-rowed, shows a parallel shape, semi-loose density and erect growth during maturation. The average number of grains is 72.3. Arists are long, clear and semi-rough. As for the grains, they are clear, elliptical, and the husk adheres to the grain, is fine and has wrinkles. The glumes are hairy and clear, with the presence of anthocyanin in the lemma veins.

BRS Savanna is the earliest genotype in the irrigated savanna. Its silking occurs at 786.6 degrees-day, being equivalent, in average, to 56 days after its emergency. This period is inferior when compared to cultivars BRS 180 (808.0 degrees-day), BRS Deméter (844.0 degrees-day) and BRS 195 (1.044.0 degrees-day, all recommended for the irrigated system in the savanna (Amabile et al. 2008), showing BRS Savanna has a shorter maturation. With a better crop adaptability and stability in the regions which are potential producers of malting barley in the Federal District, Goiás and Minas Gerais, BRS Savanna shows the best performance in altitudes higher than 800 m and latitudes 14° and 20° S. It also shows a mean erect habit, and during the years of evaluation the average height is 82 cm, being superior to the semi-dwarf cultivar BRS 195 (67 cm) and inferior to cultivar BRS 180 (90 cm) (Amabile et al. 2008). Under irrigation, according to the water management recommendation from Embrapa Cerrados, it presents lodging resistance (Table 1).

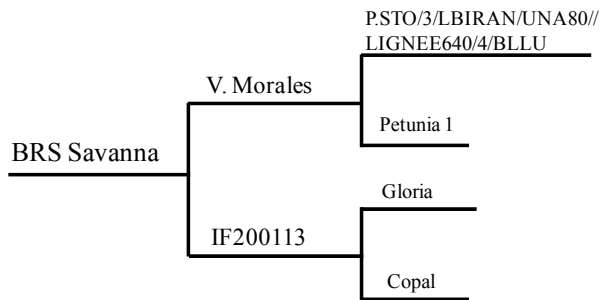
**Table 1.** Average performance of the agronomical traits of cultivar BRS Savanna and the control cultivar (BRS 195) in the Federal District, in Goiás and Minas Gerais

| Cultivar               | 2007                                    |       |       | 2008  |       |       | 2009  |       |       | 2010  | Média |
|------------------------|---|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|                        | Grain yield (kg ha <sup>-1</sup> )      |       |       |       |       |       |       |       |       |       |       |
|                        | DF                                      | GO    | MG    | DF    | GO    | MG    | DF    | GO    | MG    | DF    |       |
| BRS Savanna            | 4.726                                   | 6.038 | 5.604 | 5.501 | 5.953 | 6.018 | 8.659 | 5.433 | 5.880 | 5.265 | 5.908 |
| BRS 195 <sup>1</sup>   | 4.356                                   | 5.413 | 5.984 | 4.201 | 4.502 | 4.935 | 5.708 | 4.679 | 5.795 | 4.739 | 5.031 |
|                        | Grade 1 Classification (%) <sup>2</sup> |       |       |       |       |       |       |       |       |       |       |
|                        | DF                                      | GO    | MG    | DF    | GO    | MG    | DF    | GO    | MG    | DF    |       |
| BRS Savanna            | 83                                      | 88    | 84    | 91    | 92    | 84    | 93    | 87    | 88    | 82    | 87    |
| BRS 195 <sup>1</sup>   | 91                                      | 77    | 79    | 90    | 84    | 81    | 78    | 83    | 77    | 84    | 82    |
|                        | Weight of 1000 seeds (g)                |       |       |       |       |       |       |       |       |       |       |
|                        | DF                                      | GO    | MG    | DF    | GO    | MG    | DF    | GO    | MG    | DF    |       |
| BRS Savanna            | 47.2                                    | 49.9  | 49.3  | 41.8  | 46.7  | 43.8  | 44.9  | 46.7  | 38.3  | 48.9  | 45.7  |
| BRS 195 <sup>1</sup>   | 43.5                                    | 46.1  | 47.5  | 47.5  | 40.3  | 40.6  | 40.6  | 39.3  | 36.2  | 41.6  | 42.3  |
|                        | Grain protein content (%)               |       |       |       |       |       |       |       |       |       |       |
|                        | DF                                      | GO    | MG    | DF    | GO    | MG    | DF    | GO    | MG    | DF    |       |
| BRS Savanna            | 12.1                                    | 11.3  | 11.9  | 12.3  | 12.7  | 12.2  | 12.0  | 12.4  | 10.5  | 10.7  | 11.8  |
| BRS 195 <sup>1</sup>   | 11.9                                    | 12.0  | 11.7  | 12.9  | 13.2  | 12.9  | 12.3  | 12.7  | 12.9  | 11.6  | 12.4  |
|                        | Mean plant height (cm)                  |       |       |       |       |       |       |       |       |       |       |
|                        | DF                                      | GO    | MG    | DF    | GO    | MG    | DF    | GO    | MG    | DF    |       |
| BRS Savanna            | 80                                      | 79    | 75    | 83    | 80    | 80    | 85    | 87    | 89    | 78    | 82    |
| BRS 195 <sup>1</sup>   | 63                                      | 64    | 68    | 64    | 70    | 70    | 70    | 72    | 65    | 68    | 67    |
|                        | Mean number of days to silking          |       |       |       |       |       |       |       |       |       |       |
|                        | DF                                      | GO    | MG    | DF    | GO    | MG    | DF    | GO    | MG    | DF    |       |
| BRS Savanna            | 55                                      | 56    | 57    | 57    | 58    | 59    | 55    | 54    | 56    | 55    | 56    |
| BRS 195 <sup>1</sup>   | 69                                      | 70    | 68    | 74    | 73    | 75    | 71    | 70    | 69    | 70    | 71    |
| Number of environments |   | 8     |       |       | 8     |       |       | 8     |       | 6     |       |

<sup>1</sup> Control cultivar<sup>2</sup> percentage of grains retained in a 2.5mm diameter strainer**Table 2.** Malting quality traits of cultivar BRS Savanna shown by the trials performed in Minas Gerais (MG), Goiás (GO) and Federal District (DF) and control cultivar (BRS 195) from trials performed in the Federal District (DF) in 2008 e 2009

| Malting Traits <sup>1</sup>                    | 2008        |       |         | 2009        |       |         |
|--|-------------|-------|---------|-------------|-------|---------|
|  | BRS Savanna |       | BRS 195 | BRS Savanna |       | BRS 195 |
|  | MG          | DF    | DF      | GO          | DF    | DF      |
| Total Protein (%)                              | 10.9        | 12.4  | 12.0    | 11.8        | 12.3  | 11.6    |
| Extract M.F. i.a. (%)                          | 79.3        | 80.9  | 77.0    | 78.6        | 80.9  | 76.8    |
| Hartong VZ 45 °C                               | 43.1        | 46.4  | 33.6    | 36.6        | 47.1  | 40.7    |
| Viscosity (mPa s)                              | 1.55        | 1.49  | 1.56    | 1.56        | 1.52  | 1.55    |
| Boiled wort color EBC                          | 5.9         | 6.8   | 6.0     | 5.9         | 8.8   | 6.0     |
| Soluble N (mg 100g <sup>-1</sup> )             | 838.0       | 873.0 | 712.0   | 707.0       | 880.0 | 888.0   |
| Kolbach Index (%)                              | 50.1        | 42.1  | 43.6    | 38.5        | 50.1  | 48.2    |
| Friability (%)                                 | 73.9        | 68.2  | 81.4    | 77.0        | 82.8  | 69.4    |
| Glassy grains (%)                              | 0.2         | 2.2   | 0.1     | 0.5         | 0.6   | 2.3     |
| b-glucans in the mash (mg 100g <sup>-1</sup> ) | 208.0       | 257.0 | 159.0   | 206.0       | 30.0  | 77.0    |

<sup>1</sup> Analysis performed at Laboratório da Malteria do Vale, Taubaté,SP.



**Figure 1.** BRS Savanna Pedigree.

The most indicated seeding period for BRS Savanna is from May 1- 30. Planting should not be performed before this period because there is a risk of occurring phytosanitary problems. Before this period, planting seeds is not recommended either because of the diseases such as net blotch (*Pyrenophora teres*), spot blotch (*Cochliobolus sativus*)

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and brusone (*Magnaporthe grisea*) and also due to a less grain productivity. Further seeding should also be avoided so that the grain harvesting does not coincide with the rainy period, which may result in significant loss in grain quality for brewery purpose.

## SEED PRODUCTION

The basic seeds of BRS Savanna will be produced by Embrapa Produtos e Mercado. From March to April 2012, BRS Savanna was enrolled to be registered in the Ministério da Agricultura Pecuária e Abastecimento/Registro Nacional de Cultivares (MAPA/RNC), which protocol number is 70500.003807/2012-91.

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