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CULTIVAR RELEASE

BRSMG Caçula: very early upland rice cultivar for Minas Gerais

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Abstract – *The basic objective of the upland rice breeding program developed in the state of Minas Gerais is to make new commercial cultivars available. A new cultivar named BRSMG Caçula is being released, with the main traits: earliness, lodging tolerance, grain quality, disease tolerance, and high grain yield.*

Key words: Oryza sativa*, second harvest, upland rice, rice improvement.*

INTRODUCTION

In Minas Gerais, upland rice crop is being affected by a drastic reduction in production area and grain yield (Soares et al. 2005a, Conab 2011), caused mainly by the low prices paid to farmers, and particularly by the competition with the more profitable crops corn and soybean. Furthermore, in view of the high risk of crop failure, upland rice has been treated as marginal crop. On the other hand, the area under center-pivot irrigation has increased substantially, reaching 303,368 ha in 2010 (Embrapa 2011), an area of which a considerable part could be used for upland rice cultivation. For this purpose, earlier cultivars are constantly needed to allow the production of at least two crops per year, facilitating crop rotation and maximizing land use. Atroch et al. (2000) found that the performance of upland rice cultivars is similar in rainfed and sprinkler-irrigated systems, with no significant interaction, indicating no need to test the same group of cultivars in both cultivation systems. Therefore, the cultivars recommended for rained cultivation may also be planted under center pivot irrigation. To breed such early cultivars that met the demands of the producers, the upland rice breeding program of the Federal University of Lavras (UFLA) joined efforts with the Agricultural Research Company of Minas Gerais (Epamig) and Embrapa Rice and Beans. As a result, the new cultivar BRSMG Caçula was made available as of 2012, for cultivation in rained and sprinkler-irrigated systems, in both the first and second growing season, as far as the temperature and humidity conditions permit it.

MATERIAL AND METHODS

The cultivar BRSMG Caçula was selected within the population CG3 obtained by recurrent selection by Embrapa Rice and Beans, which had been sent to Minas Gerais in 1999 for evaluation, generation development and selection of lines. In 2000, several $S_{0:2}$ families were selected, which were developed to homozygosity ($S_{0:6}$) by the bulk method to extract inbred lines. Several lines were selected within the family 422, one of which was labeled CMG 1152 (genealogy CG3-422-6B-20) and which, after being evaluated in observation and preliminary tests of value for cultivation and use (VCU), gave rise to cultivar BRSMG Caçula.

The field evaluations consisted of 22 trials conducted in rained conditions in several environments of Minas Gerais, from 2007/2008 to 2010/2011. The number of trials per location varied in the different growing seasons. In 2007/2008, the tests were conducted in Lambari (2) (lat 21° 58' S, long 45° 23' W, alt 845 m asl), Lavras (2) (lat 45° 00' S, long 21° 14' W, alt 919 m asl), Patos de Minas (lat 18° 46' S, long

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46° 31 W, alt 856 m asl), Patrocínio (lat 18° 57' S, long 47° 00' W, alt 972 m asl), Piumhi (lat 20° 28' S, long 45° 56' W, alt 760 m asl), and São Sebastião do Paraíso (lat 20° 54' S, long 46° 59' W, alt 940 m asl). In the following growing season (2008/2009), the tests were conducted in Lambari (2), Lavras, Patos de Minas and Piumhi; in 2009/2010, in Lambari (2), Lavras, Patos de Minas and Piumhi. In the last growing season (2010/2011), the experiments were carried out in Lambari, Lavras, Patos de Minas, and São Sebastião do Paraíso. The treatments consisted of lines and control cultivars, with a total of 20 entries per year. In each growing season, lines underperforming were replaced by other, supposedly better lines, whereas the same controls were maintained throughout the evaluation period.

A randomized block design with three replications was used. Each plot consisted of five 5- m rows, spaced 0.4 m apart. For the evaluations, the middle 4 m of three central rows was taken into consideration (4.80 m^2). Fertilization at planting consisted of 400 kg ha^{-1} of NPK fertilizer (08-28-16) plus micronutrients and as topdressing 100 kg ha^{-1} of N was applied in two rates, the first 25 days and the second 45 days after sowing, respectively. For pest prevention, the seeds were treated with a product based on thiodicarb + imidacloprid (0.7 L 100 kg^{-1} seed), and the weeds controlled by herbicides and hand weeding. Diseases were not controlled, to allow their outbreak and identification of susceptible lines. The field trials began in the first 10 days of November and lasted until the second 10-day period of December each year, according to weather conditions.

The plants were evaluated for the traits: leaf color; pubescence, flag leaf angle, tillering, average flowering cycle to full maturity, plant height, lodging, disease resistance, glume coloration, color climax at maturation, presence of awns, natural grain loss, average panicle length, grain yield, milled rice grain size, 1000-grain weight, grain class, whole grain and broken grain yield, head rice yield, gelatinization temperature, and amylose content. These assessments were made according to the Handbook of Research Methods in Rice Embrapa Rice and Beans (Embrapa 1977).

Grain yield data were statistically analyzed, for each growing season separately and in combined analysis involving six lines in common in the four years.

RESULTS AND DISCUSSION

Data of plant and grain characteristics of cultivar BRSMG Caçula are shown in Table 1. The leaves are green, without pubescence (glabrous), and the flag leaf forms a right angle with the stem; tillering is good, although the cultivar is extraordinarily early with flowering 72 to 76 days after sowing and a complete cycle of 100 to110 days, depending on the local temperature. Plant height varies greatly depending on soil fertility, spacing, seeding rate, crop management and climatic conditions. But growing in the middle of the experiment, the plants reached a height of 98 cm, i.e., very close to 1m, which is currently considered desirable for contributing to good lodging tolerance, allowing the use of high technology, particularly of higher fertilizer doses and a narrower spacing. Another important feature of the new cultivar is a moderate tolerance to the major crop diseases, reducing risks for farmers, although in environments with high pressure of panicle blast a preventive control with specific fungicides is recommended.

Table 1. Characteristics of the cultivar BRSMG Caçula in tests of value for cultivation and use under rainfed conditions, at different locations in Minas Gerais, in the growing seasons from 2007/2008 to 2010/2011

Plant traits	Description
Leaf color	green
Pubescence	Absent
Flag leaf angle	upright
Tillering	good
Mean flowering – 50%	72 - 76 days
Complete plant cycle	100 - 110 days
Plant height	98 cm
Lodging	Moderately resistant
Disease resistance	
Leaf blast	Moderately resistant
Panicle blast	Moderately susceptible
Bown spot	Moderately resistant
Grain spot	Moderately resistant
Leaf scald	Moderately susceptible
Glume color	Straw
Apex color at flowering	Green
Apex color at maturity	White
Arista	Absent
Grain shattering	Intermediate
Mean panicle length	18.8 cm
Grain traits	**Description**
Milled grain length	7.60 mm
Milled grain width	2.15 mm
Milled grain thickness	1.83 mm
Length/width ratio	3.53
100-brown grain weight	29.1 g
Class	Long-fine
Amylose content	24.60%
Gelatinization temperature (GT)[1]	4.2
Chalkiness[2]	2.6
Whole grain yield	58.8 %
Broken grain yield	13.2 %
Milled rice yield	72.0 %

[1] High = grades 2 and 3; Intermediate = 4 and 5; low = 6 and 7;

[2] 1=excellent; 2=good; 3=regular; 4=poor; 5=waste.

The glumes are straw-colored and the apex is green at flowering and white at maturation; awnless grains, and intermediate natural grain loss. The average panicle length in the experiments was 18.8 cm. It is however worth remembering that this trait is rather variable between environments in upland rice, depending mainly on soil fertility, rainfall distribution, spacing and seeding rate.

Cultivar BRSMG Caçula belongs to the "agulhinha" class, ie, a long-grain rice, with long fine grains, with the highest prices on the Brazilian market. To classify rice as long-grain, at least 80% of the whole grains must be 6.00 mm or longer, have a maximum width of 1.90 mm and a length/width ratio of over 2.75 after polishing. The grain size (Table 1) indicates that the new cultivar belongs to the long-grain rice class. One of the most pronounced features of BRSMG Caçula is a good cooking quality, as can be confirmed by lab results: intermediate amylose content (24.60%) and gelatinization temperature (4.2) (Table 1). The white center was graded 2.6, i.e., between regular and good. Another feature that distinguishes BRSMG Caçula from most other upland rice cultivars is the high yield of whole grains in processing (58.8%). This feature is rare among the cultivars planted in this environment, where frequent water stress along with high incidence of diseases (panicle blast and grain stain) favor higher a percentage of broken grains. In this aspect, BRSMG Caçula is clearly superior to BRSMG Curinga (54.0%), BRSMG Conai (54.0%), BRSMG Relâmpago (44.3%), and BRSMG Caravera (50.3%) (Soares et al. 2005a, Soares et al. 2005b, Soares et al. 2010). From 2007/2008 to 2010/2011, the whole grain yield was also 5.8% higher than that of Canastra. The greater resistance to grain breakage in processing allows a delayed harvest without major damage to rice, because field work cannot always be performed at the right time.

The grain yield data of BRSMG Caçula and of the controls BRSMG Caravera, BRSMG Relâmpago, BRSMG Curinga, BRSMG Conai, and Canastra are shown in Table 2. Despite the extreme earliness, which generally reduces yields, the potential grain yield of the new cultivar BRSMG Caçula is high, since it was statistically ($p \leq 0.05$) similar to BRSMG Curinga and superior to two cultivars (BRSMG Conai and Canastra), already well-known by rice farmers. This demonstrates the efficiency of the cultivar in converting solar energy and nutrients into rice grains, in a short time. In comparison with BRSMG Relâmpago, BRSMG Caçula performed similarly in the first three growing seasons (2007/2008 to 2009/2010), however, in 2010/2011, quite atypical weather conditions (intense Indian summer in January/February) were decisive for grain yield, favoring or disfavoring the different tested genotypes, depending on the planting date and flowering at different times. BRSMG Caravera, in turn, had a higher grain yield than the other cultivars, in the average of four years of assessment (except for BRSMG Relâmpago), although the cycle was longer than of BRSMG Caçula (mean flowering of 83 days) (Soares et al. 2008).

The question arises is why should BRSMG Caçula be released? And under which conditions should it be used by producers? The cultivation of upland rice has always been considered a high-risk crop by farmers due to frequent dry spells in January and especially in February and March, causing partial or even total crop loss. Reducing this risk has always been a research target to mitigate the potential damage of dry spells (Embrapa 1999). Among the possible alternatives are increased genetic resistance to drought, the adoption of cultural practices such as deep plowing and shorter cultivar cycles. The first option is more complex and research will still take some time to develop drought-resistant cultivars; the second alternative would be easy to apply, but with the advent of no-till, producers are no longer willing to deep-plow the soil, so the remaining option is to use cultivars with shorter cycles. How can this strategy reduce the threat of dry spells? By circumvention, since the risk of drought stress is highest in the stages of booting, panicle exertion and flowering, which could lead to partial or total sterility of spikelets. Therefore, the sooner these stages occur in the field, coinciding with periods of

Table 2. Mean grain yield (kg ha^{-1}) of BRSMG Caçula and cultivars in Minas Gerais

Cultivars[1]	2007/2008 (8 trials)	2008/2009 (5 trials)	2009/2010 (5 trials)	2010/2011 (4 trials)	Mean[2] (22 trials)
BRSMG Caravera	3971 a	4608 a	3107 b	3822 b	3892 a
BRSMG Relâmpago	3473 b	3875 c	3589 a	4106 a	3706 a
BRSMG Caçula	3603 a	3806 c	3398 a	3697 b	3620 b
BRSMG Curinga	3447 b	3609 c	2847 b	4107 a	3467 b
BRSMG Conai	3386 b	3841 c	2487 c	3479 b	3302 c
Canastra	2795 b	3354 d	2269 d	3066 c	2851 d
Mean	3446	3849	2950	3713	3473

[1] Means followed by the same letter belong to the same group, by the Scott-Knott test ($p < 0.05$);

[2] Weighted mean.

high rainfall, the lower is the risk of sterility, with a consequent reduction in grain yield. A lower risk implies in the adoption of better technologies, greater yield and higher economic return.

Under sprinkler-irrigation there is no risk of water stress, but the investment costs are high, forcing producers to maximize the use of the area. For this purpose, two to three crops must be grown per year, which is only possible with early cultivars of the species to be planted. The extremely early BRSMG Caçula makes it uniquely suited for planting in the main as well as the second growing season, particularly under center-pivot irrigation. For being photoperiod-insensitive, the cultivar can be grown in the second growing season.

In summary, BRSMG Caçula represents a combination of characteristics highly valued by rice farmers, namely yield potential, early maturity, lodging resistance, moderate tolerance to major diseases, long grain, good quality food, photoperiod insensitivity, and high head rice yield, the most important trait for mill owners. Therefore, this new cultivar represents a significant contribution to rice production in the state of Minas Gerais.

The successful release of a new cultivar depends on the availability of seed on the market, especially in the first year, when demand is greatest. To meet this requirement, in 2010/2011, genetic seed was produced on the UFLA Campus and in 2011/2012, the first basic seed was planted on the Experimental Farm of Lambari of the State Agricultural Research Corporation of Minas Gerais (Epamig). A 3-ha field was sown for an expected harvest of 15 tons, a sufficient amount to meet the demand for the growing season 2012/2013.

CONCLUSION

The cultivar BRSMG Caçula is being released for upland rice cultivation for the entire State of Minas Gerais, in view of the grain yield potential, earliness, chemical and physical grain quality and tolerance to lodging and to the major rice diseases.

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