

RB036066 – a sugarcane cultivar with high adaptability and yield stability to Brazilian South-Central region

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Abstract: *The sugarcane cultivar RB036066 is medium-maturing and has a long period of industrial suitability; in the South-Central region, harvest is recommended between June and September, and it is indicated for planting on medium to highly fertile soils. The cultivar is widely adaptable and has high sugar yield and stability of agricultural production.*

Key words: *Saccharum spp., selection and crop breeding.*

INTRODUCTION

The breeding program of sugarcane (*Saccharum spp.*) of the Federal University of Paraná [PMGCA/UFPR (www.pmgca.ufpr.br)] is part of the Inter-University Network for the Development of Sugarcane Industry (RIDESA), a network consisting of 10 Federal Universities that have been working successfully on the development of sugarcane cultivars that have different maturation cycles, adequate yields under the different management conditions of the crop, and are suited for the more than 9 million hectares of sugarcane cultivation in Brazil (Barbosa et al. 2015, Carneiro et al. 2015, Iida et al. 2015, Carneiro et al. 2016, Daros et al. 2017). In the South-central region of Brazil, the cultivation of medium and late-maturing cultivars with high yields managed mechanically is a great challenge, due to the damage caused by the harvest equipment.

Cultivar RB036066 should be planted in medium to highly fertile soils; it has a high phenotypic stability for tons of sucrose per hectare (TSH) and is extremely responsive to environmental improvements, responding with significant yield increases. However, the main characteristics of this new cultivar are a rapid initial growth and high tillering capacity, contributing to an excellent plant canopy closure in cane fields. The high potential sugar yield, coupled with wide adaptability and high yield stability, ensure high crop yields throughout the growing seasons.

The recommended time for harvesting RB036066 in the South-central region of Brazil is in the middle of the growing season, between June and September, but due to the long period of industrial suitability, harvest can be extended until the end of the growing season, between October and November. It has upright growth and tall plant height, resulting in excellent suitability for mechanical

Crop Breeding and Applied Biotechnology
18: 325-329, 2018
Brazilian Society of Plant Breeding.
Printed in Brazil
<http://dx.doi.org/10.1590/1984-70332018v18n3c48>

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Received: 03 July 2017
Accepted: 18 September 2017

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harvesting, with low levels of mineral impurities, suitable for industrial processing.

In addition to the above advantages, cultivar RB036066 can maintain high yields in medium-fertile soils, due to its excellent tillering capacity as well as medium-diameter stalks with long internodes, tall plant height and average weight.

PEDIGREE AND BREEDING METHODS

In 2003, caryopses were obtained from the cross of the female parent SP70-1143 with the male parent SP77-5181 (Figure 1), at the Flowering and Crossing Station of Serra do Ouro (lat 9° 13' S, long 35° 50' W and alt 450 m asl) in Murici, Alagoas, of the Federal University of Alagoas. In the same year, the caryopses were germinated in a greenhouse of the Experimental Station Paranavaí of the Federal University of Paraná, in Paranavaí, Paraná, (lat 23° 05' S, long 52° 27' W and alt 503 m asl). The first test phase (T1) was initiated in November 2003, with the planting of a total of approximately 200 thousand seedlings, descendants from hundreds of parents in two production environments (municipalities of Colorado and São Tomé).

Individual selection was applied in July 2005, in the ratoon cane stage. In 2005, the first clonal multiplication (phase T2) was carried out, with planting in the same municipalities. Each genotype of phase T2 was planted in two 5 m long furrows, spaced 1.5 m apart, in an experiment arranged in an augmented block design. The clone then named "PRP036066" was selected in 2008 due to its excellent performance throughout three growing seasons. In the next stage (phase T3) in 2010, evaluations and clonal selection were carried out based on data of two growing seasons, at eight locations in the state of Paraná [Mandaguaçu (lat 23° 21' S, long 52° 05' W and alt 580 m asl), Bandeirantes (lat 23° 06' S, long 50° 22' W and alt 492 m asl), Paranavaí (lat 23° 05' S, long 52° 27' W and alt 503 m asl), Colorado (lat 22° 50' S, long 51° 54' W and alt 400 m asl), Goioerê (lat 24° 10' S, long 53° 01' W and alt 550 m asl), Perobal (lat 23° 54' S, long 53° 24' W and alt 410 m asl), Astorga (lat 23° 11' S, long 51° 09' W and alt 634 m asl), and São Pedro do Ivaí (lat 23° 52' S, long 51° 41' W and alt 400 m asl)]. In 2010, the clonal multiplication phase (MPH) was planted and in the following year, the clone now called RB036066 was included in the final test phase of PMGCA, called experimental phase (EPH), conducted at 10 locations in the state of Paraná. In the EPH, yield traits such as ton of sugarcane per hectare and sucrose content, as well as their adaptability and yield stability were evaluated in the different soil and climate conditions of the North and Northwest regions of the State of Paraná (Figure 2). The EPH phase lasted three growing seasons. During this period, the reaction to the main diseases of the South-central sugarcane region was also evaluated. Between 2011 and 2012, experiments were conducted to evaluate the maturation period of RB036066 at nine locations in the state of Paraná.

Prior to the release of RB036066 for planting throughout Brazil, the data of 54 growing seasons were analyzed, from the first cut (10 growing seasons) to the third cut (6 growing seasons). The results confirmed the main qualities of the cultivar, in particular the high sucrose yield, associated with high stability and wide adaptability to medium to high-yield environments.

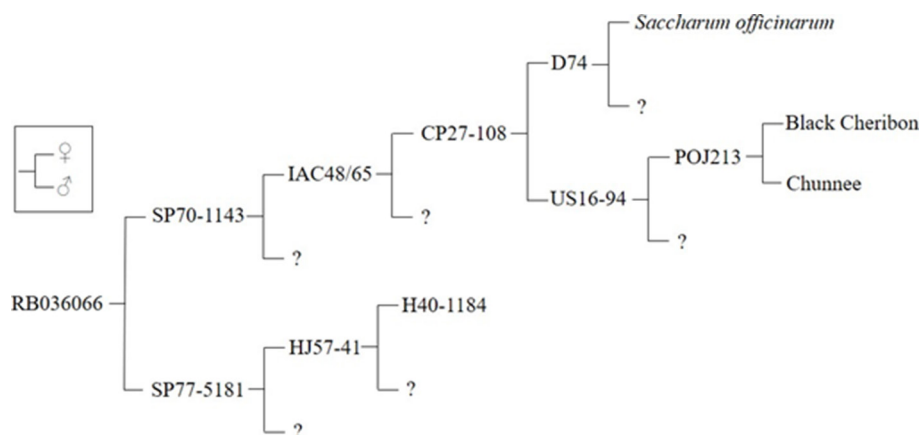


Figure 1. Pedigree of cultivar RB036066.

Since 2011, when the results were corroborated in several environments in the State of Paraná, there was an interest of the sugarcane mills and ethanol distilleries to install multiplication areas of RB036066 to evaluate the cultivar performance under the different management conditions of the producing units, representing different commercial farming systems. In this period, the cultivar stood out due to its excellent performance in the mechanically harvested areas, mainly because of its upright growth habit and tall plant height, with no lodging, even in sugarcane plantations in the final stage of the crop cycle. This information further stimulated its multiplication since 2015, especially after the national release of the RB cultivar group (Daros et al. 2015).

In June 2016, the Federal University of Paraná applied for the protection of cv. RB036066 by the National Service of Cultivar Protection (SNPC) and registration by the National Registry of Cultivars (RNC) of the Ministry of Agriculture, Livestock and Supply (MAPA). The definitive protection occurred on March 2017 (protocol no. 21806.000218/2016-34).

PERFORMANCE

The results of the experiments carried out in the mills and distilleries of the state of Paraná confirmed the superior performance of cultivar RB036066 over the standard cultivar RB867515, mainly in medium to highly fertile soils, as shown by the results obtained by the method of stability and adaptability, proposed by Eberhart and Russell (1966) (Figure 2). The yield stability in the different test environments was high, indicating a better performance for yield traits in medium to highly fertile soils.

The phenotypic adaptability of cultivar RB036066 was also high, indicating an excellent yield response when grown in high-fertility environments (Figure 2). When comparing cv. RB036066 with cv. RB867515, there was an increase in TCH of 14.42% in the mean of three growing seasons (Table 1). This characteristic of high agricultural yield (108.63 Mg ha⁻¹) associated with the sucrose content induced an increase in sugar yield of more than 25%.

The maturation curve of cultivar RB036066 was evaluated in several environments in the state of Paraná, according to the methodology described by Fernandes (2003). Based on the sucrose percentage in cane juice (SPC%), the cultivar was classified as medium-maturing, indicating the cultivar for harvesting from June onwards, in the South-central region of Brazil (Figure 3).

In a comparison of the maturation curve of cv RB036066 with that of cultivars usually harvested in the middle and

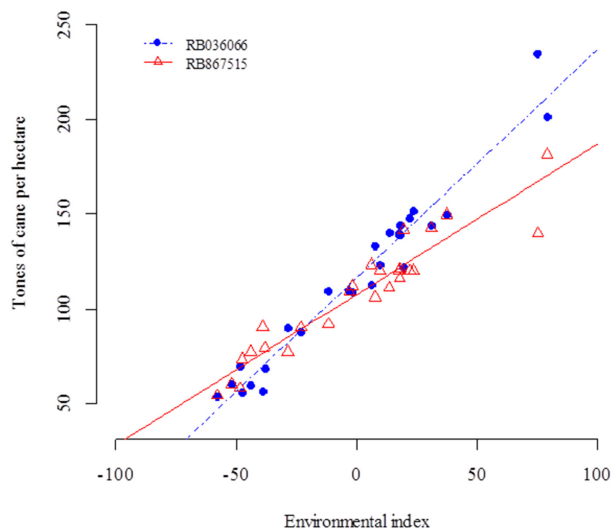


Figure 2. Phenotypic performance of RB036066 and RB867515 in 10 environments in plant cane, ratoon cane and second ratoon crops, in Paraná, Brazil.

Table 1. Comparison of RB036066 with RB867515, an important early-maturing cultivar, evaluated in the state of Paraná, from 2011 to 2014, based on the means of growing seasons

Crop	Cultivars	TCH [€]	(%)*	TPH	(%)*	SPC (%)	(%)*
First-ratoon	RB867515	105.34	100	12.31	100	11.69	100
	RB036066	118.6	112.588	13.38	108.692	11.28	96.4927
Second-ratoon	RB867515	100.26	100	12.72	100	12.69	100
	RB036066	111.1	110.812	15.85	124.607	14.27	112.451
Third-ratoon	RB867515	79.23	100	9.69	100	12.23	100
	RB036066	96.2	121.419	14.43	148.916	15	122.649
Mean	RB867515	94.94	100	11.58	100	12.2	100
	RB036066	108.63	114.42	14.55	125.648	13.52	110.82

[€] TCH = tons of cane per hectare, TPH = tons of sucrose per hectare and SPC = sucrose percentage in cane juice (apparent percentage of sucrose); * Relative yield of the variable, considering cultivar RB867515 as reference.

at the end of the growing season, the sucrose level of cv RB036066 was higher than that of cv RB867515 between June and November in the restrictive soils, i.e., with low to medium fertility, and similar to that of cultivar RB855536 in the same period in favorable soils (Bandeirantes and São Pedro do Ivaí), i.e., with high fertility.

It is noteworthy that sucrose (SPC%) concentrations were higher from June onwards, and remained stable until November, as well as the mean maturation control cultivar in favorable environments. Therefore, this new cultivar is an excellent alternative for planting when high stalk and sugar yields during the harvest from June to November in the South-central region are desired. In years with high flowering induction in sugarcane plantations, cultivar RB036066 showed sporadic flowering, but evaluations of density and stalk sucrose content, losses were lower than for other cultivars on the market usually used as control in the final test phase (EPh). On the other hand, the adequate management of cultivar RB036066 enabled harvesting between June and September, with high agricultural yields, extending the period of industrial suitability of this new sugarcane cultivar even further.

Cultivar RB036066 has good plant health, is resistant to brown rust (*Puccinia melanocephala* Syd. and P. Syd.) and tolerant to orange rust of sugarcane (*Puccinia kuehnii* EJ Butler), and to sugarcane smut (*Sporisorium scitamineum* (Syd.) M. Piepenbr, M. Stoll & Oberw.).

Cultivar RB36066 was evaluated for the presence of the *Bru1* gene, which confers resistance to brown rust, caused by *Puccinia melanocephala*. Two markers (R12H16 and 9O20-F4-Rsal) that are strongly associated with *Bru1* gene were used. Amplification conditions and restriction using the Rsal enzyme were carried out according to Costet et al. (2012). The presence of the *Bru1* gene was confirmed in RB36066 for both markers evaluated.

OTHER TRAITS

According to the official descriptors for sugarcane (SNPC/MAPA), cultivar RB036066 has an upright growth habit and the stalks have curved internodes, an oval section, arranged in a slight zigzag pattern, medium to long length, and mean diameter, with yellow-purple and purple-green color when exposed to sun, without wax or cracks.

The sugarcane heart is purple green, with little wax, medium length and oval cross section. The quantity of slightly dark green leaves is regular, the leaf architecture arched, with ascending ligule and medium, lanceolate auricles, distributed unilaterally.

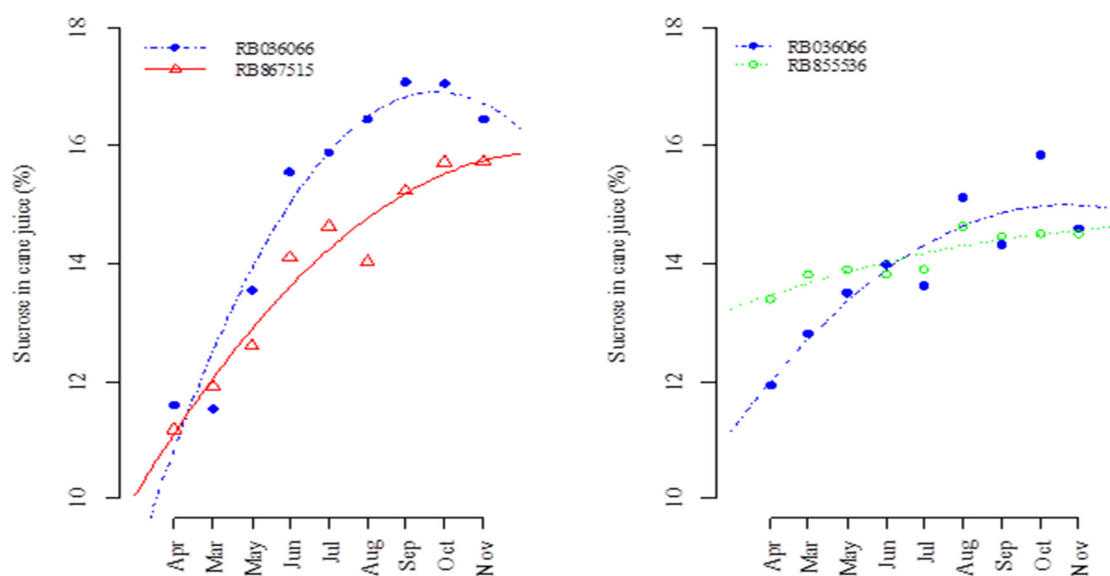


Figure 3. Maturation curves of RB036066 and two other important sugarcane cultivars planted at four different locations in the South-central region of Brazil.

The growth ring is yellow-green, medium wide and medium salient. The root area is medium wide, medium salient, with bud insertion close to the leaf scar. Clear presence of wax in the root node region. The bud is oval, slightly prominent, medium-sized, occasionally exceeding the growth ring, with narrow flower cushion, germ pore in apical position surrounded by hairs.

MAINTENANCE OF SEEDLINGS AND DISTRIBUTION

The seedlings of cultivar RB036066 are maintained and distributed by the Sugarcane Breeding Program of the Department of Plant Science and Plant Health of the Federal University of Paraná, 80.035-050, Curitiba, PR, Brazil.

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