

## RB036091 – an early-maturing sugarcane cultivar for the Central South of Brazil

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**Abstract:** Cultivar RB036091 is an early-maturing sugarcane with a long period of industrial suitability; in the Central South region of Brazil, harvest is recommended between April and August, and the cultivar is indicated for planting on moderate to highly fertile soils. It is widely adaptable and has a high sugar yield and stability of agricultural yield.

**Keywords:** *Saccharum* spp., selection, crop breeding.

### INTRODUCTION

A group of 10 Federal Institutions of Higher Education in Brazil (UFAL, UFG, UFMT, UFPI, UFPR, UFRPE, UFRRJ, UFS, UFSCar and UFV) form RIDESA, an interuniversity consortium for the development of the sugarcane sector, which is working on the creation of new cultivars (Barbosa et al. 2012, Barbosa et al. 2015, Carneiro et al. 2016, Daros et al. 2017, Daros et al. 2018, Carneiro et al. 2019 and Diniz et al. 2019). The sugarcane (*Saccharum* spp.) breeding program of the Federal University of Paraná (UFPR) also belongs to this group, since UFPR has become one of the main institutions of breeding research and has released six sugarcane cultivars in recent years. The most important was cv. RB966928, the second most cultivated in Brazil in the 2018/2019 growing season (Braga et al. 2019). Some of the main breeding objectives of the programs for the main cultivation regions of the country are high-yielding and early-maturing cultivars, tolerant to the main diseases and adapted to mechanical planting and harvesting.

Cultivar RB036091, released in 2015 after 12 years of evaluation, has become a relevant option in the range of sugarcane lines for mid-season harvest in medium to high-yielding environments in the Central South region. The cultivar was registered and protected in 2017 (registration no. 20170212) and protection entered into force as of 03/03/2017.

### BREEDING PROGRAM AND PEDIGREE

In May 2003, RB036091 was derived from a multiple cross with the female parent RB855589, on a hybridization field of the Federal University of Alagoas (9°18'S, 35°56'W; 500 m asl), in Murici, AL (Figure 1). In August of the same year, the resulting seeds were germinated on an experimental field

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of UFPR, in the county of Paranavai, PR, (23°02'S, 52°17'W, 480 m). In November, the seedlings were planted in the field, at two locations in northwestern Paraná, thus establishing the first selection phase (T1) with approximately 200,000 seedlings.

In July 2005, the clones in the first ratoon crop stage were selected individually, representing the second selection stage (T2). Each T2 clone was planted on an experimental plot (approximately 15 m<sup>2</sup>), in an augmented block design. In 2008, cultivar RB036091 was selected for the superior agro-industrial performance over commercial standards in three harvests.

In the third stage (T3), the clones were evaluated over two harvests at eight locations in Paraná (Table 1). Two years later, a clonal propagation phase was installed, and in 2011, the last test phase, called experimental phase (EPh), was planted at eight locations in Paraná. In this phase, agronomic and industrial characteristics were evaluated, as well as their adaptability to and stability in the various edaphic and climatic regions in the north and northwest of Paraná. The EPh phase was conducted during four growing seasons. In the four years of evaluation, the natural infection of the main sugarcane diseases was assessed.

During the plant cane and first ratoon crops, the maturation curve of RB036091 was evaluated in different environments of the state of Paraná.

Before indicating RB036091 for cultivation in Brazil, data were compiled in 54 experimental harvests, from the plant cane (24 harvests) to the third ratoon (8 harvests), which confirmed the main qualities and superior traits of cultivar RB036091, in particular the high sucrose yield in cane plant and ratoon crops and good plant health.

## PERFORMANCE

The experimental data of the mill and distillery areas clearly showed higher yields of cv. RB036091 in relation to the commercial standard cultivars RB855536 and RB867515, with an average of > 100 cane yield (TCH; t ha<sup>-1</sup>) after four cuts and with a higher mean stalk and sugar yield (TPH; t ha<sup>-1</sup>) of cv. RB855536 across the harvests (Table 2).

In a comparison of cultivar RB036091 with RB867515, the TCH and TPH yield increased by 14% and 17%, respectively, over four growing seasons (Table 2). An evaluation of the performance of cv. RB036091, using the adaptability and stability method of Eberhart and Russel (1966) (Figure 2), showed responsiveness, indicating superior yield-related traits of cultivar RB036091 over RB867515, especially in medium to high-yielding environments.

The results of cv. RB036091 were best in environments with medium to high agricultural fertility, exceeding the performance of the cultivars used as experimental standards (RB867515 and RB855536). Consequently, it is indicated for planting in the sugarcane-growing environments A, B and C (Demattê 2004).

The maturation curve, indicating sucrose accumulation in a sequence of periodic harvests, was established for growing environments in the Paraná and São Paulo, two of the major sugarcane-growing states in the Central South region of Brazil. Sucrose percentage in cane juice (SPC) was calculated by the methodology described by Fernandes (2003). The SPC of the maturation curve classifies cv. RB036091 as medium-maturing, indicated for cultivation as of June in the Central South region (Figure 3). Compared to commercial cultivars harvested in the same growing

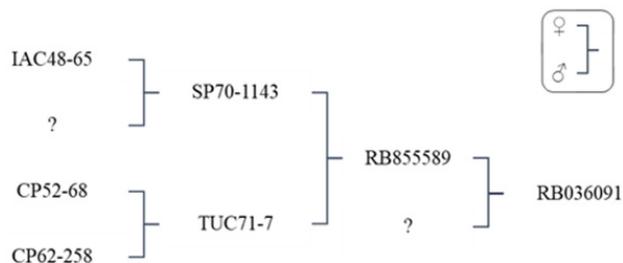


Figure 1. Pedigree of cultivar RB036091.

Table 1. Experimental locations of the phases T3 and EPh in the state of Paraná, Brazil

Sites	Latitude (S)	Longitude (W)	Altitude (m)
Mandaguaçu	23° 20'	52° 00'	570
Bandeirantes	23° 00'	50° 20'	490
Paranavai	23° 00'	52° 17'	480
Colorado	22° 50'	51° 50'	400
Goioerê	24° 08'	53° 00'	550
Perobal	23° 55'	53° 22'	400
Astorga	23° 10'	51° 08'	633
São Pedro do Ivaí	23° 51'	51° 40'	400

**Table 2.** Means of the main agro-industrial characteristics of cv. RB036091, compared with the standard cultivars RB867515 and RB855536, evaluated from 2011 to 2014, in Paraná, Brazil

Crop cycle	Cultivars	TCH <sup>€</sup>	(%)*	TPH	(%)*	SPC%	(%)*	Fiber	(%)*
Plant cane	RB867515	100.61 a	100	13.88 a	100	13.54 a	100	12.04 a	100
	RB855536	82.24 b	82	11.27 b	81	13.70 a	101	12.32 a	102
	RB036091	104.15 a	104	14.35 a	103	13.78 a	102	12.81 a	106
First ratoon	RB867515	100.26 b	100	13.72 b	100	13.69 a	100	11.70 a	100
	RB855536	117.52 ab	117	16.52 a	120	14.06 a	103	11.07 a	95
	RB036091	122.96 a	123	18.27 a	133	14.86 a	109	11.92 a	102
Second ratoon	RB867515	79.23 b	100	12.30 b	100	15.53 b	100	12.44 a	100
	RB855536	91.15 a	115	13.09 ab	106	14.36 a	92	12.75 a	103
	RB036091	87.64 a	111	13.79 a	112	15.73 a	101	12.48 a	100
Third ratoon	RB867515	71.65 c	100	10.95 b	100	15.28 a	100	13.35 a	100
	RB855536	99.70 a	139	14.78 a	135	14.82 a	97	12.80 a	96
	RB036091	89.02 b	124	13.77 a	126	15.47 a	101	12.95 a	97
Mean	RB867515	87.94	92	12.82	92	14.51	100	12.38	100
	RB855536	97.65	102	13.90	100	14.24	98	12.24	99
	RB036091	100.94	106	15.10	109	14.96	103	12.54	101

€ TCH = tons of cane per hectare, TPH = tons of Pol per hectare and SPC = sucrose percentage in cane juice (apparent sucrose percentage); \* Relative yield of the variable, considering cultivar RB867515 as reference. Means followed by the same letter in a column (crop cycle) are not significantly different by Tukey's test at 5% probability.

season, the curve showed that the sucrose levels of cv. RB036091 exceeded those of RB835054 and RB855536 between June and October, in restrictive as well as favorable environments.

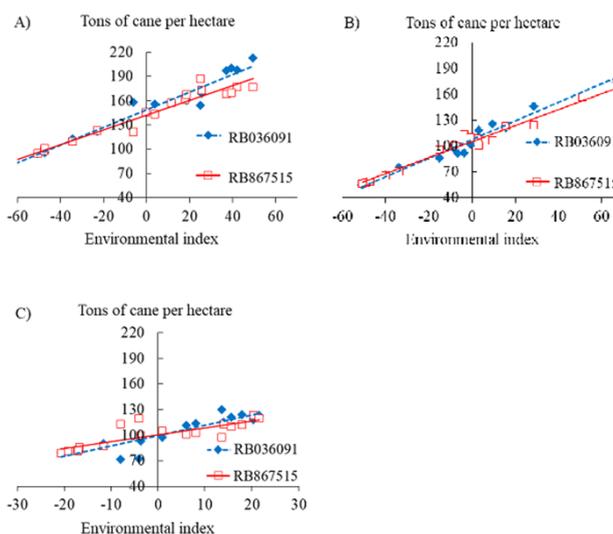
From June onwards, the SPC increased and remained high and constant until October. Therefore and due to the high stalk and sugar yields in the harvest between June and September, this new cultivar is an excellent alternative for sugarcane cultivation for the Central South region.

Cultivar RB036091 has rapid early growth, excellent sprouting and tillering capacity in cane plant and ratoon crops, excellent canopy closure and high yield stability, as well as responsiveness to environmental improvements.

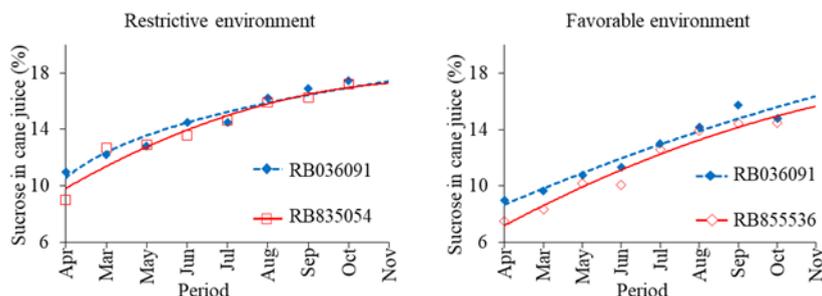
In years with high flowering occurrence in the sugarcane fields, occasional flowering of cultivar RB036091 was observed, but in evaluations of stalk density and SPC, the losses were lower than in other commercial cultivars evaluated in the FEPH.

However, in the 2017/18 growing season, which was favorable for this event, no flowering of cv. RB036091 was observed, with average scores of 1/1 (Daros et al. 2019), i.e., until the evaluation month (July), rare flowering or no tiller growth was recorded. Compared with cv. RB92579, with a tiller induction of 25%, no stalk density loss and therefore no stem pithiness of the tillers was observed.

Cultivar RB036091 is tolerant to two relevant sugarcane diseases: sugarcane smut (*Sporisorium scitamineum*) and orange rust (*Puccinia kuehni*) and is resistant to brown rust (*Puccinia melanocephala*). To assess brown rust resistance, cv. RB036091 was evaluated for the presence of the resistance gene *Bru1*, which was confirmed using the



**Figure 2.** Adaptability and stability of cultivar RB036091 and RB867515 in eight growing environments in (A) plant cane, (B) first ratoon crop and (C) second ratoon crop, in Paraná, Brazil.



**Figure 3.** Maturation curves of cultivar RB036091 in comparison to the commercial cultivars RB835054 and RB855536, in restrictive and favorable environments in Paraná, Brazil.

molecular markers R12H16 and 9O20-F4-*Rsal*. The PCR reactions and amplification conditions were carried out as proposed by Costet et al. (2012). The evaluated markers confirmed the presence of gene *Bru1* in RB036091.

## OTHER TRAITS

Based on the minimum descriptors for sugarcane (SNPC/MAPA), cv. RB036091 has a slightly decumbent (semi-erect) growth habit and has medium to high tillering intensity, stalks with cylindrical internodes and a circular cross section arranged in a slight zigzag, with medium internode length and diameter, which are purple-yellow under straw, purple when exposed to sunlight and waxy. The cane top is medium long, green-purple with a weak to regular amount of wax. The bud shape is oval, slightly prominent, medium wide, with a narrow bud cushion and pubescence surrounding the bud. The leaves have an arched blade curvature, regular to high density, medium-wide limbs, few hairs, intermediate light to dark green color, an ascending ligule and medium auricle, and lanceolate with unilateral distribution. The root band has medium width and salience, is purple yellow under the straw, with narrow bud insertion in relation to the growth ring.

## SEEDLING MAINTENANCE AND DISTRIBUTION

Seedlings of cv. RB036091 are maintained and distributed at the Federal University of Paraná, 80.035-050, Curitiba, PR, Brazil, by the RIDESA Breeding Program.

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