

RB985476 – a sugarcane cultivar with high agro-industrial yield and disease resistance

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Abstract: *RB985476 has a high tillering capacity, excellent canopy cover, high longevity, high agro-industrial yield, medium to low fiber content and high germination capacity after mechanical harvesting. RB985476 is resistant to smut, brown and orange rusts and recommended for harvest in the middle growing season in the south-central region of Brazil.*

Keywords: *Saccharum spp.*, breeding, productivity.

INTRODUCTION

Sugarcane is an important crop for food and bioenergy production. Breeding programs around the world search for more productive cultivars and that meet the demands of agricultural and industrial production. The Federal University of São Carlos (UFSCar) had a sugarcane breeding program (PMGCA) recognized worldwide and that is part of the the Inter-University Network for the Development of Sugarcane Industry (RIDESA, www.ridesa.com.br). RIDESA is a network of ten public Federal Universities that have successfully developed sugarcane cultivars adapted to different environments and agricultural managements enabling cultivation in more than 9 million hectares in Brazil (Carneiro et al. 2016, Chapola et al. 2016, Daros et al. 2017, 2018, Carneiro et al. 2019). A new cultivar, RB985476, released by PMGCA/UFSCar, has high tillering and excellent ratooning ability even under mechanized harvesting. In addition, this new cultivar is suitable for mechanical planting and is resistant to major sugarcane diseases.

PEDIGREE AND BREEDING METHOD

The RB985476 cultivar was originated from a full-sib cross between female H53-3989 and male RB855206 (Figure 1) performed in 1998 at the Flowering and Crossing Station of Serra do Ouro in the municipality of Murici, Alagoas state, Brazil (lat 9° 14' 35.7" S, long 35° 50' 15.2" W, alt 450 m asl). Sugarcane caryopses were germinated under controlled conditions in the same year as the crossing by the Sugarcane Breeding Program of the UFSCar on the grounds of the Centre for Agricultural Sciences (CCA) in the municipality of Araras, São Paulo state, Brazil. Seedlings were transplanted to the field for the first selection stage (T1), in which each genotype was selected in the

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first ratoon for morphological traits such as higher stalk number, absence of flowering, reduced bagasse pith, and greater resistance to major diseases (Morais et al. 2015, Brasileiro et al. 2016).

The selected clones were then planted in an experimental trial consisting of an augmented block design (first clonal assessment trial - T2) (Federer 1956), together with several standard commercial cultivars, at two different locations in the state of São Paulo: Araras (lat 22° 18' 57.7" S, long 47° 22' 49.5" W, alt 707 m asl) and Valparaíso (lat 21° 19' 07.9" S, long 50° 55' 49.7" W, alt 460 m asl). Each experimental plot consisted of two 2.5 m rows, with no replicates. Clones were evaluated in plant cane and in the first and second ratoon crops based on the same criteria as described in T1, as well as the stalk weight per plot (WP) and kilogram of brix per plot (KBP) (Balsalobre et al. 2016). Clones with desirable traits were selected and then planted in an augmented block design (Federer 1956) at five locations under different climate and soil conditions in separate regions of Sao Paulo state (Table 1). At this stage, plots consisted of two 5 m rows spaced 1.40 m apart, with two replicates. Selection was carried out based on the mean performance of both plant and ratoon crops across all environments. Selection criteria were similar to those in stage T2, with sucrose content (PC expressed in %) and kilogram of pol per plot (KPP) considered as additional traits (Morais et al. 2015, Diniz et al. 2019).

At the completion of stage T3, the selected clones were planted in the final assessment trials (FAT), arranged in a randomized block design with three or four replicates. Standard commercial cultivars of intermediate/late maturation were used as controls and distributed within the blocks. A total of 14 experimental trials were distributed over several regions, each with distinctive soil and climate conditions. Data from three to four harvests (plant cane and two and/or three ratoon crops) were analyzed (Table 1). Agronomic and agro-industrial traits evaluated at the final stage consisted of tons of cane per hectare (TCH), PC, tons of pol per hectare (TPH), and fiber content (%). In addition, coefficient of environmental variation, effects of genotype × environment interaction, and clone adaptability and stability (Eberhart and Russell 1966) were estimated by individual (each site) and combined (all sites) analyses of variance. A maturation curve constructed from the most promising FAT clones was used to identify the best harvest period according to the PC.

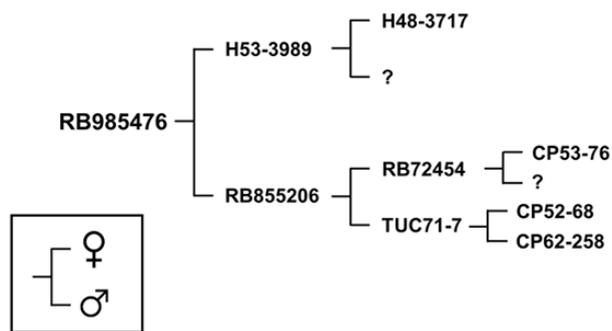


Figure 1. Pedigree of sugarcane cultivar RB985476.

Table 1. Locations of the third selection stage (T3) and final assessment trials (FAT) in São Paulo state, Brazil

Locations	Latitude	Longitude	Altitude	Stage
Sertãozinho	21° 08' 16" S	47° 59' 24" W	601 m	T3
Tarumã	22° 44' 56" S	50° 34' 42" W	429 m	T3/FAT
Nova Europa	21° 46' 52" S	48° 33' 57" W	502 m	T3/FAT
Barra Bonita	22° 28' 22" S	48° 33' 49" W	526 m	T3/FAT
Guariba	21° 21' 48" S	48° 13' 49" W	649 m	T3/FAT
Guaíra	20° 19' 31" S	48° 18' 39" W	518 m	FAT
Pradópolis	21° 21' 33" S	48° 04' 20" W	533 m	FAT
Araraquara	21° 47' 38" S	48° 10' 33" W	664 m	FAT
Américo Brasiliense	21° 43' 26" S	48° 06' 07" W	715 m	FAT
Olímpia	20° 44' 13" S	48° 54' 39" W	480 m	FAT
Cosmópolis	22° 38' 45" S	47° 11' 45" W	652 m	FAT
Paraguaçu Paulista	22° 24' 48" S	50° 34' 32" W	509 m	FAT
Piracicaba	22° 43' 41" S	47° 38' 49" W	526 m	FAT
Catanduva	21° 08' 16" S	48° 58' 22" W	503 m	FAT

PERFORMANCE

Cultivar RB985476 has slow initial development and a semidecumbent growth pattern. The stalks are of medium diameter, are yellowish green in color, and have a green, slightly purplish, and lightly waxed sheath. Tillering capacity is high and exhibits longevity with good capacity of germination under mechanical harvesting besides good canopy cover. In addition, cultivar RB985476 also has a high agro-industrial yield (Table 2), yield stability, and medium to low fiber content. Under the climatic and soil conditions prevalent in south-central Brazil, the harvest may occur between July and September (Figure 2). Furthermore, cultivar RB985476 eventually flowers and produces little to no pith.

RB985476 is responsive when allocated to better soils and climate. Agricultural yield (TCH) was determined to be higher than that of cultivar RB867515 in intermediate to favorable environments, and similar in more unfavorable environments (Figure 3). This response of RB985476 has been demonstrated in pre-commercial areas, and therefore cultivation of RB985476 is recommended in environments classified as intermediate and favorable by Prado (2008).

The agricultural yield (TCH) and sucrose content (PC in %) produced by RB985476 cultivar were 126 t ha⁻¹ and 15.3%, respectively. The performance of agro-industrial yield (TPH) was superior to that of commercial standard cultivars of intermediate/late maturation, based on means of the data deriving from the three to four harvests included in the 13

Table 2. Means tons of cane per hectare (TCH) and tons of POL per hectare (TPH) of cultivars RB985476 and RB867515, according to the type of environment and crop cycle. Estimation of yield gain of cultivar RB985476 compared to cultivar RB867515. Mean results of 42 harvests in São Paulo state, Brazil

Environments	Crop cycle	TCH				TPH			
		RB985476	RB867515	Difference ¹	%	RB985476	RB867515	Difference	%
All environments	Plant-cane	162.94	159.07	3.87	2.43	23.13	22.16	0.97*	4.38
	First-ratoon	118.13	116.65	1.48	1.27	18.45	18.06	0.39*	2.16
	Second-ratoon	106.00	99.07	6.93*	7.00	17.07	15.55	1.52*	9.77
	Mean	129.80	126.22	3.58*	2.84	18.97	18.24	0.73*	4.00
Favorable environments	Plant-cane	178.71	172.64	6.07	3.52	25.11	23.82	1.29	5.42
	First-ratoon	128.14	126.90	1.24	0.98	19.08	18.80	0.28	1.49
	Second-ratoon	125.74	115.97	9.77*	8.42	20.17	17.85	2.32*	13.00
	Mean	145.58	141.26	4.32	3.06	20.74	19.79	0.95*	4.80
Unfavorable environments	Plant-cane	144.55	143.24	1.31	0.91	20.81	20.22	0.59	2.92
	First-ratoon	108.12	106.4	1.72	1.62	17.83	17.32	0.51	2.94
	Second-ratoon	86.26	82.18	4.08*	4.96	13.98	13.25	0.73	5.51
	Mean	111.41	108.68	2.73	2.51	16.91	16.43	0.48*	2.92

¹ Difference between cultivar RB985476 and reference RB867515; * Significant at 5% (t test).

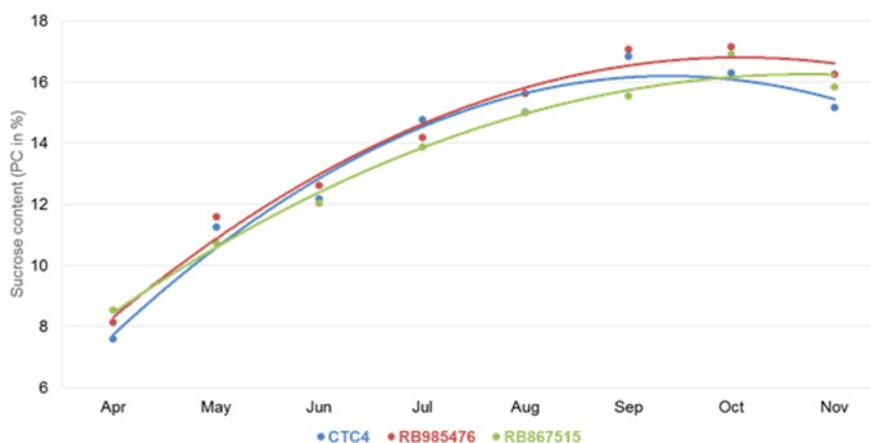


Figure 2. Comparison of the sugarcane cultivar RB985476 maturation curve with those of the commercial standard cultivars CTC4 and RB867515.

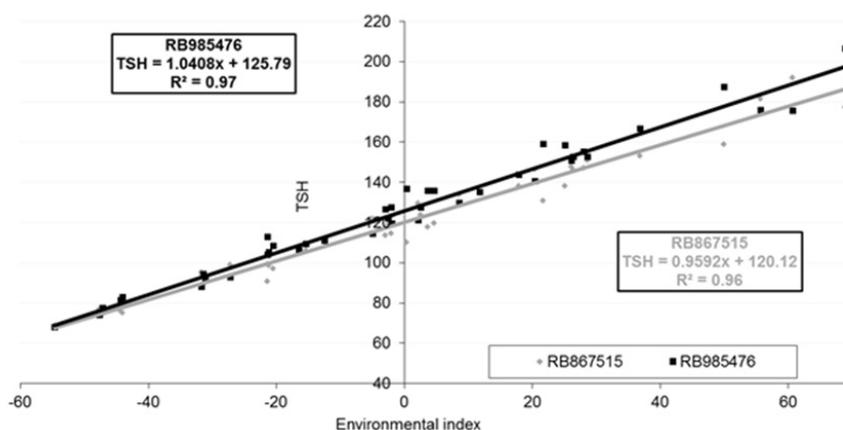


Figure 3. Comparison of cultivar RB985476 adaptability and stability with that of the commercial standard cultivar RB867515. Mean data of tons of cane per hectare (TCH) were adjusted based on regression analysis (Eberhart and Russell 1966). The points indicate the dataset of 13 experiments and a total of 41 harvests.

experiments.

OTHER CHARACTERISTICS

Disease response

RB985476 was evaluated to major sugarcane diseases through tests of artificial inoculation and natural infection, as a means of assessing the response against pathogens of the environments of south-central Brazil.

Natural tests were carried out in areas favorable to infection by several diseases due to climatic conditions and high inoculum pressure. Resistance to The main diseases evaluated under natural infection conditions were orange rust (*Puccinia kuehni*), brown rust (*Puccinia melanocephala*), smut (*Sporisorium scitamineum*), leaf mosaic (sugarcane mosaic virus), and leaf scald (*Xanthomonas albilineans*) were assessed under conditions of natural infection. Evaluations were based on leaf area percentage with symptoms (% severity) for orange and brown rusts (Amorim et al. 1987) and on the number of infected clumps (% incidence) for smut, leaf mosaic, and leaf scald.

Greenhouse tests of artificial inoculation for smut and mosaic were conducted in accordance with the procedures according to Matsuoka (1979). Evaluations were based on a grade scale for each disease, which considers the amount of infected plants (% incidence) and is used to classify the genotype as resistant, intermediate, or susceptible to infection by that pathogen. The results of the inoculation tests indicated that RB985476 is highly resistant to the rusts and smut, tolerant to leaf scald, and moderately resistant to leaf mosaic (Table 3). It is therefore recommended that this cultivar be planted without restriction.

In addition, analysis of extracted genomic DNA with R12H16 and 9O20-F4-*Rsa*I, two molecular markers commonly used in the diagnosis of *Bru*1, a gene associated with brown rust resistance (Costet et al. 2012), revealed the presence of the *Bru*1 gene in RB985476 (haplotype 1, Table 3).

Basic seed maintenance and distribution

Seedlings of cultivar RB985476 are maintained and distributed by the Sugarcane Breeding Program of the Federal University of São Carlos, Araras, São Paulo, Brazil, and have been registered with the RNC (#36370) and SNPC (#20170233).

Table 3. Resistance of RB985476 cultivar to common sugarcane pathogens in south-central Brazil

Disease	Cultivar RB985476
Smut	R
Brown rust	R ⁺
Orange rust	R
Leaf mosaic	MR
Leaf scald	T

R = resistant

T = tolerant

MR = moderately resistant

+ = Presence of *Bru*1 molecular markers (haplotype 1: presence of both R12H16 and 9O20-F4-*Rsa*I markers).

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