Sugarcane Varieties for Animal Feeding in the Pre-Amazon Region of Brazil

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Received: July 9, 2019      Accepted: August 29, 2019      Online Published: October 15, 2019
doi:10.5539/jas.v11n17p309          URL: https://doi.org/10.5539/jas.v11n17p309

Abstract
The expansion of agricultural frontiers in Brazil has resulted in the growth of ruminant production in the Pre-Amazon Region. However, this production is favored mainly in the rainy season, due to the greater supply of pasture for the animals. This fact limits the maintenance of production due to the lack of quality forage for the animals throughout the year. This work aimed to evaluate the nutritional value of the different sugarcane varieties for animal feeding during four crop cycles. In this experiment, the varieties RB 92579, RB 867515 and RB 863129 were studied for cane plant, first, second and third ratoons. The experiment was divided in four stages according to each cycle, and each cycle lasted approximately 10 to 11 months. For the productivity analysis and other parameters samples were collected at the end of each experimental cycle, when the dry matter (DM), crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), Brix, NDF/Brix and productivity were determined. The RB 92579 variety showed higher productivity ($P < 0.05$) in all the studied cycles, and remained above the national productivity average in all the cycles ($±75$ ton ha$^{-1}$). This same variety, presented the best results for all nutritional parameters (DM, CP, NDF, ADF and FDN/Brix) when compared to the other varieties. The productivity/nutritional relation value must be taken into account when choosing a variety for animal feeding, being the RB 92579 variety the most expressive, during four cycles, which lasted 4 years.

Keywords: nutritional value, productivity, Saccharum spp.

1. Introduction
With the expansion of agricultural frontiers in Brazil, the Pre-Amazon Region is in full growth with regard to the production of ruminants, mainly goats, sheep, and dairy cattle. However, this growth is considered seasonal, once the production is only accentuated in the rainy season when there is a greater supply of pasture for the animals. This fact is a limiting factor for the constant maintenance of production due to the lack of quality forage for the animals throughout the year, specially in the Pre-amazon region, where research is needed to improve ruminant production.

The Brazilian Legal Amazon Region extends over an area of approximately 5,200,000 km$^2$ and represents 59% of Brazil’s land mass. Its population of twenty four million people are distributed over 775 municipalities and the region is home to a very high ecological and socio-economic diversity. The livestock activity in these region has its importance in the socioeconomic-spatial context. Thus, agriculture studies in the Pre-Amazon region represent an important role, since results found can be expected to expand to other parts of Amazon, where it is important to maintain sustainability (Silva et al., 2009).

Used in the rest of the country as an excellent forage resource in the dry season due to its innumerable attributes, such as the easy implantation, the need for few crop treatments, as well as its high productivity (ranging from 100 to 120 ha$^{-1}$ or even more), sugarcane has increased its expressiveness in the agricultural scenario in Brazil’s Pre-Amazonian Region, currently with 840 ha$^{-1}$ planted, and average productivity of 51.64 ton ha$^{-1}$ in this region (Vidal, 2018). In addition, their harvest season coincides with the period of pasture shortage. Regarding animal feeding, the nutritional value of sugarcane should not be considered as an isolated factor, but as a complex formed by chemical composition, and secondary constituents that, together, may interfere with the ingestion and
use of the forage consumed by the ruminants, as well as other factors, such as age, parts of the plant and mainly the variety.

In view of the diversity of the available varieties in the industry, the varieties selection for forage purposes is of great importance and is directly linked to the success of the nutritional management of the animals, where the adequate choice is the guarantee to have good bulky quality throughout the period of forage shortage (Silva et al., 2018). However, one point to be observed is that this forage also has other characteristics that may limit its use by animals of great genetic potential, among which, highlights the low crude protein, sulfur, phosphorus, manganese, and slow ruminal degradation fiber that limits the intake of dry matter (Goes et al., 2018), there is thus, the need to select varieties that have the highest crude protein, low fiber content, combined with high productivity.

In addition to increasing productivity, the use of best-adapted cultivars is a low-cost input in the production system and, therefore, easily adopted by farmers. Thus, new cultivars resulting from the identification of parameters of high yield and acceptable quality in different regions must be constantly assessed, while considering, in particular, the existence of genotype × environment interactions to determine the agronomic behavior of the genotypes and their adaptation to different local conditions.

In this context, for the success of animal production in this region while maintaining environmental sustainability, it is evident the need for studies on the nutritional value of sugarcane varieties for a better choice in the implantation of this crop, in order to meet the needs of animal feeding. Thus, this study aimed to evaluate the nutritional value of different sugarcane varieties for animal feeding, with higher potential for the Pre-amazon region of Brazil.

2. Method

This study was conducted in an experimental area at the Federal University of Maranhão, located at latitude 3°44′26″ and longitude 43°21′33″, along with four crop cycles (cane plant, 1st, 2nd, and 3rd ratoons). The climate of the region corresponds in the Koppen classification to type Aw, and it is characterized by rains in summer and dry in winter. The soil in the region is classified as Oxisol-Latossolo Amarelo (Embrapa, 2013), and presented the following characteristics: pH 4.82 in water, 0.81 cmolc dm⁻³ Ca, 1.54 cmolc dm⁻³ Mg, 0.01 cmolc dm⁻³ Na, 0.01 cmolc dm⁻³ K, 0.48 cmolc dm⁻³ Al, 4.83 cmolc dm⁻³ H + Al and 0.54 mg kg⁻¹ P.

The average temperature during the experimental period was 29 °C, and the average rainfall was 120 mm in the summer, and 27.5 mm in the winter, according to the data obtained by the Northeast Region Real-Time Climatic Monitoring Program (PROCLIMA) in the INPE CPTEC site (Figures 1A and 1B). The experiment was implemented in May 2013, with conventional soil preparation, and the varieties used were: RB 867515, RB 863129 and RB 92579.
The RB 92579 variety presents a high sprout, high tillering for both cane plant and ratoons, providing a good closing between the lines. Classified as medium ripeness, this variety expresses high productivity with high sucrose and average fiber contents. The RB 867515 variety, by being fast growing, presents high sprouting for both cane plant and for regrowth, average tillering and good closure between rows. The production and sucrose contents are high, but their maturation is late. The RB 863129 variety, presents excellent sprouting for cane plant and great regrowth for the ratoons, combined with a good closing between the lines. It presents high productivity and high sucrose contents, with an average fiber content (Singh et al., 2017).

The fertilization of the cane plant occurred after the rooting of the seedlings, using the super-triple phosphate and potassium chloride in the doses of 120 kg P₂O₅ ha⁻¹ and 140 kg K₂O ha⁻¹. In the consecutive cycles (1st, 2nd, and 3rd ratoons), urea was used as a source of nitrogen and potassium chloride as a source of potassium in the doses of 120 kg N ha⁻¹ and 140 kg K₂O ha⁻¹. For all the evaluated cycles, approximately 300 days after the fertilizer application, which occurred one month after each harvest of each cycle, the manual harvesting and despoiling of the sugarcane was performed to evaluate the productivity.

The yield of stalks was obtained by taking the fresh weight of stalks collected in a useful area of 3 m² in each plot to estimate productivity. After that, three plants of each plot were randomly collected. Subsequently, the material was ground in a Willey mill to obtain 1.0 mm particles to determine the dry matter (DM) content and, based on DM, the crude protein (CP) content, according to methodologies described by Silva and Queiroz (2002); neutral detergent fiber (NDF), acid detergent fiber (ADF) by the Van Soest method, described and simplified by Souza et al. (1999). The soluble solids content (%) of sugarcane was measured with the aid of a field refractometer, according to the methodology proposed by Costa et al., (2017). The NDF/Brix ratio was calculated according to the method proposed by Magalhães et al. (2018), taking into account the fiber content in relation to the soluble solids content in sugarcane.

The experimental design was completely randomized, with the arrangement in 3 × 4 split plots (three varieties x four years). The data were submitted to the Shapiro Wilk normality test and Cochran homoscedasticity and obtained a normal distribution and a homoscedastic population, in which case there was no need to transform them. All data were submitted to the variance analysis and had the average compared by the Turkey test at 5% (p < 0.05) of probability by the Infostat 2016 program.
3. Results and Discussion

3.1 Productivity

The production of green mass per hectare is an important measure to enable the choice of a variety for animal feeding. As sugarcane destined for animal feeding is generally not handled as effectively, and as the cane is generally cultivated for industrial purposes, the productivity of green matter is generally lower than 100 ton ha⁻¹ (Walter et al., 2015).

For the productivity parameter, the RB 92579 variety was higher regarding the others (P < 0.05), with a productivity 22% higher (100 ton ha⁻¹) when compared to RB 867515, with the productivity of 90 ton ha⁻¹ and with RB 863129, with a productivity of 89 ton ha⁻¹, there was no significant difference (P > 0.05) between these two varieties (Figure 2). These results demonstrate that the varieties obtained had productivity above the national average of 75 ton ha⁻¹ according to the CONAB (2016) data.

In the 1st, 2nd and 3rd ratoons was observed that the RB 92579 variety (Figure 1) obtained again a higher productivity of stalks (P < 0.05) (90.89 and 75 ton ha⁻¹ respectively) when compared to the others varieties (RB 867515 at 78.77 and 66 ton ha⁻¹ and RB 863129 at 80, 78.5 and 50 ton ha⁻¹) (Figure 2).

Figure 2. Productivity of three varieties of sugarcane in four experimental years. Different capital letters within the cycles and lowercase letters between the cycles differ statistically by the Tukey test (P < 0.05)

Comparing the data of cane plant and the 1st ratoon of the three varieties with those obtained in the 2nd and 3rd ratoons, it is observed a drop in stalks productivity. The RB 92579 variety that presented better results in the stalks productivity, had a decrease of 2% when compared to the first ratoon, and of 11% when comparing the cane plant with the second ratoon. According to Cervone et al. (2018), the loss of productivity during the cycles is inevitable by being a regrowth.

In general, the RB 867515 and 863129 varieties expressed productivity (P < 0.05) lower than the RB 92579 variety in all cycles. This result can be explained by the information from the Catálogo Nacional de variedades de cana de açúcar “RB” (Ridesa, 2010), which mentions that these two varieties are more demanding on soil fertility, thus having minor responses even when subjected to similar conditions.

In works conducted by Antunes (2017) the RB 92579 was shown as one of the most productive variety, with values ranging from 90 to 100 ton ha⁻¹ followed by the RB 867515 variety.

It is important to point out that all the evaluated varieties presented average productivity up to the 2nd ratoon higher than expected for the national average, which was 73 to 75 ton ha⁻¹ for the agricultural year 2015/2016 (CONAB, 2016). In the 3rd ratoon, only the RB 92579 variety was above this average, as a consequence of the adequate management adopted during the experimental period, with the use of manual harvesting and without burning allied to intrinsic factors of the variety itself.

The yield of sugarcane stalks may be related to the genetic characteristics of the variety, with emphasis on drought tolerance and fast growth with high productivity (Baracat Neto et al., 2017). Allied to this, there is the fact that the culture is an excellent soil nitrogen extractor due to the long cycle and extensive root system.
Targino et al. (2017) reported that the RB 92579 variety due to its greater rusticity is more efficient in the interception, absorption, and use of N present in the soil, thus reflecting directly on its productivity. Because it is a semi-perennial crop, it was possible to observe during the cycles a decrease in the productivity of all the varieties used. This characteristic is in agreement with the data observed by Vardanega et al., (2015), which reports that this reduction in productivity is related to the attrition suffered by the crop, not the total regrowth of the sugarcane, causing flaws in the lines and also by being an intrinsic feature of the sugarcane crop.

3.2 Dry Matter

The dry matter data for cane plant, 1st and 2nd ratoons for the RB 92579 variety differed significantly (P < 0.05) from the others, presenting higher dry matter (DM) content. In the third ratoon, there was no interaction between the varieties (P > 0.05) (Table 1). According to Bezerra e Ragauskas (2016) that evaluated the RB 92579 variety, together with the characteristics expressed in the Catalogo Nacional de Variedades “RB” (Ridesa, 2010), this better performance is due to this variety present a high sprout and high tillering, both in cane plant and in the ratoons, providing a fast and efficient inter-row closure, coupled with its fast and efficient adaptability to tropical climates.

### Table 1. Dry matter (DM) contents of three sugarcane varieties in four experimental cycles.

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Cane plant SD</th>
<th>1st ratoons SD</th>
<th>2nd ratoons SD</th>
<th>3rd ratoons SD</th>
<th>CV (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RB 92579</td>
<td>30.96 aA (1.51)</td>
<td>32.02 aA (0.8)</td>
<td>33.00 aA (0.9)</td>
<td>25.30 aB (2.0)</td>
<td>10.9</td>
</tr>
<tr>
<td>RB 867515</td>
<td>23.61 bA (1.15)</td>
<td>24.73 bA (0.9)</td>
<td>26.01 bA (0.6)</td>
<td>24.89 bA (0.8)</td>
<td>4.88</td>
</tr>
<tr>
<td>RB 863129</td>
<td>23.09 bA (0.9)</td>
<td>25.01 bA (0.8)</td>
<td>26.82 bA (2.3)</td>
<td>25.08 bA (0.8)</td>
<td>7.25</td>
</tr>
<tr>
<td>CV (%)</td>
<td>15</td>
<td>13.2</td>
<td>12.1</td>
<td>4.9</td>
<td></td>
</tr>
</tbody>
</table>

Note: Averages followed by lowercase letters for the varieties within each cycle and capital letters for each cycle within the varieties differ by the Tukey test at 5%. SD: Standard Deviation.

In a work carried out by Silva et al. (2018) where they used, among others, the RB 92579 and RB 867515 varieties, DM contents ranging from 20.98 to 33.86% were observed, showing that the results may be quite different, depending on the variety, being this factor important, once the production of matter is one of the factors that aims to define the economic potential and the feasibility of implementing a particular variety beyond its indication for animal feed (Sindhu et al., 2016).

The DM contents found in all years were similar to those found in the literature, ranging from 20.4 to 33.9% (Costa et al., 2017; Silva et al., 2019).

3.3 Crude Protein

Regarding the crude protein content (CP) in the stalks, there was no difference (P > 0.05) between varieties for the 1st, 2nd and 3rd ratoons. However, for cane plant, the RB 867515 variety presented lower content (P < 0.05) of CP in relation to the others. In the fourth experimental year (3rd ratoon), an increase in CP content was observed for the three varieties (Table 2).

### Table 2. Crude protein (CP) contents in the stalks of the three sugarcane varieties in four experimental cycles.

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Cane plant SD</th>
<th>1st ratoons SD</th>
<th>2nd ratoons SD</th>
<th>3rd ratoons SD</th>
<th>CV (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RB 92579</td>
<td>2.32 aA (0.3)</td>
<td>1.93 bA (0.3)</td>
<td>1.91 bA (0.7)</td>
<td>2.94 aA (0.7)</td>
<td>18.6</td>
</tr>
<tr>
<td>RB 867515</td>
<td>1.50 bA (0.3)</td>
<td>1.82 aA (0.2)</td>
<td>1.79 aA (0.3)</td>
<td>2.18 aA (0.2)</td>
<td>17.8</td>
</tr>
<tr>
<td>RB 863129</td>
<td>2.13 aA (0.3)</td>
<td>1.52 bA (0.2)</td>
<td>1.55 bA (0.1)</td>
<td>2.29 bA (0.2)</td>
<td>20.8</td>
</tr>
<tr>
<td>CV (%)</td>
<td>12.2</td>
<td>15.0</td>
<td>13.3</td>
<td>20.6</td>
<td></td>
</tr>
</tbody>
</table>

Note: Averages followed by lowercase letters for the varieties within each cycle and capital letters for each cycle within the varieties differ by the Tukey test at 5%. SD: Standard Deviation.

The observed results showed a certain seasonality between the evaluated varieties and between the cutting years, with a decrease of CP being observed during the three years of evaluation for the RB 92579 variety, with an increase in the fourth year. These data are similar to those found by Bezerra et al. (2017), that obtained CP levels
ranging from 1.52 to 2.31%. Then Silva et al. (2018) evaluated the RB 92579 variety, they obtained average CP contents of 2.93%.

Giacomini et al. (2014) found values of 3.6, 2.8 and 2.5% CP over three cycles of the culture. On the other hand, Muraro et al. (2010) found very high values, in the order of 5.49, 6.18, and 3.47% when worked with different cutting times after the fertilization.

Sindhu (2016) obtained values of up to 2.95% of CP when evaluating the RB 92579 variety with different levels of nitrogen fertilization, where it was possible to observe that soil fertility influenced directly in CP contents, the same author expressed that the best CP values were found with the use of 120 kg of N ha⁻¹.

It was observed that in the cycles where there was this reduction in the levels of CP (1st and 2nd ratoons), coincided with the cycles where there was an increase in NDF contents. This trend was also observed by Sani et al. (2016), where these authors relate this reduction in CP contents with an increase in the deposition of structural fibers during the cycles, and the absorption ineffective of nitrogen caused by mechanical stress at the time of cutting.

In the sugarcane leaves, it is possible to find, on average of five to six times the CP amount found in the stalk. This high concentration of CP in the leaves probably occurs due to the high enzymatic activity present in the leaves. However, this amount is not very expressive considering the animal requirement for CP, once the leaves represent an average of 10 to 15% of the total of the plant, and as the digestibility of the NDF present in the leaf is lower than the present in the stalks, the use of genetic improvement to develop a variety with larger amounts of leaves becomes a totally impracticable strategy (Costa et al., 2017).

The CP content in the sugarcane crop is invariably low, being this a characteristic of the forage. Therefore, this parameter should not be used as a criterion when choosing the variety for ruminant feed. However, it is possible to correct this characteristic with low cost, through the use of a source of non-protein nitrogen in the diet, generally the urea (Adejoro et al., 2017).

3.4 Neutral Detergent Fiber (NDF)

The observed values for NDF showed that there was a difference (P < 0.05) among the varieties, where RB 92579 presented higher levels in the first three experimental years (cane plant, 1 and 2 ratoons) (Table 3), while the varieties RB 867515 and RB 863129 did not differ from each other (P > 0.05). In the third ratoon, the RB 867515 variety obtained the lower value of NDF (P < 0.05) when compared to the others.

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Cane plant</th>
<th>SD</th>
<th>1st ratoons</th>
<th>SD</th>
<th>2nd ratoons</th>
<th>SD</th>
<th>3rd ratoons</th>
<th>SD</th>
<th>CV (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RB 92579</td>
<td>48.48ᵃ</td>
<td>(1.3)</td>
<td>51.09ᵃ</td>
<td>(1.4)</td>
<td>51.02ᵃ</td>
<td>(0.2)</td>
<td>44.71ᵇ</td>
<td>(2.0)</td>
<td>6.1</td>
</tr>
<tr>
<td>RB 867515</td>
<td>44.03ᵇ</td>
<td>(1.0)</td>
<td>45.21ᵇ</td>
<td>(0.2)</td>
<td>46.06ᵇ</td>
<td>(1.2)</td>
<td>37.11ᵇ</td>
<td>(1.5)</td>
<td>8.8</td>
</tr>
<tr>
<td>RB 863129</td>
<td>45.65ᵇ</td>
<td>(0.2)</td>
<td>45.02ᵇ</td>
<td>(1.2)</td>
<td>46.02ᵇ</td>
<td>(0.6)</td>
<td>42.44ᵇ</td>
<td>(1.0)</td>
<td>3.6</td>
</tr>
<tr>
<td>CV (%)</td>
<td>4.6</td>
<td>6.6</td>
<td>5.4</td>
<td>8.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Averages followed by lowercase letters for the varieties within each cycle and capital letters for each cycle within the varieties differ by the Tukey test at 5%. SD: Standard Deviation.

In general, all the evaluated varieties obtained averages similar to those observed in studies found in the literature, such as Magalhães et al. (2018) which observed average NDF contents of 44.18%, evaluating 18 sugarcane varieties, among them the varieties RB 92579 and RB 863129. However, Giacomini et al. (2014) found larger NDF contents that ranged from 37.9 to 63.9% of NDF, among them the RB 867515 variety.

Then Sani et al. (2016) found in different varieties average NDF oscillations closer to those observed in this work, with values of 48.66%; 48.1%; 50.40%; 44.78% and 46.02%, among the varieties, were those studied in this study. To complement, these authors describe that varieties with high contents of NDF (above 52%), tend to provide a limiting effect on animal consumption, since it restricts feed intake by ruminants, caused by the filling of the rumen with low digestion material, thus directly implying in the digestibility (Yao et al., 2017). The NDF content of the cane plant in this work was below the average levels found in the literature, where all studied varieties were close to or below the limiting level.
Giacomini (2014) state that it is interesting that the sugarcane variety chose, seeking the ruminant feeding has low contents of fibrous components and higher levels of non-structural carbohydrates, once the fiber is of low digestibility component and sugars of great digestibility.

The obtained data show that the varieties present different dynamics regarding the NDF during the cuts, depending on the genotypes.

### 3.5 Acid Detergent Fiber (ADF)

According to the data obtained (Table 4), it was possible to observe that there was no significant difference in the ADF content among the varieties within the cane plant, 1st and 2nd ratoon cycles. In the third ratoon, the RB 92579 variety differed statistically from the others (P < 0.05), with the lowest content of ADF.

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Cane plant</th>
<th>SD 1st ratoons</th>
<th>SD 2nd ratoons</th>
<th>SD 3rd ratoons</th>
<th>SD CV (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RB 92579</td>
<td>29.46&lt;sup&gt;a&lt;/sup&gt;B (2.3)</td>
<td>30.06&lt;sup&gt;AB&lt;/sup&gt; (3.6)</td>
<td>31.53&lt;sup&gt;a&lt;/sup&gt;A (1.6)</td>
<td>34.50&lt;sup&gt;a&lt;/sup&gt;A (1.8)</td>
<td>9.5</td>
</tr>
<tr>
<td>RB 867515</td>
<td>29.41&lt;sup&gt;a&lt;/sup&gt;B (0.7)</td>
<td>29.37&lt;sup&gt;a&lt;/sup&gt;B (2.0)</td>
<td>29.81&lt;sup&gt;a&lt;/sup&gt;B (1.2)</td>
<td>36.20&lt;sup&gt;ab&lt;/sup&gt;A (1.0)</td>
<td>10.3</td>
</tr>
<tr>
<td>RB 863129</td>
<td>29.55&lt;sup&gt;a&lt;/sup&gt;B (0.8)</td>
<td>29.77&lt;sup&gt;a&lt;/sup&gt;B (0.9)</td>
<td>32.94&lt;sup&gt;ab&lt;/sup&gt;B (2.3)</td>
<td>39.03&lt;sup&gt;a&lt;/sup&gt;A (1.9)</td>
<td>12.8</td>
</tr>
<tr>
<td>CV (%)</td>
<td>4.5</td>
<td>7.5</td>
<td>6.6</td>
<td>7.0</td>
<td></td>
</tr>
</tbody>
</table>

**Note.** Averages followed by lowercase letters for the varieties within each cycle and capital letters for each cycle within the varieties differ by the Tukey test at 5%. SD: Standard Deviation.

Wanapat, Kang, and Polyorach (2013), and Giaconimi et al. (2014) report that for the culture used for animal feeding, it is important to emphasize the choice of low fiber varieties because the ADF is the least digestible from the cell wall by the microorganisms present in the rumen of the animal, and this fiber consists almost entirely of lignin and cellulose.

During the four experimental years, all the varieties showed below the limiting levels expressed by Van Soest (1994), and Silva and Queiroz (2002), who considered that the ADF in sugarcane is a digestible limiting when at levels higher than 40%, where the efficiency in animal use.

In this study was observed a significant increase in the values of ADF with the passing, in fact, Chandra et al. (2015) reported that early and medium varieties as the evaluated in this experiment tend to have higher values of ADF when related to later varieties, once these varieties, tend to have their structural constituents formed faster, being represented by the polysaccharides of the vegetal cell wall, and this characteristic intensifies when passing the cycles of the culture.

According to Euclides et al. (2009), different varieties of sugarcane have unique characteristics, different cellulose/lignin concentrations in the composition of their tissues, and may vary over the cycles. Thus, choosing varieties with lower ADF contents results in a diet of better nutritional value and animal use.

### 3.6 Soluble Solids (SS)

For the soluble solids contents in the stalks, there was no interaction (P > 0.05) between the varieties and the evaluated years (Table 5). The soluble solids contents ranged between 19 and 23.5°Brix, where these were higher than those found by Cruz et al. (2014), and those who observed in their studies, contents ranging from 15 to 20%. These sugars contents present in the varieties can vary according to the cutting season, plant age, climatic conditions, and also by the difference between the methods of obtaining the soluble solids contente.

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Cane plant</th>
<th>SD 1st ratoons</th>
<th>SD 2nd ratoons</th>
<th>SD 3rd ratoons</th>
<th>SD CV (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RB 92579</td>
<td>21.5&lt;sup&gt;a&lt;/sup&gt;A (1.3)</td>
<td>21.5&lt;sup&gt;a&lt;/sup&gt;A (0.6)</td>
<td>23.5&lt;sup&gt;a&lt;/sup&gt;A (0.7)</td>
<td>21.5&lt;sup&gt;a&lt;/sup&gt;A (1.5)</td>
<td>5.8</td>
</tr>
<tr>
<td>RB 867515</td>
<td>19.0&lt;sup&gt;a&lt;/sup&gt;A (0.2)</td>
<td>20.0&lt;sup&gt;a&lt;/sup&gt;A (0.4)</td>
<td>19.5&lt;sup&gt;a&lt;/sup&gt;A (0.3)</td>
<td>20.1&lt;sup&gt;a&lt;/sup&gt;A (0.2)</td>
<td>24</td>
</tr>
<tr>
<td>RB 863129</td>
<td>19.6&lt;sup&gt;a&lt;/sup&gt;A (0.7)</td>
<td>19.0&lt;sup&gt;a&lt;/sup&gt;A (0.7)</td>
<td>19.8&lt;sup&gt;a&lt;/sup&gt;A (2.7)</td>
<td>19.8&lt;sup&gt;a&lt;/sup&gt;A (0.9)</td>
<td>6.8</td>
</tr>
<tr>
<td>CV (%)</td>
<td>6.7</td>
<td>6.0</td>
<td>11.4</td>
<td>6.0</td>
<td></td>
</tr>
</tbody>
</table>

**Note.** Averages followed by lowercase letters for the varieties within each cycle and capital letters for each cycle within the varieties differ by the Tukey test at 5%. SD: Standard Deviation.
3.7 NDF/Brix Relation

According to Carvalho et al. (2011), and Sá Neto et al. (2014), the Brix together with the NDF/BIX ratio is a very important variable in the choice of forage variety being this relation must be low (lower than 2.7), that is, it must contain a reduced NDF fraction and a high sugar content. When selecting varieties that present high value of NDF, an accumulation of undegraded material in the rumen may occur, limiting the consumption, through the physical mechanism of ruminal depletion, thus compromising the animal consumption and consequently resulting in lower energy consumption.

Based on the obtained data, it was possible to observe that there was no difference (\( P < 0.05 \)) between the three varieties evaluated for the cane plant and 3rd ratoon cycles in relation to the NDF/Brix (Table 6). On the other hand, there was the interaction of the RB 92579 variety in the 1st and 2nd ratoons, differing statistically (\( P < 0.05 \)) from the other varieties. This increase in the NDF/Brix relation occurred with the ratoons of the RB 92579 variety, which showed an increase in NDF content.

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Cane plant</th>
<th>SD 1st ratoons</th>
<th>SD 2nd ratoons</th>
<th>SD 3rd ratoons</th>
<th>SD CV (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RB 92579</td>
<td>2.3(^{a})</td>
<td>(0.2)</td>
<td>2.1(^{b})</td>
<td>(0.1)</td>
<td>1.9(^{b})</td>
</tr>
<tr>
<td>RB 867515</td>
<td>2.4(^{a})</td>
<td>(0.1)</td>
<td>2.6(^{a})</td>
<td>(0.1)</td>
<td>2.3(^{a})</td>
</tr>
<tr>
<td>RB 863129</td>
<td>2.3(^{a})</td>
<td>(0.1)</td>
<td>2.5(^{a})</td>
<td>(0.2)</td>
<td>2.3(^{b})</td>
</tr>
</tbody>
</table>

Note. Averages followed by lowercase letters for the varieties within each cycle differ by the Tukey test at 5%. SD: Standard Deviation.

Pereira et al., (2015) commented that must to be attentive to some cases where varieties that present higher NDF contents along with high sugar contents (as long as it has a low NDF/Brix relation) can, in this case, provide the animal a higher energy consumption, with a lower consumption of forage mass, if compared to varieties with lower sugar and NDF contents. In the case of the variety RB 92579, the opposite of the commented by Daniel et al. (2016) was observed, where the increase of the NDF content in the 1st and 2nd ratoons, even allied to the Brix increase, did not favor the NDF/Brix relation in these two ratoons.

In general, it was possible to observe that all the varieties presented in all the cycles, an FDN/Brix relation within the values recommended by Costa et al. (2017), that recommend that this one is smaller than 2.7.

4. Conclusion

The sugar cane variety RB 92579 is recommended for cultivation and animal feeding in the soil and climatic conditions of the Pre-Amazon region of Brazil, by presenting a better relation between productivity and nutritive value. Although the varieties RB 867515 and RB 863129 presented adequated nutrional value and productivity, the RB 92579 characteristics remained stable during four cycles.

References


Centro de Previsão do Tempo e Estudos Climáticos (CPTEC), Instituto Nacional de Pesquisas Espaciais (INPE), 2013-2016. Retrieved from https://www.cptec.inpe.br


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