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Evaluation of sugarcane for animal feed in the Baixada Fluminense – RJ[1]

Avaliação de cana-de-açúcar para alimentação animal na Baixada Fluminense – RJ

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ABSTRACT - The edaphoclimatic adaptation of sugarcane varieties and clones can ensure higher forage productivity for animal feed. An experiment was conducted at the Seropédica campus of the Federal Rural University of Rio de Janeiro for the evaluation of two varieties (RB867515 and RB969017) and two clones (RB058046 and RB098022) of sugarcane under a randomized block design with seven replications. Biometric variables, tillers m^{-1}, leaf area index (LAI), Brix degree, maturation index (MI), as well as forage and total yields, were evaluated during the cultivation of the sugarcane-plant cycle. Sugarcanes were planted on 10/08/2018 and harvested on 09/13/2019, totaling 323 days after planting (DAP). The data were analyzed using the R software, under randomized blocks and repeated measurements in time for biometric variables, tillers m^{-1}, LAI, Brix Degree and MI. Means were compared using the Tukey test ($p < 0.10$). Clone RB098022 presented 20.2% more tillers m^{-1} than both the other varieties. At 296 DAP, both clones and the variety RB969017 presented MI higher than 0.85, indicating them as an earlier cycle than the variety RB867515 (MI = 0.91 to 323 DAP). Higher and similar forage and total yields were obtained with clone RB098022 and variety RB867515 (means 141.6 and 151.2 Mg ha^{-1}, respectively). All sugarcanes adapted to edaphoclimatic conditions during plant cane cultivation, and it is recommended to use the clone RB098022 and the variety RB867515 for animal feed in the Baixada Fluminense region.

Key words: Biometric variables. Brix Degree. Maturation index. Productivity. *Saccharum officinarum*.

RESUMO - A adaptação edafoclimática das variedades e/ou clones de cana-de-açúcar pode garantir maior produtividade de forragem para a alimentação animal. Para tanto, foi elaborado um experimento no campus de Seropédica da Universidade Federal Rural do Rio de Janeiro, para avaliação de duas variedades (RB867515 e RB969017) e dois clones (RB058046 e RB098022) de cana-de-açúcar, sob um delineamento de blocos casualizados, com sete repetições. Foram avaliadas variáveis biométricas, perfilhos m^{-1}, índice de área foliar (IAF), Grau Brix e índice de maturação (IM), além das produtividades de forragem e total durante o cultivo do ciclo de cana-planta. O plantio foi realizado em 08/10/2018 e a colheita em 13/09/2019, aos 323 dias após plantio (DAP). Os dados foram analisados pelo software R, sob blocos ao acaso, e medidas repetidas no tempo para as variáveis biométricas, perfilhos m^{-1}, IAF, Grau Brix e IM. As médias foram comparadas pelo teste Tukey ($p < 0,10$). O clone RB098022 apresentou 20,2% mais perfilhos m^{-1} que ambas as variedades. Aos 296 DAP ambos os clones e a variedade RB969017 apresentaram IM maiores que 0,85, caracterizando-os como de ciclo mais precoce do que a variedade RB867515 (IM = 0,91 aos 323 DAP). Maiores produtividades e semelhantes de forragem e total foram verificadas para o clone RB098022 e a variedade RB867515 (médias de 141,6 e 151,2 Mg ha^{-1}, respectivamente). Todos os materiais genéticos se adaptaram às condições edafoclimáticas durante o cultivo decana-planta, sendo recomendado a utilização do clone RB098022 e da variedade RB867515 para a alimentação animal na região da Baixada Fluminense. Todos os materiais genéticos se adaptaram às condições edafoclimáticas durante o cultivo decana-planta, sendo recomendado a utilização do clone RB098022 e da variedade RB867515 para a alimentação animal na região da Baixada Fluminense.

Palavras-chave: Grau Brix. Índice de maturação. Produtividade. *Saccharum officinarum*. Variáveis biométricas.

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INTRODUCTION

Sugarcane is the main crop of the sugar-energy agroindustry in Brazil. Its products, especially sugar and ethanol, have socioeconomic and environmental importance in the country by boosting Brazilian agribusiness (BORDONAL *et al*., 2018; CURSI *et al*., 2021). In addition, the crop is a significant source of roughage to supplement animal feed during the off-season (FREITAS *et al*., 2018; SIQUEIRA *et al*., 2012). This is the result of its wide adaptation, good productivity, and easy cultivation in different Brazilian regions (AUDE, 1993; BORDONAL *et al*., 2018; CURSI *et al*., 2021). According to Siqueira *et al.* (2012), the use of sugarcane in animal feed is traditional in Brazil and is an advantageous food source compared to other sources of roughage in some regions. In the most recent assessment of the milk production chain in Rio de Janeiro, the use of sugarcane in the food supplementation of the herd was adopted by 75% of farms (FEDERAÇÃO DA AGRICULTURA, PECUÁRIA E PESCA DO ESTADO DO RIO DE JANEIRO, 2010; SOUSA *et al*., 2011).

Despite its traditional and widespread use, sugarcane for animal feed still presents many challenges, such as the choice of variety or clone for each region. According to Siqueira *et al.* (2012), the choice of the wrong variety, associated with the presences or absence of errors, such as inadequate agronomic management is the primary cause of crop failure for many ranchers. Currently, 214 varieties of sugarcane are registered with the Ministry of Agriculture, Livestock and Supply with different edaphoclimatic requirements, especially with respect to maturation and harvest time (CURSI *et al*., 2021). The choice of varieties for each region requires studies evaluating productivity and adaptation potentials at the regional and local level (SIQUEIRA *et al*., 2012).

The main focus of the development and release of varieties by sugarcane breeding programs is the sugar-energy sector demand where these varieties are launched after being tested for different soil and climate conditions (DAROS; OLIVEIRA; BARBOSA, 2015). The choice of the variety of sugarcane for animal feed should consider two fundamental aspects precocity and speed in maturation, because faster maturation implies better quality, combined with its coincidence with the off-season of pastures (SIQUEIRA *et al*., 2012). However, most breeding programs for sugarcane do not focus on the release of varieties or clones for animal feed (LANDELL; SILVA, 2004), which makes the choice of correct variety for different Brazilian regions more complicated.

Sugarcane varieties are classified according to their maturation as early, medium and late, which is determined by the elevation of the maximum concentration of soluble carbohydrates (higher Brix Degree) (AUDE, 1993; CURSI *et al.*, 2021; SIQUEIRA *et al*., 2012). Knowledge of varieties regarding maturation is crucial in animal feed, since high concentration of soluble carbohydrates increases digestibility, resulting in more energetic, better-quality roughage and higher animal intake (MAGALHÃES *et al*., 2012).

The objective of this work was to evaluate the biometric, physiological and productive variables of two varieties (RB867515 and RB969017) and two clones (RB058046 and RB098022) of sugarcane in the plant sugarcane cycle in its edaphoclimatic conditions of the Baixada Fluminense, RJ with a focus on their use in animal feed.

MATERIAL AND METHODS

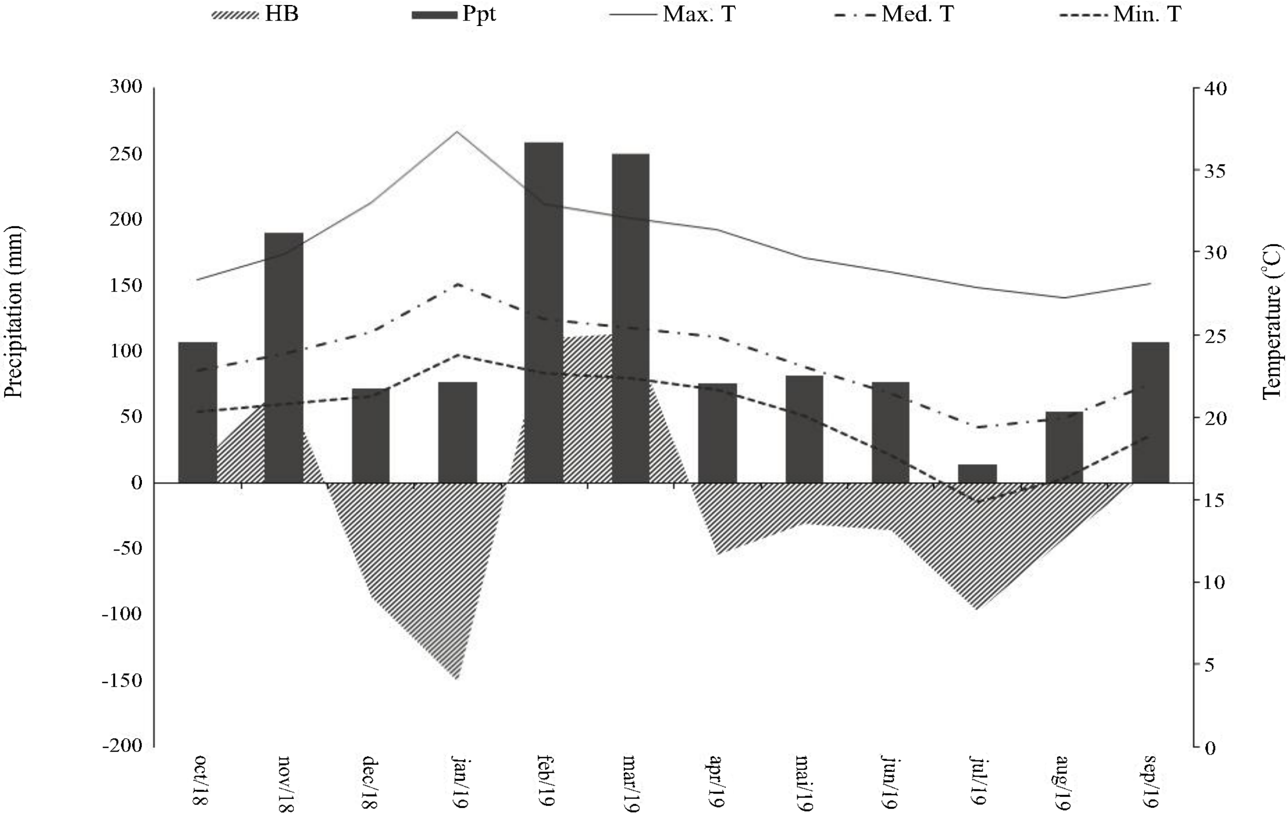
The experiment was carried out on 08/10/2018 (sugarcane plantation), in 3,000 m^2 belonging to the Animal Science Institute of UFRRJ in Seropédica – Rio de Janeiro State, located at 22º46’47.64” S and 43º40’49.56” W. The climate of the region is Aw, according to the Köppen classification, which indicates a humid summer and dry winter, average annual temperature of 24.6 °C and rainfall of 1,200 mm, respectively. The soil is classified as Medium texture Dystrophic Yellow Argisol (SANTOS *et al.*, 2018).

The climatological data were obtained from records of the Ecologia meteorological station, in Seropédica - RJ (INSTITUTO NACIONAL DE METEOROLOGIA, 2020), and the hydrological balance were drawn up on the basis of calculations of Thornthwaite and Mather (1955) during the sugarcane cycle (Figure 1).

Soil sampling and chemical analysis for fertility evaluation were done before planting (July/2018) and the following results were obtained: pH 5.8 (water), 2.67% Organic Matter (OM), 45 mg dm^{-3} P, 158 mg dm^{-3} K and 2.2, 0.8, 0.0, 0.11 and 2,6 $cmol_c$ dm^{-3} Ca, Mg, Al, Na and H + Al respectively. Limestone (1.0 Mg ha^{-1}) was incorporated at a depth of 20 cm in the total area of the planting site by ploughing and harrowing in August 2018, as recommended by Portz *et al*. (2013). Before planting, in October 2018, two levelling harrows were carried out and furrows were opened with 1.2 m spacing and 35 cm in depth. 80 kg ha^{-1} of P_2O_5 were used for planting and distributed in furrows in the form of simple superphosphate. Topdressing was applied with 50 kg ha^{-1} of N and 60 kg ha^{-1} of K_2O and broadcasted in the total area in the form of urea and potassium chloride, respectively, 45 days after planting.

The varieties RB867515 (RB72454 X ?) and RB969017 (F36-819 X ?) of medium/late and early/ medium maturation, respectively, were used for low to

Figure 1 - Hydric balance (HB, mm), precipitation (ppt, mm), maximum temperature (Max. T, ºC), medium temperature (Med. T, ºC) e minimum temperature (Min. T, ºC) during the experimental period of the plant cane cycle (October/2018 to September/2019), in Seropédica-RJ



medium fertility environments. These varieties present rapid initial growth, high agricultural productivity, and high sucrose concentration (DAROS; OLIVEIRA; BARBOSA, 2015). Clones RB058046 (SP89-1115 X ?) and RB098022 (RB997984 X SP77-5181), in contrast, are being developed by the Sugarcane Genetic Improvement Program of the Federal Rural University of Rio de Janeiro (*Programa de Melhoramento Genético da Cana-de-açúcar da Universidade Federal Rural do Rio de Janeiro* - PMGCA-UFRRJ) with results presenting average maturation, high productivity, high sucrose content, good tillering, and good adaptability in environments with high water deficit (REDE INTERUNIVERSITÁRIA PARA O DESENVOLVIMENTO DO SETOR SUCROENERGÉTICO, 2021). Seedlings came from the experimental field at UFRRJ, located in Campos dos Goytacazes - RJ. After being pre-selected in the field, they were cut, transported to the experimental area, and planted the day after cutting (on 10/08/2018).

A randomized block design was used, with four treatments represented by four sugarcanes (two varieties and two clones) and seven replicates. The experimental plots (experimental units) consisted of twelve (12) lines with 7 m length and 1.20 m of line spacing, resulting in an area of 100.8 m^2 per parcel. Thus, the total area of plots was 2,822.4 m^2, which along with lane areas, resulted in a total experimental area of 3,000 m^2.

Five non-destructive evaluations were performed at 167, 192, 230, 261 and 289 days after planting (DAP). For this purpose, five tillers were marked in each experimental plot (one in each central line) where biometric variables (height of plant/tiller, stem diameter, +3 leaf length and width, and number of leaves) were evaluated.

Plant/tiller height was estimated by measuring distance (in cm) from soil to +1leaf, using a measuring tape. The stem diameter was measured (in mm) at the base of the tiller (2 cm from the ground) using a digital calliper.

The average number of leaves per tiller was estimated by counting the number of leaves (fully expanded leaves with a minimum of 20% green area) from +1 leaf, while leaf length and width were measured (in mm) in the median part of +3 leaf (Kuijper classification system). The leaf area per tiller (LAT) was calculated according to the methodology described by Hermann and Câmara (1999): $AT = C \times L \times 0.75 \times (N + 2)$, where C is +3 leaf length, L is width of +3 leaf, 0.75 is the correction factor for leaf area of the crop, and N is the number of open leaves with at least 20% green area.

The number of live tillers (green and non-dry/ dead or senescent) per linear groove meter (tillers m^{-1}) was also examined in the five central lines of parcels by counting.

The leaf area index (LAI) was calculated by multiplying the leaf area per tiller (LAT) by the number of tillers contained in the useful area of the plot (42.0 m^2, considering the five central lines of the plot). The obtained product was divided by the useful area, to determine AT per 1 m^2 of soil area.

Brix Degree (soluble solids contents) was estimated based on mean values of samples evaluated at the apex (third internode below the oldest non-detachable leaf that does not detach easily from the plant) and at the base (second internode above the soil) of five canes/ tillers from each plot (experimental unit) using a portable field refractometer (ITREF-32 model) in four evaluations carried out at 200, 265, 296, and 323 DAP.

The maturation index (MI) was calculated by dividing the Brix Degree values of the apexes by those of the stem bases. According to Stupiello (1987), MI less than 0.60 characterizes green sugarcane in vegetative growth stage that between 0.60 and 0.70 denotes low maturity sugarcane that between 0.70 and 0.84 indicates average maturity, that greater than 0.85 implies mature sugarcane; and that greater than 1.0 stipulates a decline in sugarcane maturation.

Canes were harvested on 09/13/2019, at 340 DAP. Productivity was evaluated by harvesting two linear m in a useful line (central) of the plot based on the evaluation of the minimum maturation index (> 0.85) according to Stupiello (1987). Fractions of the green shoot, which were stems + green leaves (pointers) and dried leaves (straw), were separated and weighed on a 5 g precision digital scale.

Given that the production of sugarcane is for animal feed where the chopped sugarcane (stems and green leaves) is supplied to animals, the production of stems together with the green leaves (forage yield) and straw (dried and/or dead leaves) was evaluated to estimate the total productivity (forage and straw).

Statistical analyses were performed using the R Software (R CORE TEAM, 2020), version 4.0.3 Platform: x86_64-w64-mingw32 / x64 (64-bit). Initially, results were tested for the basic prerogatives of analysis of variance (normality of experimental errors, homogeneity of variances and additivity of the model by the Shapiro-Wilk and Bartlett tests).

Biometric variables, tillers m^{-1}, Brix Degree and LAI were submitted to the mixed model using the "nlme" R package (PINHEIRO *et al*., 2021), with four treatments/ sugarcanes (two varieties and two sugarcane clones) under a complete randomized block design and repeated measurements in time (DAP). Treatments, DAP, and their interactions were considered fixed effects, while blocks and errors were considered random effects. Four covariance structures were tested in models: 1st order autoregressive compound symmetry, identity and unstructured. The covariance structure that resulted in the lowest Akaike information criterion for each variable was selected. Means of treatments were compared by the Tukey test at 10% significance for type I error, using the "lsmeans" R package (RUSSEL, 2016).

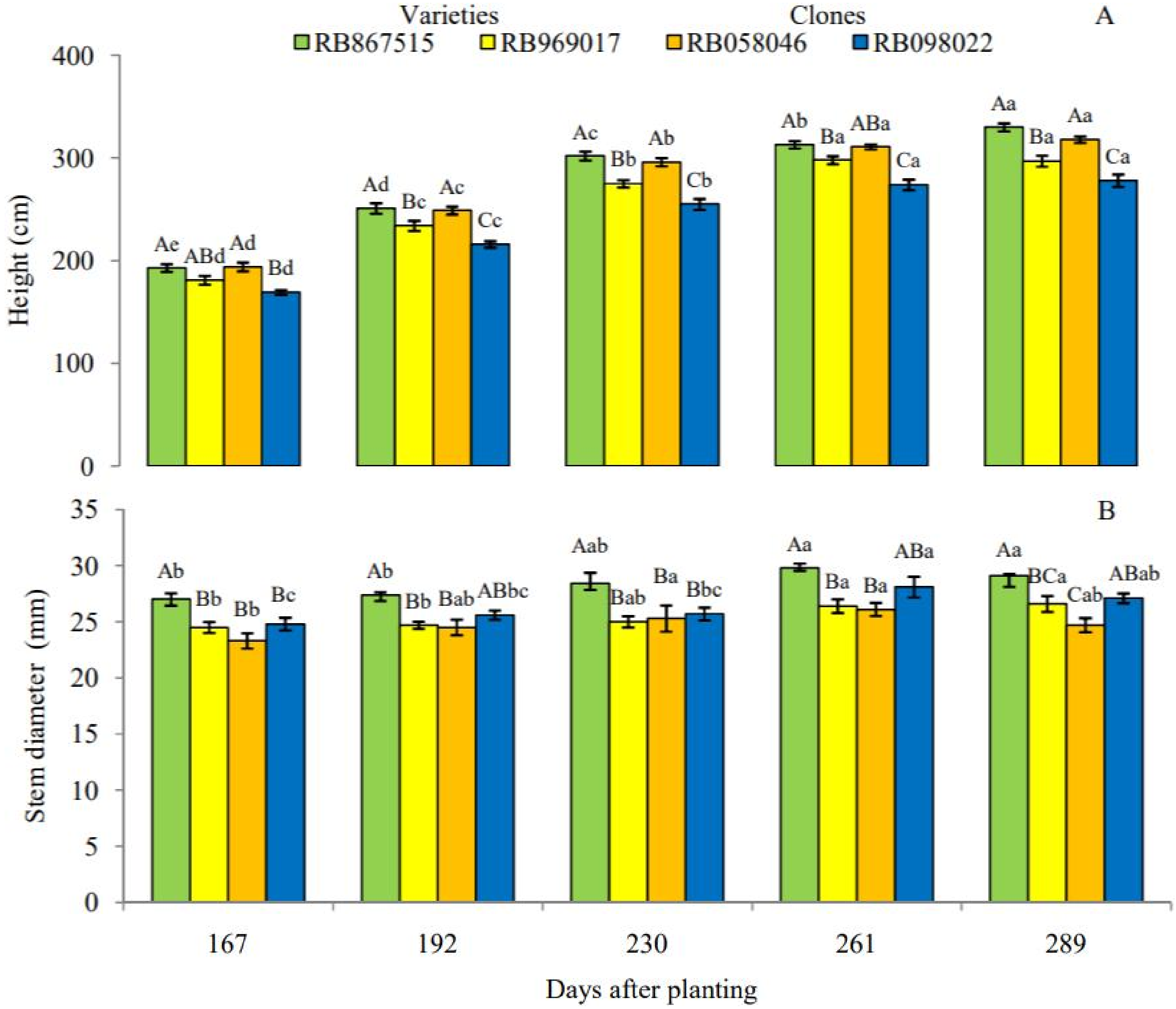
Analysis of variance was performed for productivity variables under a randomized complete block design. These means were compared using the Tukey test at 10% significance for type I errors, using the "ExpDes.pt" R package (FERREIRA; CAVALCANTI, NOGUEIRA, 2021).

RESULTS AND DISCUSSION

A significant interaction ($p = 0.01$) between sugarcane varieties or clones and DAP for height (Figure 2 A) was observed. The variety RB867515 and clone RB058046 presented greater plant height than that in the variety RB969017 and clone RB098022 in all evaluations, except in the evaluation performed at 261 DAP, when plant height in clone RB058046 did not differ from the variety RB969017. The lowest height was observed for clone RB098022 in all evaluations, varying from the other sugarcanes in the evaluations performed at 192, 230, 261, and 289 DAP. Plant heights increased over time for the four sugarcanes in evaluations performed between 167 and 261 DAP, with stabilization of growth at 261 and 289 DAP, except for the variety RB867515, which presented higher plant growth at 289 DAP. Plant height can vary depending on intrinsic characteristics, differing between sugarcanes of the same species or as a function of other production factors, such as adaptation to edaphoclimatic conditions, cultural treatments, and pest and disease involvement, among others (DAROS; OLIVEIRA; BARBOSA, 2015). Based on plant height, the higher growth of the variety RB867515 was confirmed (MARTINS *et al.*, 2020; SCHULTZ *et al.*, 2014), as well as for the clone RB058046, evidencing similarity between them regarding the highest growth rate compared to those of the variety RB969017 and the clone RB098022.

There was an effect of treatment/sugarcanes ($p = 0.01$) and DAP ($p = 0.01$) on stem diameter (Figure 2B). The largest diameter of stems was verified for the variety RB867515 compared to that of the variety RB969017 and clone RB058046 in all DAP. The stem diameter was larger than that of the clone RB098022 in evaluations performed at 167 and 230 DAP, but was similar at 192, 261 and 289 DAP. In general, increase in stem diameters of all sugarcanes were observed throughout the experimental period with stabilization from 261 DAP. The similarity of the stem

Figure 2 - Height (A) and stem diameter (B) of two sugarcane varieties and two sugarcane clones during the plant cane cycle evaluated at 167, 192, 230, 261 and 289 days after planting, in Seropédica - RJ. Capital letters compare the means of varieties and clones in each evaluation or days after planting (DAP). Lowercase letters compare the means of varieties or clones between days after planting (DAP). Tukey test ($p < 0.10$). The bars represent the standard error of the mean



diameters between clone RB098022 and variety RB867515 was highlighted, especially in the last two evaluations, since this was one of the varieties with the highest productive potential and greater occupation of planted area in parts of the sugarcane producing regions of Brazil (CURSI *et al.*, 2021; DAROS; OLIVEIRA; BARBOSA, 2015). In the Baixada Fluminense, the variety RB867515 has been evaluated by Silva *et al.* (2009), Schultz *et al.* (2014) and Martins *et al.* (2020) and its productive potential has been proven in different soils and fertilization managements, with mineral fertilizers and by inoculation with diazotrophic bacteria. Accordingly, the similarity in the diameter of stems of clone RB098022 with variety RB867515 is a positive and prominent factor for this sugarcane still in development (not released as a variety).

The stem diameter is one of the components of sugarcane yield and one of the biometric variables that has a higher correlation with production, along with the number of tillers and the height of the stems (LANDELL; SILVA, 2004). These characteristics are defined by the genotype, but their expression is influenced by climate, management and cultural practices used (SILVA; COSTA, 2004).

For the LAI, interaction effect between sugarcane genotypes and DAP ($p = 0.05$) was found. In general, the highest values were observed for clones and the lowest for varieties, except for the evaluation performed at 289 DAP (Figure 3). At 167 and 192 DAP, the clone RB098022 was superior to the two varieties, but did not differ from clone RB058046. At 230 DAP, the two clones did not differ from each other and the variety RB969017. However they were superior to the variety RB867515, which was similar to variety RB969017. At 261 DAP, the two clones did not differ from each other and the variety RB867515, but were superior to the variety RB969017, which was similar to variety RB867515. At 289 DAP, there was no difference in the LAI between the four sugarcanes, mainly due to the greater reduction in the LAI for both clones than that in the two varieties, which was confirmed by the more significant reduction of the LAI of clones in time (between 261 and 289 DAP), as compared to that in varieties. These results suggests that the death and shedding of the leaves of clones RB058046 and RB098022 occurs more markedly than in the varieties RB867515 and RB969017 during their maturation phases, which at first may seem an undesirable phenomenon in the production of sugarcane for animal feed, since green leaves contribute to forage productivity. However, one must consider that the contribution of green leaves to animal feed at the time of harvest and after its maturation is small compared to that of stems, and that the nutritional quality of ripe stems is higher than that of leaves (SIQUEIRA *et al*., 2012).

The Brix Degree was influenced by the effect of sugarcane genotypes (p = 0.01) and DAP (p = 0.01), with constant increases from the first (200 DAP) to the last evaluation (323 DAP), except for the Brix Degree of clone RB058046, which did not differ between the evaluations at 296 and 323 DAP (Figure 4 A). At 200 DAP, the clone RB058046 presented a higher Brix degree than that of the variety RB867515 but did not differ from the variety RB969017 and clone RB098022. At 265 and 296 DAP, the variety RB969017 and both clones did not differ from each other but were superior to the variety RB867515. At 323 DAP, the variety RB969017 and clone RB098022 presented the highest values of Brix Degree, differing from the variety RB867515, which presented the lowest value, but did not differ from the clone RB058046, which presented intermediate value compared to the others. All sugarcanes presented Brix Degree lower than 18% up to 265 DAP, and higher than 18% at 296 DAP. According to Aude (1993), in a thorough review on the subject, the maturation of sugarcane is achieved when it presents 18% of Brix Degree. Based on this, both varieties and clones did not reach the harvest point up to 265 DAP, but only after 296 DAP.

The maturation index varied with the interaction between treatment/sugarcanes and DAP (p = 0.02). The maturation index differed among the sugarcanes in all DAP, demonstrating consistent increases over time (Figure 4 B). At 200 DAP, clone RB058046 presented the highest index (0.66), differing from other sugarcanes.

Figure 3 - Leaf area index of two sugarcane varieties and two sugarcane clones during the plant cane cycle evaluated at 167, 192, 230, 261 and 289 days after planting, in Seropédica - RJ. Capital letters compare the means of varieties and clones in each evaluation or days after planting (DAP). Lowercase letters compare the means of varieties or clones between days after planting (DAP). Tukey test ($p < 0.10$). The bars represent the standard error of the mean

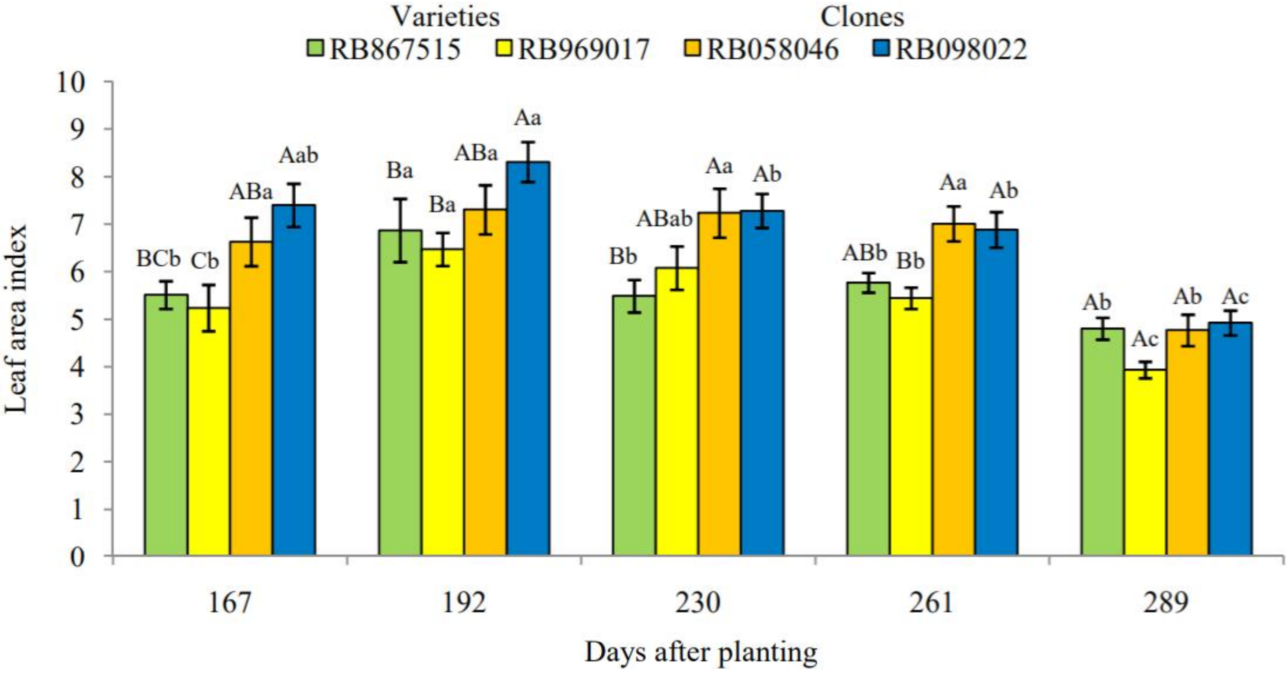
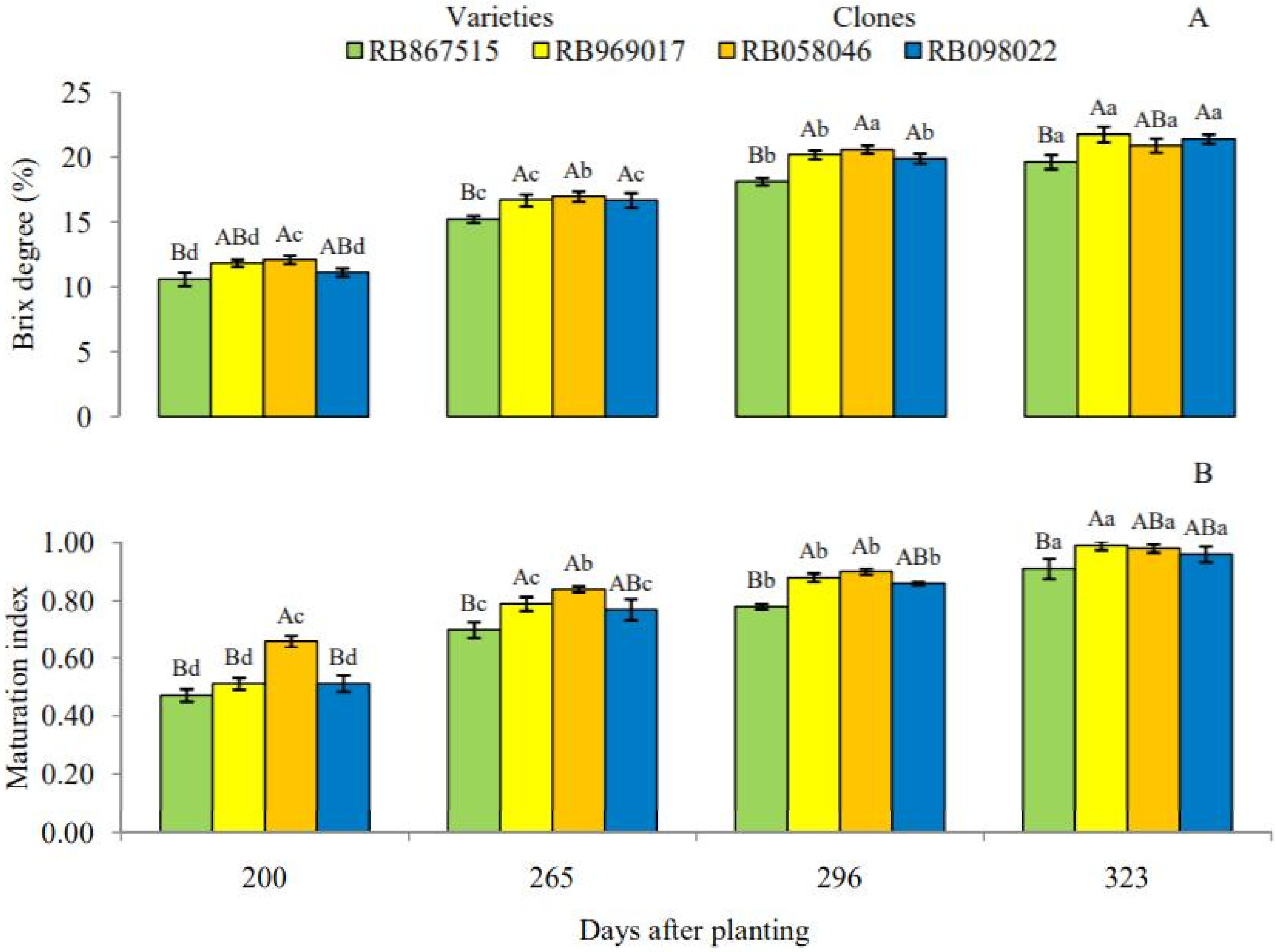


Figure 4 - Brix degree (A) and maturation index (B) of two sugarcane varieties and two sugarcane clones during the plant cane cycle evaluated at 167, 192, 230, 261 and 289 days after planting, in Seropédica - RJ. Capital letters compare the means of varieties and clones in each evaluation or days after planting (DAP). Lowercase letters compare the means of varieties or clones between days after planting (DAP). Tukey test ($p < 0.10$). The bars represent the standard error of the mean



At 265 and 296 DAP, the variety RB969017 and clone RB058046 presented the highest values (means of 0.83 and 0.87 at both DAP, respectively), higher than the variety RB867515, which presented the lowest value in both DAP (mean 0.74); while clone RB098022 showed an intermediate value, similar to that of other sugarcanes at these same DAP (mean of 0.81). At 323 DAP, the variety RB969017 presented the highest maturation index (0.99), higher than that of the variety RB867515, which denoted the lowest value (0.91). Clones presented intermediate values to those observed for varieties and did not differ from them.

All genotypes sugarcane reached an adequate maturation index (0.85) for harvesting up to 265 DAP (AUDE, 1993; STUPIELLO, 1987). At 296 DAP, the variety RB969017 and the two clones presented maturation indices of 0.88, 0.90 and 0.86, respectively, while the variety RB867515 reached 0.78. This confirms that the variety RB969017 (DAROS; OLIVEIRA; BARBOSA, 2015) and clones mature earlier than the variety RB867515 in the edaphoclimatic conditions of the study. According to Magalhães *et al*. (2012) who evaluated the consumption and performance of cattle in feedlots, the increase in Brix Degree and consequently the maturation index of sugarcane reduces the content of neutral detergent fiber. In addition, the increase in soluble carbohydrates together with sugarcane maturation improves the digestibility of fibers and increases the energy value of the roughage (MAGALHÃES *et al*., 2012). Therefore, the increase in both Brix Degree and sugarcane maturation index improves the nutritional value of its forage for animal nutrition.

Based on reports of Aude (1993) and Magalhães *et al.* (2012), all sugarcanes can be harvested at 296 DAP. However, the variety RB969017 and the two clones can result in forage with higher digestibility, compared to that with the variety RB867515. Furthermore, based on these results and published reports, it can also be affirmed that the association of the cultivation of early maturation sugarcanes (varieties or clones) (such as clone RB058046 and variety RB969017) with medium-maturation (such as clone RB098022) to medium/late maturation materials (such as variety RB867515) can maintain and even improve the nutritional quality of the forage provided as supplementation in the dry period of the year which, in general, extends from May to September in the Southeast region of Brazil (SIQUEIRA *et al*., 2012).

For tillers m^{-1}, the only effect observed was of treatment/sugarcanes ($p = 0.06$; Table 1). Clone RB098022 presented 20.2% and 11.2% more tillers m^{-1} than the average of both varieties (RB867515 and RB969017) and clone RB058046, respectively. The average tillers m^{-1} of both clones (RB058046 and RB098022) was 16.5% higher than that of the variety RB867515. These results revealed the potential of both clones, mainly RB098022, regarding soil area occupancy capacity and sugarcane yield (AUDI, 1993; DAROS; OLIVEIRA; BARBOSA, 2015) in the Baixada Fluminense region.

Differences in forage, straw and total yields were observed among sugarcanes genotypes (Table 1). The highest yields were observed for clone RB098022, higher than those of clone RB058046 and variety RB969017, which presented the lowest yields. The variety RB867515 presented intermediate productivity compared to the other sugarcanes without differing from them, except for straw that was higher than that of the variety RB969017. Yields achieved by the four sugarcanes in a 340-day cycle indicate good adaptation to local edaphoclimatic conditions, when considering that the national average productivity (plant cane and ratoon) has remained between 70 and 75 Mg ha^{-1} in recent years (BORDONAL *et al*., 2018; CURSI *et al*., 2021). Nevertheless, Carvalho-Netto *et al.* (2014) have reported that the attainable sugarcane productivity is 148 Mg ha^{-1} while Marin *et al.* (2016) have stated that the productive potential of the crop is up to 134 Mg ha^{-1}; thus one must estimate that total yields obtained in the present study were similar to or even higher than these potentials reported in the literature for some sugarcanes evaluated.

The results of this study show the importance of considering two aspects when choosing the variety or clone for farming sugarcane crops to animal feed; first is the potential yield and second the pattern of the period of maturation. Despite the four genotypes had well adapted to local soil and climate conditions, there was a significant difference in total yield, with the variety RB969017 and the clone RB058046 being less productive than clone RB098022, while the variety RB867515 did not differ from the other materials evaluated, showing intermediate productivity. Regarding the maturation period, the variety RB867515 is medium to late, the variety RB969017 is early to medium, and the two clones are medium maturation (REDE INTERUNIVERSITÁRIA PARA O DESENVOLVIMENTO DO SETOR SUCROENERGÉTICO, 2021). In this way, the choice of the most productive genotypes and also considering the period for maturation will allow producing forage in greater quantity and better nutritional value. Therefore, based on these results, it is possible to affirm that for the Baixada Fluminense the best recommendation is the cultivation of the clone RB098022 and the variety RB867515, starting the harvesting of the sugarcane field and feeding the animals by the clone and ending with the variety, ensuring forage with good nutritional value throughout the harvesting cycle.

There are no reports in the literature about the productivity potential of the two clones since they are in the evaluation/developmental phase (REDE INTERUNIVERSITÁRIA PARA O DESENVOLVIMENTO DO SETOR SUCROENERGÉTICO, 2021), and results verified in this study are unprecedented for these sugarcanes. The productivity of clone RB098022 was highlighted, resulting from the combination between a

Table 1 - Tillers per linear meter (tillers m^{-1}) and forage, straw and total natural matter yields (Mg ha^{-1}) of two sugarcane varieties and two clones, in the cane plant cycle at 340 DAP

Variável	Varieties				SEM	P value
	RB867515	RB969017	RB058046	RB098022		
Tillers $m^{-1\dagger}$	9.7 C	10.1 BC	10.7 B	11.9 A	1.1	0.06
Forage yield$^{\phi}$	132.0 AB	127.4 B	116.6 B	151.3 A	5.8	0.10
Straw yield‡	8.7AB	6.1 C	8.0 BC	10.1 A	0.7	0.05
Total yield§	140.7AB	133.5 B	124.6 B	161.4 A	1.8	0.09

† Tillers number per linear meter. $^{\phi}$ Stems and green leaves. ‡ Dry and/or dead leaves. § Stems, green leaves and straw. SEM: standard error of the mean high number of tillers (Table 1) and the largest diameter of the stems in the final phase of development (Figure 2B), similar to the variety RB867515 in forage and total yields. It is worth mentioning that the variety RB867515 is one of the most cultivated in the entire national territory, with wide emphasis in the literature on its adaptation, acceptance and productivity in the most diverse edaphoclimatic conditions (CURSI *et al.*, 2021), being often used as a “control” variety/treatment in many agronomic experiments. Accordingly, Schultz *et al.* (2014) have evaluated different treatments in a Dystrophic Haplic Planosol in the Baixada Fluminense region, RJ, and have obtained an average productivity of 97.1 Mg ha^{-1} for the variety RB867515 without nitrogen fertilization in the sugarcane-plant cycle after 14 months of cultivation. For this same variety and region, Martins *et al.* (2020) have obtained a productivity of 182.2 Mg ha^{-1} without nitrogen fertilization in a Dystrophic Yellow Argisol at 360 DAP. Schultz *et al.* (2017) also observed high productive potential for the same variety in Campos dos Goytacazes – Rio de Janeiro (Northern Region of the State - Usina Sapucaia) and Coruripe - Alagoas (Northeastern Region of Brazil - Coruripe Plant). These authors evaluated the potential of biological nitrogen fixation values for different sugarcane varieties and found that the variety RB867515 can have these values higher than 60%, which is one of the factors contributing to the high productive potential of the variety. For the RB969017 variety, only descriptions of RIDESA variety release catalogue are described (REDE INTERUNIVERSITÁRIA PARA O DESENVOLVIMENTO DO SETOR SUCROENERGÉTICO, 2021), with emphasis on excellent tillering, great interrow closing, high productivity (169.9, 107.1 and 101.4 Mg ha^{-1} in plant cane, first and second ratoon, respectively), and recommendation of cultivation in soils with low to medium fertility and early to medium harvest (DAROS; OLIVEIRA; BARBOSA, 2015).

CONCLUSIONS

1. Both varieties (RB867515 and RB969017) and both clones (RB058046 and RB098022) present good edaphoclimatic adaptation in plant cane cultivation in the Baixada Fluminense region, but to the animal feed, the use of a combination of the clone RB098022 and the variety RB867515 might be a good strategy for forage production;
2. Based on the Brix Degree, maturation index and forage and total yields, clone RB098022 and the variety RB867515 are recommended for use in animal feed in the Baixada Fluminense region;
3. Depending on the precocity of clone RB098022 compared to that of variety RB867515, the harvest for animal feed shall be initiated by the clone at the beginning of the dry period, followed by the variety RB867515 from the middle to the end of the dry period, when both reach adequate minimum maturation index.

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