Scientific Paper

Evaluation of agrobotanical variables in hybrid *Saccharum* spp. cultivars

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Abstract

Objective: To evaluate a group of agrobotanical variables in hybrid *Saccharum* spp. cultivars for sugar and forage production.

Materials and Methods: An experiment in a randomized block design with three replications was established at the Holguin Sugarcane Research Institute. Six cultivars and a control (My5514) were used. Thirteen agrobotanical variables and phytosanitary performance under natural conditions were evaluated. Variance analysis and multiple comparison of means test (Tukey) were performed when there were significant differences between cultivars.

Results: All cultivars maintained the same performance pattern for the variables pol percentage and fiber content. Cultivars B7274 and C86-12 significantly outperformed the control in the agricultural and sugar yield variables with values higher than 123 and 22,5; respectively. The best results in stem length and diameter were obtained in C86-156, SP70-1284 and C86-12, with no significant differences with the control. In the variable stem fresh weight, most of the cultivars significantly outperformed the control. Cultivar B7274 (19,5 %) achieved the best values for fresh weight of the top, although in general all cultivars had similar results to the control.

Conclusions: The cultivars showed performance similar to the control in most of the agrobotanical studied variables. B80250 and C323-68 stood out.

Keywords: animal feeding, biomass, crude fiber

Introduction

The potential of hybrid *Saccharum* spp. as forage for feeding cattle and sheep in the tropics is supported by its advantages over other crops, including its high biomass production, wide range of agroecological adaptation, resistance to prolonged droughts, and maintenance of its nutritional value for considerable periods (Salazar-Ortiz *et al*., 2018). It is the crop that produces the highest quantity of biomass per hectare, with a geographical plasticity that makes it grow in 104 countries in different continents (FAOSTAT, 2019). *Saccharum* spp. hybrid is a versatile crop and one of the most efficient converters of solar energy into dry matter (Mishra, 2019).

Regarding animal feeding, the nutritive value of hybrid *Saccharum* spp. should not be considered as an isolated factor, but as a complex formed by the chemical composition and secondary constituents, which together can interfere with the intake and use of the forage consumed by ruminants, as well as in other factors: age, plant parts and, mainly, variety (Alves *et al*., 2019).

Hybrid *Saccharum* spp. has the advantage of being perennial, adaptable to almost any soil, resistant to pests, does not cause erosion and needs few inputs of fossil origin (Bastidas *et al*., 2012; Bezerra *et al*., 2017; Reis *et al*., 2019).

It is a crop that produces biomass in the dry season of the year, when all pastures and forages decrease their production, is resistant to drought and provides important environmental services through the incorporation of organic matter from its residues into the soil (Partelli *et al*., 2018). In the dry season, it represents a viable alternative to solve forage shortages (Medina-García, 2019). In addition to this, it is compatible with practices and techniques that can double the income per hectare of planted sugarcane in a few years (Singh *et al*., 2019). These possibilities make hybrid *Saccharum* spp. forage an option to face livestock feeding (Martín-Méndez, 2021).

Although in recent years in Cuba there has been little research related to the use of hybrid *Saccharum* spp. as animal feedstuff, studies show that if it is conveniently supplemented it can sustain

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good weight gains and milk productions (Molavian *et al*., 2020; Reyes *et al*., 2020; Brêtas *et al*., 2021).

The selection of *Saccharum* spp. cultivars for forage purposes requires a characterization of the agronomic response, nutritive value and consumption of the materials (López *et al*., 2004). Therefore, this work was carried out with the objective of evaluating a group of agrobotanical variables in hybrid *Saccharum* spp. cultivars for sugar and forage production.

Materials and Methods

Location. The experiment was planted in an experimental block of the Sugarcane Research Institute of Holguín, located at coordinates latitude 20º 40'09''59 and longitude 75º 46'13''85.

Edaphoclimatic characteristics. The soil where the study was developed is classified as a gleyic chromic vertisol in terms of depth (Hernández-Jiménez *et al*., 2015). The experiment was conducted under rainfed conditions. During the research period, rainfall was 1 675,9 mm and the average temperature was 25,3 °C, edaphoclimatic characteristics similar to those present in the animal husbandry areas of the province.

Experimental design and treatments. A randomized block design with three replications was used, with plots of four 7,5-m furrows per variety (48 m^2). Six hybrid *Saccharum* spp. cultivars used in sugar production areas (C86-12, B7274, B80250, C323-68, SP70-1284 and C86-156) were used as treatments. The cultivar My5514 was used as control, which has shown a dry matter digestibility of more than 50 % and other traits suitable for use as animal feedstuff. Jorge *et al*. (2002) used that cultivar as control in a study with 26 hybrid *Saccharum* spp. cultivars to evaluate forage traits. González (2019) points out that it is the variety recommended as a forage variety that has been exploited for the longest time.

The experiment was conducted and evaluated as stipulated in the rules and procedures of the sugarcane breeding program in Cuba (Jorge *et al*., 2011).

Measurements. The evaluations were carried out on the vine plant at 15 months of age. The evaluated variables were percent pol (PPC), agricultural yield (TCH), tons of pol per hectare (TPH), fiber content (CF), percent fresh weight of stem (PFT), percent fresh weight of top (PFC), percent fresh weight of dry leaves (PFS), growth habit (HCR), presence of thorns (ESP), number of active leaves (HAC), stem length (LTA) and stem diameter (DTA). The leaf/stem ratio (H: T) was also evaluated by the weight of the leaf portion of the plants with regards to the weight of their stems (Bastidas *et al*., 2012). The phytosanitary performance of the cultivars under natural conditions was observed.

Statistical analysis. Assumptions were tested and variance analysis was performed. Tukey's test for multiple comparison of means was applied when differences were significant. The Statistica package was used for statistical data analysis.

Results and Discussion

The results of the analysis of variance for the PPC variable, which represents sugar content, and for the CF variable, showed that there were no significant differences among the cultivars under study, so that they all maintained the same performance pattern for both variables.

It was favorable that the cultivars had fiber content similar to the control and even numerically lower values (table 1). In studies carried out by Jorge *et al*. (2002), the fiber percentage had an inverse relationship with the forage indicator (dry matter digestibility percentage), so it should be taken into account that in the case of the fiber content variable, the best cultivars were those that showed the lowest values (B7274, B80250, C323-68 and C86-156).

Table 1. Average values reached by the cultivars of *Saccharum* spp. hybrid in the PPC and CF variables.

Cultivar	Mean PPC	Mean CF
Control-My5514	16,82	14,37
B80250	17,32	14,00
C323-68	17,57	14,23
B7274	16,68	13,43
C86-12	18,30	14,53
SP70-1284	16,13	14,33
C86-156	17,88	14,23

The variables TCH and TPH, representing agricultural yield and sugar, respectively, and the variables stem length, number of active leaves and stem diameter, showed significant differences among cultivars for $p \leq 0.05$ (Table 2). Cultivars B7274 and C86-12 significantly outperformed the control in the variables TCH and TPH. The best results in the variables stem length and diameter were obtained by cultivars C86-156, SP70-1284 and C86-12, with no significant differences with the control My5514.

Table 2. Comparison of cultivar means for the variables TCH, TPH, LTA, HAC and DTA.

Cultivar	TCH	TPH	LTA	HAC	DTA
Control-My5514	104,1^{c}	17,5^{c}	269,2^{a}	12,1^{a}	2,8^{ab}
B80250	94,8^{d}	16,4^{c}	251,7^{c}	8,9^{bc}	2,7^{bc}
C323-68	103,8^{c}	18,2^{bc}	253,2^{c}	9,8^{b}	2,3^{d}
B7274	140,6^{a}	23,4^{a}	256,7^{bc}	8,4^{c}	2,4^{cd}
C86-12	123,1^{b}	22,5^{ab}	260,7^{abc}	9,9^{b}	3,0^{a}
SP70-1284	93,3^{d}	15, 1^{c}	266,8^{ab}	8,7^{c}	2,9^{ab}
C86-156	90,1^{e}	16,1^{c}	268,5^{a}	9,2^{bc}	2,7^{b}
P - value	0,000	0,000	0,000	0,000	0,000
SE ±	3,807	0,728	1,091	0,122	0,027

TCH: agricultural yield, TPH: tons of pol per hectare, LTA: stem length, HAC: active leaves and DTA: stem diameter.

The highest number of active leaves was shown by the control, which significantly outperformed the other cultivars. However, cultivars C86-12 and C323-68 showed the closest values to the control in this variable, with an average of nine active leaves. This is favorable, since according to Jorge *et al*. (2002) there is a direct relationship between the number of active leaves and the percentage of dry matter digestibility. The number of active leaves of all cultivars varied between 9 and 13, which coincides with reports by Amaya-Estévez *et al*. (1995), who stated that the total number of functional leaves expanded per stem normally fluctuates between 6 and 13.

The analysis of the variables fresh weight percentage of stem, top and dry leaves (phenological composition) and leaf: stem ratio indicated significant differences among cultivars for all the above-mentioned variables.

The comparison among cultivars showed that, for the variable PFT, most of them significantly outperformed the control (table 3). The PFC was in a range between 12,58 and 19,48, similar to that reported by Fernández-Gálvez *et al*. (2019). Cultivar B7274 achieved the best values for this variable, although in general all cultivars had results similar to the control. This is an indicator to take into account, because according to Fernández-Gálvez *et al*. (2021) any plant intended for forage in animal feeding must produce high volumes of biomass. Duarte-Álvarez and Gonzalez-Villalba (2019) expressed that sugarcane has high nutritional requirements, due to its high biomass production capacity. The highest values of the

Table 3. Variables of phenological composition and leaf: stem ratio of cultivars.

Cultivar	% PFT	% PFC	% PFS	H:T
My5514	69,3^{c}	17,9^{ab}	12,8^{a}	0,3^{a}
B7274	73,9^{bc}	19,5^{a}	6,6^{bc}	0,3^{a}
B80250	77.0^{ab}	13,7^{ab}	9,4^{ab}	0,2^{ab}
C86-156	78,4^{ab}	13,2^{b}	8,4^{bc}	0,2^{b}
SP70-1284	79,7^{ab}	12,6^{b}	7,7^{bc}	0,2^{b}
C86-12	79,8^{ab}	16,5^{ab}	4,2^{c}	0,2^{ab}
C323-68	80,7^{a}	14,1^{ab}	5,4^{bc}	0,2^{ab}
P - value	0,000	0,012	0,000	0,004
SE ±	0,950	0,674	0,646	0,011

% PFT: percentage of fresh weight of stem, % PFC: percentage of fresh weight of top, % PFS: percentage of fresh weight of dry leaves, and H:T: leaf - stem ratio.

variable percentage of fresh weight of dry leaves were shown by the control My5514, without significant differences with the cultivar B80250, and significantly surpassed the rest of the cultivars under study, which were between 4,17 and 8,37 %. Similar results were reported by Fernández-Gálvez *et al*. (2021).

Fernández-Gálvez *et al*. (2019) reported that the percentage in weight represented by the straw fraction depends, to a large extent, on the plant's capacity for self-clearing. That is, the senescent leaves detach easily from the stem in a natural way.

The results of the multiple comparison of means for the variable leaf: stem ratio (table 3) showed that the best values corresponded to cultivars B7274, B80250, C86-12 and C323-68, with no significant differences with the control. In general, the values of this variable were low, due to the fact that the evaluation age was 15 months. Ruiz-Silvera *et al*. (2009) in a study conducted with hybrid *Saccharum* spp. for fodder use obtained that the leaf: stem ratio was higher when the crop was harvested at a younger age. These authors suggest that this variable is of great importance for the use of the crop for forage purposes, since it facilitates manual harvesting and contributes to a higher presence of the digestible fraction for the animal; it is preferable that the leaf: stem ratio be equal to or higher than 1. Lagos-Burbano and Castro-Rincón (2019) suggested that it is convenient that the varieties of hybrid *Saccharum* spp. for forage have a morphological composition that is characterized by the highest possible proportion of leaves and top with regards to the stem.

Regarding growth, cultivars C86-12, B7274, B80250 and C86-156 showed an erect growth habit, a characteristic that should be taken into account when evaluating hybrid *Saccharum* spp. cultivars for forage purposes. Studies developed by Martínez (1998), at the Pastures and Forages Station of Sancti Spíritus, suggest that the sugarcane destined for forage and its association with grasses should preferably be erect. Cultivars SP70-1284 and C323-68 showed oblique growth habit, similar to that shown by the control.

The results of the phytopathological evaluations of the main diseases affecting the crop (brown rust, smut and sugarcane mosaic virus) under natural conditions showed that most of the genotypes under study showed multiple resistance to the aforementioned diseases. Only cultivars B80250 and C323-68 showed symptoms of brown rust and smut. This result was expected, since these cultivars showed degree of susceptibility to these diseases in the background infection and artificial inoculation trials. This is reported in their data sheets. However, the symptoms present during the evaluated period did not notably affect the development of the crop, which can be observed when analyzing their performance in the other evaluated variables. Nevertheless, these phytopathological results should be taken into account at the time of commercial production of these cultivars, and proper management and phytosanitary surveillance should be carried out.

Regarding the variable quantity of thorns present in the top, most of the cultivars had no thorns, only C86-12 and My5514 showed some (less than 60 % of the top covered by thorns).

Conclusions

All the cultivars under study showed performance similar to the control in most of the agrobotanical variables. B80250 and C323-68 stood out.

It is recommended to continue studies with these cultivars to determine digestibility percentage, green biomass productivity and regrowth capacity at different cutting ages, for their use in animal feeding.

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Conflict of interests

The authors declare that there is no conflict of interests among them.

Authors' contribution

- Yulexi Mendoza-Batista. Research design and set-up, data processing, experimental evaluations and paper writing.
- Reider Argota-Campo. Design and set-up of the research and taking of field measurements.
- Rubisel Cruz-Sarmiento. Advice and editing of the paper.
- Oscar Suárez-Benítez. Research advice and design.
- Arian Céspedes-Zayas. Research set-up, data processing and experiment evaluations.
- Yoandris Vaillant-Cáceres. Research set-up and experimental evaluations.

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