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# Selection of accessions of *Urochloa brizantha* (Hochst. ex A. Rich.) R. D. Webster for acid soils

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## Abstract

A collection of 19 *Urochloa brizantha* accessions was studied, in association with *Stylosanthes guianensis* on a soil characterized by acidity, in order to select the best ones for this soil type. The measured and estimated variables were: vegetative height, availability and non-consumed pasture residue. In addition, leafiness, cover, vigor, CP content, fiber (NDF and ADF) degradation and IVDMD, were determined. The interpretation of the results was done through principal component analysis; and for grouping the associations and selecting those that had similar characteristics, cluster analysis was used. The existence of a high accumulated variability (75,9 %) was detected in the first four components. When analyzing the agronomic and nutritional value performance, after three years of exploitation, the formation of six groups was identified; the associations in which the accessions that form group II were present (CIAT-16335 and CIAT-26646) stood out, reaching the highest values in height, availability and utilization, as well as high vigor and high CP contents and IVDMD. These associations that included the accessions that belonged to group II (CIAT-16335 and CIAT-26646) were present showed the best performance, when making an overall analysis of agronomic and nutritional value variables. It is recommended to study structural and floristic composition variables, as well as the seed production potential, in order to propose a pre-commercial variety for the agroecosystems with acid soil.

Keywords: height, evaluation, nutritional value

## Introduction

In the 1980's, the species of cultivated pastures represented approximately 60 % of pasturelands in the country. Nevertheless, after more than three decades under exploitation, they barely reach 19 %, and some show a high degree of degradation (CITMA, 2012).

In addition to this problem, there is a marked fertility loss in soils dedicated to animal husbandry (Hernández, 2016), element that constitutes one of the main causes of the degradation of cultivated pastures, whose consequence results in a reduction of plant biomass yield and quality and its direct implication in the decrease of milk and meat production (Padilla *et al*., 2013).

Such aspects force the adoption of strategies aimed at the application of technologies that include the introduction and evaluation of species and/or accessions, which can contribute to the improvement of the feeding basis of animal husbandry zones and which, in turn, allow to reach adequate production, quality and persistence of pasturelands; because animal feeding is supported mainly on the utilization of pastures and forages, as it is one of the cheapest sources (Verdecia-Acosta *et al*., 2014).

In many studies it has been proven that the species of the *Urochloa* genus grow on a broad range of soils, and some of them are recommended specifically for acid soils, in Cuba as well as in other tropical zones of America (Silva *et al*., 2016); in this type of soil, *Urochloa decumbens* (Stapf) R. D. Webster, *Urochloa humidicola* (Rendle) Morrone & Zuloaga, *Urochloa dictyoneura* (Fig. & De Not.) Veldkamp, and *Urochloa brizantha* (Hochst. ex A. Rich.) R. D. Webster, stand out.

Based on the above-described facts, it is essential to identify the *U. brizantha* materials that adapt better to these soils, from their morphophysiological and productive characteristics; such accessions could make a better utilization of nutrients and provide sufficient biomass, with the required quality, for the maintenance, production and reproduction of grazing animals.

Hence the objective of this study was to select the best accessions of a *U. brizantha* collection in association with *Stylosanthes guianensis* for acid soils.

## Materials and Methods

*Location of the experimental area.* The study was conducted in areas of the Pastures and Forages Research Station of Cascajal, Santo Domingo municipality –Villa Clara province, Cuba–, located at 22º 36' North latitude and 80º 04' West longitude, at 60 m.a.s.l.

*Characteristics of the climate.* The climate of the zone is classified as tropical, characteristic of Cuba. The performance of the climate variables is shown in table 1; the rainfall volume varied among the years the study lasted, and only in the first year the rainfall was higher compared with the other two years.

The maximum, minimum and mean temperature, relative humidity and light hours showed similar values among the years.

*Soil of the experimental area.* The study was conducted on a distic, petroferric, Ferruginous, Nodular Gley soil, characterized by acid pH (4,2), as well as low organic matter content (1,91 %), total N (0,40 %) and assimilable P (1,90 mg/100 g). regarding these characteristics, it can be considered an acid soil and with low fertility, according to Hernández-Jiménez *et al.* (2015).

### *Experimental procedure*

*Soil preparation.* For the soil preparation the conventional method was used, consisting in plowing, harrowing, crossing, harrowing and furrowing.

*Design and treatments.* A randomized block design was used with three replicas. The plots measured 23,52 m$^2$, and were separated by 1,50 m spaces on both sides.

The treatments were represented by 19 previously selected *U. brizantha* accessions: CIAT-16300, CIAT-16317, CIAT-16809, CIAT-16469, CIAT-16322, CIAT-16132, CIAT-16128, CIAT-16335, CIAT-1539, CIAT-26290, CIAT-16332, CIAT-16819, CIAT-16303, CIAT-16334, CIAT-16448, CIAT-26646, CIAT-16485, CIAT-16197 and CIAT-26032, in association with *S. guianensis.*

*Planting, sowing and establishment.* The grass was planted by vegetative seed, consisting in portions of tillers formed by five to eight 20-cm long shoots, approximately. A distance between plants and between rows of 0,70 m was used, which is equivalent to a density of 20 000 plants/ha. The rows as well as the external tillers were separated from the plot edges by 0,35 m; the depth was 10 cm.

As legume, *S. guianensis* (Aubl.) Sw. CIAT-184 was used, accession selected in Cuba as commercial variety (MINAG, 2016), which has shown adaptation to this soil type (Castañeda-Alvarez *et al.,* 2016). It was planted by drilling, at a depth of 2 cm and space between rows of 0,70 m, with density of 1,5 kg of PGS/ha. Its seeds were previously scarified in water at 80 ºC during two minutes.

The planting as well as the seeding were simultaneously performed in April, related to the rainfall occurred in that month. During 45 days after these activities the space between the plots was manually weeded twice, and some weak or dead grass plants were replaced, so that all the treatments were represented by a similar number of tillers. Throughout the experimental period neither irrigation nor fertilization was used.

*Animals.* Homogeneous groups of 29 crossbred (Creole x Zebu) fattening animals (20,3 LAU) were used, with an average weight of 350 kg and good health status, which had water and mineral salts available 24 h per day in a paddock designed for this purpose. No energy or protein supplementation was offered.

*Management.* A simulated grazing system was used, in which the animals were led to the area when the treatments reached resting times between 85 and 95 days in the dry season (DS) and between 50 and 60 days in the rainy season (RS). The average permanence days were 2 and 1 day and the grazing intensity was 94,4 and 47,2 LAU days/ha for both seasons, respectively. During the three years of the study a total of 15 rotations were made, five in each year, from which two corresponded to the DS and three to the RS.

*Measurements.* The "Methodology for the evaluation of herbaceous species", proposed by the

Table 1. Climate performance during the research.

| Year | Variables | | | | | |
|---|---|---|---|---|---|---|
| | Rainfall (mm) | Temperature (°C) | | | Relative humidity (%) | Light hours |
| | | maximum | minimum | mean | | |
| 1 | 1 697,7 | 31,5 | 19,5 | 24,4 | 78 | 7,9 |
| 2 | 1 153,5 | 31,3 | 19,2 | 24,3 | 76 | 8,0 |
| 3 | 1 262,3 | 30,2 | 18,5 | 23,6 | 77 | 7,8 |

Pastures and Forages Research Station Indio Hatuey (Machado *et al*., 1997) and approved by the National Sub-Commission of Pasture and Forage varieties, was taken as basis.

*Agronomic variables.* The plant height was represented by the mean value of this variable in the four tillers used for the determination of availability (this was equivalent to a sample size of 8,3 %). For the leafiness, cover and vigor a walk was made that included the entire plot; and the value of each variable was visually calculated, according to the gradological scale used. The biomass availability was estimated one day before the animals entered the area, and the residue of non-consumed pasture, when the animals left.

The measurements and estimations were made in all the rotations.

*Variables of the nutritional value.* The bromatological composition was determined through the proximal chemical analysis. Of each sample the N content was analyzed by the Kjeldahl method, and the CP content was estimated (N x 6,25). The fiber (NDF and ADF) degradation was determined through the Van Soest method.

The *in vitro* gas production technique was used for obtaining the IVDMD and the parameters of the different phases of this process: fraction *b*, fraction *c* and *Lag* phase.

The analyses were conducted in the Nutrition laboratory of the School of Veterinary Medicine of the Autonomous University of Mexico State, Toluca, Mexico State.

*Statistical analysis.* The principal component analysis (PCA) was used. To identify the components that explained the highest variations, those that had a proper value higher than one were selected; while in order to identify the variables that influenced the most the variability extracted for each component it was taken into consideration that the sum or preponderance factors reached a value higher than 0,60.

To group the accessions and select those that had most prominent similar characteristics the cluster analysis was used; from the results obtained in the PCA. As grouping criterion the Euclidean distance was used, and Ward method as form of ascending hierarchical aggregation (Torres *et al*., 2006). The cutting line for forming the groups was based on the criterion expressed by Núñez-Colín and Escobedo-López (2011). The statistical package SPSS version 15® was used.

## Results and Discussion

When performing the PCA (table 2) the existence of high accumulated variability in the first

Table 2. Results of the PCA and relation among the variables.

| Analyzed variables | Principal components | | | |
|---|---|---|---|---|
| | CP1 | CP2 | CP3 | CP4 |
| Vegetative height (cm) | -0,46 | <u>0,70</u> | 0,01 | 0,40 |
| Vigor (Ve) | <u>0,89</u> | 0,05 | -0,10 | -0,01 |
| Leafiness (Ve) | 0,36 | 0,14 | -0,38 | 0,26 |
| Availability (t DM/ha/rotation) | -0,58 | <u>0,69</u> | -0,14 | 0,27 |
| Utilization (%) | <u>0,80</u> | -0,16 | 0,32 | 0,13 |
| CP (%) | 0,22 | -0,01 | <u>0,78</u> | 0,41 |
| NDF (%) | 0,19 | 0,29 | 0,02 | <u>-0,84</u> |
| ADF (%) | 0,33 | 0,37 | <u>-0,60</u> | -0,10 |
| IVDMD | 0,58 | 0,56 | 0,23 | 0,31 |
| Fraction *b* | -0,53 | -0,41 | 0,55 | -0,17 |
| Fraction *c* | 0,20 | <u>0,65</u> | 0,54 | -0,34 |
| *Lag* phase | 0,14 | <u>-0,70</u> | -0,24 | 0,32 |
| Proper value | 3,0 | 2,6 | 1,9 | 1,5 |
| Variance (%) | 25,0 | 21,9 | 16,0 | 12,9 |
| Accumulated (%) | 25,0 | 46,9 | 63,0 | 75,9 |

Underlined values indicate higher contribution.

four components was noted, based on the variables included in the study. The variance in CP1 reached a value of 25,0 %, and in CP2, 21,9 %. In CP1, the variables with higher influence on the extracted variance were vigor and utilization percentage; while in CP2, vegetative height, *Lag* phase, availability and fraction *c*, all positively related; *Lag* phase did it inversely.

Although two elements of the degradability equation did not show a strong incidence on the principal components: IVDMD and fraction *b*, it is considered that they should be taken into consideration due to their importance in the interpretation of results.

The IVDMD was explained in the CP1-CP2 plane and, thus, linked to agronomic and nutritional factors: vigor, utilization percentage, vegetative height, availability, fraction *c* and *Lag* phase, all positively related to that variable except the last one. These variables, excluding the last, showed a stressed trend to reaching higher percentages of IVDMD, aspect that coincides with the expected result when agronomic and nutritional value variables like these are jointly analyzed (Tsuzukibashi *et al.*, 2016).

On the other hand, fraction *b*, with sum or preponderance values close to 0,60, in CP3, was linked to factors of the nutritional value, such as CP and ADF, positively with the former and inversely with the latter, which is in correspondence with the significance of that variable.

The previously described results allow to consider that there was a higher differentiation degree among the associations with regards to the variables present in CP1-CP2, and much less for variables such as CP, ADF and NDF, which only extracted 16,0 and 12,9 % in CP3 and CP4, respectively.

When forming the groups through the cluster analysis, based on the results of the PCA, the presence of six different groups was detected. Table 3 shows the typification of the accessions by groups and their identification.

Similarity was found among the associations in groups V and VI for the mean value of the variable vegetative height, although its values were lower than that of groups I, III and IV. However, the ones that formed group II (CIAT-26646 and CIAT-16335) exceeded that of the last ones.

Table 3. Typification of the accessions by group and their identification.

| Variables | Group I | | Group II | | Group III | | Group IV | | Group V | | Group VI | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | SD | X | SD | X | SD | X | SD | X | SD | X | SD |
| Height | 64,2 | 7,2 | 70,1 | 4,9 | 67,8 | 2,3 | 58,3 | 3,1 | 40,2 | 3,2 | 46,9 | 6,1 |
| Vigor | 3,0 | 0,0 | 4,0 | 0,0 | 4,0 | 0,0 | 4,0 | 0,0 | 4,0 | 0,0 | 4,0 | 0,0 |
| Leafiness | 3,4 | 0,5 | 4,0 | 0,0 | 4,0 | 0,0 | 3,7 | 0,5 | 3,7 | 0,5 | 4,0 | 0,0 |
| Availability | 3,6 | 0,5 | 3,8 | 0,8 | 3,4 | 0,2 | 2,8 | 0,3 | 2,3 | 0,1 | 2,7 | 0,0 |
| Utilization | 25,3 | 5,3 | 64,0 | 8,1 | 21,4 | 13,4 | 48,4 | 27,9 | 57,1 | 2,3 | 57,8 | 8,8 |
| CP | 9,9 | 1,3 | 11,2 | 1,7 | 9,4 | 1,6 | 10,4 | 1,6 | 10,4 | 1,8 | 9,3 | 1,1 |
| NDF | 76,1 | 1,2 | 75,3 | 1,2 | 75,0 | 0,9 | 78,4 | 2,1 | 75,8 | 1,1 | 77,6 | 0,7 |
| ADF | 41,0 | 1,2 | 42,8 | 0,9 | 41,1 | 1,6 | 40,8 | 1,4 | 40,7 | 0,6 | 43,7 | 0,0 |
| IVDMD | 50,2 | 5,0 | 65,1 | 2,5 | 50,4 | 1,9 | 54,8 | 1,1 | 51,9 | 0,8 | 57,2 | 1,6 |
| Fraction *b* | 163,8 | 3,6 | 143,6 | 5,2 | 140,7 | 3,3 | 153,1 | 1,7 | 158,8 | 8,5 | 142,7 | 7,0 |
| Fraction *c* | 0,02 | 0,0 | 0,02 | 0,0 | 0,02 | 0,0 | 0,02 | 0,0 | 0,02 | 0,0 | 0,02 | 0,0 |
| *Lag* phase | 1,49 | 0,5 | 1,39 | 1,2 | 1,1 | 0,4 | 0,5 | 0,1 | 2,1 | 0,2 | 1,8 | 0,2 |

| Group | Quantity of accessions | Name of the accessions♦ |
|---|---|---|
| I | 5 | CIAT-16300, CIAT-16322, CIAT-16819, CIAT-16332, CIAT-16132 |
| II | 2 | CIAT-26646, CIAT-16335 |
| III | 2 | CIAT-16197, CIAT-16809 |
| IV | 4 | CIAT-16317, CIAT-16334, 1539, CIAT-26290 |
| V | 3 | CIAT-26032, CIAT-16448, CIAT-16485 |
| VI | 3 | CIAT-16128, CIAT-16303, CIAT-16469 |

♦ Associated with *S. guianensis*

Regarding vigor, the accessions that formed group I (CIAT-16300, CIAT-16322, CIAT-16819, CIAT-16332, CIAT-16132) showed the worst performance with regards to those in the other groups, which, as average, reached value 4 according to the scale used.

In the associations that were part of groups IV, V and VI a relatively similar value was detected for the variable availability, but lower than that of the other groups. Among the latter (I, II and III), the associations integrated by CIAT-26646 and CIAT-16335 (group II) stood out with the highest value, aspect that is considered of relevant interest, because it defines the biomass volume that is available for animal feeding.

The percentage of utilization by the animals in the above-mentioned associations was also higher when compared with the mean of the other groups; this has marked importance, due to the role this variable plays in the consumption made by the animals. This same pattern was found for CP.

The parameters that are obtained when the calculations are made to define the IVDMD values through the gas production technique constitute an extremely important tool to estimate the capacity of degradation of the forages that compose the diet of ruminants and, also, the factors with higher influence on it (Vargas-Bayona *et al*., 2013).

Hence, when analyzing in these associations the performance of fraction *c* and the *Lag* phase, variables that characterize the forage degradation rate, it was observed that the values of the former were similar for all the groups; while the associations that formed group IV showed the best result (0,5) for the latter, which means that they showed the lesser time for the rumen microorganisms to start the feed degradation.

Ortega-Aguirre *et al*. (2015) stated that there are differences among the parameters of the degradability equation for fractions b and c among forages of different species, but not among accessions of the same species. In this research such performance was rather shown in fraction b, which showed variability for the studied associations, according to the PCA.

An outstanding place corresponds to group II (CIAT-16335 and CIAT-26646), regarding the performance of the evaluated materials. These accessions reached the greatest height, high vigor, the highest values of availability and also in terms of utilization, as well as high CP contents and IVDMD. In this last variable similar results have been reported in the grass *Megathyrsus maximus* cv. Mombaza (60,9 %) and a little bit higher in *Brachiaria hibrido* cv. Mulato (67,5 %), according to the report by Silva *et al*. (2016).

The accession CIAT-26646, in particular, has stood out in diverse animal husbandry systems. In that sense, Njarui *et al*. (2016) referred the potentialities of this material, which stood out for its good acceptability, high resistance to pest attack, good growth, high degree of associability with legumes of twining or creeping growth habit, as well as a CP content of 11 %. These and other outstanding characteristics have allowed such accession to become one of the most widely used in tropical regions for cattle production (Caballero, 2014).

In the species *U. brizantha* there are satisfactory results regarding their agronomic performance and nutritional value, such as the ones reported by Tsuzukibashi *et al*. (2016), who found, depending on the cutting age, different values of the nutritional variables (up to 68 and 30 % for NDF and ADF, respectively; and between 8,8 and 18,6 % of CP) when studying cvs. Marandú. Piatã and Xaraés; this confirms that this species has cultivars with acceptable quality for livestock feeding.

It is concluded that the associations in which the accessions that formed group II (CIAT-16335 and CIAT-26646) were present showed the best performance, when making an overall analysis of agronomic and nutritional value variables Likewise, to study structural and floristic composition variables, as well as the seed production potential, is recommended, in order to propose a pre-commercial variety for the agroecosystems with acid soil without using inputs.

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