Scientific Paper

Population performance of a collection of *Urochloa brizantha* (Hochst. ex A. Rich.) R.D. Webster in association with *Stylosanthes guianensis* CIAT-184 (Aubl.) Sw

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Abstract

The objective of this study was to evaluate the structural and floristic composition performance of 19 accessions of *Urochloa brizantha*, associated with *Stylosanthes guianensis* CIAT-184 on an acid soil, after three years of simulated grazing. The variables live shoots-dead shoots ratio and floristic composition were analyzed. The measurements were made in all the rotations during the experimental period. The substitution of dead shoots was favorable in most of the treatments; four accessions stood out (CIAT-16322, CIAT-26646, CIAT-16332 and CIAT-16335) in which, at the end of the period, the index of substitution of dead shoots was over two. From the accessions, 36,6 % reached a percentage higher than 80 % at the end of the experimental period; the accessions CIAT-16317, CIAT-16335 and CIAT-16332 were the ones with higher presence of the base pasture (> 90 %). In all the associations the legume was represented in a low percentage (< 16 %); while the weeds remained, in most cases, below 20 %. In general, the evaluated *U. brizantha* accessions showed an acceptable persistence or stability in time, and CIAT-16322, CIAT-26646, CIAT-16332 and CIAT-16335 stood out.

Keywords: botanical composition, grasses, legumes, shoot

Introduction

Although the agronomic and nutritional value variables are important in the process of plant selection, it is considered essential to complement this information with that from no less transcendental variables, such as floristic composition and live shoots-dead shoots ratio (Ls/Ds); the latter as component of the pasture structure (Olivera, 2016). In addition, an analysis of the variation of the structural indicators of pasture and of floristic composition provides elements to discuss about the possible contrast among the treatments for a certain condition.

Thus, it is necessary to know the performance of pasture, because the inadequate use of the pastureland –in terms of under- or overgrazing or due to ignorance– affects cattle production (Vanegas-Moreno, 2015); because pasture, as feeding basis, contributes to cattle the necessary feedstuff and energy (Pintado-Lazo and Vásquez-Rodríguez, 2016).

The association of pasture with legumes is beneficial, because they play an important role in the fixation and subsequent increase of N in the associated forage; this has been the object of research, which has allowed to conclude that the N fixed by legumes shows values between 50 and 300 kg N/ha/year (Carrero, 2012). For such reason, the association of legumes with grasses is an excellent alternative to fix this element and make it available for the associated species, with which higher forage production is achieved (Luengas-Barrera and Hena-Ruiz, 2016).

In addition, it is known that the systems with legumes –herbaceous or shrubby–, associated with grasses, can play a very outstanding role in the ecosystem, due to it and other qualities of those species. In that sense, *Leucaena leucocephala* (Lam). de Wit, *Teramnus labialis* (L.f.) Spreng., *Centrosema molle* Mart. ex Benth., *Stylosanthes guianensis* (Aubl.) Sw., among others, stand out.

For such reason, the objective of this study was to evaluate the structural and floristic composition performance of 19 accessions of *Urochloa brizantha*, associated with *S. guianensis* CIAT-184 on an acid soil, after three years of simulated grazing.

Materials and Methods

The study was conducted in areas of the Cascajal Pastures and Forages Research Station, located in the Santo Domingo municipality –Villa Clara province, Cuba–, at 22º 36' North latitude and 80º 04' West longitude, at 60 m.a.s.l.; on a petroferric dystic Gley Nodular Ferruginous, which shows acid pH (4,2), as well as low organic matter contents (1,91 %), total N (0,40 %) and assimilable P (1,90 mg/100 g). According to these characteristics, it is considered as an acid and low fertility soil (Hernández-Jiménez *et al*., 2015). The climate variables are shown in table 1.

Experimental procedure

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

The treatments were represented by the 19 *U. brizantha* accessions, previously selected from a study carried out before: CIAT-16300, CIAT-16317, CIAT-16809, CIAT-16469, CIAT-16322, CIAT-16132, CIAT-16128, CIAT-16335, 1539, CIAT-26290, CIAT-16332, CIAT-16819, CIAT-16303, CIAT-16334, CIAT-16448, CIAT-26646, CIAT-16485, CIAT-16197 and CIAT-26032.

Measurements. The following measurements were made at the end of the experimental period, which was of three years of evaluation under simulated grazing, in which 15 rotations were carried out. For such purpose the recommendations made by Machado *et al*. (1999) were followed:

- Live shoots-dead shoots (Ls/Ds) ratio. It was determined by the physical count of the number of live shoots and dead shoots in two tillers from each plot, in the three replicas, for all the accessions. To count the dead shoots those which were in a status of total deterioration, that is, necrotic or detached from the tiller, were considered. In this case, the sample size was 4,25 %.
- Floristic composition. To determine the floristic composition of the existing species in the flora of each one of the associations, a 1,0-m^2 frame was used divided into four quadrants. In each of them the percentage of weeds was estimated, as well as the percentage of *U. brizantha* and *S. guianensis* CIAT-184. Two samplings were systematically performed per plot in each replica, which represented a sample size of 8,5 % of the whole plot.

Statistical analysis. For the data processing variance analysis was carried out from a model that included the effects of the accessions and/or associations and the replicas. Before it the normal distribution was tested through the Kolmogorov-Smirnov test, and the variance homogeneity, by Levene's test. The means were compared through Duncan's multiple range test, for a significance level of $p < 0{,}05$. For such purpose the statistical package SPSS® (version 15.0) was used.

Results and Discussion

Table 2 shows the results of the studied variables (Ls/Ds ratio and floristic composition of the pastureland) in each of the studied associations. Thirteen of the 19 evaluated accessions (68,4 %) ended with a favorable Ls/Ds ratio, that is, with a production rate of live shoots over 1 (Machado, 2002); CIAT-16335, CIAT-16332 and CIAT-26646 stood out for ending with a value higher than 2, showing highly significant differences ($p < 0{,}001$) when compared with the other treatments. Nevertheless, although CIAT-16322 also finished the experimental period with an index higher than two, it showed statistical differences with regards to the three above-mentioned ones.

Such performance indicates that these accessions were capable of maintaining a favorable production rate of live shoots, particularly the most outstanding ones, and, thus, keeping an acceptable density of the new material. This favors the substi-

Table 1. Performance of climate during the research.

Year	Rainfall (mm)	Variable				
		Temperature (ºC)			Relative humidity (%)	Hours light (h)
		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

Table 2. Performance of the Ls/Ds ratio and floristic composition of the pastureland.

Accession	Ls/Ds	Grass	*S. guianensis*	Arvenses
CIAT-16300	1,24^{cd}	80,00^{h}	16,30^{h}	3,70^{abc}
CIAT-16322	2,09^{f}	84,00^{i}	10,03^{cdefgh}	6,00^{bc}
CIAT-16819	1,85^{e}	66,07^{fg}	4,80^{abcde}	20,07^{d}
CIAT-16334	1,21^{cd}	60,57^{cd}	6,37^{abcdef}	26,87^{e}
CIAT-26646	2,27^{g}	83,83^{i}	12,20^{fgh}	4,03^{abc}
CIAT-16197	0,78^{b}	64,20^{ef}	2,47^{ab}	20,60^{d}
CIAT-16809	0,52^{a}	51,47^{b}	9,23^{cdefg}	30,33^{e}
CIAT-16128	1,30^{d}	60,00^{cd}	10,03^{cdefgh}	15,97^{d}
CIAT-16332	2,29^{g}	96,87^{l}	1,70^{a}	1,43^{ab}
CIAT-16317	1,10^{c}	91,93^{k}	4,27^{abcd}	3,77^{abc}
CIAT-16132	1,08^{c}	45,47^{a}	11,13^{efgh}	35,73^{f}
CIAT-26290	0,74^{b}	58,37^{c}	10,20^{defgh}	28,40^{e}
CIAT-16303	0,82^{b}	62,53^{de}	9,40^{cdefg}	26,13^{e}
CIAT-16448	1,23^{cd}	59,17^{cd}	8,13^{abcdef}	26,17^{e}
CIAT-16485	1,85^{e}	78,03^{h}	15,00^{gh}	7,00^{c}
CIAT-26032	1,36^{d}	68,93^{g}	6,00^{abcdef}	16,97^{d}
CIAT-16469	0,54^{a}	88,50^{j}	4,40^{abcde}	6,13^{bc}
CIAT-16335	2,30^{g}	96,47^{l}	3,33^{abc}	0,20^{a}
1539	0,42^{a}	62,53^{de}	8,67^{abcdefg}	28,80^{e}
SE ±	0,082***	1,11***	1,99***	1,64***

a, b, c, d, e, f, h, g: means with different letters in the same column significantly differ at $p < 0,05$, (*** $p < 0,001$).

tution of dead shoots by live shoots, and this way the maintenance of the integrity of tillers is ensured, which may be considered as an adaptation element of such accessions.

In this sense, Ramírez-Reynoso *et al*. (2011) claimed that the production and survival of shoots is a mechanism used by plants to maintain persistence, which depends on their capacity to remove dead shoots and keep the population density of stems stable, aspect that contributes decisively in the stability of the pastureland and which is directly determined by the combined effect of seasonal patterns of the emergence, death and survival processes of those plant components (Ramírez-Reynoso *et al*. 2011).

These authors also referred to the fact that there are remarkable differences among species and cultivars to achieve stability of the population density of the shoots, and, thus, favor pastureland persistence. For such reason, they stated that the variations that occur in the emergence, death and survival rate of the shoots are valuable to understand the mechanisms that are involved in pasture persistence and regrowth, which is considered important in the selective process. In addition, these variations in plant structure may be influenced by genetics, plant physiology and interaction with the surrounding environment (climate variables and soil).

However, although the rainfall volume and other climate variables, such as temperature, relative humidity and hours light, were propitious for the production of new shoots, it was observed that some of the accessions showed a very low production index of new shoots. Among them were 1539, CIAT-16809 and CIAT-16469, with 0,42; 0,52 and 0,54, respectively; which did not differ statistically among them, but they did differ from the other accessions, and showed a marked trend towards tiller degradation and, subsequently, pastureland degradation.

The existence of other accessions with better replacement index than the above-mentioned one (lower than 0,55), but which, similarly, reached values below one, was also noted, as in the case of

CIAT-16303, CIAT-16197 and CIAT-26290, which did not differ among them. This is considered as an element that limits the possible selection of all those materials as a whole.

When analyzing the values in floristic composition of the pastureland, it was proven that the associations made up by accessions CIAT-16332 and CIAT-16335 concluded the experimental period with more than 95 % of the area covered by the grass, with which they were significantly higher ($p < 0{,}001$) than the other evaluated ones.

These accessions were followed, in descending hierarchical order, by CIAT-16317, CIAT-16469, CIAT-16322, CIAT-26646, CIAT-16300 and CIAT-16485, among which highly significant differences ($p < 0{,}001$) were also found, but all of them with a percentage of covered area that varied between 78,0 and 91,9 %.

The results showed that all those accessions concluded the experimental period with high values of area covered by the grass, which indicates that they kept outstanding population stability after 15 rotations under those conditions. These values are considered an adequate and, in turn, recommended index for the selection and proposal of the possible commercial varieties (Machado *et al*., 1999).

In the accession CIAT-16132 the lowest covered area percentage (45,4 %) was detected, although other two (CIAT-16809 and CIAT-26290), also with highly significant differences between them ($p < 0{,}001$), showed values of 51,4 and 58,3 %; and, in turn, values below one in terms of the Ls/Ds ratio; which contrasts with the performance maintained by the most advantageous materials, as was previously discussed.

In turn, in the associations in which the grass had a lower percentage in the floristic composition the weeds increased (table 2). It is known that these species develop mechanisms that facilitate the colonization of empty spaces that the pasture does not occupy during the establishment or exploitation period (Sardiñas *et al*., 2015).

The association in which the accession CIAT-16335 was found, without differing from CIAT-16332, CIAT-16317 and CIAT-26646, showed the lowest area invaded by the other weed species (0,20 %); while the association made up by the accession CIAT-16132 was the most invaded one, although the absolute value did not exceed 35,73 %. According to Padilla *et al*. (2013), when the invasion surpasses 65 %, the floristic composition of the pastureland and the pasture yield are considerably affected. In this case, in none of the associations the weeds exceeded 60 % (table 2).

On the other hand, *S. guianensis* CIAT-184 is one of the legumes which have shown better adaptability attributes under the acidity conditions of Cuban soils, and is among the varieties reported by MINAG (2017) as commercial, for which it was chosen to establish the association in this research.

According to the results (table 2), highly significant results ($p < 0{,}001$) were found in the area occupied by *S. guianensis*. The highest value was detected in the association with CIAT-16300 (16,30 %); it did not differ from the one found in the associations made up by CIAT-16485, CIAT-26646, CIAT-16132, CIAT-26290, CIAT-16322 and CIAT-16128, in which the percentage of this legume varied in the range from 10,0 to 15,0 %.

The lowest values were found in the associations with CIAT-16332, CIAT-16197, CIAT-16335, CIAT-16469, CIAT-16819 and CIAT-16317, all with less than 5 % and without significant differences among them.

Thus, it is possible to state that the representation of *S. guianensis* in the floristic composition, in all cases, was little consistent, particularly in the last rotations in which values below 10 % were observed (table 2); because for the legumes in the association to have impact, they should be in a proportion never lower than 30 % (Roca-Cedeño *et al*., 2014).

Some of the factors that contributed to the detriment of the population of *S. guianensis* could be related with the growth habits of the grass, which is tillering and erect; for which it is not easily associated with non-twining herbaceous legumes (Smith, 2014).

In addition, Traveset (2015) asserted that the character of the competition and competitive ability of one species not only depend on the species and its needs, but also on the environmental conditions, and change with them.

It is also known that, from the physiological point of view, grasses show a series of advantages with regards to legumes, among which the higher photosynthesis rate can be mentioned, which confers them higher growth and development (Vanegas-Moreno, 2015; Gutiérrez-Guiñan, 2016); as well as higher tolerance to high temperatures (Pozo *et al*., 2011), allowing them to compete favorably.

S. guianensis, even when it was maintained throughout the exploitation period, did it with low percentage and showed a strong trend to disappear; especially if it is taken into consideration that its population at the beginning of the experimental stage fluctuated between 31,2 and 36,3 %, depending on the criterion for considering the plot area as established (Machado *et al*., 1999).

It is concluded that, for the analyzed population variables, the associations made up by the accessions CIAT-16322, CIAT-26646, CIAT-16332 and CIAT-16335 stood out, which have potential for their utilization on acid soils.

Bibliographic references

Carrero, J. A. *Importancia de las leguminosas forrajeras*. http://buenaproduccionanimal.wordpress.com/. [03/03/2014], 2012

Gutiérrez-Guiñan, J. L. *Introducción a la fisiotecnia vegetal*. México: Universidad Autónoma del Estado de Mexico, Centro Universitario UAEM Zumpango, 2016.

Hernández-Jiménez, A.; Pérez-Jiménez, J. M.; Bosch-Infante, D. & Castro-Speck, N. *Clasificación de los suelos de Cuba 2015*. Mayabeque, Cuba: Instituto Nacional de Ciencias Agrícolas, Instituto de Suelos, Ediciones INCA, 2015.

Luengas-Barrera, Martha Z. & Hena-Ruiz, H. H. *Diagnóstico y plan de mejoramiento de ganado de cría en la finca Villa Cambeus, Vereda Chire, municipio Hato Corozal, departamento de Casanare, Colombia*. Trabajo realizado para optar por el título de Tecnología en Producción Animal. Bogotá: Escuela de Ciencias Agrícolas, Pecuarias y del Medio Ambiente, Universidad Nacional Abierta y a Distancia, 2016.

Machado, R. *Variaciones morfoestructurales y poblacionales de Andropogon gayanus y su relación con la vegetación adventicia bajo pastoreo intensivo*. Tesis presentada en opción al grado científico de Doctor en Ciencias Agrícolas: EEPF Indio Hatuey, Universidad de Matanzas, 2002.

Machado, R.; Roche, R.; Toral, Odalys & González, E. Metodología para la colecta, conservación y caracterización de especies herbáceas, arbóreas y arbustivas útiles para la ganadería. *Pastos y Forrajes*. 22 (3):181-204, 1999.

MINAG. *Lista oficial de variedades comerciales. Registro de variedades comerciales*. La Habana: Ministerio de la Agricultura, Dirección de Semillas y Recursos Fitogenéticos, 2017.

Olivera, Yuseika. *Evaluación agronómica y del valor nutritivo y selección de accesiones de Brachiaria brizantha (Hochst. ex A. Rich.) Stapf en suelos ácidos*. Tesis presentada en opción al grado científico de Doctor en Ciencias Agrícolas: EEPF Indio Hatuey, Universidad de Matanzas, 2016.

Padilla, C.; Sardiñas, Y.; Febles, G. & Fraga, Nidia. Estrategias para el control de la degradación en pastizales invadidos por *Sporobolus indicus* (L) R. Br. *Rev. cubana Cienc. agríc*. 47 (2):113-117, 2013.

Pintado-Lazo, J. X. & Vásquez-Rodríguez, C. A. *Relaciones entre composición botánica, disponibilidad y la producción de leche en vacas a pastoreo en los sistemas de producción en el cantón Cuenca*. Tesis previa a la obtención del título de Médico Veterinario y Zootecnista. Cuenca, Ecuador: Facultad de Ciencias Agropecuarias, Universidad de Cuenca, 2016.

Pozo, P. P. del; Herrera, R. S. & Blanco, F. Bases ecofisiológicas del manejo de los pastos. En: Milagros Milera, ed. *André Voisin. Experiencia y aplicación de su obra en Cuba*. Matanzas, Cuba: EEPF Indio Hatuey. p. 371-397, 2011.

Ramírez-Reynoso, O.; Silva, Sila C. da; Hernández-Garay, A.; Enríquez-Quiroz, J. F.; Pérez-Pérez, J.; Quero-Carrillo, A. R. *et al.* Rebrote y estabilidad de la población de tallos en el pasto *Panicum maximum* cv. Mombaza cosechada en diferentes intervalos de corte. *Rev. Fitotec. Mex*. 34 (3):213-219, 2011.

Roca-Cedeño, A. J.; Vera-Cedeño, J. C.; Guevara-Viera, R. V.; Flores-de-Valgas-Rodriguéz, Ana M.; Brito-Donoso, F.; Guevara-Viera, G. E. *et al*. Efecto del por ciento de leguminosas, tiempo de reposo y calidad estimada del pastizal en respuesta productiva de vacas lecheras en pastoreo. *Rev. Prod. Anim*. 26 (1):12-19, 2014.

Sardiñas, Y.; Varela, M.; Padilla, C.; Torres, Verena; Noda, Aida & Fraga Nidia. Control de *Sporobolus indicus* L (R) Br. (espartillo) y rehabilitación de un pastizal de *Megathyrsus maximus* (guinea likoni) en estado de deterioro. *AIA*. 19 (2):35-49, 2015.

Smith, Eliana. *Evaluación del comportamiento agronómico del pasto brizanta (Brachiaria brizantha) en cinco fundos ganaderos del Eje Carretero Yurimaguas–Pampa Hermosa*. Monografía para optar por el título Profesional de Ingeniero Zootecnista. Yurimaguas, Perú, 2014.

Traveset, Anna. Impacto de las especies exóticas sobre las comunidades mediado por interacciones mutualistas. Monográfico: Las invasiones biológicas y su impacto en los ecosistemas. *Ecosistemas*. 24 (1):67-75, 2015. DOI: http://doi.org/10.7818/ECOS.2015.24-1.11.

Vanegas-Moreno, Luz Á. *Dinámica de crecimiento y criterios de pastoreo para optimizar el uso de praderas Brachiaria brizantha cv. Toledo*. Tesis investigativa para optar al título de Magister en Ciencia Animal. Programa Maestría en Ciencia Animal. Bogotá: Facultad de Ciencias Agropecuarias, Universidad de Lasalle, 2015.

Received: August 3, 2018

Accepted: October 22, 2018