Technical note

Agronomic evaluation and selection of *Brachiaria* spp. accessions on moderate fertility soils

Lisset Castañeda-Pimienta, Yuseika Olivera-Castro and Hilda Beatriz Wencomo-Cárdenas

Estación Experimental de Pastos y Forrajes Indio Hatuey, Universidad de Matanzas, Ministerio de Educación Superior Central España Republicana, CP 44280, Matanzas, Cuba
E-mail: lisset.castañeda@ihatuey.cu

Abstract

In order to determine the agronomic performance of six accessions belonging to four species from the *Brachiaria* genus, a study was conducted during a year (rainy and dry seasons). The plant height was measured; likewise, leafiness, vigor and cover, affectations by phytophagous insects and pathogen microorganisms, chlorosis and biomass yield, were estimated. Principal component analysis (PCA) and cluster analysis were applied to the results, through the statistical package SPSS version 11.5. The total variance was high (higher than 90 %) for both seasons, related to the measured and/or estimated variables. The variables with the highest variability were height, affectations by pathogenic microorganisms and yield; in addition to leafiness, cover and vigor. An integral analysis allows to conclude that the accessions *Brachiaria decumbens* and *Brachiaria brizantha* CIAT-16322 stood out during the evaluation, for coinciding in both seasons. Their insertion in the flow of varieties is recommended, in order to obtain a commercial variety to be used in animal husbandry systems, in zones with predominance of moderate-fertility soils.

Keywords: species, soil fertility, grasses

Introduction

The introduction of new pasture species emerges as a need to replace species of low nutritional value and productivity (Machado *et al*., 2010). However, in the rational and stable exploitation of the areas dedicated to pasture cultivation it is necessary to achieve an adequate level of adaptation of new and better species and/or accessions with regards to the ones that currently prevail in animal husbandry ecosystems, because not all of them have the same demands in resources or the same degree of tolerance to the adverse agents of the environment.

Although the forage potential of the species from the *Brachiaria* genus was first acknowledged in Australia more than 60 years ago, in tropical America they were planted in the last 20-25 years, which has proven the great impact they can have on biomass production. This is explicitly illustrated in the achievements reached in such countries as Brazil and Nicaragua, where productivity was increased between five and ten times in more than 70 million hectares with regards to the native grassland, when *Brachiaria* genotypes were used (Mejía *et al*., 2009; López, 2014).

The species from this genus grow on a wide range of soils; some of them are specifically recommended for problem soils (MINAG, 2012), as well as for other tropical zones of America (Canchila *et al*., 2011); in these environments *Brachiaria decumbens* (Stapf), *Brachiaria humidicola* (Rendle) Schweick. and *Brachiaria brizantha* (Hochst. ex A. Rich.) stand out.

The objective of this study was to determine the agronomic performance of six accessions belonging to four species from the *Brachiaria* genus and to select the ones with better general performance, based on quantitative variables.

Materials and Methods

The study was conducted in areas of the Pastures and Forages Research Station Indio Hatuey, in the Perico municipality –Matanzas province–, on a moderate-fertility lixiviated Ferralitic Red soil (Hernández-Jiménez *et al*., 2015).

Table 1 shows the climate variables during the experimental period. The rainfall volume in both seasons was higher than the mean of 20 years before the research period.

The other variables (maximum, minimum and mean temperature, and relative humidity) showed very similar values, in correspondence with the seasons, and varied in a very narrow range around the mean.

Procedure and measurements. For the soil preparation the conventional method was used, consisting in plowing, harrowing and furrowing. Planting was performed in furrows separated at 0,70 m, with a distance of 0,60 m between plants, and tiller

Table 1. Climate variables.

Year	Season	Rainfall (mm)	Minimum temperature (°C)	Mean temperature (°C)	Maximum temperature (°C)	Relative humidity (%)
1	RS	1 349,1	21,1	25,2	32,8	83,2
	DS	415,8	16,5	22,7	29,9	78,7
x	RS	1 035,5	20,7	26,0	32,1	83,1
	DS	263,9	16,0	22,1	29,7	80,8

x : mean of 20 years before the research.

portions which were 20 cm long and had approximately between five and eight shoots, were used. A 3 x 1 m simple plot design was used, without replicas, with separation between the rows of 1,5 m. during the experimental period neither irrigation nor fertilization was used. The study lasted a year after establishment.

The treatments consisted in six accessions belonging to four species from the *Brachiaria* genus: *B. decumbens*, *B. brizantha*, *B. brizantha* CIAT-16322, *B. brizantha* CIAT-26646, *Brachiaria purpurascens* and *B. humidicola*.

The estimations and measurements were made according to the pasture evaluation methodology, approved by the National Sub-Commission of Pasture and Forage Varieties (Machado *et al*., 1997). The height was measured in four plants per treatment; in addition, leafiness, vigor, cover, affectations by phytophagous insects and pathogen microorganisms, chlorosis and biomass yield were estimated, with a 15-day frequency throughout the whole experimental stage.

Statistical processing. The variability and relation among all the variables were obtained through a principal component analysis (PCA). In order to establish the variables with the highest influence on variability, in each component, those with a proper value equal to or higher than 1 were accepted; in addition, the fact that the sum or preponderance values were higher than 0,60 was taken as selection criterion. The grouping of the treatments with similar characteristics, depending on the measured and estimated variables, was made from a cluster analysis, from the results of the PCA. For these analyses the statistical package SPSS version 11.5 for Microsoft® Windows® (Visuata, 1998) was used.

Results and discussion

Table 2 shows the results of the PCA during the rainy season (RS). Three components were formed in which accumulated variance of 90,51 % was detected. The variables that explained better the variance in the first component (43,91 %) were height, yield, vigor and affectations by pathogen microorganisms

Table 2. Results of the PCA and relation among the evaluated variables, in the RS.

Variable	Principal component		
	PC1	PC2	PC3
Height	0,809	0,485	-0,101
Affectations by phytophagous insects	0,464	0,289	-0,708
Affectations by pathogen microorganisms	-0,953	-0,145	0,018
Leafiness	0,532	0,766	0,233
Cover	0,310	0,088	0,856
Vigor	0,691	0,598	0,388
Chlorosis	-0,127	0,934	-0,247
Yield	0,929	-0,148	0,174
Proper value	3,51	2,18	1,54
Variance (%)	43,91	27,33	19,26
Accumulated variance (%)	43,91	71,25	90,51

(in inverse sense). The second component extracted 27,33 % of the total variance and was explained mainly by leafiness and chlorosis; while the third component extracted 19,26 % of the variance, explained by the cover and the affectations by phytophagous insects (in a negative sense).

In turn, the high variability explained in each of the components suggests that it contains variables that influence positively the grouping of the studied accessions, and was related to the performance of the latter.

Through the cluster analysis, based on the results of the PCA, four groups were formed (table 3).

The accessions belonging to group I (*B. decumbens* and *B. brizantha* CIAT-16322) had more leaves, and showed higher cover, vigor and yield; in addition, they suffered little affectation by pathogen microorganisms, just like the ones from the other groups, and because of the degree obtained that affectation degree did not influence the general performance of the accessions. From them, *B. brizantha* CIAT 16322 has stood out for its good results in zones with predominance of low-fertility acid soils (Canchila *et al*., 2008).

The accessions belonging to groups II and IV showed a similar performance, with the minimum difference that *B brizantha* CIAT-26646 and *B. humidicola* (group IV) turned out to be better in the numerical index regarding height and yield. *B. purpurascens* (group III) showed the worst results in most of the variables. Nevertheless, this is one of the recommended accessions for edaphic conditions with predominance of poor drainage.

When the principal component analysis was conducted for the dry season (DS), the three components explained 91,69 % of the total variance (table 4).

The first component explained 46,58 % of the total variance and was represented mainly by height, leafiness, cover and vigor. On the other hand, the second explained 24,48 % and in its formation yield and affectations by pathogen microorganisms (negatively) contributed; while in the third component 20,62 % of the accumulated variance was extracted, explained by the affectations by phytophagous insects and chlorosis.

The high variation percentage explained by the components suggests that they include the variables which should be taken into consideration to group the studied accessions; among them is height, extracted in PC1, and it can be affirmed that this variable showed a logical performance, because in the small collection which was evaluated there were species of tillering habit and others of decumbent habit (Olivera *et al*., 2006; Peters *et al*., 2011).

It is important to emphasize that the knowledge of the relations among the traits of agronomic interest plays a significant role in the selection process. Thus,

Table 3. Results of the cluster analysis.

Variable	Group I		Group II	Group III	Group IV	
	X	SD	X	X	X	SD
Height	53,95	12,23	51,90	27,0	65,2	18,20
Affectations by phytophagous insects	0,00	0,00	0,00	0,00	0,00	0,00
Affectations by pathogen microorganisms	0,09	0,06	0,14	0,20	0,07	0,17
Leafiness	4,00	0,00	3,04	3,00	3,00	0,00
Cover	4,00	0,00	3,00	3,00	3,00	0,00
Vigor	4,00	0,00	3,00	2,00	3,00	0,00
Chlorosis	0,00	0,00	0,02	0,00	0,01	0,25
Yield	2,53	10,5	1,67	1,56	2,42	25,42
Group	Quantity		Accessions			
I	2		*B. decumbens*, *B. brizantha* CIAT-16322			
II	1		*B. brizantha*			
III	1		*B. purpurascens*			
IV	2		*B. brizantha* CIAT-26646, *B. humidicola*			

Table 4. Results of the PCA and relation among the evaluated variables, in the DS.

Variable	Principal component		
	PC1	PC2	PC3
Height	0,786	0,542	0,297
Affectations by phytophagous insects	-0,563	0,158	0,755
Affectations by pathogen microorganisms	-0,198	-0,770	-0,177
Leafiness	0,971	-0,222	-0,070
Cover	0,901	0,298	-0,037
Vigor	0,982	0,115	-0,037
Chlorosis	0,173	0,068	0,976
Yield	-0,059	0,944	-0,019
Proper value	3,72	1,95	1,65
Variance (%)	46,58	24,48	20,62
Accumulated value (%)	46,58	71,06	91,69

the accessions that combine desirable traits, such as good yield and little affectation by abiotic and biotic stress, become a material to be considered for inclusion in exploitation systems in which animals, plants and the environment co-exist, according to Seguí *et al*. (1989) and Palacios and Del Libro (2014), and coinciding with the criteria expressed by Gómez-Miranda (2016), who studied three grass varieties in a system where abiotic and biotic factors interacted.

Thus, in order to identify the best-performance accessions, a cluster analysis was made based on the results of the PCA during this stage, which allowed the formation of three groups (table 5).

B. decumbens, B. brizantha and *B. brizantha* CIAT-16322 (group I), in general, performed better than the accessions from the other groups. These were taller plants; with higher leafiness, cover and vigor and more yield, except for the variables affectations by phytophagous insects and chlorosis, in which *B. humidicola* (group III) performed better; however, the values of such variables were minimal, for which it is considered that they did not negatively influence the development, growth and production of these accessions.

It is valid to emphasize that two of the accessions that formed group I in this period were the same which stood out in the RS (*B. decumbens* and *B.*

Table 5. Results of the cluster analysis.

Variable	Group I		Group II		Group III
	X	SD	X	SD	X
Height	41,23	2,20	29,50	4,38	19,00
Affectations by phytophagous insects	0,11	0,05	0,34	0,08	0,08
Affectations by pathogenic microorganisms	4,57	1,98	5,59	1,30	8,32
Leafiness	3,71	0,32	2,94	0,28	3,20
Cover	3,47	0,50	2,32	0,25	2,40
Vigor	3,36	0,31	2,46	0,06	2,60
Chlorosis	0,96	0,20	1,20	0,11	0,28
Yield	0,66	0,14	0,64	0,25	0,53

Group	Quantity	Accessions
I	3	*B. decumbens, B. brizantha*, *B. brizantha* CIAT-16322
II	2	*B. purpurascens, B. brizantha* CIAT-26646
III	1	*B. humidicola*

brizantha CIAT-16322), for which they should be strongly monitored, so that it is possible to verify whether they do or do not maintain the advantageous position, with regards to the other evaluated accessions.

The results of the PCA in both seasons showed high variability in the studied variables, because the accumulated variance was higher than 90 %.

In general, the agronomic performance of the accessions for the RS and DS (tables 3 and 5, respectively) showed that the season had a determinant effect on the expression of the values in the analyzed variables, which is in accordance with the climate data (table 1). The influence of climate on the performance of the evaluated species was reported by Argel *et al*. (2007) and Ruiz-Fonseca *et al*. (2008), when studying different species from the *Brachiaria* genus.

It was proven that these accessions adapted, to a higher or lower extent, to the soil and climate conditions under which the trial was conducted, using neither irrigation nor fertilizers; for which it can be assumed that they produced forage due to their quality to grow on moderate-fertility soils, although there were differences of the accessions among the groups.

When making an integral analysis of the evaluation period, two accessions (*B. decumbens* and *B. brizantha* CIAT-16322) were observed to show a relevant performance in the studied variables. That is why their insertion in the flow of varieties is recommended, in order to obtain a commercial variety to be used in animal husbandry systems in zones with predominance of moderate-fertility soils.

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