# *Performance of 19* Panicum maximum *Jacq. accessions under grazing conditions on a moderate fertility soil*

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## ABSTRACT

The objective of this work was to determine the performance of 19 *Panicum maximum* accessions on moderate fertility soils. A randomized block design was used with three repetitions and 20 $m^2$ plots. The rotations (simulated rational grazing) were made between 60 and 70 days (dry season) and between 32 and 40 days (rainy season). An acceptable variability was detected among treatments (70,7 %). The most variable indicators were: availability, utilization percentage, leaf percentage and plant height. A cluster analysis was applied and two groups were formed: giant types (group 1) and medium types (group 2). The treatments of group 1 reached a mean availability of 5,0 t DM/ha/rotation and exceeded in 0,7 t DM/ha/rotation those of group 2. However, the latter showed lower symptoms of chlorosis (34,0 %), were more tolerant to pathogen microorganisms (25,0 %) and were less affected by drought (42,0 %) and showed higher vigor (3,8) as mean of the three years. It is concluded that availability, height, leaf percentage and utilization percentage had a main role in variability. The other indicators were relatively little variable, but they also allowed to judge the performance of these materials. The medium types CIH-6, SIH-810 and CIH-22 are recommended as pre-commercial varieties for similar conditions as the ones in this work, as well as to include the giant type SIH-759 in trials in which cutting or grazing is used with higher intensity.

Key words: *Panicum maximum*, grazing, soil

## INTRODUCTION

In the first 30 years dedicated to the introduction and selection of forage germplasm at the Experimental Station of Pastures and Forages EEPF "Indio Hatuey", results were accumulated and disseminated according to the logic of the so-called "geocentric model". Based on this model, in which the species and varieties were considered the main axis for the adoption of the research strategies, hundreds of introduction or evaluation fields were studied throughout the country on a large diversity of soils (Milera y Machado, 2012).

Nevertheless, in the last 10 years the approach used for the selection of forage germplasm in Cuba has been aimed at the search for accessions with adaptation to specific environments in a casuistic way (Olivera and Machado, 2004; Olivera *et al*., 2007). The assumed work strategies include pre-selection, from a high number of accessions for those environments and in particular for those in which unfavorable conditions, specially the edaphic ones, prevail, because they constitute one of the determinant factors in the general performance of the plant material, including quality and productivity (Martuscello *et al*., 2012).

It is a proven fact that 65 % of the Cuban soils are diagnosed as belonging to categories III and IV. This implies that they are affected by one or another limiting factor, which causes their potential yield to be below 50 % (Pérez de los Reyes, 2011). For such reason, 44,8 % has low fertility; 37,3 %, low water retention; 43,3 %, moderate erosion; 40,3 %, pH 6,0 (in KCl); 12,2 %, pH 4,6; while 69,6 % shows very low OM content (Instituto de Suelos-MINAGRI, 2001). In the particular case of the soils dedicated to livestock production, physical-chemical deficiencies are shown which limit good pasture establishment (Paretas *et al*., 1989). Thus, 25 % is acid (Paretas, 1990) and more than 19 % has low fertility (Hernández, 1996).

Under the above-described conditions, grasses –and especially the accessions of the species *Panicum maximum*-, although characterized

by high plasticity, do not always show the best adaptability and good performance, particularly when there are specific edaphic and management conditions.

Machado and Olivera (2004), when evaluating several ecotypes of this species on moderate fertility soils under shade conditions, with neither irrigation nor fertilization, concluded that all the genotypes grew and developed well; but marked differences were detected among the treatments in terms of biomass availability and presence of chlorosis for many of them.

Such results, as well as others obtained in the country, prove that work should continue to be done with *P. maximum* accessions for these soil types, particularly under grazing conditions due to the excellent characteristics of this species to be exploited with animals (Onyeanagu and Ugwuany, 2012). Likewise, the search for new materials with higher potential, which cause a medium-term impact on the development of livestock production is justified, aspect also previously reported by Costa and Oliveira (1994).

Due to the above-explained reasons, the objective of the work was to determine the performance of 19 *P. maximum* accessions under simulated grazing conditions, on moderate fertility soils.

## MATERIALS AND METHODS

*Soil and climate*. The experiment was conducted on a hydrated Ferralitic Red soil of the EEPF "Indio Hatuey" (Hernández *et al*., 1999), which has slightly acid pH (5,60 in KCl), low phosphorus contents (2,43 mg/100 g) and moderate contents of total nitrogen (0,18 %) and organic matter (3,20 %). Among the exchangeable cations calcium prevails (11,84 meq/100 g); while the cation exchange capacity is slightly low (19,21 meq/100 g). These characteristics correspond to a moderate fertility soil, according to the report by Álvarez (2002).

In the last 15 years the annual average temperature was 24,3 ºC; the highest values were 33,4 ºC in August, and the minimum ones, 14,2 ºC in January. The average value of annual rainfall was 1 331,18 mm; the rainfall during the rainy season (May-October) represented, as average, 79,8 % of the total annual volume. The evaporation reached maximum values in April (220 mm) and the annual average relative humidity was 82,6 .

*Treatments and design*. The treatments were the following accessions: CIH-13, SIH-697, CIH-3, CIH-15, CIH-6, CIH-22, CIH-104, SIH-759, SIH-421, SIH-810, SIH-10, SIH-127 (control), CF-305, CC-1146, Montícola, Serpentinícola, Tardío pequeño, Gramalote de Puerto Rico and Likoni (control). A randomized block design was used with three repetitions and plots measuring 5,4 x 4,0 m, separated by spaces of 1,50 m in both senses.

*Procedure*. The soil preparation consisted in plowing, harrowing, crossing and harrowing. For planting, tuft fractions were used, which were separated at 70 cm between rows and equal distance between plants. The latter were established in a period of eight months (more than 80 % fully developed). The duration of the study was three years and neither irrigation nor fertilization was used.

*Measurements*. In all the rotations availability (A) and residue (R) were measured, from which the utilization percentage (U) was calculated ($U = A - R/A \times 100$). Pasture height (H), leaf percentage (L), chlorosis percentage (C), infestation percentage caused by pathogen microorganisms (E), damage caused by phytophagous insects (P), live shoots/dead shoots ratio (ls/vs), leaf percentage affected by drought (D) and plant vigor (V) were also determined.

*Management*. The plots occupied a paddock of a grazing area, which was done by eight buffalo cows managed through a simulated rational grazing system. The rotations started during the dry season. For such purpose, young animals were initially used, weighing 210 kg as average. Afterwards the weight increased to 344 kg during the second year and to 475 kg in the third, which was taken into consideration for the modifications of the grazing intensity. The rotations were made between 60 and 70 days during the dry season, and between 32 and 40 days in the rainy season. In the first two years, the grazing intensity was 80 AU days/ha and 120 AU days/ha for these seasons, respectively. In the third it increased to 134,3 and 160,2 AU days/ha, for those seasons, in order to select the individuals capable of standing a higher degree of intensification without causing damage (or causing minimum damage) in the integrity of the tufts and plots.

The stay time fluctuated between 3,0 and 3,5 days during the rainy season, and between 4,0 and 4,5 days in the dry season. A total of 22 rotations were made.

*Statistical analysis*. The extracted variability and the relation among the variables were determined through a principal component analysis (PCA). To establish the components that extracted higher variability, those which had

a proper value equal to or higher than 1 were accepted. To determine the variables with higher influence on variability, the fact that the sum or preponderance factors were higher than 0,65 was taken as criterion. In order to identify the most outstanding treatments, with relation to the variables, a cluster analysis was applied. For this procedure the statistical pack SPSS, version 15.0, was used.

## RESULTS AND DISCUSSION

The variability extracted in the first three components may be considered acceptable (table 1), because the proper value for all of them was higher than 1. This allows to characterize the studied germplasm related to all the variables and their later selection.

The availability, utilization percentage, leaf percentage and plant height had higher bearing on the variability extracted in CP1. The positive relation established between availability and height, as well as between utilization and leaf percentage, which tended in the same direction, respectively, should be emphasized. However, between the last two indicators and the first two ones an inverse relation was detected. Such performance is obvious, if it is taken into consideration that the tallest genotypes with higher biomass volume (higher availability) showed in general a lower degree of utilization by the animals, as will be analyzed below.

CP2, with only 17,1 % of the extracted variability, was mainly explained by the percentage of infestation produced by pathogen microorganisms, the effect of drought and plant vigor. In the last one an inverse performance as compared with the first two was detected, which is in correspondence with the pattern that should be expected among the stress and vigor indicators. Nevertheless, based on the principle of this type of analysis (Philippeau, 1986; Clavijo, 2010), there was no relation between these indicators and those previously analyzed. This indicates that the affectations produced by drought and pathogen microorganisms influenced little the availability and utilization by the animals, even in the giant types, in which they were more marked.

The degree of affectation by chlorosis and phytophagous insects and the ls/ds ratio were the least variable indicators, with only 11,5 % of the variability. As it is logical, chlorosis and the damage caused by such insects may only be detected in the shoots (regrowths); hence they were positively related.

Table 2 shows the distribution of the treatments through cluster analysis. Two large groups were formed. The first one (group 1), with four subgroups, was formed by the giant types; except subgroup 2, which had the presence of treatment CIH-15, of medium size. The second (group 2), with three subgroups, was represented by medium-size types; except Gramalote de Puerto Rico, of medium-giant size.

Table 1. Matrix of principal components (rotated).

| Variable | $CP_1$ | $CP_2$ | $CP_3$ |
|---|---|---|---|
| Availability | 0,81 | 0,10 | -0,32 |
| Utilization | -0,84 | -0,25 | -0,16 |
| Leaf percentage | -0,73 | -0,50 | -0,09 |
| Height | 0,89 | 0,12 | -0,16 |
| Chlorosis percentage | 0,16 | 0,25 | 0,74 |
| Pathogen microorganisms | 0,24 | 0,90 | -0,01 |
| Drought percentage | -0,00 | 0,88 | 0,13 |
| Ls/ds ratio | -0,34 | -0,21 | 0,66 |
| Vigor | -0,24 | -0,76 | -0,07 |
| Phytophagous insects | 0,57 | 0,11 | 0,76 |
| Proper value | 4,210 | 1,716 | 1,157 |
| Variance (%) | 42,10 | 17,10 | 11,50 |
| Accumulated variability (%) | 42,10 | 59,20 | 70,70 |

Table 2. Distribution of the treatments and mean values of the variables per group and subgroups.

| Group | Subgroup | Treatment | A. | U. | H. | L. | C. | E. | D. | ls/ds | V. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | CIH-13* | *5,1 | 45,6 | 97,6 | 66,5 | 39,5 | 55,8 | 67,6 | 2,8 | 3,0 |
| | 2 | SIH-697<br>Serpentinícola<br>CIH-15 | **4,5 | 46,2 | 88,1 | 73,9 | 35,1 | 40,0 | 47,0 | 2,9 | 3,1 |
| | 3 | CIH-3<br>SIH-10<br>CC-1146 | **5,4 | 39,1 | 107,3 | 67,7 | 49,1 | 35,8 | 46,5 | 2,9 | 3,4 |
| | 4 | SIH-759* | *5,2 | 35,2 | 112,0 | 61,2 | 32,1 | 31,1 | 45,6 | 2,4 | 3,7 |
| | X | | **5,0** | **42,1** | **99,4** | **61,3** | **46,6** | **39,3** | **49,2** | **2,8** | **3,3** |
| 2 | 5 | G. Puerto R.<br>SIH-421<br>CF-305<br>SIH-127<br>Tardío Pequeño<br>CIH-104 | **4,3 | 52,9 | 80,6 | 76,7 | 32,3 | 25,1 | 42,9 | 3,2 | 3,8 |
| | 6 | CIH-6<br>SIH-810<br>Likoni | **4,9 | 48,3 | 97,0 | 78,0 | 27,5 | 25,2 | 38,8 | 2,4 | 3,8 |
| | 7 | CIH-22<br>Montícola | **3,5 | 53,4 | 73,1 | 80,6 | 48,9 | 26,5 | 43,9 | 2,9 | 3,7 |
| | X | | **4,3** | **51,8** | **83,7** | **77,8** | **34,0** | **25,0** | **42,0** | **2,9** | **3,8** |

Legend: * Mean of subgroup 1 and 4 (one treatment) ** Means of the other subgroups
X: General mean of the group

The giant type treatments (group 1) reached, as general mean, an availability of 5,0 t DM/ha/rotation, with which they exceeded in 0,7 t those of group 2 (4,3 t DM/ha/rotation). This result for the accessions of group 2 may be considered outstanding, not only for its adequate availability value, but also because its utilization percentage was, as average, 10,1 % higher as compared to that of giant types. This could have been supported by the high percentage of leaves shown by the medium types, which was higher in 10 % as compared with the giant types and, besides, due to the lower confluence of damage caused by stress, as will be discussed below. Thus the findings by Machado and Olivera (2004), when evaluating a germplasm formed by medium and giant types of P. maximum under simulated grazing conditions, on similar soils, with neither irrigation nor fertilization, were corroborated. Even, the mean utilization percentage of the most outstanding medium types in this indicator (CF-305 and SIH-421) was 22,6 % higher than the one detected in giant types CC-1146 and SIH-759, which were the least efficiently used by the animals.

Based on this result, it is possible to state that the availability was high, independently from the mean values found for each of these groups, which confirms the aspects discussed about the favorable adaptation which all the genotypes had to the environmental conditions, even for those treatments which showed a relatively low value (3,1 t DM/ha/rotation), as in the case of Montícola.

On the other hand, the medium types (group 2) showed less symptoms of chlorosis, were more tolerant to the infestation by pathogen microorganisms (fungi and viruses) and slightly less affected by drought, and remained with more vigor as mean of the three years, although in the ls/ds ratio no marked differences were detected.

With relation to the transcendence these results may have, a casuistic analysis of each of the subgroups formed is necessary. The treatments of subgroup 3 from group 1 (CIH-3, CIH-10 and CC-1146) produced, as average, higher biomass volume (availability); but their height, the low percentage of leaves, the affectations by chlorosis and pathogen microorganisms and the effect of drought caused –as a whole- that they were among the least used types. A similar pattern in these last indicators was detected in subgroup 4, whose only representative (SIH-759) was the treatment with the lowest utilization percentage. It is valid to state

that CIH-3 and CIH-10 are two hybrid apomictic clones selected in the breeding program carried out with this species (Machado *et al*., 2006), in which the dry matter production, under a cutting system, was taken into consideration as indicator for the selection of the materials.

A better performance among the giant types was found in subgroup 2 (SIH-697, Serpentinícola), which although similar to subgroup 1 (CIH-13) in terms of utilization, surpassed it regarding the leaf percentage and showed less marked chlorosis symptoms; and it was also more tolerant to the effects of pathogen microorganisms and drought.

Among all these treatments, the medium type CIH-15 –which was placed among the giant types due to its performance- was the most advantageous in terms of utilization and the least invaded by weeds (Machado, 2012), although it showed strong symptoms of drought-induced stress, but in lower proportion than CIH-13 (subgroup 1). It is important to indicate that CIH-15 and CIH-13 are also sexual hybrids selected in the above-mentioned breeding program.

Nevertheless, some giant type treatments showed outstanding qualities for several indicators, besides for biomass availability; this was the case of SIH-759, which showed low presence of chlorosis, relatively lower presence of fungi and viruses, and the highest vigor; thus, this genotype could be used with other purposes, such as forage production, and even be utilized under grazing conditions, but with a differentiated management (higher stocking rate).

Among those which were part of group 2 (medium) subgroup 6 stood out, which included treatments CIH-6, SIH-810 and Likoni. They achieved the highest mean availability, acceptable utilization percentage (particularly CIH-6, with 52,3 %), from moderate to high leaf percentage, low symptoms of chlorosis and lower affectation by drought.

When making a comparison with cv. Likoni –commercial variety used as control due to its relevant characteristics in Cuba (Cordoví and Galindo, 1979; Gerardo et al., 1984)-, it was surpassed by CIH-6 and SIH-810 in terms of availability, height, leaf percentage and presence of chlorosis; as well as by CIH-6 in utilization percentage and vigor. This performance confirms that cv. Likoni is not a good choice for unfavorable environments (Machado et al., 2006), although it was the most outstanding in tolerance to drought and showed very low percentage of weeds (Machado, 2012).

SIH-127, another commercial variety used in this research as control, was part of group 5. This group was characterized by a utilization mean a little higher than the previously described one and similar leaf percentage and vigor, but also by higher percentage of chlorosis and higher affectation by drought. Particularly, SIH-127 was one of the most prominent treatments regarding availability among the medium types, only surpassed by CIH-6 and SIH-810, and the most outstanding treatments in leaf percentage and ls/ds ratio. However, compared with other variety, the presence of chlorosis was lower in CIH-6 and SIH-810; and there was lower presence of pathogen microorganisms in the latter.

In the treatments of subgroup 7 (CIH-22 and Montícola) the lowest availability was detected and only the utilization percentage was slightly higher; but they showed the most acute symptoms of chlorosis and affectation by drought. Yet, it should be stated that CIH-22 stood out, with 3,9 t DM/ha/rotation and 54,8 % of utilization, which was placed among the ones with higher leaf proportion (80,7 %); this indicator, as it is known, determines higher pasture density, favoring intake by the animals.

It should be stressed that CIH-22, CIH-6 and SIH-810 were the most visited treatments by the animals, according to the observations made in this experiment by Galloso (2010), who detected 411 visits in CIH-22, 443 in CIH-6 and 350 in SIH-810, as compared with 211 and 295 in Likoni and SIH-127, respectively.

These results indicate that among the evaluated genotypes for moderate fertility soil conditions, in which neither irrigation nor fertilization was used, the treatments CIH-6, SIH-810 and CIH-22 stood out and were selected, which have remarkable characteristics that support them as pre-commercial varieties which may be used, together with SIH-127, for these conditions.

## CONCLUSIONS

The phenotype and the selection made by the animals had a main role in the detected variability, aspects which were confirmed by the availability, height and leaf percentage (phenotypic characters), as well as the utilization percentage.

The infestation caused by pathogen microorganisms, the effect of drought, the presence of chlorosis, the damage produced by phytophagous insects, the ls/ds ratio and vigor were

little variable indicators; however, they allowed to evaluate the performance of these materials – together with the other variables- and thus detect the most advantageous treatments.

Although there was superiority in the giant genotypes in terms of biomass availability, as compared with the medium types, the latter were more efficiently utilized, and at the same time they showed the lowest stress affectation rates and higher vigor during the experimental period.

## RECOMMENDATIONS

The medium types CIH-6, SIH-810 and CIH-22 are recommended as pre-commercial varieties for similar conditions as the ones used here, as well as to include the giant type SIH-759 in trials in which cutting or grazing are used with higher intensity.

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## Reseñas de Publicaciones

**PLANTAS TÓXICAS EN EL TRÓPICO**

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El libro *Plantas tóxicas en el trópico* es el resultado del trabajo conjunto de especialistas del Centro Nacional de Sanidad Agropecuaria, la División de Criminalística de la República de Cuba y el Instituto de Investigaciones en Fruticultura Tropical, para actualizar a la comunidad técnica vinculada a la salud animal y la toxicología veterinaria en una temática que cobra cada día mayor impacto por su reconocida significación social, económica y productiva en la esfera de la alimentación animal; y, en consecuencia, directa e indirectamente, para la salud humana.

Esta edición aborda 140 especies vegetales que son consideradas potencialmente tóxicas como resultado de la recopilación de un abundante material obtenido en el desarrollo de investigaciones y servicios científico-técnicos, así como de la bibliografía nacional e internacional disponible. En cuanto a su estructura, el libro está organizado alfabéticamente, de acuerdo con el nombre científico de cada planta.

Resulta oportuno disponer de referencias que aporten al conocimiento para dar respuesta correcta y poder mitigar las consecuencias que, sobre la salud animal y humana, producen estos accidentes con implicaciones en la cadena alimentaria del hombre.

Por la originalidad y especificidad del tema se convierte en un importante complemento relacionado con el campo de la toxicología contemporánea para nuestro país y muchos otros con ecología tropical similar.

Constituye la presente obra científica un material de consulta necesario para investigadores, docentes y personal técnico, en el alcance de un mayor conocimiento acerca de las temáticas que son abordadas por este colectivo de autores.

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