# Indicators accounting for the variability, in humid basis, among *Pennisetum purpureum* clones

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An experiment was carried out to determine the agronomical indicators, expressed in humid basis, most contributing to account for the variability in 49 clones of *Pennisetum purpureum*, obtained by *in vitro* tissue culture from the apical tissue of *P. purpureum* cv Cuba CT-115. A completely random design with five replications was applied. The experiment lasted one year. The analysis of the main components indicated that in the rainy period two components accounted for 81.65% of the variability among clones integrated by height, leaf and stem contents and length of the fourth leaf completely opened, internode length and fresh matter yield. In the dry period two main components accounted for 84.68% of the variability between clones integrated by the same indicators than in the rainy period. It is concluded that the above mentioned indicators, expressed in humid basis, can be used for establishing the variability among Pennisetum clones. This determines savings in time and resources, without losing the quality and scientific rigor in the research. Similar studies are recommended under different environmental conditions and with other pasture varieties including other indicators.

Key words: *multivariate analysis, agronomical indicators, Pennisetum*

The evaluation of new pastures, introduced or obtained by different ways, is a process consuming material and human resources. It is relatively expensive and requires using sampling systems and data analysis allowing the correct pasture selection, according to the productive purpose and the edaphoclimatic conditions where it will be exploited.

In the Institute of Animal Science diverse essays have been conducted and appropriate sampling methods have been established for specific conditions, including the evaluation of new varieties (Martínez *et al*. 1988, Herrera *et al*. 1990, Fortes *et al*. 2007 and Sardiñas *et al*. 2008). Also, multivariate analysis methods have been applied securing higher precision and scientific rigor to the results and, in turn, facilitate data analysis with greater integrity.

A common practice has been the quantification of the agronomical indicators in dry basis for eliminating the variability that the water contents could introduce to the indicator measured. However, in the available home and international literature there was no information dealing with this topic, especially regarding the initial evaluation of new pastures.

The objective of this work was to study the possibility of using the agronomical indicators expressed in humid basis, without losing quality and scientific rigor the results.

## Materials and Methods

*Treatment and experimental design*. Forty nine *P. purpureum* clones obtained by *in vitro* tissue culture were analyzed and compared to its progenitor *P. purpureum* cv. Cuba CT-115. A completely random design with five replications was applied. The experimental unit was de row of 5 m long.

*Experimental procedure*. Plants obtained in the laboratory were sown in a typical red ferrallitic soil (Hernández *et al*. 1999), for obtaining sufficient vegetative seeds. Conventional soil preparation was carried out and during this phase there was no irrigation or fertilization.

Once achieved sufficient amount of vegetative seeds, the experiment was set up at the beginning of the rainy season, in a similar soil and with the above mentioned preparation. At 135 days, the homogeneity cut of the experimental area was made and the systematic samplings were practiced every 90 d during the rainy and dry periods. The sampling cut was made with a machete, at 10 cm height above soil level. There was no irrigation or fertilization and the experiment lasted one year.

*Measurements*: Plant height from the soil to the growth point using a graduated rule; length and width of the fourth leaf completely opened from apex downwards; length of the fourth internode from soil level were measured in each cut. Leaves and stems were separated manually for their quantification and for determining biomass yield (Herrera 2006). All measurements were taken in five sprouts of each replication and according to the sampling methodology before mentioned. All results were expressed in humid basis.

*Statistical analysis*. Data from each climatic season (rainy and dry periods) and from the annual total were submitted to multivariate analysis of main components (Visuata 1998). To establish the main components those with eigen value higher than one were selected. For the selection of the indicators those of preponderance value higher than 0.75 were taken into account.

## Results and Discussion

For the application of the multivariate analysis of main component, the first stage is determined for ascertaining the degree of relationship between the

studied variables. Results obtained in the rainy period are shown in table 1.

Two main components were established with eigen value higher than one and preponderance factor equal or higher than 0.75. This allowed explaining 81% of the variability among clones, taken into account the studied indicators (table 2).

In the first component, showing greater influence on the explanation of the variability among clones, are the leaf and stem contents, height and width of leaves. In the second, are leaf and internode lengths and fresh matter yield. From these variables, leaf contents and leaf width were those presenting negative correlation.

In previous studies, on evaluating king grass (*P. purpureum* cv. king grass) clones obtained by tissue culture, Martínez *et al*. (1988) indicated that on applying the multivariate analysis, height indicators, leaf and stem contents, leaf length and width, internode length and width and dry matter yield accounted for 85% of the variability among clones. Later, Herrera *et al*. (1990) confirmed these indicators on assessing king grass mutants obtained by physical mutagenesis.

In the studies of the above cited authors all indicators were expressed in dry basis, while in this results are referred in humid basis. This could indicate that for this rainy period the endogenous water content does not seem to have influenced on the variables studied, since it was attained to explain 81.65% of the variability between clones. This could cause valueless results or the possibility of establishing a methodological guide capable of explaining the variability among clones in a certain proportion.

Fortunately, in this way happened, since the selected indicators accounted for more than 80% of the variability, which can be considered as an adequate value. Results shown regarding the definition of the sampling method indicated that the plant dry matter content had poor variation in each seasonal period. If the variance values explained in both studies are compared, it can be stated that difference between them was of only five percentile units. This could also be determined by the fact that in this study the internode thickness was not taken into consideration, contrary to what occurred in the experiments above mentioned.

These results were considered encouraging, since offered a new analysis option in this type of experiments. However, the response in the dry period was not known. Thus, the same analysis was realized in that period.

There was a relationship between the indicators measured in the dry period, suggesting the possibility

Table 1. Correlation between the indicators studied in the rainy period

| Indicators | Leaf, % | Stem, % | Height, cm | Leaf width, cm | Leaf length, cm | Internode length, mm | FM[1] |
|---|---|---|---|---|---|---|---|
| Leaf | 1.00 | -0.67 | -0.69 | 0.48 | -0.45 | -0.45 | -0.24 |
| Stem, % | -0.67 | 1.00 | 0.64 | -0.38 | 0.35 | 0.35 | 0.17 |
| Height, cm | -0.69 | 0.64 | 1.00 | -0.44 | 0.54 | 0.54 | 0.37 |
| Leaf width, cm | 0.43 | -0.38 | -0.44 | 1.00 | -0.13 | -0.13 | -0.04 |
| Leaf length, cm | -0.45 | 0.35 | 0.54 | -0.13 | 1.00 | 1.00 | 0.39 |
| Internode length, mm | -0.45 | 0.35 | 0.54 | -0.13 | 1.00 | 1.00 | 0.39 |
| FM[1] | -0.24 | 0.17 | 0.37 | -0.04 | 0.39 | 0.39 | 1.00 |

[1]Fresh matter yield

Table 2. Results from the analysis of main component in the rainy period

| Indicators | Main component | |
|---|---|---|
| | 1 | 2 |
| Leaf, % | -0.80 | -0.33 |
| Stem, % | 0.80 | 0.22 |
| Height, cm | 0.75 | 0.47 |
| Leaf width, cm | -0.77 | 0.11 |
| Leaf length, cm | 0.22 | 0.93 |
| Internode length, mm | 0.22 | 0.93 |
| FM[1] | 0.06 | 0.83 |
| Individual value | 3.64 | 1.37 |
| Variance explained, % | 52.02 | 29.63 |
| Total variance, % | 52.02 | 81.65 |

[1]Fresh matter yield

of applying the analysis of main component (table 3).

Results from the analysis of main components indicated that two components were established that allowed explaining 84.08% of the variability among clones, taking into account the studied indicators (table 4).

This value is slightly higher to that registered for the rainy period, which could be due to the difference in the performance of the climatic indicators between periods. The dry period (winter) is characterized by low temperatures, rainfall, daylight intensity and duration, while in the rainy period (summer) the opposite occurs favoring a greater pasture development.

Another element to bear in mind is the absence of fertilization and irrigation during the experimental period. This influences on the clones not to express, in their entirety, their growth potential. For that, variations between seasonal periods decrease, an aspect that has been widely dealt with in the scientific literature. In studies of Díaz (2007) the analysis of main components was applied to explain the variability among *Pennisetum purpureum* clones, resistant or tolerant to drought, obtained by *in vitro* tissue culture (Herrera 2001). This author obtained similar results to those here reported, but included also, other indicators such as foliar area and absolute growth rate, considered as elements that could contribute to explain the resistance or adaptation to drought. Álvarez (2009) on studying through multivariate analysis the variability among *Pennisetum purpureum* clones with resistance or tolerance to salinity and obtained by *in vitro* tissue culture (Herrera 2001), reported similar results but the author also included the foliar area.

Through the application of multivariate analysis, Ramírez (2010) studied different varieties of Panicum, Brachiaria and Pennisetum genera of the Eastern region of Cuba. This author indicated that between the variables of highest contribution accounting for the variability were height, leaf and stem contents and yield.

In all cited studies there is a community in a group of indicators, as height, length and width of leaves, length and thickness of the internode, leaf and stem contents and yield. However, in some cases other were included that contributed to account for the performance in certain edaphoclimatic conditions. According to Machado *et al*. (2006), it is necessary to consider important elements in the initial evaluation of pastures. The duration of the experimental period must be of one year, and including both seasonal periods; the appropriate experimental methodology and the selection of the indicators must

Table 3. Correlation between the indicators studied in the dry period

| Indicators | Leaf, % | Stem, % | Height, cm | Leaf width, cm | Leaf length, cm | Internode length, mm | FM[1] |
|---|---|---|---|---|---|---|---|
| Leaf | 1.00 | -0.74 | -0.05 | 0.47 | -0.25 | -0.39 | 0.03 |
| Stem, % | -0.74 | 1.00 | 0.27 | -0.43 | 0.35 | 0.55 | 0.12 |
| Height, cm | -0.05 | 0.27 | 1.00 | 0.02 | 0.48 | 0.53 | 0.53 |
| Leaf width, cm | 0.47 | -0.43 | 0.02 | 1.00 | -0.23 | -0.32 | 0.04 |
| Leaf length, cm | -0.25 | 0.37 | 0.48 | -0.23 | 1.00 | 0.94 | 0.23 |
| Internode length, mm | -0.39 | 0.55 | 0.53 | -0.32 | 0.94 | 1.00 | 0.21 |
| FM[1] | 0.03 | 0.12 | 0.53 | 0.04 | 0.23 | 0.21 | 1.00 |

[1]Fresh matter yield

Table 4. Results from the analysis of main component in the dry period

| Indicators | Main component | |
|---|---|---|
| | 1 | 2 |
| Leaf, % | -0.87 | -0.01 |
| Stem, % | 0.82 | 0.26 |
| Height, cm | 0.86 | 0.01 |
| Leaf width, cm | -0.75 | 0.06 |
| Leaf length, cm | 0.41 | 0.76 |
| Internode length, mm | 0.56 | 0.75 |
| FM[1] | -0.18 | 0.78 |
| Individual value | 3.18 | 1.67 |
| Variance explained, % | 48.45 | 35.63 |
| Total variance, % | 48.45 | 84.08 |

[1]Fresh matter yield

Table 5. Mean values and SD of the indicators in each climatic period

| Indicadores | Dry period | | Rainy period | |
|---|---|---|---|---|
| | Mean | SD | Mean | SD |
| Leaf, % | 33.36 | 3.73 | 34.81 | 3.13 |
| Stem, % | 66.64 | 2.90 | 65.19 | 3.59 |
| Height, cm | 134.78 | 16.98 | 134.37 | 13.30 |
| Leaf width, cm | 3.45 | 0.33 | 3.23 | 0.34 |
| Leaf length, cm | 80.98 | 11.54 | 83.55 | 9.84 |
| Internode length, mm | 81.58 | 12.09 | 88.52 | 9.83 |
| FM[1] | 13.17 | 4.63 | 41.27 | 5.85 |

[1]Fresh matter yield

be carried out according to the plant characteristics and productive purposes.

All these purposes were completely fulfilled in this research. It must be noted that the comparison to CT-115 responds to the fact that this is the progenitor of the clones obtained. This does not comply with its yield, since it is known that its main characteristics are the shortening of the internode distance, its high leaf contents and scarce flowering, characteristics which makes it appropriate for grazing (Martínez and Herrera 2006).

It is essential to submit the importance of some indicators not included in this analysis. The high flowering is a negative aspect for pasture utilization as animal feed, since growth is stopped and its nutritive value decreases (Herrera and Ramos 2006). Leaf bud germination is an important indicator, determining the establishment time and its population. This will assure a fast establishment, appropriate population, rational use of land and resources, grassland longevity and favorable economical effects (Hernández *et al*. 2006). Plant susceptibility to pest and diseases has a main function in grassland exploitation, since they cause negative effects: yield reduction, animal production decrease, use of chemical or biological products for their control and unfavorable economical effects (Alonso and Lezcano 2006). These aspects must be considered in future research studies to further the reaching and reliability of results encountered.

Results found were encouraging, since they allowed accounting for the high variability value among clones with the quantified indicators in humid basis. This aspect was not previously reported in the available literature. This constitutes an option for the initial plant evolution system, since it reduces the time for getting rigorous and precise information. It accounts for 80 and 85% of the variability among clones, values which are considered appropriate for its selection.

Height, leaf and stem contents, length and width of the fourth leaf completely opened from the apex, as well the length of the fourth internode from soil level and fresh matter yield, were promising indicators to account, with a high precision degree, for the variability among *P. purpureum* clones under the conditions of this study.

Results of this study represent a methodological guide for the evaluation of *Pennisetum purpureum* clones. This information was not previously available at home scientific literature. From these conditions, future studies are required to confirm these results. In those studies the indicators in humid basis must be contemplated in other environmental conditions and with other pasture species.

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**Received: October 8, 2012**