Characterization of purple elephant grass in the tropical zone of Babahoyo, Ecuador

Carlos Amador Sacoto
Universidad Agraria del Ecuador, Av. 25 de Julio, 090104, Guayaquil, Ecuador, camador@uagraria.edu.ec https://orcid.org/0000-0002-5534-5474

Geovanny Dario Lindao Vera
Asesor independiente, Babahoyo, Ecuador, dariolindao61@gmail.com https://orcid.org/0000-0002-7694-5401

Edwin Hasang Morán
Universidad Agraria del Ecuador, Av. 25 de Julio, 090104, Guayaquil, Ecuador, ehasang@uagraria.edu.ec https://orcid.org/0000-0001-6832-2047

Simón Farah Asang*
Universidad Agraria del Ecuador, Av. 25 de Julio, 090104, Guayaquil, Ecuador, sfarah@uagraria.edu.ec https://orcid.org/0000-0003-3245-2936

Arturo Alvarado Barzallo
Universidad Agraria del Ecuador, Av. 25 de Julio, 090104, Guayaquil, Ecuador, aealvarado@uagraria.edu.ec https://orcid.org/0000-0002-9806-9684

Abstract

This research aims to morphologically describe the "purple" king grass with its English name King Grass (Pennisetum purpureum), in the Babahoyo canton in tropical Ecuador. It was taken as a basis of analysis of morphological diversity of 16 individuals in the study area in Babahoyo province of Los Ríos. For the evaluation of the phenotypic characteristics of the king grass, characterizers used in other studies of the same nature were adapted, being possible to describe each individual phenotypically from a set of qualitative and quantitative data. The present characterization research showed no phenotypic differences in the ecotypes subjected to the evaluation of "purple" king grass (P. purpureum) in the tropical zone of the Babahoyo canton. The variables evaluated exceeded a CV > to 50%, indicating that individuals with each other have little variability. According to the results obtained in the correlation coefficient, it was possible to determine the existence of a direct relationship between some of the variables evaluated, such as the weight of the leaf with the height of the plant with a value of 0.63; Similarly, an existing relationship between the width of the leaf with stem diameter was evidenced with a value of 0.59 of the correlation coefficient. Among other data analyzed, a strong relationship between dry and wet weight is also shown with a value of 0.92 among the evaluated variables.

Keywords: *King Grass, diversification, variability, evaluation.*

Introduction

Grasses are the basis of feeding ruminant livestock, being of fundamental importance in the supply feed from forage plants capable of producing high volumes of biomass with high nutritional content and low fiber, providing a highly productive performance of animals (Fontoura et al., 2015; Rosa et al., 2019). Currently, there is a great diversity of genera and cultivars of grasses as food for livestock production. Among that diversity of species is the elephant grass (Pennisetum purpureum Schum.), having a prominent role due to its high potential in producing dry matter. This species occurs in all tropical and subtropical regions, standing out for the quality of forage, vigor and persistence. On the other hand, PurpleKing Grass is mainly used for fodder grass and silage (Paciullo et al., 2015; Pereira et al., 2017).

A morphological characterization is a tool for identifying outstanding individuals. This consists of describing each individual or ecotype's shape or physical configuration to be evaluated under one or different environments (Maldonado et al., n.d.). Morphological characterization phenotypically describes each individual from a qualitative and quantitative dataset. The materials obtained in a forage germplasm collection are considered a phylogenetic resource (Olivera et al., 2014). Morphological characterization is a tool for identifying outstanding individuals. This consists of describing each individual or ecotype's shape or physical configuration that will be evaluated under one or different environments (Benitez et al., 2017). From this, ecotypes with outstanding characteristics can be selected to be included in genetic improvement plans and rehabilitation of grasslands. This makes it possible to identify species with high productive potential by relating phenotypic characters to agronomic ones (Cruz Morillo et al., 2016; Suárez Ayala et al., 2016).

Morphological characterization data can be analyzed using simple or complex statistical methods, ranging from central tendency and dispersion graphs and statistics to multivariate ones. The analysis aims to reduce the volume of information characteristic in works of this nature. By applying these methods to MBD it is possible to conclude the variability and usefulness of germplasm (Franco & Hidalgo, 2003). This work's general objective was to characterize King Grass“purple” (P. purpureum), as a tool for decision-making in the implementation of livestock systems in the tropical zone of the Babahoyo canton in the province of Los Ríos.

Materials and Methods

Location and description of the experimental field.

The experimental work was carried out in the rural area of the Babahoyo canton of the province of Los Ríos in Ecuador, with altitude conditions of 8 m.a.s.l., with the UTM geographical coordinates: 01-49´S latitude and 79-32´ W longitude. The average annual rainfall is 2,656 mm; 76% relative humidity; and the temperature is 26.2°C.

Genetic material

The experimental work was carried out using the material of King Grass “purple” (Pennisetum purpureum) that was found distributed in the lower tropical zone of the Babahoyo canton in the province of Los Ríos. The material was subjected to analysis using taxonomic references and morphological descriptors to characterize and identify genetic differences between the different samples of the individuals collected.

Statistical analysis

For this study, the agronomic behavior of the quantitative variables of the different individuals about each characteristic was analyzed. This analysis consisted of obtaining the arithmetic mean, standard deviation (SD) and coefficient of variation (CV), which were used in the study of statistical data.

Morphological characterization.

For the morphological characterization of the grass, the technical guide for the description of pink grass (Melinis repens -Willd.) proposed by Corrales-Lerma et al. (2017) was used as a basis, which consisted of evaluating or measuring plant height (AP), foliage height (AF), stem diameter (DT), leaf length (LH), number of leaves per plant (NH), sheet width (AH), wet weight yield (PH), dry weight yield (PS), dry matter yield percentage (%RMS).

Sample size

The sample size was defined using the methodology used by Franco & Hidalgo (2003) and Franco & Hidalgo (2003), which proposes the following equation 1:

$$n = \frac{4CV^2}{AND^2\%}$$

Where

QoL = Percentage of variation associated with the descriptor that is considered most variable within the individuals evaluated. This value was also verified in the literature, in research that refers to populations.

E2% = Permissible error expressed as a percentage of the sample mean ($\bar{X}$) and the true mean (μ) of the descriptor, expressed as a percentage of the true mean (μ) with a confidence level of 95%. For this study, 16 individuals with a QoL = 40 and E of 20 were taken as the population to be evaluated.

Results and discussion

Variability of the species

A Cv > 50% suggests that there is variability in the species. Likewise, a Cv < 20% indicates that the species may have little variability. In the present research, the stability of the species can be evidenced since none of the variables exceeded a Cv > 50% (Table 1).

Table 1. Variability of the species in "purple" King Grass grass (Pennisetum purpureum).

VARIABLE	N	MEDIA	D.E.	E.E.	CV
Floor height (m)	16.00	2.03	0.15	0.04	7.28
Stem diameter (cm)	16.00	1.80	0.34	0.09	19.14
# Macollas	16.00	8.13	2.75	0.69	33.89
Blade length (cm)	16.00	101.44	6.90	1.72	6.80
Blade width (cm)	16.00	3.25	0.67	0.17	20.56
Blade weight (g)	16.00	8.00	1.03	0.26	12.91
Wet Weight	16.00	606.50	123.93	30.98	20.43
Dry weight	16.00	268.60	49.45	12.36	18.41
%RMS	16.00	55.34	4.13	1.03	7.47

The result of the present research work reflects that there is little variability of the species analyzed about the morphological characteristics of King Grass "purple"

(Pennisetum purpureum). The different individuals collected and subjected to morphological descriptors show genetic stability in the species of P. purpureum, the parameters evaluated in the characterization do not show a significant variation. These results agree with Maldonado et al. (2019), in work carried out with 15 genotypes of grasses of the species P. purpureum, where there was little variability (coefficient of variation less than 25%) in the quantitative qualities of the genotypes, but a variation was found in the qualitative qualities, such as color and shape of the stem, position, Arrangement, shape, color and foliolus border.

Correlation coefficients

Table 2 shows a direct relationship between some of the variables evaluated. For example, the leaf's weight with the plant's height was 0.63. Similarly, there was a relationship between leaf width and stem diameter with a value of 0.59. On the other hand, the analysis also shows a strong relationship between dry and wet weight, with a value of 0.92.

Table 2. Pearson's correlation coefficients in "purple" King Grass grass (Pennisetum purpureum).

	Hp (m)	Dt (cm)	# Mc	Lh (cm)	Wh (cm)	Phj (gr)	Ph (gr)	Ps (gr)	%Rms
Floor height (m)	**1.00**	0.94	0.17	0.11	0.12	0.01	0.58	0.51	0.98
Stem diameter (cm)	0.02	**1.00**	0.53	0.53	0.02	0.36	0.77	0.96	0.40
# Macollas	0.36	0.17	**1.00**	0.03	0.16	0.93	0.95	0.90	0.72
Blade length (cm)	0.42	0.17	0.54	**1.00**	0.21	0.49	0.93	0.87	0.77
Blade width (cm)	0.40	0.59	0.37	0.33	**1.00**	0.12	0.81	0.90	0.78
Blade weight (g)	0.63	0.24	0.02	0.19	0.41	**1.00**	0.76	0.89	0.59
Wet Weight	-0.15	0.08	-0.02	0.02	-0.07	-0.08	**1.00**	0.00	0.07
Dry weight	-0.18	-0.01	0.03	-0.04	-0.04	-0.04	0.92	**1.00**	0.73
%RMS	0.01	0.23	-0.10	0.08	-0.07	-0.14	0.47	0.09	**1.00**

Note: Hp (plant height); Dt (plant diameter); Mc (tiller); Lh (blade length); Wh (blade width); Phj (leaf weight); Ph (wet weight); Ps (dry weight).

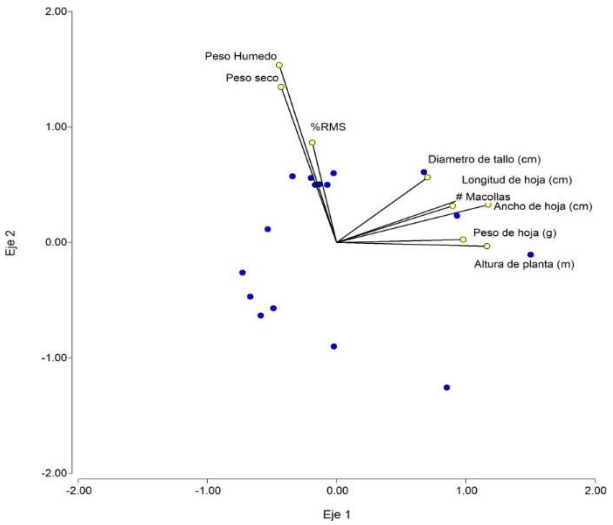
Purple grass is a highly efficient vegetable due to its ability to transform light energy into biomass, making it an ideal pasture to produce much fodder. Like other pastures, the production of foliage or leaf area of P. purpureum is closely conditioned to factors such as climatic conditions, age of the plant and the different activities in the agronomic management of the crop. On the other hand, foliage production is also directly related to other intrinsic factors of the vegetable, such as stem diameter, root area and plant size (Cortes & Olarte, 2018; Madera et al., 2013). The present research reflected that in the production of foliage by purple King Grass there was a relationship between variables such as leaf weight with plant height and leaf size with stem diameter, showing that efficient production of foliage or biomass by P. purpureum, depends on a direct relationship between the aforementioned variables.

Principal Component Analysis

Figure 1 shows the correlation between the most prominent variables, such as stem diameter, leaf length, number of tillers, leaf

width, leaf weight, and plant height, is graphically observed in the upper right quadrant. Also, in the upper left quadrant, there is a correlation between wet weight, dry weight.

Figure 1. Main Components



Conclusions

According to the research, the non-existence of phenotypic differences in the evaluated individuals of King Grass“purple” (Pennisetum purpureum) is determined since the variables evaluated did not exceed a QoL > 50%, which indicates that the species have little variability.

The correlation coefficient shows the results in direct relation between some of the variables evaluated. For example, the weight of the leaf with regard to the height of the plant with a value of 0.63; Also, a relationship between leaf width and stem diameter is shown at a value of 0.59.

Similarly, the analysis shows a strong relationship between dry weight and wet weight, with a value of 0.92. In the percentage of dry matter yield, an average of 55.34% is shown, which is an important production for this material, indicating good behavior of the material in the climatic conditions presented in the study area (Babahoyo-Los Ríos).

It is important to carry out this type of research in different sectors with different agroclimatic conditions to have references on the behavior of the variables studied in this characterization work.

Similarly, other species of cutting and grazing ponds should be considered using the same techniques as the research variables, being that the production and establishment of grassland systems are alternatives to mitigate the effect of climate change.

Acknowledgments

The authors of this work want to express their special gratitude to the agricultural producers who own the properties where the sampling and collection of the plant material of the “purple” King Grass (Pennisetum purpureum) was carried out and especially to the Technical University of Babahoyo for its collaboration facilitating the properties to carry out the characterization work and provide material for the corresponding analysis.

This work is carried out based on the research project carried out-prior to obtaining the degree of Agricultural Engineering by Mr. Geovanny Darío Lindao Vera former student of the Technical University of Babahoyo of the career of Agronomic Engineering. The data and more content shown in this work were obtained from Lindao (2020) with the due authorization of the author.

Reference

Benitez, E., Chamba, H., Sánchez, E., Parra, S., Ochoa, D., Sanchez, J., & Guerrero, R. (2017). Characterization of naturalized pastures of the Southern Ecuadorian Amazon Region: potentials for animal feed. Forests Latitude Zero, 7, 83–97. http://revistas.unl.edu.ec/index.php/bosques/article/view/323/296

Corrales-Lerma, R., Morales-Nieto, C. R., Villarreal-Guerrero, F., Santellano-Estrada, E., Melgoza-Castillo, A., Álvarez-Holguín, A., & Avendaño-Arrazate, C. H. (2017). MORPHOLOGICAL AND NUTRITIONAL CHARACTERIZATION OF PINK GRASS [Melinis repens (Willd.) Zizka] IN THE STATE OF CHIHUAHUA. MORPHOLOGICAL AND NUTRITIONAL CHARACTERIZATION OF NATAL GRASS [Melinis Repens (Willd.) Zizka] IN THE STATE OF CHIHUAHUA. , 10(10), 103–109. http://search.ebscohost.com/login.aspx?direct=true&db=fap&AN=126549200&site=ehost-live

Cortes, D., & Olarte, O. (2018). Purple king grass (Pennisetum Purpureum x Pennisetum Typhoides), a forage hope in the agricultural colony of Acacias. Working Papers -ECAPMA, 2, 1–10. https://doi.org/10.22490/ECAPMA.2772

Cruz Morillo, A., Tovar, Y. P., & Morillo, Y. (2016). Morphological characterization of Selenicereus megalanthus (K. Schum. ex Vaupel) Moran in the province of Lengupá. Developing Science, 7(2), 23–33. http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S0121-74882016000200002&lng=en&nrm=iso&tlng=en

Fontoura, C. F., Brandão, L. E., & Gomes, L. L. (2015). Elephant grass biorefineries: Towards a cleaner Brazilian energy matrix? Journal of Cleaner Production, 96, 85–93. https://doi.org/10.1016/j.jclepro.2014.02.062

Franco, T. L., & Hidalgo, R. (2003). Statistical Analysis of Morphological Characterization Data of Plant Genetic Resources. In Technical Bulletin No. 8, International Institute of Plant Genetic Resources IPGRI (Issue 8).

Lindao Vera, G. D. (2020). Morphological characterization of“purpl” King Grass (Pennisetum purpureum), under the edaphoclimatic conditions of Babahoyo [BABAHOYO: UTB, 2020]. In Technical University of Babahoyo. http://dspace.utb.edu.ec/handle/49000/7995

Madera, N. B., Ortiz, B., M., B. H., & Magaña, H. (2013). Influence of the cutting age of purple grass (Pennisetum purpureum) on the production and in vitro digestibility of dry matter. Advances in Agricultural Research, 17(2), 41–52.

Maldonado, J., Guerra, C., Ovando, M., Valle, F., Ovando, E., & Gálvez, L. (n.d.). Morphological characterization of 15 grasses of Pennisetum purpureum species. Agro Productividad, 12, 39–46.

Maldonado, J., Guerra, C., Ovando, M., Valle, F., Ovando, E., & Gálvez, L. (2019). Morphological characterization of 15 grasses of Pennisetum purpureum species. Agro Productividad, 12(12), 39–46.

Olivera, Y., Machado, R., Ramírez, J., del Pozo, P. P., & Castañeda, L. (2014). Morphological characterization of 19 accessions of Brachiaria brizantha in an acidic soil. Pastures and Forages, 37(2), 138–144. http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S0864-03942014000200002&lng=es&nrm=iso&tlng=es

Paciullo, D., Gomide, C. de M., Morenz, M. F., Andrade, D. F., Andrade, Paulino José, P., Andrade, M., Lédo, F., & Pereira, A. (2015). Pasture characteristics and performance of dairy heifers in elephant grass cv pasture. BRS Kurumi. Brazilian

Agricultural Research Company. Research and Development Bulletin 35, 35, 21. http://www.embrapa.br

Pereira, A. Vander, Lédo, F. J. da S., & Machado, J. C. (2017). BRS Kurumi and BRS Capiaçu - New elephant grass cultivars for grazing and cut-and-carry system. Crop Breeding and Applied Biotechnology, 17(1), 59–62. https://doi.org/10.1590/1984-70332017v17n1c9

Rosa, P. P. da, Silva, P. M. da, Chesini, R. G., Oliveira, A. P. T. de, Sedrez, P. A., Faria, M. R., Lopes, A. A., Roll, V. F. B., & Ferreira, O. G. L. (2019). Characteristics of Elephant Grass Pennisetum purpureum (Schumach) and its new cultivars BRS Kurumi and BRS Capiaçu. Agricultural Research Gaúcha, 25(1/2), 70–84. https://doi.org/10.36812/PAG.2019251/270-84

Suárez Ayala, D. V., Àlvarez Venegas, M. del R., Gómez Urrego, J. F., Carrasco De Los Rios, M. M., & Burbano Guerrero, D. C. (2016). Clinical and laboratory characterization of patients with febrile neutropenia in a pediatric hospital in Pasto-Colombia. Pediatrics, 49(2), 48–53. https://doi.org/10.1016/j.rcpe.2016.05.001

Benitez, E., Chamba, H., Sánchez, E., Parra, S., Ochoa, D., Sanchez, J., & Guerrero, R. (2017). Characterization of naturalized pastures of the Southern Ecuadorian Amazon Region: potentials for animal feed. Forests Latitude Zero, 7, 83–97. http://revistas.unl.edu.ec/index.php/bosques/article/view/323/296

Corrales-Lerma, R., Morales-Nieto, C. R., Villarreal-Guerrero, F., Santellano-Estrada, E., Melgoza-Castillo, A., Álvarez-Holguín, A., & Avendaño-Arrazate, C. H. (2017). MORPHOLOGICAL AND NUTRITIONAL CHARACTERIZATION OF PINK GRASS [Melinis repens (Willd.) Zizka] IN THE STATE OF CHIHUAHUA. MORPHOLOGICAL AND NUTRITIONAL CHARACTERIZATION OF NATAL GRASS [Melinis Repens (Willd.) Zizka] IN THE STATE OF CHIHUAHUA. , 10(10), 103–109. http://search.ebscohost.com/login.aspx?direct=true&db=fap&AN=126549200&site=ehost-live

Cortes, D., & Olarte, O. (2018). Purple king grass (Pennisetum Purpureum x Pennisetum Typhoides), a forage hope in the agricultural colony of Acacias. Working Papers -ECAPMA, 2, 1–10. https://doi.org/10.22490/ECAPMA.2772

Cruz Morillo, A., Tovar, Y. P., & Morillo, Y. (2016). Morphological characterization of Selenicereus megalanthus (K. Schum. ex Vaupel) Moran in the province of Lengupá. Developing Science, 7(2), 23–33. http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S0121-74882016000200002&lng=en&nrm=iso&tlng=en

Fontoura, C. F., Brandão, L. E., & Gomes, L. L. (2015). Elephant grass biorefineries: Towards a cleaner Brazilian energy matrix? Journal of Cleaner Production, 96, 85–93. https://doi.org/10.1016/j.jclepro.2014.02.062

Franco, T. L., & Hidalgo, R. (2003). Statistical Analysis of Morphological Characterization Data of Plant Genetic Resources. In Technical Bulletin No. 8, International Institute of Plant Genetic Resources IPGRI (Issue 8).

Lindao Vera, G. D. (2020). Morphological characterization of“purpl” King Grass (Pennisetum purpureum), under the edaphoclimatic conditions of Babahoyo

[BABAHOYO: UTB, 2020]. In Technical University of Babahoyo. http://dspace.utb.edu.ec/handle/49000/7995

Madera, N. B., Ortiz, B., M., B. H., & Magaña, H. (2013). Influence of the cutting age of purple grass (Pennisetum purpureum) on the production and in vitro digestibility of dry matter. Advances in Agricultural Research, 17(2), 41–52.

Maldonado, J., Guerra, C., Ovando, M., Valle, F., Ovando, E., & Gálvez, L. (n.d.). Morphological characterization of 15 grasses of Pennisetum purpureum species. Agro Productividad, 12, 39–46.

Maldonado, J., Guerra, C., Ovando, M., Valle, F., Ovando, E., & Gálvez, L. (2019). Morphological characterization of 15 grasses of Pennisetum purpureum species. Agro Productividad, 12(12), 39–46.

Olivera, Y., Machado, R., Ramírez, J., del Pozo, P. P., & Castañeda, L. (2014). Morphological characterization of 19 accessions of Brachiaria brizantha in an acidic soil. Pastures and Forages, 37(2), 138–144. http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S0864-03942014000200002&lng=es&nrm=iso&tlng=es

Paciullo, D., Gomide, C. de M., Morenz, M. F., Andrade, D. F., Andrade, Paulino José, P., Andrade, M., Lédo, F., & Pereira, A. (2015). Pasture characteristics and performance of dairy heifers in elephant grass cv pasture. BRS Kurumi. Brazilian Agricultural Research Company. Research and Development Bulletin 35, 35, 21. http://www.embrapa.br

Pereira, A. Vander, Lédo, F. J. da S., & Machado, J. C. (2017). BRS Kurumi and BRS Capiaçu - New elephant grass cultivars for grazing and cut-and-carry system. Crop Breeding and Applied Biotechnology, 17(1), 59–62. https://doi.org/10.1590/1984-70332017v17n1c9

Rosa, P. P. da, Silva, P. M. da, Chesini, R. G., Oliveira, A. P. T. de, Sedrez, P. A., Faria, M. R., Lopes, A. A., Roll, V. F. B., & Ferreira, O. G. L. (2019). Characteristics of Elephant Grass Pennisetum purpureum (Schumach) and its new cultivars BRS Kurumi and BRS Capiaçu. Agricultural Research Gaúcha, 25(1/2), 70–84. https://doi.org/10.36812/PAG.2019251/270-84

Suárez Ayala, D. V., Àlvarez Venegas, M. del R., Gómez Urrego, J. F., Carrasco De Los Rios, M. M., & Burbano Guerrero, D. C. (2016). Clinical and laboratory characterization of patients with febrile neutropenia in a pediatric hospital in Pasto-Colombia. Pediatrics, 49(2), 48–53. https://doi.org/10.1016/j.rcpe.2016.05.001