AP AGRO PRODUCTIVIDAD

Colegio de Postgraduados

Forage accumulation, morphological composition and height of *Panicum maximum* cv. Tanzania with organic and chemical fertilization

Nelson Erik López-Zerón[1], Claudia Yanet Wilson-García[2*], Paulino Sánchez-Santillán[3], María de los Ángeles Maldonado-Peralta[3], Adelaido Rafael Rojas-García[3], Karla Mariany Hernández-Muñoz[2], Marco Antonio Juárez-Hilario[2]

[1] Centro de Bachillerato Tecnológico Agropecuario 178, Carr. San Luis Acatlán Horcasitas Km 0.5, San Luis Acatlán, Guerrero, México, C.P.41600.
[2] Universidad Autónoma Chapingo, Sede San Luis Acatlán, Carr. San Luis Acatlán-Tlapa de Comonfort Km 5, San Luis Acatlán, Guerrero, México, C.P. 41600.
[3] Universidad Autónoma de Guerrero, Facultad de Medicina Veterinaria y Zootecnia No. 2, Carr. Acapulco-Pinotepa Nacional Km 197, Cuajinicuilapa, Guerrero, México, C.P. 41940.
* Correspondence: cwilsong@chapingo.mx

ABSTRACT

Objective: To evaluate the dry matter accumulation, morphological composition and height in the *Panicum maximum* cv. Tanzania grass in order to determine the optimal cutting point under four fertilization schemes.

Methodology: Tanzania grass was evaluated with fertilizations: T1) chemical (120-60-00 NPK), T2) vermicompost (10 t ha^{-1}), T3) compost (10 t ha^{-1}), and T4) compost+leachate. Cuts were made every 14 days where dry matter (DM), morphological composition and height were measured. A randomized complete block design was used, with an arrangement of measures repeated over time.

Results: The maximum accumulation of DM in the T1, T2 and T3 treatments was at 80 days after cutting, the maximum height was with T1 at 80 days after cutting with 206.2 cm. Fertilization with biological products such as vermicompost, compost+leachate and compost presented a higher proportion and conservation of leaves over time.

Study Limitations/Implications: Grasslands are not seen as a crop so in most cases they are not fertilized; when they are, it is done with chemical fertilization so there is little information about organic fertilization in tropical fodders.

Conclusions: The optimal cutting point is from 50 DAC for chemical treatment, compost+leachate and vermicompost. Fertilization with vermicompost or compost+leachate can be an inexpensive and affordable option for producers to fertilize their meadows.

Keywords: *Urochloa maxima*, *Megathyrsus maxima*, compost, vermicompost, leachate.

Citation: López-Zerón, N. E., Wilson-García, C. Y., Sánchez-Santillán, P., Maldonado-Peralta, M. de los Á., Rojas-García, A. R., Hernández-Muñoz, K. M., & Juárez-Hilario, M.A. (2022). Forage accumulation, morphological composition and height of *Panicum maximum* cv. Tanzania with organic and chemical fertilization *Agro Productividad*. https://doi.org/10.32854/agrop.v15i7.2342

Academic Editors: Jorge Cadena Iñiguez and Libia Iris Trejo Téllez

Received: March 23, 2022.
Accepted: July 15, 2022.
Published on-line: August 08, 2022.

Agro Productividad, 15(7). July. 2022. pp: 151-158.

INTRODUCTION

In tropical zones of Mexico, there is important diversity in grasses which are the most important source of feed in bovine and ovine livestock production; however, in most cases there is not an adequate management of grasslands, which is why it is difficult to apply

Image by Annette Meyer at Pixabay

nutrients, causing for the yield and the nutritional value of fodders to be low throughout the year (Suttie, 2003).

The grasslands on the Costa Chica are hardly considered to be a crop, which is why they are not fertilized, irrigated or given management regarding the entry and exit of livestock to allow a good establishment, density and quality. On the contrary, extensive grazing is carried out in the grasslands causing overexploitation of resources, and in general only the fire method is used to regenerate them, causing grave damage to the soil and the ecosystem (Rojas *et al.*, 2005). Because of this, it is necessary to generate information about the genotypes in their different growth stages, biomass accumulation, since it is documented that fodder quality can be determined indirectly with various analyses such as morphological composition and plant height, which can be used as indicators of the nutritional value of the fodder harvested (Araya and Boschini, 2005).

Organic fertilization in grasslands represents an opportunity to improve the grass quality, in addition to producers being able to compost animal manure and apply it, accompanied by leaf fertilization with leachates; however, there is scarce information about the adequate doses for grasslands, and only in some grasses (Sánchez-Santillán *et al.*, 2021; Jiménez *et al.*, 2010).

The *Panicum maximum* cultivar Tanzania grass is reported as an option in animal feed due to its high dry matter yield and quality (Andrade-Solórzano *et al.*, 2020), although there is not enough information about the response to organic fertilization. This is the reason why the objective was to evaluate the accumulation of dry matter, morphological composition, and height of the *Panicum maximum* cv. Tanzania grass under four fertilization plans, to determine the optimal cutting point.

MATERIALS AND METHODS

Experimental site

The study was performed in the Costa Chica region of the state of Guerrero in the municipality of San Luis Acatlán, at the *Campus* of Universidad Autónoma Chapingo (16° 51' 28.99" N and 98° 43' 26.13" W, at 311 masl). The region's climate is tropical with summer rains, with mean annual precipitation of 1395 mm (García, 2004), and data were also taken from the station nearest to the study zone (Figure 1). Soil analysis was conducted prior to sowing, where a sandy clay loam texture was found, with pH of 5.95, 4.22% organic matter, electric conductivity of 0.18 dSm^{-1}, apparent density of 1.30 g cm^3, free of total carbonates (0.01%), and moderately low in phosphorus (10.6 ppm).

Plant material and establishment

The land was prepared with two rake passes, on a surface of 5000 m^2. The establishment was carried out in August 2017, and the plant material was *Panicum maximum* cv. Tanzania grass. Three separate strips were established at 1 m between strip, and four lines in each strip separated by 20 cm. The density used was 6 kg ha^{-1} of pure sprouting seed. Weed management was performed manually. The evaluations were made after one year of grass establishment.

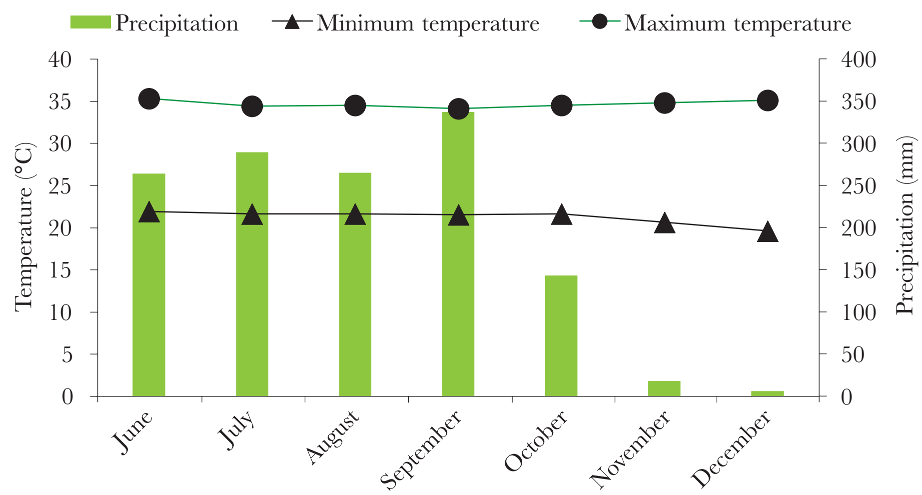

Figure 1. Maximum and minimum monthly mean temperature and accumulated rainfall during the study period. Source: Meteorological station located in El Carmen, San Luis Acatlán, Guerrero, Mexico.

Treatments

The grassland had one year of establishment when the homogenization cutting of the grass was made. The treatments were applied 15 days after the homogenization cut (DAC). Four fertilization plans were established: T1) chemical 120-60-00 NPK, where the sources of nitrogen and phosphorus were urea and DAP, respectively; T2) a dose of 10 t ha^{-1} vermicompost was applied; T3) consisted in 10 t ha^{-1} of compost; and T4) was 10 t of compost plus three applications of leachate to the fodder at intervals of 7 days, at a dose of 20%, applied with a manual aspersion backpack and an adjustable nozzle at 40 psi.

Variables

Sampling was done every fourteen days, with a total of six, which began at twenty days after homogenization cutting. Each sample was taken randomly, throwing a rod frame of 0.5 m × 0.5 m (0.25 m^2), from which all the fodder was cut at a height of 10 cm. The sample was weighed green with an electric scale (Truper, 40 kg); later, the grass was homogenized and a representative sub-sample was taken of 100 g, which was separated into leaf, stem, spike and dead material; it was placed in a paper bag and introduced into a forced air furnace (APSA) at a temperature of 55 °C until constant weight, which was done with the 100 g separated into the components. The dry matter yield per hectare and the percentage of the four morphological components were estimated (Cruz *et al.*, 2011). The height of each experimental unit was taken with a ruler with ten repetitions, and the average was obtained. The samplings were made at 20, 35, 50, 65, 80 and 105 DAC of homogenization.

Statistical analysis

A completely randomized block design was established, with repeated measurements arranged in time, three blocks were traced perpendicularly to the slope, and an analysis of variance was conducted with the SAS (Statistical Analysis System Version 9.0 for Windows

2011) Proc Mixed procedure, as well as Tukey's means comparison ($p \leq 0.05$). The Curve Expert Professional 2.0 software (Curve Expert Computer Software. Vers 2.0 N.p. D.d. Web) was used to adjust the growth curves according to the most adequate model with its respective model and coefficient for each type of fertilization evaluated.

RESULTS AND DISCUSSION

The fodder accumulation curve with base treatment of vermicompost was adjusted to an exponential growth model (R^2=96%). The maximum dry matter accumulation was obtained with T2 (vermicompost), which happened at 80 d, with a total of 25,288.2 kg DM ha^{-1} (Figure 2); however, there was no difference compared to the other treatments in the same sampling date ($p \leq 0.05$). Likewise, for the case of the dates 20 and 35 DAC there was no difference ($p \leq 0.05$), although these two dates showed difference with the dates 50, 65, 80 and 95 DAC ($p \leq 0.05$).

The date that presented a maximum leaf accumulation was 50 DAC, with 14,830 kg ha^{-1}, which represents a leaf-stem rate of 2.9. After this date, the amount of leaf decreased, while the amount of leaf, inflorescence and dead material increased the same as all the treatments except the treatment with compost, where most of the leaf accumulation was found at 80 DAC.

The results obtained in this study are similar to those reported by Cornejo *et al.* (2019), who report that the Tanzania grass presented a yield of 3.21 t DM ha^{-1} at 30 DAC; however, in that study no type of fertilization is reported.

T1 (chemical) showed a maximum dry matter accumulation at 80 DAC with a yield of 24,516 kg DM ha^{-1}; however, this yield was equal to the cuts from dates 50, 65 and 95 DAC ($p \leq 0.05$) (Figure 3). The cutting date when the most leaf accumulated was at 50 DAC with 11,043 kg DM ha^{-1}. The dry matter accumulation curve with the chemical fertilization treatment was adjusted to an exponential model (R^2=95%), since it is equal ($p \leq 0.05$) in the first two dates of sampling, from 20 to 35 DAC, although the dry matter increases. However, from date 35 DAC to 50 DAC an exponential increase is seen, from 6,532 to 20,743 kg DM ha^{-1}, which later remains similar until the end of the curve, since

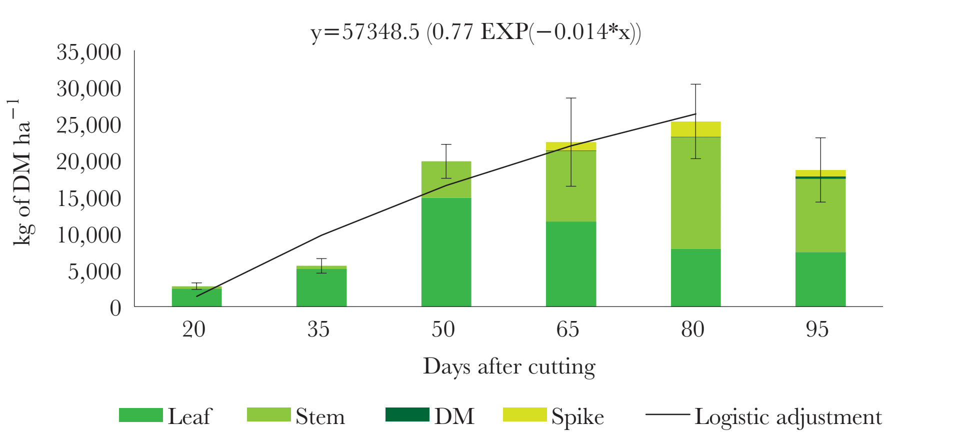

Figure 2. Dry matter accumulation and morphological composition of the Tanzania grass under a fertilization system with vermicompost.

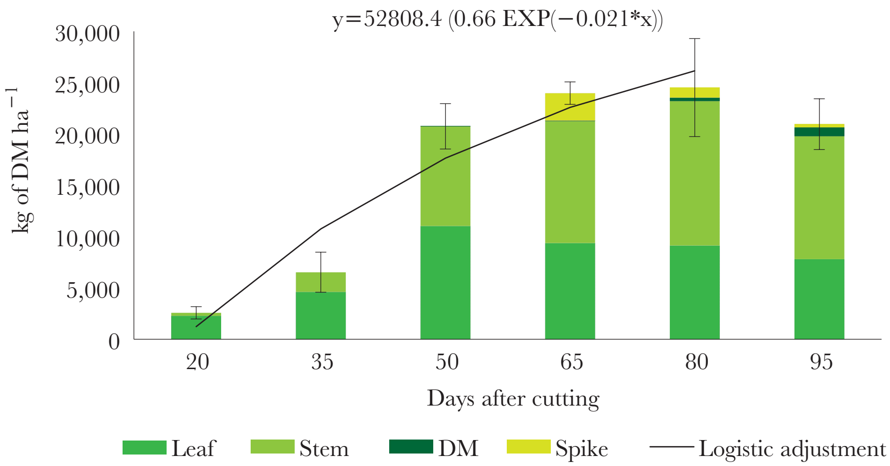

Figure 3. Dry matter accumulation and morphological composition of Tanzania grass under a chemical fertilization system.

there were no differences from 50 to 95 DAC. Likewise, an increase in stem production was seen from date 50 to 80 DAC, until a decrease of all morphological components in the last date of sampling.

The values obtained in this experiment are higher than those reported by Fortes *et al.* (2014), who report a yield of 3.94 kg of DM ha^{-1} at 90 DAC with a treatment of 50 kg of N ha^{-1}; this situation is possibly because the authors indicate that the experiment was developed in the dry season, which made the development of grass difficult.

T4 (compost+leachate) showed a constant increase of dry matter accumulation, since the maximum yield was found in the last date of sampling at 95 DAC with 23,963 kg DM ha^{-1}, contrary to what happened with the other treatments where the maximum yield was at 80 DAC. However, the maximum accumulation of the leaf component also happened at 50 DAC with 10,165 kg DM ha^{-1}. The first two dates of sampling behaved equally ($p \leq 0.05$), although different from the subsequent four dates (Figure 4). The dry matter accumulation curve was adjusted with an exponential model (R^2=98%).

The treatment that had lowest dry matter accumulation was T3 (compost), since at 80 DAC a yield of 20,833 kg DM ha^{-1} was reached, and the same happened with leaf accumulation which was 8,472 kg ha^{-1}, although compared to the other treatments where the maximum amount of leaf happened at 50 DAC. With fertilization based on compost, it happened at 80 DAC, which coincides with the maximum accumulation of the totality of the morphological components (Figure 5). The best adjustment for dry matter accumulation was the exponential model (R^2=99%).

Regarding the comparison of treatments between the same dates of sampling, no differences were observed ($p \leq 0.05$). This indicates that all the treatments can be an option to have some fodder available in the production systems (Luna *et al.*, 2015).

The height variable presented differences only in the cuts at 50 and 65 DAC, where T1 showed differences with the organic fertilization treatments ($p \leq 0.05$); however, in the dates 80 and 95 DAC there were no differences between any of the treatments (Table 1).

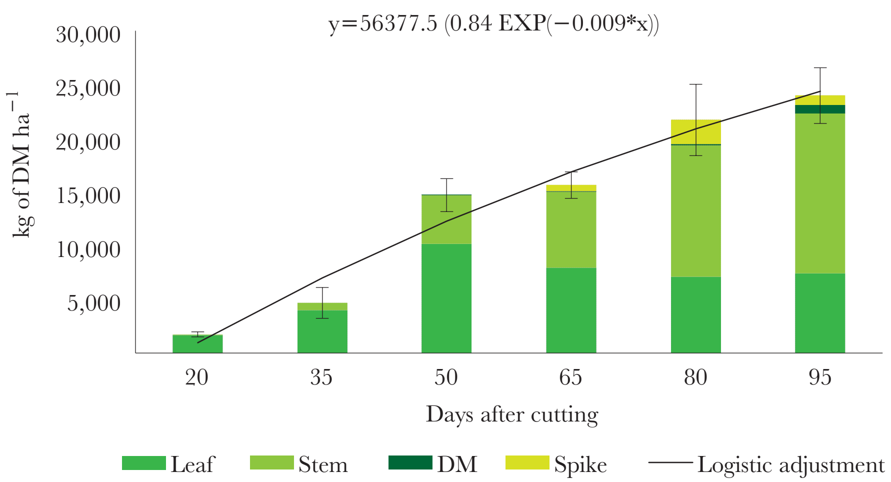

Figure 4. Dry matter accumulation and morphological composition of Tanzania grass under a fertilization system with compost+leachate.

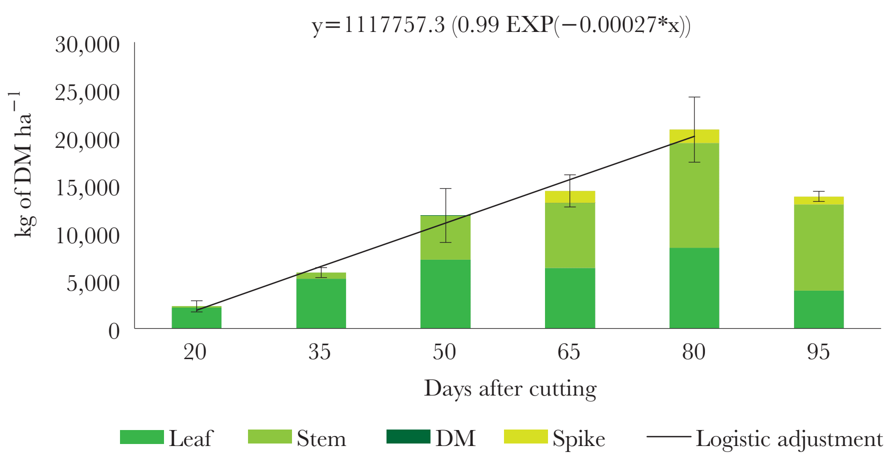

Figure 5. Dry matter accumulation and morphological composition of Tanzania grass under a fertilization system with compost.

Table 1. Tanzania grass heights (cm) in different cutting stages under different fertilization plans.

Treatment	Days after cutting					
	20	35	50	65	80	95
T3: Compost	66[a]	102a	143a	183[a]	187a	186a
T2: Vermicompost	67[a]	107a	152a	188[a]	193a	192a
T4: C+L	59[a]	99a	146a	189[a]	197a	195a
T1: Chemical	67[a]	115a	185b	204.7b	206.2a	199a

Different literals within each column indicate difference ($p \leq 0.05$).
C+L=compost+leachate

The results from this study are similar to those obtained by Sánchez-Hernández *et al.*, (2019), who report a height of 214.5 cm at 85 DAC with chemical fertilization, suggesting that this type of grass adapts well in tropical climates and that it is an option both for cutting and for grazing.

Nitrogenous fertilization in grasses affects the growth and quality of fodders, since when it is available, the development of plants will be faster with the more that this element is available. However, chemical fertilizers can alter the chemical properties of soils, generating environmental damages; therefore, organic fertilization is presented as an agroecological alternative to improve grass quality, increasing the availability of soil nutrients in the long term and conserving its physical and chemical properties, in addition to protecting the soil's fauna (Álvarez *et al*., 2016).

CONCLUSIONS

The organic treatments such as compost, vermicompost and leachate represent an option to fertilize the grasslands with Tanzania grass; likewise, the optimal cutting point is from 50 DAC when fertilized with chemical fertilizer, compost plus leachate, and vermicompost, although it can be until 80 DAC when it is fertilized with compost, since the quality is maintained until that date by the amount of leaf that there is in relation to the stem, although with lower dry matter yields than the other three treatments.

REFERENCES

Álvarez, P.G.R., Vargas, B.J.C., Franco, C.F.J., Álvarez, P.P.E., Samaniego, A.M.C., Moreno, M.P.A., Chacón, M.E., García, M.A.R., Arana, M.R.S., Ramírez, R.J.L., (2016). Rendimiento y calidad del pasto *Megathyrsus maximus* fertilizado con residuos líquidos de cerdo. *REDVET Revista Electrónica de Veterinaria. 17*(6)., 1–9.

Andrade-Solórzano, C. A., Vivas-Arturo, W. F., Parraga-Alava, R. C., Mendoza-Rivadeneira, F. A. (2020). Comportamiento morfofisiológico, nutricional-productivo del pasto Tanzania (*Panicum maximum* cv) a tres edades de corte. *Cienciamatría, 6*(1), 566-582. Doi: 10.35381/cm.v6i1.349

Araya, M.M., Boschini F. C. (2005). Producción de forraje y calidad nutricional de variedades de *Pennisetum purpureum* en la Meseta Central de Costa Rica. *Agronomía Mesoamericana. 16*(1). 37-43, DOI: 10.15517/am.v16i1.5180

Cornejo-Cedeño, S. A., Vargas-Zambrano, P. A., Párraga-Alava, R. C., Mendoza-Rivadeneira, F. A., Intriago-Flor, F. G. (2019). Respuesta morfológica, nutricional y productiva del Pasto Tanzania *Panicum maximum* cv. a tres edades de corte. *Pro Sciences: Revista De Producción, Ciencias E Investigación. 3*(23), 9–17. Doi: 10.29018/issn.2588-1000vol3iss23.2019pp9-17

Curve Expert. 2014. Curve Expert Computer Software Ver. 2.2 N.p. D.d. Web.

Cruz-Hernández, A., Hernández-Garay, A., Enríquez-Quiroz, J. F., Gómez-Vázquez, A., Ortega -Jiménez, E., Maldonado-García, N.M. (2011). Producción de forraje y composición morfológica del pasto Mulato (*Brachiaria* híbrido 36061) sometido a diferentes regímenes de pastoreo. *Revista mexicana de ciencias pecuarias, 2*(4), 429-443.

Fortes, D., García, C. R., Cruz, A. M., García, M., Romero, A. (2014). Comportamiento morfoagronómico de tres variedades forrajeras de *Megathyrsus maximus* en el periodo lluvioso. *Revista Cubana de Ciencia Agrícola, 48*(3), 293-296.

Gándara, L., Borrajo, C.I., Fernández, J.A., Pereira, M.M., (2017). Efecto de la fertilización nitrogenada y la edad del rebrote sobre el valor nutritivo de *Brachiaria brizantha* cv. "Marandú." *Revista de la Facultad de Ciencias Agrarias. 49*(1). 69–77.

García, E. (2004). Modificaciones al sistema de clasificación climática de Köppen. 5ª. (Ed.). Instituto de Geografia. Universidad Nacional Autónoma de México (UNAM). México, DF. 90 p.

Jiménez, O. M. M., Granados, L., Oliva, J., Quiroz, J., Barrón, M. (2010). Calidad nutritiva de *Brachiaria humidicola* con fertilización orgánica e inorgánica en suelos ácidos. *Archivos de Zootecnia*. 59. 561-570, Doi: 10.4321/S0004-05922010000400009

Luna, M.R., Chacón, M.E., Ramírez, R.J., Álvarez, P.G., Álvarez, P.P., Plúa, P.K., Álava, M.A., (2015). Rendimiento y calidad de dos especies del género *Pennisetum* en Ecuador. *REDVET 16*(8). 1–10.

Rojas, H. S., Olivares, P. J., Jiménez, G. R., Hernández, C.E. (2005). Manejo de praderas asociadas de gramíneas y leguminosas para pastoreo en el trópico. *Rev. Electrónica de Veterinaria 6*(5). 1-19, Sánchez-Hernández, M.A., Valenzuela-Haro, Y.E., Morales-Terán, G., Rivas-Jacobo, M.A., Fraire-Cordero, S., Hernández-Sánchez, S. (2019). Crecimiento de pasto Guinea (*Megathyrsus maximus* (Jacq.) B.K. Simon & S.W.L. Jacobs) en respuesta a fertilización química en clima cálido húmedo. *Agroproductividad. 12*(8). 47-52. Doi: 10.32854/agrop.v0i0.1450

Sánchez-Santillán, P., Wilson-García, C.Y., López-Zerón, N.E., Saavedra-Jiménez, L.A., Maldonado-Peralta, M. de los Á., Melo-Trani, M.Y. (2021). Rendimiento, calidad y biogás *in vitro* en pasto *Megathyrsus maximus* cv. Aruana con diferente fertilización. *Ecosist. Recur. Agropec. 8*(2). Doi: 10.19136/era.a8nII.2957

SAS Institute Inc, 2011. Statistical Analysis System, SAS, User's Guide. SAS Inst., Cary, NC.

Suttie J. M., 2003. Conservación de heno y paja: para pequeños productores y en condiciones pastoriles. Organización de las Naciones Unidas para la Agricultura y la Alimentación. Roma. 336 p.