Scientific Paper

Influence of the topographic condition of the slope on the productive performance of *Megathyrsus maximus* (Jacqs.) B.K. Simon & S.W.L. Jacobs

Odilón Estuardo Schnabel-Delgado *https://orcid.org/0000-0002-9009-9387*, Rubén Darío Rivera-Fernández *https://orcid.org/0000-0003-2436-1321* y María Gabriela Farías-Delgado *https://orcid.org/0000-0001-8675-6535*

Carrera Agropecuaria, Universidad Laica Eloy Alfaro de Manabí-Extensión Chone. Código Postal 130301, Chone, Ecuador.
E-mail: odilon.schnabel@uleam.edu.ec, ruben.rivera@uleam.edu.ec, maria.farias@uleam.edu.ec

Abstract

Objective: The objective of this research was to determine the influence of the topographic condition of a grazing area on the productive performance of *Megathyrsus maximus* (Jacqs.) B.K. Simon & S.W.L. Jacobs in Convento parish, Chone canton, Manabí province, Ecuador.

Materials and Methods: Three topographic conditions were studied: upper (C1), middle (C2) and lower (C3). The trial was developed in the rainy season between February and May, under the farmer's management conditions. The variables were: cutting time, biomass, leaf/stem ratio and yield.

Results: The first cutting was done at 30 days under all conditions, the second cutting in C1 maintained the same interval, unlike C2 and C3, which was 75 days. In addition, a third cutting (50 days) was achieved in C1. Biomass was affected by condition, being statistically different ($p < 0,05$). C1 showed a higher average, with 1,43 kg/m^2. On the contrary, leaf/stem ratio had a similar performance under all conditions.

Conclusions: The yield of *M. maximus* was determined by the production and the area occupied on the slope. The productive estimation of the grass in areas of irregular topography is determined by the topographic condition of the region, and is related to cutting times and pasture development.

Key words: biomass, pasture, yield

Introduction

In Latin America, animal husbandry plays a substantial role because of its contribution to the economy, food security and poverty reduction (Norberg, 2020). According to INEC (2020), Ecuador has 39,7 % of the area dedicated to agricultural production, cultivated or occupied by pasture. According to León *et al*. (2018), the most cultivated forage is *Megathyrsus maximus* (Jacqs.) B.K. Simon & S.W.L. Jacobs.

Although this grass shows wide plasticity, it does not always show good yields under adverse edaphic and management conditions (Machado, 2013). Its productive potential is conditioned by the environment, mainly by rainfall, according to references by Polo (2021), especially when it is established on hillside soils, where there is low recovery capacity due to erosion (Quiroga *et al*., 2020) or poor management of grazing areas (Gersie *et al*., 2019). According to Azevedo-Martuscello *et al*. (2012), there is research dedicated to selecting genetic material that is adapted to unfavorable environments.

Biomass production in the tropics is based on the forage production season (Benavides-Cruz *et al*., 2021). In the rainy season there is forage surplus, and in the dry season there is a shortage (Nuñez-Delgado *et al*., 2019). To all this extensive grazing is added. For much of the year, soils remain dry, as there is no irrigation system (Zamora-Pedraza and López-Acosta, 2017).

Megathyrsus produces biomass in semi-arid environments, where there is a prolonged dry season (Pereira *et al*., 2022), although in these environments yields are low and lack nutritional quality (López-Vigoa *et al*., 2017). In pastures dedicated to grazing, low productivity and gradual degradation have been observed, for which it is important to study this genus in a grazing system and on soils of low or moderate fertility (Onyeonagu and Ugwuany, 2012).

The Chone canton, in the Manabí province, has 53,5 % of the total area cultivated with pasture. The main species found is *M. maximus* (Instituto Espacial Ecuatoriano, 2013). Its presence as the dominant grass on the soils of Chone, where areas of heterogeneous topography, irregular rainfall distribution and poor pasture management predominate, are adverse conditions that require the application of techniques

Received: November 04, 2022
Accepted: January 04, 2023

How to cite a paper: Schnabel-Delgado, Odilón Estuardo; Rivera-Fernández, Rubén Darío & Farías-Delgado, María Gabriela. Influence of the topographic condition of the slope on the productive performance of *Megathyrsus maximus* (Jacqs.) B.K. Simon & S.W.L. Jacobs. *Pastures and Forages.* 46:e04, 2023.

that allow to establish, adequately, the time of cutting, days of rest, size of paddocks, animal load, biomass production and yield that leads to correct management of the pasture (Gersie *et al*., 2019). The objective of this research was to determine the influence of the topographic condition of a grazing area on the productive performance of *M. maximus*, in the Convento parish of the Chone canton, Manabí province, Ecuador.

Materials and Methods

Location. The study was carried out at the El Suspiro farm, in the Convento parish, Chone canton -Ecuador, located at -0,283333 South latitude and -80,05 West longitude, at an altitude of 183 m above sea level.

Edaphoclimatic conditions. The area has a dry subtropical climate and a predominantly mountainous system with cultivated pasture areas with slopes between 25 and 45 %. Annual rainfall is approximately 1 200 mm, concentrated between January and April. The soil has a shallow clayey texture, of little depth, which can be between 35 and 10 cm, depending on the slope.

Pasture conditions. The pasture was established on a hillside, on a slope of approximately 35 %, which has three different conditions. The first (C1) corresponds to the upper part of the slope, which covers a convex section. The second (C2) is located in the intermediate part, between the upper part and the lower part, and the third (C3) corresponds to the concave section of the irregular topography, which also shows cracks due to runoff. Figure 1 shows the different conditions.

Research design. The trial was developed in a plot established with *M. maximus* during the rainy season between February and May, 2022. The plot was stratified according to slope. Each condition had a 100-m^2 plot, without altering the farmer's management. The start of the trial began with a homogenizing cutting, 10 cm above the ground. In each plot, growth levels were identified at the time of cutting or harvesting.

Evaluated variables

- *Biomass*. It was carried out by means of gauging, with a frame of one square meter. Each sample was taken randomly and in triplicate.
- *Yield*. It was determined in tons of green matter per hectare (t GM/ha) through the sum of the harvests carried out during the experiment, by weighting the obtained biomass in each condition.
- *Cutting time*. Cutting time (days) was estimated at the time the pasture reached a height of 90-100 cm.
- *Leaf/stem ratio*. It was determined by the ratio of the weight of the leaves and stems of the grass stock.

Statistical analysis. The evaluated variables for each plot were tabulated and analyzed using descriptive statistics. In addition, a comparison of yield among the different topographic conditions of the hillside was carried out by means of variance analysis. The statistical program Infostat® was used as data processor.

Results and Discussion

The timing of *M. maximus* cutting on a slope is determined by the conditions of the slope and

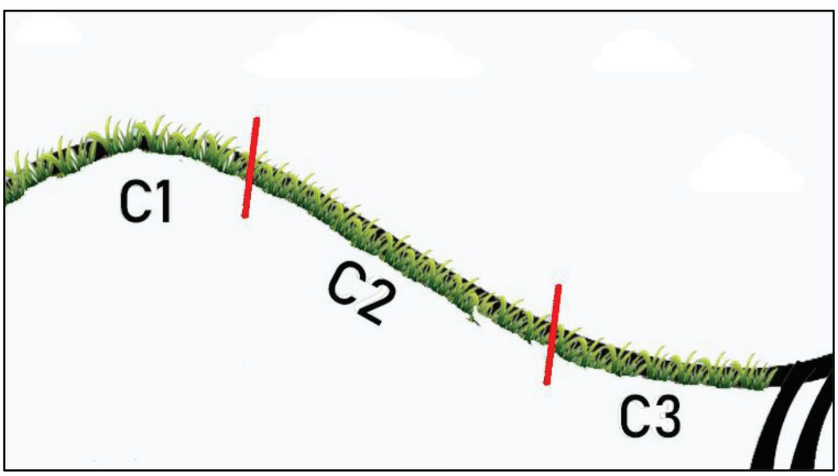

Figure 1. Diagram of the topographic conditions considered in the study.

the rainy season. Table 1 shows that cutting conditions occurred at 30 days, independently from slope condition. However, in the second cutting, C1 maintained the same cutting time, and in the other conditions it took 75 days for the plant to reach the characteristics for making the cut. Under these conditions, topography could be an influential factor, as it refers to areas of moisture accumulation and, therefore, higher forage production (Bailey *et al*., 2015). In addition, a third cutting was achieved in C1, suggesting that this area presents differences that cause the plant to show better performance.

Table 1. Estimated cutting time (days) of *M. maximus* under the different conditions.

Condition	1st Cutting	2nd Cutting	3st Cutting
C1	30	30	50
C2	30	75	-
C3	30	75	-

C1: corresponds to the upper part of the slope that encompasses a convex section, C2: located in the intermediate part between the upper and lower part, C3: corresponds to the concave section of the irregular topography

Having different cutting times suggests that the condition of the grazing area influenced the development of the pasture, due to the slope factor, including soil type and genetic potential of the plants (Vargas-Burgos *et al*., 2014). Although *M. maximus* is characterized by withstanding extensive droughts (Álvarez-Perdomo *et al*., 2016) and, therefore, tolerance to dehydration, it is supposed that there is increased water uptake and loss because it has very dense and deep roots.

Regarding biomass, there were statistical differences ($p < 0,05$), so the condition had effects on green biomass production. C1 presented a higher average, with 1,43 kg/m^2 higher than the other conditions. This result is different from the report by Kelly *et al*. (2008), who stated that the topographic gradient and soil constitution are shallower and less productive in the upper part, and deeper and more productive in the lower part.

The resulting values are higher than those reported by Cedeño-Villamar *et al*. (2022), when evaluating *Megathrysus* cultivars at different stages of physiological maturity. The leaf/stem ratio did not show statistical differences, although the highest average was reached by C1 with 0,75. In both variables, the averages decreased depending on condition, which is related to the phenological stage of the grass, which when approaching flowering causes a decrease in the ratio of leaves to stems (Martín *et al*., 2014).

Table 2. Average biomass and leaf/stem ratio of *M. maximus* under the different conditions.

Condition	Biomass, kg GM/m^2	Leaf/stem ratio
C1	$1,43^{a}$	0,75
C2	$1,35^{ab}$	0,71
C3	$0,81^{b}$	0,66
P - value	0,03	0,40
SE ±	0,14	0,05

Different letters in the same column indicate statistical differences $p < 0,05$
C1: corresponds to the upper part of the slope that includes a convex section, C2: located in the intermediate part between the upper and lower part, C3: corresponds to the concave section of the irregular topography

The yield of *M. maximus* grass under the conditions of a traditional farm, where there are grazing areas on slopes and different conditions, must be estimated accurately, if it is taken into account that there is surplus in the rainy season (Núñez-Delgado *et al*., 2019).

The differences among the various conditions according to the area of the plot in which it participates and the production of green biomass in each cutting are shown in table 3. In C2, 16,5 t/ha were reached, which is higher than the other conditions. This may be due to the larger area. However, with half the area C1 reached 12,8 t/ha, as well as higher production per area unit and leaf/stem ratio (table 2). The yield of all conditions and cuttings made during the trial reached 35,6 t of MV/ha.

Table 3. Estimated green matter (GM) yield, considering the estimated area of each condition in the plot under study.

Condition	Weighted area	Yield, t GM/ha
C1	0,25	12,8
C2	0,5	16,5
C3	0,25	6,3
Total	100	35,6

C1: corresponds to the upper part of the slope covering a convex section, C2: located in the intermediate part between the upper and lower part, C3: corresponds to the concave section of the irregular topography

Conclusions

The *M. maximus* yield was determined by the production and the area it occupied on the slope. The productive estimation of the pasture in areas of irregular topography was calculated by the topographic condition of the area, and is related to cutting times and grass development.

Acknowledgements

The authors thank the Lay University Eloy Alfaro of Manabí for financing the project "Sustainable management of forage species". In addition, gratitude is expressed to the undergraduate students who participated in the execution of the project.

Conflict of interests

The authors declare that there is no conflict of interests among them.

Authors' contribution

- Odilón Estuardo Schnabel Delgado. Research design, interpretation of results, manuscript writing and revision.
- Rubén Darío Rivera Fernández. Statistical analysis, manuscript writing and revision.
- María Gabriela Farías Delgado. Field trial management and data collection.

Bibliographic references

Álvarez-Perdomo, G. R.; Vargas-Burgos, J. C.; Franco-Cedeño, F. J.; Álvarez-Perdomo, P. E.; Samaniego-Armijos, M. C.; Moreno-Montalván, P. A. *et al.* Rendimiento y calidad del pasto *Megathyrsus maximus* fertilizado con residuos líquidos de cerdo. *REDVET. Rev. Electrón. Vet.* 17 (6):1-9. https://www.redalyc.org/pdf/636/63646808003.pdf, 2016.

Azevedo-Martuscello, Janaina; Braz, T. G. dos S.; Jank, Liana; Cunha, D. de N. F. V. da & Fonseca, D. M. da. Genetic diversity based on morphological data in *Panicum maximum* hybrids. *R. Bras. Zootec.* 41 (9):1975-1982. https://www.scielo.br/j/rbz/a/mCTssxjdTfKh93YdJPrXhfq/abstract/?lang=en, 2012.

Bailey, D. W.; Steephenson, M. & Pittarello, M. Efecto de la heterogeneidad del terreno sobre la selección de sitio de alimentación y los patrones del movimiento del ganado. *Ciencia de la producción animal*. 55:298-308, 2015.

Benavides-Cruz, J. C.; Ricardo-Torres, D. & Castillo-Sierra, J. Productividad forrajera y calidad del suelo en lechería especializada bajo sistemas silvopastoriles en Trópico Alto de Colombia. *RCZ*. 7 (12):14-17. http://anzoo.org/publicaciones/index.php/anzoo/article/view/98, 2021.

Cedeño-Villamar, A. X.; Vivas-Arturo, W. F.; Luna-Murillo, R. A. & Medina-Vergara, Linda L. Respuestas agronómicas de gramíneas y leguminosas en el subtrópico ecuatoriano. *Ciencia Latina Revista Científica Multidisciplinar*. 6 (3):268-282, 2022. DOI: https://doi.org/10.37811/cl_rcm.v6i3.2461.

Gersie, S. P.; Augustine, D. J. & Derner, J. D. Cattle grazing distribution in shortgrass steppe: Influences of topography and saline soils. *Rangel. Ecol. Manag.* 72 (4):602-614, 2019. DOI: https://doi.org/10.1016/j.rama.2019.01.009.

INEC. *Manual del encuestador y supervisor. ESPAC 2020*. Quito: Instituto Nacional de Estadística y Censos. https://www.ecuadorencifras.gob.ec/documentos/web-inec/Estadisticas_agropecuarias/espac/espac-2020/MANUAL%20ESPAC%202020.pdf, 2020.

Instituto Espacial Ecuatoriano. *Generación de geo información para la gestión del territorio a nivel nacional escala 1:25000. Componente 4: Sistema Productivos*. Quito: Instituto Espacial Ecuatoriano. 2013.

Kelly, E. F.; Yonkers, C. M.; Blecker, S. W. & Olson, C. G. Desarrollo y distribución del suelo en el ecosistema estepario de pastos cortos. En: W. Lauenroth e I. C. Burke, eds. *Ecología de la estepa de pasto corto: una perspectiva a largo plazo*. Nueva York: Oxford University Press. p. 30-54, 2008.

León, R.; Bonifaz, Nancy & Gutiérrez, F. *Pastos y forrajes del Ecuador. Siembra y producción de pasturas*. Cuenca, Ecuador: Universidad Politécnica Salesiana. https://dspace.ups.edu.ec/handle/123456789/19019, 2018.

López-Vigoa, O.; Sánchez-Santana, Tania; Iglesias-Gómez, J. M.; Lamela-López, L.; Soca-Pérez, Mildrey; Arece-García, J. *et al.* Los sistemas silvopastoriles como alternativa para la producción animal sostenible en el contexto actual de la ganadería tropical. *Pastos y Forrajes*. 40 (2):83-95. https://www.redalyc.org/articulo.oa?id=269158172001, 2017.

Machado, R. Comportamiento de 19 accesiones de *Panicum maximum* Jacq. bajo condiciones de pastoreo en un suelo de mediana fertilidad. *Pastos y Forrajes*. 36 (2):202-208. http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S0864-03942013000200005&lng=es&tlng=es, 2013.

Martín, G. O.; Nicosia, M. G.; Fernández, M. M.; Olea, L. E.; Toll-Vera, J. R. & Agüero, S. N. Disponibilidad de tallos y hojas en *Trichloris pluriflora* diferido, bajo diferentes condiciones ambientales en la Llanura Deprimida de Tucumán. *Rev. Agron. Noroeste Argent*. 34 (2):162-165, 2014.

Norberg, Matilda B. *The political economy of agrarian change in Latin America. Argentina, Paraguay and Uruguay*. Cham, Germany: Palgrave Macmillan, 2020.

Núñez-Delgado, J.; Ñaupari-Vásquez, J. & Flores-Mariazza, E. Comportamiento nutricional y perfil alimentario de la producción lechera en pastos cultivados (*Panicum maximum* Jacq.). *Rev. Inv. Vet. Perú*. 30 (1):178-192, 2019. DOI: http://dx.doi.org/10.15381/rivep.v30i1.15681.

Onyeonagu, C. C. & Ugwuany, B. N. Dry matter yield of guinea grass (*Panicum maximum* Jacq.) in response to cutting hight and nitrogen fertilizer application. *Int. J. Agric Sci.* 2:1084. https://journaldatabase.info/articles/dry_matter_yield_guinea_grass_panicum.html, 2012.

Pereira, M. de G.; Difante, G. dos S.; Ítavo, L. C. V.; Rodrigues, J. G.; Gurgel, A. L. C.; Dias, A. M. *et al.* Production potential and quality of *Panicum maximum* cultivars established in a semi-arid environment. *Trop. Anim. Sci. J.* 45 (3):308-318, 2022. DOI: https://doi.org/10.5398/tasj.2022.45.3.308.

Polo, E. A. Rendimiento y componentes de valor nutritivo de tres cultivares *Panicum maximum*. *Scientia*. 31 (1):44-49. https://www.redalyc.org/journal/6517/651769491005/651769491005.pdf, 2021.

Quiroga, D. R. A.; Coronato, Andrea; Ángeles, G. R. & Valle, H. F. del. Zonificación de áreas susceptibles a procesos erosivos en laderas desencadenados por la ganadería extensiva, Tierra del Fuego, Argentina. *Rev. Univ. geogr., Bahia Blanca*. 29 (2):75-94. http://www.scielo.org.ar/scielo.php?script=sci_arttext&pid=S1852-42652020000200004&lng=es&tlng=es, 2020.

Vargas-Burgos, J. C.; Leonard, I.; Uvidia, H.; Ramírez, J. L.; Torres, V.; Andino, M. *et al.* El crecimiento del pasto *Panicum maximum* vc Mombaza en la Amazonía Ecuatoriana. *REDVET. Rev. Elect. Vet.* 15 (9):1-7. https://www.redalyc.org/articulo.oa?id=63632727007, 2014.

Zamora-Pedraza, Gregoria & López-Acosta, J. C. *Cercos vivos. Más allá de una línea de árboles*. Xalapa, México: Universidad Veracruzana. https://www.uv.mx/cienciauv/files/2017/04/013-CYL-CERCOS-VIVOS-01.pdf. 2017.