Short communication

Characterization of the production of *Megathyrsus maximus* (Jacq.) B.K. Simon & S.W.L. Jacobs and *Urochloa decumbens* (Stapf) R.D. Webster in goat grazing

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Abstract

Objective: To characterize the production per area unit of *Megathyrsus maximus* (Jacq.) B.K. Simon & S.W.L. Jacobs and *Urochloa decumbens* (Stapf) R.D. Webster in a rational Voisin grazing system with goats in Manabí, Ecuador.

Materials and Methods: The total study area was 0,22 ha, divided into eleven quarters of each pasture, with a stocking rate of 12 adult goats, water *ad libitum* and supplementation with nutritional blocks. The treatments were: T1) *M. maximus* and T2) *U. decumbens.* Data were analyzed with general linear and mixed models. A randomized complete block design was applied, with a significance level of 0,05 (Tukey) and the R program was used. During the dry season of 2022, green forage production/ha, days of recovery and remnant were measured.

Results: In green forage production/ha there were differences (p= 0,0068) and *M. maximus* pasture obtained the best yields (11 800 kg). This same grass showed the shortest resting time (56 days). Differences (p= 0,0036) were recorded for remnant. The highest average was reached in *M. maximus* (3 700 kg).

Conclusions: *M. maximus* and *U. decumbens* showed high green forage production per area unit in the rational Voisin grazing system with goats, although *M. maximus* obtained higher yields, better recovery and higher remnant during the evaluation.

Keywords: green forage, weight gain, ruminant

Introduction

Lee *et al*. (2017) state that pastures in the tropics constitute the most abundant and economical source, which allows guaranteeing ruminant feeding. Pasture performance depends directly on climate conditions; while other factors, such as management, condition that these fully express their productive potential (Álvarez-Perdomo *et al*., 2017). Hence the importance of proper management of grazing areas in each productive unit (Costantini *et al*., 2018).

When high stocking rates are used or the occupation and resting periods of the paddocks are not appropriate, overgrazing occurs, which causes pasture degradation, being necessary to apply management practices that help improve yields and profitability of the productive system (Cruz *et al*., 2018). These degradation processes are evaluated according to the type of pasture vegetation cover, presence of weeds and floristic composition, associated with inappropriate recovery (Castro-Castillo *et al*., 2022).

Other factors, such as the use of fire, excessive mowing and application of herbicides also accelerate pasture degradation processes. Hernandéz *et al.* (2002) reported that, with relatively low stocking rates (between 1,29 and 0,89 cattle units per ha), moderate to severe levels of degradation were found due to these agro-technical practices.

Regenerative agriculture and animal husbandry work holistically, which conditions management principles equivalent to rational grazing (RG) (Spratt *et al*., 2021). In 2012, Voisin proposed a series of postulates for intensive pasture management, which respect the resting time of the enclosed pastures or paddocks. This allows the accumulation of sufficient reserves in the pasture roots and guarantees adequate regrowth. In this regard, the aforementioned author emphasized that forage should be used when it has the necessary nutrients to feed ruminants, which allows maximizing forage harvest and managing a high stocking rate in a reduced space.

Received: June 15, 2023
Accepted: February 26, 2024

How to cite a paper: Macay-Anchundia, Miguel Angel; Pesantez-Muñoz, Maria Jose; Cevallos-López, Verónica Carolina & Francel Xavier López-Mejía. Characterization of the production of *Megathyrsus maximus* (Jacq.) B.K. Simon & S.W.L. Jacobs and *Urochloa decumbens* (Stapf) R.D. Webster in goat grazing. *Pastures and Forages*. 47:e03, 2024.

Piñeiro *et al*. (2017) and Milera-Rodríguez *et al*. (2019) corroborated these studies and ratified that intensive rational grazing is an ecologically sustainable system, which provides sufficient feedstuff for livestock and can significantly help in the development of edaphic biota, since it allows having greater moisture retention and, thus, avoiding soil compaction by grazing.

The objective of this research was to characterize the production per area unit of *Megathyrsus maximus* (Jacq.) B.K. Simon & S.W.L. Jacobs and *Urochloa decumbens* (Stapf) R.D. Webster, managed in a Voisin rational grazing system (VRG) with goats in Manabí, Ecuador.

Materials and Methods

Location. The study was established during the dry season (June-December) of 2022, in the areas of the project Productive improvement and regenerative animal husbandry with tropical small ruminants, of the Experimental Farm Río Suma, of the Universidad Laica Eloy Alfaro of Manabí, in the El Carmen canton, Manabí, Ecuador.

This farm is located at 0°16′00″S latitude and 79°26′00″W longitude, under humid tropical conditions, at an altitude of 249 m.a.s.l.

Edaphoclimatic characteristics. The research was developed on a clay loam soil (Aguilar *et al*., 2014), with average rainfall regime of 2 659 mm, 86 % relative humidity, average temperature of 24 °C and 1 026 daylight hours per year (INEC, 2021).

Treatments and experimental design. The evaluated treatments consisted of two forage species (*M. maximus* Jacq. and *U. decumbens*), with approximately five years of establishment and two years of management, without fertilization or use of herbicides or chemical or synthetic pesticides. They were divided into eleven plots each (figure 1) and managed with VRG in two grazing cycles, according to a randomized complete block experimental design (RCBD). The total grazing area was 0,22 ha and 12 adult goats of Saanen and Anglo Nubian breeds were used.

Experimental procedure. Prior to entering the paddocks, the gauging was calculated (five samples at a time) for each forage species. A frame or quadrant (1 x 1 m) was used to determine the productivity per hectare of each treatment (Gómez-Villalva *et al*., 2021). Based on the gauging, the weight of the animals (33 kg/animal on average) and their consumption requirements (4,3 kg/day/animal), the estimated daily consumption area of the goats (45 m^2 on average) was calculated. Assuming that they would consume the total leaf area assigned to them, occupancy times per plot ranged from 10 to 15 hours, which implied increasing or decreasing the area to be grazed, according to these requirements. This was done by implementing divisions in the paddocks with the help of easily movable wire mesh. These provided that the goats remained grazing for a period of approximately five hours in the morning and five in the afternoon, which began between 7:00 and 8:00 a.m. and ended between 17-18 hours (Mahecha *et al*., 2002). After the consumption of all the assigned

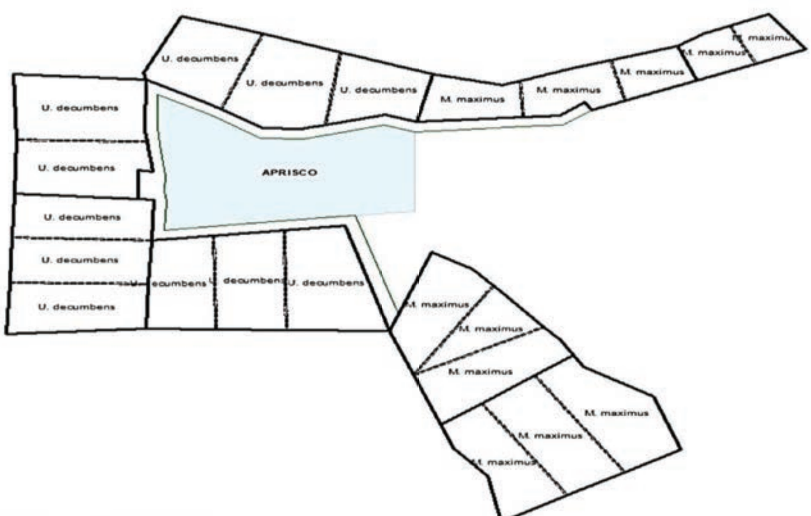

Figure 1. Field sketch.

leaf area and the departure of the animals, samples were taken with the help of the same quadrant to calculate the remainder left in the paddock. This moment was considered as day 0 to later calculate the forage resting time.

During the night, the animals rested in high pens, 70 cm above the ground, conditioned in the sheepfold. During the research phase, they had water *ad libitum* and were supplemented with nutritional blocks.

Grazing was planned by pasture species until the end of the rotation of each one. After consuming all the plots of one species, grazing of the other was started, in order to determine if the types of pasture influenced the weight gain of the goats. The optimal point to restart grazing the plots was assumed to be when the pasture was at 10 % inflorescence or identifying the third withered basal leaf, as reported by Voisin and Lecomte (1968).

Mathematical analysis. General linear and mixed models were applied to analyze data for the variables green forage production/ha, remnant (kg/ha), days to recovery (d), animal weight (kg) and forage intake (kg). Data analysis was performed with the R program (R Core Team, 2022). Tukey's 0,5 % confidence test was applied, with significance level set at α = 0,05.

Results and Discussion

Forage production and remnant. There were differences for the variable green forage production/ha (p= 0,0068) in favor of *M. maximus*, with a yield of 11 800 ± 759 kg of green forage/ha, compared with 8 800 kg in *U. decumbens* (figure 2). It should be considered that these paddocks were not fertilized, for which the nutrient supply was provided by the excreta and urine deposited by the animals during grazing.

Báez-Lizarazo and Salamanca-Carreño (2022) report that the green forage production/ha of *U. decumbens* genotypes is 4 100 kg/ha and of *Urochloa humidicola* 3 250 kg/ha, values that are lower than those of this research. However, for fertilized *M. maximus*, at 40 days, Gómez-Villalva (2021) reported yields of 20 300 kg of green forage/ha for one year, higher than in this study. This could indicate that Voisin rational grazing increases productivity per hectare in *U. decumbens* grass, which seems to be favored by short grazing times and longer resting periods, allowing higher recovery and higher productivity (Urón-Castro and Bastos-Alvarado, 2021). The shorter the occupancy time, the lower the negative effects due to paddock compaction, which favors the increased capacity of the pasture to re-sprout and develop (Gómez, 2017).

Regarding the remnant (figure 3), there were differences for this variable (p= 0,0036). Pasture *U. decumbens* showed the lowest mean (2 200 ± 130 kg/ha); while in *M. maximus* the value was 3 700 ± 130 kg/ha.

The remnant is the amount of grass remaining after defoliation, either by direct or mechanical grazing. Romo-Arias (2019) mentions that the remnant allows ensuring that pastures or forages obtain their potential, taking care of the cows' intake and quality of the mouthful.

Reategui *et al.* (2019), in studies where grazing pressure on forage availability of *U. decumbens* was measured, concluded that high grazing pressure (HGP) recorded between 623 and 223 kg/ha of non-harvestable phytomass. Low grazing pressure

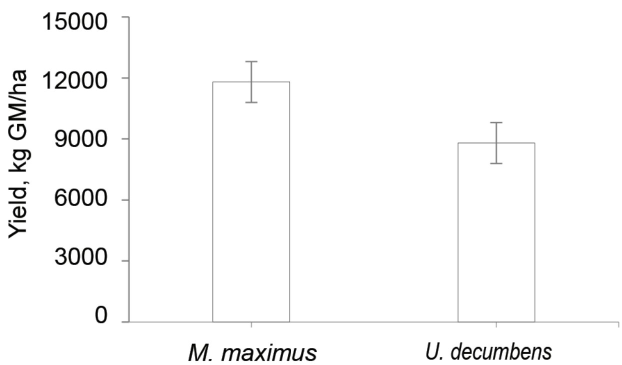

Figure 2. Productivity of *M. maximus* and *U. decumbens* grasses as a function of rotations (kg/ha).

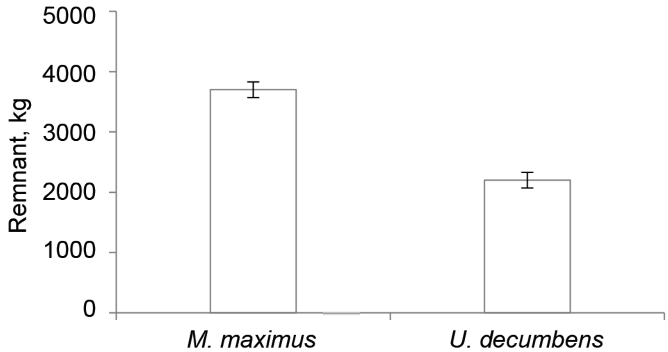

Figure 3. Remnant of pastures *M. maximus* and *U. decumbens* (kg).

(LGP), between 637 and 440 kg/ha, would indicate that the higher the animal load per area unit, the lower the non-harvestable phytomass. Zietsman (2014) favored high cattle stocking rates with few intervals to stimulate higher forage intake by the ruminant and, thus, decrease selectivity and increase intake per occupied area. This allowed leaving enough non-harvestable phytomass with nutrient reserves necessary for faster and more efficient regrowth. These grazing principles were established by Voisin and Lecomte (1968).

In this study, the stocking rate was high, but equal for both grasses, so the difference in remnant or refuse could be more related to the growth habit of the plants and the accessibility of the tenderest leaves and stems by the animals. Goats are browsing animals par excellence, with less ability to graze deeply and the erect disposition of the stems of *M. maximus*, compared with the decumbent habit of *U. decumbens*, could have determined that the animals did not graze more deeply and, therefore, there was a greater amount of remnant of this erect grass.

Again, it is reaffirmed that the VRG in goats allows to comply with the purpose of the occupation law proposed by Voisin, which establishes that the occupation should be of one day or less, and should not exceed three days (Matamoros, 2020) and, therefore, satisfactory results are obtained in terms of pasture performance.

Pasture management. The division and rotation of paddocks (figure 1), with the area divided into 22 paddocks, is a widely practiced and well-established methodology in tropical America. This is because most ranchers conserve pastures as perennial crops and their persistence depends on the rest or recovery times to which they are subject (Warren, 2018). Figure 4 shows that differences existed for the variable paddock recovery days (p= 0,0032). *U. decumbens* grass needed more time to recover, with mean of 67 ± 4,05 days; while the recovery of *M. maximus* occurred at 55 ± 4,05 days.

Vélez-Mora (2021) suggested that, once the correct resting period for paddocks has been established, a good rotation management plan should be implemented to obtain yields between

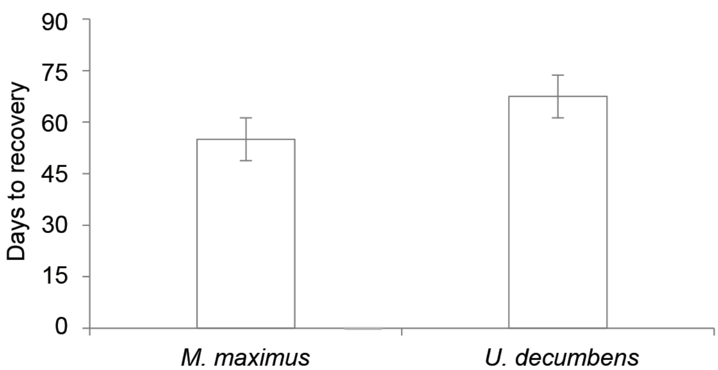

Figure 4. Recovery days of *M. maximus* and *U. decumbens*.

60 and 120 kg DM/ha/day. However, this will be subject to the type of pasture used, since an optimal paddock rotation will depend not only on the days of rest, but also on the physiological state of the pastures, which will vary among species and genera. The correct management of resting times will allow greater persistence and yield of pastures and better production indexes on farms (Gómez-Villalva, 2021).

This can be achieved with intensive rational management, which has had a positive impact in different countries in Central and South America (Milera-Rodríguez, 2019). This grazing system, in addition to increasing yields, allows contributing to the ecological management of the soil, plant and animal systems (Urón-Castro and Bastos-Alvarado, 2021). By implementing Voisin grazing, optimal development is established in the recovery time of pastures, providing the ecosphere with low gas emissions animal husbandry. Thus, results are offered that represent a resilient option in the face of climate change and a contribution to the food self-sufficiency of the countries (Montoya-Quintero, 2019).

Animal weight and forage intake. The entire flock of goats was weighed before starting and at the end of grazing for each species, and their respective weight gains were compared. With a paired t-test, it was found that there were no differences (p = 0,8043) in the weight gain of the animals, as a function of the consumed pasture (table 1). According to Urón-Castro and Bastos-Alvarado (2021), these results can occur when grazing systems such as ultra-high density grazing (UHD) or VRG are implemented, since there may be animals that show better feed conversion than others. Additionally, forage intake of the animals was similar (p=0,345), with 2,15 kg for *M. maximus* and 1,85 kg for *U. decumbens*. This would indicate compliance with the law of maximum yields, proposed in the VRG, with the development of more efficient grazing and better utilization of the available biomass (Guevara-Viera *et al.*, 2003).

Conclusions

M. maximus and *Urochloa* sp. showed high green forage production per area unit under the VRG system with goats. *M. maximus* grass showed the highest green forage production per hectare, more green forage remaining after grazing and faster recovery compared with *Urochloa* sp.

Acknowledgments

The authors would like to thank the project of productive improvement and regenerative animal husbandry with tropical small ruminants of the Universidad Laica Eloy Alfaro of Manabí, El Carmen extension, for their availability for the field work. Gratitude is also expressed to the peer reviewers and editors of this journal for their comments, which helped to improve this work.

Conflict of interests

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

Authors' contributions

- Miguel Ángel Macay-Anchundia. Presentation of the proposal and follow-up of the field work.
- María José Pesantez-Muñoz. Development of the field phase and written work.
- Verónica Carolina Cevallos-López. Data analysis and interpretation of results.
- Francel Xavier López-Mejía. Writing and editing.

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Table 1. Weight gain and estimated pasture intake.

Pasture species	N	Weight gain, kg	Intake	P - Value
M. maximus	12	0,96	2,15	0,8043
U. decumbens	12	0,69	1,85	0,3450

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