Colegio de Postgraduados

Analysis of the growth of Chetumal grass established in a tropical climate

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ABSTRACT
Objective: To evaluate the growth of Chetumal grass (*Urochloa humidicola* CIAT 679), in order to determine the optimal moment for the first harvest.
Design/Methodology/Approach: A completely randomized experimental block design, with measurements repeated over time, and three repetitions was used. Morphological composition (MC), growth rate (GR), plant height (PH), intercepted radiation (IR), leaf:stem ratio (L:S), leaf:no-leaf ratio (L:NL), and aerial biomass (AB) —as well as leaf biomass (LB), stem biomass (SB), dead material (DM), net growth (NG), and total biomass (TB)— were evaluated every fifteen days, except for the two first samplings, which were carried out on a monthly basis. Data were analyzed using the GLM procedure of the SAS software and Tukey's mean comparison test ($\alpha \leq 0.05$).
Results: The morphological composition (MC) of the Chetumal grass was statistically different ($p<0.05$), during the different growth ages. The maximum accumulation of total biomass (TB) (13,324 kg DM ha^{-1}), leaf biomass (LB) (2,569 kg DM ha^{-1}), and growth rate (GR) (99 kg DM ha^{-1} d^{-1}) was reached at 135 DAS. On that day, the prairie reached a 68 cm plant height (PH) and 100% intercepted radiation (IR). The L:S ratio decreased from 1.62 to 0.31, while L:NL ratio changed from 1.62 to 0.22.
Study Limitations/Implications: The *Brachiaria humidicola* cv. Chetumal grass reached its highest potential during the rainy season.
Findings/Conclusions: The first cut of the *Urochloa humidicola* cv. Chetumal grass can be carried out at 135 DAS, when the highest accumulation of total biomass (TB), leaf biomass (LB), and growth rate (GR) is recorded.

Keywords: *Brachiaria humidicola*, *Urochloa humidicola* cv. Chetumal, plant height, growth, and intercepted radiation.

Citation: Calzada-Marín, J. M., Ortega-Jiménez, E., Enríquez-Quiroz, J. F., Vaquera-Huerta, H., Escalante-Estrada, J. A. S., & Antonio-Medina, A. (2023). Analysis of the growth of Chetumal grass established in a tropical climate. *Agro Productividad*. https://doi.org/10.32854/agrop.v16i12.2781

Academic Editors: Jorge Cadena Iñiguez and Lucero del Mar Ruiz Posadas

Received: June 13, 2023.
Accepted: November 14, 2023.
Published on-line: January 24, 2024.

Agro Productividad, 16(12) suplemento. December. 2023. pp: 147-153.

INTRODUCTION

In Mexico, cattle raising must be productive, if it is to achieve profitability and competitiveness. However, there are divisions between regions, 12% of which are located in the humid tropics (Torres *et al.*, 2020). Twenty-nine percent of the pastures are native to those regions and account for a dry matter production of 183 million tons and a low load capacity (Enríquez et al., 2021). However, there are other alternatives regarding grass species, including genus *Urochloa* (Bastidas *et al.*, 2023). Nearly 2.6 million hectares (≈6.4% of the national territory) are covered by these grasses.

Prairie productivity depends on physiological, agronomic, and environmental features (Merchant-Fuentes and Solano-Vergara, 2016). Therefore, germination, introducing new species, or selecting different varieties can help to improve the vigor of the grasses and to preserve their populations or their descendants (Barker *et al.*, 2021). The CIAT 679 material has two propagation methods: seed and stolon (Bastidas *et al.*, 2023). This material can be associated with forage production, if its morpho-physiological characteristics are taken into account, including plant height, leaf:stem ratio, leaf expansion rate, and tiller dynamics (Álvarez *et al.*, 2020; de Dios-León *et al.*, 2022). Cruz-Hernández *et al.* (2017) analyzed two intensities (13-15 and 9-11 cm plant height) of *Brachiaria humidicola* cv Chetumal and recorded an increase in crude protein and a higher forage accumulation after 28 d of grazing. Therefore, the objective of this study was to evaluate the growth of Chetumal grass (*U. humidicola* CIAT 679), during its establishment in a tropical climate, and to determine the optimal moment for its first harvest.

MATERIALS AND METHODS

The research was carried out in the Papaloapan Experimental Unit of the Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias (INIFAP), located in the municipality of Isla, Veracruz, at 18° 06' N and 95° 31' W, at 65 m.a.s.l. According to the modifications made by García (2004) to the Köppen climate classification, the area has an Aw0 climate, with a 1,000-mm average precipitation and a 25.7 °C mean annual temperature (Figure 1). The region has an orthic acrisol soil, with a sandy loam texture, and a 4.0-4.7 pH (Enríquez and Romero 1999).

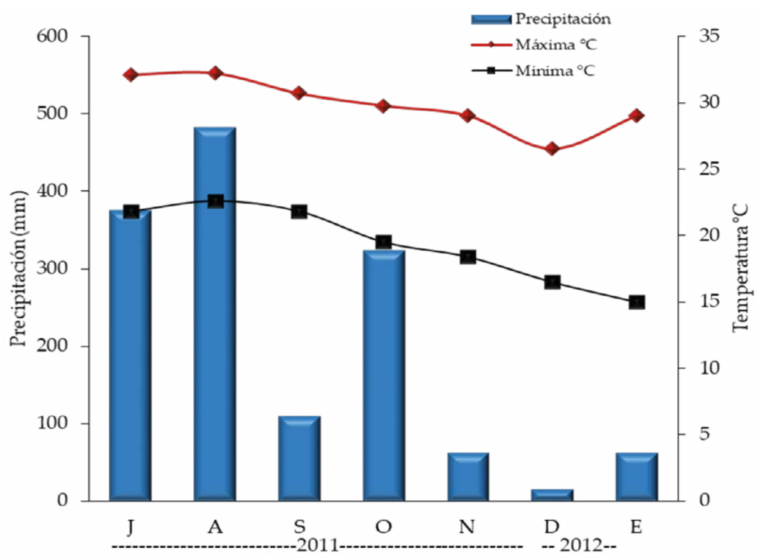

Figure 1. Accumulated monthly precipitation and monthly average maximum and minimum temperatures during the study period in Isla, Veracruz.

The experiment was established on July 22, 2011. The experiment consisted of 3 repetitions and was carried out in 5×16 m wide and long plots. Botanical seeds were sown in furrows, with a 0.50-m separation, resulting in a 14 kg ha^{-1} density. Two 120-80-00 kg ha^{-1} NPK fertilization doses were applied at 43 and 112 days after sowing (DAS).

The variables evaluated were the different growing ages (30, 60, 75, 90, 105, 120, 135, 150, 165, and 180 DAS). A destructive and random sampling was carried out. For each plant age, the forage was harvested at soil level, in 1-m lineal transects per plot. The total fresh weight of the transect of the harvested material was determined; subsequently, the material was dehydrated in a forced air oven (at 55 °C) and, then, it was weighted again, to obtain dry matter (DM) yield. A sub-sample was divided into its morphological components; afterwards, the leaf:stem (L:S) and the leaf:no-leaf (L:NL) ratios were determined.

The cutting yield was used to calculate growth rate (GR), according to the following formula:

$$GR = HF/t$$

Where: HF=harvested forage (kg ha^{-1} DM) and t=days from the sowing date to the cutting (Peters *et al.*, 2022).

In order to determine the intercepted radiation (IR), five random readings were carried out at approximately 12:00 h, using a 1-m rule (divided into cm). The readings were divided by age and plot. The shadow cast on the rule was taken as the radiation intercepted by the canopy (Calzada-Marín *et al.*, 2014; Mendoza-Pedroza and Álvarez-Vázquez, 2022). The quadrant method (1 m^2) was used to determine coverage (Herrera-Haro and García, 2021). Plant height was established with five random measurements, placing the rule at ground level.

A completely randomized experimental block design, with repeated measurements, 10 treatments (the same number as the growth stages), and 3 repetitions was used. In addition, a regression analysis was conducted for each variable. This analysis described the trend, from the moment that the best model is selected, according to the coefficient of determination and the significance degree of the model. Data were analyzed using the SAS GLM procedure and Tukey's mean comparison test ($\alpha \leq 0.05$).

RESULTS AND DISCUSSION

Regrowth age had a significant effect ($p<0.01$) in the total biomass (TB), leaf biomass (LB), stem biomass (SB), dead material (DM), and net growth (NG) accumulation. Consequently, they have a positive relationship with the regrowth age (Figure 2). The biomass accumulation of the different components was adjusted to a third-degree polynomial, with a high determination coefficient ($R^2>0.90$). While Álvarez-Adán (2019) mentioned that temperatures >30 °C favors growth rates, Gichangi *et al.* (2017) reported similar models for the Mulato (*Brachiaria hybrid*) and Fountain (*Pennisetum* sp.) grasses.

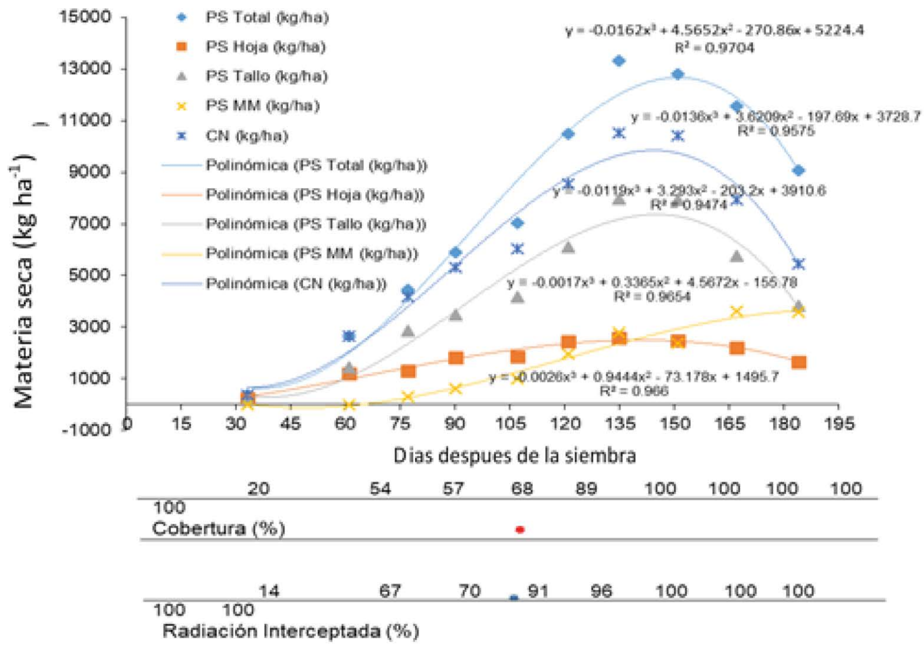

Figure 2. Accumulation dynamics of the total forage of Chetumal grass, by morphological component, plant height, intercepted radiation, and coverage percentage.

The highest TB accumulation (13,324 kg ha^{-1} DM) was recorded 153 days after the sowing (DAS), reaching the highest LB (2,569 kg ha^{-1} DM), SB (7,969 kg ha^{-1} DM), and NG (10,538 kg ha^{-1} DM). In later ages, TB, LB, SB, and NG decreased, as a result of the increase of biomass losses, caused by senescence and decomposition. This phenomenon was reflected in a DM (Gusmão *et al.*, 2020). Solofondranohatra *et al.* (2021) reported that, when plants reach their optimal leaf area index, the shadow on the lower layers of the canopy increases and senescence is higher than the growth of the leaves. Meanwhile, a high forage production and a low accumulation of dead material can be obtained, when 95% of the radiation is intercepted during the vegetative stage (Niinemets, 2018). This phenomenon took place in this study at 135 DAS, recording a 100% IR and a 68 cm plant height. In grasses such as *Digitaria eriantha* Steud, the highest regrowth height recorded higher senescence rates, while optimal defoliation height took place between 35 and 45 days after the regrowth (Gusmão *et al.*, 2020)

Growth rate (GR) was statistically different ($p<0.01$) as a result of the regrowth age. The GR-adjusted model was a third-degree polynomial, with a high determination coefficient ($R^2>0.90$). Emergence increased until it reached a 99 kg DM ha^{-1} day^{-1} maximum growth at 135 DAS. Subsequently, it decreased to 50 kg ha^{-1} day^{-1}, towards the end of the study (Figure 3). The increase of GR is directly related to the vegetal biomass, the canopy increase, and the photosynthetic capacity, as a result of the accumulation of more leaf area, reaching a maximum growth (Martínez-Méndez *et al.*, 2020). The highest GR (Figure 3) was recorded by the accumulation of the leaf biomass (Cruz-Hernández *et al.*, 2020).

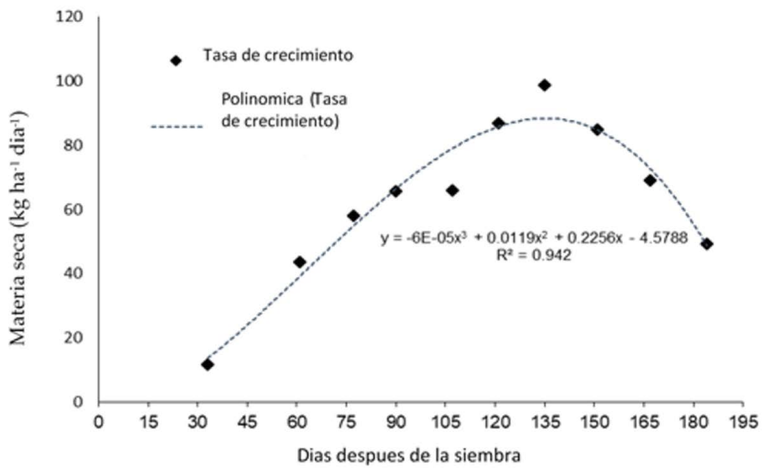

Figure 3. Changes in the growth rate of Chetumal grass over time.

Calzada-Marín *et al.* (2019) pointed out that a higher IR accumulation (95%) results in a higher photosynthetic activity and consequently, a maximum GR. In conclusion, the optimal moment to carry out the first cutting or the grazing is when the GR reaches its maximum point. Figure 4 shows that the morphological components (the leaves) are related to forage quality, while animal productivity is connected to the proportion of leaves included in their diets. Cruz-Hernández *et al.* (2017) studied *Brachiaria humidicola* grass and recorded that the highest leaf accumulation took place during the rainy season, with grazing every 28 days. The morphological composition of the plants in this study consisted of 62% leaves and 38% stems at 33 DAS. At day 77, the number of leaves diminished, while stem proportion increased and DM started to appear. Meanwhile, at 135 DAS, the

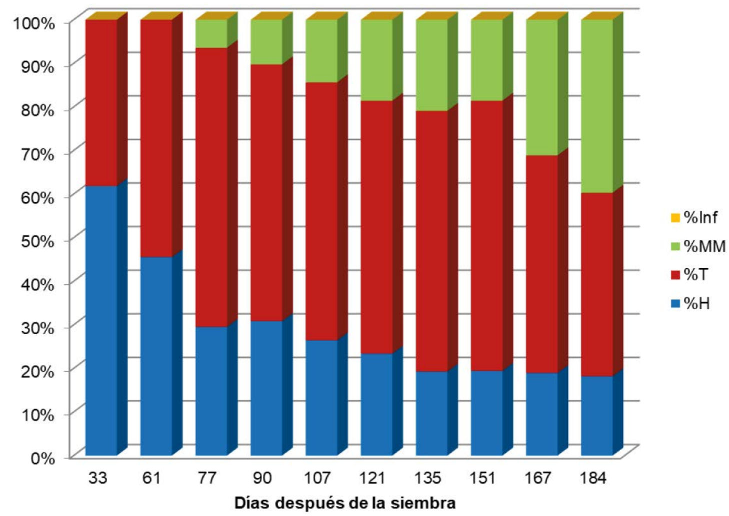

Figure 4. Morphological changes of *Urochloa humidicola* CIAT 679 grass, at different growing stages. Inf%: inflorescence percentage; %MM (DM%): dead material (mm); %T (S%): stem percentage; %H (L%): leaf percentage.

following percentages were recorded: 19% (leaves), 60% (stem), and 21% (dead material) (Rojas García *et al*., 2020).

The L:S ratio was adjusted to a regression model using a third-degree polynomial (R^2=0.97), with 1.62-0.31 variations, while the L:NL ratio was determined with a potential regression model (R^2=0.95), recording 1.62-0.22 values during the growth stages (Figure 4). Both ratios show a decrease trend as the plant matures, given the increase of the stem and dead material biomass (Figure 2). The difference between both ratios was noticeable at 135 DAS, as a consequence of the DM increase. Calzada-Marín *et al*. (2018) reported this behavior in *Dactylis glomerata* L. and *Pennisetum purpureum* Schum.

CONCLUSIONS

Based on the results obtained in this study, the first defoliation or cutting of the Chetumal grass (*Urochloa humidicola* CIAT 679) should be carried out between 120 and 135 DAS or when the grass of the prairie reaches a plant height of 66-68 cm and 100% of the radiation is intercepted.

ACKNOWLEDGEMENTS

The authors would like to thank the Papaloapan Experimental Unit of the Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias (INIFAP), located in Isla, Veracruz, Mexico.

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