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On a Nonlinear Model for Dry Matter Yield of *Brachiaria Hibrido Cv.* Cayman in Drought Season

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Abstract

In this paper nonlinear models to describe growth dynamics of plants based on dry matter yield of *Brachiaria hibrido cv.* Cayman at different interval between cuts in drought season were used. Results showed in drought conditions Gompertz model shows a weakness compared to the others. so, its use would be restricted in such climatological conditions. It is possible suggest logistic model use in drought conditions. while in rainy season. use a logistic or Gompertz model is subject to the previous accomplishment of a covariance analysis. Nitrogen fertilization. interval between cuts. intrinsic growth rate of *Brachiaria hibrido cv.* Cayman. as well as other factors affect this species development determine dry matter yield sustainability.

Keywords: *Brachiaria hibrido cv;* Nitrogen fertilization;

Introduction

Knowledge of the biomass accumulation dynamics of a forage species at different seasons is a useful methodology for better planning and harvesting of the crop to obtain the highest yields and plant material of good nutritional quality [1]. For forage yield have been used various species and varieties of creeping or erect growth habit. including Brachiaria brizantha. it is of great interest to know their growth dynamics in different edaphoclimatic conditions. in order to establish mechanisms that help to its best use and management. In this way. obtaining non-linear models can be very helpful to explain and predict pastures and forages behavior in relationship certain factors such as cutting age. studies that are limited in the geographical area [2]. Gompertz models [3]. Logistic [4]. Richards [5]. Von Bertalanffy & Brody [6,7] are the most frequently used to describe the plants growth. animals and organisms. In this sense. knowledge and control of growth and development of the crops. are great utility parameters for researchers. since their characterization allows, they can be seen. besides enabling the management programs to be designed for growth inherent to each species. The main objective of this work is to study the dynamics of dry matter yield of *Brachiaria hibrido cv*. Cayman in drought using non-linear models.

Materials and Methods

Data was obtained from a trial carried out to study the grasses management with different interval between cuts in the Palma Sola farm located in the municipality of Papelón. Potuguesa. Venezuela located between 450570.307 west longitude 985346.992 North Latitude. with an annual rain average of 1.847.3mm. Plant material used is certified commercially embedded seed of *Brachiaria hibrido cv.* Cayman. The treatments consisted interval between cuts: 21. 28. 35. 42 and 49 days. under scheme of a completely randomized block design. The response variate to be considered for the model is the total biomass. The indicator describes this variate is kilograms of dry matter per hectare (kg MS* ha-^{1}). The covariate of model was interval between cuts. Two non-linear models were considered (Gompertz & Nelder [3,4]). to study the relationship between cutting age and yield. The statistical analyzes were carried out in the R programming environment.

Logistic model

Below is the logistic model:

where B is any positive real number depends on initial condition.

A s maximum growth value of the population.

K is the intrinsic rate of growth.

$$N(t) = \frac{A}{1 + Be \wedge -Kt}$$

Gompertz Model

Below is the Gompertz model:

$$N(t) = Ae \wedge -Be \wedge -Kt$$

where: B: is a positive real number moves the model to the left or to the right.

e= irrational number (base of the neperian logarithm). A = is the maximum growth value t = time. k = establishes the intrinsic rate of growth. This equation is known as Gompertz equation.

Results and Discussion

Tables 1 & 2 and Figure 1 show fit results of two non-linear models to cumulative dry matter (Kg MS ha^{-1}) in *Brachiaria hibrido cv*. Cayman pastures. Cayman at different interval between cuts in dry season. It is observed how both models show an excellent fit to the data of accumulated dry matter set with a R2 close to 1.0 for Logistic and Gompertz models. However. gompertz model shows the lower value of AIC (99.712) compared to the values obtained by logistic model corresponding to an AIC = 180.958 (Table 1). Results indicated above suggest in the dry season (Table 2) the best fit model to estimate the cumulative dry matter yield (Kg MS ha^{-1}) in *Brachiaria hibrido cv*. Cayman at different interval between cuts is Gompertz model. These results match with was indicated by Rodríguez [8] in a trial to estimate the growth dynamics of Pennisetum purpureum vc. Cuba CT-169. who report that growth classic models. Gompertz and Logistic for the rainy season. are those of better fit for dry matter accumulation and plant height. Likewise. Martínez [9]. Rodríguez & Rodríguez [8,10] in the modeling of cumulative dry matter yield of King Grass or its clones. concluded gompertz and logistic models were the best fit. In those papers are considered functions allow to estimate the biomass production as a time function. Likewise. these results coincide with reported by Villegas [11] in a trial to estimate dry matter production in Brachiaria brizantha at different interval between cuts and under nitrogen fertilization.

Table 1: Fit of a logistic model to estimate accumulated dry matter yield (Kg MS ha^{-1}) in *Brachiaria hibrido cv.* Cayman at different interval between cuts (days) during the dry season.

Interval between Cuts (days)	Age at the inflection point (t) (days)	Auto Correlation		Model Fitting	Estimated Parameters of the Model and its Significance						
		dw	*P value*	*R2*	*AIC*	*A*	*P value*	*B*	*P value*	*K*	*P value*
21	61	1.662	0.0002	99.30	246.72	5456	0.0000	6.449	0.0000	0.0308	0.0000
28	64	2.696	0.0008	99.49	205.14	7273	0.0000	7.696	0.0000	0.03173	0.0000
35	69	3.591	0.0088	99.78	149.83	9386	0.0000	8.699	0.0000	0.03142	0.0000
42	80	2.472	0.0007	99.88	151.05	13260	0.0000	8.446	0.0000	0.0266	0.0000
49	84	2.338	0.0006	99.84	152.05	13260	0.0000	8.446	0.0000	0.0266	0.0000
Mean		2.5518	0.00222	99.658	180.958	9727	0.0000	7.9472	0.0000	0.02943	0.0000

Table 2: Fit of a gompertz model to estimate accumulated dry matter yield (Kg MS ha^{-1}) in *Brachiaria hibrido cv.* Cayman at different interval between cuts (days) during the dry season.

Interval between Cuts (days)	Age at the inflection point (t) (days)	Auto Correlation		Model Fitting		Estimated Parameters of the Model and its Significance					
		dw	P value	R2	AIC	A	P value	B	P value	K	P value
21	54	1.662	0.0002	99.45	241.83	6724	0.0000	2.411	0.0000	0.01635	0.0000
28	56	2.696	0.0008	99.61	200.89	8756	0.0000	2.641	0.0000	0.0172	0.0000
35	66	3.591	0.0088	99.78	205.56	12270	0.0000	2.810	0.0000	0.0156	0.0000
42	75	2.472	0.0007	99.88	151.06	16860	0.0000	2.772	0.0000	0.0136	0.0000
49	75	2.338	0.0006	99.84	151.06	16860	0.0000	2.772	0.0000	0.0136	0.0000
Mean	2.5518	0.00222	99.712	190.08	12294	0.0000	2.6812	0.0000	0.01527	0.0000	

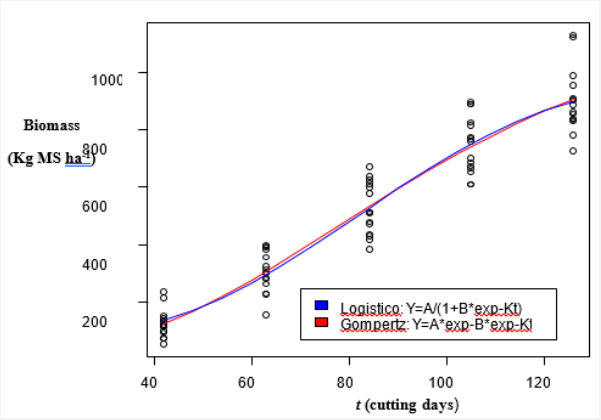

Figure 1: Fit of two nonlinear models for estimate accumulated dry matter yield (Kg MS ha^{-1}) in *Brachiaria hibrido cv.* Cayman at different interval between cuts (days) during the dry season.

On the other hand. in Table 2 it is observed that highest value of the inflection point ordinate (75 days). is obtained for a cutting age of 42 and 49 days. This suggests that under this experimental condition the accumulated dry matter yield of *Brachiaria hibrido cv*. Cayman is in a constant manner for a longer time period than the rest of the experimental conditions in this trial. In this sense. determining optimal moments of cut or harvest. based on values obtained in the growth dynamics of the species in a particular place and climate. allows to maximize forage yield. greater obtaining of the leaf component instead of stems and dead material. obtaining forage of higher nutritional quality in comparison to the cuts that are made when the forage is already dry [12]. Therefore. this result suggests that the cut age. the intrinsic rate of growth of *Brachiaria hibrido cv*. Cayman. as well as other factors that affect the development of this forage species. determine sustainability in dry matter yield of this species. which coincides with what was

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pointed out by Bello in a theoretical description of nonlinear models. especially of the gompertz model and logistic model in relation to factors that affect the ordinate X of the inflection point. Moreover. the growth dynamics determine the phenological behavior of the crop at different year seasons. which varies depending on the environmental conditions that arise [1]. so that the growth and quality of the pastures it can vary considerably according to the management to which they are subjected. with favorable or non-favorable effects according to the plant species and the edaphoclimatic conditions [13]. This coincides with that reported by Cruz [14]. who in a trial with *B. hibrido cv.* Mulato grass at different frequency and intensity of grazing. concluded that during rainy season the pasture presents greater forage accumulation of forage when harvested in rest periods of 28 days

Conclusion

In the drought period. the best fit model to estimate the accumulated dry matter yield in *Brachiaria hybrids cv.* Cayman at different interval between cuts was the Gompertz model. Both models tend to underestimate the initial dry matter yield. The Gompertz model presented a higher growth speed than the logistic model. Finally. the inflection point in Logistic model and the Gompertz are conditioned by the intrinsic growth rate. by the initial dry matter production and by the factors that affect grass growth.

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