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Growth equation of Tanzania's re-sprouting on an established plot enriched with rabbit droppings

Ecuación del crecimiento de rebrote de Tanzania en una parcela establecida enriquecida con excremento de conejo

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RESUMEN

La biomasa es el resultado de la transformación de la energía solar en energía química. La producción de biomasa vegetal es muy importante para la alimentación animal y por ende para la producción de productos para consumo humano. El objetivo del presente trabajo fue contar con una ecuación que indique el crecimiento de rebrote de Tanzania en una parcela enriquecida con excremento de conejo durante el periodo de lluvias. En la granja se encuentra la parcela establecida por 4 años con pasto Tanzania en suelo enriquecido con estiércol de conejo a razón de 10 kg/m^2 una vez al año 30 días antes del periodo de lluvias. Las mediciones del rebrote se realizaron al azar, con cinta métrica del nivel de corte anterior hasta la altura promedio del forraje de un marco de 1.0 m^2, cada 10 días después del corte y hasta los 60 días, y se tomaron 10 mediciones por tiempo. A los datos recolectados del pasto se sometieron a un procedimiento matemático para tipificar su curva de crecimiento con un alto grado de exactitud, este método conocido como Gauss Jordan. El crecimiento promedio y DS en cm registrado para los días 10, 20, 30, 40, 50 y 60, fue de 49±7.4, 69±8.9, 82±10.3, 101±8.9, 154±11.4 y 191±7.4 respectivamente. Se obtuvo una ecuación polinómica de segundo grado y un coeficiente de determinación R^2 del 0.98 %.
Palabras clave: forraje, maduración, rendimiento.

ABSTRACT

Biomass is the result of the solar energy transformation into chemical energy. The production of plant biomass is very important for animal feed and therefore for the production of products for human consumption. Therefore, the objective of this work was to have an equation that indicates the growth of Tanzania's re-sprouting in the rainy season. On the farm is the plot established for 4 years with Tanzania grass in soil enriched with rabbit manure at a rate of 10 kg/m^2 once a year 30 days before rains. The re-sprouting measurements were made randomly, with tape measure from the previous cut level to the average forage height of a 1.0 m^2 frame, every 10 days after the cut and up to 60 days, and 10 measurements were taken per time. The data collected from the grass underwent a mathematical procedure to typify its growth curve with a high degree of accuracy, this method known as Gauss Jordan. The average growth and DS in cm recorded for days 10, 20, 30, 40, 50 and 60, was 49±7.4, 69±8.9, 82±10.3, 101±8.9, 154±11.4 and 191±7.4 respectively. A second-degree polynomial equation and an R^2 coefficient of determination of 0.98% were obtained.
Keywords: forage, maturation, yield.

INTRODUCTION

Biomass is the result of the transformation of solar energy into chemical energy. The production of plant biomass is very important for animal feed and therefore for the production of products for human consumption. This production is influenced by different factors such as species and variety, parasites or other microorganisms, soil, climate, season, management, age, cut, grazing, irrigation, droughts, burning, fertilizers, enrichment with composts, among others. The advances of science promoted agricultural development based on the green revolution; which only promotes the production of food, whether for human or animal use; marginalizing the importance of biomass as an enrichment of the soil resource, by having the necessary inputs to replace its natural fertility (Martínez and Leyva, 2014).

Plants belonging to the grass family such as legumes are important, since they are capable of providing a large amount of calories and proteins; In addition to being plants that have a large amount of biomass, and in turn serve for animal feed (KASS, 1997).

The fabaceae (*Fabaceae*) or legumes (*Leguminosae*), are a family of the order of the fabales; gathers trees, shrubs and perennial or annual herbs; easily recognizable by its fruit type legume and its compound and stipulated leaves. It is a family of cosmopolitan distribution with approximately 730 genera and some 19,400 species; which makes it the third most wealthy family of species after the compound (*Asteraceae*) and orchids (*Orchidaceae*) (KASS, 1997).

The production of biomass by tree plants is important, since with the integration of trees in the pastures, it is an option to improve the productivity and sustainability of livestock. With the use of silvopastoral systems, important meat and milk indicators are achieved in places in Mexico and the rest of Latin America (Aguirre, 2013).

The grass family is probably the most important for the human economy; in fact, about 70% of the arable land of the world is planted with grasses, and 50% of the calories consumed by humanity comes from the numerous species of grasses, which are used directly in food, or, indirectly as forages for domestic animals (KASS, 1997). In terms of global production, the four most important crops are grasses: sugarcane, wheat, rice and corn. Barley and sorghum are among the first 12 crops. On the other hand, sugarcane is a crop that provides a large amount of biomass (Parodi, 2005).

Thus, the annual net productivity of some plants are: sugar cane with 1725 and 4.73, beets with 765 and 2.10, rice with 497 and 1.36, corn with 412 and 1.13, oats with 359 and 0.98 and wheat with 344 and 0.90 g/annual m^2, and per day respectively (Odum, 2000).

Biomass can also be produced with the germination of grains under control of temperature, humidity, density and good quality of the seed; it reaches a yield of 10 to 12 times the weight of the seed, in a period of 7 to 10 days. In a work done with corn in cardboard trays with only water irrigation and every 24 hours, an average height of 30.45±4.5 cm was achieved, a yield 3.5±0.3 Kg and with 80.5% germination (Zagal-Tranquilino *et al*., 2016).

Tanzania grass, currently found in tropical and subtropical areas, where it is used to feed ruminants because of their re-sprouting, leaf blade size, leaf ratio and palatable biomass production (Patiño *et al.,* 2018) . Its nutritional content amounts to 21.2% dry matter (DM), 11.6% crude protein, 41.1% acid detergent fiber, 68.6% neutral detergent fiber and 1.63% fat; it also contains ashes (13.4%), calcium (0.29%) and phosphorus (0.26%) (Molina *et al*., 2015).

Verdecia *et al*. (2008) published 1270 g/m^2 of DM per cut at 105 days of Tanzania grass; However, the older the plant, the lower the nutritional qualities. The ages evaluated were 30, 45, 60, 75, 90 and 105 days. In the results can be seen that the yield in DM increases with the age of the plant, with its highest results at 105 days, with (12.7 tMS/ha/cut); while the proportion leaf-stem, crude protein, digestibility of DM and organic, decreased with age. Its best behavior was at 30 days with (11.62%, 63.5% and 68.74%) respectively while fiber increased with age being its highest values at 105 days, with 35.53% (Verdecia *et al*., 2008).

Rabbit manure in MS contains 3% nitrogen, 2.9% phosphorus and 4.8% potassium; it also has a basic pH of 7.2 to 9, which makes it advisable for acidic lands (Rabada, 1978). The theoretical value of the dejections can be calculated by determining the equivalent contribution of the elements nitrogen (N), phosphorus (P), and potassium (K), by chemical fertilizers for nitrogen; for example, urea, for phosphorus superphosphate; and for potassium, the potassium sulfate. To get an immediate idea, suffice it to say that by providing about 15 ton/ha of fertilizer based on rabbit excreta, an average of 125 units of nitrogen, 180 units of phosphorus and 100 units of potassium (Maiani, 1990) is provided.
On the other hand, the Gompertz, Logistics, Richards, Bertalanffy and Brody models are the most frequently used growth functions to describe the growth of animal plants and organs. Biological growth can be replicated using mathematical functions, which predict the evolution of live weight over time; these allow evaluations of the level of production in livestock farms, and can easily classify the productivity of a specific species for a given area (García, 2005; Noguera *et al*., 2008).
For the aforementioned, the objective of the present work was to have an equation that indicates the growth of Tanzania's re-sprouting in an established plot, enriched with rabbit droppings during the rainy season.

MATERIAL AND METHODS

The present study was carried out in the school of the Technical High School No. 1, located in Xalisco Nayarit, Mexico. The place has a warm sub humid climate, with rains in the summer; the average annual temperature of 21.3 ºC, with an average rainfall of 1152.3 mm, with an altitude of 915 m above sea level (INEGI, 2006).

On the farm is the plot with irrigation system, 4 years old, with Tanzania grass (*Megathyrsus maximus*, Jacq) and receives rabbit manure at a rate of 10 kg/m^2 (0.3 kg of N, 0.3 of P and 0.48 kg of K), once a year 30 days, before the rainy season. The fodder receives cuts all year before maturation or glean, since in this way the guinea pigs (animals that are raised for pets on the farm), consume all the fodder, without the need to chop it.

The study was carried out in the summer, which is the rainy season, since the forage has greater growth during that time. A uniformity cut was made to the forage at 15 cm from the ground and the re-sprouting measurements were made randomly, with tape measure from the previous cut level to the average forage height of a 1.0 m^2 frame, every 10 days after the cut and up to 60 days, and 10 measurements were taken per time.

The data collected from the grass were subjected to a mathematical procedure to typify its growth curve, with a high degree of accuracy, this method known as Gauss Jordan (Dekker and Hoffman, 1989; Peter and Wilkinson, 1976).

RESULTS AND DISCUSSION

The average growth and DS in cm, recorded for days 10, 20, 30, 40, 50 and 60 after the Tanzania grass cut was 49±7.4, 69±8.9, 82±10.3, 101±8.9, 154±11.4 and 191±7.4 respectively. When analyzing the data, a second-degree polynomial equation and a coefficient of determination R^2 were obtained.
Where x = day. See figure 1.

$$y = 0.0438x2 - 0.2511x + 50.1$$

$$R^2 = 0.9875$$

It should be noted that by increasing the degree of the polynomial equation in theory a better fit and a higher coefficient must be obtained, but at the time of applying it, a significant increase was not obtained, so it was concluded to use the second degree, since it is shorter and easier to process by the user.

When replacing the equation calculated in this work and 35 days after the cut, it indicates a growth of 94.96 cm, which is consistent with those obtained by Sánchez *et al*. (2019). However, the results found in the present work achieve a growth of 191±7.4 cm at 60 days after cutting.

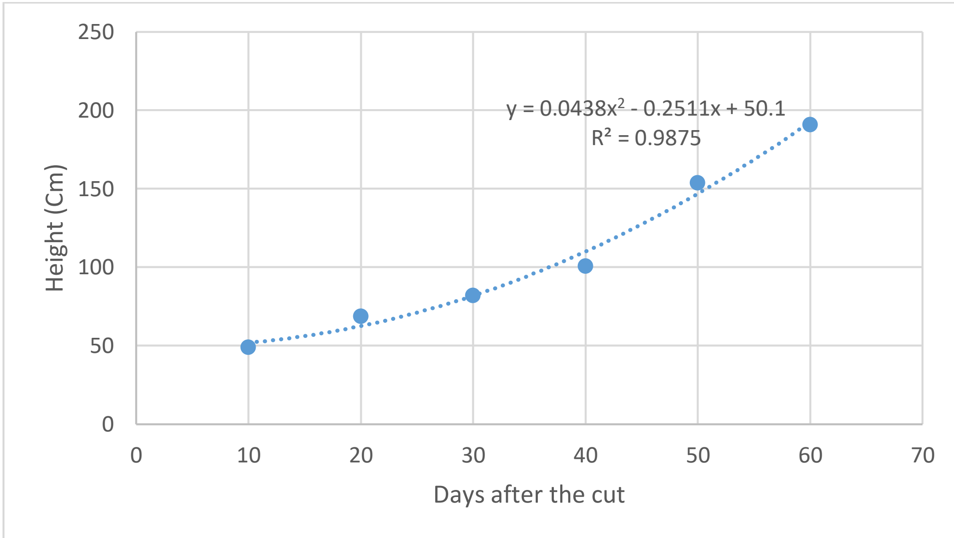

Figure 1. Growth of Tanzania's re-sprouting on an established plot enriched with rabbit droppings during the rainy season with a second-degree polynomial equation

In a work to measure the growth of Tanzania grass, on a plot established for one year with fertilizer in the rainy season, they found that the growth varied between 7 and 35 days after cutting, from 81 to 115 cm without fertilizer, and 106 at 160 cm with fertilizer. The results suggest that fertilization with nitrogen (N), phosphorus (P) and potassium (K) increases plant height, chlorophyll content and yield in DM, when a dose of 260-60-40 is applied per hectare in the rainy season (Sánchez *et al*., 2019).

The addition of nitrogen, phosphorus and potassium (0.3 kg of N, 0.3 kg of P and 0.48 kg of K per m^2), through rabbit manure (10 kg/m^2) was very low, since the calculated dose was 3.0 -3.0-4.8 per hectare and in a study on Tanzania grassland the effect of nitrogen application was measured. It was concluded that the highest seed yield was achieved with the application of 100 kg of N/ha (Joaquín *et al*., 2009).

Verdecia *et al*. (2008) published the yield of Tanzania grass, achieving 9.4 tMS/ha at 60 days, after the cut in rains. As can be seen, the yield in DM increases as the age progresses there, being significant differences for $p < 0.05$ between each of the ages studied in both periods of the year, obtaining the best results at 105 days of age with (12.7 and 3.81 tMS/ha/year). The lowest at 30 days with (3.4 and 1.02 tMS/ha/year), for the rainy and dry periods respectively.

However, at 60 days of age, it has 8.0% crude protein and digestibility of 54%; these values as the forage age increases are negatively affected. It also lowers palatability, since animals do not consume the forage completely.

CONCLUSION

The average growth and DS in cm recorded for days 10, 20, 30, 40, 50 and 60 after the cut in Tanzania grassland during the rainy season was 49 ± 7.4, 69 ± 8.9, 82 ± 10.3, 101

± 8.9, 154 ± 11.4 and 191 ± 7.4 respectively. A second-degree polynomial equation and an R2 coefficient of determination of 0.98% were obtained.

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