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Research Article

Indicators of Yield of *Tithonia diversifolia* in the Zone of Granma Province, Cuba

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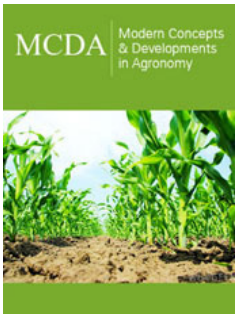

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Abstract

The *Tithonia diversifolia* is a plant that has a large root volume, a special ability to recover nutrients from the soil, even when they are found in small proportions, its wide range of adaptation allows it to reach high productions of livestock feed. In order to establish the relationship between age and performance indicators of this species in the edaphoclimatic conditions of Cauto Valley, the study was developed following a randomized block design, with five treatments (60, 90, 120, 150 and 180 days). The production of total, edible biomass and dray matter yield (DMY) were evaluated; as well as the establishment of the relationship between these and the days of the forage, regression equations (linear, quadratic, cubic, logarithmic and gompertz) were analyzed and the descending method was used for their selection. With increases as plant maturity progresses, the best results were obtained at 180 days (46.18t GM/ha; 10.96t DM/ha), during the rain for total foliage and DMY, while the edible biomass in dry season with 16.20t GM/ha; with first, second and third order function settings and R2 higher than 0.90 in both climatic season. The established models explain the close relationship between dependent and independent variables, with their increase in both seasonal periods.

Keywords: Shrub; Biomass; Equations; Age; Yield

Introduction

The *Tithonia diversifolia* known as a useful plant as an improved in soil fertility, mainly when it is handled as green manure, mixed with the soil or as an accompanying crop. This is a species that prevents erosion [1]. It is used in live fences, as flora for beekeeping, in medicine and in silvopastoral cattle. It is also used as cutting fodder for pigs, sheep, rabbits, cows and buffalo. It has the potential to feed ruminant and monogastric animals and is a forage of high nutritional value [2]. Taking into account the potential (quantitative and qualitative) forage of this species, which is listed as promising for sustainable systems of agricultural production, it is necessary to expand the scientific evaluation of the productivity of its forage in Cuba [3]. Therefore, the objective of this work is to establish the relationship between age and performance indicators of the shrub *Tithonia diversifolia* in the edaphoclimatic conditions of Valle del Cauto.

Material and Methods

Research area, climate and soil

The study was carried out in the Teaching-Productive Department of the University of Granma, which is located in the southeast of Cuba, 17.5km from the city of Bayamo. The experiment was carried out for two years (2014-2015), and two seasonal periods were considered, the rainy (May-October) and dry (November-April). The soil present in the area was Calcic hastustept [4], with a pH of 6.2. The content of P_2O_5, K_2O and total N was 2.4; 33.42 and 3 (mg/100g of soil) respectively, with 3.6% organic matter. Regarding the behavior of climatic variables, during the rainy season, rainfall was 731.4mm; the average, minimum

and maximum temperature and relative humidity registered values of 26.73; 22.31 and 33.92 °C and 80.78; 51.02 and 96.22%, respectively. In the dry season, the pluviometry reached values of 270 mm; the temperature was 24.05; 18.29 and 31.58 °C and the relative humidity of 76.21; 44.16 and 97.03%, in both cases for the mean, minimum and maximum averages.

Experimental design and treatments

A random block design with four replicates was used and the treatments were the regrowth ages of 60, 90, 120, 150 and 180 days.

Procedures

The established species had 98% of the population and at the beginning of each seasonal period a homogeneity cut was made at 15cm above the ground level. The samplings were carried out in 10 plants in a row eliminating the edge effect in an area of 0.5ha^{-1}, according to the treatments. The sample was homogenized and weighed to determine the total biomass and dry matter yield, later they were separated manually into leaves, petioles and stems with a diameter less than 2cm to know the edible biomass. Then two kilograms were taken for each of the treatments for the determination of the MS. During the experimental stage, no irrigation or fertilization was applied.

Statistical calculations and analysis

The relationship between performance and age was established through regression analysis using the following expressions: linear, quadratic, cubic, logarithmic and gompertz where the one with the best fit was used for the results, for which they were taken in counts the criteria of [5-7]. The high value of the coefficient of determination (R^2), high significance of the expression and its parameters, low standard errors; as well as the analysis of variance of the regression. The SPSS version 22 statistical system was used.

Result and Discussion

The total biomass increased (P<0.001) up to 180 days in *Tithonia diversifolia* (Figure 1) by 46.18 and 44.20t GM (green material)/ha, for the rainy and dry season, respectively. Quadratic and cubic equations were adjusted for the two cases. The edible biomass in *Tithonia diversifolia* (Figure 2) during the rain increased by 2.94t GM/ha until 120 days and then decreased until 180 days, while during the rainy season it increased 10.96t GM/ha at 180 days, with adjustment to quadratic equations in both cases. For the dry matter yield (Figures 3) the greatest results were at 180 days with increases of 16.09 and 15.93t DM/ha, and linear curve adjustments for the seasonal periods of rain and dry, respectively. Total, edible biomass and dry matter production increased with the age of the regrowth (Figures 1-3), although the useable by the animal in the rainy season decreased after 120 days. This behavior can be attributed to the prevailing conditions for the growth of the plant, with which it reaches a greater size and degree of development. This affects, above all, the most woody parts, which explains why an increase in the useful biomass is not always observed despite prolonging the study time [8].

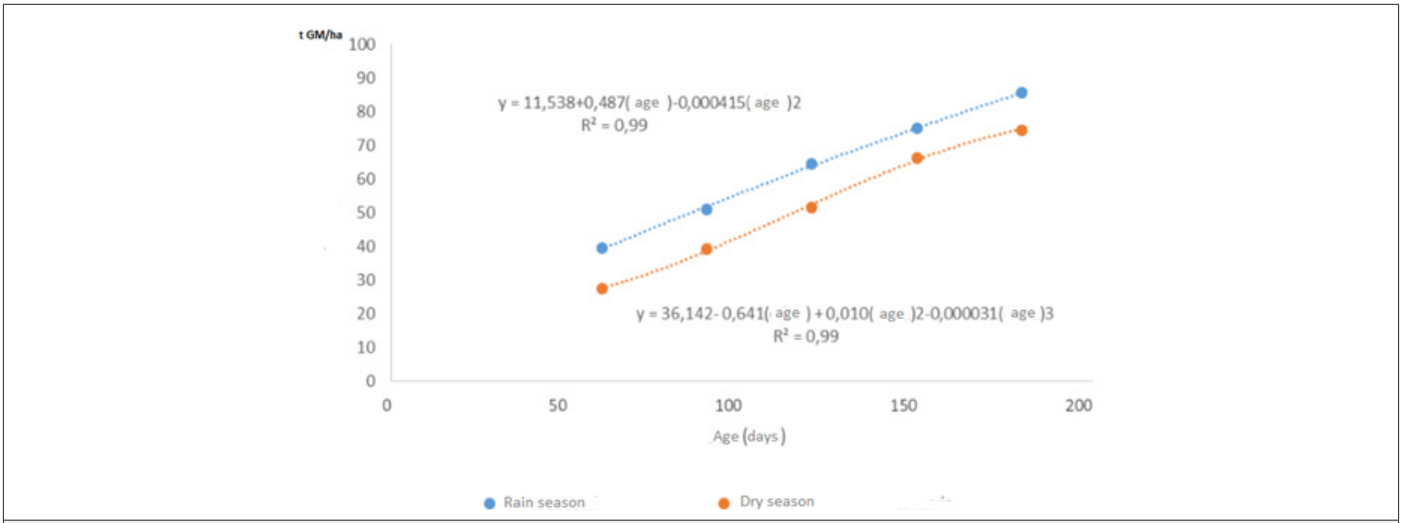

Figure 1: Total biomass of *Tithonia diversifolia* in both periods of the year.

The DM increased with the regrowth age, due, among other aspects, to the increase in its structural components. The studies of Rios [9] showed similar values to those found in this investigation at the age of 180 days, although the climatic conditions were different. The results of this investigation coincide with those reported by Mahecha and Rosales [10]; Ruiz et al. [3], who reported that as the regrowth age advances, there is greater development of the supporting tissues and an increase in the proportion of stems in the useful biomass. This increases the plant cell wall and decreases the cell content, differences that can be accentuated in the rainy season. On the other hand, Verdecia et al. [8], when studying the behavior of *T. diversifolia* in Valle del Cauto conditions, they found a decrease of 0.5t GM/ha of useful biomass in the one with the rain season, from 120 to 180 days, these results are lower than those reported

in this study with a decrease of 1.77t GM/ha, due to the variability of climatic conditions in this region of the Cuban East, among other aspects.

When carrying out studies for Ruiz et al. [11], of the biomass production given by *Tithonia diversifolia* when using different planting densities and cutting heights, when using 2.66 plants/m^2, a marked effect of the amount of shrubs and height on the variables evaluated. Yields under these conditions were 82, 57 and 46t GM/ha, respectively. In studies of Sanchez et al. [12] reported the highest values for edible biomass in Leucaena from 3.81 to 3.88t GM/ha at 90 days of cut. An aspect of great importance for the management of the species because the production of edible biomass (non-lignified stem-leaves) of the shrub legumes tends to describe a curve where, in a first phase, they experience a sustained increase until reaching maximum yield. achieving a satisfactory leaf-stem relationship; in the next, this behavior declines significantly, with the presence of the woody part prevailing.

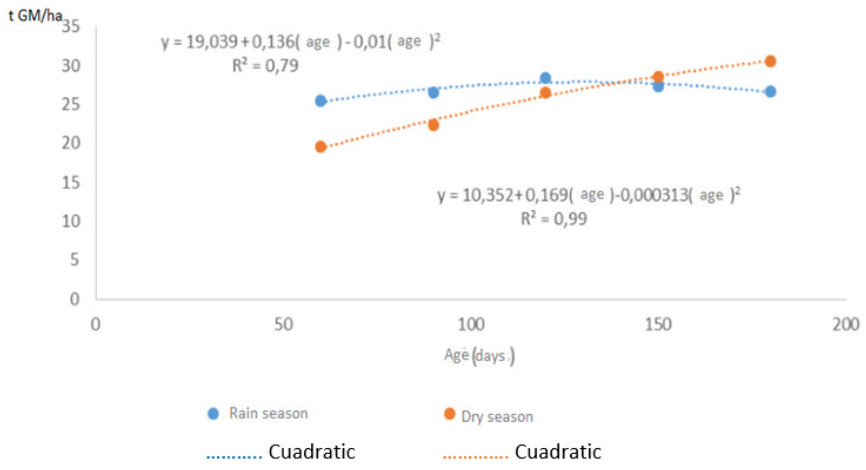

Figure 2: Edible biomass of *Tithonia diversifolia* in both periods of the year.

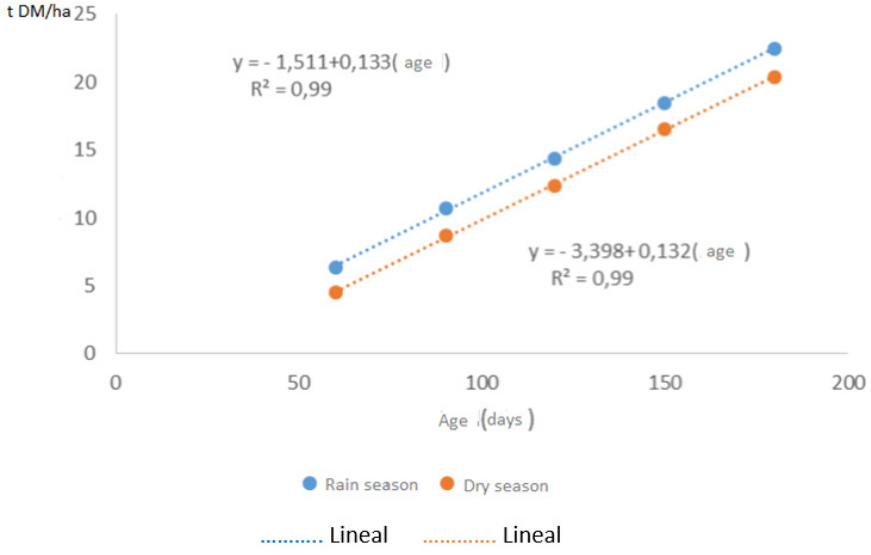

Figure 3: Dry matter yield of *Tithonia diversifolia* in both periods of the year.

When evaluating Mendoza et al. [13] Brosimum alicastrum in different areas of Yucatan (Mexico), they found an increase in yield with the age of the plant, with its greatest results at 12 months with 2.13; 2.26 and 11.85Kg DM/tree, this behavior is attributed to the fact that by increasing the cutting phase it allows the plant to increase the leaf area, and with it its photosynthetic capacity and higher production. On the other hand, Simon et al. [14], it states that the trees during the first weeks after cutting, enter a slow recovery stage, mainly caused by the limited amount of carbohydrates, until the plant manages to have new leafy shoots capable of carrying out the photosynthesis that help this to a stage of rapid growth and accumulation of dry matter. When studying the effect of regrowth age Sosa et al. [15], they found the highest yields at 12 weeks with 2 and 0.90tMS / ha for the rainy and dry periods, respectively. Behavior attributed to the prevailing edaphoclimatic conditions, hence the differences found between this study and the current one where

productions are higher with 10 and 7 tMS/ha in each of the climatic stations.

Conclusion

The established regression equations explain the close relationship between the regrowth age and the performance indicators, with the increase of these in both seasonal periods.

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