Revista Científica Interdisciplinaria Investigación y Saberes
2023, Vol. 13, No. 2 e-ISSN: 1390-8146
Published by: Universidad Técnica Luis Vargas Torres

Evaluation of the effect of biofertilizer application on primary production in pennisetum grasses (purple king grass and iniap 811), at 3 harvesting ages

Evaluación del efecto de la aplicación de biofertilizantes, sobre la producción primaria en pastos del género pennisetum (king grass morado e iniap 811), a 3 edades de cosecha

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Received 2023-01-12
Revised 2023-05-22
Published 2023-05-07
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Pages: 1-12

Abstract

The present research was carried out to evaluate the effect of the addition of two levels of biofertilizer on the production of two cut grasses INIAP-811 and King Grass Morado, at 30 - 45 and 60 days of age. The three treatments were distributed in a randomized block experimental design and the variables were plant height, leaf/stem ratio, biomass production and nutritional quality. The results obtained for plant height were for King Grass at T3 with 243.2 cm, and for INIAP-811 at T2 with 193.13 cm, both at 60 days of age. In the protein variable, 16.88% was obtained at 30 days for T2 of the Purple King Grass, with INIAP-811 grass, the T3 treatment with 16.31% at 30 days of age. In the variable biomass production at 60 days of age, with

How to cite this article (APA): Iglesias, W., Chávez, V., Lujano, M., Rodríguez, M. (2023) Evaluation of the effect of biofertilizer application on primary production in pennisetum grasses (purple king grass and iniap 811), at 3 harvesting ages, *Revista Científica Interdisciplinaria Investigación y Saberes*, 13(2) 1-12.

47.40 kg/m2 , the T2 for King Grass Morado, for INIAP-811, about 31.50 kg/m2 also at 60 days. In the leaf-to-stem ratio, T3 obtained 3.1:1 for King Grass Morado, while INIAP-811 obtained 2.05:1, both at 30 days of age. Based on the results obtained, we conclude that harvests at 45 and 60 days of age, plus the application of a biofertilizer significantly influences the agronomic and nutritional characteristics of the grass.

Keywords: Biofertilizer, King Grass Purple, INIAP-811, Pennisetum sp.

Resumen

La presente investigacion se realizó con la finalidad de evaluar el efecto en la adicion de 2 niveles de biofertilizante en la produccion de dos pastos de corte INIAP-811 y King Grass Morado,a los 30 - 45 y 60 dias de edad. Los tres tratamientos fueron distribuidos con un diseño experimental de bloques al azar y las variables fueron altura de planta, relación hoja/tallo, producción de biomasa y calidad nutricional. Los resultados obtenidos en altura de planta fueron en el pasto King Grass en el T3 con 243.2 cm, para el pasto INIAP-811 el T2 con 193.13 cm., ambos 60 días de edad. En la variable proteína se obtuvo a los 30 días, un 16.88% para T2 del King Grass Morado, con el pasto INIAP-811, el tratamiento T3 con 16,31% a 30 días de edad. En la variable producción de biomasa a los 60 días de edad, con 47,40 kg/m2 , el T2 para el King Grass Morado, para INIAP-811, unos 31.50 Kg/m2 también a 60 días. En la varibale relación hoja-tallo, el T3 obtuvo 3.1:1 del King Grass Morado, mientras que INIAP-811, obtuvo 2.05:1, ambos a 30 días de edad. Con base a los resultados obtenidos concluímos que cosechas a los 45 y 60 días de edad, más la aplicación de un biofertilizante influye significativamente en las características agronómicas y nutricionales del pasto.

Palabras clave: Biofertilizante, King Grass Morado, INIAP-811, Pennisetum sp.

Introduction

Due to the high demand for food worldwide, natural resources have been overexploited and this has produced high levels of pollution in both water and soil, affecting and reducing the numerous animal and plant species that inhabit them.

One of these major pollutants are chemical fertilizers, since for decades they have been used in many cases inappropriately, altering soils and water, forcing the producer to have to apply more chemical fertilizers to have a greater efficiency in the use of soils, which influences an economic impact due to the high economic value of these.

Livestock is one of the activities that uses the largest extensions of land, especially pastures, which are its main source of food. In Ecuador until the year 2021, INEC identified that in natural pastures an area of 646130 hectares is used and in cultivated pastures an area of 2'376139 hectares, being superior to the area used for agriculture.

Pasture fertilization becomes an effective tool to maintain the soil at an optimum production level; however, for the good use of fertilizers and for the nutrients applied through them to be properly absorbed by the plant, there must be an adequate level of moisture in the soil and fertilization levels must be used in accordance with the demands and absorption capacity of the plants.

In pastures, their nutritional requirements depend on the farming system used. In pastures where grazing is used, cattle feces and urine together with fallen leaves provide nutrients to the soil, decreasing the requirements and use of fertilizers (Franzluebbers, 2010).

Biofertilizer saves up to 50% of the volume of chemical products needed, which favors the reduction of inputs and costs, and influences the exercise of a sustainable and ecologically healthier agriculture, as stated by Noda (2009).

Biofertilizers are microbial preparations that are applied to soil and/or crops to partially or totally replace synthetic fertilizers (Armenta et al., 2010). Due to the increasing cost and pollution of conventional fertilizers which could have environmental consequences if used

incorrectly, new, more economical and efficient alternative fertilizers have had to be found in order to safeguard the environment (Soria et al., 2001).

The objective of this research was to evaluate the effect of conventional fertilization and biofertilizers on the quantity and quality of pastures, as well as to determine the result of biofertilizers on pastures, the efficiency of conventional fertilizers and to compare the yield obtained in the different treatments.

Methodology

The research was carried out in the Pastures and Forages program of the Animal Husbandry Engineering program of the Faculty of Agricultural Sciences of the Universidad Tecnica Luis Vargas Torres.

The research was conducted within the research line of Production, management and sustainable development of agricultural, livestock and forestry products with an ecosystem approach / Development and integrated livestock management at local, regional and national levels - within the GIAP Research Group - Animal Husbandry Department - Faculty of Agricultural Sciences - Technical University "Luis Vargas Torres" of Esmeraldas.

The effect of the addition of two levels of biofertilizers on the production of two cut grasses INIAP-811 and King Grass Morado was studied. The treatments resulted from the interaction of the grass with the biofertilizer at three mowing ages (30-45-60 days).

Table 1. *Composition of the biofertilizer.*

COMPONENT	%
HUMIC ACID	14.0 - 14.5
FULVIC ACID	3.26 - 3.35
POTASSIUM	10 - 12
NITROGEN	4 - 6
PHOSPHORUS	2 - 3

The three treatments were distributed in a completely randomized block experimental design and the variables studied were plant height, leaf/stem ratio, biomass production and nutritional quality. The data were subjected to an analysis of variance with Duncan's test ($p \leq 0.05$).

First, the plots used before starting the research were adapted and glyphosate and amine were applied for weed control. Equalization cuts were made and then the biofertilizer was applied in the morning hours using 6 applications: 6cc for T2 and 8cc for T3.

Once the pastures reached 30, 45 and 60 days of age, agronomic data and nutritional values were collected. For the bromatological analysis, a sample of 2 kg of fresh grass was taken, cut into 5 cm pieces and sent to the laboratory.

Results

In the plant height variable, Lujano obtained that at 30 days of age the greatest height was obtained by T3 (R1) with 141.93 cm, as did Rodriguez with 101.50 cm, although numerically there are differences, but taken to the statistical analysis no significant differences were found ($p>0.05$).

At 45 days of age Lujano obtained that T3 (R2) reached a height of 205.40 cm, unlike Rodriguez who obtained better results in T2 and T1 with values of 156 and 153 cm respectively, finding statistical differences between the investigations and at 60 days, Lujano obtained in T3 (R3) 243.27 cm and Rodriguez in treatments 2 and 3, with 193.13 and 184.27 cm respectively, finding numerical differences between the investigations.

Table 2. *Plant height (cm).*

DAYS	TREATMENT /REPETITION	HEIGHT I LUJANO	HEIGHT I RODRIGUEZ
	T1 (R1)	139.72 a	94.21 ab
30	T2 (R1)	132.00 a	83.20 a
	T3 (R1)	141.93 a	101.50 b
	T1 (R2)	199.53 b	153.47 b

45	T2 (R2)	173.07 a	156.00 b
	T3 (R2)	205.40 b	135.07 a
	T1 (R3)	220.13 a	162.00 a
60	T2 (R3)	238.60 ab	193.13 b
	T3 (R3)	243.27 b	184.27 b

From these results it can be affirmed that as a higher dose of fertilizer is applied, plant height increases as shown in table 2, in this research at 60 days the control, T1 (R3) reached a height of 220.13 cm and T3 (R3) that was applied 8 cc of biofertilizer reached 243 cm, our results were LESS than Viera (2011), who in his research work the control reached a height of 237 cm, while in the treatment that used 50% inclusion of the biol obtained a height of 262 cm at 60 days of age. In another work, Zaldaña (2013), with results at 8 weeks of 228.1 cm in treatments 1 (control) and 279.4 cm in the treatments that used magnecol and chicken manure levels, these results being HIGHER than those presented in this research at 8 weeks of grass age.

Peña (2018), mentions that 45 days of INIAP-811 grass, reaches a plant height of 212.75 cm, being SUPERIOR to T2 which obtained a plant height of 156.00 cm, this is due to the fact that Peña's research was conducted in dry season in Peru. In this variable, Lujano obtained that at 30 days T3 (R1) obtained the best ratio with results of 3.10:1, while Rodriguez in the same treatment and repetition, obtained a ratio of 2.05:1 being the best at 30 days. While at 45 days Lujano obtained a better ratio at T2 (R2) obtaining values of 1.89:1, Rodriguez obtained a better ratio at T3R2, with 1.5:1.

At 60 days, Lujano had better results with T1 (R3) with a value of 1.12:1, while Rodriguez obtained values of 1.18:1 in treatments 1 and 3, similar to each other but with a numerical difference but not with statistical significance with the result of Lujano, without application of biofertilizer.

Table 3. *Leaf:Stem Ratio (Averages)*

DAYS	TREATMENT /REPETITION	LUJANO LEAF/STEM RATIO	RODRIGUEZ LEAF/STEM RATIO
30	T1 (R1)	2.08:1	1.97:1
	T2 (R1)	2.81:1	1.94:1
	T3 (R1)	3.10:1	2.05:1
45	T1 (R2)	1.43:1	1.62:1
	T2 (R2)	1.89:1	1.38:1
	T3 (R2)	1.23:1	1.75:1
60	T1 (R3)	1.12:1	1.18:1
	T2 (R3)	0.92:1	1.16:1
	T3 (R3)	0.90:1	1.18:1

However, our result was SUPERIOR having the T1 (R1) at 30 days 2.08:1, to that reported by Hurtado (2012), who in the leaf/stem ratio obtained values of 1.38:1.

Elvira (2014), at 60 days obtained 0.41:1 for the leaf/stem ratio, being this value LOWER, than the result obtained in this research of 1.12:1 for T1 (R3) at the same age. We can observe the production level of the treatments: at 30 days Lujano obtained the highest amount of biomass in T1 (R1) with 7.93 kg/m2 and Rodriguez with 3.7 kg/m2.

At 45 days the best result was for treatment T3 (R2) with 20.41 Kg/m2 , for Lujano and for Rodriguez it was T1R1 with 3.7 Kg/m2 . At 60 days the best average was obtained by T2 R3, for Lujano, with a production of 47.40 Kg/m2 and Rodriguez in the same treatment and repetition, with 24.7 Kg/m2 .

Table 4. *Average Biomass Production (Kg/m2).*

DAYS	TREATMENT /REPETITION	BIOMASS (KG/M²) LUJANO	BIOMASS (KG/M²) RODRIGUEZ
30	T1 (R1)	7.93	3.7
	T2 (R1)	7.57	4.5

	T3 (R1)	6.80	5.0
	T1 (R2)	18.14	10.8
45	T2 (R2)	17.52	9.0
	T3 (R2)	20.41	8.5
	T1 (R3)	33.57	15.3
60	T2 (R3)	47.40	24.7
	T3 (R3)	44.67	31.5

The production of King Grass for the control was 7.93 kg/m2 in green matter, which was the fundamental factor from an agronomic point of view mentioned by Sánchez and Álvarez (2003), and also in relation to the effects of fertilization, Ramos (1979).

The higher the application of fertilizer, the lower the yield, thus complying with the minimum law or limiting factors mentioned by Serrano (2005) and Pedro (1992).

As reported by Arias (2012), in his study he analyzed three varieties of Pennisetum sp., among them INIAP-811, where at 30 days he reached an average biomass of 7.91 (kg/m2), being this value LESS than T3 with 5.0 (kg/m2), of this research, this is because the two investigations were conducted in dry season and rainy season.

Peña (2018) Peru, mentions that the 45 days of INIAP-811 grass, reached an average biomass of 12.75 (kg/m2), being SUPERIOR to T1 which obtained an average biomass of 10.8 (kg/m2), this is due to the fact that Peña's research was conducted in dry season in Peru.

León (2018), mentions that the forage potential of this genus of cut-and-carry type pasture in forage yield at 60 days with nitrogen fertilization of 131.42 (kg/ha), being this value LOWER than T3 that obtained an average biomass of 7875 (kg/ha), in the research presented. This is due to the fact that 8cc of biofertilizer was applied to this treatment.

Nutritional variable of the pasture

Table 5 shows that Lujano's T2R1 obtained a good relationship between the percentage of PB (16.88%) and FC (30.9%), the best relationship among its cosehca ages. For Rodriguez, the best

percentage ratio was obtained by T3R1 with 16.31% PB and 29.90% FC.

Table 5. *Nutritional comparison of PB and FC (%).*

DAYS	TREATMENT /REPETITION	PB		FIBER %	FIBER %
		LUJANO	RODRIGUEZ	LUJANO	RODRIGUEZ
	T1 (R1)	13,13	13.01	29,1	30.80
30	T2 (R1)	16,88	16.06	30,9	31.02
	T3 (R1)	14,38	16.31	30,8	29.90
	T1 (R2)	11,73	11.72	34,6	34.20
45	T2 (R2)	14,56	14.96	34,3	34.17
	T3 (R2)	13,91	14.06	36,41	35.02
	T1 (R3)	10,88	9.00	37,2	36.72
60	T2 (R3)	11,07	12.50	36,8	38.02
	T3 (R3)	10,5	11.81	39,02	37.89

Source: AGROLAB (2021).

Peña (2018), mentions that the protein of INIAP-811 grass, at 30 days is 14.28% being this value LOWER than T3, which reached an average protein of 16.31%; this is due to the fact that the research did not use biofertilizer.

As reported by Arias (2012), in his study he analyzed three varieties of Pennisetum sp., among them INIAP-811, he reported that the grass protein obtained an average of 14.42 % at 45 days, the result is SIMILAR to treatment T2 which obtained 14.96%; and this can be attributed, to the fact that the research was conducted in the summer season and biofertilizer was not applied.

The average ash content found in the present investigation is 15.16 at 45 days and 16.07% at 60 days, being HIGHER than that reported by Guerrero (2012) in a study with purple King Grass carried out in the Ponce Enriquez canton, Azuay province, where average values of 13.81 and 12.56 % were found for ages 45 and 60, respectively.

Conclusions

For the height of King Grass Purple, T3 at the age of 60 days reached the greatest height of 243.27 cm and for INIAP 811, T2 at the same age reached a height of 193.13 cm. This result shows that the higher the dose of fertilizer applied and the higher the age of the grass, the greater the plant height. Regarding the leaf-stem ratio, the best results were obtained at 30 days of age in King Grass Morado, with T3 of 3.10:1 and for INIAP 811, its T3 with 2.05:1, probably due to the fact that the greater the height of the plants, the formation of structural fiber is favored, decreasing the length of the leaf and increasing the length of the stem, the opposite case with young plants.

When evaluating the biomass production variable, we noticed that King Grass Morado obtained a higher production of green matter at T2 with 47.40 kg/m2. Similarly for INIAP 811, with its T3 with 24.70 kg/m2, both at 60 days of age; this leads us to the conclusion that the recommended application of the biofertilizer is beneficial for increasing the number and width of leaves in the grass. Under the conditions in which this work was carried out, and based on the results obtained, it can be concluded that, in nutritional quality, T2R1 of Lujano (King Grass Morado), obtained a good relationship between the percentage of PB of 16.88% and FC 30.9%, at 30 days, the best relationship between their harvest ages. For Rodriguez (INIAP 811), the best percentage ratio was obtained with T3R1 with 16.31% PB and 29.90% FC, same age (30 days). Obtaining good nutritional content and quantity of biomass, thus being a good alternative for use in the feeding of ruminants in different farms in the region.

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