SHORT NOTE [NOTA CORTA]

Tropical and Subtropical Agroecosystems

AGRONOMIC EVALUATION AND CHEMICAL COMPOSITION OF AFRICAN STAR GRASS (*Cynodon plectostachyus*) IN THE SOUTHERN REGION OF THE STATE OF MEXICO

[EVALUACIÓN AGRONÓMICA Y COMPOSICIÓN QUÍMICA DEL PASTO ESTRELLA DE ÁFRICA (*Cynodon plectostachyus*) EN EL SUR DEL ESTADO DE MÉXICO]

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SUMMARY

African Star Grass is one of the forage resources most commonly used by farmers in regions with warm-humid climates. This study was carried out to determine the nutritional and agronomic characteristics of African Star Grass *(Cynodon plectostachyus)* through the following variables: crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), organic matter digestibility (OMD), net forage accumulation (NFA), stem:leaf ratio, and live:dead matter ratio in the three pastures evaluated. The work took place from April 2007 to March 2008, with evaluations carried out on a monthly basis. The data were analyzed in a randomized block design in which the blocks were the pastures, and the treatments were the months of evaluation. There were no differences between the pastures evaluated for the NDF, ADF or OMD (P>0.05). Differences were found, however, in CP, while in the monthly evaluation, differences were found between the periods evaluated (P<0.05) for these variables. Differences were also found in the agronomic evaluation of pastures (P<0.05) among height of pasture, net forage accumulation (NFA), live matter, dead matter, leaf and stem, both among pastures and in the monthly evaluations. African Star Grass can therefore be considered a good choice for milk production systems in the southern region of the state of Mexico, due to its nutritional and agronomic characteristics.

Key words: Pasture; agronomy; nutritional characteristics.

RESUMEN

El pasto estrella de áfrica es uno de los recursos forrajeros más utilizados por los productores en regiones con climas cálidos-húmedos. El objetivo fue determinar las características nutricionales y agronómicas del pasto estrella de áfrica (*Cynodon plectostachyus*), a través de las variables: proteína cruda (PC), fibra detergente neutro (FDN), fibra detergente ácido (FDA), digestibilidad de la materia orgánica (dMO), acumulación neta de forraje (ANF), relación tallo-hoja y la relación de material vivo-muerto en las tres praderas evaluadas. El trabajó se realizó de abril de 2007 a marzo de 2008, realizando evaluaciones mensuales. Los datos se analizaron mediante un diseño de bloques al azar, donde los bloques fueron las praderas y los tratamientos fueron los meses de evaluación. No se encontró diferencias entre las praderas evaluadas para las variables FND, FAD y dMO (P>0.05), sin embargo si se encontraron diferencias en PC, en la evaluación mensual, se encontraron diferencias entre los periodos evaluados (P<0.05) para estas variables. En cuanto a la evaluación agronómica de las praderas se encontraron diferencias (P<0.05) entre altura de la pradera, acumulación neta de forraje (ANF), material vivo, material muerto, hoja y tallo, tanto entre las praderas como en la evaluación por mes. Se concluye que el pasto estrella de áfrica representa una opción buena para los sistemas de producción de leche en el sur del Estado de México, debido a las características nutricionales y agronómicas que se obtuvieron en este trabajo.

Palabras clave: Pradera; agronomía; características nutricionales.

INTRODUCTION

Despite the enormous amount of forage resources existing worldwide, livestock production in the Latin American tropics faces serious problems related to the availability, quality and productivity of pastures, consisting mainly of native, improved and naturalized grasses with low productive potential. During the dry season and droughts, forage production fails to satisfy the nutritional requirements of livestock for maintenance, growth and milk production, particularly in semitropical regions such as the southern part of Mexico State (Romero *et al*., 2004).

Grass constitutes the nutritional basis for cattle herds in the tropics (Elizondo and Boschini, 2003). However, during the dry season, the supply and quality of dry matter are unable to meet the minimal requirements for grazing animals (Razz and Clavero, 1997). During the dry season, tropical grasses are characterized by high structural carbohydrate content, low soluble carbohydrate content and less than 7% protein (Hernández *et al.,* 2005; Hess *et al.*, 1992 and Skerman *et al*., 1992). This is due to the prevailing climate conditions where they grow, particularly the high degree of solar radiation, meaning they lignify rapidly while their digestibility drops to below 55% (Van Soest, 1994; Hess *et al.,* 1992). In general terms, the production obtained from livestock fed on tropical grasses is limited by the relatively low digestibility of the latter and the low consumption of dry matter (Ørskov, 2005). An increase in the digestibility of potentially digestible fractions or in the rate of passage of non-digestible fractions is a strategy for achieving a significant increase in the consumption of digestible nutrients (Pinzón and Montenegro, 2001).

African Star Grass is a forage species that has been established and has persisted in pastures in the Mexican tropics and currently occupies a large area of the latter. Its growth dynamics are characterized by a rapid elongation of stolons, production and death of leaves, meaning that after three or four weeks, after cutting or grazing, dead lignified plant matter (consisting mainly of leaves and stems) not consumed by cattle, begins to accumulate. These characteristics mean that the grass requires intensive management, with paddocks being rotated with short periods of occupation and rest (3-5 and 21-28 days, respectively) that will vary according to the time of year (rainy or dry season) in order to make the most of its productive potential (Hernández *et al*., 2005). In the southern region of the state of Mexico, farmers do not have a well-defined management system for their Star Grass paddocks, making it impossible to determine its type of growth and productive potential. The aim of this study was therefore to evaluate the production and chemical composition of African Star Grass pastures in the southern part of Mexico State.

MATERIAL AND METHODS

Location of experimental site

This study was carried out in the community of Rincón de Aguirre, in the municipality of Tejupilco, located in the southeast region of Mexico State. It lies between 18º45´30” and 19º04´32” north, and 99º59´07” and 100º 36´ 45” west, at 1,340 m.a.s.l. The soil in this municipality has moderate to high fertility (Carta Estatal de Regionalización Fisiográfica, 1980). The experiment was carried out in small-scale milk production systems located in the southern part of Mexico State, specifically in three production units, two of which are classified as small production units, while the other belongs to the group of large production units, according to the classification drawn up by Hernández (2008). The pastures were studied over a period of one year, from April 2007 to March 2008.

Pasture Characteristics

Three paddocks sown with African Star Grass, with an approximate area of one hectare each, and continuous grazing by Holstein cows, were used. Six exclusion cages were randomly placed in each paddock, according to the method proposed by Hodgson (1994) to measure NFA. Since the cages were adapted to the growth and size of the grass, the cages, measuring 1.0 m high, 1.20 m long and 0.60 m wide, were bigger than those used by Hodgson (1994). Every 28 days, grass inside and outside the cage was cut. A 1.20 x 0.60 m quadrant was used to cut the forage inside the quadrant. The agronomic variables evaluated were: height, net forage accumulation, live:dead ratio and stem:leaf ratio in addition to the chemical analyses and digestibility of African Star Grass.

Pasture Height

The pastures were measured every 28 days using the rising plate technique described by Hodgson (1994). Measurements were taken every 20 steps with 30 zigzag measurements carried out in each paddock.

Net Forage Accumulation (NFA)

Six exclusion cages were placed in each paddock. The pasture was cut every 28 days using a 0.72 m^2 quadrant. On the day of the measurement, the cage was placed randomly in the pasture. Afterwards, five height measurements were randomly carried out next to the cage, making sure the characteristics of the area to be measured were similar to those of the area excluded by the cage. The 0.72 m² cage was then placed on the ground and all the forage inside the quadrant next to the exclusion cage was then cut down to ground level using sheep shears.

On day 28, the cage was removed and five height measurements were carried out inside the exclusion cage and the forage was cut down to ground level using the same quadrant. The procedure was repeated during the next 11 periods. The cut matter was weighed fresh and placed in previously labeled plastic bags to be sent to the laboratory and processed. NFA was calculated using the following formula: NFA=Initial average weight of available dry matter outside the cage on day zero-final average weight of dry matter inside the cage on day 28.

Live-Dead Ratio

Samples were taken from three of the six exclusion cages to determine the live:dead ratio. Twenty-five grams of the sample were weighed while the live matter was separated from the dead matter and weighed separately. Green matter was regarded as live matter, while matter without this coloring was regarded as dead.

Stem-Leaf Ratio

In order to obtain the stem:leaf ratio, a sample was taken from each of the three exclusion cages per paddock. A compound sample was subsequently obtained, and 25g were weighed. The stems were separated from the leaves and each weighed separately. This procedure was also carried out every 28 days.

Chemical Analysis

Samples of African Star Grass were obtained using Langland's simulated grazing technique (Langland, 1974). This involves hand plucking the forage to a similar height to that produced by grazing cattle. These samples were dried in a stove at 60º until constant weight was obtained. Samples were ground up and the amount of dry matter, ashes and organic matter was determined. Organic Matter Digestibility was calculated using the Daysi-ANKOM method while the nitrogen content was obtained using the Kjeldahl method (AOAC, 1984). The result was multiplied by a factor of 6.25 (AFRC, 1993) to obtain the amount of crude protein (CP). The amount of neutral detergent fiber (NDF) and acid detergent fiber (ADF) was determined using the ANKOM method described by Holden (1999) and using the Van Soest *et al*. (1994) technique.

Experimental Design

A randomized block experimental design (Steel and Torrie, 1997) was used, in which the blocks were the paddocks and the treatments were the months of evaluation. The variables analyzed were proximal chemical analysis, Net Forage Accumulation, live:dead ratio and stem:leaf ratio. The general linear model used was as follows:

$Y_{ij} = \mu + t_i + B_{ij} + t_j + e_{ijk}$

Where:
Y_{ij}= Variables response
μ= General mean
B_{ij}= Block effect (j= 1, 2, 3)
t_j= Treatment effect (i= 1,2, 3…12)
$\boldsymbol{e_{ij}}$= Random error

Statistical Analysis

The results were analyzed using analysis of variance and expressed in means with their respective standard error. The statistical differences between the means ($P<0.05$) were determined through a Tukey test; the Minitab Statistical Package (version 14) (2000) was used.

RESULTS AND DISCUSSION

The climate in the study zone is classified as A (C) wg, semi-hot with summer rains. The climate diagram (Figure 1) shows the temperatures and rainfall registered from April 2007 to March 2008 in the area where the experiment was carried out.

Table 1 shows the average values of the main characteristics of star grass by pasture. Significant differences were observed for the average CP content ($P<0.05$) but not for the rest of the variables evaluated. The higher CP content observed in Pasture 2 may be due to the fact that these farmers sometimes uses 100 kilos of urea per hectare/year to fertilize his pastures. The protein contents observed in this study are within the range reported in the literature. For star grass, González *et al*. (1996) found protein contents of 90 g/ kg DM. NDF and ADF contents are high but within the expected range for this type of tropical climate grass. Hernández (1995), for example, reports an average NDF content of 700 g/kg DM in star grass, while Fernández *et al.* (1991) report 456.3 g/kg DM of ADF for the rainy season and 442.3 g/kg DM for the dry season for the same grass, which is higher than the average annual values found in this study. Digestibility has relatively low values that are probably associated with the high levels of cell walls observed, since it is a well-known fact that there is a negative correlation between fiber content and digestibility (Weiss, 1993).

For example, Barajas *et al*. (1994) in Sinaloa report higher digestibility figures for African Star Grass organic matter than those found in this study, of 63.21%.

Nutritional and Agronomic Variables by Pasture

Table 2 shows the average agronomic variables for each of the months and in the case of NFA, annual accumulation is also presented. The average monthly height of Pasture 2 was significantly higher (P<0.05) than the other two, probably because it is the only one where fertilizer has been used, in addition to the fact that it is located in an area where there are virtually no slopes, so rainfall water and nutrients do not run away. Ramos *et al.* (1995) report that when pastures are fertilized, the grass grows higher. However, the average monthly and total NFA, live matter, dead matter, and the amount of stems and leaves are larger (P<0.05) in Pasture 3. This is due to the fact that the farmers cuts the grass in such a way that it encourages the emergence of new shoots, which therefore increases the amount of live matter, leaves and stems.

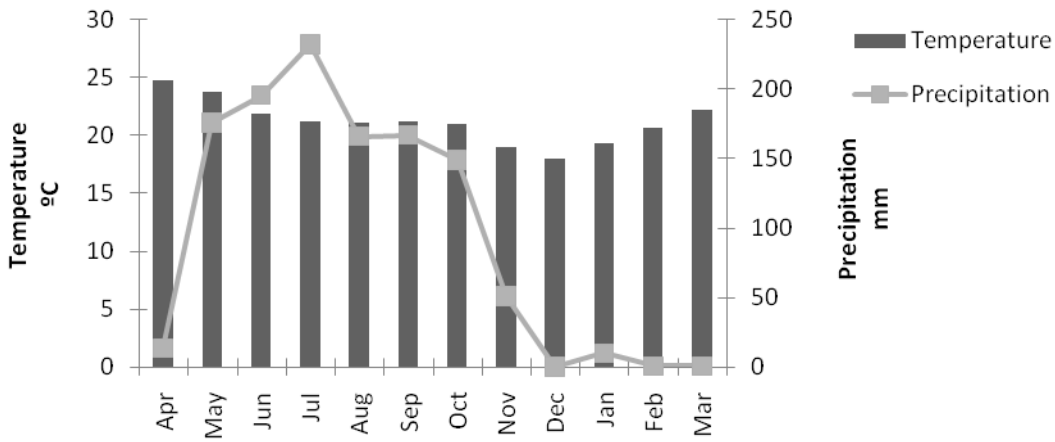

Figure 1. Average Temperature (°C) and Rainfall (mm) in Tejupilco, Mexico (April 2007 to March 2008).

Table 1. Chemical composition and digestibility of African Star Grass *(Cynodon plectostachyus)* in three pastures used in small-scale milk production systems in the southern region of Mexico State.

Variable	Paddock 1	Paddock 2	Paddock 3	P	SE
C. P. (g/kg DM)	82.80[a]	87.50[b]	83.10[a]	0.01	1.11
NDF (g/kg DM)	695.00	694.50	698.70	0.89	8.6
ADF (g/kg DM)	337.00	336.60	328.20	0.59	6.8
OMD (g/kg DM)	538.80	537.60	541.00	0.32	1.59

Means and standard error of the mean (SE) with different superscript ([a,b]) between the rows indicates significant differences (P<0.05)

Table 2. Average monthly agronomic variables of African Star Grass (*Cynodon plectostachyus*) in three pastures used in small-scale milk production systems in the southern region of Mexico State

Variable	Paddock 1	Paddock 2	Paddock 3	P	SE
Height (cm)	8.61[a]	12.86[b]	8.66[a]	<0.00	0.63
NFA (DM kg/ha/month)	728[a]	1098[b]	1193[b]	0.007	49.03
NFA (DM kg/ha/year)	8746	13170	14313	-	-
Live matter (DM kg/ha)	877[a]	938[a]	1433[b]	0.05	37.99
Dead matter (DM kg/ha)	398[a]	372[a]	706[b]	0.04	11.66
Leaf (DM kg/ha)	610[a]	577[a]	963[b]	0.04	7.59
Stem (DM kg/ha)	721[a]	674[a]	1052[b]	0.05	7.60

Means and standard error of the mean (SE) with different superscript ([a,b]) between the rows indicates significant differences (P<0.05)

Nutritional Variables Per Period

The nutritional content of African Star Grass is conditioned by climate factors, particularly rainfall. This can be seen in Figure 2, in which the amount of crude protein during the rainy months (June to October) is greater than during the dry season ($P<0.05$). This tallies with what has been reported by Macedo (2000). For Sánchez and Soto (1996), good quality tropical grass must have more than 70g/kg DM of CP. This study shows that between January and May, the grass fails to meet these criteria. The contents reported in this research are halfway between those reported by Cabrera *et al*. (2005) with 56 g/kg DM and those of Sánchez *et al.* (1998) with 103 g/kg DM during the dry season and 117 g/kg DM during the rainy season.

There were differences in NDF content (Figure 2) in the months evaluated ($P<0.05$), since it tends to decline as a result of precipitation, while the grass begins to grow once the rainy season begins. NDF content is important since, according to Van Soest (1994), it is the structural factor most closely related to the reduction of consumption insofar as it increases its content in plants; Herrera (1984) has also noted that NDF content increases with the age of the grass. Macedo (2000) found NDF values close to 800g/kg DM and 550 g/kg DM for ADF, which are higher than those reported in this study. As from November, star grass begins a period of senescence due to the fact that NDF and ADF contents increase while the digestibility of organic matter decreases. González *et al.* (1996) and Ramos *et al*. (1995) report similar low digestibility rates, with 450 and 443 g/kg DM, respectively.

Agronomic variables by period

Agronomic variables (Figure 3) show that NFA is conditioned by rainfall. It rises from May to October and falls from November onwards ($P<0.05$). Total forage production was 12.75 tons DM/hectare/year, which is approximately half (23.1 t DM/ha/year) of that reported by Ramírez (1997). The stem:leaf ratio in grasses is also marked by the amount of rain, since the amount of leaf is greater from May to October and decreases from November to April, while the reverse is true of stems (Figure 1 and 3). Pozo *et al*. (1984) reported a production level of 3371.9 Kg/ha/year for stems and 2118.3 Kg/ha/year for leaves, during the rainy season, different from the yields found in this study which were 4415.06 kg/ha/year for stems and 2767.78 kg/ha/year. Herrera (1984) also noted a drop in leaf production during the period of lower precipitation.

Live and dead material in the pasture is related to the new accumulation of forage as accumulated forage blocks light to old material and promotes its death. There is an increase in dead matter at the end of the rainy season, while total forage production generally drops during the dry season. Pozo *et al.* (2000) reported a similar percentage of dead matter (20.7% to 27.4%) to that found in this study, which was 21%.

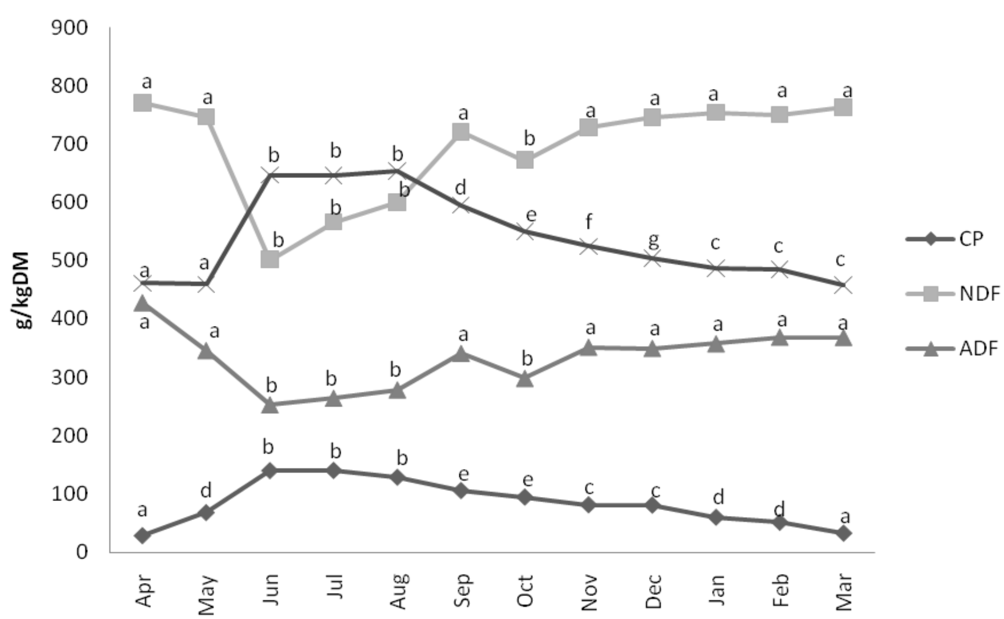

Figure 2. Nutritional variables per period of African Star Grass (*Cynodon plectostachyus*) in small-scale milk production systems in the southern region of Mexico State. Different literals between lines show significant differences ($P<0.05$)

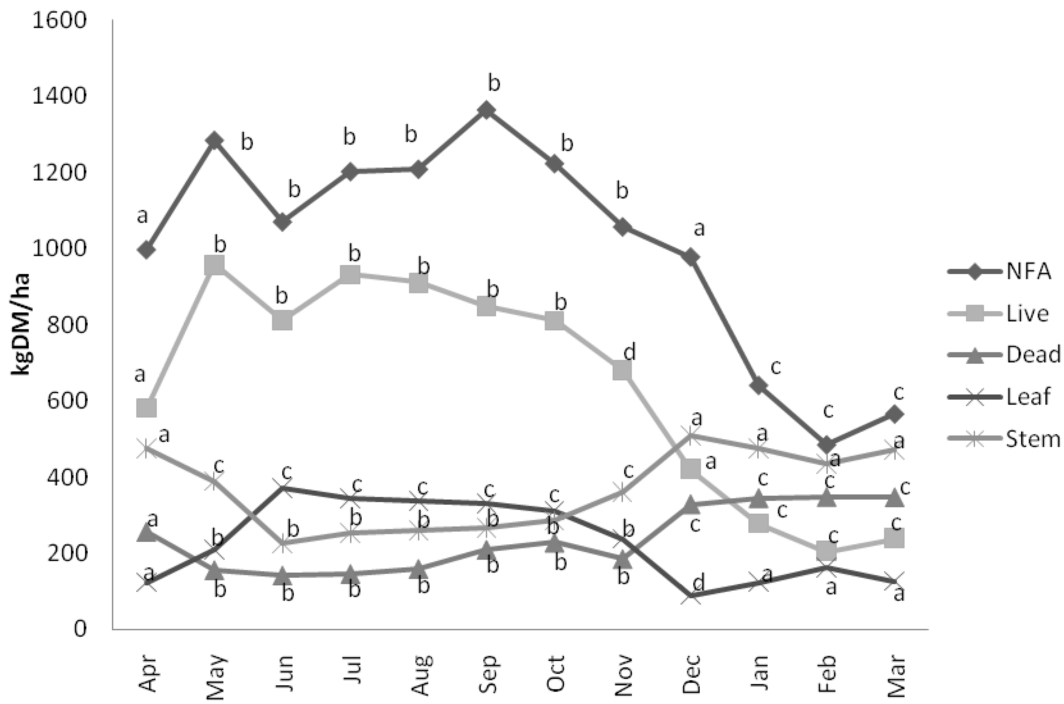

Figure 3. Agronomic variables per period of African Star Grass (*Cynodon plectostachyus*) in small-scale milk production systems in the southern region of Mexico State. Different literals between lines show significant differences (P<0.05)

One of the climate variables that have direct effects on NFA is precipitation (Figure 4); this variable increases in line with precipitation. During the months when precipitation is virtually nil, NFA drops considerably. Precipitation is the variable with the greatest influence on NFA since the humid tropics in Mexico have the highest rainfall in the country. Meléndez *et al.* (2000) reported African star grass production of 21.38 t/ha, nearly twice that found in this study, which covers an area that is part of the dry tropics.

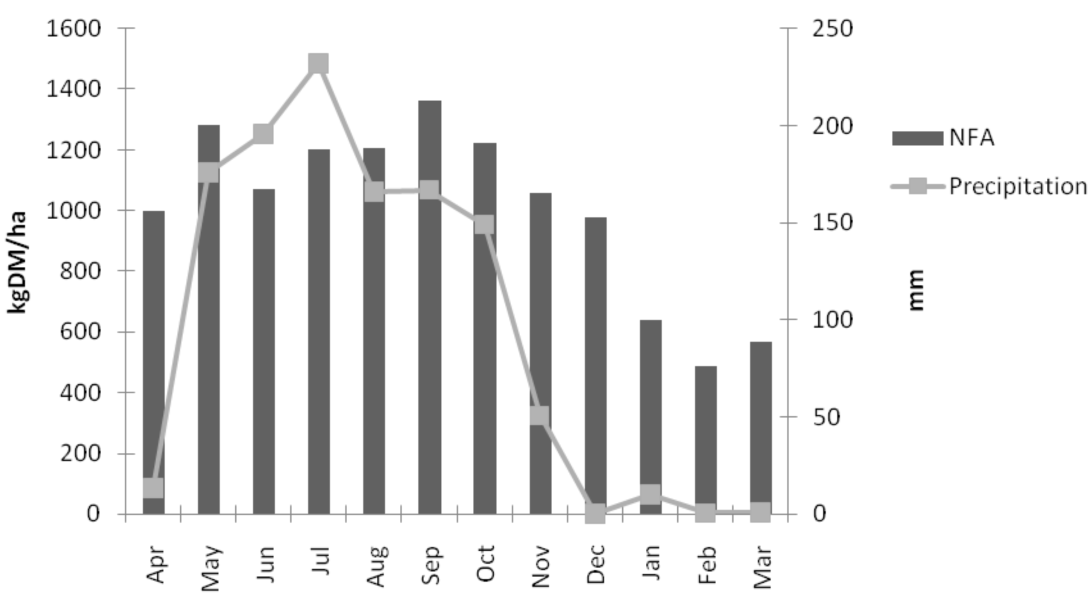

Figure 4. Ratio of net forage accumulation of African Star Grass Forage *(Cynodon plectostachyus)* to precipitation in small-scale milk production systems in the southern region of Mexico State

Figure 5 shows the influence of temperature on the growth of star grass. Constant temperatures (June to October) coincide with the greatest NFA, although precipitation, as mentioned, is more relevant (Figure 4). The highest temperature is also observed in April when NFA is also low in comparison with the months of constant temperatures that coincide with the rainy season.

CONCLUSIONS

The nutritional quality of grass is basically determined by the amount of rain, and one can see that CP and OMD contents are greater than during the dry season. However, one should also consider the way farmers manage pastures, since this is essential to obtaining higher forage accumulation and providing more forage for livestock. Irrigation opens a window for production of good quality forage throughout the year since, as demostrated, water is the most important variable that drives Star Grass yield and quality. The temperature is fairly constant throughout the year. In NFA terms, star grass is a good choice, since compared with other grasses in the region, it has greater production than *Axonopus compressus* and *Paspalum notatum*.

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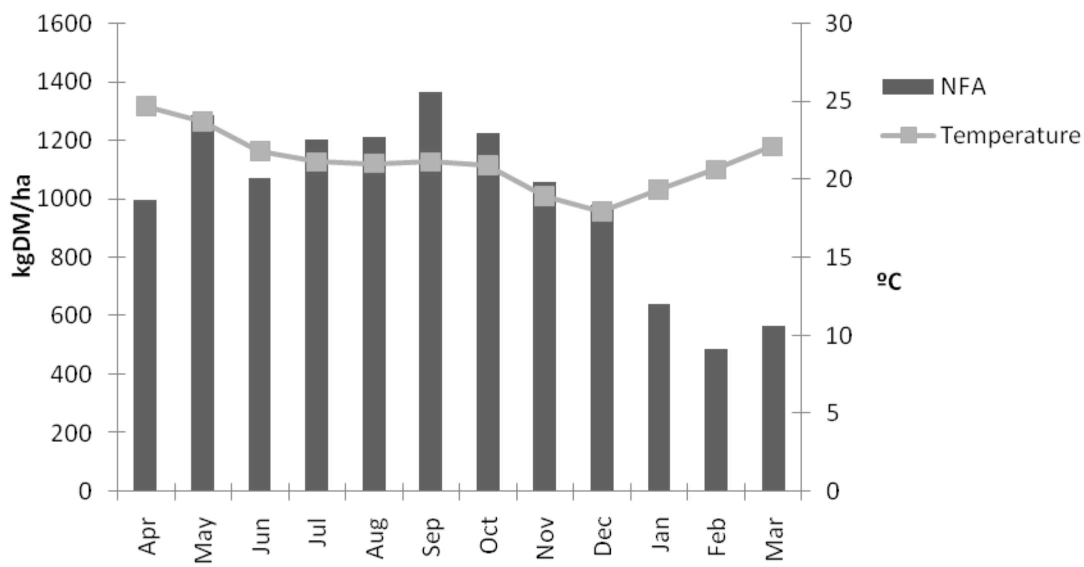

Figure 5. Ratio of net accumulation of African Star Grass forage (*Cynodon plectostachyus*) to temperature in small-scale milk production systems in the southern region of Mexico State

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