PRODUCTIVE PARAMETERS FOR MARANDU PALISADEGRASS IRRIGATED IN MONOCROP AND OVERSEEDED

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ABSTRACT: The production of meat and milk are of utmost importance for the national economy, with pastures being the principal source of cattle feeding. The seasonality of production and the irregularity of rain are relevant themes of studies on techniques that bypass these problems in the livestock sector. In this sense, the aim of this study was to evaluate the productive parameters and the water productivity of Marandu grass irrigated in a monocrop with overseeding during the fall/winter period. The experiment took place in Piracicaba-SP over the course of a year and included productive cycles of Marandu palisadegrass irrigated in a monocrop, in a crop overseeded with black oat and ryegrass (MBOR), and in a crop overseeded with cereal rye and ryegrass (MCR). The following factors were estimated: total forage productivity, litter production, leaf area index, forage canopy height, and water productivity. It was possible to identify that overseeding and irrigation contributed to reducing the effects of seasonality, obtaining productive values close to the those for the spring/summer cycles, with the MBOR set being the more productive and efficient at consuming water.

KEYWORDS: Pastures; Seasonality; Water productivity.

PARAMETROS PRODUTIVOS DO CAPIM MARANDU IRRIGADO EM CULTIVO SOLTEIRO E SOBRESSEMEADO

RESUMO: A produção de carne e leite são de suma importância para a economia nacional, sendo as pastagens a principal fonte de alimentação bovina. A estacionalidade de produção e a irregularidade de chuvas são relevantes temas de estudos de técnicas que contornem estes problemas do setor agropecuário. Nesse sentido, o objetivo deste trabalho foi avaliar os

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parâmetros produtivos e a produtividade de água do capim Marandu irrigado em cultivo solteiro com realização de sobressemadura no período de outono/inverno. O experimento foi realizado em Piracicaba-SP durante o período de um ano e abrangeu ciclos produtivos de capim Marandu irrigado em cultivo solteiro (MS), em cultivo sobressemeado com aveia preta e azevém (MAA) e em cultivo sobressemeado com centeio e azevém (MCA). Foram estimados a produtividade total de forragem, produção de material morto, índice de área foliar, altura do dossel forrageiro e produtividade de água. Foi possível identificar que a sobressemeadura e a irrigação contribuíram para reduzir os efeitos da estacionalidade, obtendo valores produtivos próximos aos de ciclos do período primavera/verão, sendo o conjunto MAA o mais produtivo e eficiente no consumo de água.

PALAVRAS-CHAVE: Pastagens; Estacionalidade; Produtividade de água.

INTRODUCTION

Pastures play an important role in the production of cow meat in Brazil, being considered the food base for ruminants. Among several varieties of forages in Brazil, *Urochloa brizantha cv. Marandu* (*Syn Brachiaria brizantha* cv Marandu) stands out for its productivity and forage quality. The grass is commercialized and accounts for roughly 70% of the total volume of seed sales among various species, including exportation to the rest of Latin America (MACEDO *et al.*, 2013).

Keeping in mind the importance of continuously increasing agricultural productivity to meet the demand for food, studies on techniques to minimize seasonal effects and rain precipitation irregularity are of the utmost importance to farming. Among these studies and techniques are those related to pasture irrigation. Irrigation is one of the techniques that consists of providing water at the appropriate time and in the quantity required by the plant, reducing the differences in productivity throughout the year (VELOSO, 2012). Another technique aimed at reducing seasonal effects on forage production, especially in the central-south region of Brazil, is overseeding. This consists of introducing species adapted to cold climates and to low intensity sunlight into a pre-established cover of forage, with the goal of improving productive performance in the fall/winter period (BERTOLOTE, 2009).

In this context, it is necessary to have knowledge of the interactions between different species adapted to winter with a tropical forage, as well as the productive gains achieved through the techniques of overseeding and irrigation. Therefore, the aim of this study was to evaluate the productive parameters and the water productivity of Marandu palisadegrass irrigated in a monocrop with overseeding during the fall/winter period.

MATERIALS AND METHODS

The experiment was conducted between September 2017 and September 2018 in an experimental area of the Luiz de Queiroz College of Agriculture (ESALQ/USP), in Piracicaba – SP, located at latitude 22º14'02" S and longitude 47º37'23" O, the regional climate was classifed Cwa (rainy summer and dry winter) (ALVARES *et al.*, 2013). The experimental area was divided into two 12 x 12 m parcels, in witch Marandu palisadegrass has been planted since 2016. Both plots had exclusive Marandu palisadegrass cultivation in the spring and summer period. In the fall/winter period, overseeding was conducted with black oat and ryegrass (MBOR) in one plot; the other parcel was overseeded with cereal rye and ryegrass (MCR). The sowing rate of winter crops were 100 kg $ha^{-1}$of black oat and cereal rye and 50 kg ha^{-1} of ryegrass.

The irrigation system utilized in the experiment was a standard sprinkler, with spacing of 12 x 12 m and a flow rate of 1.64×10^{-3} m^3 s^{-1}, with a watering schedule that varied in accordance with the crop's water consumption, measured by weighing lysimeters installed in the plots. The lysimeters were composed of a circular, rigid PVC box, with a diameter of 1.22 m, height of 0.58 m and a volume of 500 liters, with brick walls 0.12 m thick for withstanding the surrounding soil.

The experimental used a completely randomized design, considering the productive cycles as treatments. The evaluations were done at the end of each growth cycle (GC), with six GCs lasting 28 days in the spring/summer period, one 35-day GC in the fall, and three GCs lasting 42 days in the fall/winter period for each overseeded set. The productive parameters studied were forage canopy height (FCH), leaf area index (LAI), total forage production (TFP), litter production (LP), and water productivity (WP).

The forage canopy height was obtained by means of a ruler graduated in cm, measuring the height from the last expanded leaf to the soil. The forage LAI was estimated by means of a C Plant Canopy Analyzer, model LAI-2000 (LI-COR®), in hours with little solar radiation, as cited by Sanches (2017) and Souza (2017).

The phytomass accumulated was obtained at the end of each cycle using a randomly placed square sampler with an area of 0.25 m^2, cutting the forage at a height of 0.15 m. After, the forage was separated into dead and alive material, and the fresh and dry weights were estimated in kg ha^{-1}. To determine the mass of the dry material (kg ha^{-1}), the samples were placed in a forced circulation oven for 72 hours at 65º C. After this procedure, the Total Forage Production (TFP) and litter production (LP) were estimated.

Water productivity was calculated by taking the ratio between the TFP and the crop evapotranspiration (equation 1), determined by means of a weighing lysimeter, in accordance with Sanches (2017).

$$WP = \frac{TFP}{10(ETc)} \qquad (1)$$

In which:

WP – Water Productivity, (Kg DM m^{-3});

TFP - Total Forage Production in each cycle, (Kg DM ha^{-1}); and

ETc – Crop Evapotranspiration determinated by weighing lysimeter (mm $cycle^{-1}$).

The data were subjected to an *F*-test variance analysis ($p \leq 0.05$) and, when significant, the measurements were compared by means of a Tukey Test ($p \leq 0.05$) by using SISVAR software (FERREIRA, 2008).

RESULTS AND DISCUSSION

During the experimental period the rain precipitation was 977.3 mm, below the annual historic average 1275.5 mm in the region of Piracicaba. It was necessary the water supply by irrigation of 471.1 mm in the plot 1 and 399.6 in the plot 2; emphazing the difference in water requirement was due the winter forage crop evapotranspiration during autumn and winter. The temporal distribution of rain precipitation, average and mininum air temperature, can be observe in the Figure 1:

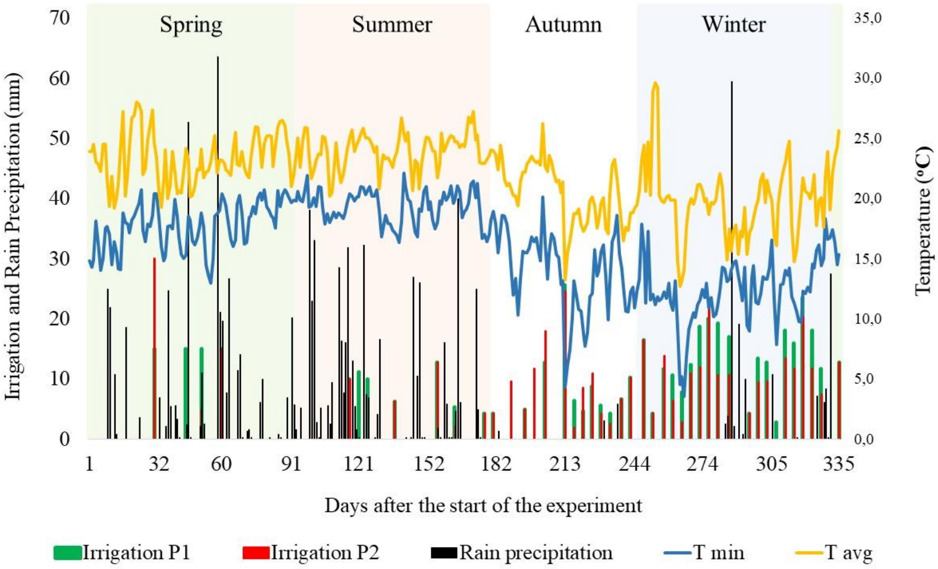

Figure 1. Rain precipitation value (mm), average air temperature (T avg, ºC) and minimun air temperature (T min, ºC) during the experimental period 09/2017 to 09/2018. Piracicaba: Irrigation P1 = irrigation in the plot 1, in the winter with Marandu palisadegrass + Black Oat + Ryegrass; Irrigation P2 = irrigation in the plot 2, in the winter with Marandu palisaderass + Cereal Rye + Ryegrass.

The results of the productive parameters and water productivity of the Marandu grass in a monocrop are shown in Table 1.

Table 1. Data measured per forage productive cycle, litter production, forage canopy height, leaf area index, and water productivity of Marandu palisadegrass in a monocrop. Piracicaba – SP, 2017/2018.

Cycle	Dates	TFP (kg DM ha^{-1})	LP (kg ha^{-1})	FCH (cm)	LAI	WP (kg DM m^{-3})
1	sep-oct	2637,55 cd	34,30 c	38,10 b	1,63 c	3,17 b
2	oct-nov	3732,65 a	64,25 bc	41,30 b	3,30 b	4,50 ab
3	nov-dec	2678,85 bcd	71,65 bc	41,30 b	4,24 ab	3,21 b
4	dec-jan	3377,65 ab	61,05 c	58,60 a	4,44 ab	5,15 a
5	jan-feb	2947,30 bcd	155,15 ab	57,30 a	4,92 a	3,12 b
6	feb-mar	2307,00 c	27,35 c	56,25 a	4,64 ab	3,94 ab
7	apr-may	1068,95 d	240,85 a	39,55 b	3,34 b	1,31 c

*lowercase letters distinguish between lines

The largest productive parameter values occurred in the 2nd and 4th cycles, which differ significantly from the other cycles. It is worth noting that precipitation events during these cycles were the largest that occurred during the study period. It was observed that the liquid radiation and the photoperiod were sufficient for the culture to achieve its best performance. Souza (2017) conducted experiments with Marandu palisadegrass in the Piracicaba/SP region and verified that the highest production among seven productive cycles, approximately 2,500 kg ha^{-1}, occurred at the beginning of spring, similar to what occurred in this study.

In the 7th cycle (fall period) there was a decline in the productive parameters due to the lower photoperiod and the reduction in average temperatures. Alencar *et al*., (2013) measured the forage production of Marandu palisadegrass in the spring/summer and fall/winter periods and observed a difference in productivity between 49.5% and 53.9% in increasing drops in nitrogen.

Lowest values of LAI and FCH were observed in the cycles 1 and 7. In the first cycle occurred a measurement error with the sensor, resulting a value below the expectation. In the 7th cycle, there was a drop in the value of LAI and FCH, in reason of photoperiod reduction and decrease of air temperature. Gomide *et al*., (2009) observed the same effect in Marandu grass, in which, obtained a LAI = 3.1, in a seasonality period.

In relation of water efficiency use, Marandu palisadegrass presented a WP between 1.31 and 5.15 kg DM m^{-3}. The values were near in comparison to observed by Lopes et al., (2014), in an irrigated *Urochloa decumbens* experiment, in which, obtained a WP between 2.2 and 4.4 kg DM m^{-3}.

The results of the productive parameters and the water productivity for the Marandu palisadegrass in different overseeded sets are presented in Table 2. The 8th cycle occurred between the months of May and June, the 9th cycle occurred between the months of July and August, the 10th cycle occurred between the months of August and September.

Table 2. Data measured per forage productive cycle, litter production, forage canopy height, leaf area index, and water productivity for Marandu palisadegrass mixed with black oat and ryegrass (MBOR) and with cereal rye and ryegrass (MCR).

Cycle	MBOR				
	TFP (kg DM ha^{-1})	LP (kg ha^{-1})	FCH (cm)	LAI	WP (kg DM m^{-3})
8	1171,70 b	51,70 b	40,20 c	5,09 b	1,39 b
9	2597,20 a	747,60 a	54,80 b	5,25 ab	2,78 a
10	3246,30 a	468,40 a	62,30 a	5,70 a	3,14 a
Average	2338,40	422,57	52,43	5,35	2,44
	MCR				
	TFP (kg DM ha^{-1})	LP (kg ha^{-1})	FCH (cm)	LAI	WP (kg DM m^{-3})
8	898,40 b	11,73 c	53,60 b	4,26 c	0,99 b
9	2324,70 a	950,60 a	74,40 a	5,97 a	2,17 a
10	2926,80 a	437,20 ab	72,10 a	5,67 b	2,73 a
Average	2049,97	466,51	66,70	5,30	1,96

* lowercase letters distinguish between lines

It can be observed that the average of the fall/winter productive cycles with overseeding approached those of the spring/summer period, especially the MBOR grass cover which adapted better to the local climate of the region. The TFP results were similar to those found by Souza (2017), who obtained values between 1.200 and 2.700 kg DM ha^{-1} in five cycles of Marandu palisadegrass mixed with black oat and ryegrass in the Piracicaba – SP region.

In relation to FCH, the forage set MCR presented greater values than MBOR. Gralak et al (2014) estimated a FCH = 41.2 cm, similar than observed in this work. As the duration of each cycle was 42 days, there were tillers in the flowering phase and presented high heights, mainly in the rye and ryegrass.

The LAI results of this work were similar than Gralak *et al* (2014) obtained LAI = 4.75 in a forage set with 50 % Black oat and 50 % ryegrass, similar than observed in the cycle 8 and 9. Kottman (2015) estimated LAI for cereal rye in the north of Germany, obtained a value 4.9 utilizing the sensor SunScan canopy analysis system (Delta-T Devices, Cambridge, UK). In this work, the values of LAI estimated in three cycles were similar in comparison to this author.

Values of LAI were greater in the overseeded period than in monocrop, being the forage set MCR presented greater values than MBOR. One hypothesis for greater LAI in comparison to monocrop is the increase of LP in the winter when there is restriction in tropical forage growth, hence the raise of litter at the base of the canopy could influence at the measurement by the sensor as observed by Sibrissia and Silva (2008), in a forage experiment, in which, LAI-2000 overestimated measurement in forages in reason of litter excess.

In regards to water productivity (WP), the lowest values were found in the 8th cycle in both mixtures, with no significant difference between the 9th and 10th cycles. The water productivity results obtained, especially for the 8th and 9th cycles, approach those found by Neal *et al*., (2011), who estimated WP values between 0.95 and 2.5 kg DM m^{-3} in the fall/winter period in an oat and ryegrass mix. In the 10th cycle there were elevated WP values, from 2.73 to 3.14 kg DM m^{-3}. Sanches (2017) estimated an average value of 3.05 kg DM m^{-3} in a mix of Mombaça grass with black oat and ryegrass, in Piracicaba – SP, being an intermediate value close to that found in this study.

CONCLUSION

It can be observed in this study that irrigation and overseeding were techniques that increased the various productive parameters in the seasonal periods, obtaining values close to periods of higher sunlight and precipitation, with the Marandu palisadegrass mixed with black oat and ryegrass being the most productive and efficient at water consumption.

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