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Productivity of Tifton 85 grass irrigated and overseeded with winter forages

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ABSTRACT. Intercropping with cool season species has been used as an alternative to increase productivity off-season (fall/winter) of irrigated pastures. This study was conducted from May to October 2009 in Icaraíma, Paraná State, to evaluate the productivity and morphological composition of the Tifton 85 grass overseeded with winter forage in irrigated system. The experiment was a randomized block design with four replicates and repeated measures over time. The experimental plots consisted of five treatments, three as oats overseeding using the genotypes IAPAR 61, IPR 126, and FMS2 on Tifton 85 pasture and one as overseeding of oats combined with rye (IPR 126 + IPR 89) also on Tifton 85 grass and, finally, a control with only Tifton 85 without overseeding. The overseeding of IPR 126 oats achieved the highest cumulative productivity, 4102 kg DM ha^{-1}, with leaf/stem ratio higher than that of exclusive Tifton 85 exclusive, 1.77 and 1.08, respectively. However, overseeding of winter forages did not increase the overall productivity of the pasture.

Keywords: oats, rye, leaf/stem ratio, morphological composition.

Produtividade de pastagem de capim Tifton 85 irrigada e sobressemeada com forrageiras de inverno

RESUMO. A consorciação com espécies hibernais vem sendo utilizada como alternativa para aumentar a produtividade de entressafra (outono/inverno) das pastagens irrigadas. Este trabalho foi conduzido no período de maio a outubro de 2009, no município de Icaraíma, Estado do Paraná, com o objetivo de avaliar a produtividade e a composição morfológica do capim Tifton 85 com sobressemeadura de forrageiras de inverno em sistema irrigado. O delineamento utilizado foi de blocos casualisados com quatro repetições e com medidas repetidas no tempo. As parcelas experimentais foram implantadas por meio de cinco tratamentos, sendo três na forma de sobressemeadura de aveia, utilizando os genótipos Iapar 61, IPR 126, e FMS2 em pastagem de capim Tifton 85 e, um na forma de sobressemeadura de aveia em consórcio com centeio (IPR 126 + IPR 89), também em capim Tifton 85 e, por fim, um tratamento testemunha com apenas capim Tifton 85 sem sobressemeadura. A sobressemeadura com aveia IPR 126 obteve a maior produtividade acumulada, igual 4.102 kg MS ha^{-1}, com razão folha/colmo superior ao capim Tifton 85 exclusivo, iguais 1,77 e 1,08, respectivamente. No entanto, as sobressemeaduras de forrageiras de inverno não aumentaram a produtividade total da pastagem.

Palavras-chave: aveia, centeio, razão folha/colmo, composição morfológica.

Introduction

In Brazil, pastures are the main, less costly forage resource used for ruminant production due to lower investment in facilities and equipments and the lowest expenditure with labor, inputs etc. (Maixner et al., 2009; Soriano et al., 2013).

However, a major drawback of tropical grass pastures is the pronounced seasonality in forage production resulting from the presence of two well-defined seasons (rainy and dry) (Moreira et al., 2004a). During the rainy season, weather conditions are usually favorable to the growth of forage species, while during the dry period, adverse weather conditions, such as reduction in rainfall, temperature and radiation, limit the growth and development of forage plants (Moreira et al., 2008; Paciullo et al., 2008), reducing the quantity and quality of forage available in the fall, winter and early spring, resulting in low performance of animals (Canto et al., 2002; Moreira et al., 2003a, b; Moreira et al., 2004b).

Thus, strategies to solve the problem of discontinuity in the forage production during the year, due to climate variations resulting from seasons, regardless of geographical location, are essential to maximize animal production and productivity per area (Balieiro Neto et al., 2007; El-Memari Neto et al., 2003; Maixner et al., 2009).

Overseeding of winter forage on tropical pastures has been used as a practical and economical measure of food supply in the off-season. But two factors should be taken into consideration before adopting the technique: irrigation in case of water deficit and checking average temperatures in the region, not too low to affect the growth of winter forage, not too high to favor the production of species already planted (Gerdes et al., 2005).

Among the tropical pastures, *Cynodon* grasses have high productive and nutritional potential (Moreira et al., 2004a; Moreira et al., 2003b) and cease their growth at temperatures at or below 4°C (Burton et al., 1993), thus being more tolerant to seasonality. Nevertheless, oats overseeding on *Cynodon* grasses not always significantly increase the total forage production (Moreira et al., 2006a), but even in these cases, the technique may be advantageous once the morphological composition can be significantly altered (Olivo et al., 2010).

In this context, this study evaluated the productivity and morphological composition of the Tifton 85 grass (*Cynodon* spp.) alone or overseeded with cool season annual grasses in irrigated system in Northwestern Paraná State.

Material and methods

This experiment was conducted under field conditions, from May to October 2009, in an area of Red Yellow Dytrophic Latosol of sandy texture in the municipality of Icaraíma, Paraná State (23º 23' 25'' South, 53º 38' 95'' West and 385 m altitude).

During the experimental period, June was the coldest month. In every month, rainfall was superior to evapotranspiration, but its distribution was not homogeneous, making necessary the monthly water supplementation through irrigation (Table 1). Irrigation management was supplementary, by means of a simplified water balance, with variable irrigation schedule for water deficit equal to or higher than 5 mm (ET - p ≥ 5 mm). Evapotranspiration (ET) was obtained from the meteorological data of the local station and estimated by the Penman-Monteith equation.

Soil analysis at the 0 - 0.20 m layer showed the following chemical characteristics: pH in water = 6.1; Al = 0.00 $cmol_c$ dm^{-3}; Ca + Mg = 2.38 $cmol_c$ dm^{-3}; H + Al = 2.36 $cmol_c$ dm^{-3}; organic matter = 7.90 $cmol_c$ dm^{-3} and base saturation = 51.93%.

The experimental area was installed over twenty paddocks (plots) with intermittent stocking grazing, with 400 m^2 each. The occupation period consisted of one day and the grazing cycle, approximately 30 days, totaling five cycles during the experimental period.

This was a randomized block design with four replications and repeated measures over time. The experimental plots consisted of five treatments, three as oats overseeding using 50 kg ha^{-1} of the genotypes Iapar 61, IPR 126, and FMS2 on Tifton 85 pasture and one as overseeding of oats combined with rye (IPR 126 + IPR 89) at 70 kg ha^{-1} also on Tifton 85 grass and, finally, a control with only Tifton 85 without overseeding. These treatments were respectively referred to as T85+61, T85+126, T85+MS, T85+126+89 and T85 (Tifton 85 grass alone). Intercropping with rye in T85+126+89 was made in order to promote the seasonal distribution.

Overseeding was performed on May 8th, 2009 through four-row seeder. Seeds were sown at 5 cm depth and the base fertilization was performed by applying 350 kg ha^{-1} of the formula 8:16:16. Topdressing was made after grazing, applying 25 kg ha^{-1} N as urea.

Before the entry of animals (dairy cows) into the paddocks, two iron frames with 0.25 m^2 (50 x 50 cm) each were thrown at random, totaling 0.5 m^2 per paddock. Inside each frame, grass was cut at the same height pre-determined for animal grazing, equal to 10 cm.

Table 1. Minimum temperature (Tmin), mean temperature (Tmed), evapotranspiration (ET), rainfall (R) and irrigation (I).

Month	Tmin (ºC)	Tmed (ºC)	ET (mm)	R (mm)	I (mm)
May	16.4	20.7	97.9	229.8	73.4
June	12.6	16.1	62.6	127.2	51.6
July	13.5	17.0	57.1	127.9	22.1
August	15.2	19.7	94.7	101.7	86.1
September	16.3	20.5	90.5	112.0	52.4
October	18.4	22.9	133.9	297.9	59.5

In the laboratory, oats was separated from Tifton 85 grass and samples were subdivided into leaf, stem and dead material, and sent to forced air oven at 65°C for 72 hours to determine the dry matter (DM). After, the samples were weighed in a balance accurate to 0.01 g. From the morphological separation, it was determined the total forage productivity (PTF), winter forage productivity (PFI), morphological composition (CM), leaf/stem ratio (RFC) and productivity variation (VP). VP was estimated according to Moreira et al. (2006a):

$$VP = \left(\frac{TFP}{PT85} \right) \cdot 100$$

where:

VP = variation in productivity (%);

TFP = total forage productivity (kg DM ha^{-1});

PT85 = productivity of Tifton 85 alone (kg DM ha^{-1}).

The experimental data were subjected to analysis of variance and means were compared by tukey's test at 5% significance level.

Results and discussion

In the second cycle (cut in July), the treatments T+126 and T+MS achieved the highest productivities. Overseeding of oats with rye (T+126+89) promoted the lowest total forage productivity (TFP), 11,079.73 kg DM ha^{-1} (Table 2). In general, the temperatures during the experimental period (Table 1) favored the development of the pasture of Tifton 85 alone, resulting in TFP similar to the other overseeded treatments. Similarly, Moreira et al. (2006b), Jaboticabal, São Paulo State and Neres et al. (2011) in Marechal Candido Rondom, Paraná State, observed no increases in dry matter productivity in the Tifton85 overseeded with winter forage.

The mean total forage productivity (PTF) obtained by grazing, 3,144 kg DM ha^{-1} $cycle^{-1}$, was higher than that found by Olivo et al. (2010), in Santa Maria, Rio Grande do Sul State, 2469 kg DM ha^{-1} $cycle^{-1}$, in Coastcross pasture overseeded with ryegrass. However, similar to the mean productivity obtained by (Silva et al., 2012), in Dois Vizinhos, Paraná State, 3410 kg DM ha^{-1} $cycle^{-1}$, in African star grass pasture overseeded with oats.

Based on some research results, the accumulation of dry matter of Tifton 85 grass during the trial period can be considered significant. Marcelino et al. (2003) analyzed Tifton 85 grass under irrigation in Planaltina, Federal District, found an annual average accumulation of 114.5 kg DM ha^{-1} day^{-1}. In an experiment with Tifton 85 grass fertigated with liquid sewage waste plus mineral fertilizer in Lins, São Paulo State, Fonseca et al. (2007) registered productivity of 105.75 kg DM ha^{-1} day^{-1}. Bow and Muir (2010), in Stephenville, Texas, United States, obtained productivity of Tifton 85 grass alone under irrigation of about 124.7 kg DM ha^{-1} day^{-1}. In this work, considering only the experimental cycle, i.e. from May to October, the accumulation in the treatment with exclusive Tifton 85 grass was 112.73 kg DM ha^{-1} day^{-1}.

Overseeding with IPR oats 126 presented the highest winter forage productivity (WFP), however, by adding rye (T+126+89), productivity was lower, not differing from the other treatments (Table 3).

Table 2. Total forage productivity (kg DM ha^{-1}) in of Tifton 85 alone and overseeded with winter forages.

Cycles	TE	T+MS	T+126	T+126+89	T+61
1	3935.99 a	2638.03 ab	2393.40 ab	1957.98 b	3475.05 ab
2	2685.20 b	4338.25 a	5290.73 a	2463.88 b	1929.50 b
3	3968.35 a	4086.14 a	3594.12 a	2213.92 a	4540.31 a
4	2958.09 ab	2272.19 bc	2900.15 abc	1974.05 c	3457.95 a
5	3293.40 a	2323.88 ab	2080.88 b	2470.03 ab	2662.25 ab
Total	16841.01 a	15658.48 a	16245.77 a	11079.93 b	16065.05 a

TE: Tifton 85 alone; T+MS: Tifton 85 overseeded with FMS 2 oats; T+126: Tifton 85 overseeded with IPR 126 oats; T+126+89: Tifton 85 overseeded with IPR 126 oats and IPR 89 rye; T+61: Tifton 85 overseeded with Iapar 61 oats; Means followed by different lowercase letters in the same row or uppercase letters in the same column are significantly different by tukey's test ($p < 0.05$).

Table 3. Productivity of the winter forage (kg MS ha^{-1}) in overseeded treatments.

Cycles	T+MS	T+126	T+126+89	T+61
1	122.60 a	461.41 a	396.58 a	641.02 a
2	595.75 b	1136.85 a	267.04 bc	214.83 c
3	813.25 a	902.69 a	718.82 a	420.60 a
4	459.27 a	506.09 a	511.95 a	722.91 a
5	319.88 c	1094.88 a	509.50 b	249.85 c
Total	2310.75 b	4101.92 a	2403.90 b	2249 b

T+MS: Tifton 85 overseeded with FMS 2 oats; T+126: Tifton 85 overseeded with IPR 126 oats; T+126+89: Tifton 85 overseeded with IPR 126 oats and IPR 89 rye; T+61: Tifton 85 overseeded with Iapar 61 oats; Means followed by different lowercase letters in the same row or uppercase letters in the same column are significantly different by tukey's test ($p < 0.05$).

The mean productivity of oats per grazing cycle of 553 kg DM ha^{-1} $cycle^{-1}$ was higher than that reported by Moreira et al. (2006a), who registered 200 kg DM ha^{-1} $cycle^{-1}$ and lower than that found by Silva et al. (2012), in Dois Vizinhos, Paraná State, which examined four cultivars of oats overseeded on African star grass pasture and obtained an average of 1910 kg DM ha^{-1} $cycle^{-1}$. However, in both cases there was no variation in the total forage productivity.

The inclusion of rye may have increased competition between species, as in T+126+89 the productivity of winter forage (PFI) and total forage (PTF) were lower compared to T+126 (Tables 2 and 3), but for pasture composition, these treatments were similar (Table 4). T+126 had proportion of winter forage similar to T+126+89, 22 and 20.45%, respectively. Nevertheless, compared to other treatments, the T+126 showed higher percentage. The literature indicates an extensive participation of winter forage in *Cynodon* pastures, ranging from 10% to over 60% (Moreira et al., 2006a; Neres et al., 2011; Olivo et al., 2010; Rocha et al., 2007), since this contribution depends on the climate, the grazing height, the fertilization level, the irrigation management, the behavior of tropical and winter forage species, the interval between cuts and the experimental period.

Overseeding in general, except for T+126+89, caused no variations in productivity (VP) compared to the Tifton 85 alone (Table 5), corroborating the results reported by Moreira et al. (2006b) and Silva et al. (2012). The treatments T+MS and T+126 presented higher VP in the second grazing cycle in relation to the Tifton 85 alone and other treatments of overseeding, coinciding with the decrease in productivity of the pasture of Tifton 85 alone in this cycle (Table 2), certainly influenced by the lower temperature in June (Table 1).

Different from that observed by et al. (2006a), the overseeded treatments exhibited leaf/stem ratio (RFC) above one (1) (Table 6). This fact can be attributed to earlier overseeding with shorter interval between grazing cycles, used in this experiment. The overseeding of IPR 126 oats on Tifton 85 pasture (T+126) showed a higher leaf/stem ratio than Tifton 85 alone (TE).

Table 4. Pasture composition in percentage of winter forage, Tifton 85 grass and Senescent Material.

Cycles	TE	T+MS	T+126	T+126+89	T+61
			% Tifton 85		
1	95.46 a	78.10 b	75.85 b	79.79 ab	87.80 ab
2	93.46 a	75.75 b	73.10 b	78.03 b	83.22 ab
3	89.71 a	74.41 a	63.48 a	61.96 a	82.87 a
4	90.60 a	77.13 abc	57.43 c	64.23 bc	78.55 ab
5	99.51 a	85.11 ab	42.87 c	76.66 b	89.60 ab
Mean	93.75 a	77.95 bc	65.82 d	72.14 cd	84.41 ab
			% Winter forages		
1	0.00 b	5.57 a	11.34 a	11.76 a	11.04 a
2	0.00 c	13.59 ab	21.63 a	11.97 b	9.62 b
3	0.00 c	19.96 ab	23.23 ab	30.68 a	7.40 bc
4	0.00 b	19.14 a	16.88 ab	26.61 a	21.19 a
5	0.00 c	12.87 bc	48.16 a	21.21 b	9.00 bc
Mean	0.00 d	14.34 bc	22.00 a	20.45 ab	11.65 c
			% Senescent Material		
1	4.54 bc	16.47 a	12.82 ab	8.45 abc	1.16 c
2	6.53 a	10.66 a	5.27 a	10.00 a	7.16 a
3	10.29 a	5.63 a	13.30 a	7.35 a	9.73 a
4	9.40 ab	3.74 b	25.70 a	9.15 ab	0.26 b
5	0.49 b	2.02 b	8.97 a	2.12 b	1.40 b
	6.25 ab	7.71 ab	12.18 a	7.41 ab	3.94 b

TE: Tifton 85 alone; T+MS: Tifton 85 overseeded with FMS 2 oats; T+126: Tifton 85 overseeded with IPR 126 oats; T+126+89: Tifton 85 overseeded with IPR 126 oats and IPR 89 rye; T+61: Tifton 85 overseeded with Iapar 61 oats; Means followed by different lowercase letters in the same row or uppercase letters in the same column are significantly different by tukey's test ($p < 0.05$).

Table 5. Variation in productivity (%) of overseeded treatments in relation to Tifton 85 grass alone.

Cycles	TE	T+MS	T+126	T+126+89	T+61
1	100 a	67.02 ab	60.80 b	39.67 b	72.00 ab
2	100 b	161.56 a	197.03 a	81.82 b	63.86 b
3	100 a	102.97 a	90.57 ab	37.68 b	103.82 a
4	100 a	76.81 ab	98.04 a	49.43 b	92.46 a
5	100 a	70.56 ab	63.18 b	59.53 b	73.25 ab
Média	100 a	95.25 a	102.00 a	53.50 b	81.00 a

TE: Tifton 85 alone; T+MS: Tifton 85 overseeded with FMS 2 oats; T+126: Tifton 85 overseeded with IPR 126 oats; T+126+89: Tifton 85 overseeded with IPR 126 oats and IPR 89 rye; T+61: Tifton 85 overseeded with Iapar 61 oats; Means followed by different lowercase letters in the same row or uppercase letters in the same column are significantly different by tukey's test ($p < 0.05$).

Table 6. Leaf/stem ratio of the Tifton 85 alone and overseeded with winter forage.

Cycles	TE	T+MS	T+126	T+126+89	T+61
1	1.18 a	1.22 a	1.47 a	1.16 a	1.20 a
2	1.07 a	1.10 a	1.32 a	1.52 a	0.70 a
3	0.60 b	1.13 ab	2.24 a	1.64 a	0.78 b
4	0.68 a	2.09 a	1.45 a	2.24 a	0.95 a
5	1.55 a	1.75 a	1.75 a	1.89 a	1.81 a
Mean	1.08 b	1.57 ab	1.77 a	1.69 ab	1.09 ab

TE: Tifton 85 alone; T+MS: Tifton 85 overseeded with FMS 2 oats; T+126: Tifton 85 overseeded with IPR 126 oats; T+126+89: Tifton 85 overseeded with IPR 126 oats and IPR 89 rye; T+61: Tifton 85 overseeded with Iapar 61 oats; Means followed by different lowercase letters in the same row or uppercase letters in the same column are significantly different by tukey's test ($p < 0.05$).

Conclusion

The IPR 126 oats is the most productive in overseeding and has a higher leaf/stem ratio than the Tifton 85 grass alone.

Overseeding of winter forages does not increase productivity of Tifton 85 pastures.

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