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44. Screening native and cultivated tropical pastures for silvipastoral systems in Southern Brazil.

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Abstract

The aim of this study was to screen native and cultivated pasture species under shade conditions in three different sites in Southern Brazil. A number of tropical pastures species were tested under silvipastoral systems (*Pinus taeda* 15x3 m and 9x3 m) and under artificial shading (80 and 50% continuous shade) compared with full sunlight condition. Total dry matter yield of the following cultivated pastures were measured in Santa Catarina (26°25'S and 52°21'O) and Paraná (25° 25'S and and 49° 80'O) States over a year: *Brachiaria decumbens* cv. Basilisk; *Brachiaria brizantha* cv. Marandu; *Axonupus catharinensis*; Cynodon sp cv. Tifton-85; *Panicum maximum* cvs Tanzania, Mombaça and Aruana; *Hemarthia altissima* cv. Florida; *Paspalum notatum* cv. Pensacola; *Arachis pintoi* cvs. Alqueire and Amarillo. The native pasture species were also monitored in Rio Grande do Sul State (31°19'53"S and 54°06'25"O): *Paspalum dilatatum* (ecotypes A to E), *Paspalum notatum* (ecotypes A to E) and *Paspalum regnelli* (ecotype A). The main results indicated that *Axonupus catharinensis* (maximum of 19,0 ton $ha^{-1}year^{-1}$), *Brachiaria brizantha* cv. Marandu (maximum of 22,6 ton $ha^{-1}year^{-1}$); *Panicum maximum* cvs Tanzania (maximum of 15,4 ton $ha^{-1}year^{-1}$), Aruana (maximum of 15,11 ton $ha^{-1}year^{-1}$) and Mombaça (maximum of 11,9 ton $ha^{-1}year^{-1}$) showed the best potential yield to grown under intermediate tree shade level. *Paspalum regnelli* was the most productive native pasture grown under artificial shade (maximum of 18,5 ton $ha^{-1}year^{-1}$). Further work should be done to evaluate selected pastures under graze and trees and to offer commercial cultivars and seeds adapted to shade conditions.

Key words: *agroforestry; forage; shade tolerant.*

Introduction

In Southern Brazil, there is a great opportunity to establish tree-pasture systems. In this region, agriculture (maize, soybean, wheat, etc.) and animal production (beef, dairy cattle and sheep) are the

dominant systems. Tree plantation areas (*Pinus* sp., *Eucalyptus* sp. and *Acacia* sp.) are increasing quickly due to domestic and international demand for wood (SBS, 2005). As a consequence of silviculture and agriculture expansion, native grasslands of Pampa Biome (176.496 km^2 located in Southern Brazil) decreased from 14 million hectares in 1970 to 9 million hectares in 2006 (Carvalho, 2006). The establishment of silvipastoral systems is an opportunity to integrate trees to grassland systems in Southern Brazil without land degradation. The strategy is to establish silvipastoral systems with low tree density (less than 500 trees ha^{-1}) in Pampa Biome, particularly in areas strongly occupied with "Annoni Grass" (*Eragrostis plana*) weed and areas susceptible to soil erosion.

One important step to silvipastoral system research area is to select pasture species tolerant to shade (Varella et al., 2001; Varella, 2008). In Southern Brazil, there is a range of tropical and temperate pastures grown in full sunlight conditions. However, the potential yield of some of these pasture species under shade condition is still unknown. In addition, screening native pastures of Pampa Biome to shade tolerance is a new approach, especially to integrate those with trees and animals in threaten areas. This work aims to report preliminary results of a research that screened shade tolerant native and cultivated tropical pastures for silvipastoral systems in Southern Brazil areas.

Material and methods

In Rio Grande do Sul (RS) State, an experiment (Embrapa Sheep and Cattle, CPPSUL, 31°19'S and 54°06'O) was conducted to screen tropical native pasture species and ecotypes submitted to three radiation levels: full sunlight, 50% and 80% shade clothes. In this experiment, 11 native pasture ecotypes were tested: *Paspalum dilatatum* biotype Virassoro (ecotypes A to E), *Paspalum notatum* (ecotypes A to E) and *Paspalum regnelli* (ecotype A). The experimental design was a split plot randomised block in three replicates, with the main plots as radiation condition and subplots as pasture species or ecotypes. Climate is typically subtropical with frequent frosts in winter and warm in summer. Mean average air temperature is 18 °C. The annual rainfall is 1470 mm. The soil texture range from loam to clay (between 14-23% clay), has low acidity and low phosphorous level. Fertilizers were applied annually at the following rates: 100 kg N ha^{-1}, 80 kg P_2O_5 ha^{-1} 60 kg K_2O ha^{-1}.

In Santa Catarina (SC, 26°25'S and 52°21'O) and Paraná (PR, 25°25'S and and 49°80'O), tropical cultivated pasture plots were grown in full sunlight (100% PAR), underneath adult 9x3 m and 15x3 m *Pinus taeda* plantations. Average tree height was 31,5m and 32,2m under 9x3m and 15x3m stand, respectively, in PR site. In SC, average tree height was 13,9m and 14,0m under 9x3m and 15x3m stand, respectively. These experiments were established in Univer sidade Federal Tecnológica do Paraná (UFTPR) and Universidade Federal do Parana (UFPR), respectively. This study tested the following tropical perennial pastures: *Brachiaria decumbens* cv. Basilisk; *Brachiaria brizantha* cv. Marandu; *Axonupus catharinensis*; Cynodon sp cv. Tifton-85; *Panicum maximum* cvs Tanzania, Mombaça and Aruana; *Hemarthia altissima* cv. Florida; *Paspalum notatum* cv. Pensacola; *Arachis pintoi* cvs. Alqueire and Amarillo. The experimental design in both experiments was a split plot randomised block in three replicates, with the main plots as radiation condition and subplots as pasture species. In SC site, climate is subtropical with high annual rainfall and mild temperature in summer. The average air temperature is 18,5 °C and annual rainfall is 1539 mm (data from 1976 to 2006). The soil is typically clay (over 30%), acid and deep. In PR site, average air temperature is 20°C and annual rainfall is 1600 mm (historical data). Soil has variable textural layers, ranging from clay to loam, acid with high aluminium levels and medium depth. Total dry matter yield (kg ha^{-1} $year^{-1}$) was measured at the end of each season, using a 0,25 m^2 quadrat and samples were cut 0,10m above ground level. Microclimate variables (photosynthetic phot flux density, air temperature and wind speed) were monitored by Agronomic Research Institution of Paraná (IAPAR) over a year period in SC and PR sites. In Embrapa CPPSUL. Photosynthetic photon flux density and soil moisture at 0,20 cm depth was measured every two weeks. Data analysed in this paper was the pasture total annual dry matter yield (TDM).

Results and discussion

Climate variables changed within silvipastoral systems compared with full sunlight in SC and PR sites (Morais et al., 2007). In SC. pasture species grown under 15x3m experienced an annual aver-

aged of 74% photosynthetic photon flux density (PPFD) compared with full sunlight, whereas plants under 9x3m experienced 49%. In PR site, PPFD were 35 and 65% under 9x3m and 15x3m stands, respectively, compared with full sunlight. In both sites, average minimum temperatures were between 1-2 °C higher within silvipastoral systems compared with full sunlight in winter. In addition, wind speed was higher (average 6 m s^{-1}) in full sunlight compared with under trees treatments (average 3 m s^{-1}). Overall, it was observed lower soil temperatures and air humidity under tress than in full sunlight in both experiments.

The experiment established in SC State showed that TDM of *Brachiaria brizantha* cv. Marandu, *Panicum maximum* cvs Tanzania and Mombaça grown under the15x3 m *Pinus taeda* treatment was similar to that found in full sunlight (Table 1). The other pasture species decreased TDM as shading increased from 100% to 49% PPFD. Although *Axonupus catharinensis* was not the most productive pasture, this forage showed the lowest decrease on TDM from 100% PAR to 49% PPFD condition, which indicated a good potential yield for silvipastoral systems. Dry matter yield data for *A. catharinensis* is rarely cited in the literature. Santos (2005) observed much lower TDM (10 ton $ha^{-1}year^{-1}$ in full sunlight) compared with that measured in fullsunlight (25 ton $ha^{-1}year^{-1}$) and under 15x3 m pinus stand (19 ton $ha^{-1}year^{-1}$).

Table 1. Total dry matter yield (TDM) of different cultivated pasture species submitted to full sunlight and two *Pinus taeda* densities. Data collected between August 2006 and April 2007 in Abelardo Luz/ SC, Southern Brazil.

Pasture species		Pinus 15x3m		Pinus 9x3m	
	Full sunlight	Under tree rows	Between tree rows	Under tree rows	Between tree rows
	Kg TDM ha^{-1}				
Panicum maximum cv. Aruana	27818 a A*	9784 c C	20447 b B	2285 ef D	2708 cd D
Brachiaria brizanta cv. Marandu	26186 ab A	19866 a B	25375 a A	7166 b C	11802 a C
Axonopus catharinensis	24835 bc A	19153 a B	18890 b B	10151 a C	12401 a C
Cynodon sp. cv. Tifton 85	24014 bc A	7410 d BC	9553 e B	5260 bc C	5080 b C
Brachiaria decumbens cv. Basilisk	23229 cd A	13459 b B	8697 e C	4703 cd C	6254 b C
Hemarthria altissima cv. Florida	21118 d A	9741 cd	12874 d B	6454 bc C	6943 b C
Panicum maximum cv. Tanzânia	21072 d A	12256 b B	15535 c AB	941 ef C	1095 de C
Paspalum notatum cv. Pensacola	17352 e A	8608 cd C	12626 d B	0 f D	0 f D
Panicum maximum cv. Mombaça	13740 f A	13852 b A	10012 e AB	2968 de C	4683 bc
Arachis pintoi cv. Alquere	6092 g A	2867 e B	2717 f B	715 ef C	1171 de C
Arachis pintoi cv. Amarillo	6014 g A	2396 e B	2009 f B	1124 ef B	1080 de B
Means	19462 A	10340 B	12772 B	4043 C	4862 C

*Means followed by the same capital letter in the row are not different (P>0,05) by Tuckey test.
*Means followed by the same lower case lettter in the column are not different (P>0,05) by Tuckey test

In PR State, *Panicum maximum* cvs Tanzania and Aruana showed the greatest TDM under 15 x 3m *Pinus* treatment, followed by *Brachiaria brizantha* cv. Marandu, *Panicum maximum* cvs Mombaça and Tanzania grown under the 9 x 3m treatment (Table 2). Overall, plants grown under a *Pinus* 9x3m stand showed about 20% less TDM yield than under the 15x3m *Pinus* stand. Overall, potential yield for *P. maximum* cvs. *Aruana, Mombaça. B. brizantha* and *A. catharinensis* was higher in SC than in PR site under 15x3 m stand. This is because radiation available under 15x3m stand was higher in SC (74%) than in PR (65%) experiment. The exception was the *P. maximum* cv Tanzânia TDM, which was similar under the two Pinus stands in both experiments and this may be related to a lower photosynthetic saturation point for this forage compared with the others.

Table 2. Total dry matter yield (TDM, Kg DM ha^{-1} yr^{-1}) of different cultivated pasture species submitted to full sunlight and two *Pinus taeda* densities. Data collected between February 2006 and February 2007 Curitiba/PR, Southern Brazil.

Pasture species	*Pinus* 15x3m stand	*Pinus* 9x3m stand
	Between tree rows	
Panicum maximum cv. Aruana	13113 b*	8092 ef
Brachiaria brizanta cv. Marandu	10193 cd	11900 bc
Axonopus catharinensis	9950 cde	8288 ef
Cynodon sp. cv. Tifton 85	7070 fg	4158 h
Brachiaria decumbens cv. Basilisk	11186 cd	9599 de
Panicum maximum cv. Tanzânia	15430 a	10504 cd
Paspalum notatum cv. Pensacola	6016 g	3596 h
Panicum maximum cv. Mombaça	11067 cd	10985 cd
Means	10503 a	8390 b

*Means followed by the same capital letter in the column are not different (P>0,05) by Duncan test.

In Embrapa CPPSUL experiment, it was not observed interaction between main plots (radiation conditions) and subplots (pasture species) for TDM (Table 3). Native pasture TDM was different for radiation condition treatments (P=0,0006). Mean pasture annual yield was greater under 50% shade than in full sunlight and 80% shade plots. This was an atypical result, probably influenced by a severe drought period (average 10% soil moisture in full sunlight, 14% under 50% shade and 16% under 80% shade) over summers 2006 and 2007, which greatly affected pasture growth in full sunlight plots and benefited plants under shade. It was also observed differences between pasture species (P<0,0001). Paspalum regnelli was the most productive native pasture (16,24 ton TDM ha^{-1} $year^{-1}$), followed by P. dilatatum (8,68 ton TDM ha^{-1} $year^{-1}$) and P. notatum (4,98 ton TDM ha^{-1} $year^{-1}$). This study showed a great potential yield for P. regnelli and P. dilatatum to grow under intermediate shade conditions. Studies with native pastures under shade condition is a new approach in Southern Brazil. In this experiment, TDM for P. regnelli was superior than most reported in the literature in full sunlight condition. Primavesi et. al. (2006), for example, observed a maximum of 9 ton $ha^{-1}year^{-1}$ under high nutrients levels. Further study should be taken to evaluate pasture and animal production under trees.

Table 3. Total dry matter yield (TDM, Kg DM ha^{-1} yr^{-1}) per year of different native pasture species and ecotypes (A to E) submitted to 3 radiation conditions. Data from December 2006 to October 2007 in Bagé/RS, Southern Brazil.

Pasture species	Full sunlight	50% Shade	80% Shade	Means
	Kg TDM ha^{-1} $year^{-1}$			
Paspalum notatum A	3780,93	5692,53	4954,27	4809,24 e*
Paspalum notatum B	4128,53	6689,20	5577,53	5465,08 ed
Paspalum notatum C	3181,97	5416,20	4117,33	4238,50 e
Paspalum notatum D	5469,60	7415,87	6023,70	6303,06 cde
Paspalum notatum E	3343,47	4469,33	4502,93	4105,24 e
Paspalum dilatatum A	7579,63	10056,93	6923,40	8186,66 bcd
Paspalum dilatatum B	10078,07	10607,73	7485,93	9390,58 b
Paspalum dilatatum C	9327,63	9682,78	9398,47	9469,63 b
Paspalum dilatatum D	9026,63	8484,35	7634,40	8381,79 bc
Paspalum dilatatum E	8044,10	9997,90	5820,07	7954,02 bcd
Paspalum regnelli A	14568,83	18461,07	15694,13	16241,34 a
Mean	8115,13 B**	8734,26 A	7102,92 B	5994,1

*Means followed by the same letter in the column are not different by Tuckey test.
**Means followed by the same letter in the row are not different by Tuckey test.

Conclusion

The tropical cultivated pastures *Brachiaria brizantha* cv. Marandu; *Panicum maximum* cvs Mombaça and Aruana and *Axonupus catharinensis* showed good potential yield to grown under intermediate (above 65% fullsunlight PPFD) trees shade level. Native pasture *Paspalum regnelli* showed great potential yield under artificial shade conditions. Further study should be done to confirm the potential yield of the selected pastures under tree shade and animal grazing condition.

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