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Article

Phytosociology in Degraded and Renewed Pastures in Agrosilvopastoral Systems

Fitossociologia em Pastagem Degradada e Renovada com Sistemas Agrossilvipastoris

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ABSTRACT - In pastures, the incidence of weeds reduces the productivity and quality of forage. The identification of the weed species in pastures is fundamental to choose the renewal method. Thus, the objective of this work was to perform phytosociology before and after the renewal of a *Brachiaria decumbens* pasture, with the implantation of agrosilvopastoral systems. Eighteen different crop arrangements for pasture renewal were evaluated. The renewal systems were by eucalyptus integration (at 12 x 2 m or 12 x 3 m spacings) with maize, *Brachiaria brizantha* cv. Marandu (palisade grass) and/or *Macrotyloma axillare* (perennial horsegram), or monoculture and intercropping of palisade grass and perennial horsegram, as well as the evaluation of the application or not of the herbicide bentazon, at the recommended dose for maize crops (0.72 kg ha^{-1}). Relative frequency, relative density, relative abundance, relative dominance, coverage value index, importance value index, dry matter and similarity index were evaluated. In the first survey, before the pasture renewal, 23 plant species were identified. After the implantation of agrosilvopastoral systems, the species *Sida cordifolia*, *Lantana camara* and *B. decumbens* were the only occurring ones before and after the renewal of the pasture with agrosilvopastoral systems. The use of palisade grass and the application of the herbicide were efficient in controlling weeds. In systems that contained palisade grass and perennial horsegram, the latter was not found in the survey conducted one year after the implantation.

Keywords: intercropping, crop-livestock-forest, weed, pasture management.

RESUMO - Nas pastagens, a incidência de plantas daninhas reduz a produtividade e qualidade da forrageira. A identificação das espécies infestantes em pastagens é fundamental para a escolha do método de renovação. Assim, objetivou-se com este trabalho realizar a fitossociologia antes e após a renovação da pastagem de ***Brachiaria decumbens*** *com a implantação de sistemas agrossilvipastoris. Foram avaliados 18 diferentes arranjos de cultivo para renovação da pastagem. Os sistemas de renovação foram por integração de eucalipto (nos espaçamentos de 12 x 2 ou 12 x 3 m) com milho,* ***Brachiaria brizantha*** *cv. Marandu (capim-marandu) e/ou* ***Macrotyloma axillare*** *(java), ou monocultivo e consórcio de capim-marandu e java, além da avaliação da aplicação ou não do herbicida bentazon na dose recomendada para a cultura do milho (0,72 kg ha^{-1}). Foram avaliados frequência relativa, densidade relativa, abundância relativa, dominância relativa, índice de valor de cobertura, índice de valor de importância, massa seca e índice de similaridade. No primeiro levantamento, antes da renovação da pastagem, foram identificadas 23 espécies de plantas. Após a implantação dos sistemas agrossilvipastoris, as espécies* ***Sida cordifolia, Lantana camara*** *e* ***B. decumbens***

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foram as únicas incidentes nos levantamentos antes e após a renovação da pastagem com sistemas agrossilvipastoris. A utilização do capim-marandu e aplicação do herbicida foram eficientes no controle das plantas daninhas. Nos sistemas que continham capim-marundu e java, está última não foi encontrada no levantamento realizado um ano após a implantação.

Palavras-chave: consórcio, lavoura-pecuária-floresta, planta daninha, manejo de pastagem.

INTRODUCTION

The estimated pasture area in Brazil is 200 million hectares (FAO, 2015); pasture is the main food source for ruminants. However, the lack of management and the inadequate use of these areas have consequences, such as the reduction of nutrient supply to the soil and the low productivity and quality of forage, in addition to the compaction promoted by mechanization and cattle treading, resulting in the emergence of weeds and potential environmental degradation. In this regard, the renewal of pasture areas is fundamental for the development of the national cattle industry.

The first step to define an adequate pasture renewal and weed management program is the identification of the species in the area, in order to know the morphological, anatomical and ecological characteristics and the competitive ability of each weed species, serving as criterion to adopt the best form of control (Mascarenhas et al., 2009). The phytosociological survey is a method that helps identifying the botanical composition; when used in agroecosystems, it is fundamental for the integrated weed management (Krenchinski et al., 2015).

Integrated cropping systems, such as the agrosilvopastoral ones, also known as crop-livestock-forestry integration, have been recommended for the last decades, since, besides promoting the renewal of pastures, they present advantages such as the production of agricultural crops and woodlands, as well as maintaining agrobiodiversity (Santos et al., 2015a).

Weeds growing in agroforestry systems can influence the productivity and quality of integrated crops, and this justifies their control. Herbicides based on bentazon are indicated for soybean, beans, maize, wheat, and rice (Brazil, 2016); they are a possible alternative to be used in agroforestry systems. In addition, the use of herbicides to control weeds in agricultural systems often represents a better cost-benefit relation than manual weeding (Toledo et al., 1996; Model and Favreto, 2010).

Currently, there are studies in literature reporting the incidence of weeds in pastures (Ferreira et al., 2014, Inoue et al., 2012, Santos et al., 2015b). However, there are few studies reporting the post-renewal phytosociological changes following the implantation of agrosilvopastoral systems (Lacerda et al., 2013; Brighenti et al., 2016). In addition to this, there are also few studies describing the action of bentazon on the weed community in intercropping systems (Gbehounou and Bàrberi, 2016; Nogueira and Corriea, 2016).

In light of the aforementioned, this study aimed at performing phytosociology before and after the renewal of a pasture, through the implantation of agrosilvopastoral systems.

MATERIAL AND METHODS

The experiment was conducted at the Fazenda Experimental do Moura (FEM), in Curvelo, Minas Gerais state. It is located at the following coordinates: 18º44’52.03" S and 44º26’53.56" W. The climate, according to Köppen, is tropical savannah type. Rainfall and temperature data during the experimental period (Figure 1) were obtained from the weather station of the National Institute of Meteorology (Instituto Nacional de Meteorologia - INMET, 2015), located at 13 km from the experimental area.

Phytosociological surveys were carried out at two distinct times, before and after the implantation of the agrosilvopastoral systems. The first survey was carried out in November 2014 on *Brachiaria decumbens* pastures, without proper management for over 10 years, presenting exposed soil, infested by weeds.

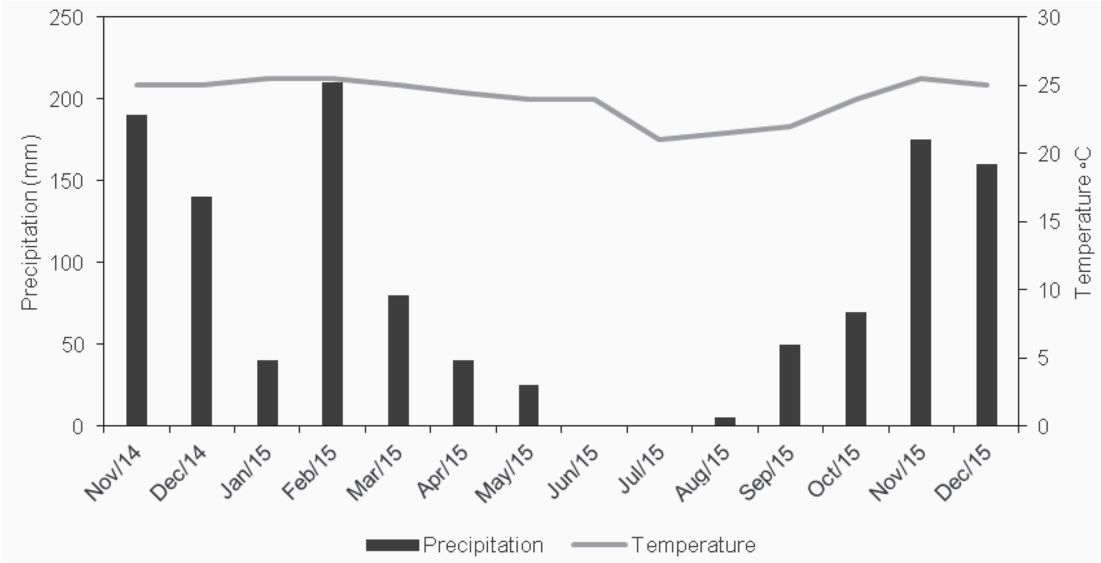

Figure 1 - Precipitation (mm) and average temperature (°C) during the experimental period, obtained at the weather station. Curvelo, Minas Gerais state, 2014/2015.

In order to survey the plants in the pasture ecosystem, the inventory square method was used. A 1 m side cast square was used, randomly thrown on the pasture 30 times, totaling a sampling area of 30 m². All species (except for the ones in full senescence) were identified within the square perimeter; they were counted, collected at ground level and packed in a kraft paper bag. Plants were then dried in a forced air circulation oven at 55 °C, until constant weight.

After identifying the species, the following parameters were estimated according to Muller-Dombois and Ellenberg (1974):

$$Relative\ Frequency\ (RFR) = \frac{absolute\ frequency\ of\ the\ species}{\Sigma\ of\ the\ absolute\ frequency\ of\ all\ species} \times 100$$

$$Relative\ Density\ (RDE) = \frac{absolute\ density\ of\ the\ species}{\Sigma\ of\ the\ absolute\ density\ of\ all\ species} \times 100$$

$$Relative\ Abundance\ (RAB) = \frac{absolute\ abundance\ of\ the\ species}{\Sigma\ of\ the\ abundance\ of\ all\ species} \times 100$$

$$Relative\ Dominance\ (RDO) = \frac{absolute\ dominance\ of\ the\ species}{\Sigma\ of\ the\ total\ biomass\ of\ all\ species} \times 100$$

$$Importance\ Value\ Index\ (IVI) = RFR + RDE + RAB$$

$$Coverage\ Value\ Index\ (CVI) = RDO + RDE$$

The pasture was renewed in December 2014. The soil was prepared conventionally one month before the implantation, with one plowing and two harrowings. Eighteen crop arrangements for pasture renewal were evaluated, with three replications. Treatments are described in Table 1. Each experimental unit was represented by an area of 12 m wide by 18 m long, totaling 216 m².

In all treatments, 400 kg ha^{-1} of the 8-28-16 (N-P_2O_5-K_2O) formula were used during the implantation of the species. At maize sowing (SHS 7920 hybrid), seeds of *Brachiaria brizantha* cv. Marandu (palisade grass) and/or *Macrotyloma axillare* (perennial horsegram) were homogenized to the fertilizer and distributed with spacing of 0.40 m, being sown on and between maize furrows.

Table 1 - Crop arrangements in agrosilvopastoral, monoculture and forage intercropping systems, with and without the application of bentazon

Treatment	
1	eucalyptus (12 x 2) + maize + palisade grass
2	eucalyptus (12 x 3) + maize + palisade grass
3	eucalyptus (12 x 2) + maize + palisade grass with the application of bentazon(1)
4	eucalyptus (12 x 3) + maize + palisade grass with the application of bentazon
5	eucalyptus (12 x 2) + maize + perennial horsegram
6	eucalyptus (12 x 3) + maize + perennial horsegram
7	eucalyptus (12 x 2) + maize + perennial horsegram with the application of bentazon
8	eucalyptus (12 x 3) + maize + perennial horsegram with the application of bentazon
9	eucalyptus (12 x 2) + maize + palisade grass + perennial horsegram
10	eucalyptus (12 x 3) + maize + palisade grass + perennial horsegram
11	eucalyptus (12 x 2) + maize + palisade grass + perennial horsegram with the application of bentazon
12	eucalyptus (12 x 3) + maize + palisade grass + perennial horsegram with the application of bentazon
13	palisade grass
14	palisade grass with the application of bentazon
15	perennial horsegram
16	perennial horsegram with the application of bentazon
17	palisade grass + perennial horsegram
18	palisade grass + perennial horsegram with the application of bentazon

(1) Bentazon at the dose of 0.72 kg ha^{-1}, corresponding to the dose indicated by the manufacturer (Basagran 600®) for maize.

For palisade grass or perennial horsegram in monoculture, 4 kg ha^{-1} of viable pure seeds were used, while for the intercrop 2 kg ha^{-1} of viable pure seeds of each species were used. The transplanting of eucalyptus was carried out at the same time as the sowing of the other species, in 12 x 2 and 12 x 3 m spacings, at a distance of 1.5 m from maize furrows, using clonal hybrid eucalyptus seedlings of *Eucalyptus grandis* x *E. urophylla* (Urograndis), clone 144, obtained from the company Agrocity in Inimutaba, Minas Gerais state.

Covering fertilization was carried out in all treatments 20 days after sowing (DAS), applying 100 kg of N ha^{-1} in the form of urea and ammonium sulfate (50:50).

Bentazon was applied at 30 DAS of the forage species and eucalyptus transplanting, when maize plants had two completely expanded leaves, at the recommended dose for maize (0.72 kg ha^{-1}), using a CO_2 constant pressure backpack sprayer with a 300 kPa pressure regulating valve (Jacto), equipped with a fan-type flat jet nozzle (XR11002) and with a spray volume of 200 L ha^{-1}. The herbicide was applied late in the afternoon, under appropriate temperature and wind speed conditions.

In May 2015, at 140 DAS, maize was harvested manually and a homogenization cut was performed on forage plants at 20 cm from the soil. Subsequently, fertilization was carried out with 100 kg ha^{-1} of N in the form of ammonium sulfate.

One year after the renewal of pastures, in December 2015, the second phytosociological survey was carried out, using a 1 m side cast square, which was thrown twice in each treatment. The evaluated procedures and parameters were conducted similarly to the first survey.

Comparisons between plant species and treatments for the relative frequency, relative density, relative abundance, relative dominance, importance value index, coverage value index and produced dry matter parameters were performed in a descriptive way.

At the end, the comparison between treatments was established through the Similarity Index (Sorensen, 1972), which varies from 0 to 100; the minimum value is obtained when the two areas do not have species in common, and the maximum one is obtained when they present the same species.

RESULTS AND DISCUSSION

Phytosociological survey before pasture renewal

In this survey, eight botanical families were identified, totaling 23 species. The Fabaceae family stood out with eight species, followed by Poaceae and Asteraceae, with four species each (Table 2).

Table 2 - Relative frequency (RFR), relative density (RDE), relative abundance (RAB), relative dominance (RDO), importance value index (IVI), coverage value index (CVI) and dry matter (DM) of species identified in a degraded *Brachiaria decumbens* pasture. Curvelo, Minas Gerais state, 2014

Species	RFR (%)	RDE (%)	RAB (%)	RDO (%)	IVI	CVI	DM (kg ha^{-1})
Aeschynomeme rudes	1.4	0.7	3.1	0.3	5.2	1.0	4.4
Ageratum conyzoides	1.4	0.4	1.5	0.2	3.3	0.6	2.5
Andira sp.	1.4	0.4	1.5	9.3	3.3	9.7	123.2
Andropogon gayanus	6.9	6.1	5.2	0.9	18.2	7.0	12.2
Baccharis dracunculifolia	4.2	2.9	4.1	0.3	11.2	3.2	4.1
Brachiaria decumbens	21.4	27.9	8.5	6.6	55.8	34.5	88.5
Brachiaria plantaginea	19.1	27.5	9.0	3.1	54.6	30.6	40.8
Byrsonima sp.	1.4	0.4	1.5	9.5	3.3	9.9	126.1
Cassia sp.	1.4	0.4	1.5	5.7	3.3	6.1	76.0
Desmodium adscendens	5.6	11.4	12.2	1.7	29.2	13.1	22.1
Eugenia dysenterica	1.4	0.7	3.1	17.9	5.2	18.6	238.9
Eupatorium maximilianii	2.8	1.4	3.1	12.4	7.3	13.8	164.7
Hyparrhenia rufa	1.4	1.8	7.6	0.8	10.8	2.6	10.9
Lantana camara	1.4	0.4	2.1	2.4	3.9	2.8	32.3
Machaerium sp.	1.4	0.7	3.1	3.0	5.2	3.7	39.7
Neotonia wightii	1.4	0.4	1.5	0.1	3.3	0.5	1.6
Senna obtusifolia	1.4	0.4	1.5	13.8	3.3	14.2	183.2
Sida cordifolia	1.4	2.9	12.2	1.7	16.5	4.6	22.1
Sida rhombifolia	6.9	4.3	3.7	2.9	14.9	7.2	3.9
Solanum lycocarpum	2.8	1.4	3.1	3.7	7.3	5.1	49.3
Solanum sisymbrifolium	2.8	1.8	4.3	2.0	8.9	3.8	32.3
Stylosanthes spp.	6.9	2.5	2.1	1.7	11.5	4.2	23.1
Vernonia spp.	4.2	2.9	4.1	2.3	11.2	5.1	30.4

The species presenting the highest values in terms of relative frequency were *B. decumbens* and *B. plantaginea*, indicating greater distribution throughout the area, followed by the species *Stylosanthes* spp., *Sida rhombifolia* and *Andropogon gayanus*.

Higher relative density values were observed for *B. decumbens*, *B. plantaginea*, *D. adscendens*, *A. gayanus* and *S. rhombifolia*, with a higher number of individuals per area than the other species, thus expressing great capacity of infesting pasture areas, mainly from *B. plantaginea*.

The highest relative abundance in the area was obtained by *S. cordifolia* and *D. adscendens*, both with the same index, followed by *B. plantaginea*, *B. decumbens* and *H. rufa*, evidencing the highest concentration of these species in the area.

The species that stood out in terms of relative dominance in the pasture in relation to the production of biomass were *E. dysenterica*, *S. obtusifolia*, *E. maximilianii*, *Byrsonima* sp. and *Andira* sp. These species also presented the highest values in terms of produced dry matter, obtaining 238.9, 183.2, 164.7, 126.1 and 123.2 kg ha^{-1} respectively, while the cultivated species *B. decumbens* showed low values of relative dominance and dry matter (88.53 kg ha^{-1}).

The highest importance value index was observed for *B. decumbens*, followed by *B. plantaginea*, *D. adscendens*, *A. gayanus* and *S. cordifolia*; it allowed inferring that these species are relevant within the study environment.

B. decumbens, *B. plantaginea*, *E. dysenterica*, *S. obtusifolia*, *E. maximilianii* and *D. adscendens* presented the highest coverage rates: 34.5, 30.6, 18.6, 14.2, 13.8 and 13.1, respectively.

E. dysenterica showed the highest dry matter production, followed by *S. obtusifolia*, *E. maximilianii*, *Byrsonima* sp., *Andira* sp. and *B. decumbens*; the latter was the species that had been initially cultivated in the area.

Phytosociological survey after pasture renewal

Plants presenting the highest relative frequency values for treatment 1, with eucalyptus (12 x 2) + maize + palisade grass, were *B. brizantha*, *S. cordifolia* and *Ipomoea* spp., indicating the highest distribution of these plants (Table 3). In this same crop arrangement, *H. suaveolens* plants showed higher relative abundance over the other species, followed by *B. brizantha* and *S. cordifolia*. *H. suaveolens* also showed high relative density and importance value index values. Moreover, it was observed that the highest coverage value index was observed for palisade grass. *E. dysenterica*, in spite of not presenting high values for most of the phytosociological parameters, obtained a dry matter production of 128.0 kg ha^{-1}; this was only lower than palisade grass, which obtained 5,411.7 kg ha^{-1}, and which could be a competitive weed due to its form of growth.

In the treatment 2, with eucalyptus (12 x 3) + maize + palisade grass, *B. brizantha* presented a relative frequency value of 43%, while *S. cordifolia* presented 29% for the same parameter. Similar results were obtained for relative density, where *B. brizantha* stood out with 82%, whereas *S. cordifolia* obtained 9%. Palisade grass also had the highest relative abundance (66.7%), relative dominance (99.95%), coverage value index (182.1), importance value index (192.3) and dry matter (5,111.3 kg ha^{-1}) values, demonstrating its good establishment and productivity in the renewed pasture (Table 3).

In treatments 3 and 4, eucalyptus (12 x 2) + maize + palisade grass with the application of bentazon, and eucalyptus (12 x 3) + maize + palisade grass with the application of bentazon, the cultivated forage species was the only one found in the area. However, dry matter values were lower in comparison to bentazon-free arrangements (Table 3).

In treatments 5 and 6, eucalyptus (12 x 2) + maize + perennial horsegram and eucalyptus (12 x 3) + maize + perennial horsegram, respectively, a high incidence of weeds was observed, when compared to systems containing *B. brizantha*. In treatment 5, the species *M. axillare*, *B. decumbens*, *H. suaveolens* and *S. cordifolia* were the most frequent, since all of them showed a relative frequency value of 13.6%, while *D. teres*, *L. camara* and *P. oleracea* obtained 9.1% for this parameter. As for relative density, *S. cordifolia*, *H. suaveolens*, *D. teres* and *L. camara* stood out from the others. This cultivated legume had a low relative density value. *S. cordifolia*, *H. suaveolens*, *D. teres* and *L. camara* stand out in terms of relative abundance. For the importance value index, *S. cordifolia*, *H. suaveolens* and *B. decumbens* presented the highest values, exceeding perennial horsegram. *S. cordifolia* had a higher coverage value index. *B. decumbens* was the species with the highest relative dominance and also the highest dry matter production (Table 3).

In treatment 6, perennial horsegram showed a similar development to that of treatment 5, observing the highest relative frequency values in *L. camara*, *S. cordifolia* and *S. micranthum* (Table 4).

In treatment 7, eucalyptus (12 x 2) + maize + perennial horsegram with the application of bentazon, the species perennial horsegram, *B. decumbens*, *Ipomoea* spp., *M. pudica* and *S. cordifolia* had the highest relative frequency values; the latter also had the highest values of relative density, relative abundance, coverage value index and importance value index. However, it was *B. decumbens* that presented the highest relative dominance and dry matter production (Table 4).

In treatment 8, eucalyptus (12 x 3) + maize + perennial horsegram with the application of bentazon, the species perennial horsegram, *Ipomoea* spp., *L. camara* and *S. cordifolia* had the highest relative frequency values; the last two species also showed high relative density and

Table 3 - Relative frequency (RFR), relative density (RDE), relative abundance (RAB), relative dominance (RDO), importance value index (IVI), coverage value index (CVI) and produced dry matter (DM) of species identified in agrosilvopastoral systems with different crop arrangements. Curvelo, Minas Gerais state, 2015

Species	RFR (%)	RDE (%)	RAB (%)	RDO (%)	IVI	CVI	DM (kg ha^{-1})
1 - Eucalyptus (12 x 2) + maize + palisade grass							
Brachiaria brizantha	29.9	21.9	9.7	97.1	119.0	61.5	5,411.7
Diodia teres	10.0	1.6	2.1	0.01	1.6	13.6	0.7
Eugenia dysenterica	10.1	1.6	2.1	2.3	3.9	13.6	128.4
Hyptis suaveolens	10.0	54.7	72.7	0.1	54.8	137.4	4.4
Ipomoea sp.	20.0	6.3	4.2	0.02	6.3	30.4	1.0
Sida cordifolia	20.0	14.1	9.3	0.5	14.5	43.4	27.0
2 - Eucalyptus (12 x 3) + maize + palisade grass							
Brachiaria brizantha	43.0	82.0	66.7	99.95	182.1	192.3	5,111.3
Lantana camara	14.0	4.5	11.1	0.01	4.6	19.9	1.0
Senna obtusifolia	14.0	4.5	11.1	0.02	4.6	30.2	1.0
Sida cordifolia	29.0	9.0	11.1	0.02	9.2	49.3	0.4
3 - Eucalyptus (12 x 2) + maize + palisade grass with the application of bentazon(1)							
Brachiaria brizantha	100	100	100	100	200	300	3,595.0
4 - Eucalyptus (12 x 3) + maize + palisade grass with the application of bentazon							
Brachiaria brizantha	100	100	100	100	200	300	4,782.0
5 - Eucalyptus (12 x 2) + maize + perennial horsegram							
Acanthospermum australe	4.5	0.1	0.4	0.1	0.3	5.1	5.0
Aeschynomene rudis	4.6	0.1	0.4	0.2	0.3	5.1	3.7
Brachiaria decumbens	13.6	0.6	0.6	43.0	43.6	14.8	965.7
Diodia teres	9.1	2.0	2.9	14.8	16.8	13.9	332.0
Hyptis suaveolens	13.6	15.8	15.4	2.9	18.8	44.8	65.7
Ipomoea spp.	4.5	0.1	0.4	0.4	0.6	5.1	10.0
Lantana camara	9.1	1.5	2.2	2.8	4.3	12.7	62.3
Macrotyloma axillare	13.6	0.5	0.5	14.5	15.0	14.6	325.0
Mimosa candollei	4.5	0.1	0.4	1.5	1.6	5.1	33.4
Portulaca oleracea	9.1	0.7	1.1	0.1	0.8	10.9	0.7
Sida cordifolia	13.6	78.3	76.0	19.7	98.1	167.9	443.7

(1) Bentazon at the dose of 0.72 kg ha^{-1}, corresponding to the dose indicated by the manufacturer (Basagran 600®) for maize.

relative abundance. Perennial horsegram had the highest relative dominance and the highest dry matter production, followed by *S. cordifolia* (Table 5).

In treatment 9, eucalyptus (12 x 2) + maize + palisade grass + perennial horsegram, *S. cordifolia* had a relative abundance value of 61.7%, and palisade grass had 21.9%. The importance value index presented by *S. cordifolia* was also higher than the one presented by palisade grass. However, palisade grass presented relative frequency, relative dominance, coverage value index, and produced dry matter way above the other species (Table 5).

In treatment 10, eucalyptus (12 x 3) + maize + palisade grass + perennial horsegram, the species *S. cordifolia* presented high values for the relative density, relative abundance and importance value index parameters (Table 5).

In treatment 11, eucalyptus (12 x 2) + maize + palisade grass + perennial horsegram with bentazon application, relative abundance was higher for *B. brizantha*, followed by *L. camara* and *M. pudica* (Table 6).

In treatment 12, eucalyptus (12 x 3) + maize + palisade grass + perennial horsegram with the application of bentazon, *L. camara* presented relative abundance values that were similar to those of palisade grass, but the production of dry matter was much lower. Values of relative

Table 4 - Relative Relative frequency (RFR), relative density (RDE), relative abundance (RAB), relative dominance (RDO), importance value index (IVI), coverage value index (CVI) and produced dry matter (DM) of species identified in agrosilvopastoral systems with different crop arrangements. Curvelo, Minas Gerais state, 2015

Species	RFR (%)	RDE (%)	RAB (%)	RDO (%)	IVI	CVI	DM (kg ha^{-1})
6 - Eucalyptus (12 x 3) + maize + perennial horsegram							
Acanthospermum australe	4.5	0.4	0.9	0.8	1.2	5.9	18.0
Brachiaria decumbens	4.6	0.3	0.6	7.1	7.4	5.5	162.0
Diodia teres	9.1	46.2	53.2	1.1	47.1	108.5	26.0
Hyptis suaveolens	4.5	1.3	3.1	0.8	2.2	9.0	18.7
Ipomoea spp.	9.1	0.5	0.6	0.1	0.6	10.3	0.4
Lantana camara	13.6	8.2	6.3	33.9	42.1	28.1	774.5
Macrotyloma axillare	13.6	1.1	0.8	22.7	23.8	15.5	518.7
Mimosa candollei	4.5	0.3	0.6	0.1	0.3	5.4	0.7
Portulaca oleracea	4.6	0.3	0.6	0.5	0.7	5.5	10.6
Ricinus communis	4.5	0.9	2.2	0.6	1.5	7.7	13.0
Sida cordifolia	13.6	40.1	30.7	31.1	71.1	84.4	710.4
Sidastrum micranthum	13.6	0.4	0.3	1.4	1.8	14.4	33.0
7 - Eucalyptus (12 x 2) + maize + perennial horsegram with the application of bentazon(1)							
Acanthospermum australe	6.3	0.3	0.4	1.1	1.3	7.0	23.7
Ageratum conyzoides	6.3	2.1	3.4	1.3	3.4	11.8	29.3
Brachiaria decumbens	12.6	0.8	0.6	40.3	41.0	14.0	905.0
Brachiaria plantaginea	6.3	0.3	0.4	0.3	0.5	7.0	6.0
Diodia teres	6.3	2.9	4.7	3.8	6.7	13.8	84.7
Ipomoea spp.	12.6	5.0	4.0	0.8	5.7	21.6	17.0
Lantana camara	6.3	18.1	29.2	19.9	38.0	53.6	446.6
Macrotyloma axillare	12.6	2.6	2.1	3.7	41.0	14.0	255.0
Mimosa candollei	6.3	0.3	0.4	0.1	0.3	7.0	6.0
Mimosa pudica	12.6	2.4	1.9	0.1	2.5	16.8	2.3
Sida cordifolia	12.6	65.4	52.8	28.9	94.2	130.7	649.3

(1) Bentazon at the dose of 0.72 kg ha^{-1}, corresponding to the dose indicated by the manufacturer (Basagran 600®) for maize.

dominance, coverage value index and dry matter production observed for palisade grass were the highest (Table 6).

In treatments 13 and 14, palisade grass monoculture without and with the application of the herbicide, respectively, no weed incidence was observed. However, the application of bentazon reduced the dry matter production of palisade grass in comparison to the treatment without the application of the herbicide (Table 7).

In treatment 15, perennial horsegram monoculture, the highest values in terms of relative density and relative abundance were observed for *D. teres*, *S. cordifolia* and *B. decumbens*. However, the highest coverage value index, relative dominance and dry matter production values were observed for *B. decumbens* (Table 7).

In treatment 16, perennial horsegram with bentazon application, the species perennial horsegram and *B. decumbens* had the highest relative frequency values, but the highest relative density and relative abundance values were observed for *S. cordifolia*, *C. benghalensis*, *D. teres* and *B. decumbens*. In this crop arrangement, *B. decumbens* stood out in terms of relative dominance and dry matter production. On the other hand, *S. cordifolia* stands out as for coverage value index and importance index (Table 7).

In treatment 17, palisade grass + perennial horsegram, the species *B. brizantha*, *E. dysenterica* and *S. cordifolia* showed the same relative frequency values; however, *B. brizantha* had a relative dominance of 97.9%, as well as the highest production of dry matter. Perennial horsegram disappeared from the intercrop (Table 7).

Table 5 - Relative Relative frequency (RFR), relative density (RDE), relative abundance (RAB), relative dominance (RDO), importance value index (IVI), coverage value index (CVI) and produced dry matter (DM) of species identified in agrosilvopastoral systems with different crop arrangements. Curvelo, Minas Gerais state, 2015

Species	RFR (%)	RDE (%)	RAB (%)	RDO (%)	IVI	CVI	DM (kg ha^{-1})
8 - Eucalyptus (12 x 3) + maize + perennial horsegram with the application of bentazon[(1)]							
Acanthospermum australe	4.6	0.9	2.2	5.5	6.4	7.7	67.2
Amaranthus spp.	4.6	0.3	0.7	10.7	11.0	5.6	130.6
Baccharis dracunculifolia	4.6	1.5	3.7	1.6	3.1	9.8	20.0
Brachiaria decumbens	4.6	2.4	5.9	6.9	9.2	12.9	83.7
Brachiaria plantaginea	4.6	1.2	3.0	11.4	12.6	8.7	138.7
Commelina benghalensis	4.6	0.3	0.7	0.4	0.7	5.6	4.7
Diodia teres	9.1	11.3	14.1	3.7	15.0	34.5	45.3
Ipomoea spp.	13.7	1.5	1.2	0.7	2.1	16.4	8.0
Lantana camara	13.7	40.4	33.7	8.8	49.1	87.7	106.7
Macrotyloma axillare	13.7	1.8	1.5	24.0	25.8	17.0	292.0
Sida cordifolia	13.7	38.0	31.7	23.6	61.6	83.4	287.3
Solanum sisymbrifolium	4.6	0.3	0.7	2.1	2.4	5.6	26.0
Stylosanthes spp.	4.6	0.3	0.7	0.6	0.9	5.6	7.6
9 - Eucalyptus (12 x 2) + maize + palisade grass + perennial horsegram							
Brachiaria brizantha	50.0	45.7	21.9	98.5	144.2	117.6	4,821.4
Diodia teres	16.7	5.7	8.2	0.1	5.7	30.6	0.4
Mimosa pudica	16.7	5.7	8.2	0.5	6.2	30.6	22.7
Sida cordifolia	16.7	42.9	61.7	1.0	43.9	121.2	51.4
10 - Eucalyptus (12 x 3) + maize + palisade grass + perennial horsegram							
Acacia plumosa	9.1	2.7	5.3	0.3	3.3	17.1	11.0
Brachiaria brizantha	27.3	20.3	13.2	98.1	118.4	60.7	3,409.5
Diodia teres	9.1	4.1	7.9	0.1	4.1	21.1	0.4
Ipomoea spp.	9.1	1.4	2.6	0.1	1.4	13.1	0.3
Lantana camara	18.2	4.1	3.9	1.0	5.0	26.2	33.5
Ricinus communis	9.1	1.4	2.6	0.4	1.9	13.1	20.0
Sida cordifolia	18.2	66.2	64.5	0.1	66.3	148.9	1.7

(1) Bentazon at the dose of 0.72 kg ha^{-1}, corresponding to the dose indicated by the manufacturer (Basagran 600®) for maize.

Table 6 - Relative Relative frequency (RFR), relative density (RDE), relative abundance (RAB), relative dominance (RDO), importance value index (IVI), coverage value index (CVI) and produced dry matter (DM) of species identified in agrosilvopastoral systems with different crop arrangements. Curvelo, Minas Gerais state, 2015

Species	RFR (%)	RDE (%)	RAB (%)	RDO (%)	IVI	CVI	DM (kg ha^{-1})
11 - Eucalyptus (12 x 2) + maize + palisade grass + perennial horsegram with the application of bentazon[(1)]							
Brachiaria brizantha	43.5	59.7	33.3	99.2	158.9	136.5	3,207.3
Hyptis suaveolens	14.5	5.0	8.3	0.1	5.0	27.8	0.4
Lantana camara	14.5	14.9	25.0	0.1	15.0	54.4	4.0
Mimosa pudica	14.5	14.9	25.0	0.5	15.4	54.4	15.3
Sida cordifolia	14.5	5.0	8.3	0.2	5.2	27.8	7.3
12 - Eucalyptus (12 x 3) + maize + palisade grass + perennial horsegram with the application of bentazon							
Brachiaria brizantha	62.5	71.4	45.5	98.5	169.9	179.4	2,712.6
Ipomoea spp.	20.8	4.8	9.1	0.1	4.8	34.7	0.4
Lantana camara	20.8	23.8	45.5	1.5	25.3	90.1	72.3

(1) Bentazon at the dose of 0.72 kg ha^{-1}, corresponding to the dose indicated by the manufacturer (Basagran 600®) for maize.

Table 7 - Relative Relative frequency (RFR), relative density (RDE), relative abundance (RAB), relative dominance (RDO), importance value index (IVI), coverage value index (CVI) and produced dry matter (DM) of species identified in monoculture and forage intercropping. Curvelo, Minas Gerais state, 2015

Species	RFR (%)	RDE (%)	RAB (%)	RDO (%)	IVI	CVI	DM (kg ha^{-1})
13 - Palisade grass							
Brachiaria brizantha	100	100	100	100	200	300	5,069.7
14 - Palisade grass with the application of bentazon[(1)]							
Brachiaria brizantha	100	100	100	100	200	300	3,245.3
15 - Perennial horsegram							
Brachiaria decumbens	18.2	3.4	2.1	85.5	88.9	23.7	2,447.3
Diodia teres	9.1	63.6	77.8	5.6	69.3	150.4	283.3
Eugenia dysenterica	18.2	0.3	0.2	1.2	1.5	18.7	61.7
Hyptis suaveolens	18.2	1.5	0.9	3.6	5.0	20.5	181.3
Macrotyloma axillare	18.2	0.3	0.2	0.8	1.1	18.7	370.6
Sida cordifolia	18.2	30.9	18.9	3.3	34.2	68.0	166.0
16 - Perennial horsegram with the application of bentazon							
Brachiaria decumbens	21.2	5.7	3.0	62.1	69.7	26.8	1,825.0
Commelina benghalensis	9.1	13.3	13.9	5.2	18.5	36.3	152.3
Digitaria horizontalis	9.1	1.0	1.0	1.2	2.2	11.2	120.0
Diodia teres	10.1	8.7	9.0	0.8	9.5	28.8	22.7
Hyptis suaveolens	10.1	0.7	0.7	2.6	3.2	11.5	75.7
Macrotyloma axillare	21.2	2.3	1.2	22.1	23.4	22.7	285.3
Sida cordifolia	10.1	68.0	71.1	4.8	71.7	151.6	128.0
Solanum sisymbrifolium	9.1	0.3	0.6	1.3	1.6	9.8	39.0
17 - Palisade grass + perennial horsegram							
Brachiaria brizantha	33.3	70.0	70.0	97.9	167.9	173.3	6,069.6
Eugenia dysenterica	33.3	10	10	0.3	10.2	53.3	11.3
Sida cordifolia	33.3	20	20	1.8	21.9	73.4	84.6
18 - Palisade grass + perennial horsegram with the application of bentazon							
Brachiaria brizantha	100	100	100	100	200	300	3,243.3

[(1)] Bentazon at the dose of 0.72 kg ha^{-1}, corresponding to the dose indicated by the manufacturer (Basagran 600®) for maize.

In treatment 18, palisade grass + perennial horsegram with bentazon application, only the presence of *B. brizantha* was observed, indicating that the herbicide was efficient in weed control within this treatment, but with no benefit to perennial horsegram (Table 7).

The low similarity indices between the *B. decumbens* pasture before the renewal and the crop arrangements after the renewal indicate that the species found in the areas have changed. The highest values were obtained in comparison to the monoculture of perennial horsegram, due to the great incidence of weeds in these areas (Table 8). The maximum similarity index value was obtained when comparing areas where palisade grass had settled, making it impossible for other species to appear.

In all performed surveys, in the pre-renewal pasture and in the crop arrangements of agrosilvopastoral systems, the Fabaceae family showed the highest number of species, followed by Poaceae and Asteraceae. In monocultures and intercrops without eucalyptus, the Poaceae family presented more species. Studies in literature indicate similar results to those of this study, as observed by Ferreira et al. (2014), who identified a larger number of species from the family Poaceae, followed by Malvaceae and Fabaceae, in different pasture areas of the Rio Doce Valley. Santos et al. (2015a) observed that in pasture areas of *Melinis minutiflora* (molasses grass) the most present families were Poaceae and Asteraceae.

The identification of other non-forage species in the pre-renewal *B. decumbens* pasture indicates the large infestation of undesired plants, which is an indicator of degradation. The

Table 8 - Similarity index (%) between *B. decumbens* pasture areas (PBD) before renewal and the different crop arrangements of agrosilvopastoral, monoculture and forage intercropping systems. Curvelo, Minas Gerais state, 2015

Trat	PBD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	7.4																	
2	12.5	25.0																
3	0.0	16.7	25.0															
4	0.0	16.7	25.0	100														
5	13.3	30.8	15.4	0.0	0.0													
6	9.3	28.6	14.3	0.0	0.0	76.9												
7	13.3	21.4	15.4	0.0	0.0	61.5	53.3											
8	16.2	18.8	13.3	0.0	0.0	41.2	38.9	50.0										
9	3.7	42.9	33.3	25.0	25.0	15.3	14.3	42.9	13.3									
10	6.8	44.4	37.5	14.3	14.3	28.6	35.7	28.6	25.0	22.2								
11	7.4	22.2	50.0	20.0	20.0	14.3	21.4	14.3	12.5	50.0	33.3							
12	4.0	28.6	40.0	33.3	33.3	16.7	15.4	16.7	14.3	16.7	42.9	33.3						
13	0.0	16.7	25.0	100	100	0.0	0.0	0.0	0.0	25.0	14.2	20.0	33.3					
14	0.0	16.7	25.0	100	100	0.0	0.0	0.0	0.0	25.0	14.2	20.0	33.3	100				
15	11.5	50.0	11.1	0.0	0.0	41.7	38.5	30.8	26.7	25.0	18.2	22.2	0.0	0.0	0.0			
16	10.7	27.3	9.1	0.0	0.0	35.0	33.3	26.7	31.3	20.0	15.4	18.2	0.0	0.0	0.0	55.6		
17	8.3	50.0	40.0	33.3	33.3	7.1	7.1	7.1	6.6	40.0	25.0	33.3	20.0	33.3	33.3	12.5	10.0	
18	0.0	16.6	25.0	100	100	0.0	0.0	0.0	0.0	25.0	14.3	20.0	33.3	100	100	0.0	0.0	33.3

criteria to determine the levels of pasture degradation are difficult. However, parameters such as a reduction in the quantity and quality of cultivated species, a change in the botanical composition and an invasion by new weeds indicate degraded pastures (Jakelaitis et al., 2014). The low dry matter yield of *B. decumbens* in the pasture before renewal corresponds to only 6.64% of the total productivity of the occupying flora; this allows characterizing the pasture as one in an advanced degradation stage.

All species belonging to the Poaceae family that were identified in the surveys have fodder value. In addition to them, among the Fabaceae species, it was possible to find forage plants such as *Stylosanthes* spp., *N. wightii* and *D. adscendens*, as well as the cultivated species *M. axillare*, which play the role of soil nitrifiers, due to their symbiosis ability with atmospheric nitrogen fixing bacteria. In addition, forage legume species help improving the diet of the cattle, because they have high protein values (Santos et al., 2015a).

E. dysenterica, *S. obtusifolia*, *E. maximilianii*, *Byrsonima* sp. and *Andira* sp. had the highest relative dominance and dry matter values in the pre-renewal *B. decumbens* pasture. Probably, this behavior was observed because they are perennial plants and have tree or shrub size, being able to reach an elevated height, which provides strong competition with forage plants in pasture areas. Moreover, the species *E. maximilianii* is considered as an indicator of a degraded pasture (Santos et al., 2015a). *E. maximilianii*, *Byrsonima* sp. and *Andira* sp. disappeared from the area after the implantation of agrosilvopastoral systems, possibly because they presented low frequency in the pasture before the renewal.

Generally speaking, the adoption of agrosilvopastoral systems, without the use of herbicides as a method to control weeds, promoted a reduction in the number of identified species in relation to the degraded pasture; this allowed inferring that only adopting the renewal and choosing species that are more adapted to the conditions of the system, regardless of the adopted system, is a way of reducing the incidence of weeds.

The phytosociological survey in the arrangements containing perennial horsegram and palisade grass reveals that perennial horsegram plants were not able to prevail in the area one year after sowing. This possibly occurred due to the competition caused by palisade grass, which reached a higher relative frequency value in all the different crop arrangements, and which presented a consistent distribution in all areas.

B. decumbens and *S. cordifolia* were the only species found in both surveys, showing persistence in the areas, even after pasture renewal. According to Inoue et al. (2012), the *Sida* genus presents great infestation and competition capacity within intercropping systems and monocultures of low-competitive species.

The presence of *S. lycocarpum*, *S. sisymbrifolium*, *M. pudica* and *M. candollei* in pasture areas is undesirable because they have a large number of thorns on their stems, which may cause injuries to the palate of lactating animals, resulting in a productivity and quality decrease of milk (Tuffi-Santos et al., 2004; Santos et al., 2015a). *L. camara*, found in pastures before and after their renewal, is also undesirable, because it is a toxic plant (Mello et al., 2010); in most cultivation arrangements containing the perennial horsegram species, *L. camara* presented a higher importance value index than that of perennial horsegram. In some treatments, *L. camara* showed a higher dry matter production than the cultivated forage species, reaching a higher production, up to 57.0%, which represents a high risk for grazing animals.

S. obtusifolia is also toxic to cattle; it has erected shrub growth and stems without thorns (Carvalho et al., 2014). Although this species did not stand out in most phytosociological parameters due to its growth characteristics, it might provide shading for fodder plants, and should therefore be controlled in pasture areas.

The practice of plowing and harrowing in preparing the pasture renewal area exposed seeds to the upper layers of soil, influencing the incidence of some new plant species after the implantation of agrosilvopastoral systems. Moreover, soil plowing, herbicide application, and fertilizer and corrector application may help or suppress the development of some weed species (Braga et al., 2012).

Taking into account the dry matter production of the flora found in agrosilvopastoral systems in the different crop arrangements, palisade grass was responsible for most of it. This demonstrates the good establishment of this grass and its efficiency in the inhibition of weeds, resulting in productive pastures. The fast establishment characteristic gives competitive advantages to *B. brizantha* in relation to weeds (Machado et al., 2011). The possible existence of allelopathic compounds emitted by *B. brizantha* may also have helped the development of this forage species over some weeds (Martins et al., 2006).

In spite of the weed incidence where the herbicide was not applied, *B. brizantha* plants had greater productivity compared to the areas where bentazon was applied. This reduction, when deriving from the application of the herbicide, was possibly caused by its action, which interfered in the development of the forage grasses. These results corroborate what was observed by Rezende et al. (2014) who, when evaluating the use of bentazon at the 0.72 kg ha^{-1} dose in maize intercrop with palisade grass, observed a reduction in the dry matter of this forage species.

Palisade grass productivity refers to the accumulation of mass between May and December 2015, since all plots were cut after the harvest of maize. However, these values report the success of pasture renewal in relation to the low productivity of *B. decumbens* before the implantation of agrosilvopastoral systems.

M. axillare plants showed high frequency in the intercrops of agrosilvopastoral systems with perennial horsegram + eucalyptus crop arrangements, representing their good distribution in the area. However, in treatment 5, *B. decumbens*, *H. suaveolus* and *S. cordifolia* showed a higher importance value index in relation to the cultivated forage legume, similarly to what occurred in treatments 6 and 8, where the plants with the highest importance value index were *S. cordifolia*, *L. camara* and *D. teres*. In treatment 7, *L. camara*, *M. pudica*, *Ipomoea* spp. and *S. cordifolia* were superior as for this parameter. Thus, it is worth mentioning the low development capacity of perennial horsegram in pasture areas, allowing the establishment of weeds in the area.

Perennial horsegram presented low dry matter production value; it was responsible for just 14.5% and 10.5% of the total production in treatments 5 and 6, and for 22.7% and 23.9% in treatments 7 and 8, respectively. Dry matter production was also low in intercrops where bentazon was applied. Possibly, perennial horsegram may have suffered with the action of the herbicide, reducing its development, in addition to the competition of weeds. The application of bentazon in treatments where there was only perennial horsegram, with no palisade grass, was not enough to control weeds.

M. axillare plants did not support the competition promoted by *B. brizantha*, and were unable to remain in palisade grass + perennial horsegram + eucalyptus intercropping areas, where once again the grass stood out in terms of phytosociological parameters. However, it was possible to observe again a reduction in the dry matter production of the grass in areas where the herbicide was applied.

The phytosociological calculations obtained in areas of perennial horsegram and palisade grass, in monoculture and in intercropping, confirm the growth and development observed in agrosilvopastoral systems, where palisade grass plants suppressed the development of weeds, as well as the development of perennial horsegram grown in intercropping. Planting perennial horsegram in monoculture areas did not show good coverage, allowing weeds to settle with greater vigor; this resulted in low yield pasture. This fact may be related to the photosynthetic metabolism of each cultivated forage species, since *B. brizantha* plants present a C4 metabolism, which expresses high growth capacity under conditions of high temperature and luminosity, whereas *M. axillare* plants have a C3 metabolism and saturate with high luminosity indices and have their development reduced by high temperatures (Taiz and Zeiger, 2013). Moreover, it is known that forage grasses from the *Brachiaria* genus have high competitive capacity towards other species (Machado et al., 2011). Since the study deals with system implantation, the shading provided by the different spacings was not relevant, because eucalyptus plants were still small (approximately 50 cm); however, in shaded systems, the growth of perennial horsegram may be different due to C3 metabolism, with greater efficiency in the use of light energy (Taiz and Zeiger, 2013).

The superiority of palisade grass in terms of coverage value index in all crop arrangements emphasizes the competition capacity promoted by the forage grass, due to its capacity of soil covering and its interference in the incidence of the other species.

The development characteristics of *H. suaveolens*, *D. teres*, *L. camara* and *S. cordifolia*, which presented relevant values as for relative density and relative abundance, but not as for relative frequency, indicate that the infestation of these species in the area is occurring in spots (Albuquerque et al., 2013).

Agrosilvopastoral systems were able to inhibit the emergence of some weed species that were present in the degraded pasture area, but allowed the spontaneous emergence of weeds that are commonly found in agricultural areas, such as *D. teres* and *Ipomoea* spp. (Albuquerque et al., 2013, Soares et al., 2015). In spite of this, the use of palisade grass and the application of bentazon were efficient in controlling weeds, reducing the number of species and the dry matter production of weeds.

The low values of the similarity indices obtained between the pre-renewal *B. decumbens* pasture and the different implanted crop arrangements reflect a great change in the weed flora after pasture renewal. The recurrence of null values in the similarity index among crop arrangements of agrosilvopastoral, monoculture and intercropping systems between forage species without eucalyptus is due to the comparison between areas where palisade grass was the only identified plant and areas where only perennial horsegram was planted, highlighting the difference in the competition exerted by both species.

Thus, it is possible to infer that agrosilvopastoral systems with palisade grass are alternatives capable of recovering degraded pasture areas, unlike systems with perennial horsegram. Moreover, bentazon helps controlling weeds in pastures where there are palisade grass and maize in an agrosilvopastoral system.

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REFERENCES

Albuquerque J.A.A. et al. Fitossociologia e características morfológicas de plantas daninhas após cultivo de milho em plantio convencional no cerrado de Roraima. **Agro@ambiente**. 2013;7:313-21.

Braga R.R et al. Ocorrência de plantas daninhas no sistema lavoura-pecuária em função de sistemas de cultivo e corretivo de acidez. **Rev Ceres**. 2012;59:646-53.

Brighenti A.M. et al. Fitossociologia de plantas daninhas em áreas de integração lavoura-pecuária. **Livestock Res. Rural Dev.** 2016;28:1-7.

Brasil. Ministério da Agricultura Pecuária e Abastecimento. **Sistema de Agrotóxicos Fitossanitários**. [acessado em mar. de 2016] Disponível em: http//:www.agrofit.agricultura.gov.br.

Carvalho A.Q. et al. Intoxicação espontânea por *Senna obtusifolia* em bovinos no pantanal Sul-mato-grossense. **PesqVet Bras.** 2014;34:147-52.

Food and Agriculture Organization of the United Nations – FAO. **Perspectivas agrícolas no Brasil**: desafios da agricultura brasileira 2015-2024. 2015. [acessado em abr. de 2016]. Disponível em: http//:www.agri-outlook.org.

Ferreira E.A. et al. Levantamento fitossociológico de plantas daninhas em pastagens degradadas do Médio Vale do Rio Doce, Minas Gerais. **Rev Ceres**. 2014;61:502-10.

Gbehounou G., Bàrberi P. Weed management. In: **Mainstreaming ecosystem services and biodiversity into agricultural production and management in East Africa**. Rome: FAO, 2016. p.29-45.

Instituto Nacional de Meteorologia – INMET. [acessado em dez. 2015]. Disponível em: http//:www.inmet.gov.br.

Inoue M.H. et al. Levantamento fitossociológico em pastagens. **Planta Daninha**. 2012;30:55-63.

Jakelaitis A., Soares M.P., Cardoso I.S. Banco de sementes de plantas daninhas em solos cultivados com culturas de pastagens. **Glob Sci Technol.** 2014;7:63-73.

Krenchinski F.H. et al. Levantamento florístico e fitossociológico de plantas daninhas: uma revisão dos métodos encontrados. **Rev Agro. Amb.** 2015;8:217-28.

Lacerda F. et al. Weed dynamics during the change of a degraded pasture to agroforestry system. **Agrofor Syst.** 2013;87:909-16.

Machado V.D. et al. Fitossociologia de plantas daninhas em sistemas de integração de sorgo com braquiária sob diferentes formas de implantação da pastagem. **Planta Daninha**. 2011;29:85-95.

Martins D., Martins C.C., Costa N.V. Potencial alelopático de soluções de solo cultivados com *Brachiaria brizantha*: efeitos sobre a germinação de gramíneas forrageiras e plantas daninhas de pastagens. **Planta Daninha**. 2006;24:61-70.

Mascarenhas M.H.T. et al. Flora infestante em pastagens degradadas sob recuperação pelo sistema de integração lavoura-pecuária, em região de cerrado. **Rev Bras Milho Sorgo**. 2009;8:41-55.

Mello G.W.S. et al. Plantas tóxicas para ruminantes e equídeos no norte piauiense. **Pesq Vet Bras.** 2010;30:1-9.

Model N.S., Favreto R. Comparação de custos de tratamentos de controle de plantas daninhas em abacaxizeiro cultivado no Rio Grande do Sul, Brasil. **Pesq Agropec Gaúcha**. 2010;16:45-50.

Muller-Dombois D., Ellenberg H.A. **Aims and methods of vegetation ecology**. New York: 1974. 547p.

Nogueira C.H.P., Correia N.M. Selectivity of herbicides bentazon and nicosulfuron for *Crotalaria juncea* intercropped with maize culture. **Planta Daninha**. 2016;34:747-57.

Rezende P.N. et al. Eficiência de herbicida aplicado em pós-emergência em milho consorciado com *Urochloa brizantha* cv. Marandu. **Agro@ambiente**. 2014;8:345-51.

Santos M.V. et al. Componentes produtivos do milho sob diferentes manejos de plantas daninhas e arranjos de plantio em sistema agrossilvipastoril. **Ci Rural**. 2015a;45:1545-50.

Santos M.V. et al. Levantamento fitossociológico e produção de forragem em pasto de capim-gordura. **Rev Ceres**. 2015b;62:561-7.

Sorensen T.A. Method of stablishing groups of equal amplitude in plant society based on similarity of species content. In: Odum E.P. editor. **Ecologia**. México: Interamericana, 1972.

Soares M.R.S. et al. Phytosociological survey of weed in cassava cultivation in Southwestern Bahia, Brazil. **Afr J Agric Res.** 2015;10:2120-9.

Taiz L., Zeiger E. **Fisiologia vegetal**. 5ª. ed. Porto Alegre: Artmed, 2013.

Toledo R.E.B. et al. Comparação dos custos de quatro métodos de manejo de *Brachiaria decumbens* Stapf. em área reflorestada com *Eucalyptus grandis* W. Hill ex Maiden. **Rev Árvore**. 1996;20:319-30.

Tuffi Santos L.D. et al. Levantamento fitossociológico em pastagens degradadas sob condições de várzeas. **Planta Daninha.** 2004;22:343-9.