Floristic and Structural Variation of Weeds in Eucalyptus Plantations as Influenced by Relief and Time of Year[1]

Variação Florística e Estrutural de Plantas Daninhas em Cultivos de Eucaliptos em Função do Relevo e da Época do Ano

TUFFI SANTOS, L.D.[2], CARDOSO FILHO, O.[3], SANTOS JÚNIOR, A.[4], SANT'ANNA-SANTOS, B.F.[5], FELIX, R.C.[5], and LEITE, F.P.[5]

ABSTRACT - The objective of this work was to analyze the floristic variation and phytosociological structure of weeds as influenced by relief and time of year in eucalyptus plantations in Santana do Paraíso and Guanhães - MG. The total area sampled for each locality was approximately 10 ± 3 hectares, comprising three types of relief: lowland, slope, and upper area. In each type of relief, 10 plots of 1 m^2 were sampled, corresponding to 30 plots per locality, where they were randomly allocated in a zigzag. The taxonomic identification was performed in four assessments, corresponding to the months of November and March, comprising two ratings each season, always at the same points, and geo-referenced using the Global Positioning System (GPS). A total of 3,893 individuals, 18 families and 61 species, were identified in Santana do Paraiso and a total of 1,166 individuals, 13 families and 58 species, in Guanhães. In both localities, the most representative families in terms of wealth were: Poaceae, Asteraceae, and Fabaceae. *Galinsoga parviflora* was the most abundant species. The *Vernonia polyantes* was identified only in the lowlands, while *Arrabida florida* was identified in the slope and upper area. On the other hand, *Emilia coccinea*, *Sida rhombifolia*, *S. paniculatum* and *Spermacoce latifolia* were common to all three environments. *Commelina benghalensis* was present only in the month of March, while *G. parviflora* was present only in the month of November. It was concluded that the floristic and phytosociological variation of weeds in eucalyptus plantations is influenced by the type of relief and time of year, which should guide the management practices used in the culture.

Keywords: *Eucalyptus*, dynamics, phytosociology, ecological adaptation.

RESUMO - Objetivou-se analisar a variação florística e a estrutura fitossociológica de plantas daninhas em função do relevo e da época do ano em cultivos de eucalipto nos municípios de Santana do Paraíso e Guanhães-MG. A área total amostrada para cada localidade foi de aproximadamente 10 ± 3 hectares, compreendidos em três tipos de relevo: baixada, encosta e parte alta. Em cada tipo de relevo, foram amostradas 10 parcelas de 1 m^2, correspondendo a 30 parcelas por município, onde foram distribuídas aleatoriamente em zigue-zague. A identificação taxonômica foi efetuada em quatro avaliações, correspondentes aos meses de novembro dos anos de 2009 e 2010 e março de 2010 e 2011, sempre nos mesmos pontos, os quais foram georreferenciados por meio do Sistema de Posicionamento Global (GPS). Foi identificado, no município de Santana do Paraíso, um total de 3.893 indivíduos, distribuídos em 18 famílias e 61 espécies; já em Ganhães identificaram-se 1.166 indivíduos, sendo 13 famílias e 58 espécies. Em ambos os municípios, as famílias mais representativas, em termos de riqueza, foram Poaceae, Asteraceae e Fabaceae. ***Galinsoga parviflora*** *foi a espécie mais abundante.* ***Vernonia polyantes*** *ocorreu apenas na baixada, e* ***Arrabida florida***, *na encosta e parte alta. Já* ***Emilia coccinea***, ***Sida rhombifolia***, ***S. paniculatum*** *e*

[1] Recebido para publicação em 2.10.2012 e aprovado em 20.4.2013.

[2] Professor do Instituto de Ciências Agrárias, Universidade Federal de Minas Gerais – ICA/UFMG, Campus Montes Claros-MG, <ltuffi@ufmg.br>, <bsantannaufmg@gmail.com>; [3] Mestre em Ciências Agrárias/Agroecologia pelo ICA/UFMG, Campus Montes Claros-MG, <otavio_moc@yahoo.com.br>; [4] Engº-Agrº., pelo ICA/UFMG, Mestrando em Fitotecnia, DFT/UFV, <antonio_agronomia@yahoo.com.br>, [5] Pesquisador na Celulose Nipo-Brasileira, CENIBRA, Minas Gerais, <rinaldo.felix@cenibra.com.br>, <fernando.leite@cenibra.com.br>.

Spermacoce latifolia *foram comuns aos três ambientes.* ***Commelina benghalensis*** *esteve presente apenas no período correspondente a março, assim como* ***G. parviflora*** *no mês de novembro. Diante do estudo, conclui-se que a variação florística e fitossociológica de plantas daninhas em cultivos de eucalipto é influenciada pelo tipo de relevo e pela época do ano, o que deve nortear práticas de manejo na cultura.*

Palavras-chave: *Eucalyptus*, dinâmica, fitossociologia, adaptação ecológica.

INTRODUCTION

In Brazil, eucalyptus has gained prominence in the forestry sector, occupying about 4.9 million hectares in 2011 (ABRAF, 2012). The reason for the farmers' preferred choice of this kind of plantation is its fast growth, high forest productivity and the widespread use of timber, in addition to the availability of cultivation technologies easily employed in properties.

In eucalyptus plantation, one of the greatest difficulties in achieving high cultivation yield is related to the availability of growth factors, almost often scarce in the production environments. This fact is exacerbated by the presence of weeds that are well adapted to unfavorable edaphoclimatic conditions, aggressive in terms of colonization of new areas and with large numbers of propagules with high dispersal ability and longevity (Lorenzi, 1990). Although some species of the genus *Eucalyptus* have characteristics that favor its establishment in the land, this fact does not prevent them from the interference of weeds, especially in the early stages of development. Thus, these plants require intense management during the first years of the culture, which, in case of re-infestation, may extend to almost the entire cycle for operational and productivity reasons (Bentivenha et al., 2006).

Weed management in planted forests can be done mechanically or chemically. Chemical control may cause changes in the environment such as alterations in the diversity of vegetal species; in the microbiological activity in soil, including beneficial microorganisms such as mycorrhizae, nitrogen fixing bacteria and phosphate solubilizing bacteria; and impacts on the physical and chemical characteristics of soil (Dodd & Jeffries, 1989; Paula Junior, 1995). In addition, the culture itself may be poisoned by the herbicide used (Tuffi Santos et al., 2011) and cause damages to the trees production. The management practices used, the land topography, the edaphoclimatic conditions (Oliveira & Freitas, 2008) and the phenological stage of eucalyptus trees may interfere with the weed dynamics in the fields.

Studies on the composition and floristic and structural variation of weeds in planted lands are important to understand the populations and biology of the existing species, to provide information on the diversity and to understand the dynamics of these plants – an important contribution for the recommendation of management practices.

This study aimed to analyze the floristic and phytosociological structure of weeds in eucalyptus cultures as influenced by the topography of planted areas and time of year.

MATERIAL AND METHODS

Floristic and phytosociological surveys were conducted in *Eucalyptus* spp. stands in the areas of Forestry Projects of Japanese-Brazilian Pulp (CENIBRA), in Santana do Paraíso and Guanhães - Minas Gerais.

Santana do Paraíso is located at km 232 of highway MG 381, at the geographic coordinates of 19° 21' 49'' south latitude and 42° 34' 07'' W longitude. Altitude is 240 m, and the regional climate is humid tropical, corresponding to the category Aw of Köppen climate classification, with reduced rainfall in the winter. Guanhães is located at km 381 of highway MG 434, at the geographic coordinates of 18° 46' 30'' south latitude and longitude of -42° 55' 57'' W. The altitude is 1,012 m, and the regional climate is humid tropical (Aw).

Total trial area of each locality was approximately 10 ± 3 hectares, comprising

three types of relief: lowland, slope and upper area. In each type of relief 10 plots of 1 m^2 were sampled, determined by a wooden frame, corresponding to 30 plots per locality, which were systematically and randomly distributed in the areas in zigzag design (Oliveira & Freitas, 2008). The samples were geo-referenced using the Global Positioning System (GPS), with the center points of each plot recorded by software of geographic data, and delimited with stakes, ensuring the reliability of sampling in the same plot in different times of the survey.

The selected areas were previously cultivated with eucalyptus in homogeneous planting, with clear-cut logging of the entire plot. For planting, the plot was cleared via desiccation with application of glyphosate herbicide over the entire area 30 days prior to planting for control of weeds and remaining eucalyptus shoots. Then, 700, 1,000 and 1,500 kg ha^{-1} of lime was applied in the lowland, slope and upper land, respectively, according to recommendations.

After liming, the area was subsoiled and furrows were plowed, and the equivalent to 700 kg ha^{-1} of natural phosphate was distributed onto the furrows. Planting took place in January 2010 using clonal seedlings with spacing of 3 x 2.5 m. Six months after planting, fertilization was incremented with the addition of 100 kg ha^{-1} hectare of NPK (6-30-6) to the three types of relief. Subsequent to planting, two chemical weedings were performed with application of 2.5 L ha^{-1} of glyphosate during the period of study, as determined by the need of management of weed competition. The assessment times regarding the application of glyphosate and the age of the eucalyptus plantation studied are presented in Table 1. Taxonomic identification was performed in four evaluations, corresponding to the months of November, 2009 and 2010 and March, 2010 and 2011 (Table 1).

The weed species in each plot were identified through consultation with herbariums, experts specialists, specialized literature (Lorenzi & Souza, 2001; Lorenzi, 2008; Lorenzi & Matos, 2008), and catalog of the weeds found in the company's reforestation areas.

The phytosociological parameters calculated were density and relative frequency (Mueller-Dombois & Ellenberg, 1974). With the number of individuals per species of weeds found in each area, the most abundant species in eucalyptus plantations were determined as a function of the type of relief and sampling time. The predominant families in number of species were also determined. In addition, Venn diagram was used to determine the species distributed at or exclusive to each type of relief and respective occurrence times.

RESULTS AND DISCUSSION

In the surveys conducted in eucalyptus plantations, in Santana do Paraíso a total of 3,893 individuals were found, distributed in 18 families and 61 species. In Guanhães, 1,166 individuals were identified, comprising 13 families and 58 species. In both localities, the most representative families in terms of richness were Poaceae, Asteraceae e Fabaceae (Figure 1).

Poaceae and Asteraceae were reported as the most representative families in previous phytosociological studies (Caporal & Boldrini, 2007; Oliveira & Freitas, 2008).

Table 1 - Situation of the sampling times in relation to the eucalyptus culture cycle and weeds management practices used during the period of experimental assessment in Santana do Paraíso and Guanhães-MG

Assessment	Santana do Paraíso	Guanhães
November 2009	60 days before planting	30 days before planting
March 2010	90 days after planting and 60 days after the first application of glyphosate	120 days after planting and 30 days after the first application of glyphosate
November 2010	300 days after planting and 90 days after the second application of glyphosate	330 days after planting and 90 days after the second application of glyphosate
March 2011	425 days after planting	455 days after planting

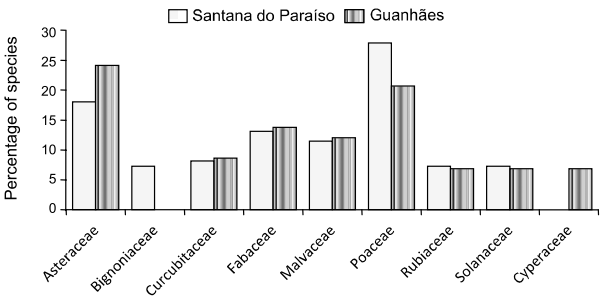

Figure 1 - Percentage of species in the main families of weeds found in eucalyptus plantations in Santana do Paraíso and Guanhães-MG.

According to Holm et al. (1991), species of the family Poaceae produce large quantities of seeds, which favor its dissemination and colonization in the most varied environments. These characteristics, combined with the competitive ability and edaphoclimatic adaptation may explain the high incidence of these species. Thus, these families have been predominant in floristic surveys of cultivated areas (Rodrigues et al., 2010).

The highest incidence of the family Poaceae was found in the first and third assessments (Table 2), both in November, a time corresponding to the spring season. In accordance with this, Welker & Longhi-Wagner (2007) report that annual tropical species of this family usually stay dormant or with dormant seeds in winter and grow in the spring.

In Santana do Paraíso, in the surveys performed in March, *Commelina benghalensis* and *Pteridum aquilinum* were the most important species in terms of density and relative frequency (Table 2), *C. benghalensis* having density and frequency relatively expressive in the lowland, and *P. aquilinum* in the lowland and sloped areas. In the investigations conducted in November, *Galinsoga parviflora* was the species with the highest phytosociological ratings (Table 2). This might have occurred because of climatic factors with regard to the adaptive conditions of each species, considering that March is part of the summer season, and November, spring.

Table 2 - Phytosociological parameters of species sampled in eucalyptus plantation in areas of Santana do Paraíso – MG, at different times of year. RD = relative density and RF = relative frequency

Scientific name	Family	Lowland		Slope		Upper land		Lowland		Slope		Upper land	
		RD	RF	RD	RF	RD	RF	RD	RF	RD	RF	RD	RF
		(%)											
		November 2009						March 2010					
Andropogon gayanus	Poaceae	-	-	-	-	1.77	2.56	-	-	-	-	-	-
Bambusa sp.	Poaceae	0.22	1.47	-	-	13.01	15.38	-	-	-	-	-	-
Bidens pilosa	Asteraceae	-	-	-	-	-	-	-	-	-	-	7.00	5.00
Brachiaria arrecta	Poaceae	0.1	1.47	0.92	1.88	-	-	-	-	-	-	-	-
Brachiaria brizantha	Poaceae	0.54	4.41	-	-	1.18	2.56	2.27	9.09	15.02	18.6	15.00	30.00
Brachiaria decumbens	Poaceae	0.22	1.47	-	-	0.29	2.56	-	-	-	-	-	-
Brachiaria plantaginea	Poaceae	0.05	1.47	-	-	-	-	2.55	12.72	1.72	2.32	-	-
Brachiaria sp.	Poaceae	-	-	0.83	1.88	3.84	5.12	-	-	-	-	-	
Calopogonium mucunoides	Fabaceae	-	-	-	-	-	-	0.42	5.45	0.31	2.32	-	-
Chamaesyce hyssopifolia	Euphorbiaceae	-	-	-	-	-	-	25.71	9.09	-	-	-	-
Commelina benghalensis	Commelinaceae	-	-	-	-	-	-	33.87	10.90	5.00	4.65	-	-
Corchorus olitorius	Malvaceae	0.81	7.35	-	-	0.29	2.56	-	-	-	-	-	-
Desmodium barbatum	Fabaceae	-	-	-	-	-	-	-	-	1.56	2.32	32.00	5.00
Digitaria horizontalis	Poaceae	0.70	1.47	-	-	-	-	-	-	-	-	-	-
Digitaria insularis	Poaceae	0.70	7.35	2.31	11.32	11.24	20.51	0.22	1.81	0.15	2.32	7.00	10.00
Digitaria sanguinalis	Poaceae	-	-	-	-	-	-	0.07	1.81	-	-	-	-
Echinochloa colona	Poaceae	-	-	0.55	1.88	-	-	-	-	-	-	-	-
Echinochloa crusgalli	Poaceae	0.10	1.47	0.55	1.88	-	-	-	-	-	-	-	-
Glycine wightii	Fabaceae	-	-	-	-	-	-	2.91	16.36	8.45	11.62	-	-
Ipomoea alba	Convolvulaceae	-	-	-	-	-	-	0.21	1.81	-	-	-	-
Luffa aegyptiaca	Cucurbitaceae	-	-	-	-	-	-	-	-	0.15	2.32	-	-
Mimosa pudica	Fabaceae	-	-	-	-	-	-	-	-	2.34	2.32	-	-
Momordica charantia	Cucurbitaceae	-	-	-	-	-	-	1.77	5.45	0.46	4.65	1.00	5.00
Panicum maximum	Poaceae	0.98	8.82	4.36	15.10	10.35	5.12	-	-	0.31	4.65	-	-

Cont...

Table 2 , cont.

Scientific name	Family	Lowland		Slope		Upper land		Lowland		Slope		Upper land	
		RD	RF	RD	RF	RD	RF	RD	RF	RD	RF	RD	RF
		(%)											
		November 2009						March 2010					
Paspalum plicatulum	Poaceae	0.87	2.94	-	-	-	-	-	-	-	-	-	-
Portulaca oleracea	Portulacaceae	-	-	-	-	-	-	-	-	-	-	19.00	10.00
Pothomorphe umbellata	Piperaceae	0.22	1.47	-	-	-	-	-	-	-	-	-	-
Pteridium aquilinum	Dennstaedtiaceae	0.81	5.88	1.66	5.66	-	-	-	-	0.15	2.32	-	-
Richardia brasiliensis	Rubiaceae	0.05	1.47	0.27	1.88	27.21	12.82	26.63	16.36	52.42	18.60	-	-
Scoparia dulcis	Plantaginaceae	0.21	4.41	-	-	-	-	-	-	-	-	-	-
Sida rhombifolia	Malvaceae	0.21	4.41	-	-	-	-	3.33	9.09	-	-	-	-
Sida spinosa	Malvaceae	0.27	1.47	-	-	-	-	-	-	-	-	-	-
Solanum viarum	Solanaceae	-	-	-	-	0.88	2.56	-	-	-	-	-	-
Sonchus oleraceus	Asteraceae	-	-	-	-	-	-	-	-	0.31	2.32	-	-
Spermacoce latifolia	Rubiaceae	-	-	-	-	-	-	-	-	-	-	12.00	25.00
Vernonia polyanthes	Asteraceae	-	-	-	-	-	-	-	-	-	-	4.00	5.00
Wissadula subpeltata	Malvaceae	0.22	1.47	0.27	3.77	-	-	-	-	-	-	-	-
		November 2010						March 2011					
Acanthospermum hispidum	Asteraceae	-	-	-	-	-	-	7.69	5.88	7.77	5.71	8.69	15.00
Andropogon gayanus	Poaceae	-	-	-	-	-	-	1.09	2.94	-	-	-	-
Arrabidaea florida	Bignoniaceae	-	-	-	-	-	-	-	-	1.03	2.85	-	-
Bambusa sp.	Poaceae	0.31	1.92	-	-	4.08	7.69	-	-	-	-	-	-
Bidens subalternans	Asteraceae	0.93	3.84	0.37	2.22	-	-	1.09	2.94	1.55	5.71	4.34	5.00
Blainvillea biaristata	Asteraceae	-	-	0.18	2.32	2.04	3.84	-	-	-	-	-	-
Brachiaria plantaginea	Poaceae	3.12	3.84	-	-	-	-	1.09	2.94	-	-	-	-
Brachiaria sp.	Poaceae	5.93	9.61	-	-	-	-	15.38	11.76	4.66	11.42	-	-
Calopogonium muconoides	Fabaceae	-	-	0.56	4.44	2.04	3.84	-	-	-	-	-	-
Chamaecrista nictitans	Fabaceae	-	-	-	-	2.04	3.84	-	-	-	-	-	-
Chamaesyce hirta	Euphorbiaceae	1.56	3.84	-	-	-	-	2.19	5.88	-	-	-	-
Commelina benghalensis	Commelinaceae	0.93	1.92	0.18	2.22	-	-	-	-	-	-	-	-
Commelina diffusa	Commelinaceae	-	-	-	-	-	-	2.19	2.19	-	-	-	-
Crotalaria pallida	Fabaceae	-	-	1.13	2.22	-	-	-	-	-	-	-	-
Desmodium tortuosum	Fabaceae	1.25	3.84	-	-	-	-	-	-	-	-	-	-
Digitaria insularis	Poaceae	13.43	13.46	9.65	20.00	6.12	7.69	4.39	11.76	7.25	8.57	-	-
Digitaria sanguinalis	Poaceae	-	-	-	-	-	-	-	-	0.51	2.85	15.21	15.00
Eleusine indica	Poaceae	1.56	3.84	-	-	-	-	-	-	-	-	-	-
Emilia coccinea	Asteraceae	-	-	0.37	4.44	-	-	-	-	-	-	-	-
Emilia fosbergii	Asteraceae	6.87	1.92	0.56	2.22	-	-	3.29	2.94	1.03	5.71	-	-
Galinsoga parviflora	Asteraceae	43.75	15.38	59.09	13.33	-	-	-	-	-	-	-	-
Glycine wightii	Fabaceae	0.31	1.92	-	-	-	-	2.19	5.88	1.55	2.85	-	-
Mikania cordifolia	Asteraceae	0.31	1.92	-	-	2.04	3.84	-	-	0.51	2.85	2.17	5.00
Mimosa setosa	Fabaceae	-	-	-	-	2.04	3.84	-	-	-	-	-	-
Panicum maximum	Poaceae	1.56	3.84	1.32	8.88	2.04	3.84	-	-	-	-	4.34	5.00
Phyllanthus tenellus	Phyllanthaceae	5.31	5.76	-	-	-	-	-	-	-	-	-	-
Physalis pubescens	Solanaceae	-	-	0.75	2.22	-	-	-	-	-	-	-	-
Porophyllum ruderale	Asteraceae	-	-	0.18	2.22	6.12	7.69	-	-	3.1	14.28	2.17	5.00
Pteridium aquilinum	Dennstaedtiaceae	-	-	11.93	4.44	-	-	29.67	17.64	45.59	11.42	-	-
Senna obtusifolia	Fabaceae	-	-	-	-	-	-	2.19	2.94	-	-	-	-
Setaria vulpiseta	Poaceae	-	-	-	-	14.28	19.23	-	-	-	-	15.21	15.00
Sicyos polyacanthus	Cucurbitaceae	0.62	3.84	-	-	-	-	-	-	-	-	-	-
Sida cordifolia	Malvaceae	0.62	1.92	-	-	-	-	-	-	-	-	-	-
Sida rhombifolia	Malvaceae	3.12	5.76	-	-	2.04	3.84	24.17	20.58	1.03	2.85	-	-
Sidastrum micranthum	Malvaceae	7.81	9.61	-	-	-	-	-	-	-	-	-	-
Spermacoce latifolia	Rubiaceae	-	-	7.95	17.7	44.89	19.23	3.29	2.94	23.31	17.14	45.65	30.00
Stachys arvensis	Lumiaceae	0.62	1.92	-	-	-	-	-	-	-	-	-	-
Tibouchina moricandiana	Melastomaceae	-	-	1.13	4.44	-	-	-	-	1.03	5.71	-	-
Vernonia polyanthes	Asteraceae	-	-	-	-	2.04	3.84	-	-	-	-	2.17	5.00
Wissadula subpeltata	Malvaceae	-	-	3.59	4.44	6.12	3.84	-	-	-	-	-	-

However, they show differences relating to environmental factors, such as, for example, rainfall, solar radiation, among others. This has possibly caused the occurrence of vegetal species. For Carvalho & Nakagawa (2000), most of these plants have seeds or structures that lie dormant in periods that are unfavorable to germination and growth, leaving their establishment to a favorable time. In Guanhães, as well as in Santana do Paraíso, *Spermacoce latifolia* was very representative (Tables 2 and 3), but not showing specificity depending on the topography, which can be attributed to its ability to adapt to different environments. According to Lorenzi (2008), it is a plant found in almost the entire Brazilian territory.

The occurrence of species that are difficult to control with glycophosate and mechanical methods, such as *Commelina benghalensis*, *Spermacoce latifolia*, *Digitaria insularis*, *Mikania cordifolia*, *Vernonia polyanthes*, *Tibouchina moricandiana* and *Arrabidaea florida*, must be monitored. The repeated and frequent application of this herbicide, commonly used in eucalyptus plantations (Tuffi Santos et al., 2011), may favor species that are tolerant to glyphosate, in contrast to other weeds that are controlled with this herbicide, exacerbating the problem of difficult control and the frequency and density of the problem-species.

Arrabidea florida, belonging to the family Bignoniaceae, was present in all assessments, presenting high density and frequency values, especially at the sloped and upper areas, in all periods studied (Table 3). The high occurrence may be due to its climbing-habit form of development, allowing coverage of large areas.

Table 3 - Phytosociological parameters of species sampled in eucalyptus plantations in Guanhães - MG in different times of year. RD = relative density and RF = relative frequency

Scientific name	Family	Lowland		Slope		Upper land		Lowland		Slope		Upper land	
		RD	RF	RD	RF	RD	RF	RD	RF	RD	RF	RD	RF
		(%)											
		November 2009						March 2010					
Arrabidaea florida	Bignoniaceae	9.48	15.9	-	-	18.65	17.14	-	-	38.29	24.00	18.35	17.14
Bambusa sp.	Poaceae	-	-	-	-	-	-	-	-	2.12	4.00	-	-
Brachiaria brizantha	Poaceae	-	-	15.02	18.6	1.58	5.71	-	-	-	-	-	-
Brachiaria plantaginea	Poaceae	-	-	1.72	2.32	-	-	-	-	6.38	4.00	32.81	20
Calopogonium muconoides	Fabaceae	-	-	0.31	2.32	-	-	-	-	-	-	-	-
Chamaecrista nictitans	Fabaceae	-	-	-	-	2.38	2.85	-	-	-	-	2.34	2.85
Chaptalia nutans	Asteraceae	15.02	18.6	-	-	-	-	1.21	2.38	-	-	-	-
Sicyos polyacanthus	Cucurbitaceae	1.72	2.27	-	-	-	-	-	-	-	-	-	-
Commelina benghalensis	Commelinaceae	-	-	5.00	4.65	-	-	-	-	-	-	-	-
Conyza bonariensis	Asteraceae	12.06	13.63	-	-	-	-	-	-	-	-	-	-
Desmodim barbatum	Fabaceae	10.34	4.54	1.56	2.32	-	-	-	-	-	-	-	-
Diatenopterix sorbifolia	Sapindaceae	0.86	2.27	-	-	-	-	-	-	-	-	-	-
Echinochloa polystachya	Poaceae	1.72	2.27	-	-	-	-	-	-	-	-	-	-
Emilia fosbergii	Asteraceae	0.86	2.27	-	-	-	-	-	-	-	-	-	-
Gaya guerkeana	Malvaceae	-	-	-	-	-	-	-	-	-	-	2.34	11.42
Glycine wightii	Fabaceae	10.34	4.54	8.45	11.62	-	-	-	-	-	-	-	-
Imperata brasiliensis	Poaceae	-	-	-	-	-	-	-	-	10.63	16.00	-	-
Melampodium paniculatum	Asteraceae	-	-	-	-	-	-	-	-	-	-	0.39	2.85
Mikania cordifolia	Asteraceae	-	-	-	-	0.39	2.85	-	-	-	-	-	-
Mimosa pudica	Fabaceae	-	-	2.34	2.32	-	-	-	-	-	-	-	-
Momordica charantia	Cucurbitaceae	-	-	0.46	4.65	-	-	-	-	-	-	-	-
Palicourea marcgravii	Rubiaceae	0.86	2.27	-	-	-	-	-	-	-	-	-	-
Panicum maximum	Poaceae	-	-	0.31	4.65	-	-	-	-	-	-	-	-
Piper aduncum	Piperaceae	10.34	6.81	-	-	-	-	-	-	-	-	-	-
Pluchea sagittalis	Asteraceae	-	-	-	-	-	-	3.03	4.76	4.25	8.00	-	-
Pteridium aquilinum	Dennstaedtiaceae	-	-	-	-	-	-	-	-	6.38	4.00	-	-
Richardia brasiliensis	Rubiaceae	-	-	52.42	5.71	-	-	-	-	-	-	0.78	5.71
Sida rhombifolia	Malvaceae	7.75	9.09	-	-	-	-	29.09	16.66	4.25	4.00	30.85	20
Solanum asperolanatum	Solanaceae	11.2	6.81	-	-	10.71	14.28	14.54	14.28	17.02	20.00	10.54	14.28
Spermacoce latifolia	Rubiaceae	11.2	9.09	-	-	-	-	-	-	-	-	-	-
Vernonia polyanthes	Asteraceae	12.93	15.9	-	-	-	-	1.21	2.38	2.12	4.00	-	-

Cont...

Table 3 , cont.

Scientific name	Family	Lowland		Slope		Upper land		Lowland		Slope		Upper land	
		RD	RF	RD	RF	RD	RF	RD	RF	RD	RF	RD	RF
		(%)											
		November 2010						March 2011					
Arrabidaea florida	Bignoniaceae	-	-	35.63	13.88	30.0	17.85	-	-	3.52	6.45	10.47	20.69
Bambusa sp.	Poaceae	-	-	-	-	-	-	5.40	10.25	9.41	12.9	6.66	17.24
Blainvillea biaristata	Asteraceae	1.80	4.76	3.19	2.77	-	-	-	-	-	-	-	-
Brachiaria mutica	Poaceae	-	-	-	-	-	-	17.56	10.25	9.41	12.9	18.09	24.13
Brachiaria sp.	Poaceae	18.07	9.52	6.91	16.66	10.58	10.71	9.45	17.94	-	-	-	-
Chenopodium ambrosioides	Amaranthaceae	-	-	-	-	-	-	-	-	-	-	2.85	3.44
Conyza canadensis	Asteraceae	-	-	0.53	2.77	1.76	3.57	-	-	-	-	-	-
Crepis japonica	Asteraceae	0.60	2.38	-	-	18.65	17.14	-	-	-	-	-	-
Crotalaria micans	Fabaceae	-	-	0.53	2.77	-	-	-	-	-	-	-	-
Crotalaria pallida	Fabaceae	-	-	0.53	2.77	-	-	-	-	-	-	-	-
Cyperus rotundus	Cyperaceae	-	-	-	-	-	-	1.35	2.56	2.35	3.22	-	-
Dactyloctenium aegyptium	Poaceae	1.80	2.38	-	-	-	-	4.05	2.56	-	-	-	-
Desmodium tortuosum	Fabaceae	-	-	-	-	-	-	1.35	2.56	1.17	3.22	-	-
Digitaria insularis	Poaceae	-	-	-	-	0.58	3.57	-	-	-	-	-	-
Digitaria sanguinalis	Poaceae	-	-	-	-	-	-	5.40	5.12	-	-	-	-
Emilia coccinea	Asteraceae	13.85	16.66	1.06	2.77	2.35	3.57	-	-	-	-	-	-
Emilia fosbergii	Asteraceae	-	-	-	-	-	-	-	-	-	-	0.95	3.44
Erechtites hieraciifolius	Asteraceae	-	-	-	-	3.52	3.57	-	-	-	-	-	-
Galinsoga parviflora	Asteraceae	1.80	4.76	5.85	2.77	-	-	-	-	-	-	-	-
Glycine wightii	Fabaceae	0.60	2.38	-	-	-	-	-	-	-	-	-	-
Malvastrum coromandelianum	Malvaceae	4.21	4.76	1.06	2.77	-	-	-	-	-	-	-	-
Phyllanthus tenellus	Phyllanthaceae	-	-	-	-	1.76	7.14	-	-	1.17	3.22	-	-
Porophyllum ruderale	Asteraceae	-	-	0.53	2.77	-	-	1.35	2.56	-	-	-	-
Pteridium aquilinum	Dennstaedtiaceae	0.60	2.38	-	-	-	-	-	-	-	-	-	-
Pteridium sp.	Dennstaedtiaceae	-	-	-	-	-	-	2.70	5.12	2.35	3.22	-	-
Rhynchospora corymbosa	Cyperaceae	1.20	4.76	-	-	-	-	-	-	-	-	-	-
Scleria pterota	Cyperaceae	-	-	-	-	-	-	-	-	1.17	3.22	-	-
Setaria vulpiseta	Poaceae	0.60	2.38	2.12	2.77	-	-	2.70	5.12	-	-	0.95	3.44
Sida rhombifolia	Malvaceae	6.62	11.9	2.12	5.55	3.52	14.28	4.05	7.69	4.7	6.45	3.80	6.89
Sidastrum micranthum	Malvaceae	-	-	2.12	5.55	-	-	-	-	-	-	-	-
Siegesbeckia orientalis	Asteraceae	-	-	-	-	-	-	1.35	2.56	-	-	-	-
Solanum paniculatum	Solanaceae	7.83	7.14	7.97	11.11	9.41	3.57	16.21	7.69	3.52	6.45	1.90	3.44
Spermacoce latifolia	Rubiaceae	13.85	14.28	29.78	22.22	18.23	25.00	22.97	12.82	57.64	29.03	54.28	17.24
Tibouchina moricandiana	Melastomaceae	-	-	-	-	0.58	3.57	-	-	1.17	3.22	-	-
Vernonia polyanthes	Asteraceae	1.20	4.76	-	-	-	-	4.05	5.12	-	-	-	-
Wissadula subpeltata	Malvaceae	0.60	2.38	-	-	-	-	-	-	-	-	-	-

Vernonia polyanthes is another species that is prominent in view of its high density and frequency values in the lowland in the first survey (Table 3), as well as regarding its stay in the same area, though with lower values. Probably, the high density and frequency of this species are established based on its affinity for the soil composition in the area of occurrence. *V. polyanthes* multiplies easily in soils of high fertility (Alzugaray & Alzugaray, 1984).

Throughout the study period, *G. parviflora* was the most abundant species in eucalyptus plantations in the areas under study, particularly in the lowland (Figure 2).

In each kind of relief, exclusive species were found in addition to those that were common to all areas. During the surveys, it was possible to identify the occurrence of alterations in the number of species common to each area of study (Figure 3).

Such changes may have been due to the management of the culture or even influenced by the culture growth. According to Mulugueta & Stoltenberg (1997), the different forms of management condition the seeds to the soil microenvironments, as a function of alterations in the properties and superficial composition of this substrate.

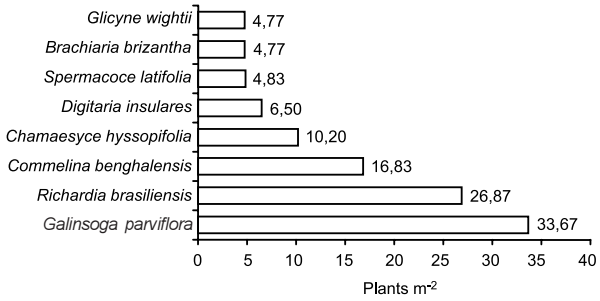

Figure 2 - Number of plants/m² by weed species present in eucalyptus plantations in Santana do Paraíso and Guanhães-MG.

In Santana do Paraíso, in the first survey, the three areas had six species in common (Figure 3): *Desmodium barbatum*, *Digitaria insularis*, *Galinsoga parviflora*, *Glycine wightii*, *Panicum maximum* and *Richardia brasiliensis*. In the second, they were three (Figure 3): *Brachiaria brizantha*, *Digitaria insularis* and *Momordica charantia*. In the third, only one (Figure 3): *Panicum maximum*. In the fourth and last survey, three species in common were identified (Figure 3): *Acanthospermum hispidium*, *Bidens subalternans* and *Spermacoce latifolia*. But in the study areas in Guanhães, it was observed a difference in regard to the common species. In the first study (November, 2009), there were no species in common. In March 2010, two species were found (Figure 4): *Sida rhombifolia* e *Solanum asperolanatum*. In November 2010, they were five (Figure 4): *Brachiaria* sp., *Emilia coccinea*, *S. rhombifolia*, *S. paniculatum* and *Spermacoce latifolia*. In the last assessment, conducted in March 2011, in the three types of relief, five species in common were found (Figure 4): *Bambusa* sp., *Brachiaria mutica*, *S. rhombifolia*, *S. paniculatum* and *S. latifolia*. It can be seen that there was a change in the species that are common to all areas. It can be inferred that this is a result of the local environmental conditions provided by the eucalyptus growth.

The families Poaceae and Asteraceae showed several common species to all areas under study, with emphasis on *R. brasiliensis*, *B. subalternans*, *D. insularis* and *Panicum maximum*. *Glicyne wightii*, *Pothomorphe umbellata* and *Scoparia dulcis* were exclusive in Santana do Paraíso, while *Conyza bonariensis*, *Diatenopterix sorbifolia*, *Melampodium paniculatum* and *Rhynchospora corymbosa* were only found in Guanhães.

Some weeds have the ability to adapt and multiply in environments with contrasting characteristics, a good indicator of the species plasticity.

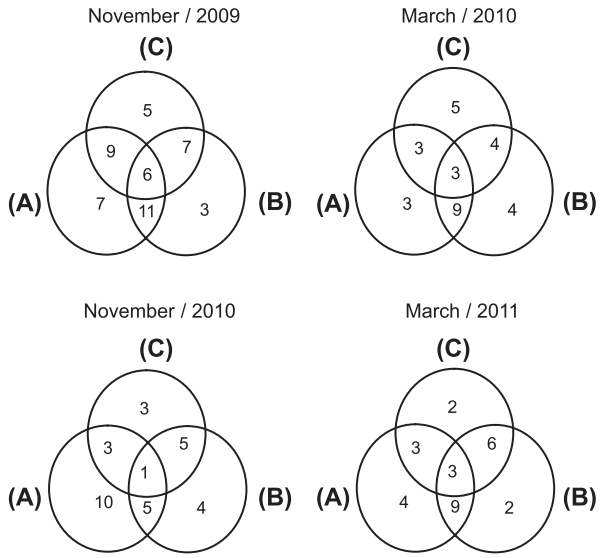

Figure 3 - Venn diagram with number of species of the community of weeds found in eucalyptus plantation in the lowland (A), slope (B) and upper area (C) in Santana do Paraíso-MG at different times.

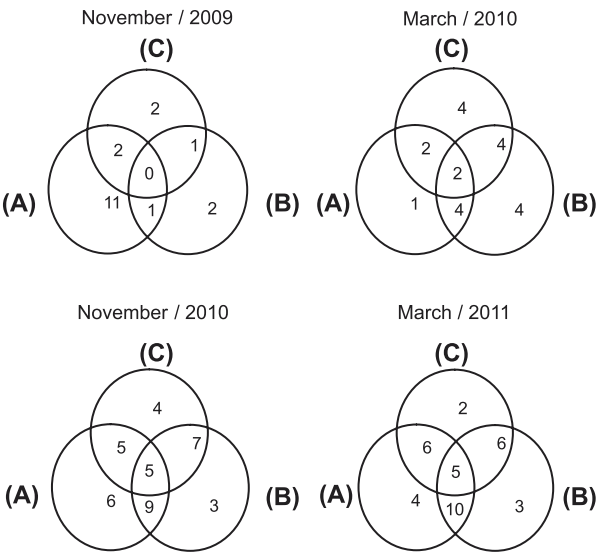

Figure 4 - Venn diagram with number of species of the community of weeds found in eucalyptus plantation in the lowland (A), slope (B) and upper area (C) in Guanhães-MG at different times.

Changes in the eucalyptus cultivation environment are in part determined by growth and alterations in the architecture of the trees canopy as well as the required resources of each phenological stage. Thus, studies on the weeds dynamics as discussed herein should be extended to the whole cycle of the eucalyptus culture.

Floristic and phytosociologic variation of weeds in eucalyptus forestry is influenced by the topography and time of year, as a result of the ecological conditions to which they are submitted in each situation. The largest number of individuals is found in the lowlands, and the lowest one in the upper area. Some species have affinity for a given type of topography, and some occur preferably at a certain time of the year. In contrast, there are some weeds that are present in all kinds of topography. However, the occurrence of weeds in eucalyptus plantation has no patterns regarding the topography and time of year, requiring a specific evaluation to decide on the management practices to be adopted. The species *Commelina benghalensis*, *Spermacoce latifolia*, *Digitaria insularis*, *Mikania cordifolia*, *Vernonia polyanthes, Tibouchina moricandiana* and *Arrabidaea florida* are considered of difficult management in forested areas and have importance in the eucalyptus plantations investigated.

ACKNOWLEDGEMENTS

The authors wish to thank the Japanese-Brazilian Pulp and its field technicians for the support and research funding. To FAPEMIG for the financial aid and to CNPq for the scholarship awarded to the first and fifth authors.

LITERATURE CITED

ASSOCIAÇÃO BRASILEIRA DE PRODUTORES DE FLORESTAS PLANTADAS – ABRAF. **Anuário Estatístico da ABRAF 2012**: ano base 2011. Brasília: 2012. 150 p.

ALZUGARAY, D.; ALZUGARAY, C. **Flora Brasileira:** primeira enciclopédia de plantas do Brasil. São Paulo: Três, 1984. v. 1. p. 65-66.

BENTIVENHA, S. R. P. et al. Mobilização do solo e crescimento inicial do eucalipto em função do tipo de haste subsoladora, profundidade de trabalho e características do solo. **Eng. Agríc.**, v. 23, n. 3, p. 588-605, 2006.

CAPORAL, F. J. M.; BOLDRINI, I. I. Florística e fitossociologia de um campo manejado na Serra do Sudeste, Rio Grande do Sul. **R. Bras. Bioci.**, v. 5, n. 2-3, p. 37-44, 2007.

CARVALHO, N. M.; NAKAGAWA, J. **Sementes**: ciência, tecnologia e produção. Jaboticabal: FUNEP, 2000. 588 p.

DODD, J. C.; JEFFRIES, P. Effests of herbicides on tree vesicular-arbuscular fungi associated with winter wheat (*Triticum aestivum* L.). **Biol. Fert. Soils**, v. 7, n. 2, p. 113-119, 1989.

HOLM, L. G. et al. **The world's worst weeds**: distribution and biology. 2.ed. Malabar: Krieger, 1991. 609 p.

LANA, J. M. **Levantamento de plantas conviventes com plantios de eucalipto em áreas da CENIBRA**. 2001. 84 p. (Technical Report and Identification Catalog)

LORENZI, H. **Plantas daninhas do Brasil:** terrestres, aquáticas, parasitas e tóxicas. 4.ed. Nova Odessa: Plantarum, 2008. 640 p.

LORENZI, H.; MATOS, F. J. A. **Plantas medicinais no Brasil:** nativas e exóticas. 2.ed. Nova Odessa: Instituto Plantarum, 2008. 544 p.

LORENZI, H.; SOUZA, H. M. **Plantas ornamentais no Brasil:** arbustivas, herbáceas e trepadeiras. 3.ed. Nova Odessa: Instituto Plantarum, 2001. 1088 p.

LORENZI, H. Manual de identiûcação e controle de plantas daninhas: Plantio direto e convencional. 3.ed. Nova Odessa: Instituto Plantarum, 1990. 269 p.

MUELLER-DOMBOIS, D.; ELLENBERG, H. **Aims and methods of vegetation ecology**. New York: John Wiley, 1974. 547 p.

MULUGUETA, D.; STOLTENBERG, D. E. Increase weed emergence and seed bank depletion by soil disturbance in no-tillage systems. **Weed Sci.**, v. 45, n. 2, p. 234-241, 1997.

OLIVEIRA, A. R.; FREITAS, S. P. Levantamento fitossociológico de plantas daninhas em áreas de produção de cana-de-açúcar. **Planta Daninha**, v. 26, n. 1, p. 33-46, 2008.

PAULA JUNIOR, T. J. et al. Efeito de glifosate e oxyfluorfen sobre *Pisolithus tinctorius* e sobre a micorrização de raízes de *Eucalyptus grandis*. **R. Árvore**, v. 19, n. 2, p. 248-255, 1995.

RODRIGUES, A. C. P. et al. Períodos de interferência de plantas daninhas na cultura do sorgo. **Planta Daninha**, v. 28, n. 1, p. 23-31, 2010.

TUFFI SANTOS, L. D. et al. Glyphosate reduces urediniospore development and *Puccinia psidii* disease severity on *Eucalyptus grandis*. **Pest Manag. Sci.**, v. 67, n. 7, p. 876-880, 2011.

WELKER, C. A. D.; LONGHI-WAGNER, H. M. A família *Poaceae* no Morro Santana, Rio Grande do Sul, Brasil. **R. Bras. Bioci.**, v. 5, n. 4, p. 53-92, 2007.