BIOMASS AND NUTRIENT ACCUMULATION BY THE SPONTANEOUS VEGETATION IN ORGANIC COFFEE CROPS

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ABSTRACT: To evaluate biomass production and nutrient accumulation by the spontaneous vegetation in organic coffee crops and the phytosociology of these species, an experiment was set up at Fazendinha Agroecológica, in Seropédica, Rio de Janeiro state, in Brazil. The experiment consisted of 3 treatments, corresponding to the systems of cultivation of 8 year-old conilon coffee trees (*Coffea canephora* Pierre ex A. Froehner) in association with the tree legumes *Gliricidia sepium* (Jacq.) Kunth ex Walp. and *Erythrina variegata* L. (treatments 1 and 2), and a full sun cultivation system (treatment 3), distributed in a random block design with 6 replicates. Although 6 hoeings were performed over the course of 1 year, the aerial biomass produced by the spontaneous vegetation and the N, P, K, Ca, Mg and micronutrient contents accumulated were measured in only five periods, to estimate the amount of nutrients that could be recycled after decomposition. The phytosociology of the spontaneous vegetation was evaluated in October 2006 and June 2007. Based on the species found, richness, abundance, relative frequency of species and Shannon's diversity index were determined. The most significant biomass production values were obtained between October and December 2006, the highest results being found in coffee grown with gliricidia. No differences regarding the N, K, and Ca contents in the biomass were observed between the different treatments; however, the highest P content was registered in coffee grown in the full sun system, while the highest Mg content was found in coffee grown with gliricidia. The diversity of plant species is small and no differences were observed between the systems. The most frequent invasive plant species in the systems, in both periods assessed, were *Commelina diffusa* Burm. f. and *Paspalum conjugatum* L.

Key words: Organic agriculture, weeds, invasive plants, nutrient cycling, phytosociology.

BIOMASSA E ACÚMULO DE NUTRIENTES PELA VEGETAÇÃO ESPONTÂNEA EM CULTIVO DE CAFÉ ORGÂNICO

RESUMO: *Com o objetivo de avaliar a produção de biomassa e o acúmulo de nutrientes pela vegetação espontânea em cultivos orgânicos de café e a fitossociologia dessas espécies, foi desenvolvido um experimento na Fazendinha Agroecológica em Seropédica, RJ, onde foram avaliados três tratamentos, que corresponderam aos sistemas de cultivo de café Conilon (Coffea canephora Pierre ex A. Froehner) associado às leguminosas arbóreas Gliricidia sepium (Jacq.) Kunth ex Walp. e Erythrina variegata L. (tratamentos 1 e 3) e cultivo a pleno sol (tratamento 2), com oito anos de idade, os quais foram no distribuídos no delineamento em blocos ao acaso com seis repetições. Apesar de terem sido realizadas seis roçadas durante o ano, em apenas cinco épocas, avaliaram a biomassa aérea produzida pela vegetação espontânea e os teores de N, P, K, Ca e Mg e micronutrientes acumulados na biomassa, com a finalidade de estimar a quantidade de nutrientes possíveis de serem reciclados após a decomposição. A fitossociologia da vegetação espontânea foi avaliada em outubro de 2006 e junho de 2007, e pelas espécies encontradas, determinaram a riqueza, a abundância, a frequência relativa das espécies e o índice de diversidade de Shannon. As produções mais significativas de biomassa foram obtidas no período de outubro a dezembro de 2006, registrando-se a maior produção no cultivo do café com glirícidia. Não há diferença entre os tratamentos quanto aos teores de N, K, Ca na biomassa; porém, o maior teor de P é observado no café a pleno sol, e o de Mg, no café com gliricídia. A diversidade de espécies vegetais é baixa e não há diferença entre os sistemas. As espécies de plantas invasoras encontradas em maior frequência nos sistemas nas duas épocas avaliadas são a Commelina diffusa Burm. f. (trapoeraba) e Paspalum conjugatum Berg. (Capim-forquilha).*

Palavras-chave: Agricultura orgânica, plantas daninhas, plantas invasoras, ciclagem de nutrientes, fitossociologia.

1 INTRODUCTION

Brazil is the world's 6th largest organic coffee producer, with a yield of approximately 80.000 sacks that represents 0,2% of the country's total coffee production (MOREIRA, 2003). Due to a series of difficulties faced by producers, the mean yield of organic systems is generally considered low (10 to 15 processed 60 kg sacks per hectare). One of the main difficulties in organic coffee production is the

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low concentration of nutrients in the alternative sources, among which nitrogen is the most limiting due both to its low concentration and to the high demands of the coffee trees. Theodoro et al. (2007), however, have registered a yield of 37,7 sacks/ ha^{-1} in organic arabica coffee crops in the south of Minas Gerais state, Brazil.

In conventional production systems, although extensive use of mineral fertilizers is allowed, it leads to a gradual degradation of the soil, especially of organic matter, and is considered one of the causes of low productivity rates. To maintain production levels, the demand for mineral fertilizers is constantly increasing which, consequently, leads to higher production costs.

The most efficient alternatives for enhancing organic matter in soils and promoting nutrient cycling in the systems are green manure or management of the live coverage and of the spontaneous vegetation cut off residues, leaf fall, pruning of the branches, among others, which return large quantities of organic carbon to the soil and decrease erosion losses. Green fertilization has been widely used to introduce large amounts of organic matter, originating from the vegetative biomass produced, into the soil to keep it covered and protected from erosion; moreover, it also increases biological activity and stimulates important biological processes, such as nutrient cycling and biological nitrogen fixation, and controls invading species (ERASMO et al., 2004; NASCIMENTO & MATTOS, 2007; RICCI et al., 2002a; THEODORO, 2006).

Theodoro et al. (2003) assessed the chemical characteristics of soil and leaf macro and micronutrients in 21 organic coffee crops representative of Minas Gerais state, Brazil. The authors concluded that organic coffee production systems are efficient in supplying N to the trees, which can be done through green fertilization, application of organic compounds, spontaneous vegetation cut off and permanent vegetative covering of the soil.

Spontaneous vegetation competes with coffee for water and nutrients, leading to production losses that vary between 55,9% to 77,2% (GARCIA BLANCO et al., 1982). For this reason, the species that occur spontaneously in agricultural areas are considered invaders or weeds that result in more losses than benefits to the crops (FAVERO et al., 2000; SANTOS et al., 2000).

In organic agriculture herbicides are forbidden. More labor is then necessary to control spontaneous vegetation, which increases production costs (RICCI & OLIVEIRA, 2007).

A simple and cost effective alternative is to leave the spontaneous vegetation between the lines, cutting it off periodically to manage competition with the coffee trees (SANTOS et al., 2002), instead of eliminating it completely. When properly managed, this vegetation protects the soil from erosion and sunlight, decompacts the soil, increasing its airing and water retention, produces biomass, recycles nutrients from the deeper layers of the soil to its surface, making them available to the coffee trees again and, finally, it serves as a shelter for predators of possible coffee pests (BARUQUI & FERNANDES, 1985; MESQUITA et al., 1992; RICCI et al., 2002b; VASCONCELOS & PACHECO, 1987). Alcântara et al. (2007) assessed 7 methods of controlling invasive plants in coffee crops and concluded that the treatment without any type of control (control) increased soil pH and decreased Al^{3+} concentration and Al^{3+} saturation at 15 and 30 cm depths. The treatment closest to the control was the cut off treatment.

There is evidence that spontaneous vegetation influences the diversity and abundance of herbivorous insects and associated natural predators in the cultivation systems. Some spontaneous plants have important ecological roles in sheltering and sustaining a complex of arthropods that help to suppress pest populations (ALTIERI et al., 2002).

The spontaneous vegetation between the lines in coffee crops is also a green fertilizer and an efficient way of recycling nutrients to the coffee trees, supplying them significant quantities of macro (P, Ca, Mg, K and N) and micronutrients (FAVERO et al., 2000; QASEM, 1992).

The aim of this work was to assess biomass production and nutrient accumulation by the aerial part of the spontaneous vegetation in two coffee cultivation systems, full sun and in association with other plant species, and also to assess the phytosociology of these species.

2 MATERIAL AND METHODS

The experiment was set up at the Fazendinha Agroecológica (km 47), an organic production unit in the SIPA (Integrated Agroecological Production System) project's experimental area, located in Seropédica, Rio de Janeiro state, Brazil. The area is destined for organic production and is part of a project developed by Embrapa Agrobiology, in association with the UFRRJ (Federal Rural University of Rio de Janeiro) and PESAGRO – Rio (Company of Agricultural Research of Rio de Janeiro).

The experimental area was planted in February 1999 with conilon coffee (*Coffea canephora* Pierre ex A. Froehner), cultivar 8121, provided by the Instituto Capixaba de Pesquisa, Assistência Técnica e Extensão Rural – INCAPER. The coffee trees (1000 in total) were distributed in 8 rows planted in curve levels in a 3,0 m x 1,5 m spacing. Only the 6 central rows were used in this study.

The experiment consisted of 3 treatments in a random block design with 6 replications (cultivation rows): coffee in association with the tree legumes *Gliricidia sepium* Kunth ex Walp. and *Erythrina variegata* L. (treatment 1), *Erythrina variegata* L. (treatment 3) and coffee produced in the full sun system (treatment 2).

The tree species were planted in a 9 m x 9 m spacing, from cuttings 2,20 m high and 0, 10 m in diameter, taken from trees on the property.

Previous soil analysis provided the following values: water pH (5,6); Al (0,1 $cmol_c$ dm^{-3}); Ca (1,6 $cmol_c$ dm^{-3}); Mg (1,3 $cmol_c$ dm^{-3}); P (15,1 mg dm^{-3}); K (387 mg dm^{-3}).

In 2006 liming was not done and annual fertilization was done with 1 kg of castor berry cake (5% to 6% of N) per plant, supplied in one single application at the end of January. This fertilization corresponded to the application of 110 to 133 kg of N per hectare.

The experiment lasted 1 year, during which cutting off was done 6 times using forestry cleary saws on the following dates: July, October and December 2006; January, March and May 2007. On 5 dates (except January 2007) the spontaneous vegetation's aerial biomass was estimated by collecting all the biomass in two 0,5 m x 0,5 m squares (0,25 m^2), at the center of the lines in each plot. The material was weighed and dried in a forced air circulation furnace at 65ºC for 72 hours. After drying, the material was weighed, ground and its N, P, K, Ca, Mg and micronutrient content was determined (EMBRAPA, 1997) to estimate the quantity of dry matter produced, the concentration of nutrients accumulated by the vegetation in each treatment and to estimate the amount of nutrients recycled after decomposition of this biomass left below the soil surface.

The spontaneous vegetation's phytosociology was also assessed in 2 periods: the first in October 2006 (start of the rainy season) and the second in June 2007 (dry season), using the shoetipe methodology adopted by CATIE (STAVER, 2001). This methodology consists of walking between the coffee lines, where 20 points have been marked in each plot. Between two points, five steps are counted and the species found in the center of the shoetip (diameter of a pencil) is identified.

The richness (number of species), abundance (number of individuals) and relative frequency (F) of the species (*pe* = n/N) and the Shannon diversity index (H') were determined. The Shannon diversity was calculated through the equation $H' = -\sum n/N \ln n/N$ (MAGURRAN, 1988), where n = number of individuals of a determined species and N = total number of individuals.

Data variation analysis using the F test and comparison of the means through the Scott-Knott test (5% probability) were done by the SISVAR program (FERREIRA, 2000).

3 RESULTS AND DISCUSSION

The largest amount of biomass was produced by the spontaneous vegetation in October and December 2006 (treatment means) (Figure 1), a period that coincided with the start of the rainy season and of higher temperatures. The largest amount of biomass was obtained in the plots coffee associated with gliciridia, (14,7 Mg ha^{-1}), in relation to coffee cultivated in the full sun system (12,6 Mg ha^{-1}) and in association with eritrina (12,5 Mg ha^{-1}).

During a one year period, the spontaneous vegetation's biomass production standards were similar in the three systems. A greater biomass production rate was observed between October and March (Figure 1). This reinforces the importance of intense management of the vegetation during this period, which coincides with the filling grain phase and which may affect coffee production. According to Pitelli (1985), in studies of the capacity of invasive plants to compete with crops, dry biomass production by the spontaneous vegetation is more important than nutrient accumulation. The author affirms that an invasive species may, however, accumulate more nutrients due to its low dry biomass production, interfering less with the crop.

In the treatments assessed, the full sun system (treatment 2) and the coffee cultivated with eritrina (treatment 3) presented statistically similar biomass production results, both of which were inferior to results obtained for coffee cultivated with gliricidia (treatment 1). These values are contrary to the results found by Ricci et al. (2004) in the same study area.

Regarding the shading levels of the tree species assessed in this work, eritrina has a more defined canopy, providing less shade and, consequently, allowing for more sunlight in the system. Gliricidia, on the other hand, has a more spread out, homogenous canopy, shading practically the entire crop. This characteristic might explain why treatments 2 and 3 presented similar biomass results.

Ricci et al. (2004) also concluded that coffee cultivated with gliciridia and banana provided less richness and abundance and a lower Shannon diversity index, besides reducing significantly the spontaneous vegetation's dry biomass levels. In this work, spread dayflower (*Commelina diffusa* Burm. f.) and fork grass (*Paspalum conjugatum* Berg.) were the most frequent invasive species in the coffee grown with gliciridia. According to Lorenzi (2000), both prefer more humid and semi-shaded soils, which probably favored their germination and growth and contributed to the system's higher biomass production.

Regarding the nutrients accumulated by the spontaneous vegetation's biomass, the treatments did not present significant differences of N concentration in any of the periods assessed (Table 1). There was a difference, however, regarding the periods, as higher concentrations were found in October 2006 (start of the rainy season) and May 2007. In October, the higher N content was possibly due to decomposition of the coffee biomass, resultant of the cleaning pruning done in September 2006. The biomass (dead covering) was spread over the soil between the lines and its decomposition was intensified by the onset of the rains.

It is unlikely that the higher N accumulation observed in May 2007 is related to the annual fertilization of the crop, as this was done at the end of January 2007, and fertilizer application was concentrated in a radius of, approximately, 0,50 m from the plant stems and the spontaneous vegetation's biomass was sampled at the center of the lines.

The spontaneous vegetation's biomass presented different P and Mg concentrations in the treatments. The highest P content was observed in the full sun treatment, while Mg appeared in a higher concentration in the coffee with gliricidia (Table 1). The highest accumulation of these nutrients was registered in May 2007, similar to the N results (Table 1).

There were no significant differences in biomass K and Ca concentrations between the treatments, considering the means of the periods assessed (Table 1). The highest K contents in the vegetation's biomass were observed in October and December 2006, and the lowest in July 2006 and March and May 2007. During these months, coffee beans demand more K, which could have decreased its accumulation in the vegetation. The higher soil humidity (rainy season) may also have caused the higher K concentrations in October and December, as K is transported to the root surface through diffusion and mass flow mechanisms, a process of nutrient transportation in the soil that depends on its humidity level (OLIVEIRA et al., 2004).

Ronchi et al. (2003), studying the effects of the interference, more specifically of the competition, of five invasive weed species (*Bidens pilosa* L., *C. diffusa*, *Leonurus sibiricus* L., *Richardia brasiliensis* Gomes, *Nicandra physaloides* (L.) Gaertn. and *Sida rhombifolia* L.) on the relative macro and micronutrient concentration of coffee seedlings, concluded that the affect of these species on nutrient accumulation in coffee varied according to the species and to their density (number of individuals per area unit). Among the five species studied, *B. pilosa*, *C. diffusa*, *L. sibiricus* and *R. brasiliensis*, even in low densities, led to a considerable reduction of relative nutrient contents in coffee plants. *B. pilosa* was the weed that extracted the highest amount of nutrients, while *N. physaloides* and *S. rhombifolia* interfered least with the crop.

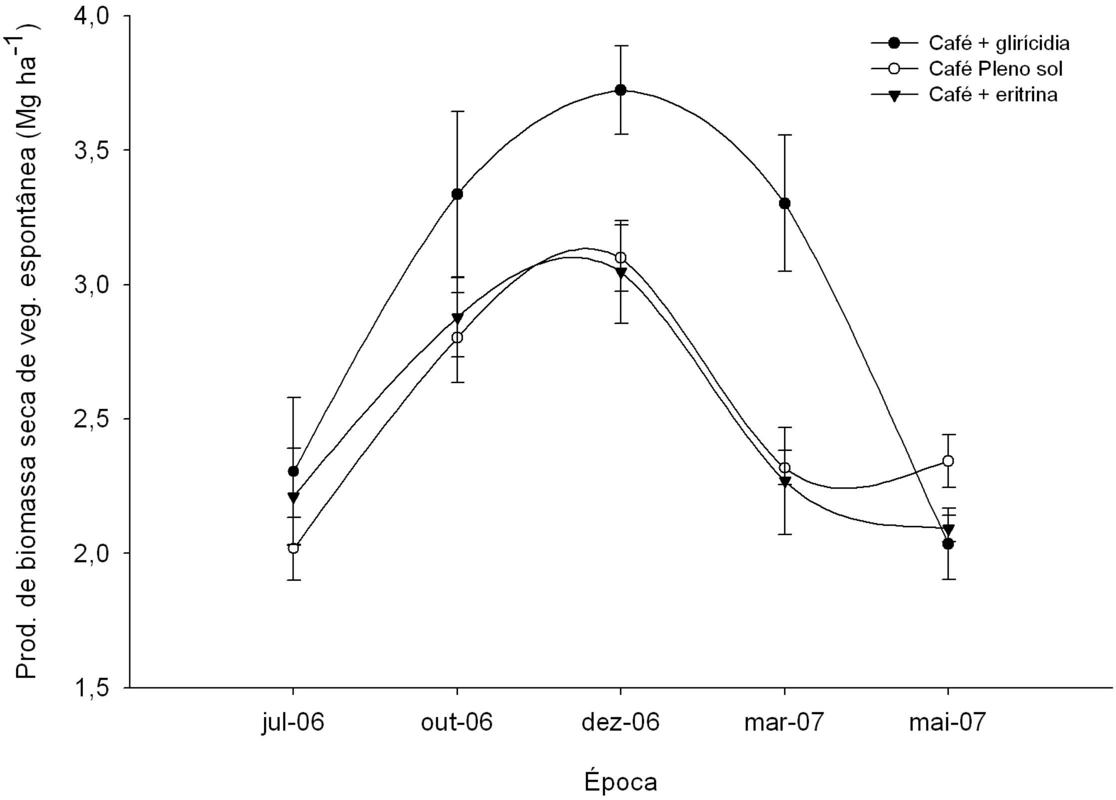

Figure 1 – Spontaneous vegetation's mean dry biomass production in Mg ha^{-1} (mean of the 6 replications) in function of the treatments and periods assessed. Seropédica, Rio de Janeiro state.

Table 1 – Macronutrient concentrations (g kg^{-1}) (mean of 6 replications) in the spontaneous vegetation's biomass, in function of the treatments and periods assessed. Seropédica, Rio de Janeiro state, 2006-2007.

Treatments	Jul/06	Oct/06	Dec/06	Mar/07	May/07	Mean
			N			
Coffee+ glirícidia	17,02 aB	21,42 aA	15,69 aB	14,57 aB	21,41 aA	18,02 a
Coffee in the full sun system	16,61 aB	19,74 aA	16,72 aB	13,70 aC	20,81 aA	17,52 a
Coffee + eritrina	16,36 aB	18,50 aB	14,89 aB	16,07 aB	22,75 aA	17,71 a
Mean	17,67 C	19,89 B	15,76 C	14,78 C	21,66 A B	17,75
CV 1 (%) (plot)	26,9					
CV 2 (%) (sub-plot)	13,8					

To be continued…

Table 1 – Continued…

Treatments	Jul/06	Oct/06	Dec/06	Mar/07	May/07	Mean
			K			
Coffee+ glirícidia	11,2 bD	23,8 aA	21,9 aA	18,7 aB	16,2 aC	18,3 a
Coffee in the full sun system	11,1 bC	20,5 aB	23,8 aA	19,5 aB	19,0 aB	18,8 a
Coffee + eritrina	15,3 aB	22,3 aA	21,4 aA	19,7 aA	20,6 aA	19,9 a
Mean	12,5 C	22,2 A	22,3 A	19,3 B	18,6 B	19,0
CV 1 (%) (plot)	24,1					
CV 2 (%) (sub-plot)	15,0					
			P			
Coffee+ glirícidia	1,99 aA	2,20 aA	1,97 bA	1,45 aB	2,21 bA	1,96 b
Coffee in the full sun system	2,09 aB	2,32 aB	2,38 aB	1,74 aC	2,96 aA	2,30 a
Coffee + eritrina	1,56 bC	1,65 bC	1,88 bB	1,34 aC	2,29 bA	1,74 c
Mean	1,88 C	2,05 B	2,09 B	1,51 D	2,49 A	2,00
CV 1 (%) (plot)	16,1					
CV 2 (%) (sub-plot)	15,9					
			Ca			
Coffee+ glirícidia	12,41 aA	5,67 aB	3,90 aD	2,79 aC	4,40 aC	5,83 a
Coffee in the full sun system	6,73 bA	5,77 aA	4,43 aB	3,70 aB	5,46 aA	5,22 a
Coffee + eritrina	9,55 aA	6,03 aB	4,43 aC	4,02 aC	5,36 aB	5,88 a
Mean	9,56 A	5,82 B	4,25 D	3,50 E	5,07 C	5,64
CV 1 (%) (plot)	35,1					
CV 2 (%) (sub-plot)	23,6					
			Mg			
Coffee+ glirícidia	5,76 aC	6,21 aB	4,94 aD	4,55 aD	7,47 aA	5,79 a
Coffee in the full sun system	3,22 bA	3,28 bA	2,81 bA	2,07 cB	3,42 cA	2,96 c
Coffee + eritrina	5,43 aA	4,05 bB	3,28 bC	2,98 bC	5,47 bA	4,24 b
Mean	4,80 B	4,51 B	3,68 C	3,20 C	5,45 A	4,33
CV 1 (%) (plot)	18,2					
CV 2 (%) (sub-plot)	17,5					

Means followed by different letters in upper case in the line (period), and lower case in the column (systems), differ in the Scott-Knott test ($P<0,05$).

The amount of recycled macronutrients, estimated based on the biomass produced by the spontaneous vegetation, shows that there were variations of N, P and Mg concentrations between the treatments (Table 2), but no variations of K and Ca. The highest quantities of recycled N and Mg were obtained in the treatment coffee with gliciridia. These differences may be related to the presence of the trees which, by producing aerial biomass, enhanced soil fertility and, consequently, increased the cycling process. Dias et al. (2006) concluded that tree species have a differential capacity for altering soil fertility levels. Therefore, based on the results, gliciridia benefited nutrient cycling in the system, which is reflected in the nutrients accumulated in the vegetation's biomass, since spontaneous species, according to Lorenzi (2000), are more capable of accumulating nutrients in their tissues than cultivated crops.

The total mean values (mean of the three treatments) of N, P, K, Ca and Mg recycled by the vegetation's biomass after 5 cut offs, from July 2006 to May 2007, were, respectively, 232,8; 26,4; 258,5; 72,4 and 57,5 kg ha^{-1} (Table 2). These values are equivalent to the application of 517 kg ha^{-1} of urea (45 % de N), 147 kg ha^{-1} of simple super phosphate (18% of soluble P_2O_5 in citric acid), 431 kg ha^{-1} of potassium chloride (60% of K_2O), 362 kg ha^{-1} calcium sulfate (20% of calcium) and 359 kg ha^{-1} monohydrated magnesium sulfate- $MgSO_4.H_2O$ (16% of magnesium).

Comparing the micronutrient concentrations in the spontaneous vegetation's biomass, there were differences between the treatments, but from the data it was not possible to determine clearly the influence of tree species on nutrient accumulation by the spontaneous vegetation (Table 3). However, in the period assessed, it was observed that, in the dryer months, Cu and Fe (May 2007) and Mn (October 2006 and May 2007) concentrations were higher. The Zn concentrations remained stable in all the periods.

The phytosociological assessments done in October 2006 (start of the rainy season) and May 2007 (start of the dry season) showed no differences in spatial diversity, expressed by the Shannon index, between the treatments (Table 4).

According to the reference values cited by Cavalcanti & Larrazábal (2004), the Shannon diversity is considered high when above 3, average between 2 and 3, low between 1 and 2 and very low when it is below 1. In this work, diversity varied from 0,41 to 0,56 in the treatment assessments in October 2006, and from 0,44 to 0,50 in June 2007, considered, therefore, low.

The most frequent plant species in all the treatments and in both the periods assessed were spread C. *diffussa* (dayflower) and *P. conjugatum* (fork grass). Spread dayflower represented 49,4% of the population in October 2006 and 35,6% in May 2007, while fork grass represented 29,2% and 28,1% in the same periods, respectively. Both species are usually found in fertile and moist soils, in perennial crops, and are tolerant to certain levels of shade (Lorenzi, 2000). This is consistent with the higher humidity (less exposure to the sun) conditions of the treatments with trees (treatments 1 and 3), and also indicates that the management practices in the area are enhancing soil fertility.

Table 2 – Total macro and micronutrients recycled by the biomass produced after 5 cut offs, carried out in July, October and December 2006 and March and May 2007 (mean of 6 replications). Seropédica, Rio de Janeiro state, 2006-2007.

Treatments	Total recycled (kg ha^{-1} year^{-1})					Total recycled (kg ha^{-1} year^{-1})			
	N	P	K	Ca	Mg	Cu	Fe	Mn	Zn
Coffee+glirícidia	260,5 a	28,4 a	280,5 a	81,1 a	82,9 a	101,8 a	9585 a	1560 b	535 a
Full sun system	219,5 b	28,9 a	243,5 a	64,9 a	37,3 c	77,0 b	8470 a	2605 a	540 a
Coffee + eritrina	218,5 b	21,9 b	251,5 a	71,2 a	52,2 b	91,6 a	5410 b	3015 a	565 a
Mean	232,8	26,4	258,5	72,4	57,5	90,1	7822	2393,3	546,7
CV plot (%)	33,0	22,6	28,2	45,2	31,5	22,9	69,2	37,0	15,5
CV sub-plot (%)	20,3	18,9	23,7	26,6	27,9	17,3	58,4	29,7	17,3

Means followed by different lower case letters in the column differ in the Scott-Knott test ($P<0,05$).

Table 3 – Micronutrient concentrations (mg kg^{-1}) (mean of six replications) in the spontaneous vegetation's biomass, in function of the treatments and periods assessed. Seropédica, Rio de Janeiro state, 2006-2007.

Treatments	Oct/06	Dec/06	Mar/07	May/07	Mean
			Cu		
Coffee + glirícidia	5,78 aB	6,76 aB	5,95 aB	8,88 aA	6,84 a
Coffee in full sun system	6,03 aB	6,27 aB	6,38 aB	9,79 aA	7,12 a
Coffee + eritrina	5,54 aB	5,98 aB	4,91 aB	7,84 bA	6,06 b
Mean	5,78 B	6,34 B	5,74 B	8,83 A	6,67
CV 1 (%) (plot)			20,1		
CV 2 (%) (sub-plot)			17,4		
			Fe		
Coffee + glirícidia	879 aA	569 aA	379 Aa	751 bA	644 a
Coffee in full sun system	449 bA	468 aA	187 aA	498 bA	400 b
Coffee + eritrina	337 bC	802 aC	315 aB	1262 aA	679 a
Mean	555 B	613 B	294 C	837 A	574
CV 1 (%) (plot)			63,1		
CV 2 (%) (sub-plot)			55,8		
			Mn		
Coffee + glirícidia	116 bA	84 bA	85 bA	138 bA	106 b
Coffee in full sun system	251 aA	200 aB	206 aB	262 aA	230 a
Coffee + eritrina	220 aA	159 aB	202 aA	230 aA	203 a
Mean	195 A	148 B	164 B	210 A	180
CV 1 (%) (plot)			28,1		
CV 2 (%) (sub-plot)			24,0		
			Zn		
Coffee + glirícidia	39,2 aA	34,1 aA	32,9 aA	33,7 aA	35,0 b
Coffee in full sun system	44,0 aA	41,3 aA	46,2 bA	38,6 aA	41,8 a
Coffee + eritrina	45,1 aA	41,2 aA	42,3 bA	42,0 aA	43,4 a
Mean	42,7 A	38,8 A	40,5 A	38,1 A	40,1
CV 1 (%) (plot)			10,3		
CV 2 (%) (sub-plot)			16,6		

Means followed by different upper case letters in the line (period) and lower case letters in the column (systems) differ in the Scott-Knott test (P<0,05).

Table 4 – Shannon índex values (H') of spontaneous plants, in October 2006 and June 2007. Seropédica, Rio de Janeiro state.

Period	Cultivation systems (treatments)			Mean
	Coffee + glirícidia	Coffee in full sun system	Coffee + eritrina	
October 2006	0,56 aA	0,41 aA	0,50 aA	0,47 A
June 2007	0,46 aA	0,44 Aa	0,50 aA	0,49 A
Mean	0,51 a	0,42 a	0,50 a	0,48
CV plot (%)	26,1			
CV sub-plot (%)	23,4			

Means followed by different lower case letters in the line (systems) and upper case letters in the column (period) differ in the Scott-Knott test (P<0,05).

4 CONCLUSIONS

The highest biomass production level was observed between October and December 2006, and the highest value was obtained in coffee cultivated with gliciridia.

The most frequent species in the systems in both periods assessed were *Commelina diffusa* Burm. f. and *Paspalum conjugatum* Berg., predominantly found in fertile and humid soils.

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