DIVISÃO 3 - USO E MANEJO DO SOLO

3.1 - Fertilidade do solo e nutrição de plantas

DECOMPOSITION AND NUTRIENT RELEASE OF LEGUMINOUS PLANTS IN COFFEE AGROFORESTRY SYSTEMS[1]

Eduardo da Silva Matos[2], Eduardo de Sá Mendonça[3], Irene Maria Cardoso[4], Paulo César de Lima[5] & Dirk Freese[6]

SUMMARY

Leguminous plants used as green manure are an important nutrient source for coffee plantations, especially for soils with low nutrient levels. Field experiments were conducted in the Zona da Mata of Minas Gerais State, Brazil to evaluate the decomposition and nutrient release rates of four leguminous species used as green manures (*Arachis pintoi, Calopogonium mucunoides*, *Stizolobium aterrimum* and S*tylosanthes guianensis*) in a coffee agroforestry system under two different climate conditions. The initial N contents in plant residues varied from 25.7 to 37.0 g kg^{-1} and P from 2.4 to 3.0 g kg^{-1}. The lignin/N, lignin/polyphenol and (lignin+polyphenol)/N ratios were low in all residues studied. Mass loss rates were highest in the first 15 days, when 25 % of the residues were decomposed. From 15 to 30 days, the decomposition rate decreased on both farms. On the farm in Pedra Dourada (PD), the decomposition constant *k* increased in the order *C. mucunoides* < *S. aterrimum* < *S. guianensis* < *A. pintoi*. On the farm in Araponga (ARA), there was no difference in the decomposition rate among leguminous plants. The N release rates varied from 0.0036 to 0.0096 d^{-1}. Around 32 % of the total N content in the plant material was released in the first 15 days. In ARA, the N concentration in the *S. aterrimum* residues was always significantly higher than in the other residues. At the end of 360 days, the N released was 78 % in ARA and 89 % in PD of the initial content. Phosphorus was the most rapidly released nutrient (*k* values from 0.0165 to 0.0394 d^{-1}). Residue decomposition and nutrient release did not correlate with initial residue chemistry and biochemistry, but differences in climatic conditions between the two study sites modified the decomposition rate constants.

Index terms: nutrient cycling, agroecology, plant residue, residue quality.

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[1] Received for publication in March 2009 and approved in December 2010.
[2] Researcher, Embrapa Agrosilvopastoral, Av. dos Jacarandás 2639, 78550-003 Sinop (MT), Brazil. E-mail: eduardo.matos@embrapa.br
[3] Professor, Plant Production Department, Agriculture Science Center, Federal University of Espírito Santo, 29500-000 Alegre (ES), Brazil. E-mail: esmjplia@gmail.com
[4] Professor, Soil Science Department, Federal University of Viçosa – UFV. CEP 36570-000 Viçosa (MG), Brazil. E-mail: irene@ufv.br
[5] Researcher, EPAMIG – Agriculture Research Institute of Minas Gerais. Vila Gianetti 46, 36570-000 Viçosa (MG), Brazil. E-mail: plima@epamig.ufv.br
[6] Researcher, Chair of Soil Protection and Recultivation, Brandenburg University of Technology, 03046 Cottbus, Germany. E-mail: freese@tu-cottbus.de

RESUMO: *DECOMPOSIÇÃO E LIBERAÇÃO DE NUTRIENTS DE LEGUMINOSAS HERBÁCEAS EM CAFEZAIS SOB SISTEMAS AGROFLORESTAIS*

Leguminosas utilizadas como adubos verdes são consideradas uma fonte importante de nutrientes para a cultura do cafeeiro, especialmente em solos com baixa disponibilidade de nutrientes. Experimentos de campo foram realizados com o objetivo de avaliar as taxas de decomposição e liberação de nutrientes de leguminosas empregadas como adubos verdes em cafezais sob sistemas agroflorestais na Zona da Mata de Minas Gerais. Os teores iniciais de N e P nos materiais vegetais variaram de 25,7 a 37,0 e de 2,4 a 3,0 g kg^{-1}*, respectivamente. As relações lignina/N, lignina/polifenol e (lignina+polifenol)/N apresentaram baixos valores para todas as espécies estudadas. As maiores perdas de matéria seca ocorreram nos primeiros 15 dias de avaliação, quando 25 % do material foi decomposto. Entre 15 e 30 dias de avaliação, houve redução da taxa de decomposição em ambas as propriedades. Na propriedade de Pedra Dourada (PD), a constante de decomposição* k *aumentou na sequência* C. mucunoides < S. aterrimum < S. guianensis < A. pintoi. *Já em Araponga (ARA), não houve diferença nas taxas de decomposição das leguminosas estudadas. As taxas de liberação de N variaram entre 0,0036 e 0,0096 d*$^{-1}$*. Cerca de 32 % do total de N no material vegetal foi liberado nos primeiros 15 dias. Até os 360 dias, foram liberados pelos adubos verdes, em média, 77,5 % do N em Araponga e 88,5 % em Pedra Dourada. O P apresentou a maior velocidade de liberação, variando de 0,0165 a 0,0394 d*$^{-1}$*. As taxas de decomposição e liberação de nutrientes não se correlacionaram com as composições química e bioquímica iniciais, porém as diferenças climáticas entre as duas áreas modificaram as constantes de decomposição dos resíduos das leguminosas.*

Termos de indexação: ciclagem de nutrientes, agroecologia, qualidade do resíduo vegetal.

INTRODUCTION

Efforts have been made to convert land use management systems with little or no addition of fertilizers into sustainable land uses that increase the efficiency of the nutrient cycling process and provide a valuable nutrient source for the development of sustainable smallholder farming systems in the Zona da Mata of Minas Gerais State. Leguminous plants used as green manure are a source of organic material with significant benefits for soil and crops, due to the high N_2 fixation capacity, nutrient cycling and contribution to soil cover (Cobo et al., 2002). Several studies have shown that leguminous plants can supply the crop demand for N and K (Mafongoya et al., 1998; Lupwayi & Haque, 1999), but are generally not effective in supplying sufficient P amounts to meet crop demands (Jones et al., 1996; Lupwayi & Haque, 1999; Lupwayi et al., 2007; Mukuralinda et al., 2009). However, decomposition of green manures have important residual effects on long-term P availability (Mafongoya et al., 1998) by releasing organic compounds that reduce the P fixation capacity of the soil (Andrade et al., 2003).

Leguminous species such as *Stizolobium aterrimum, Arachis pintoi, Calopogonium mucunoides*, and S*tylosanthes guianensis* have an outstanding capacity to produce high amounts of biomass and accumulate high nutrient concentrations (Matos et al., 2008), which become available to crops after residue decomposition. Decomposition and nutrient release depend on the residue quality, which is usually defined in relation to its chemical and biochemical composition (Thomas & Asakawa, 1993; Mendonça & Stott, 2003), because both influence the activity of decomposer communities (Thönnissen et al., 2000). High nutrient contents in plant materials have been correlated with high decomposition rates and nutrient release, which induce microbial growth and activity (Cobo et al., 2002). However, the relative importance of nutrient contents depends on the amounts of structural components such as lignin, cellulose, hemicellulose, and polyphenols as well as on the ratios C/P, C/N, lignin/N and polyphenol/N (Zaharah & Bah, 1999; Thönnissen et al., 2000; Hadas et al., 2004; Lupwayi et al., 2004).

The effects of climatic conditions can also greatly influence residue decomposition. Environmental factors such as temperature, moisture and aeration affect the microbial community and activity (Robertson & Morgan, 1996), and are therefore related to the decomposition process. Oliveira et al. (2003) observed significant effects on *A. pintoi*, when the residue decomposition process was evaluated in the wet and dry seasons. However, Zaharah & Bah (1999) observed no effects of rainfall on the decomposition and nutrient release rates of gliricidia (*Gliricidia sepium*).

The nutrient release rates are essential to plan the introduction of leguminous plants used as green manure, considering the crop demand and availability of critical nutrients (Mafongoya et al., 1998). Thus, it is necessary to know the constants related to these processes in order to: (1) establish effective management practices with green manure; and (2) plan the introduction of species to release nutrients and meet crop demand, improving nutrient use efficiency. The purpose of this study was to evaluate decomposition and nutrient release rates of leguminous plants used as green manure under two edaphic and climatic conditions in the Zona da Mata of Minas Gerais State, Atlantic Forest region, Brazil.

MATERIAL AND METHODS

Study sites and experiment description

Leguminous plants (*A. pintoi, C. mucunoides, S. aterrimum and S. guianensis*) were grown in two experimental areas with coffee on two family farms, from December 2003 to April 2004. One experimental plot was located on a farm in Pedra Dourada (PD) at 20 º 50 ' S latitude, 42 º 08 ' W longitude and 690 m altitude, with highest and lowest mean annual temperatures, respectively, of 27.6 and 16.2 ºC, and 1,280 mm rainfall; the experimental area facing south. The second experiment was located on a farm in Araponga (ARA) (20 º 38 ' S latitude, 42 º 31 ' W longitude, 950 m asl, with highest mean annual temperature of 25.4 ºC and the lowest of 13.7 ºC, and 1,320 mm rainfall (Figure 1); the experimental area facing west. On both farms, the soils were classified as Red-Yellow Latosol (Brazilian taxonomy system), corresponding to a Typic Haplustox according to the U.S. soil taxonomy system. Some properties of the soils of both farms were described by Matos et al. (2008).

The three-year-old coffee trees were cultivated in agroforestry systems, spaced 3.0 x 0.8 m between rows

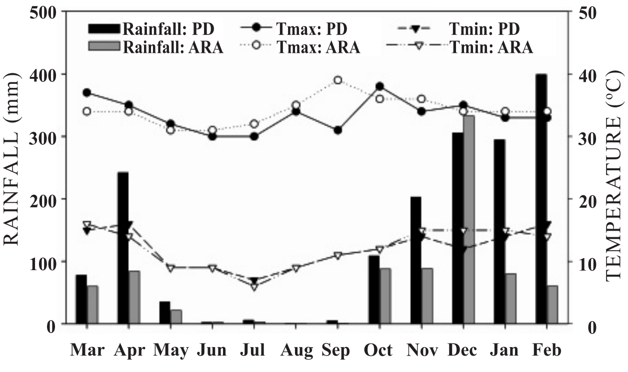

Figure 1. Monthly rainfall and maximum (Tmax) and minimum (Tmin) temperature on the studied farms in PD (Pedra Dourada) and ARA (Araponga).

and plants, respectively. The leguminous plants were grown in-between the coffee rows in a 2 x 2 m plot. Before the experiment, 1.20 Mg ha^{-1} of lime, 300 kg ha^{-1} of gypsum, 125 kg ha^{-1} of potassium sulphate and 800 kg ha^{-1} termophosphate was applied between the coffee rows in the PD area. In the ARA area, 0.26 Mg ha^{-1} lime, 64 kg ha^{-1} gypsum, 125 kg ha^{-1} potassium sulphate and 800 kg ha^{-1} termophosphate was applied. Seeds were sown at a depth of 1 cm, without *Rhizobium* inoculation. Approximately 120 days after sowing, the above-ground biomass was harvested, weighed and analyzed.

Chemical and biochemical characterization

Sub-samples of the entire plant material were dried (55 °C), ground and sieved (< 1 mm) for chemical analysis. Total C and N were analyzed by dry combustion (Perkin Elmer CHNS/O 2400). Total P was determined by the ammonium molybdate-ascorbic method (Murphy & Riley, 1962), and total K was measured by flame spectrophotometry, after sample digestion with perchloric and nitric acids (Sarruge & Haag, 1974). Soluble polyphenols were extracted with 50 % aqueous methanol and measured using Folin-Dennis reagent with a tannic acid standard for the colorimetric method (Anderson & Ingram 1996). Lignin, cellulose and hemicellulose contents were determined by the acid-detergent fiber method (van Soest et al., 1991).

Decomposition and nutrient release

Sub-samples of the fresh material (100 g) were placed in 20 x 20 cm nylon litter-bags consisting of 2 mm mesh. The litter-bags were placed on the soil surface in the shade of a coffee tree, and were removed after 15, 30, 60, 120, 240 and 360 days. The remaining material was dried (55 ºC), weighed and analyzed each time. Total N, P and K were analyzed, as described above for the initial chemical content.

The experiment was arranged in a complete randomized 2 x 4 x 7 factorial block design (two farms, four residues and seven evaluations), with four replications.

To describe the decomposition and nutrient release rates, the percentage of the remaining dry biomass and N, P and K contents were adjusted to a single exponential equation:

$$X_t = X_0 \exp[-kt]$$

where X_t is the dry weight or nutrient remaining at time t and the slope k, the decomposition or nutrient release constant. Constant X_0 is the initial quantity of dry biomass or nutrients.

The half-life ($t_{1/2}$) of the leguminous residues was calculated by the equation:

$$t_{1/2} = \frac{\ln(2)}{k}$$

Linear regression coefficients were tested by the t test at 1, 5 and 10 % using SigmaPlot 8.0.

RESULTS AND DISCUSSION

Chemical and biochemical properties of leguminous residues

The dry biomass (DB) varied from 0.95 to 2.88 Mg ha^{-1} and from 0.94 to 3.21 Mg ha^{-1} in PD and in ARA, respectively (Matos et al., 2008). The DB production of *A. pintoi* was lowest at both localities. In PD, the DB production of *S. guianensis* was highest (87 % higher than in ARA), while in ARA, *S aterrimum* produced most DB (85 % higher than in PD).

The initial N contents in plant residues varied from 25.7 to 37.0 g kg^{-1} and P contents from 2.4 to 3.0 g kg^{-1} (Table 1). Nitrogen values were lowest for *A. pintoi* on both farms. According to Mafongoya et al. (1998), the quality of plant residues with initial N and P concentrations of around 20 and 2.5 g kg^{-1}, respectively, is considered high. The C/N ratio varied from 12.2 to 15.9 and was lowest for *S. aterrimum* and *C. mucunoides* and highest for *A. pintoi*, but similar on both farms. The C/N ratio values of *C. mucunoides, S. guianensis* and *S. aterrimum* were around 8 % higher in ARA than in PD. For *S. aterrimum* the C/P ratio was highest in PD and the C/N ratio lowest in ARA. There was no difference in the C/P ratio of *A. pintoi, C. mucunoides* and *S. guianensis* in ARA, with values of around 170 (±3). According to Stevenson (1994), C/P ratio values < 200 in residues contribute to P mineralization, while the C/P ratio values that promote P mineralization vary widely in the literature (Baggie et al., 2004). The hemicellulose content varied from 12.1 to 16.9 %, and the cellulose content from 26.7 to 32.3 %. Except for *C. mucunoides* and *S. aterrimum* in PD, the variation in hemicellulose values was small (12.6 ±0.4) among leguminous species in both areas. Among the green manures, the lignin values of *S. guianensis* were lowest (4.8 % in PD and 6.1 % in ARA). The polyphenols content varied from 1.30 to 2.04 % in PD and from 1.19 to 1.86 % in ARA. *C. mucunoides* had the lowest value and *S. aterrimum* the highest value of polyphenols. Polyphenols can affect residue decomposition and nutrient release due to their ability to complex protein, reducing N availability to soil microorganisms (Hättenschwiler & Vitousek, 2000; Monteiro et al., 2002). On both farms, the LG/N and (LG/PP)/N ratios of *A. pintoi* were highest and of *S. guianensis* lowest. The concentration of structural compounds such as lignin, cellulose and hemicelluloses provides an important contribution to the decomposition rate as well as C/P, C/N, lignin/polyphenol, lignin/N, and polyphenol/N ratios, which are the main regulators of residue decomposition (Fox et al., 1990; Handayanto et al., 1995; Northup, 1995; Cobo et al., 2002; Mendonça & Stott, 2003). In general, the lignin/N, lignin/polyphenol and (lignin+polyphenol)/N ratios were low, indicating that the studied leguminous plants can be classified as residues with a high turnover rate (Thomas & Asakawa, 1993).

Decomposition

The mass loss rates were highest in the first 15 days when 25 % of the residues were decomposed in PD and ARA (Figure 2). From 15 to 30 days, the decomposition rate decreased on both farms. Except for the *S. aterrimum*, the mass loss of residues in PD was higher than in ARA. In ARA, *S. aterrimum* tended to present the lowest values of Remaining DB until 60 days (Figure 2). In a short term, decomposition rates are high due to the high content of fast decomposable components such as sugars, amino acids and proteins. In the later stages, decomposition rates tend to decrease due to the accumulation of recalcitrant components such as

Table 1. Chemical and biochemical properties of leguminous plants from farms in Pedra Dourada (PD) and Araponga (ARA)

Plant species	N	P	K	C/N	C/P	HM	CL	LG	PP	LG/N	LG/PP	PP/N	(LG+PP)/N
	g kg^{-1}					%							
							PD						
A. pintoi	25.7	2.4	23.0	15.7	158	12.1	31.2	7.8	1.68	2.9	4.6	0.62	3.5
C. mucunoides	30.9	2.4	22.4	12.5	147	16.6	26.7	9.0	1.30	2.6	6.9	0.37	2.9
S. guianensis	29.5	2.5	23.0	13.6	168	12.9	29.8	4.8	1.72	1.5	2.8	0.54	2.0
S. aterrimum	35.6	2.8	20.5	12.3	174	16.9	31.7	8.6	2.04	2.3	4.2	0.55	2.9
							ARA						
A. pintoi	27.2	2.7	22.6	15.9	170	12.3	27.8	8.4	1.82	3.3	4.6	0.71	4.0
C. mucunoides	35.2	3.0	21.0	13.6	175	12.4	28.2	7.8	1.19	2.5	6.6	0.38	2.9
S. guianensis	32.0	2.6	17.2	14.6	172	12.7	32.3	6.1	1.54	2.1	4.0	0.52	2.6
S. aterrimum	37.0	2.6	19.7	12.2	155	13.2	31.4	10.5	1.86	2.9	5.6	0.52	3.5

HM: hemicellulose; CL : cellulose; LG : lignin; and PP : Total soluble polyphenols.

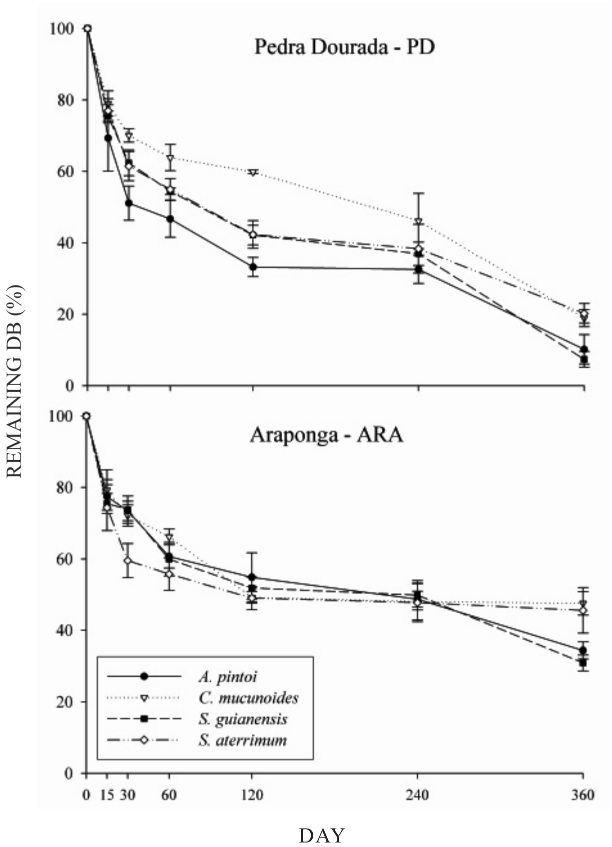

Figure 2. Remaining dry biomass (DB) expressed as the percentage of initial dry weight of the above-ground biomass, in 360 days in the municipalities of Pedra Dourada and Araponga. Vertical bars represent standard error (n = 4).

lignin, tannins and cellulose (Zaharah & Bah, 1999; Thönnissen et al., 2000; Hadas et al., 2004; Lupwayi et al., 2004).

In a comparison of the two farms, lower remaining DB values in PD ($p < 0.01$) throughout the decomposition period were observed, which increased the difference between the two farms at the end of the 360 days. This effect was probably related to the location of the experimental area, facing South in PD, resulting in greater humidity in the coffee rows than in ARA where the experimental area faces West.

In PD, the decomposition constant k increased in the order *C. mucunoides* < *S. aterrimum* < *S. guianensis* < *A. pintoi* (Table 2). No difference in the decomposition rate among leguminous plants (0.0022–0.0030 d^{-1}) was found in ARA. On average, the decomposition rates of all residues in ARA were 50.7 %, lower than in PD. Except for *C. mucunoides*, the half-life ($t_{1/2}$) of the leguminous plants in PD was 57 % shorter than in ARA. Differences in residue chemistry and biochemistry were not correlated with the decomposition rate constants of residues of both farms. Taking into account that the residues in our study presented similar composition, the edaphic and climatic factors apparently had more influence on residue decomposition than the chemical and biochemical composition. We suggest that the effects of plant constituents on the decomposition process should be more carefully evaluated in future studies involving heterogenic materials and that temperature and humidity should be controlled. Thönnissen et al. (2000) observed that the effects of residue chemistry and biochemistry on decomposition rates varied widely between seasons and locations.

Nutrient release

The K release rate (k_K) varied from 0.0076 d^{-1} for *S. aterrimum* in PD to 0.0145 d^{-1} for *A. pintoi* in ARA. In general, the behavior of the curves of K concentration in the evaluation period was similar in both areas (Figure 3). Except for *S. aterrimum*, the $t_{1/2}K$ of all leguminous residues tended to be similar on both farms. Potassium is considered a nutrient with highest release rates, since it is a non-structural component of the plants (Lupwayi & Haque, 1999;

Table 2. Decomposition (k_D) and P, N and K release (k_P, k_N and k_K) rates estimated by the linear regression equation $\hat{y} = \hat{a}\exp^{(-\hat{k}t)}$ and the half-life ($t_{1/2}$) of green manures under two edaphic and climatic conditions

Plant species	k_D	$t_{1/2}D$	k_P	$t_{1/2}P$	k_N	$t_{1/2}N$	k_K	$t_{1/2}K$
	d^{-1}	d	d^{-1}	d	d^{-1}	d	d^{-1}	d
				PD				
A. pintoi	0.0070^{*}	98.9	0.0394^{0}	17.6	0.0096^{0}	72.1	0.0120^{**}	57.8
C. mucunoides	0.0036^{**}	194.8	0.0211^{ns}	32.8	0.0056^{*}	123.7	0.0079^{**}	87.5
S. guianensis	0.0056^{**}	123.8	0.0357^{0}	19.4	0.0094^{0}	74.0	0.0113^{**}	61.3
S. aterrimum	0.0045^{*}	152.5	0.0298^{0}	23.3	0.0064^{0}	107.8	0.0076^{**}	91.5
				ARA				
A. pintoi	0.0026^{*}	269.1	0.0290^{0}	23.9	0.0048^{*}	144.8	0.0145^{**}	47.7
C. mucunoides	0.0030^{**}	233.0	0.0165^{ns}	42.0	$0.00\ 46^{0}$	149.0	0.0087^{**}	79.6
S. guianensis	0.0025^{*}	278.0	0.0358^{0}	19.3	0.0036^{0}	192.5	0.0139^{**}	50.0
S. aterrimum	0.0022^{*}	319.3	0.0344^{*}	20.1	0.0042^{0}	166.3	0.0118^{**}	58.9

^{0}, *, **: significant at 10, 5 and 1 % by the t test.

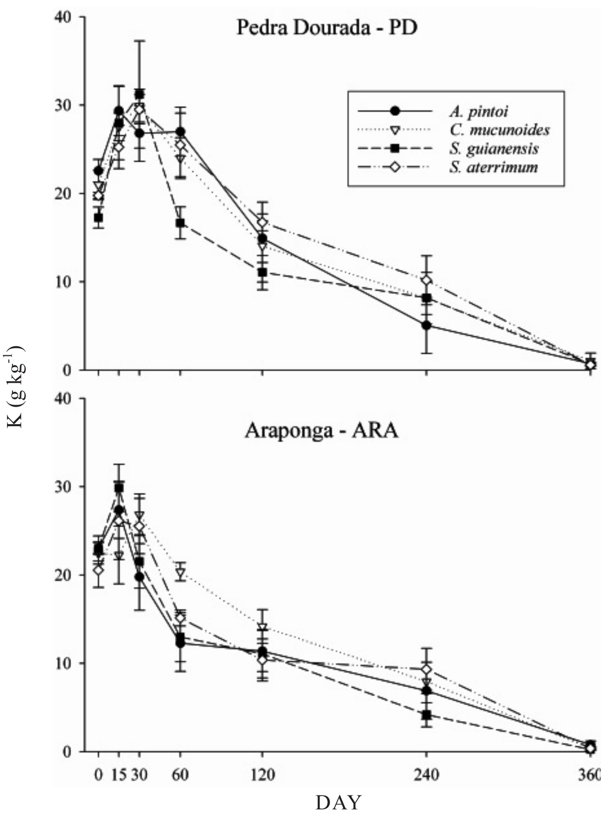

Figure 3. Potassium concentration of different leguminous plants, in 360 days in Pedra Dourada and Araponga municipalities. Vertical bars represent standard error (n = 4).

Cobo et al., 2002; Giacomini et al., 2003). Usually, the K rate depends on the rainfall during the decomposition process (Giacomini et al., 2003).

The rates of N release varied from 0.0056 to 0.0096 d^{-1} in PD and from 0.0036 to 0.0048 d^{-1}. The rates of N release followed the same trend as mass loss. In PD, the k_N values were highest for *A. pintoi* and *S. guianensis*. Around 32 % of the total N in the plant material was released in the first 15 days. In comparison, the $t_{1/2}$ values of N were higher than of the other nutrients (72.1–123.7 and 144.8–192.5 days, respectively) in PD and ARA. In ARA, N concentrations in *S. aterrimum* residues were constantly higher than in the other residues (Figure 4). In PD, the behavior of *S. aterrimum* at the end of the evaluation period was similar. Following the same trend of DB losses, the values of turnover rates for N release were 50.2 % lower in ARA than PD. At the end of 360 days, the N released corresponded to 78 % of the initial content in ARA and 89 % in PD, indicating that a great part of N accumulated in the plant tissue had been released in the first days of decomposition. Zaharah & Bah (1999) observed a similar behavior of *Gliricidia sepium*, which released half of the initial N content in the initial stage.

Phosphorus was the most rapidly released nutrient (*k* values of 0.0165–0.0394 d^{-1}) (Table 2). *A. pintoi* had the highest k_P in PD and *S. guianensis* in ARA, consequently the $t_{1/2}$P of both leguminous residues was lowest (17.6 and 19.3 days, respectively). Oliveira et al. (2003) reported similar $t_{1/2}$P values of 16.1 days for *A. pintoi*. Unlike K, generally considered the nutrient with highest release rate, P participates in cell constituents, e.g., phospholipids, nucleic acids and DNA and RNA structures, and is also part of the ATP molecule (Jahnke, 1992; Ha et al., 2007). Phosphorus release is not directly related to rainfall, but to the total inorganic P content and soluble P in the residues, and to the effective action of microorganisms on the organic fractions (Giacomini et al., 2003). On average, 60 % of the total P in plant residues was released in the first 15 days when the P concentration in the residues was reduced to 50 % of the initial concentration on both farms (Figure 5). These results agree with Ha et al. (2007) who reported that 70 % of the initial P content was released from pea residues after 15 days of evaluation in a sandy soil with low P availability. Giacomini et al. (2003) observed that 64 % of P in *Vicia sativa* was released 30 days after cutting, and was correlated with soluble P. *Gliricidia sepium* released 55 % of the initial P content after 10 days of decomposition, and there was a remaining

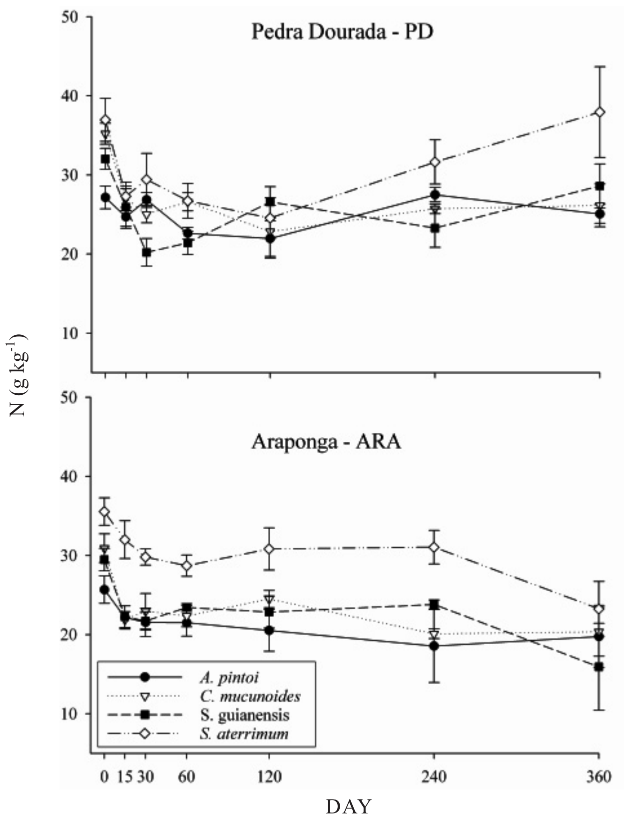

Figure 4. Nitrogen concentration of different leguminous plants, in 360 days in Pedra Dourada and Araponga. Vertical bars represent standard error (n = 4).

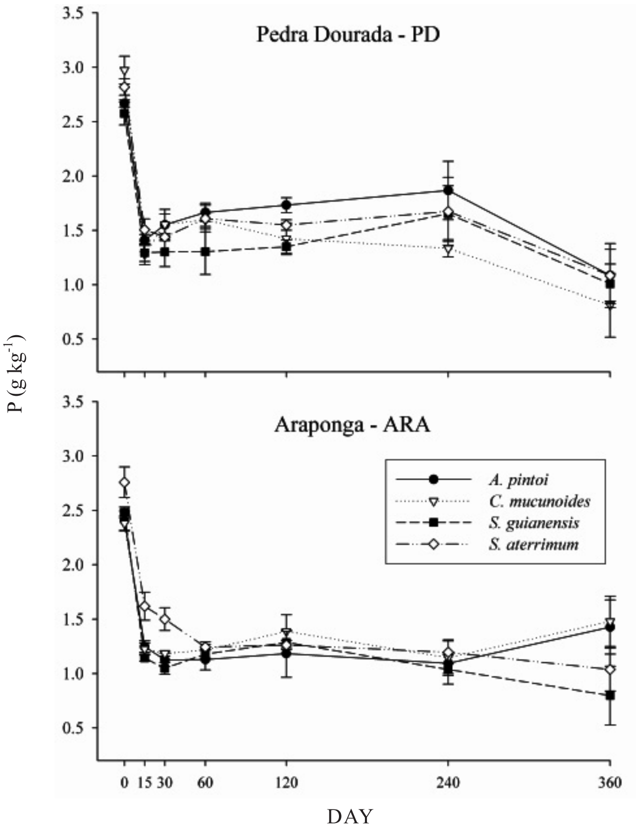

Figure 5. Phosphorus concentration of different leguminous plants, in 360 days in Pedra Dourada and Araponga. Vertical bars represent standard error (n = 4).

content of 11 % after 70 days of evaluation, which was related to recalcitrant fractions (Zaharah & Bah, 1999).

After 30 days of evaluation, the P release rate from all residues decreased, probably due to exhaustion of the inorganic P and labile organic P fractions, leaving only non-labile organic P fractions (Mueller-Harvey & Wild, 1986). Inorganic P is rapidly released to the soil after residue incorporation and can be quickly consumed by soil microorganisms (Oliveira et al., 2003; Ha et al., 2007). In the later stages of decomposition, P is released more slowly from residues by mineralization of organic forms (Ha et al., 2007). In ARA, the P contents of *S. aterrimum* were higher than of the other leguminous plants until 30 days of evaluation. In general, the P release rates from residues in PD were higher than from residues in ARA, which was related to the higher decomposition rates observed in PD, since the nutrient release constant can also be directly affected by residue mass loss.

The total nutrient release from leguminous plant residues after 360 days showed that *S. aterrimum* released the highest amounts in ARA (93.0 kg ha^{-1} of N, 7.8 of P and 63.6 K) and *S. guianensis* in PD (86.2 kg ha^{-1} N, 7.1 P and 50.4 K). Similar results were obtained by Silva et al. (2002), who reported 85.6 kg ha^{-1} N, 8.2 P and 60.5 K released by *S. aterrimum*. Since our evaluation considered only the nutrient amounts in the shoot biomass, the contribution of green manures to the annual nutrient incorporation is likely to be higher, because the contribution of the roots to soil nutrient incorporation is essential (Weatherall et al., 2006).

CONCLUSIONS

1. In Pedra Dourada, the decomposition constant *k* increased in the order *C. mucunoides* < *S. aterrimum* < *S. guianensis* < *A. pintoi*. In Araponga, the decomposition rate constants were similar in the evaluated leguminous plant residues. In general, the decomposition rates tended to be higher in the area facing South, resulting in greater humidity in the coffee plantation than in the area facing west.

2. Under field conditions, the initial chemical and biochemical composition of plant residues are not directly correlated with decomposition and nutrient release rates.

3. In the low nutrient availability soils of the Zona da Mata of Minas Gerais, P was the most rapidly released nutrient from leguminous residues.

4. The results of this study can be used as indicators of the potential amount and rate of nutrient supply of intercropped *A. pintoi, C. mucunoides, S. aterrimum and S. Guianensis* to coffee in agroforestry systems.

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