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Classification of radicular biomass and monitoring of litter in Pantanal and Cerrado Mato-Grossense

The quantification of root biomass and the assessment of its dynamics in forest ecosystems has been intensified due to its important role in carbon sequestration and storage and the possible consequences under climate change conditions. In general, biomass stocks between and within forest ecosystems are highly variable. It is necessary to study all the different components of vegetation, however, the vast majority of the works found in the literature, address only the biomass of the aerial part of the plants, with few studies involving the quantification of these stocks by the roots, in the different ecosystems. The present study objective quantify and classify a root biomass with a depth of 0 to 10 cm, and to monitor accumulated litter in the soil (litter pool), in two different regions, in the Pantanal (Acurizal) and in the Cerrado (Sensu stricto) Mato-Grossense. The root biomass was obtained by means of unformed soil samples (0-10 cm) and the roots were classified by diameter, with the aid of digital calipers, between thick (> 10 mm), medium (5-10 mm), slightly thin (2-5 mm) and fine (<2 mm). The samples collected monthly between August 2018 and July 2019. Was observed that in both areas, about 90% of the roots collected, were fine (<2 mm). The root density in Acurizal was on average 124.92 g/m² and in Sensu stricto it was on average 57.5 g/m². The difference in root density in the soil, between the two study areas, significant ($p<0.05$). However, there no significant difference in root density between the dry and wet periods in each area. The monthly average of litter pool in the area of Acurizal and Sensu stricto was, respectively: 526.52 g/m² and 588.96 g/m². In both areas, the accumulated litter was significantly different between periods of drought and precipitation.

Keywords: Roots diameter; Soil carbon stock; Forest biomass.

Classificação da biomassa radicular e monitoramento da serapilheira em áreas do Pantanal e Cerrado Mato-Grossense

A quantificação da biomassa radicular e a avaliação da sua dinâmica nos ecossistemas florestais foram intensificadas devido ao seu importante papel no sequestro e armazenamento de carbono e às possíveis consequências nas condições de mudanças climáticas. Em geral, os estoques de biomassa entre e dentro dos ecossistemas florestais são altamente variáveis. É necessário estudar todos os diferentes componentes da vegetação, no entanto, a grande maioria dos trabalhos encontrados na literatura trata apenas da biomassa da parte aérea das plantas, com poucos estudos envolvendo a quantificação desses estoques pelas raízes, nos diferentes ecossistemas. O presente estudo objetivou quantificar e classificar a biomassa radicular presente na profundidade de 0-10 cm, e monitorar o acúmulo de serapilheira no solo, em duas regiões distintas, o Pantanal (Acurizal) e Cerrado (Stricto sensu) Mato-Grossense. A biomassa radicular foi obtida por meio de amostras de solo indeformadas (0-10 cm) e as raízes foram classificadas por diâmetro com o auxílio de paquímetros, entre: grossas (> 10 mm), médias (5-10 mm), pouco finas (2-5 mm) e finas (< 2 mm). As amostras foram coletadas mensalmente entre agosto de 2018 a julho de 2019. Observou-se que em ambas as áreas, cerca de 90% das raízes coletadas, foram finas (< 2 mm). A densidade de raízes no Acurizal foi em média 124,92 g/m² e no Stricto sensu foi em média de 57,5 g/m². A diferença da densidade radicular no solo, entre as duas áreas de estudo, foi significativa ($p<0,05$). Porém, não houve diferença significativa na densidade radicular entre os períodos seco e chuvoso, em cada área. A média mensal da serapilheira acumulada em área de Acurizal e Stricto sensu foi respectivamente: 526,52 g/m² e 588,96 g/m². Em ambas as áreas, a serapilheira acumulada foi significativamente diferente entre os períodos de seca e chuva.

Palavras-chave: Diâmetro de raízes; Estoque de carbono no solo; Biomassa florestal.

Topic: **Desenvolvimento, Sustentabilidade e Meio Ambiente**

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INTRODUCTION

The ability to emit and sequester atmospheric carbon are functions common to all terrestrial ecosystems (ADUAN, 2003). Due to the importance of this function, the role of terrestrial vegetation in relation to the exchange of material between the crust and the atmosphere has been gaining increasing attention on the part of the scientific community (ADUAN, 2004).

According to Mello et al. (2015), the global carbon balance of an ecosystem can only be fully dimensioned if the contribution of each process involved in the emission and consumption of carbon is taken into account. The terrestrial ecosystems: vegetation and soil currently considered as a large carbon sink, especially soils (MACHADO, 2005). Lopes et al. (2010) claims that more than 50% of the carbon absorbed annually by plants may be allocated below the ground.

Root biomass constitutes a potential carbon reservoir and can contribute to reducing the concentration of atmospheric CO_2 (SOHRABI et al., 2016). Allometric (or metabolic) scaling theory (ENQUIST et al., 2002) indicates that inventory-based estimates of root C probably account for only 60%, on average, of the true values (ROBINSON, 2007). This discrepancy is caused mainly by incomplete sampling and mass loss during sample storage and preparation. An average 40% global underestimate in the root C pool might initially seem improbable (ROBINSON, 2007).

It is the root biomass of all organisms located below the soil line, whose function is to fix the vegetation, capture and transfer resources such as water and nutrients and to store reserves (ADUAN et al., 2003). The root system divided into thick and fine roots, as they have different functions. The coarse ones are responsible for fixing the plants in the soil, and the coarse ones have the function of absorbing water and nutrients (RATUCHNE et al., 2016). The development of the root system, quantity and extension of the roots, is directly influenced by the environmental condition of the place.

Most of the works found in the literature only address biomass and carbon stored in the aerial part of plants. This can be explained by the fact that the quantification of root biomass demands more time and labor. It is essential that further studies are carried out in order to understand the role that the root system plays in carbon cycles, and its subsequent influence on the climate, since unfortunately, roots are arguably the least understood portion of ecosystems (WANG et al., 2018).

Litter is any organic layer that falls from the aerial part of plants such as leaves, branches, branches, flowers, fruits and seeds that together with the roots go into the decomposition process, being responsible for a large part of the nutrient cycling, that is, in the nutrient transfer to the soil - plant system.

This organic layer resulting from the decomposition of plant residues is the main source of nutrients for the roots, therefore, a large part of the biomass of the fine roots (<2mm) is agglomerated in the first 30 cm of the soil. This indicates that the roots of this thickness are the main responsible for the water and nutrient absorption processes, and it is observed that this large amount of roots is related to the presence of the litter layer (WITSCHORECK, 2003).

Research aimed at quantifying forest biomass, or the biomass of each component, individually in a forest, aims to contribute to decision making in several areas, mainly in the areas of forest management and climate change, and answer the following questions: How much carbon is a forest capable of storing and emitting? What is the capacity of different ecosystems to fix and store atmospheric carbon in their biomass? What is the effect of seasonality on the production of forest biomass? (SALOMÃO et al., 1996).

However, answering these questions is not an easy task, there are several studies quantifying the aerial biomass of vegetation, however there are still few studies that aim to quantify the root biomass. The objective was quantify the seasonal distribution of root biomass and litter pool in Pantanal and Cerrado Mato-Grossense.

MATERIALS AND METHODS

Site description

Study sites are located in the Cuiaba Basin and the Pantanal in southern Mato Grosso, Brazil. Sampling in the Cuiaba Basin occurred at Fazenda Miranda (Sensu Stricto), Mato Grosso, Brazil (15°43’51’’S: 56°04’17’’W) and Baia das Pedras, located in the northern Pantanal approximately 130 km southwest of Cuiaba, Mato Grosso, Brazil. (16°29’53’’S; 56°24’46’’W).

In the Cuiaba Basin The long-term (30 year) average mean monthly air temperature ranges from a minimum of 18 °C in June - July to a maximum of 29 °C in October, (VOURLITIS et al., 2011; VOURLITIS et al., 2015). In the Pantanal a mean annual temperature is 26.5 ºC (CUNHA et al., 2004).

The regional mean annual precipitation of 1420 mm, with a wet season from October to April, and some areas experience 0.3 – 2.0 m flooding depending on topography and elevation (VOURLITIS et al., 2011). Sampling in the Pantanal occurred at Baia das Pedras which is a federally protected nature reserve located 160 km southwest of Cuiaba, Mato Grosso.

According to a study by Vourlitis et al. (2014), in which they divided the RPPN region into 4 fragments, namely: Upland forest (Cerradão), Mixed forest (Acurizal), Gallery forest (Cambarazal) and Woodland (Sensu stricto), we can observe data on the forest structure of our study area, containing measures of diameter (d), density, leaf area index (LAI), grass cover and dominant tree species (table 1):

Table 1: Mean structural characteristics, including tree diameter and density, leaf area index (LAI), grass cover, and dominant tree species for the forest and woodland stands of the Pantanal.

Ecosystem type of the Pantanal	Diameter (cm)	Density (trees.ha)	LAI ($m^2.m^{-2}$)	Grasses (%)	Primary tree species
Upland forest (Cerradão)	13.7 ± 2.0	1.441 ± 292	5.8 ± 0.1	5.1 ± 2.5	*Cf, Ef, Me, Vd*
Mixed forest (Acurizal)*	26.6 ± 3.9	1.479 ± 332	7.4 ± 0.3	2.4 ± 0.9	*Ac, Cc, Me, Sp*
Gallery forest (Cambarazal)	23.6 ± 1.9	1.020 ± 142	6.3 ± 0.2	0.6 ± 0.3	*Lp, Me, Vd*
Woodland (Sensu stricto)	13.1 ± 1.3	1.656 ± 296	3.7 ± 0.1	18.9 ± 4.1	*Af, Ca, Tau, Th*

(Ac) Aspidosperma cylindrocarpon M. Arg.; (Af) Astronium fraxinifolium;(Cf) Callisthene fasciculata;(Cc) Cupania castaneifolia Mart.; (Ca) Curatela americana;(Ef) Eugenia florida DC.; (Lp) Licania parvifolia Huber.; (Me) Mouriri elliptica Mart.; (Sp) Scheelea phalerata (Mart.) Bur.; (Tau) Tabebuia aurea;(Th) Tabebuia heptaphylla; (Vd) Vochysia divergens Pohl.
* study area.
Org: Vourlitis et al. (2014).

The soil of the study area was classified as eutrophic (BEIRIGO et al., 2011; CORINGA et al., 2012). It is a soil with high nutritional status. For presenting an intrinsic hydrological regime associated with its great biodiversity, the Pantanal Mato-Grossense is a region of great ecological and socio-economic relevance (SANTOS et al., 2015).

The Cerrado area Sensu Stricto is located on the border of the capital Cuiabá with the municipality of Santo Antônio de Leverger, approximately 15 km from Cuiabá. The structural characteristics of the phytophysiognomies of the Cuiaba basin with averages (Table 2).

Table 2: Mean structural characteristics, including tree diameter and density, leaf area index (LAI), grass cover, and dominant tree species for the forest and woodland stands of the Cuiaba Basin.

Ecosystem type of the Cuiabá Basin	Diameter (cm)	Density (trees ha^{-1})	LAI (m^2.m^{-2})	Grasses (%)	Primary tree species
Upland forest (Cerradão)	8.6 ± 0.9	1.407 ± 379	4.5 ± 0.2	32.7 ± 8.3	*Af, Ca, Tau, Re*
Woodland (*Sensu stricto*)*	9.4 ± 0.8	2.556 ± 368	3.1 ± 0.2	16.7 ± 4.3	*Ca, Qg, Qp, Tar*
Mixed grassland (Campo sujo)	6.8 ± 0.6	533 ± 62	1.3 ± 0.3	64.0 ± 5.1	*Ca, Dh*
Mixed Forest	9.2 ± 1.3	1.717 ± 438	2.5 ± 0.6	41.1 ± 7.9	*Af, Ca, Mg*
Gallery forest (Cambarazal)	11.9 ± 1.5	519 ± 132	2.1 ± 0.4	64.8 ± 8.8	*Ad, Hg, Vd*

(Ad) Alchornea discolor Poepp. & Endl.; (Af) Astronium fraxinifolium; (Ca) Curatela americana; (Dh) Diospyros hispida A. DC.; (Hg) Hirtella glandulosa Spreng.; (Mg) Matayba guianensis Radlk.; (Qg) Qualea grandiflora Mart.; (Qp) Qualea parviflora Mart.; (Re) Rhamnidium elaeocarpum Reiss.; (Tau) Tabebuia aurea; (Tar) Terminalia argentea Mart. & Zucc.; (Vd) Vochysia divergens.
* study area.
Org: Vourlitis et al. (2014).

The vegetation that makes up the *sensu stricto* cerrado fragment studied at Fazenda Miranda consists predominantly of grasses and tree species such as *Curatella americana* L; *Matayba guianensis* Radlk; *Qualea grandiflora* Mart; *Qualea parviflora* Mart; *Terminalia argentea* Mart. & Zucc (VOURLITIS et al., 2014).

It is a region of seasonal cerrado forest, with a relatively continuously covered surface of perennial grasses and a discontinuous layer of small trees and shrubs, most of which have thick bark and twisted trunks (ANTUNES JUNIOR et al., 2011).

The area in which the research was developed has dystrophic litholic soils, which can also be in the form of dystrophic concretes (Plinthosols) (EMBRAPA, 1999). Type of soil characterized by being poorly developed, not hydromorphic, moderately to excessively drained, of predominantly medium texture, and in dystrophic soils there is the problem of low natural fertility.

According to Eiten (1994), rainfall over geological time is responsible for the weathering of the cerrado soils, leaving them with a deficit in essential nutrients, and with high availability of aluminum.

Field sampling and laboratory analysis

Monthly field collections, for analysis of soil moisture and quantification of accumulated root and litter biomass, took place over 12 months (August 2018 to July 2019).

Laboratory soil analyses were conducted immediately after the soil samples were retrieved from the field. Sub-samples of the soil core were weighted for fresh weight (Mf) then oven-dried at 105°C for 24 hours and re-weighed to find the dry weight (Md). The change in mass was used to determine the gravimetric soil moisture at each location using [(Mf - Md)/ Md *100].

Litter pool stocks were measured monthly in randomly by collecting surface litter from a 25 cm diameter (490 cm^2) circular quadrat. Litterpool samples were cleaned of dirt and other inorganic debris, and dried at 70◦ C for 72 h or until constant weight. Litterpool samples were weighed to two decimal places using a digital balance.

The quantification of root biomass a direct method was used, which consists of removing undisturbed soil samples containing the roots, without the need to open trenches or trenches (RATUCHNE et al., 2016). Three samples collected monthly, between August 2018 and July 2019, randomly within a radius of 100 meters, in each study area. After removing the volumetric rings containing soil (approximately 1 dm^3), they were packed in such a way that the samples were not fragmented so that they could be taken to the laboratory. In the laboratory, the root-soil separation procedures (CECONI et al., 2007), sieved the soil (mesh 1 and 2 mm), washed the roots with distilled water, the washed roots were weighed to obtain fresh mass. Subsequently, the roots dried in the oven at 70ºC for 72 hours, to obtain the dry mass. After drying the roots, they were classified by diameter, being: thick (> 10 mm), medium (5-10 mm), slightly thin (2-5 mm) and fine (<2 mm). For the classification, millimeter paper and digital calipers used.

The root biomass data, initially obtained in grams of roots contained in a cubic decimeter of soil (g/dm^3), were converted into grams per m^2 (g/m^2) by means of mass and volume correspondences between these units.

Data analysis

In order to verify if the averages of the density of root biomass and litter accumulated in the soil were significantly different, between the two study areas and between the periods of the year, dry and wet, using a two-tailed, t-test, with a significance level of 5 %. The data subjected to a normality test. There was a correlation between the density of root biomass, soil moisture and litter pool, using Pearson's correlation coefficient. Statistical analyses conducted using MS Excel 2013 and R Core Team software.

RESULTS AND DISCUSSION

Litter dynamics

The monthly average of litter pool in Acurizal and Sensu stricto was, respectively: 526.52 g/m^2 and 588.96 g/m^2 (Figure 1). However, there was no significant difference in litter pool between the study areas.

It was observed that there was a significant difference in the accumulation of litter, between periods of drought and rain, indicating marked seasonality, both when analyzing Acurizal and *Sensu stricto* (Table 3).

Silva et al. (2009), in a transition forest in northern Mato Grosso, found values of litter pool in the soil, similar to those of the present study, with the mean monthly between the months of the dry period was 694.9 g/m^2, while in the wet period this average was 579.05 g/m^2, thus, they also observed greater accumulation in the dry period of the year.

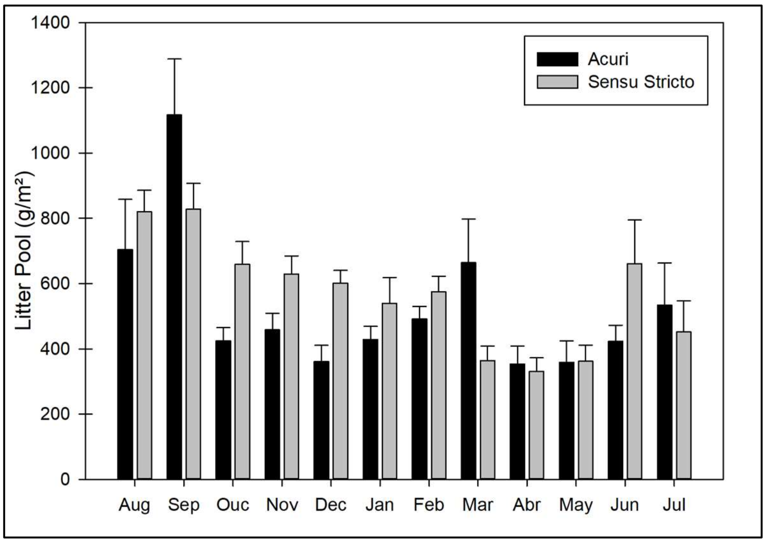

Figure 1: Quantification of the litter pool (average±SE), for the two study areas.

Table 3: Average followed by standard error, indicating the differences between the dry and wet periods, in Acurizal and Sensu stricto.

Season	Litter Pool (g/m²)	
	Acurizal	*Sensu Stricto*
Dry	627.22±75.51^a	663.18±55.29^a
Wet	454.59±29.52^b	489.13±35.66^b

*different letters in the columns indicate statistical difference ($p<0.05$) by paired-t-test.

Campos et al. (2008), in a study carried out on a sensu *stricto* Cerrado fragment, found a relationship between the wet season and the dynamics of litter pool, expressed by the Pearson coefficient which represented -0.47, indicating a correlation moderate and inversely proportional, that is, as there was a decrease in water in the system, the proportion of leaf fraction deposited in the soil increased.

The litter production and accumulation is higher in the dry season, mainly due to water stress (SILVA et al., 2007), which produces water savings in the ecosystem, resulting in a loss of plant biomass (SANCHES et al., 2009), considering that the fall of the leaves reduces the loss of water through transpiration (MARTINS et al., 1999). This increase in litter pool in the soil in the dry period is extremely important, as it functions as a barrier that makes it difficult to transfer water that retained in the soil to the atmosphere by evaporation (PIRES et al., 2006).

According to Luizão et al. (1986), the dynamics of litter in the humid tropical forest is clearly seasonal with a greater fall of litter in the dry season. There was no correlation between litter and other variables. According to another study carried out at Acurizal, where three treatments evaluated, namely: control, removal and addition of litter, they observed that its manipulation did not significantly affect the root biomass density in the soil (PINTO et al., 2018).

Root density in the soil by diameter class

The monthly average and the standard error of root density by diameter class, in Acurizal, were: thick 27.87±7.83 g/m², averages 21.78±4.26 g/m², slightly thin 27.19±3.48 and fine 48.38±2.96 g/m² (Figure 2). The smallest standard error or the smallest dispersion among the data of fine roots was observed. The low values of standard error observed for the thinner roots indicate that these roots have a homogeneous distribution in the area, while the thick roots, with high values of standard error, have high spatial variability.

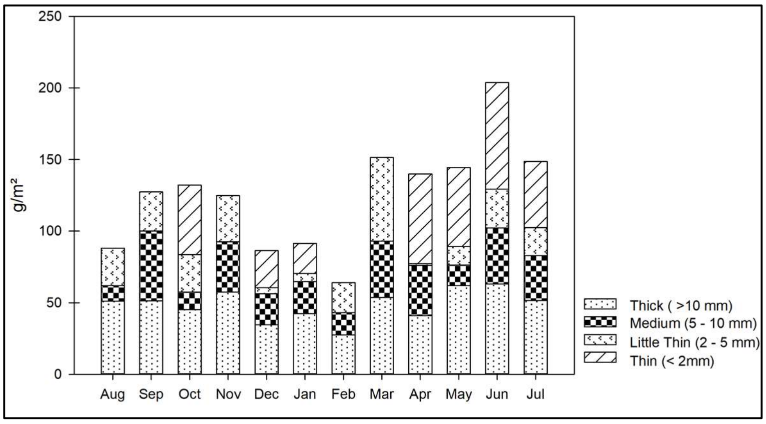

Figure 2: Density of root biomass in the soil of Acurizal.

The monthly mean root density by diameter class, in *sensu stricto*, was for thick roots 8.64±5.59 g/m², averages 14.90±5.18 g/m², slightly thin 12.52±2.79 and fine 22.80±1.33 g/m² (Figure 3). In both areas studied, the fine roots were present in a higher quantity in all samples, that is, they were homogeneously present in the first 10 cm of soil, thus, and the root biomass density averages were higher for the roots. <2mm, and the smallest standard error was for the finer roots.

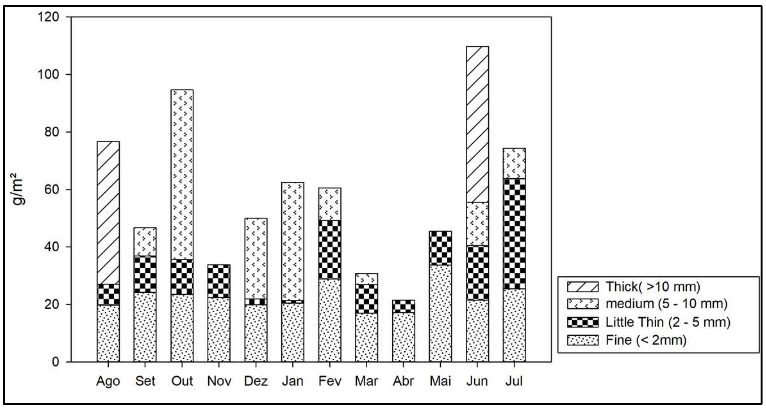

Figure 3: Density of the root biomass in the soil of the Cerrado area *sensu stricto*.

Root biomass was composed mostly of roots <2mm, however the presence of thick roots in the sample increases the value of total biomass, causing the density total radicular increase considerably. According to the classification by diameter of the roots, the thick roots are those with a diameter above 10 mm, however the method used in this study is not the most suitable for study and estimate specifically of thick roots (LEVILLAIN et al., 2011), because the objective was to verify the roots present in the soil, and not just an individual tree and its root system (ABDALA et al., 1998).

It was observed that the thick roots are distributed in the superficial layer of the soil in a more spaced way, compared to the roots with smaller diameter. What is related to the purpose of each type of root. The thicker ones have the function of supporting the vegetable, so they must be well dispersed and reach greater depth. When it comes to root biomass in the soil, regardless of depth, according to several studies, thick and fine roots are the most significant, and the smallest portion of biomass is from medium and fine roots.

This observation corroborates data from Pavão et al. (2019), who in his study of root biomass, at different depths, using the same diametric classification, obtained predominance of fine and thick roots, with fine ones being present in all samples of the layer topsoil and thick ones do not. This was also observed in the present case.

In a study of the root system of another species of palm, it was found in the article by Morales et al. (1990), that their fasciculate root system, composed of the thinnest roots, presented about 75 to 80% of the roots distributed, more or less uniformly, in the first 20 cm of the soil, being that the minority of the roots that presented larger diameters, have accentuated geotropism, being considered roots of support or anchoring. According to the pattern generally presented by palm trees (TOMLINSON, 1990).

According to Balieiro et al. (2005), the concentration of roots in the topsoil demonstrates the strategy that tropical species use to more efficiently absorb the nutrient cycled via litter deposition, keeping the roots close to the nutrient source.

At Acurizal, the number of fine roots was higher than the number of roots with a diameter greater than 2 mm in all periods analyzed. In the wet season, there was an average percentage of the total samples, 97.53% of the fine roots and only 2.47% of roots> 2mm. In the dry season, the values were similar, 97.39% of fine roots and 2.61% of roots> 2mm in diameter.

The percentage of roots in the topsoil of the Cerrado area *Sensu stricto*, was higher than that of Acurizal, in relation to fine roots, and in the wet season, this percentage was 98.67%, while for roots with largest diameter was 1.33%. In the dry season, the results were similar, 98.87% of fine roots and 1.13% of roots with diameter> 2mm. Well-defined seasonality was not observed in the root density data in the soil, however, in Acurizal the peak of root biomass was in May, and in *Sensu stricto* in June, months of the dry period of the year.

When evaluating the average root density by diametric class, between the dry and wet periods, it was observed that it was higher in the dry season, in both areas, mainly of the roots classified as fine (<2mm). However, this difference in root biomass density, between dry and wet periods, for Acurizal and *Sensu stricto*, was not significant (p> 0.05).

In a study evaluating one month from the dry period (June) and another from the wet period (December) in an early-stage and an advanced-stage forest. Menezes et al. (2010) determined that the root density was higher in June, a less wet period and with lower temperatures in the region, as in the regions where the collections of this research were carried out, however, this difference, as in the present study, was also not significant, indicating stability in the root production dynamics in these treatments.

This tendency to increase the density of root biomass in the dry period may occur due to less demand for carbon in the canopy and greater translocation of carbohydrates to root formation in this period of less vegetative production, typical of the region (XIAO et al., 2008).

Root density

We observe the monthly values of density of the total root biomass in the soil, regardless of the diametric class, and standard error (Figure 4).

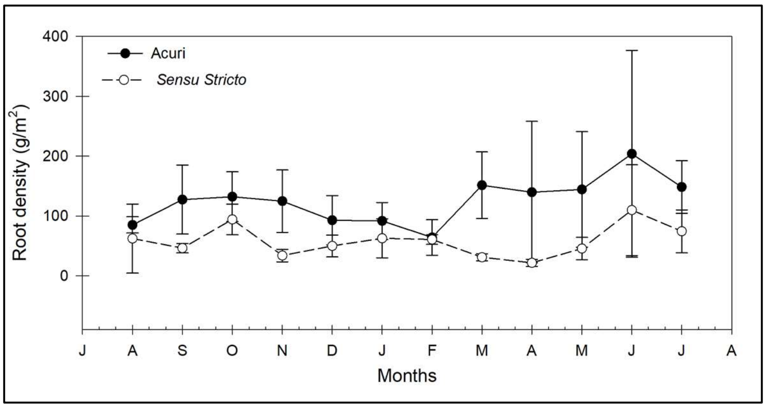

Figure 4: Root density (average±SE) in the soil (g/m²), regardless of the diameter class, in the two study areas.

Observed that the density of the root biomass in the soil remained with higher values in Acurizal, in practically every month. In Acurizal, the root density in the soil, regardless of the diameter class, was on average 124.92 g/m², while in *sensu stricto* it was 57.5 g/m². It was found that there was a difference ($p < 0.05$) in the density of root biomass in the soil between the two areas studied.

Biomass stocks vary between forest ecosystems and investigations on the amount of fine root biomass in tropical forests have produced different results. Laclau et al. (2001) demonstrated high heterogeneity in the spatial distribution of roots.

The distribution of fine roots is associated with the intensity of the root system and tends to more correlated with the conditions of the soil on which the plant is fixed. While the layout of the root system, which related to the shape, direction and distribution of the thick roots, tends to linked to plant genetics (MAKKONEN et al., 1998).

Comparing the areas, in almost every month (except January and March), the soil moisture was higher in Acurizal. According to Blainski et al. (2008), soil moisture is likely to be one of the variables that has the greatest influence on the development and distribution of the root system.

However, in the present study, soil moisture was not significantly correlated with the monthly root density in the 0-10 cm layer of the soil. When evaluating three treatments Mendes (2018) also found that, there was no significant correlation between soil moisture and root biomass in two of the three treatments studied, as the dynamics of fine roots may be more related to the seasonal availability of nutrients in the soil.

The distribution of nutrients in soils in natural environmental systems is enough variable and root growth is greater in areas with a high concentration of nutrients and relatively less in areas considered poor in nutrients (BLAIR et al., 2001). Thus, the concentration of nutrients may be one of the factors that explains the higher density of root biomass in Acurizal. For, in research carried out in *sensu stricto* (Fazenda Miranda) and in Acurizal, in which Vourlitis et al. (2014) analyzed the concentrations of nitrogen (N), phosphorus (P) and potassium (K) in the topsoil (0-10cm), it was noticed that the soil of Acurizal is more abundant in the concentration of these nutrients (N, P and K) compared to *sensu stricto*.

Considering that the root system can be affected differently by nutrients, P and K, promote root growth (KOLESNIKOV, 1971), and P limitation can mainly affect the development of the root system, especially in soils acids from tropical and subtropical regions (SILVA et al., 2009). N, on the other hand, is the nutrient most required by plants (SILVA et al., 2009), and in its nitric form it promotes greater biomass production and a higher rate of root regeneration (ABER et al., 1985).

The genetic differences between the forest populations in the study areas is one of the factors that explains the root density in the superficial layer of the soil to be greater in the area of Acurizal, considering that the standard root system presented by palm trees is characterized by fasciculate roots, which are not woody and mostly concentrated in the top layer, usually in the first 30 cm of soil depth. This accumulation of roots on the surface may be responsible for a weak resistance of the species to drought (BOVI et al., 1978).

And contrary to what is observed in Acurizal, the trees that predominate in the Cerrado area Sensu stricto, being them, *Curatella americana* L.; *Qualea grandiflora* Mart.; *Qualea parviflora* Mart. and *Terminalia argentea* Mart. & Zucc. (VOURLITIS et al., 2014), present as one of their main adaptive characteristics to the conditions of the Cerrado Sensu stricto, the investment in deep and thick roots (long and pivoting root system) allowing the reach of soil regions where there is availability water even in the dry season (PALHARES et al., 2010). As in general, they are the characteristic species of environments with dystrophic conditions, in acidic soils and with low nutrient content (FURLEY et al., 1988).

CONCLUSIONS

The density of the root biomass in the soil did not show seasonality, both in the area of Acurizal and *sensu stricto*. In both study areas, the root density in the topsoil (0-10 cm), was mostly composed of fine roots (<2mm).

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REFERENCES

ABDALA, G. C.; CALDAS, L. S.; HARIDASAN, M.; EITEN, G.. Above and belowground organic matter and root: shoot ratio in a cerrado in central Brazil. **Brazilian Journal of Ecology**, v.2, n.1, p.11-23, 1998.

ABER, J. D.; MÉLILLO, J. M.; NADELHOFFER, K. J.; MCCLAUGHERTY, C. A.; PASTOR, J.. Fine root turnover in forest ecosystems in relation to quantity and form of nitrogen availability: a comparison of two methods. **Oecologia**, v.66, p.317-321, 1985. **DOI**: https://doi.org/10.1007/BF00378292

ADUAN, R. E.; VILELA, M. F.; REIS JÚNIOR, F. B.. **Os grandes ciclos biogeoquímicos do planeta.** Embrapa Cerrados-Documentos (INFOTECA-E), 2004.

ADUAN, R. E.; VILELA, M. F.; KLINK, C. A.. **Ciclagem de carbono em ecossistemas terrestres:** o caso do cerrado brasileiro. Planaltina: Embrapa Cerrados-Documentos (INFOTECA-E), 2003.

ANTUNES JUNIOR, M. Z.; LOBO, F. A.; DALMAGRO, H. J.; VOURLITIS, G. L.; ORTIZ, C. E. R.; DALMOLIN, Â. C.; SULI, G. S.. Efeito do microclima no intercâmbio gasoso potencial de cambará (Vochysia divergens Pohl) e lixeira (Curatella americana L.) em área de Cerrado. **Revista Brasileira de Biociências**, v.9, n.1, p.77-85, 2011.

BALIEIRO, F. C.; CEDDIA, M. B.; PEREIRA, M. G.; RESENDE, A. S.; FRANCO, A. A.. Biomassa de raízes e regime hídrico do solo em plantio de Pseudosamanea guachapele (Kunth) Harms em um planossolo háplico. **Floresta**, v.35, p.221-230, 2005. **DOI**: https://doi.org/10.5380/rf.v35i2.5217

BEIRIGO, R. M.; TORRADO, P. V.; STAPE, J. L.; ANDRADE, G. R. P.. **Solos da reserva particular do patrimônio natural SESC Pantanal**. Rio de Janeiro: SESC, 2011.

BLAINSKI, E.; TORMENA, C. A.; FIDALSKI, J.; GUIMARÃES, R. M. L. Quantificação da degradação física do solo por meio da curva de resistência do solo à penetração. **Revista Brasileira Ciência do Solo**, v.32, p.975-983, 2008. **DOI**: https://doi.org/10.1590/S0100-06832008000300007

BLAIR, B. C.; PERFECTO, I.. Nutrient content and substrate effect on fine root density and size distribution in a Nicaraguan rain forest. **Biotrópica**, v.33, n.4, p.697-701,

2001. **DOI**: https://doi.org/10.1111/j.1744-7429.2001.tb00227.x

BOVI, M. L. A.; CARDOSO, M.; CIONE, J.. Sistema radicular do palmiteiro. **Bragantia**, v.37, n.1, p.85-88, 1978. **DOI**: https://doi.org/10.1590/S0006-87051978000100031

CAMPOS, E. H.; ALVES, R. R.; SERATO, D. S.; RODRIGUES, G. S. S. C.; RODRIGUES, S. C.. Acúmulo de serrapilheira em fragmentos de mata mesofítica e cerrado stricto senso em Uberlândia-MG. **Sociedade & Natureza**, v.20, n.1, p.189-203, 2008. **DOI**: https://doi.org/10.1590/S1982-45132008000100013

CECONI, D. E.; POLETTO, I.; LOVATO, T.; & SCHUMACHER, M. V. Biomassa e comprimento de raízes finas em povoamento de Acacia mearnsii De Wild. estabelecido em área degradada por mineração de carvão. **Floresta**, v.38, n.1, p.1-10, 2008. **DOI**: https://doi.org/10.5380/rf.v38i1.11022

CORINGA, E. A. O.; COUTO, E. G.; PEREZ, X. L. O.; TORRADO, P. V.. Atributos de solos hidromórficos no Pantanal Norte Matogrossense. **Acta Amazônica**, v.42, n.1, p.19-28, 2012. **DOI**: https://doi.org/10.1590/S0044-59672012000100003

CUNHA, C. N. D.; JUNK, W. J.. Year-to-year changes in water level drive the invasion of Vochysia divergens in Pantanal grasslands. **Applied Vegetation Science**.v.7, n.1, p.103-110, 2004. **DOI**: https://doi.org/10.1111/j.1654-109X.2004.tb00600.x

EITEN, G.. Vegetação do Cerrado In: PINTO, M. N.. **Cerrado:** caracterização, ocupação e perspectivas. 2 ed. Brasília: UnB, 1994. p.9-65.

EMBRAPA. Empresa Brasileira de Pesquisa Agropecuária. **Centro Nacional de Pesquisa de Solos.** Sistema brasileiro de classificação de solos. Rio de Janeiro: EMBRAPA, 1999.

ENQUIST, B. J.; NIKLAS, K. J.. Global allocation rules for patterns of biomass partitioning in seed plants. **Science,** v.295, p.1517-1520, 2002. **DOI**: https://doi.org/10.1126/science.1066360

FURLEY, P. A.; RATTER, J. A.. Soil resources and plant communities of the central brazilian cerrado and their development. **Journal of Biogeography**, p.97-108, 1988. **DOI**: https://doi.org/10.2307/2845050

KOLESNIKOV, V. A.. **The root system of fruit plants.** 2 ed. Moscow: Izdatelstvo Mir, 1971.

LACLAU, J. P.; ARNAUD, M.; BOUILLET, J. P.; RANGER, J.. Spatial distribution of Eucalyptus roots in a deep sandy soil in the Congo: relationships with the ability of the stand to take up water and nutrients. **Tree Physiology**, v.21, n.2-3, p.129-136, 2001. **DOI**: https://doi.org/10.1093/treephys/21.2-3.129

LEVILLAIN, J.; M'BOU, A. T.; DELEPORTE, P.; SAINT-ANDRÉ, L.; JOURDAN, C.. Is the simple auger coring method reliable for below-ground standing biomass estimation in Eucalyptus forest plantations?. **Annals of Botany**, v.108, n.1, p.221-230, 2011. **DOI**: https://doi.org/10.1093/aob/mcr102

LOPES, V. G.; SCHUMACHER, M. V.; CALIL, F. N.; VIERA, M.; & WITSCHORECK, R. Quantificação de raízes finas em um povoamento de Pinus taeda L. e uma área de campo em Cambará do Sul, RS. **Ciência Florestal**, v.20, n.4, p.569-578, 2010. **DOI**: https://doi.org/10.5902/198050982415

LUIZÃO, F. J.; SCHUBART, H. O. R.. Produção e decomposição de liteira em floresta de terra firme da Amazônia Central. **Acta Limnológica Brasileira**, v.1, p.575-600, 1986.

MACHADO, P. L. D. A.. Carbono do solo e a mitigação da mudança climática global. **Química Nova**, v.28, n.2, p.329-334, 2005. **DOI**: https://doi.org/10.1590/S0100-40422005000200026

MAKKONEN, K.; HELMISAARI, H.. Seasonal and yearly variations of fine-root biomass and necromass in a scots pine (Pinus sylvestris L.) stand. **Forest Ecology and Management**, v.102, n.2-3, p.283-290, 1998. **DOI**: https://doi.org/10.1016/S0378-1127(97)00169-2

MARTINS, S. V.; RODRIGUES, R. R.. Produção de Serrapilheira em clareiras de uma floresta estacional semidecidual no Município de Campinas, SP. **Brazilian Journal of Botany**, v.22, n.3, p.405-412, 1999. **DOI**: https://doi.org/10.1590/S0100-84041999000300009

MELLO, J. M.; COUTO, E. G.; AMORIM, R. S. S.; CHIG, L. A.; JOHNSON, M. S.; LOBO, F. A.. Dinâmica dos atributos físico-químicos e variação sazonal dos estoques de carbono no solo em diferentes fitofisionomias do pantanal norte mato-grossense. **Revista Árvore**, v.39, n.2, p.325-336, 2015. **DOI**: https://doi.org/10.1590/0100-67622015000200012

MENDES, L. S. S.. **Dinâmica de raízes finas em relação à disponibilidade sazonal de nutrientes e de diferentes níveis de deposição úmida em florestas tropicais**. Thesis (Doutorado em Ciência do Sistema Terrestre) - Instituto Nacional de Pesquisas Espaciais, São José dos Campos, 2018.

MENEZES, C. E. G.; PEREIRA, M. G.; CORREIA, M. E. F.; ANJOS, L. H. C.; PAULA, R. R.; SOUZA, M. E.. Aporte e decomposição da serapilheira e produção de biomassa radicular em florestas com diferentes estágios sucessionais em Pinheiral, RJ. **Ciência Florestal**, v.20, n.3, p.439-452, 2010. **DOI**: https://doi.org/10.5902/198050982059

MORALES, A. L.; VARGAS, H. S.. Observaciones sobre la distribucion radical del pejibaye (Bactris gasipaes H.B.K.) para palmito en un andosol. **ASBANA**, v.14, n.34, p.9-15, 1990.

PALHARES, D.; FRANCO, A. C.; ZAIDAN, L. B. P.. Respostas fotossintéticas de plantas de Cerrado nas estações seca e chuvosa. **Revista Brasileira de Biociências**, v.8, n.2, p.213-220, 2010.

PAVÃO, L. L.; SANCHES, L.; JÚNIOR, O. B. P.; SPOLADOR, J.. The influence of litter on soil hydro-physical characteristics in an area of Acuri palm in the Brazilian Pantanal. **Ecohydrology & Hydrobiology,** v.19, n.4, p.642-650, 2019. **DOI**: https://doi.org/10.1016/j.ecohyd.2019.04.004

PIRES, L. A.; BRITEZ, R. M.; MARTEL, G.; PAGANO, S. N. Produção, acúmulo e decomposição da serapilheira em uma restinga da Ilha do Mel, Paranaguá, PR, Brasil. **Acta Botanica Brasilica**, v.20, n.1, p.173-184, 2006. **DOI**: https://doi.org/10.1590/S0102-33062006000100016

PINTO, O. B.; VOURLITIS, G.; CARNEIRO, E. S.; DIAS, M. F.; HENTZ, C.; NOGUEIRA, J. S.. Interactions between Vegetation, hydrology, and litter inputs on decomposition and soil CO2 efflux of tropical forests in the Brazilian Pantanal. **Forests**, v.9, n.5, p.1-17, 2018. **DOI**: https://doi.org/10.3390/f9050281

RATUCHNE, L. C.; KOEHLER, H. S.; WATZLAWICK, L. F.; SANQUETTA, C. R.; SCHAMNE, P. A.. Estado da arte na quantificação de biomassa em raízes de formações florestais. **FLORAM**, v.23, n.3, p.450-462, 2016. **DOI**: https://doi.org/10.1590/2179-8087.131515

ROBINSON, D.. Implications of a large global root biomass for carbon sink estimates and for soil carbon dynamics. **Proceedings of the Royal Society B: Biological Sciences**, v.274, n.1626, p.2753-2759, 2007. **DOI**: https://doi.org/10.1098/rspb.2007.1012

SALOMÃO, D. P. R.; NEPSTAD, D. C.; VIEIRA, I. C. G. Como a biomassa de florestas tropicais influi no efeito estufa?. **Ciência Hoje**, p.38-47, 1996.

SANCHES, L.; VALENTINI, C.; BIUDES, M. S.; NOGUEIRA, J. D. S.. Dinâmica sazonal da produção e decomposição de serrapilheira em floresta tropical de transição. **Rev. Bras. Eng. Agríc. Ambient**, v.13, n.2, p.183-189, 2009. **DOI**: https://doi.org/10.1590/S1415-43662009000200012

SANTOS, A. C. A.; NOGUEIRA, J. S.. Análise do material particulado no Pantanal Mato-Grossense. **Revista Brasileira de Meteorologia**, v.30, n.3, p.254-264, 2015. **DOI**: https://doi.org/10.1590/0102-778620140059

SILVA, C. J.; LOBO, F. D. A.; BLEICH, M. E.; SANCHES, L. Contribuição de folhas na formação da serrapilheira e no retorno de nutrientes em floresta de transição no norte de Mato Grosso. **Acta Amazônica**, v.39, n.3, p.591-600, 2009. **DOI**: https://doi.org/10.1590/S0044-59672009000300014

SILVA, C. J.; SANCHES, L.; BLEICH, M. E.; LOBO, F. A.; NOGUEIRA, J. S. Produção de serrapilheira no Cerrado e Floresta de Transição Amazônia - Cerrado do Centro-Oeste Brasileiro. **Acta Amazônica**, v.37, n.4, p.543-548, 2007. **DOI**: https://doi.org/10.1590/S0044-59672007000400009

SOHRABI, H.; BAKHTIARVAND-BAKHTIARI, S.; AHMADI, K. Above and belowground biomass and carbon stocks of different tree plantations in central Iran. **Journal of Arid Land**, v.8, n.1, p.138-145, 2016. **DOI**: https://doi.org/10.1007/s40333-015-0087-z

TOMLINSON, P. B.. **The structural biology of palms**. Oxford: Clarendon Press, 1990.

VOURLITIS, G. L.; ROCHA, H. R. H. R.. Flux dynamics in the cerrado and cerrado-forest transition of Brazil. In: **Ecosystem function in global savannas:** measurement and modeling at landscape to global scales. 2011. p.97-116. **DOI**: https://doi.org/10.1201/b10275-8

VOURLITIS, G. L.; LOBO, F. A.; LAWRENCE, S.; HOLT, K.; ZAPPIA, A.; PINTO, O. B.; NOGUEIRA, J. S.. Nutrient resorption in tropical savanna forests and woodlands of central Brazil. **Plant Ecology**, v.215, n.9, p.963-975, 2014. **DOI**: https://doi.org/10.1007/s11258-014-0348-5

VOURLITIS, G. L.; LOBO, F. A.; PINTO, O. B.; ZAPPIA, A.; DALMAGRO, H. J.; ARRUDA, P. H. Z.; NOGUEIRA, J. S.. Variations in aboveground vegetation structure along a nutrient availability gradient in the Brazilian pantanal. **Plant and Soil**, v.389, n.1-2, p.307-321, 2015. **DOI**: https://doi.org/10.1007/s11104-014-2364-6

WANG, Y.; JIA, B.; XIE, Z.. The Effects of Dynamic Root Distribution on Land-Atmosphere Carbon and Water Fluxes in the Community Earth System Model (CESM1. 2.0). **Forests**, v.9, n.4, p.172, 2018. **DOI**: https://doi.org/10.3390/f9040172

WITSCHORECK, R.; SCHUMACHER, M. V.; CALDEIRA, M. V. W. Estimativa da biomassa e do comprimento de raízes finas em Eucalyptusurophylla S.T. Blake no município de Santa Maria-RS. **Revista Árvore**, v.27, n.2, p.177-183, 2003. **DOI**: https://doi.org/10.1590/S0100-67622003000200008

XIAO, C. W.; SANG, W. G.; WANG, R. Z.. Fine root dynamics and turnover rate in an Asia white birch forest of Donglingshan Mountain, China. **Forest Ecology and Management**, v.255, n.3-4, p.765-773, 2008. **DOI**: https://doi.org/10.1016/j.foreco.2007.09.062

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