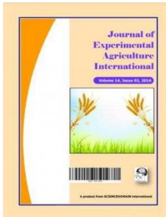

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Effects of Fertilization on Biomass and Macronutrient Content of *Eucalyptus urophylla* S.T. Blake in Arenized Soil of Pampa Biome

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Authors' contributions

This work was carried out in collaboration among all authors. Author HPS was responsible for the statistical analyzes and execution of the manuscript. Author MVS is advisor and contributed to the discussion of the data. Author AAL contributed to the discussion and was responsible for adaptation of the manuscript according to the norms of the journal. Authors DRM and ACM contributed in the discussion of the work. Author CCG was responsible for making the study area available. All authors read and approved the final manuscript.

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ABSTRACT

The objective of this study was to quantify the biomass and the macronutrient stock in an experiment of fertilization with *Eucalyptus urophylla*, planted in arenized soil at 12 months-old, in Rio Grande do Sul, Brazil. The experiment had a completely randomized design with five treatments (T1, T2, T3, T4 and T5) with three replications. The treatments T2, T3, T4 and T5, received increasing doses of triple superphosphate. On the other hand, the T1 treatment was the only one to receive natural phosphate in planting. For the determination of the biomass, fifteen trees were felled and separated in the following components: leaves, branches, stem bark, stem wood and roots. Samples of the components were collected and transported to the laboratory for biomass

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determination and chemical analysis. The total biomass varied between the treatments, with highest biomass accumulation of 6.83 Mg ha^{-1} occurring in T5. The T1 presented the highest biomass for roots representing 33.4% of the total biomass. The biomass distribution among the different components in the decreasing order was: roots > stem wood > leaves > branches > stem bark, for all the treatments. The treatment with higher doses of fertilizers (T5) presented the highest amount of nutrient accumulation in the total biomass (131.26 kg ha^{-1}). The concentration and accumulation of nutrients presented the following trend K > N > Ca > Mg > P > S. Analyzing the different components of biomass, the highest amounts of nutrients followed the order: leaves > roots > stem wood > branches > stem bark. Fertilization influenced the biomass production of *E. urophylla* in arenized soil in the Pampa biome, but without significant differences to date (12 months). The leaves had the highest concentration of macronutrients, with the exception of Ca, which was higher in the bark. The K was the element that presented highest accumulation in whole tree. The plantation of eucalyptus with fertilization management may be an alternative for the economic use of arenized soil.

Keywords: Forest nutrition; forest production; sandy soil; nutrient doses.

1. INTRODUCTION

The Pampa biome has an area of approximately 700 thousand km², present in Brazil, Argentina and Uruguay [1]. In Brazil, the Pampa is restricted to the state of Rio Grande do Sul, where it occupies an area of 176,496 km², corresponding to 63% of the state territory and 2.07% of the Brazilian territory [2].

In the west of Rio Grande do Sul, there are areas with intense degradation caused by the arenization process [3]. Arenization, a morphogenic process of arenized soil formation, can be one of the most intense environmental degradation scenarios in the Pampa biome region [4].

The first works to recover the arenized soils started from the Department of Agriculture of the State of Rio Grande do Sul, through a pilot project installed in the city of Alegrete, with which it was possible to identify that eucalyptus was the species that best suited the arenized soils [5]. However, the arenized soils present very low natural fertility and require chemical supplementation, through fertilization, to enable the implantation of forest stands.

Fertilization should maximize productivity with minimal investment and no negative impacts on the environment [6]. For this, the quantification of biomass and the allocation of nutrients in the different tree components of forest stands are essential for understanding the nutritional balance of the site [7,8], especially for definitions of sustainable management.

During the different stages of tree growth, due to changes in physiological and growth processes, there are changes in the demand, storage and distribution of nutrients in the trees [9]. After planting, there is an intense period of growth, mainly for the formation of the canopy and root system, after the canopy closure, tree growth is directed to the stem [8]. The canopy presents high concentrations of nutrients and low biochemical cycling (senescence) during the initial growth period, thus absorbing large amounts of nutrients from the soil during this period, which may restrict tree growth if the soil has a limited supply of nutrients [9].

The nutrient requirement of the species and the soil properties are useful information to adjust the fertilization regimes specific to the site, especially when it aims to maintain the nutrient stock in the soil along the rotations [10]. Silva et al. [6] showed how difficult it is to establish fertilization regimes in sandy soils with low nutrient retention and high hydraulic conductivity, since they are highly susceptible to nutrient leaching and present risks of nutrient loss through deep drainage in this type of soil.

The objective of this study was to verify the effect of fertilization on the production of biomass and stock of macronutrients of *Eucalyptus urophylla*, at 12 months-old, established in arenized soil in the Pampa biome.

2. MATERIALS AND METHODS

2.1 Characterization of the Experimental Area

The experiment was conducted in the municipality of Maçambará, western region of Rio Grande do Sul, Brazil, with geographic coordinates 29º 02' 32.67" S and 55º 19' 40.44" W.

Table 1. Physical-chemical attributes of the soil in the experimental site planted with *Eucalyptus urophylla* in the arenized Pampa biome

Attribute	Unit	Depth (cm)									
		0 20	20 40	40 60	60 80	80 100	100 120	120 140	140 160	160 180	180 200
SD	g cm^{-3}	2.1	2.3	1.9	1.8	1.7	1.8	1.9	1.7	1.6	1.6
CS	%	88.0	88.3	86.0	81.3	82.3	84.0	77.6	81.0	84.0	82.0
FS		3.0	3.5	3.0	4.0	1.6	2.7	4.3	5.4	3.3	3.4
Silt		1.0	1.6	1.0	3.0	4.7	2.6	6.0	2.3	1.4	3.3
Clay		8.0	6.6	10.0	11.6	11.3	10.6	12.0	11.3	11.3	11.3
O.M.		0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.2	0.1	0.1
pH	1:2,5 H_2O	4.8	4.7	4.6	4.6	4.6	4.6	4.6	4.7	4.7	4.6
Al	$cmol_c$ dm^{-3}	0.7	0.6	0.8	0.8	0.9	0.9	0.9	0.8	0.9	1.0
Ca		0.2	0.1	0.1	<0.1	0.2	0.2	0.1	<0.1	0.1	<0.1
Mg		0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
P[a]	mg dm^{-3}	4.6	3.4	2.3	2.9	3.5	4.3	5.0	6.9	7.3	6.9
K[a]		13.3	12.7	14.8	13.8	14.1	14.0	13.3	14.5	13.5	13.3
CECef	$cmol_c$ dm^{-3}	0.9	0.7	0.9	0.9	1.1	1.1	1.0	1.0	0.9	1.1
$CECpH_7$		2.6	2.9	3.6	3.7	3.8	3.9	3.8	3.7	3.8	3.7
V	%	7.7	4.6	4.6	3.2	4.9	5.1	3.7	2.6	2.9	2.5
m		77.2	82.1	81.7	87.0	82.9	82.3	86.1	90.4	88.6	91.3
S	mg dm^{-3}	3.9	10.1	13.9	15.6	15.9	14.4	14.6	7.0	8.9	7.7
B		0.3	0.3	0.4	0.4	0.3	0.3	0.2	0.2	0.2	0.3
Cu		0.4	0.4	0.5	0.5	0.6	0.5	0.6	0.5	0.5	0.4
Zn		0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1

Where: SD = soil density; CS = coarse sand; FS = fine sand; O.M = organic matter; [a]Extraction method Melich I. CECef = cation exchange capacity effective; CECef = cation exchange capacity pH 7.0; V = base saturation; m = aluminum saturation

Table 2. Concentration of nutrients used in the experiment with *Eucalyptus urophylla*, in arenized soil of the Pampa biome

Fertilization	Days after planting	Fertilizer	Amount of fertilizer applied (g $plant^{-1}$)				
			T 1	T 2	T 3	T 4	T 5
Planting	0	Superphosphate	-	150	200	250	300
		Natural phosphate	250	-	-	-	-
1st After Planting	30	NPK 06-30-06	60	65	72	85	96
		Potassium chloride	165	165	165	165	165
2nd After Planting	75	NPK 22-00-18	66	72	84	96	108
3rd After Planting	120	NPK 22-00-18	66	72	84	96	108
		NPK 10-25-25	-	-	-	-	137
4th After Planting	180	NPK 06-30-06	-	66	-	-	-
		FTE BR[a]	-	48	66	84	102
5th After Planting	300	NPK 06-30-06	-	30	36	42	48
		NPK 22-00-18	-	30	36	42	48
		FTE BR[a]	-	30	36	42	48
6th After Planting	420	NPK 06-30-06	-	30	36	42	48
		NPK 22-00-18	-	30	36	42	48
		FTE BR[a]	-	30	36	42	48

[a]FTE BR = constituted by Calcium (7.1%), Sulfur (5.7%), Boron (1.8%), Copper (0.8%), Manganese (2.0%), Molybdenum (1.0%) and Zinc (9.0%)

According to Köppen classification the climate in the municipality of Maçambará - RS is of the type Cfa (humid temperate climate). The average annual rainfall is 1628 mm, the average annual temperature is 20.7°C, while the average of the coldest month is 15.5°C and the average of the hottest month is 26.3°C. In winter, negative temperatures and frost formation occur [11].

The soil of the experimental area is characterized as sandy (composed of more than 80% of coarse sand), of low natural fertility, with very low organic matter content and levels below that recommended for all elements analyzed (Table 1). The soil profile presented homogeneity of the attributes analyzed between the different depths and did not present any active biological activity in the soil, nor was to the presence of roots (live or dead).

For the installation of the experiment realized the ant control activities in the areas surrounding the arenized soil, subsoiling, planting and replanting. The subsoiling was performed using subsoiler with a shank 30 cm deep. The planting was done manually, using clonal seedlings of *Eucalyptus urophylla* with 90 days-old, spacing 3.0 m x 2.0 m.

The experiment was conducted in completely randomized design with five treatments, containing three replicates for each treatment. Each plot has 60 m x 30 m, with 300 trees, and the effective plot (excluding double border) is composed of 143 trees.

The treatments received different sources and doses of fertilization (Table 2). The treatments T2, T3, T4 and T5, received increasing doses of triple superphosphate, ranging from 112.5 - 225 kg ha^{-1}. On the other hand, the T1 treatment was the only one to receive natural phosphate in planting. The dosages of triple superphosphate and natural phosphate were application in planting for all treatments.

Fertilizers were used in a varied way among treatments, the only equal dosages were for dolomitic limestone, where all received 2 Mg ha^{-1}, and a fertilization with 150 kg ha^{-1} of K_20, for all treatments, in the form of potassium chloride 30 days after planting.

2.2 Biomass

Through the inventory data, at 12 months-old, the average diameter tree of each of the plots for biomass determination was selected. The selected tree was separated in the following components: leaves; branches; stem bark and stem wood. The root system of the trees was removed by manual excavation of the useful area of each tree (6 m^2), up to 1 meter deep.

All components were weighed individually on a table scale to obtain the total wet mass in the field. Afterwards, 150 g wet mass sample was collected from each component, was placed in paper packaging, duly identified and sent to the laboratory. The samples were dried in a circulation oven and air renewal at 70ºC for 72 hours to determine the biomass.

2.3 Nutrients

After weighing, the samples were ground in a Wiley mill with 20 mesh sieve and used for chemical analysis, where the macronutrients (N, P, K, Ca, Mg and S) were determined. Nitrogen was determined by the Kjeldahl method (sulfur digestion = H_2SO_4 + H_2O_2). Phosphorus and boron by spectrophotometry (P by nitric-perchloric digestion and B by dry digestion). Potassium by flame photometry, sulfur by turbidimetry and calcium, magnesium, copper, iron, manganese and zinc by atomic absorption spectrometry (all by nitric-perchloric digestion), following the method described by Tedesco et al. [12] and Miyazawa et al. [13].

The amount of nutrients in each of the components of the trees was obtained through the product between the biomass and the concentration of nutrients. The estimate of the nutrient stock in the biomass per hectare was performed by extrapolating the stock of nutrients based on the area sampled.

2.4 Statistical Analysis

The results were statistically analyzed through the SAS for Windows [14] package, using the Tukey test at the 0.05 error probability level, considering the completely randomized design, where each sampled tree corresponded to one repetition, for each component of the biomass studied.

3. RESULTS AND DISCUSSION

3.1 Biomass

The biomass components do not differ significantly for the various treatments evaluated (Table 3). However, evaluating the management of fertilizers in eucalyptus plantations in sandy soil in Brazil, Silva et al. [6] concluded that eucalyptus responds positively to increased fertilizer doses, resulting in higher productivity.

Table 3. Distribution of biomass in the different components of *Eucalyptus urophylla*, at 12 months of age, in arenized soil in the Pampa biome

Components	T 1	T 2	T 3	T 4	T 5
			Mg ha^{-1}		
Leaves	1.02 a	1.13 a	1.14 a	1.45 a	1.58 a
Branches	0.68 a	0.79 a	0.71 a	1.24 a	1.12 a
Stem bark	0.24 a	0.31 a	0.29 a	0.34 a	0.39 a
Stem wood	0.96 a	1.45 a	1.39 a	1.59 a	1.81 a
Roots	1.45 a	1.44 a	1.30 a	1.26 a	1.92 a
Total	4.35 a	5.13 a	4.84 a	5.87 a	6.83 a

Means in a row followed by the same letter do not differ significantly at the 0.05 level according to Tukey test

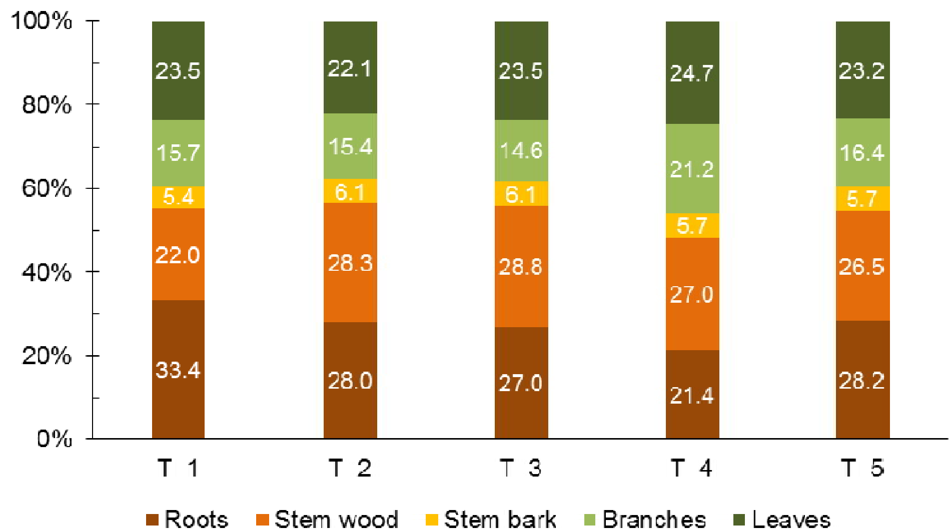

Fig. 1. Relative biomass distribution in the different components of *Eucalyptus urophylla*, at 12 months of age, in arenized soil in the Pampa biome

The highest value of biomass was found in Treatment 5 with 6.83 Mg ha^{-1} (treatment with higher doses of fertilizers) and the lowest value observed for T1 (treatment with lower dose of fertilizer), with 4.35 Mg ha^{-1}, which represents a 36.8% difference between treatments (Table 3). The production of above-ground biomass found by Schumacher & Caldeira [15] and Gatto et al. [16] for *Eucalyptus globulus* subspecies maidenii and *Eucalyptus urophylla* x *Eucalyptus grandis* was 83.2 Mg ha^{-1} and 74.5 Mg ha^{-1}, respectively. Both studies were carried out in stands at 4 years of age.

Eufrade Júnior et al. [17] studying *Eucalyptus grandis* × *E. urophylla*, at 2 years-old, observed that the stands with higher doses of fertilizer resulted in higher stem growth per hectare (difference of 7.3 Mg ha^{-1}) and a very similar growth between treatments for branches and leaves.

The biomass distribution among the different components was in the decreasing order: roots > stem wood > leaves > branches > stem bark, for all the different treatments (Fig. 1). The higher biomass share of the stem wood component was observed for T3 with 28.8% of the total biomass. The lowest percentage was observed for T1 with 22.0%, which also presented the highest amount of biomass in the roots, with 33.4% of the total biomass.

Similar results were observed by Viera et al. [18], when studying at 18 months-old stand of *Eucalyptus urograndis*, established in Neosoil, with above-ground biomass of 18.5 Mg ha^{-1}, the wood the component with the highest biomass (37.0%), followed by branches (34.2%), leaves (21.3%) and bark (7.6%).

Table 4. Macronutrients concentration in the 12 months-old *Eucalyptus urophylla* tree components grown in different fertilizer rates, in arenized soil of the Pampa biome

Element	Components	T1	T2	T3	T4	T5
				g kg^{-1}		
	Leaves	15.75 a	18.69 a	18.59 a	17.10 a	16.44 a
	Branches	2.07 a	2.61 a	3.71 a	2.66 a	3.70 a
N	Stem bark	2.65 a	3.16 a	2.42 a	2.97 a	3.36 a
	Stem wood	0.69 a	1.17 a	0.62 a	0.68 a	1.82 a
	Roots	2.58 a	1.52 a	1.81 a	1.42 a	2.45 a
	Leaves	0.84 b	1.30 a	1.39 a	1.02 ab	1.19 ab
	Branches	0.30 a	1.02 a	1.32 a	0.63 a	1.20 a
P	Stem bark	0.33 b	0.47 ab	0.47 ab	0.51 ab	0.60 a
	Stem wood	0.21 a	0.57 a	0.62 a	0.45 a	0.69 a
	Roots	0.29 a	0.27 a	0.31 a	0.34 a	0.36 a
	Leaves	8.61 a	12.39 a	9.82 a	8.61 a	9.56 a
	Branches	5.67 a	6.27 a	8.14 a	4.73 a	8.02 a
K	Stem bark	7.82 a	11.03 a	8.16 a	7.91 a	10.44 a
	Stem wood	5.30 a	6.89 a	6.44 a	6.20 a	7.67 a
	Roots	5.11 a	5.68 a	4.67 a	5.09 a	5.01 a
	Leaves	5.04 a	6.45 a	6.21 a	7.03 a	6.46 a
	Branches	3.56 a	5.10 a	4.42 a	2.88 a	3.41 a
Ca	Stem bark	8.26 a	6.85 a	6.05 a	8.26 a	6.40 a
	Stem wood	0.60 a	0.79 a	0.89 a	0.87 a	0.83 a
	Roots	2.94 a	4.22 a	3.64 a	3.82 a	3.30 a
	Leaves	1.90 a	2.12 a	2.01 a	1.89 a	1.76 a
	Branches	0.69 a	0.77 a	0.89 a	0.55 a	0.72 a
Mg	Stem bark	1.24 a	1.47 a	1.16 a	1.26 a	1.22 a
	Stem wood	0.39 a	0.48 a	0.45 a	0.47 a	0.50 a
	Roots	0.61 a	1.13 a	0.75 a	1.27 a	0.70 a
	Leaves	1.07 a	1.28 a	1.41 a	1.09 a	1.07 a
	Branches	0.34 a	0.39 a	0.44 a	0.44 a	0.44 a
S	Stem bark	0.31 b	0.38 ab	0.38 ab	0.45 a	0.43 a
	Stem wood	0.35 a	0.16 b	0.38 a	0.36 a	0.38 a
	Roots	0.45 a	0.39 a	0.43 a	0.56 a	0.49 a

Means in a line same letters do not differ significantly (P>0.05 level) according to Tukey's test

The order of distribution of the biomass of *Eucalyptus dunnii*, four years-old, also in the Pampa biome, presented by Guimarães et al. [19] was of stem wood (63%) > roots (14%) > branches (11%) > stem bark (8%) > leaves (4%), with total biomass of 121.9 Mg ha^{-1}. The difference of the results is explained by the stand in study being in an early stage of development (12 months of age) with a tendency of accumulation of biomass in the crown (leaves + branches).

In the Pampa biome, in the same region of the present study, at four years-old clonal stand of *Eucalyptus saligna*, showed above-ground biomass production of 88.81 Mg ha^{-1}, 76.8% being composed of the wood component, 9.3% bark, 7.9% branches and 6.0% leaves [20]. In *Eucalyptus urophylla* x *Eucalyptus grandis* stands, at 4.5 years of age, Carvalho et al. [21] observed a total biomass production of 74.94 Mg ha^{-1}, distributed in the following decreasing sequence: stem wood (61.2%) > roots (15.4%) > branches (10.2%) > stem bark (7.7%) > leaves (5.5%).

Genetic, environmental and silvicultural factors directly influence the productive capacity of plantations. However, according to Barros & Comerford [22], soil type and nutritional availability are the main factors influencing production in forest plantations. This stand explains the low biomass production of the present study when compared to the other studies, which are due to the very low fertility of the arenized soil, as presented in Table 1.

Table 5. Amount of macronutrients in the components of *Eucalyptus urophylla* trees, at 12 months-old, in arenized soil in the Pampa biome

Treatment	Components	N	P	K	Ca	Mg	S
		kg ha^{-1}					
T1	Leaves	16.06	0.85	8.78	5.14	1.94	1.09
	Branches	1.42	0.20	3.88	2.44	0.47	0.23
	Stem bark	0.63	0.08	1.84	1.95	0.29	0.07
	Stem wood	0.66	0.20	5.06	0.58	0.37	0.34
	Roots	3.74	0.42	7.41	4.27	0.88	0.65
	Total	22.51	1.76	26.97	14.36	3.96	2.39
T2	Leaves	21.18	1.47	14.05	7.31	2.41	1.45
	Branches	2.07	0.81	4.95	4.03	0.61	0.31
	Stem bark	0.99	0.15	3.46	2.15	0.46	0.12
	Stem wood	1.71	0.83	10.01	1.14	0.70	0.24
	Roots	2.19	0.39	8.17	6.07	1.62	0.56
	Total	28.14	3.65	40.64	20.69	5.79	2.67
T3	Leaves	21.17	1.58	11.18	7.07	2.28	1.61
	Branches	2.62	0.93	5.75	3.12	0.63	0.31
	Stem bark	0.71	0.14	2.39	1.77	0.34	0.11
	Stem wood	0.86	0.87	8.98	1.24	0.63	0.53
	Roots	2.37	0.40	6.10	4.75	0.97	0.56
	Total	27.73	3.92	34.40	17.96	4.86	3.12
T 4	Leaves	24.78	1.48	12.48	10.19	2.73	1.59
	Branches	3.31	0.79	5.88	3.58	0.69	0.55
	Stem bark	1.01	0.17	2.65	2.77	0.42	0.15
	Stem wood	1.08	0.71	9.83	1.37	0.74	0.57
	Roots	1.78	0.43	6.40	4.80	1.60	0.71
	Total	31.96	3.57	37.25	22.71	6.18	3.57
T 5	Leaves	26.01	1.88	15.11	10.21	2.78	1.70
	Branches	4.15	1.34	8.98	3.82	0.81	0.50
	Stem bark	1.32	0.23	4.09	2.51	0.48	0.17
	Stem wood	3.29	1.24	13.87	1.51	0.91	0.70
	Roots	4.71	0.68	9.63	6.36	1.35	0.94
	Total	39.48	5.38	51.68	24.40	6.32	4.00

Considering the results obtained in other biomass studies on the genus Eucalyptus, it can be seen that the values obtained in the present study are low, but close to those observed in sandy soils in the same region. However, plantations with the genus Eucalyptus in the sandstone cores of the Pampa biome, besides presenting biomass accumulation that makes forest production feasible, contributes to the soil cover, helping to soften the erosive processes that accelerate the arenized soil.

3.2 Nutrients

The leaves, the organ with the highest metabolic activity in the tree (photosynthesis and transpiration), had the highest concentration of macronutrients when compared to the other components, with the exception of Ca having the highest concentration in the bark (Table 4). This predominance of nutrient concentration in leaves, with the exception of Ca, was also observed by several authors in different species of *Eucalyptus* [18,21,23].

The P and S were the only elements that presented significant differences (P =0.05) between treatments., The lowest concentration of P in leaves was found in treatment 1 (compared to T2 and T3) and in stem bark (compared to T5) and S in the stem bark in relation to T4 and T5.

Considering an average of all the components of the biomass, of the different treatments, the concentration of nutrients presented the following trend K > N > Ca > Mg > P > S. This sequence of nutrient is different from the order obtained by Guimarães et al. [19] in *Eucalyptus dunnii*, at four years-old, also in the Pampa biome (Ca > N > K > Mg > S > P). Verão et al. [24] in 7 years-old *Eucalyptus urograndis* stands observed that the mean concentration of macronutrients, in the different biomass components, followed the decreasing order: N > Ca > K > S > Mg > P.

The concentration of nutrients in the different components of the biomass followed a distribution in the order: leaves > stem bark > branches > roots > stem wood for all the treatments. The observed sequence was similar to that found by Guimarães et al. [19] with *Eucalyptus dunnii*, at four years-old, and Viera et al. [18] with *Eucalyptus urograndis*, at 18 months-old.

Analyzing the amount of macronutrients present in the biomass, K was the element that presented the highest value in all treatments. In the treatment 5, K accumulated 51.68 kg ha^{-1} and the smallest accumulated amount was observed in T1 with 26.97 kg ha^{-1} (Table 5).

The highest amounts of nutrients among the different components followed the distribution in descending order: leaves > roots > stem wood > branches > stem bark. Viera et al. [19] observed that the branches presented highest accumulation of nutrients than the wood, changing the sequence of accumulation for leaves > branches > wood > bark.

In *Eucalyptus urophylla* x *E. grandis* stands, at 5 years-old, Gatto et al. [16] observed that the greatest amount of N, P and S were found in the stem, while K, Mg and Ca presented the highest amount in the branches, leaves and barks, respectively. The same authors reported the following order of amount of nutrients in above-ground biomass: N > K > Ca > S > Mg > P and the order for the amount of nutrients in roots: N > K > Ca > S > Mg > P.

Witschoreck and Schumacher [25], in *Eucalyptus saligna* stands, at 7 years-old, observed that the amount of nutrients decreased among the biomass components in the following order: stem wood > root > leaves > bark > branches, while the nutrients presented the following order Ca > N > K > Mg > P.

The same tendency of accumulation of nutrients, following the decreasing order of accumulation: K > N > Ca > Mg > P > S, was observed in all treatments. Distinct from the sequence observed by Guimarães et al. [19] with *Eucalyptus dunnii* (Ca > N > K > Mg > P > S), Viera et al. [18] and Carvalho et al. [21] with *Eucalyptus urograndis* (Ca > N > K > Mg > P > S and Ca > K > N > Mg > S > P, respectively). As the amount of nutrients is directly related to the biomass, the difference between the studies, mainly for Ca, can be explained by the low biomass of the components that present the highest concentration of this element (bark), compared to other studies.

4. CONCLUSION

Fertilization influenced the biomass production of *Eucalyptus urophylla* in arenized soil in the Pampa biome, but without significant differences with respect to date (12 months).

The biomass production of the stands is below that found in the literature. However considering the soil condition, the implantation of eucalyptus with fertilization management may be an alternative for the economic use of these areas.

The leaves presented the highest concentration of macronutrients, with the exception of Ca, which has a higher concentration in the stem bark.

The K was the element that presented highest accumulation in the biomass of *Eucalyptus urophylla* in arenized soil in the Pampa biome, independent of the fertilization management.

New studies evaluating the growth and the effect of fertilization on eucalyptus stands in sandy soils should be carried out with a longer period of evaluation to establish the adequate fertilization regime.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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