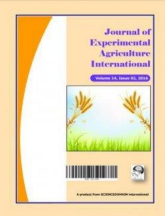

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Litter under Potential Eucalypts Genotype Stands in Eldorado do Sul, Rio Grande do Sul, Brazil

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Authors' contributions

This work was carried out in collaboration among all authors. The author KFS was responsible for the execution of the manuscript and for the translation and adaptation of the manuscript according to the norms of the journal. The author MVS is advisor and contributed to the discussion of the data. The author AAL was responsible for the statistical analyzes. The author TBQ contributed in the discussion of the work. And the author EFA was responsible for making the study area available. All authors read and approved the final manuscript.

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ABSTRACT

The objective of the study was to quantify the litter in different genotypes of eucalypts stands at 49-months-old, located in Eldorado do Sul, Rio Grande do Sul, Brazil. Areas of 720 m² were demarcated for each genotype. In each area, 15 samples were randomly collected. The litter ranged from 4.51 to 10.77 Mg ha^{-1}, highlighting the *E. dunnii* and the hybrid of *E. urophylla* x *E. globulus* with the lowest and largest accumulation, respectively. The leaves corresponded, on average, between 48.56% and 73.03% of the total litter. The differentiation between the genotypes occurred as to the accumulated litter.

Keywords: Litter; leaves; Eucalyptus genotypes stands; sustainability.

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1. INTRODUCTION

Tree plantations stabilish many beneficial ecological interactions with the ecosystem, such as watershed protection, increased organic matter and soil nutritional status [1]. This dynamic is represented by the deposition of litter as input and by the deposition as output. It is essential for the maintenance of forests or forest stands [2], especially in highly weathered soils, where plant biomass is the main nutrient reservoir [3].

The litter on the soil is usede in the cycling of biogeochemical nutrients. Afterwards, the decomposition and the release of the constituent minerals will be absorbed by the roots of the plants. This process also will increase the organic matter content in the soil [4]. In this context, nutrient return via litter is the most important route of the biogeochemical cycle [3].

In general, the increase of the litter deposition above the soil is observed after the age of maturity of the trees, when the tree canopy are closed. Ended this phase, a slight decrease or stabilization in the deposition may be observed [5].

The accumulation of litter varies according with the origin, species, forest cover, successional stage, age, collection season, forest type and site. Moreover, factors like: Edaphoclimatic conditions, index site, understory, silvicultural management and proportion of canopy. The litter decomposition also is influenced by natural disturbances such as fire, insect or artificial attack [6].

The litter deposition is higher in the period of greater physiological activity of the individuals, causing an intensification of foliage exchange and senescent material release, so it will give place a new and photosynthetically more active foliage [7].

Knowledge of the amount of litter in different eucalyptus species and provenances is of fundamental importance in order to maintain a sustainable management of soils and mineral resources [8].

The present study had as objective to estimate the litter in different *Eucalyptus* genotypes established in Eldorado do Sul, Rio Grande do Sul, Brazil.

2. MATERIALS AND METHODS

The research was developed with six different genotypes of eucalypts (Table 1), in an area belonging to the company Celulose Riograndense - CMPC, in the city of Eldorado do Sul, RS, Brazil (Fig. 1). The area is under the geographic coordinates of 30°11'303" south latitude and 51°37'477" west longitude.

The climate is characterized as subtropical humid (Cfa), according to the climatic classification of Köppen, presenting average temperature corresponding to 19°C. The average annual precipitation is iqual to1,400 mm [9].

The soil in the area is classified as Red-Yellow Argisol. Table 2 presents the chemical and physical attributes of the soil a depths from 0 to 130 cm.

In the preparation of the area, the subsoiling was performed at a depth of 60 cm, whereas surface liming was realized with 2 Mg ha^{-1} of limestone, and 200 kg ha^{-1} of single superphosphate. The fertilizer used during planting consisted of 110 g $plant^{-1}$ of N-P_2O_5-K_2O (06:30:06) + 0.3% Zn and 0.2% Cu. For coverage fertilization 200 kg ha^{-1} of N-P_2O_5-K_2O (12:00:20) + 0.7% of B were applied, and for the maintenance fertilization, 300 kg ha^{-1} of N-P_2O_5-K_2O (24:00:26) + 0,5% B were applied.

Table 1. Characterization of the studied genotypes

Genotypes	Age (months)	Spacing (m)	G (m^2 ha^{-1})
E. benthamii (Provenance 1)	49	3 x 3	24.4
E. benthamii (Provenance 2)	49	3 x 3	22.7
E. saligna	49	3 x 3	23.7
E. dunnii	49	3 x 3	16.7
E. urophylla x E. globulus (E. uroglobulus)	49	3 x 3	22.2
E. urophylla x E. grandis (E. urograndis)	49	3 x 3	26.4

E. benthamii (Provenance 1) is a provenance proven in Guarapuava, Paraná, Brazil; and E. benthamii (Provenance 2) is a source from Telêmaco Borba, Paraná, Brazil; G: Basal area

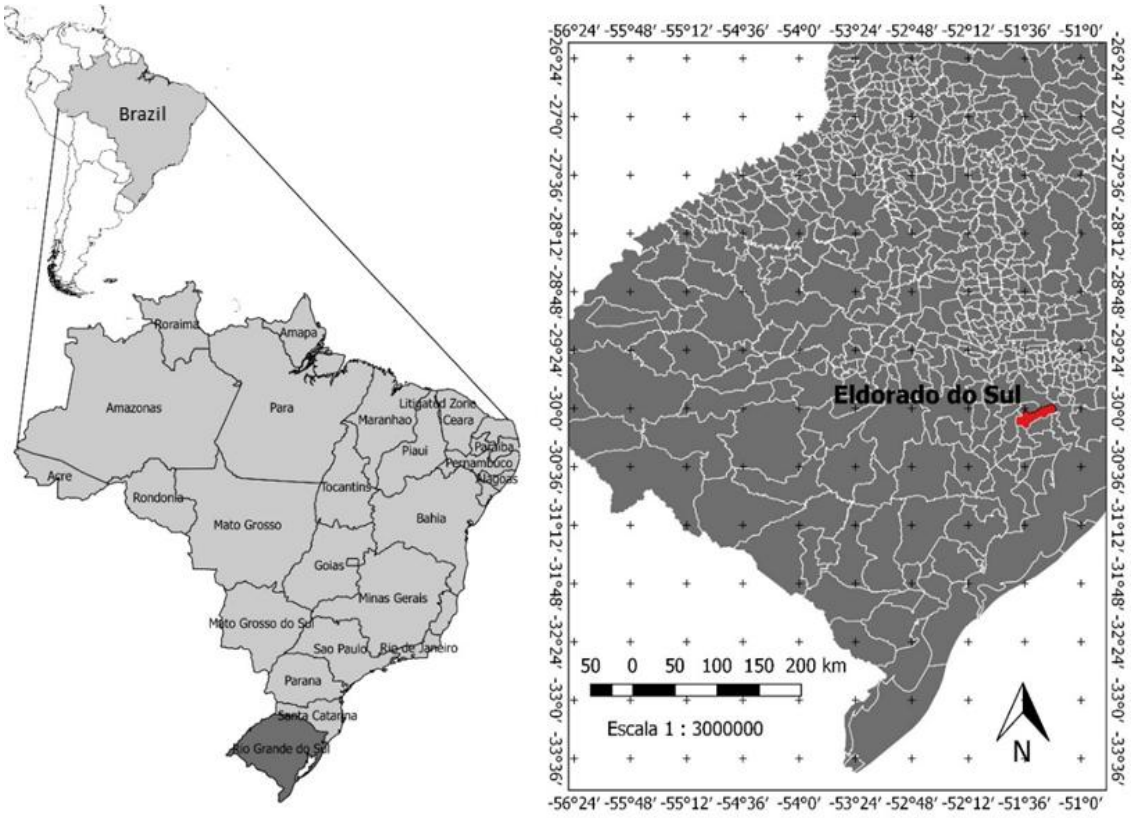

Fig. 1. Location of the municipality of Eldorado do Sul, Rio Grande do Sul, Brazil

Fig. 2. A: Canopy of a stand of *Eucalyptus* sp; B: Litter on the soil; and C: Sample of the litter on the soil for quantification

Table 2. Physical and chemical attributes of soil in the area implanted with different genotypes of *Eucalyptus*, at 49-months-old, in Eldorado do Sul, Rio Grande do Sul, Brazil

Depth	Granulometric composition				O.C
	Coarse sand	Thin sand	Silt	Clay	
	2-0.2	0.2-0.05	0.05-0.002	<0.002	
(cm)	----------mm----------				%
0-30	24.5	16.5	29.5	29.5	0.9
30-60	40.5	8.0	6.0	45.5	0.8
60-90	33.5	6.0	5.5	55.0	0.7
90-100	15.5	6.0	15.5	63.0	0.4
100-130	15.5	6.5	13.0	65.0	0.2
Depth	**V**	**m**	**T**	**pH**	**N**
(cm)	**----------%----------**		**--$cmol_c\ dm^{-3}$--**	**H_2O**	**%**
0-30	35	34	10	5.0	0.1
30-60	11	71	14	4.3	0.1
60-90	15	69	15	4.4	0.1
90-100	17	64	12	4.6	0.1
100-130	20	61	10	4.7	0.0
Depth	**P**	**K**	**Ca**	**Mg**	**S**
(cm)	**--mg g^{-1}--**	**----------$cmol_c\ dm^{-3}$----------**			**mg dm3**
0-30	2.0	0.1	3.3	0.9	19.4
30-60	1.6	0.1	0.9	0.5	32.5
60-90	1.0	0.1	1.0	0.8	61.7
90-100	0.7	0.1	1.0	0.9	60.9
100-130	0.6	0.1	0.9	0.9	59.0

O.C: organic carbon; V = saturation by bases; m = saturation by aluminum; T = total CTC

The litter collections were carried out in June 2016. In this study, a plot of 720 m^2 was stabilished, where 15 samples were collected, randomly, totaling 90 samples.

The litter sampling was done using an iron frame (Fig. 2) of 0.25 m x 0.25 m (0.0625 m²). It was placed on the surface of the land, and all the organic material present in its soil. After collection, the sampled materials were stored in plastic bags and they sent to the laboratory where they were separated in the following: leaves, branches and miscellaneous (peels, reproductive materials and non-identifiable residues).

Subsequently, the fractions were placed in paper containers for drying in a circulation oven and air renovation at 70°C until weight stabilization. Finally, the samples were weighed in a precision scale (0.01 g) and the dry weights were extrapolated to values per hectare to obtain the mass of the litter.

Statistical analyzes were applied with the aid of the statistical program Assistat 7.7 ® [10] at the level of 5% probability of error. The Tukey test was used for the comparison of means.

3. RESULTS AND DISCUSSION

In Table 3 it is possible to verify the distribution of litter for the different fractions of the studied genotypes. The litter was highest in hybrid *E. urophylla x E. globulus* (10.77 Mg ha^{-1}). *E. dunnii* (4.51 Mg ha^{-1}) showed lowest while *E. benthamii* (P1) reached intermediate values (8, 38 Mg ha^{-1}).

The litter showed a value lower than that found by Viera et al. [11], in a plantation of hybrid *E. urophylla* x *E. globulus* at four-years-old in Eldorado do Sul, RS, Brazil (14.0 Mg ha^{-1}). On the other hand, Schumacher et al. [8] studying stands of *E. grandis*, *E. cloesiana* and *E. urophylla*, with nine-years-old in Santa Maria, RS, Brazil observed values among 16.8, 16.5 and 12.6 Mg ha^{-1} whereas Santos et al. [12] analyzing a stand of *E. saligna* at four and five years of age in São Gabriel, RS, Brazil found values respectively iqual 12.76 and 12.00 Mg ha^{-1}.

Table 3. Litter for the different fractions of the eucalypts genotypes at 49-months-old

Genotypes	Leaves	Miscellaneous	Branches	Total
	(Mg ha^{-1})			
E. benthamii (P1)	6.12ab	0.53a	1.73bc	8.38a
	*(2.15)	(0.45)	(1.74)	(3.31)
E. benthamii (P2)	3.27cd	0.65a	1.14c	5.06b
	(1.41)	(0.61)	(0.57)	(1.64)
E. saligna	4.63bc	0.43a	4.10a	9.13a
	(1.26)	(0.25)	(2.59)	(3.04)
E. dunnii	2.19d	0.95a	1.46bc	4.51b
	(1.24)	(1.17)	(1.35)	(2.81)
E. urophylla x E. globulus	6.72a	0.32a	3.82a	10.77a
	(2.93)	(0.27)	(2.08)	(3.95)
E. urophylla x E. grandis	5.88ab	0.53a	3.11ab	9.49a
	(1.65)	(0.44)	(2.03)	(2.87)
CV %	38.97	108.2	71.67	38.26

CV: Coefficient of variation

*Mean of each variable in the different treatments is followed by equal letters, so it does not show significantly difference in the Tukey test at the 5% level of error. * Values in parentheses are the standard deviation of the mean*

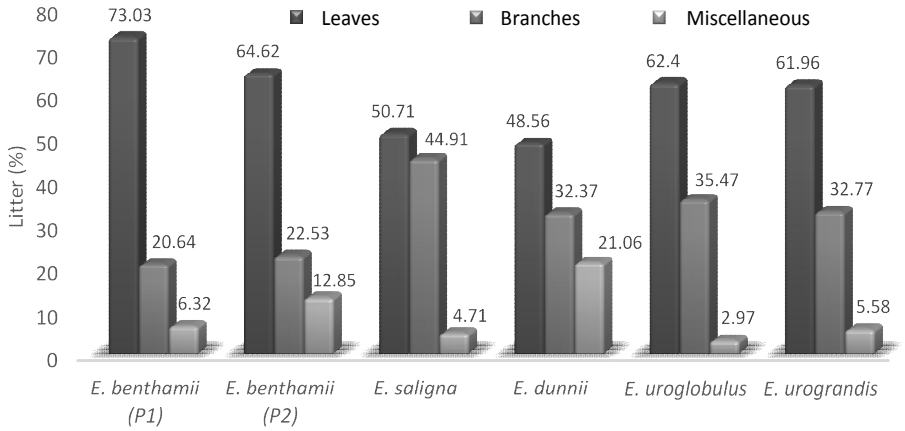

Fig. 3. Relative litter of different *Eucalypts* genotypes

Lastly, Brun et al. [4] in a planting of *E. uroglobulus*, with 5.5-years-old in Eldorado do Sul, RS, Brazil observed 19.5 Mg ha^{-1}of the litter.

In another stand of *E. grandis*, at seven-years-old, in Seropédica, RJ, Brazil, Reis et al. [3] was reported an amount of 11.84 Mg ha^{-1} litter. In the Southwest region of Brazil, in different forest sites, Gama-Rodrigues et al. [13] evaluated litter in eucalypts plantations, and then, they also observed that the amount of litter ranged from 4.2 to 37.6 Mg ha^{-1}at seven-years-old. A similar result was found by Freitas et al. [14], in a stand of *E. grandis*, at the nine-years-old, in the city of Alegrete, RS, Brazil (5.41 Mg ha^{-1}).

The production and accumulation of litter presents a significant variability, so this difference can be to due the variation in the climatic conditions, the quality of the site, the age of the stand, the characteristics of the species or the inclusion of the understory litter and the degree of forest stability [3].

In relation to total litter, the hybrid *E. urophylla* x *E. globulus* presented a accumulation of 58.12% and 53.02% higher for clones *E. dunnii* and *E. benthamii* (P2). According to Freitas et al. [14], the litter rates accumulated in forest plantation soils can vary significantly between different species in the same sites.

The leaves fraction corresponded on average, between 48.56% and 73.03% of the total litter (Fig. 3). *E. dunnii* was the clone that presented the lowest percentage of leaves deposited

among the species studied, and *E. benthamii* (P1) was the largest hybrid. The leaves usually constitute the largest proportion of the biomass of the residues falling on the soil. This proportion grows with age to a certain extent, and then it decreases due to the increase in the fall of branches and bark [3].

In this context, Kleinpaul et al. [15] studied the litter in a twelve-year-old eucalypts stand and they observed that the branches presented greater accumulation on the ground, with 38.8%. According to the author, this occurred because the eucalypts stands suffer a more intense process of self-pruning, in relation to other species so it leads to greater accumulation of branches on the ground.

Schumacher et al. [8], studying the litter in three species of eucalypts (*E. urophylla*, *E. cloesiana* and *E. grandis*), at nine-year-old, in Santa Maria, RS, Brazil, observed that the branches fraction was the most representative in all species. According to the authors this may mean a propensity of these species for the self-pruning.

For the branches fraction, the highest yields occurred in the clones *E. saligna* and *E. uroglobulus*, with 2.48 and 2.24 Mg ha^{-1}. Lower accumulation occurred in *E. dunnii*, with 2.19 Mg ha^{-1}. The miscellaneous fraction varied from 0.32 to 0.95 Mg ha^{-1}. It was the lowest value found in hybrid *E. urophylla* x *E. globulus.* The highest in *E. dunnii* did not show statistically difference for other clones.

The existence of a significant variability in the accumulation of organic litter blanket in relation to other works carried out with eucalypts species can be explained based on the variation of climate, sites, age and forest density, different genetic characteristics of each species and the stability achieved by the stand. Moreover, it depends of the time elapsed since the last intervention that may have influenced the litter. These factors will affect the balance between the amount of material deposited and the time required for its decomposition, reflecting the greater or less accumulation of litter in the forest soil and the percentage composition of the different fractions that it composethen [8].

4. CONCLUSION

The highest amount of litter occurred in hybrid *E. urophylla* x *E. globulus.* It is responsible to provid greater protection to the soil, however amount of the litter of litter was lower for *E. dunnii*.

For all genetic materials studied, the leaves fraction presented the highest contribution in the amount of the litter.

The differentiation between the genotypes occurred basically as to the accumulated litter.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Ashagrie Y, Zech W. Litter production and nutrient cycling in two plantations and *Podocarpus falcatus* dominated natural forest ecosystems in south-eastern highlands of Ethiopia. African Journal of Agricultural Research. 2013;8(38):4810-4818.
2. Balieiro FC, et al. Dinâmica da serapilheira e transferência de nitrogênio ao solo, em plantios de *Pseudosamanea guachapele* e *Eucalyptus grandis*. Pesquisa Agro-pecuária Brasileira. 2004;39(6):597-601. Portuguese.
3. Reis MGF, Barros NF. Ciclagem de Nutrientes em Plantios de Eucalipto. In: Barros NF, Novais RF. (Eds.). Relação solo-eucalipto. Viçosa; 1990. Portuguese.
4. Brun EJ, Ferraz MO, Araújo EF. Relação entre o acúmulo de serapilheira sobre o solo e variáveis dendrométricas em povoamento híbrido de *Eucalyptus urophylla* x *E. globulus* Maidenii, em Eldorado do Sul/RS. Revista Ecologia e Nutrição Florestal. 2013;1(1):24-31.
5. Poggiani F, Schumacher MV. Nutrient cycling in native forests. In: Gonçalves JLM, Benedetti V. (Ed.). Forest nutrition and fertilization. Piracicaba; 2004.
6. Caldeira MVW. Quantificação de serapilheira e de nutrientes – Floresta Ombrófila Mista Montana – Paraná. Revista Acadêmica. 2007;5(2):101-116. Portuguese.

7. Schumacher MV, Brun EJ, Rodrigues LM, Santos EM. Retorno de nutrientes via deposição de serapilheira em um povoamento de Acácia no Rio Grande do Sul. Revista Árvore. 2003;27(6):791-798. Portuguese.
8. Schumacher MV, Bauermann, GC, Copetti L, Brun EJ, König F. Fracionamento da serapilheira em três espécies de eucalipto no município de Santa Maria – RS: *Eucalyptus urophylla*, *Eucalyptus cloesiana* e *Eucalyptus grandis*. In: Ciclo de atualização florestal do CONESUL. Santa Maria; 2002. Portuguese.
9. Alvares CA, Stape JL, Sentelhas PC, Gonçalves JLM, Sparovek G. Köppen's climate classification map for Brazil. Meteorologische Zeitschrift. 2013; 22 (6): 1-18.
10. Silva FAS, Azevedo CAV. Main components analysis in the software assistat statistical attendance. In: Word congress on computers in agriculture 7, Reno-NV-USA: American Society of Agricultural and Biological Engineers; 2009.
11. Viera M, Schumacher MV, Caldeira MVW. Dinâmica de decomposição e nutrientes em plantio de *Eucalyptus urophylla* × *Eucalyptus globulus* no Sul do Brasil. Floresta e Ambiente. 2013;20(3):351-360.
12. Santos JC, Schumacher MV, Witschoreck R, Araújo EF, Lopes VG. Nutrientes na serapilheira acumulada em um povoamento de *Eucalyptus saligna* Smith em São Gabriel, RS. Revista Ecologia e Nutrição Florestal. 2014;2(1):1-8.
13. Gama-Rodrigues EF, Barros NF, Viana AP, Santos, GA. Alterações na biomassa e na atividade microbiana da serapilheira e do solo, em decorrência da substituição de cobertura florestal nativa por plantações de eucalipto, em diferentes sítios da Região Sudeste do Brasil. Revista Brasileira de Ciência do Solo. 2008;32(4): 1489-1499. Portuguese.
14. Freitas R, Schumacher MV, Caldeira MVW, Spathelf P. Biomassa e conteúdo de nutrientes em povoamento de *Eucalyptus grandis* W. Hill ex Maiden plantado em solo sujeito à arenização, no município de Alegrete-RS. Biomassa & Energia. 2004;1(1):93-104. Portuguese.
15. Kleinpaul IS, Schumacher MV, Brun EJ, Brun FRK, Kleinpaul JJ. Suficiência amostral para coletas de serapilheira acumulada sobre o solo em *Pinus elliottii* engelm, *Eucalyptus* sp. e Floresta Estacional Decidual. Revista Árvore. 2005; 29(6):965-972. Portuguese.

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