Original Research Article

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

ABSTRACT

The objective of the study was to quantify the litter in different genotypes of eucalyptus 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*genotypesstands, Sustainability.

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 dynamicis represented by the deposition of litter as input and by thedeposition 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 cyclingof biogeochemical nutrients.Afterwards, the decomposition and the release of the constituent minerals will be absorbedby 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 soilis observed afterthe age ofmaturity of the trees, when the treecanopyare 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 managementand proportion of canopy. The litterdecomposition also is influenced bynatural 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 willgive 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 CeluloseRiograndense - CMPC, in the city of Eldorado do Sul, RS, Brazil (Figure 1). The area is under the geographic coordinates of 30 ° 11'303 "south latitude and 51 ° 37'477" west longitude.

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. uropylla x E. globulus (E. uroglobulus)	49	3 x 3	22,2
E. uropylla 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 TelêmacoBorba, Paraná, Brazil.

G: Basal area.

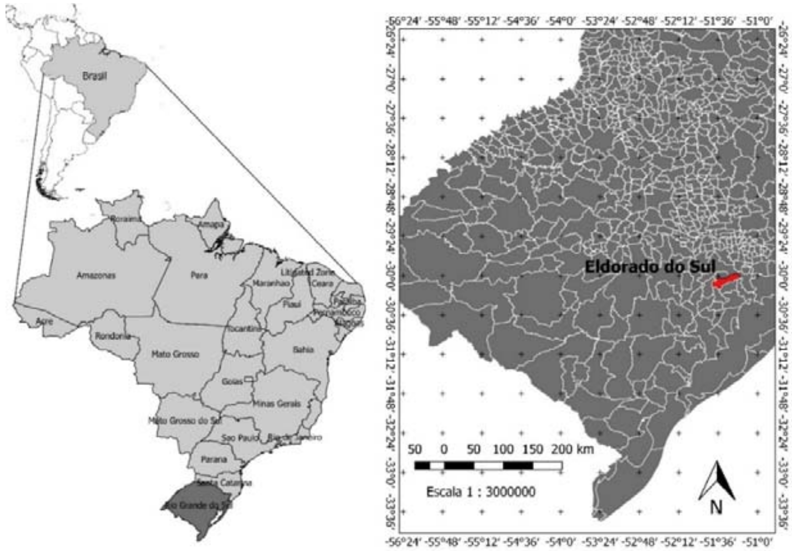

Figure 1. Location of the municipality of Eldorado do Sul, Rio Grande do Sul, Brazil

The climate ischaracterized as subtropical humid (Cfa), according to the climatic classification of Köppen, presenting average temperature corresponding to 19 °C. The average annual precipitation is iqualto1,400 mm [9].

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

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

In the preparation of the area, the subsoiling was performed at a depth of 60 cm, whereassurface limingwas 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.

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

The litter sampling wasdoneusing an iron frame (Figure 2) of 0.25 m x 0.25 m (0.0625 m^2).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 theysent 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 fordrying 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.

Figure 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.

Statistical analyzes were appliedwith 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 3it 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 lowestwhile *E. benthamii* (P1)reached intermediate values (8, 38 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 isfollowed by equal letters,so it does not showsignificantlydifferenceinthe Tukey test at the 5% level of error. * Values in parentheses are the standard deviation of the mean.

The litter showeda 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, Brazilobserved values among16.8, 16.5 and 12.6 Mg ha^{-1}whereasSantos et al.[12]analyzing a stand of *E. saligna* at four and fiveyears of age in São Gabriel, RS, Brazilfound values respectively iqual12.76 and 12.00 Mg ha^{-1}. Lastly,Brun et al. [4]in a planting of *E. uroglobulus*, with 5.5-years-old in Eldorado do Sul, RS, Brazilobserved 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 significantvariability, so this differencecan betoduethevariation in the climatic conditions, the quality of the site, the age of the stand,the characteristics of the speciesor 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 aaccumulation of 58.12% and 53.02% higher for clones*E. dunnii* and *E. benthamii* (P2). According toFreitas 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 (Figure 3). *E. dunnii* was the clone that presented the lowest percentage of leaves deposited among the species studied, and *E. benthamii* (P1)was the largesthybrid. The leaves usually constitute the largest proportion of the biomass of the residues fallingonthe soil. This proportion grows with age to a certain extent, and then itdecreases due to the increase in the fall of branches and bark[3].

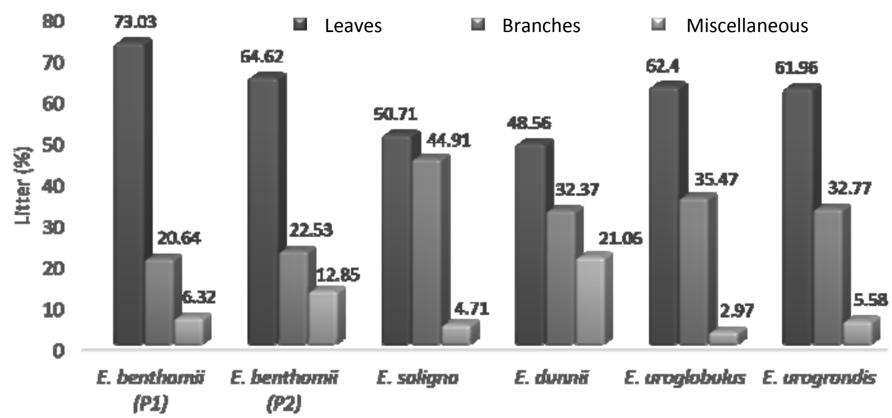

Figure 3. Relative litter of different *Eucalyptus* genotypes

In this context, Kleinpaul et al.[15] studied the litter in a twelve-year-old eucalypts standand theyobserved 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 speciessoitleads 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 accumulationoccurred in *E. dunnii*, with 2.19 Mg ha^{-1}. The miscellaneous fraction varied from 0.32 to 0.95 Mg ha^{-1}.Itwasthe lowest value found in hybrid*E. urophylla*x *E. globulus*.The highest in *E. dunnii*did not showstatistically differecefor other clones.

The existence of a significantvariability 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 dependsof 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 thatitcomposethen[8].

4. CONCLUSION

The highestamount 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 lowerfor*E. dunnii*.

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

The differentiation between the genotypes occurred basicallyas to the accumulated litter.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist.

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