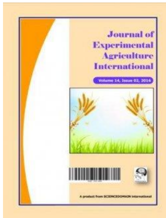

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Burlap and Breakdown of Waste Plant in Desertification Processes Semiarid of the State of Alagoas

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Land degradation in the semi-arid region results from natural processes, which can be induced by man through the inadequate use of resources. The litter exerts numerous functions in the balance and dynamics of the ecosystems, comprising the most superficial layer of the soil in forest environments. The decomposition assessment provides an integrated view of the system, improving the assessment of local impacts across the basin. The objective of this study was to analyze the litter fractionation and the rate of decomposition of the vegetal residues, aiming to use such variables as indicators of the desertification processes, in areas with increasing levels of degradation in the Piranhas municipality in the semi-arid region of the State of Alagoas. Areas were

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sampled at different stages of degradation: preserved, moderately degraded and intensely degraded, in the municipality of Piranhas-AL. The litter was collected using an iron square of 1 m², separated in woody and non-woody fraction, and the dry mass of each fraction was quantified in each area. Sampling sites were selected and ten collections were done per area. The rate of decomposition was by mass loss analysis using litter bags. The litter bags consist of polyvinyl bags with a mesh of 4 mm and dimensions of 25 x 25 cm and 1.5 cm in height. In each litter, bag was added 10 grams of collected litter, taken to greenhouse at 65ºC until constant weight. The litter bags were randomly distributed in the areas and included a growing area for comparison. Data were analyzed using descriptive statistics and t-test methods. The litter production was higher in the low caatinga area of degradation with a total value of 4.49; The value of the decomposition constant with the most prominence was in the CEMD, with 0.0034. The litter production and stock were higher in the most preserved area of the caatinga fragment after the rainy season, according to the characteristics of this biome and confirming that it is at that moment that more care should be taken as its management.

Keywords: Ecosystems; indicators; management; land degradation.

1. INTRODUCTION

In the northeastern semi-arid region, the degradation of natural resources and especially the reduction of soil fertility have been due to the increase of soil use intensity and reduction of native vegetation cover [1]. About 20% of the semi-arid Northeast is in the process of desertification, a problem that is worsened by the successive droughts that devastate the region and anthropogenic impact in a typical fragile ecosystem [2].

The process of land degradation in dry regions resulting mainly from climatic variations and human activities is known as desertification and occurs in a degradation process of environmental conditions, at a more advanced stage, affects the living conditions of the population, that is why soil degradation is one of the most important factors in establishing desertification [3].

The applications used to monitor degradation, quality indicators, include soil physical, chemical and biological properties, processes and characteristics [4], which can be used to determine the spatial extent and geographical distribution of degraded areas, and to relate human actions (causes) to environmental conditions (effects) [5]. Indicators of degradation should be quantitative, sensitive to small variations, reduced in number and simple to measure. The Burlap exerts many functions in the balance and dynamics of ecosystems, comprising the most superficial layer of the soil in forest environments, composed of leaves, branches, reproductive organs and debris [6]. It acts on the soil surface as an input and output system, through the input of vegetal material and its subsequent processes of soil fertility restoration which has a great importance, mainly in areas beginning of ecological succession [7,8].

Nowadays, there are few studies that involve the rate of decomposition of plant residues and the characterization of Burlap in the semi-arid region and its use as an indicator of the quality of areas in the process of degradation, aiming to provide subsidies for the prevention of the process and elaboration recovery strategies for already degraded areas.

2. MATERIALS AND METHODS

The project was conducted at the Xingó Center for Coexistence with Semiarid and at the Laboratory of Physics and Soil Management of Agroecology at the Federal Institute of Education, Science and Technology of the Alagoas State, Piranhas-AL campus, in the city of Piranhas-AL, Brazil. The meteorological data regarding the study period were obtained from a station installed at the site as well as from specialized institutes that have a Data Collection Platform (PCD) in the municipality of Piranhas-AL, Brazil (Fig. 1).

The sampling of the Burlap in the studied areas was carried out in two stages: the first in the dry period and the second in the rainy season, the latter in the same part of the dry period, aiming to evaluate the seasonal variation of the variables related to organic matter and activity of the microorganisms from soil. Five areas were selected for the experiment, and the following areas were chosen for the Burlap supply: (A1) degraded, (A2) intermediate and (A3) preserved. For the evaluation of the decomposition rate, besides the three areas of the Burlap, areas (A4) and (A5) where there was palm and elephant grass cultivation were used (Fig. 2).

In order to quantify the Burlap stock, 10 sampling points were collected in each area and an iron square of 1 m² was placed on the soil surface. In the three areas: degraded, intermediate and preserved, the Burlap was collected and stored in plastic bags, totaling 10 collections in each area. The Burlap was separated by picking, for removal of possible contamination or fragments of rocks, and taken to the oven with forced ventilation, being maintained at a temperature of 45ºC until constant weight, to quantify the dry weight of leaf per m². Soon after drying, Burlap samples were separated manually in woody and non-woody fraction, with each fraction being weighed later. The total dry mass is obtained by

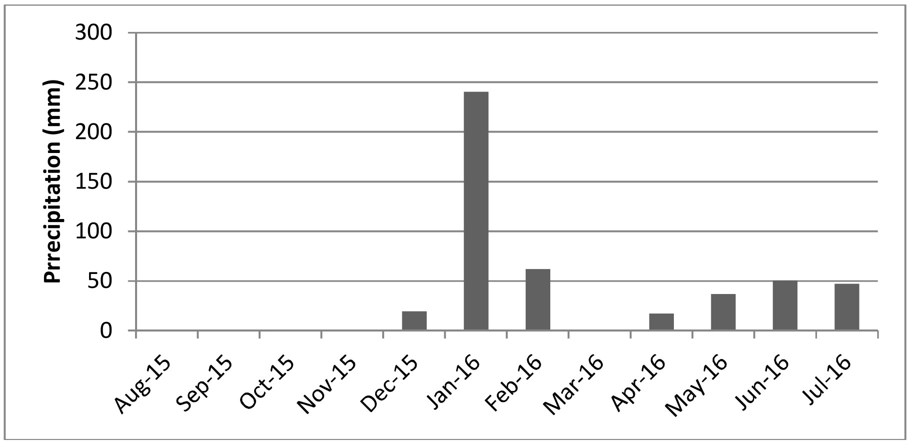

Fig. 1. Precipitation data of the study period

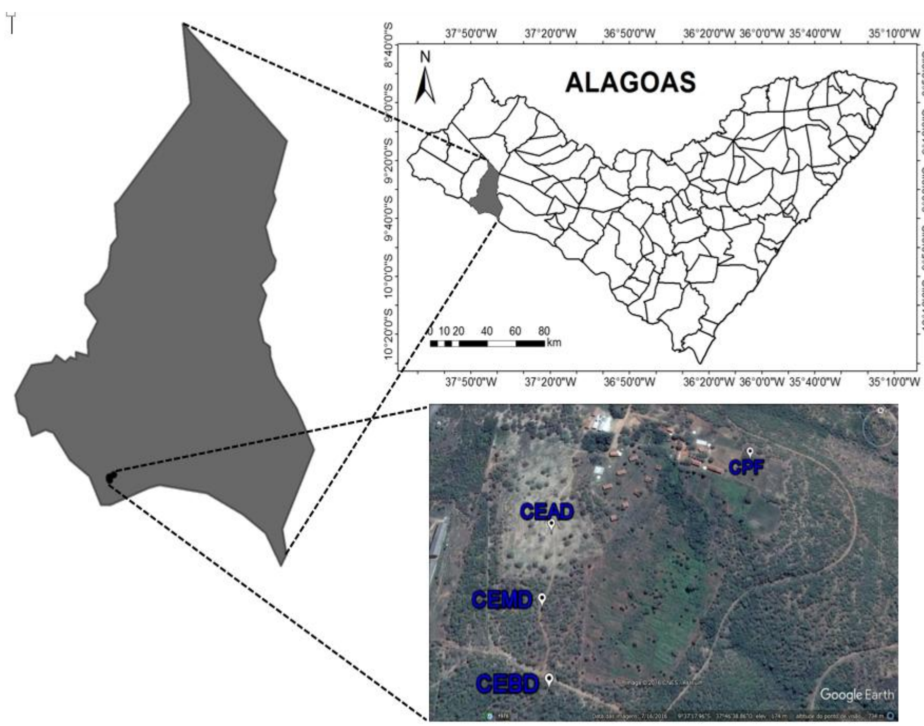

Fig. 2. Location of areas

the sum of the two fractions. In order to evaluate the degree of fragmentation of the Burlap, the material was stratified by 4 and 2 mm mesh sieves, obtaining fractions (F) of size: F ≥ 4 mm; 4mm> F ≥ 2mm and F <2mm. Afterwards, the samples were submitted to drying in a circulation oven at 65ºC for 48 hours and, afterwards, the stock of each fraction was quantified from the expression:

Stock (Mg ha^{-1}) = (material weight Mg x area of the square).

The total Burlap stock (STTS) was obtained by the sum of the three fractions.

For the contribution of the Burlap and 15 conical collectors were implanted in the Caatinga areas: 5 in each area, constructed with tubo tube, made of polyethylene plastic, with a bottom of 1 mm, with an area of 0.21 m^2 (perimeter equal to 1.62 m) and fixed in the trees. Subsequently, after each drying, the material was stratified into leaves, branches, and reproductive material. After this step, the Burlap was oven dried at 65ºC for 48 hours, and weighed in order to evaluate the contribution of each fraction to the total input of the deciduous material. The evaluation of the decomposition rate was performed by mass loss analysis using Burlap bags consisting of 4 mm mesh polyvinyl bags measuring 25 x 25 cm and 1.5 cm high. In each Burlap bag was added 10 grams of the burlap collected in the square that was taken to kiln at 65°C until reaching constant weight. In each area (A1, A2, A3, A4 and A5) 40 Burlap bags were installed at the beginning of the dry period. The collections were performed at intervals of 15, 30, 60, 90, 120 and 150 days, and four Burlap bags were collected at each collection. As well as, the collection of 3 soil samples for moisture analysis. After the collection, they were taken to the laboratory where their contents were examined for the removal of soil particles and their heavy mass in a precision analytical balance. The decomposition rate of the Burlap was quantified by evaluations of measures of mass loss, with the following formula:

$$\text{Remaining mass (\%)} = (\text{final mass / initial mass}) \times 100 \qquad (1)$$

After the calculation of the remaining mass over the period, the decomposition constant k was calculated, according to [9], with the exponential model:

$$Xt = Xo \cdot e^{-kt}, \qquad (2)$$

Where: Xt = weight of the dried material remaining after t days; Xo = weight of the dry material placed on the bags at time zero (t = 0).

The half-life (t1 / 2) will be calculated according to [10] by the equation:

$$t^{1/2} = \ln(2)/K \qquad (3)$$

Where: K = decomposition constant calculated by the above formula ($Xt = Xo \cdot e^{-kt}$).

The data were submitted to a descriptive statistical analysis with focus on the central (mean) value and the dispersion (standard deviation and coefficient of variation) and the test of adherence to the Normal frequency distribution of Shapiro-Wilk, adopting the program [11]. Then, the t-test was applied with the objective of evaluating the effect of seasonality (dry and rainy period) on the analyzed variables [12] being the software used.

3. RESULTS

In the study period (August / 2015 to July / 2016), the total annual burlap yield was 1.64 Mg ha^{-1} $year^{-1}$ for the CEAD area, 2.68 Mg ha^{-1} $year^{-1}$ for the CEMD and 4.49 Mg ha^{-1} $year^{-1}$ for CEBD (Table 1). The deposition values are in the range of those observed in caatinga forests.

The burlap contributed in the areas of CEAD and CEMD, in general, was distributed homogeneously during the evaluated period, not being verified a pattern of deciduous throughout the year, nevertheless, the difference is accentuated when we observe in the rainy seasons. The values of burlap deposition are presented in Table 1. The lowest values of the coefficient of variation (CV%) occurred in the CEAD area (29%) and (31%) in the CEMD, which were higher than observed in the CEBD (43%).

The percentage of foliar mass remaining after the 120 days of study is presented in Table 2. After 15 days of stay in the field, approximately 10% of the leaf material was decomposed in the area in all areas. This fact was also observed at 30 days, with loss of mass of 10% for CMAD, 12% for CMBS, CEBD and 17% CPF and PCE. After 30 days, no significant losses of material were observed, and at 120 days after the end of the evaluations, the percentage of remaining mass was 78.5% in CPF, 80.5% in PCE, 80.3% in CEBD and CEMD, and 90% in CMAD.

Table 1. Monthly litter production (Mg ha^{-1}) in caatinga area at different stages of degradation, Piranhas, AL, Brazil

Month	Areas of study		
	CEAD	CEMD	CEBD
	Mg ha^{-1}		
September	0,28 b B	0,35 a B	0,39 a CD
October	0,21 b B	0,27 a C	0,30 a D
November	0,07 c E	0,19 b D	0,29 a D
December	0,11 b D	0,17 a D	0,22 a D
January	0,04 b E	0,06 b E	0,10 a E
February	0,05 a E	0,07 a E	0,09 a E
March	0,11 b D	0,19 b D	0,25 a D
April	0,44c A	0,75 b A	1,84 aA
May	0,17cC	0,35 b B	0,57 a B
June	0,16cC	0,28 b C	0,44 a C
Total	**1,64**	**2,68**	**4,49**
CV (%)	**29**	**31**	**43**

Averages of 5 repetitions. Values followed with the same letter, lowercase in the row, and upper case in the column do not differ by the Bonferroni t-test (P <0.05). Caption: CEAD - Caatinga of advanced stage of degradation; CEMD - Caatinga of medium stage of degradation; CEBD - Caatinga of low stage of degradation

The values of the decomposition constant (K) and the half life (T1 / 2) during the evaluation period are presented in Table 3. The highest value of the decomposition constant (K = 0.0034 g g^{-1}, p <0.05, R2: 0.86) was observed for the CPF, followed by CEBD (K = 0.0030 g g^{-1}; p <0.05, R^2: 0.88), CEAD (K = 0.0028 g g^{-1}, p <0.05, R^2: 0.89), CEMD (K = 0.0027 g g^{-1}; p <0.05, R^2: 0.91) and PCE (K = 0.0026 g g^{-1}, p <0.05, R^2: 0.76). The values of the half-life time, that is, time in which half of the leaf material is decomposed were lower for CPF (204 days), followed by CEBD (231), CEAD (247), CEMD (256) and PCE (266 days). The highest CPF decomposition values can be attributed to the favorable microclimate.

Table 2. Percentage of remaining mass of the leaf fraction in the intervals of days, Piranhas, AL, Brazil

Days	Area of study				
	CEAD	CEMD	CEBD	CPF	PCE
	% Remaining mass				
15	93,0	97,7	96,6	92,9	95,1
30	91,3	88,7	95,8	89,9	82,8
60	81,0	93,5	86,9	90,5	95,8
90	83,1	90,2	91,3	88,4	90,6
120	90,2	80,8	80,3	78,5	80,5

Averages of 4 replicates. Caption: CEAD - Caatinga of advanced stage of degradation; CEMD - Caatinga of medium stage of degradation; CEBD - Caatinga of low stage of degradation; CPF - Cultivation of forage palm; PCE - Grass grazing elephant

4. DISCUSSION

Although some authors, such as [13] emphasize the role of the pioneer species in burlap production in the early stages, since they invest abundantly in the biomass production in a short period of time with great foliar renewal, the production values obtained in this study did not prove the role of these species, being the largest production in CEBD.

As observed in other caatinga of degradation stages, the studied areas presented differences in the production of burlap as a function of the degradation progress. The highest value of contribution in the CEBD can be attributed to the greater number of species present in this area, [14]. The greater diversity in CEBD, associated with a higher density of individuals, may be influencing a higher proportion of cup occupied by the species and consequently higher values of contribution in this area [15].

Table 3. Values of decomposition constants (K), half-life ($T^{1/2),}$ determination coefficient (R^2) and probability (P), Piranhas, AL, Brazil

Area of study	Constant K (g g^{-1} day^{-1})	$T^{1/2}$	R^2	P
CEAD	0,0028	247	0,89	0,017
CEMD	0,0027	256	0,91	0,005
CEBD	0,0030	231	0,88	0,016
CPF	0,0034	204	0,86	0,018
PCE	0,0026	266	0,76	0,024

Caption: CEAD - Caatinga of advanced stage of degradation; CEMD - Caatinga of medium stage of degradation; CEBD - Caatinga of low stage of degradation; CPF - Cultivation of forage palm; PCE - Elephant Grass Grazing

The authors explain the higher deciduousness in the dry period due to the vegetation response to water stress, since fall leaf would reduce water loss through transpiration. However, it is not possible to confirm this hypothesis in the present study, since the climatic conditions of January were atypical, when precipitation values were observed, as in November, in which precipitation of 252 mm was observed (Fig. 1).

Due to the above, it can be concluded that the higher values of contribution after rainfall, possibly, can be attributed to precipitation and wind speed, mainly in the form of storms, acting as a mechanical factor and thus contributing with greater deposition of material during these rainy seasons.

This favorable condition of microclimate preserves the available water, reducing the temperature variations of the burlap-soil system, which, in turn, may be favoring the colonization and development of the edaphic fauna in the CPF, and consequently the greater decomposition of the leaf material.

5. CONCLUSIONS

- The litter production and stock were higher in the most preserved area of the caatinga fragment after the rainy season, according to the characteristics of this biome and confirming that it is at that moment that more care should be taken as its management.
- The decomposition rate, highest half-life, production and litter stock showed potential variables as indicators in the desertification processes for this caatinga fragment.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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