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Effect of Fire on the Productivity of Homogeneous Stands of *Eucalyptus Camaldulensis* Denhn

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Abstract

The objective of this study was to evaluate the effects of fire in Eucalyptus camaldulensis stands on eight years old productivity. The work was conducted in Mutuca Farm, owned by the Sadia Oeste SAGroup, located in the municipality district of Cuiabá, State of Mato Grosso, Brazil, where the area was divided into two parts, which one of the parts was affected by fire 30 months after planting and the other hasn't been burned by fire. In each one of those parts,10 plots with 100 trees/plot were installed. The parameters of survival of the trees, amount and dimensions of the cracks in the bark, amount of side branch in the log, state health of the trees, thickness of the bark and wood volume/area and biomass production were evaluated. The results showed no significant difference in the survival of plants, however in the area without occurrence of fire no individuals with cracks in the wood were found, and the number of individuals with lateral sprouts was low while in the other area averaged 9.3 individuals with cracks and a larger number of plants with sprouts. In relation to biomass production, no significant differences was found among eucalyptus, submitted and not submitted to the action of fire in the majority of parameters evaluated, in exception for biomass production in the branches was significant.

Key words: Biomass, Eucalyptus, fire risk, forest protection.

INTRODUCTION

Although forestry companies adopt preventive measures against the risks of fire, when these phenomena occur they can bring economic losses to commercial plantations of forest species. The risk of fire to the environment can be estimated according to the theory of risks, which is based on historical data of occurrences for a certain region, thus, the prevention of any claim becomes a more secure task as more precise is the information stored in the database (RIBEIRO, 2004).

Planted homogeneous forests are potentially more susceptible to fires, in which the current tendency is to adopt a preventive forestry, that is, to establish fire protection techniques since the implantation of the stands (SOARES, 2000). According to Beutling et al. (2005), the best way to control forest fires lies in prevention actions, through efficient prevention and combat plans, however, the efficiency of these plans depends on the quality of information related to fire behavior, which can be estimated through characterization of the fuel material, terrain topography and the climatic conditions of the region.

For RIBEIRO (2004), forest fires constitute one of the most damaging events that cause changes in plant formations, whether natural or planted. Many are the causes of their origin, however, the most frequent and worrying concentrate in a small group where human factors stand out, mainly through its activities in the rural environment. BOWMAN & KIRKPATRICK (1986), when studying the behavior of *Eucalyptus delegatensis* RT Baker, syn. verified that the survival of adult trees in relation to the action of severe fires is associated with bark, that is, the mortality rate is inversely proportional to weight and thickness of the bark. The same authors observed that fire causes mortality for most shoots.

For SOARES & SANTOS (2002), among the various agents affecting forest resources, fire seems to be the greatest calamity, and forests and other types of vegetation are constantly exposed to the occurrence of fires of different intensities. According to the authors, lack of accurate information is a serious problem for native or planted forests, and proper measures have to be taken to reduce the impact of fire on forests and other forms of vegetation. There is little research on the effect of fire on planted forests in reforested areas in the State of Mato Grosso, leading to numerous questions about its real qualitative and quantitative interference in forest production. The objective of this study was to evaluate the influence of fire on biomass and yield of homogenous *Eucalyptus camaldulensis*Denhn plantation in the lowlands of Cuiabá region, State of Mato Grosso, Brazil, through different silvicultural parameters.

MATERIAL AND METHODS

The experiment was carried out in two stands of 8.5 year old homogeneous plantations of *Eucalyptus camaldulensis*, located in Fazenda Mutuca of the Sadia Oeste SA Group, located in the municipality of Cuiabá, in the state of Mato Grosso, approximately between 15º 15 'to 15 ° 22' south latitude and 55 ° 55 'to 55 ° 58' Greenwich longitude. The predominant soil is classified as Alque Quartzosa Sand and the flat, gently undulated topography (BRASIL, 1982). The climate of the region is tropical continental, always warm with dry winter and rainy summer, being therefore type Aw in the classification of Koppen. In the Cuiabá city lowland, the average annual temperature is 25.6ºC, with highest monthly average temperature occurring in October, with 27.2ºC, and the lowest occurring in July,

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with 22.8ºC.

The data were collected from an area with 17.82 ha, in which 9 ha were accidentally hit by fire 30 months after planting and another area with 16.09 ha not reached by fire, where the spacing between plants adopted for all plots was 3m x2m. The analyzes were carried out six years after the occurrence of the fire, where 10 parameters were demarcated in the burned stand and 10 plots in the non - burned stand, containing 100 individuals / plot and an area of 600 m^2 for each plot, which plots were distributed randomly. The data were collected excluding the border individuals, where the following parameters were evaluated: mortality, number of failures, number of lateral shoots, phytosanitary state, tree / ha volume, bark thickness, number and size of bark cracks.

For determining the volume / ha, measurements of circumference at breast height (CAP), using a tape measure calibrated in centimeters, and tree height, using a hypsometer, were taken of 10 trees / plot chosen randomly. In measuring the widths and lengths of the slits, a measuring tape in centimeters was also used. To calculate:

$$PSFi = \frac{PSi}{PFi}$$

at where:
PSFi= ratio between the weight of dry matter and fresh matter of the sample;
PSi = weight of the sample;
PFi = fresh sample weight.

The total biomass of each tree, in Kg, was determined by the sum of its different parts, and the total forest biomass in ton / ha, by means of the product between the total biomass of each tree, the number of trees planted per hectare and their survival rate in the field. The dry matter weight of the different parts of the PSPi trees was determined, through the product:

$$PSPi = PSFi * PFPi$$

at where:
PSPi = dry matter weight of the tree part; e
PFPi = fresh weight of the tree part.
The experimental design was completely randomized, with two treatments (occurrence and non - occurrence of fire) and 10 and 5 replicates, silvicultural and biomass variables respectively. The data were submitted to analysis of variance ANOVA, and the means were compared by the F test at the level of 5% error probability. The analyzes were performed using SISVAR software (FERREIRA, 2008).

RESULTS AND DISCUSSION

Considering that the present study was carried out six years after the occurrence of the fire, that is, after a long period after the phenomenon occurred, the result shows that the fire did not affect the survival of the individuals. The fire promoted the formation of lateral shoots close to the basal area of the plant, in a significantly larger amount in the burned area, both in number of individuals with sprouts and in the average number of sprouts of the individuals (Table 1). Several factors may be correlated with fire resistance, such as fire intensity, bark thickness and fire frequency (McCAW et al., 1994; GAVA et al., 1995).

Table 1: Average survival (%); average number individuals with cracks in the bark (cm); average thickness of the bark at the four cardinal points (cm); average amounts of individuals with sprouts and shoots / individual and average volume of wood (m^3 / ha), in the fields of *Eucalyptus camaldulensis* in the area under fire.

Silviculture parameters	Burned Area	Unfired Area	CV (%)
Survival (%)	87,7 a	86,7 a	2,8
Number of individuals with cracks	9,3	---	
Maximum crack width (cm)	4,7	---	
Length of cracks (cm)	37,54	---	
Average bark thickness (cm)- North	6,3 a	6,1 a	19,76
Average bark thickness (cm)- South	6,4 a	7,1 a	17,38
Average bark thickness (cm)- East	6,1 a	6,1 a	22,73
Average bark thickness (cm)- West	6,9 a	6,4 a	21,67
Number of individuals with shoots	6,1 a	1,3 b	35,74
Average number of shoots / individuals	2,4 a	0,70 b	29,16
Volume of wood (m^3/ha)	145,85 a	123,09 a	3,67

Means followed by the same letter in the lines do not differ from each other by the F test at the 5% probability level.

If on one hand the survival was not affected, for the individuals that suffered the action of the fire, in the stand with occurrence of fire individuals can be found with cracks in the bark, approximately nine individuals per plot, whereas in the not burned stand no individuals with cracks were observed. Another characteristic observed is that the quality of the wood was damaged, since part of the material showed dried xylem, cracked and even attacked by xylophagous microorganisms. POGGIANI et al. (1983) found differences in the height of shoots of *Eucalyptus grandis* (Hill), in areas under fire, in Bom Despacho, Minas Gerais, in which the fire effectively affected the regeneration of trees and the survival of shoots.

Rasmussen et al. (1997), studying infestations of borer of the families Buprestidae, Cerambycidae and Curculionidae in areas of *Picea engelmannii* (Pinaceae) submitted to fire, observed a high degree of infestation suggesting that the insect population developed refuges in the trees damaged by the fire and then increasing infestation in undamaged trees.

McCAW et al. (1994) studied the extent of stem damage and crown cover rate after the occurrence of intense fire in a plantation of *Eucalyptus diversicolor* F. Muell. and 16 year old *Eucalyptus muellerana* Howitt, where results showed that three successive defoliations caused by fire are capable of causing trees death.

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The authors observed that *E. muellerana* presented higher resistance to fire, due to its greater bark thickness when compared to *E. diversicolor*; however, five years after the fire, *E. muellerana* had dominant crowns and *E. diversicolor* presented 40% of crowns dominated with formation of lateral branches, originated from the stem.

Regarding the average bark thickness, there were no significant differences between the quadrants of the trees in the burning and non-burning stands, therefore, bark thickness was not affected by the fire that occurred 6 years ago. Some individuals presented burns on the bark, marks that were not erased by the time. GAVA et al. (1995) studied the correlation of bark thickness and fire survival of different populations of *Eucalyptus torelliana* F. Muell. and *Eucalyptus tereticornis* Smith. with an approximate age of 7 years, where it was observed that the temperature of 60ºC is lethal for the cambium, in laboratory studies. The authors concluded that there was a linear correlation for both species and that the outer appearance of the bark is not a safe parameter for assessing the damage in the exchange.

The productivity, expressed in volume (m^3 / ha), was higher in the burned area when compared to the area without the action of fire, that is, 145.8 m^3 / ha and 123.1 m^3, respectively. However, this difference was not significant (Table 1). GUINTO-DANILO et al. (1999) studied the effect of fire on diameter growth as well as mortality on different species of dry and moist sclerophyllous forests, where in humid forests, fire did not affect the growth rates of *Eucalyptus* species, although only in *E. tereticornis* a positive response to the annual fire was found.

In relation to biomass, the area that underwent fire had a higher average production of wood and bark, 7.57 and 43.28 t / ha respectively, which can be observed that only in relation to the bark this difference was significant (Table 2). In the studies of Schumacher (1998) this fact was verified for *Eucalyptus globulus* Labill., where the occurrence of fire may have destroyed part of the canopy, which may have caused a greater concentration of resources for wood and bark production, the latter as an element of fire resistance.

Table 2: Biomass produced (t/ha) in the homogenous stands of *Eucalyptus camaldulensis* submitted to fire.

Biomass Production	Burned Area	Unfired Area	CV (%)
Leaf(t/ha)	0,77 a	1,65 a	63,68
Branches (t/ha)	4,48 b	8,79 a	69,51
Barks (t/ha)	7,57 a	6,81 a	17,04
Unbarred trunks (t/ha)	35,71 a	29,32 a	17,97
Trunks, in bark (t/ha)	43,28 a	36,14 a	16,47

Means followed by the same letter in the lines do not differ from each other by the F test at the 5% probability level.

TOLHURST (1990) conducted studies on the effects of fire after spring and autumn season by analyzing parameters such as crown abundance, frequency, cover, height and biomass in *Eucalyptus rubida* Deane & Maiden and *Eucalyptus radiata* Sieber ex DC, in which fire that occurred in the spring promoted an increase in crown height and biomass, however, crown size decreased after the fire in autumn and biomass remained unchanged. Although in some of the biomass characteristics no significant difference was observed, in percentage terms these differences can be perceived (Figure 1).

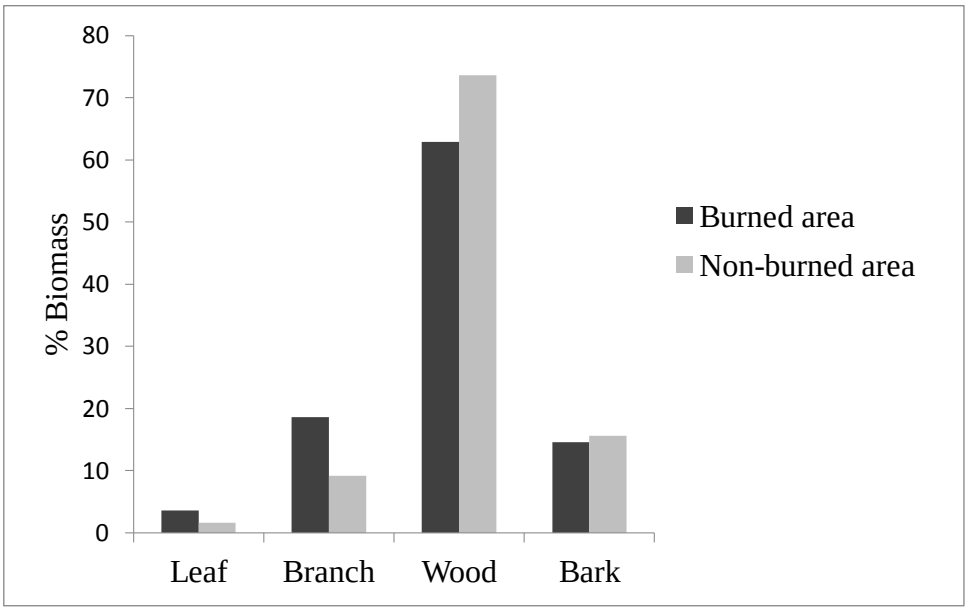

Fig. 1: Average percentage of biomass produced in *Eucalyptus camaldulensis* stands, in areas with and without fire occurrence.

It should be taken into account that the species studied presents resistance to fire, and it is necessary to have new experiments including different degrees of controlled fire intensity in order to know the production of biomass at the different fire intensities. Another factor that may have affected the study is that, in the burned understory vegetation,it may have provided greater amount of nutrients due to ash resulting from the organic matter. The phytosanitary state of the trees was observed, where no pest damage was attested, at the time of evaluation due to accidental fire.

Conclusion:

Considerations should be drawn for the study, since the intensity of the fire, which occurred six years ago, was not taken into account, as well as the fact that the fire occurred only once, therefore it is not known what the behavior of the trees would be in situations of higher incidence of fire. In another aspect, the quality of the wood was negatively affected in the burned area. However, because the final use of the wood in the stand studied is for firewood, this factor becomes contemptible.

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