Silvipastoral system of eucalyptus and dedigitaria grass in Chapada do Araripe, Pernambuco, Brazil

Sistema silvopastoril de eucalipto y hierba dedigitaria en Chapada do Araripe, Pernambuco, Brasil

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ABSTRACT

The Chapada do Araripe region, in Brazil, is an important gypsum producer, with high energy demand for the industrial process. Currently, the main source of energy is the wood from the Caatinga vegetation. Aiming to reduce deforestation and boost the regional gypsum industry, eucalyptus has been indicated as an alternative for energy generation. Integrated systems of eucalyptus with adapted forage plant is a strategy to ensure stability and diversify production systems, increasing the supply of wood for energy and fodder for animal feed. The present study was implemented in 2008, in the experimental station of the Agronomic Institute of Pernambuco - IPA, in the municipality of Araripina-PE. The experiment consisted of five 5000 m2 plots, three of eucalyptus intercropped with grass: 1) eucalyptus at spacing of 6 m x 6 m + digitaria grass, 2) eucalyptus at spacing of 12 m x 6 m + digitaria grass and 3) eucalyptus at spacing of 12 m x 12 m + digitaria grass and two controls: 4) monoculture of eucalyptus planted at

spacing of 3 m x 3 m and 5) monoculture of digitaria grass. At six years of age, it was observed that among the livestock-forest integration systems tested, the 6 m x 6 m spacing (278 trees/ha) provided the best yields in wood volume and forage biomass production.

Keywords: Caatinga, Semiárido brasileiro, Eucalyptus, agrosilvicultura

RESUMEN
La región de Chapada do Araripe, en Brasil, es una importante productora de yeso, con una elevada demanda de energía para el proceso industrial. Actualmente, la principal fuente de energía es la madera de la vegetación de la Caatinga. Para reducir la deforestación y fomentar la industria regional del yeso, se ha indicado el eucalipto como alternativa para la generación de energía. Los sistemas integrados de eucalipto con planta forrajera adaptada son una estrategia para garantizar la estabilidad y diversificar los sistemas de producción, aumentando el suministro de madera para energía y forraje para alimentación animal. El presente estudio fue implementado en 2008, en la estación experimental del Instituto Agronómico de Pernambuco - IPA, en el municipio de Araripina-PE. El experimento consistió en cinco parcelas de 5000 m2 cada una, tres de eucalipto intercalado con pasto: 1) eucalipto a espaciamiento de 6 m x 6 m + pasto dedigitaria, 2) eucalipto a espaciamiento de 12 m x 6 m + pasto dedigitaria y 3) eucalipto a espaciamiento de 12 m x 12 m + pasto dedigitaria y dos controles: 4) monocultivo de eucalipto plantado a espaciamiento de 3 m x 3 m y 5) monocultivo de pasto dedigitaria. A los seis años de edad, se observó que entre los sistemas de integración ganadero-forestal ensayados, el espaciado de 6 m x 6 m (278 árboles/ha) proporcionaba los mejores rendimientos en volumen de madera y producción de biomasa forrajera.

Palabras clave: Caatinga, Semiárido brasileño, Eucalipto, agrosilvicultura

1 INTRODUCTION

The Brazilian semi-arid region is the largest in the world and has an area of 982,566 Km2, which corresponds to 53% of the Northeast region (BAPTISTA; CAMPOS, 2013). The Caatinga occupies most of this region, presenting a great diversity of landscapes, with biological richness and endemism, but suffers from its continuous devastation and climatic limitations, with regard to rainfall distribution and soil conditions. The landscape ecology studies from metrics using geoprocessing and remote sensing are important technologies to evaluate the conditions of native forest remnants, especially in fragmented biomes and with high deforestation rate as the Caatinga (JESUS, et al., 2019). Studies on this Biome were conducted by INPE, (2015), through a mapping using the years 2013/2014 of the Landsat-8 satellite, where it was found for the Caatinga 45.06% of degraded area.

The Chapada do Araripe region stands out as a major producer of gypsum and demands the use of energy sources during the industrialization process. Currently, the main energy source in the region has been the wood extracted from the Caatinga. Recent

studies have shown excessive deforestation related to desertification areas. In order to continue boosting the region's gypsum production pole, the crop-livestock-forest integration system (ILPF) with fast-growing forest species is being disseminated as an alternative to generate energy for local industries.

The planting of eucalyptus intercropped with crops adapted to the region, such as cowpea, can reduce the initial costs of implementing energy forests and with grasses to increase the supply of forage in the region (DRUMOND et al., 2010). Among the different options of tree components, Macedo et al. (2008), highlight a large number of species that adapt to various soil and climate conditions, rapid growth, among other factors that corroborate the indication of eucalyptus as one of the main tree components for the composition of ILPF systems.

According to a survey conducted by Embrapa and public and private partners, with the objective of evaluating the degree of adoption of crop-livestock-forest integration technologies in the country, some data on the reality of the ILPF systems in the Northeast region of Brazil were presented. Of the 493 rural producers interviewed, where cattle farming was the predominant activity, 60% already knew the concept of crop-livestock-forest integration, although the adoption of the system in the region is still low, on average 41%, some states present adoption above this average, as is the case of Alagoas (51%) and Sergipe (44%) (NÓBREGA, 2018).

The inclusion of the tree component in pastures helps in the mitigation of CO2 emissions and also, in a complementary way these systems have promoted in a synergistic way the increase of biodiversity (ROVER et al., 2018; SIMIONE et al., 2019), the productive efficiency of the soil and the cycling of nutrients (BATTISTI et al., 2018) and has also provided improvement of the microclimate and ambience (DENIZ et al., 2020) and the forage production (ALMEIDA SILVA et al., 2020). Given these positive evidences, fostering the conversion of pasture areas into silvipastoral systems using fast-growing species could be an important competitive differential for the region with emphasis on increasing productivity in a sustainable way, both for the livestock and forest-based sectors.

The objective of this work was to evaluate the effects of planting density of eucalyptus intercropped with digitaria grass on wood and forage productivity, in the Chapada do Araripe.

2 MATERIALS AND METHODS

The experimental area was established in 2008 in the Experimental Station of the Agronomic Institute of Pernambuco - IPA, located in the municipality of Araripina-PE (Latitude: 7°27'41 "S, Longitude: 4°00'22 "W, Altitude: 834 m), in February 2006. The predicted annual rainfall in the region is 752.5 mm, concentrated in the months of February, March and April, with an average temperature of 26°C, evaporation of 1,127 mm/year and an average annual relative humidity of 55.2%.

The experimental area was previously plowed and harrowed and subsoiled to a depth of 40 cm in the eucalyptus planting line. Two tons of dolomitic limestone per hectare were incorporated into the soil, and a foundation fertilization was performed with 150 g/hole of NPK (06:24:12).

In an area of two hectares initially, eucalyptus (hybrid of Eucalyptus brassiana x E. urophylla) was planted at 3 m x 3 m spacing. At 18 months after planting the eucalyptus, the digitaria grass (Digitaria decumbens Stent.) was planted between the rows, using seedlings.

At 27 months, to favor the establishment of the grass, aiming to reduce shading, 50% of the eucalyptus plants were thinned, leaving the remaining plants spaced at 6 m x 6 m and, at 36 months, a new thinning was carried out, establishing plots with three population densities of eucalyptus intercropped with Digitaria decumbens: eucalyptus (6 m x 6 m) x digitaria-capim, eucalyptus (6 m x 12 m) x digitaria-capim and eucalyptus (12 m x 12 m) x digitaria-capim. Thus, the Technological Reference Unit (TRU) was formed by five 5,000 m2 plots, three of them with eucalyptus intercropped with grass, and two controls (monoculture eucalyptus at spacing of 3 m x 3 m and monoculture digitaria-grass).

At six years of age, the height and diameter at breast height of the eucalyptus plants were measured to calculate the cylindrical volume of wood and the biomass of the digitaria-grass sampled in areas 1.0 m2 repeated four times, to estimate the dry biomass of digitaria-grass in the different treatments.

3 RESULTS

At 27 months of age, when the digitaria grass had 30% occupation of the planted area (Figure 1), the first thinning was carried out.

Figure 1. Thinning of 50% of the eucalyptus plants at 27 months of age.

Photo: Marcos A. Drumond

The volumetric production of wood, in the first thinning at 27 months of age, was 53 m3 ha-1, which was equivalent to an average annual volumetric increment of wood of 23.0 m3 ha-1 year-1 (Figure 2), showing a good result in this initial phase of development.

Figure 2 Eucalyptus wood at 27 months of age, in the Chapada do Araripe, Araripina-PE.

Photo: Marcos A. Drumond

Figures 3 and 4 show the crop-livestock-forest integration system involving digitaria grass and eucalyptus (6 m x 6 m) at different ages, in the rainy period, 35 months and in the dry period, at 48 months.

Figure 3. 6 m x 6 m eucalyptus intercropped with digitaria grass in Chapada do Araripe, Pernambuco, 35 months after planting the experiment.

Photo: Marcos A. Drumond

Figure 4. Eucalyptus 6 m x 6 m intercropped with digitaria grass in the Chapada do Araripe, Pernambuco, dry period, 48 months after planting the experiment.

Photo: Marcos A. Drumond

Figure 5 shows an isolated eucalyptus plantation (hybrid of Eucalyptus brassiana x E. urophylla) at 3 m x 3 m spacing, at 48 months of age.

Figure 5. Hybrid of Eucalyptus brassiana x E. urophylla at 48 months of age in Chapada do Araripe.

Photo: Marcos A. Drumond

In Figure 6, it can be seen at six years of age that the mixed crop of deciduous grass x eucalyptus planted at 12 m x 12 m spacing, showed the worst performance for the two crops: 16.0 m3 ha-1 of eucalyptus wood and 3.621 Kg ha-1 of dry biomass of deciduous grass.

Figure 6. 12 m x 12 m eucalyptus intercropped with digitaria grass in the Chapada do Araripe, Pernambuco, six years after planting the experiment.

Photo: Marcos A. Drumond

Over a period of six years the area with mixed cultivation of digitaria x eucalyptus grass planted at spacing of 6 m x 6 m showed better productive performance for the two crops, 62.2 m3 ha-1 of eucalyptus wood and 4,241 Kg ha-1 of dry biomass of digitaria grass, while in isolated crops, eucalyptus produced 98.1 m3 ha-1 of wood and digitaria grass produced 3,273 Kg ha-1 of dry fodder (Table 1).

Table 1. Productive characteristics of eucalyptus grown at different spacings and dedigitaria grass in integrated and isolated systems, six years after establishment in the Chapada do Araripe, Pernambuco.

Treatment	Height (m)	DBH (cm)	Survival (%)	Wood volume (m^3 ha^{-1})	Forage mass (Kg DM $ha^{-1)}$
Isolated Eucalyptus (3 x 3m)	12.6	11.3	100	98.1	-
Eucalyptus (6 x 6m) + Grass	12.7	17.9	100	62.2	4,241
Eucalyptus (6 x 12m) + Grass	13.4	17.8	100	32.5	3,677
Eucalyptus (12 x 12m) + Grass	12.9	18.1	100	16.0	3,621
Digitaria grass isolated	-	-	-	-	3,273

4 CONCLUSIONS

- The spacing of 3 m x 3 m between eucalyptus plants impaired the establishment of digitaria grass;

- The average annual increment of eucalyptus wood, at 27 months, was already producing firewood, capable of meeting the demand of the calcineries, reducing the pressure on the native vegetation of the Chapada do Araripe region.

- Among the systems of livestock-forest integration tested, the spacing of 6 m x 6 m (278 trees/ha) provided the best yields in wood volume and biomass production, respectively, for the tree component and for the forage component.

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