(DOI): 10.5935/PAeT.V7.N1.06
This article is presented in English with abstracts in Spanish and Portuguese
Brazilian Journal of Applied Technology for Agricultural Science, Guarapuava-PR, v.7, n.1, p.55-61, 2014

Cientific Paper

Initial assessments on the plantation of *Eucalyptus benthamii* Maiden et Cambage deployed in different spacing

Cristiane Carla Benin[1]
Francielle Brandalise Wionzek[2]
Luciano Farinha Watzlawick[3]

Abstract

This study aimed to assess the initial development of *Eucalyptus benthamii* implanted in four different spacing. The experiment was conducted in random block design, using the following spacing: 2x3, 3x3, 3x4 and 4x4. We used height and diameter at breast heights (DBH) data collected at the ages of 2 and 3 years to assess the linear correlation between the variables, annual height and diameter increase, and the volumetric production at 3 years old. The results did not show significant difference of individual height and volume in the performed assessments. However, it was observed a higher diameter increment according to higher vital area availability. The highest productivity rate was of 66.55 m^3 ha^{-1}, registered in a 2x3 spacing between plants, while in the biggest spacing adopted (4x4) the productivity was of only 31.61 m^3 ha^{-1}, at three years old. It was concluded that there's influence of the spacing on the dendrometric variables, mainly in diameter and volume.

Keywords: initial development; planting density; *Eucalyptus*.

Avaliações iniciais em plantio de E*ucalyptus benthamii* maiden et cambage implantados em diferentes espaçamentos

Resumo

Este trabalho teve como objetivo avaliar o desenvolvimento inicial de *Eucalyptus benthamii* implantados sob quatro diferentes espaçamentos. O experimento foi conduzido no delineamento em blocos ao acaso, utilizando-se os seguintes espaçamentos: 2x3, 3x3, 3x4 e 4x4 m. Utilizaram-se dados de altura e diâmetro à altura do peito (DAP) coletados nas idades de 2 e 3 anos para a avaliação da correlação linear entre as variáveis, incremento anual em diâmetro e altura, e a produção volumétrica aos 3 anos de idade. Os resultados não demonstraram diferença significativa para a altura e volume individual nas avaliações efetuadas. No entanto, observou-se maior incremento em diâmetro conforme a maior disponibilidade de área vital. A maior produtividade foi de 66,55 m^3 ha^{-1}, registrada no espaçamento 2x3 m entre plantas, enquanto que no maior espaçamento adotado (4x4 m) a produtividade foi de apenas 31,61 m^3 ha^{-1}, aos três anos de idade. Concluiu-se que há influência do espaçamento nas variáveis dendrométricas, sobretudo no diâmetro e volume.

Palavras-chave: desenvolvimento inicial; densidades de plantio; *Eucalyptus*.

Evaluaciones iníciales en cultivo de *Eucalyptus benthamii* Maiden et Cambage implantado en diferentes espaciamientos

Resumen

Este estudio tuvo como objetivo evaluar el desarrollo inicial de *Eucalyptus benthamii* implantados bajo cuatro diferentes distancias. El experimento se llevó a cabo en el diseño de bloques completos al azar, con las siguientes distancias: 2x3, 3x3, 3x4 y 4x4 m. Se utilizaran datos de altura y diámetro a la altura del pecho (DAP) recogidos a los 2 y 3 años para la evaluación de la correlación lineal entre las variables, incremento anual en diámetro y altura, y la producción volumétrica en los 3 años de edad. Los resultados no mostraron diferencias significativas para la altura y el volumen individual en las evaluaciones realizadas. Sin embargo, se observó un mayor incremento en diámetro conforme la mayor disponibilidad de

Received at: 14/05/2013 Accepted for publication at: 01/03/2014

1 Forest Engineer, Graduate student in Forest Sciences, UNICENTRO, Irati, PR, Brazil; E-mail: cristianebenin@hotmail.com;

2 Environmental Scientist. Graduate student in Bioenergy, UNICENTRO, Guarapuava, PR, Brazil; E-mail: fran_gsn@hotmail.com

3 PhD; Forest Engineer; Professor at the Agronomy Department and Programs of post graduation in Agronomy; Forest Sciences and Bioenergy at Universidade Estadual do Centro-Oeste (UNICENTRO), CEDETEG Campus; Address: Rua Simeão Varela de Sá, 3, Bairro Vila Carli, CEP: 85.025-050, Guarapuava, Paraná, Brazil; E-mail: luciano.watzlawick@pq.cnpq.br

área vital. El mayor rendimiento fue de 66,55 m^3 ha^{-1} registrado en el espaciamiento de 2x3 m entre plantas, mientras que para el mayor espaciamiento adoptado (4x4 m) la productividad fue solamente de 31,61 m^3 ha^{-1}, a los tres años de edad. Se concluyó que no hay influencia del espaciamiento en las variables dendrometricas, especialmente en el diámetro y volumen.

Palabras clave: desarrollo inicial; densidades de cultivo; Eucalyptus.

Introduction

The *Eucalyptus benthamii* Maiden et Cambage is a species inserted in Brazil in the 90's, which has been outstanding by its good adaptability in areas of severe frost occurrence and many other sites, presenting fast growth, good stem shape and productivity (HIGA et al., 2003).

This species is noteworthy for the reforesting of south Brazilian area, due to its adaptability to the climatic conditions found on that area. Studies have shown that the *Eucalyptus benthamii* presented higher resistance to frosting and bigger growth, in comparison with the *Eucalyptus dunnii* Maiden crop, implanted in the city of Guarapuava and Colombo – PR (PALUDZYSZYN FILHO et al., 2006).

Initial assessments of the first generation of *Eucalyptus benthamii*, implanted in the city of Colombo-PR, pointed out an average height growth of 2.3 meters, and diameter growth of 2.7 centimeter a year (PEREIRA et al., 2000). Studies evidence higher suitability of wood for energetic purposes; however, with the advances on genetic improvement of the species, it becomes crucial the development of further thorough researches about the wood properties of the *Eucalyptus benthamii* and new usage alternatives.

Even though the species presents satisfactory growth, it can be fiercely influenced by the applied silvicultural techniques, mainly by the adopted planting spacing. The spacing is a very important decision and it must be chosen based on the final destination of the production, for it reflects in the wood growth, production, properties and quality.

The planting spacing, or initial density, can affect the morphology and tree growth, especially in the diameter increase (SHIMOYAMA and BARRICHELO, 1989), mainly on the initial phases of the plant development (OLIVEIRA NETO et al., 2003). The ideal and most indicated spacing is the one where it is possible to produce higher product volume (TONINI, 2003), which is highly associated with the site quality on which a population is implanted. In highly productive sites, it is noticed a fast initial growth, as it becomes constant with the ageing and population stabilization, and it is directly related with the base area of the population (SCHENEIDER, 1993).

BINKLEY et al. (2002), emphasize that the choice of inadequate arrangement and spacing for the species and planting goal can intensify the competition, the dominated tree increase and reduce the growth homogeneity, associated with the ineffective usage of the available resources.

Many authors corroborate the influence of spacing on the growth and survival characteristics of populations (BERGER, 2000), as those influences are dependant of each species' characteristics and can be either positive or negative with the raise or shortening of spacing.

Wider spacing tend to produce trees with larger diameter and higher individual volume, while in shorter spacing the trees present smaller diameter and, consequently, higher volume per area unity (FISHWICK (1976), quoted by PAULESKI (2010); BALLONI and SIMÕES, 1980; BERGER et al., 2002).

Studies conducted on the region of Cerrado, in the state of Minas Gerais, where it was assessed the growth of *Eucalyptus camaldulensis* Dehnh and *Eucalyptus pellita* F. Muell under different densities, revealed little variation of height and big response diversity regarding diameter increment, whereas the most expressive values were found on spacing with bigger useful area per plant (LELES et al., 2001).

According to the exposed and the growth potential of *Eucalyptus benthamii* for the south region of Brazil, this study aimed to asses the initial increase of diameter, height and volume of the species in a experimental planting conducted in four different spacing.

Material and Methods

The experiment took place in the city of Guarapuava, south-central region of Parana state, on the experimental area of the CEDETEG University Campus, coordinates UTM 449938.73 m E and 7192325.20 m S and 450213.90 m E and 7192129.09 m S, 1120 meters altitude (Figure 1).

The climate of the region is classified as subtropical, with yearly average temperatures of 16 to 20°C, with cold winter predominance. The rains are

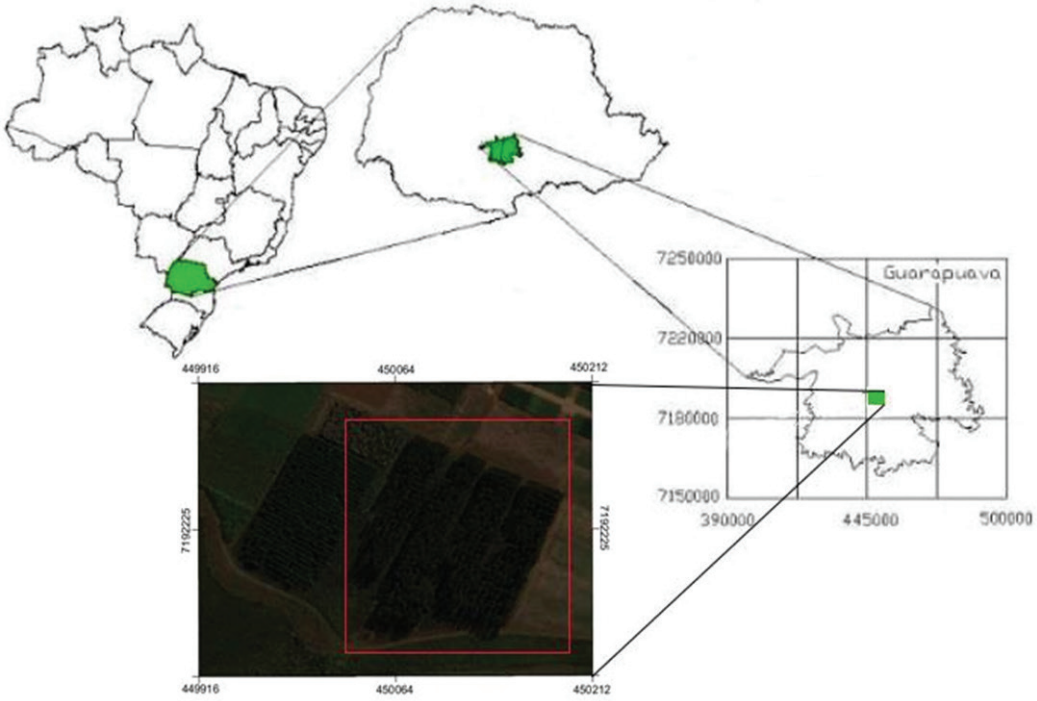

Figure 1. Location map of the city of Guarapuava-PR, experimental area of the CEDETEG University Campus. Adapted of RODRIGUES, 2012.

abundant and well distributed during all year. Due to these characteristics, the regional climate, according to the Köppen classification, is Cfb – temperate weather, with yearly average rainfall between 1800 to 2000 mm (THOMAZ and VESTENA, 2003).

The population was implanted at the end of 2006, using different initial spacing on the plantation of seedlings of *E. benthamii*. The used seedlings were originated of improved seeds, provided by the Golden Tree Reforesting Ltda.

The experimental design used was of randomized blocks, with four repetitions per treatment and twenty trees per repetition. The treatments were in 4 different spacing (2x3 m, 3x3 m, 4x3 m, 4x4 m), with the following vital areas: 6, 9, 12 and 16 m².

The minimum cultivation system was used on the soil preparation, so as to avoid the soil disturbance, for before it has been an area used to agricultural crops. The tillage was conducted with the aid of manual tools on the plantation lines. Coverage fertilization was performed after the planting, using nitrogen fertilization (NPK in the formulation (04-14-08). The application was made in side holes, by the dosage of 200 g per plant. The monitoring and ant-prevention were performed before and after the planting. For that, it were used MIP's (formicide bait), on the dosage of 5 g per 10 m², when necessary. The employed cultural treatments were the capping of seedlings for weed competition control, at the time of three and six months, by mechanical weeding. The pruning was conducted at two years old, up to 1.5 meters of clean stem.

For the development of this study, we analyzed statistically the annual increment of diameter and height and the linear correlation between the variables. For such matter, it were used dendrometric data of diameter at breast height (DBH) and total height, measured in the years of 2008 and 2009, at the ages of two and three years, respectively.

The average individual volume and the volume per acre were calculated using the medium shape factor (ff = 0.5). We opted for the employment of a medium shape factor, because the analyzed data corresponded to initial assessments and because of the non-availability of cubing data, as well as of volume equations of those ages.

The data of annual increase average of diameter, height, individual volume average and volume per acre were subjected to the homogeneity

variance test (Bartlett) and, subsequently, to the analysis of variance (ANOVA). The treatments averages were compared by the Tukey test, at 5% significance level. The statistical analyses were conducted using the statistic software ASSISTAT 7.6 and the Pearson correlation coefficients were obtained through the Microsoft Excel 7.0.

Results and Discussion

As for the linear correlation between the variables, the Pearson correlation coefficient showed a negative linear relation, at the level of a = 0.01, between height and vital space, at the ages of 2 and 3 years. The same was verified among the height and transversal area variables, and height and individual volume (Table 1).

As for the diameter and vital space, it was observed a positive linear relation. This result can explain the strong influence that the space has on the diametric growth of trees, mainly in the initial development phase of plants (BERNARDO, 1995; OLIVEIRA NETO, 2003).

The DBH variables and the transversal area showed highly correlated, with a coefficient of r = 0.99, at the two assessed ages (Table 1). For the diameter, DBH and the individual volume it was also possible to identify a high positive linear correlation. It was found an increase of that relation with the raise of the planting age r = 0.95 (Table 1).

LIMA (2010), in studying the correlation between the DBH and individual volume, in the planting of *Pinus taeda* under different spacing and at different ages, also concluded a high correlation among those variables, observing very proximate coefficients of a perfect adjustment.

For all the assessed characteristics, the homogeneity of the variances was proven by the Bartlett test ($p > 0.01$). It was not recorded significant difference in the annual height increment ($p > 0.01$). The average volume per tree didn't present statistical difference on the 3 years assessment, while the volume per acre was statistically different among the evaluated spacing ($p > 0.01$).

In spite of the fact that the assessments were conducted in initial ages of the experimental planting of *Eucalyptus benthamii*, it was possible to detect significant differences on the diametric increment in function of the different adopted spacing ($p > 0.01$).

The spacing of 16 m² per plant presented superior diametric growth (3.43 cm year^{-1}), followed by the 12 m per plant spacing (3.24 cm year^{-1}). On the 6 m² spacing, it was observed a lower diametric increment, among all the adopted spacing (2.85 cm year^{-1}) (Table 2).

Other studies also report about the positive influence of larger spacing on the diametric growth for the *Eucalyptus* sp. (BALLONI and SIMÕES, 1980; REZENDE et al., 1981), *Eucalyptus saligna* Smith (BERGER et al., 2002), and *Pinus taeda* L. (LIMA, 2010).

In reforesting of *Pinus taeda* established in the region of Jaguariaíva-PR, on the spacing of 2.5 x 1.2 m; 2.5 x 2.0 m; 2.5 x 2.8 m; 2.5 x 3.6 m and 2.5 x 4.4 m, it was observed an effect on the planting density over the diameter, exceptionally at more advanced ages and on larger spacing (SANQUETA et al., 2003). In established planting with hybrids of *Eucalyptus camaldulensis* Dehn x *Eucalyptus urophylla* S.T. Blake, in the northwestern region of Minas Gerais, the highest verified diameter average corresponded to the larger spacing (12 x 2.5 m and 6 x 4 m), noticing a decrease on the diameter values from the spacing of 6 x 3 m (MORAIS, 2006).

The results of the present study corroborate that larger spacing provide bigger area for individual growth of each tree, and in a certain way it minimizes the competition effect between plants, providing

Table 1. Pearson's correlation coefficients between the variables of height (m), vital space (m²), DBH (cm), transversal area (m²) and individual volume (m³ tree^{-1}), at the ages of 2 and 3 years, in experimental planting of *Eucalyptus benthamii*.

Variables	r (2 years)	r (3 years)
Height x vital space	- 0.42	-0.19
Height x transversal area	0.14	0.08
Height x individual volume	0.52	0.37
DBH x vital space	0.84	0.95
DBH x transversal area	0.99	0.99
DBH x individual volume	0.90	0.95

Table 2. Average annual increment of diameter and volume ha^{-1}, evaluated at the age of three, in the planting of *Eucalyptus benthamii*, established under different planting spacing, on experimental area in the city of Guarapuava-PR.

Planting spacing (m)	Average DBH (cm)	Volume (m³ ha^{-1})
4x4	3.43 a	31.61 b
4x3	3.24 ab	34.72 b
3x3	3.10 bc	41.05 b
2x3	2.85 c	66.55 a

Averages followed by the same lower case letter do not statistically differ by the Tukey test, at a 5% error probability.

a good usage of water, light, nutrients and space. However, the diametric increment rate is also, mostly, determined by the quality of the site where the tree grows and by the singular characteristics of each species.

The height increase did not suffer influence of the planting spacing, on the assessments at 2 and 3 years old. According to OLIVEIRA NETO et al. (2010), the height suffers low influence of the spacing, whereas possible effects of the vital area over this variable are associated with the quality of the site and the assessment age.

SCHNEIDER (1993) reports about the difficulty in expressing and justifying the effect of higher densities over the height growth, however, he affirms that the height growth is higher in relation with the diameter on densities that contemplate larger number of individuals per area unit, that is, in conditions of competition for light and nutrients, the trees have a favored longitudinal growth.

Nevertheless, initial studies verifying the planting spacing influence and the silvicultural implications in forests of *Eucalyptus* sp., found a reduction of average height on spacing with smaller vital area per plant (BALLONI and SIMÕES, 1980). This fact can be easily understood by the competition effect and the number of dominated trees under these conditions, which causes reflexes on the average height decrease of the population.

MORAIS (2006), in studying the dynamics of growth of hybrids clones of *Eucalyptus camaldulensis x urophylla* under different spacing observed little variation on the height growth among the treatments, whereas the most significant variations found were of 6 x 3 m spacing. In populations of *Eucalyptus urophylla* in the cerrado region of Minas Gerais, it was recorded taller plants in shorter spacing (3 x 2 m), which was justified due to the population density increase and light competition (ASSIS et al., 1999).

INOUE et al. (2011b), recorded significant differences on the height assessments of *Pinus taeda*, at seven years old, in function of nine different initial densities. The differences of average height between the tighter and wider arrangements were of 1.6 meters, which strengthens the concept that smaller vital areas between plants favor the increase of this variable.

As for the average individual volume, although this variable hasn't presented statistical difference among the treatments, it was observed a tendency for bigger individual volume in function of larger spacing. For the spacing of 4 x 4 m, the average individual volume was of 0.0505 m³ tree^{-1}, and in the shortest spacing (2 x 3 m), the volume was of 0.0400 m³ tree^{-1}. Thus, it was found that wider arrangements provide better conditions (space and nutrients) for the plant growth, which are responsive in volumetric terms.

In relation to the volume ha^{-1}, at the age of three, the shortest arrangement adopted presented higher productivity, corresponding to 66.55 m³ ha^{-1} (Table 2). On the other spacing there were no statistical differences on the productivity.

Plantations of *Eucalyptus grandis* Hill ex Maiden, with spacing varying from 2 to 6 m² plant^{-1} did not show the effects of density on the survival and diametric growth, however, it was possible to observe significant differences on the height growth and volumetric increment, on measurements up to 4 years old (REZENDE et al., 1981).

REINER et al., (2011) found that the volumetric yield per acre on the shortest spacing (1.5 x 1.5 m) was superior to the wider arrangements, for the *E. dunni* at the age of three, in experimental planting on the southwest of Parana.

This way, the highest volumetric production on smaller vital areas is related to higher density of trees per unit area (SCHNEIDER, 1993), also to

the better usage of factors of site production and occupation.

Conclusions

The diameter presented to be strongly related to the vital space, transversal area and individual volume on initial assessments of those variables.

The wider spacing presented higher rates of diametric increment, confirming that the development of that variable is proportional to the available vital space for each plant.

The highest production of volume per acre was proven on the spacing of 2 x 3 meters.

The total height and volume did not suffer effect of planting spacing on the initial assessments. It is suggested to follow the development of those dendrometric variables in future ages.

References

ASSIS, R. L.; FERREIRA, M. M.; MORAIS, E.J. Produção de biomassa de *Eucalyptus urophylla* S.T. Blake sob diferentes espaçamentos na região de cerrado de Minas Gerais. **Revista Árvore,** v.23, n.2, p.151-156, 1999.

BERGER, R. **Crescimento e qualidade da madeira de um clone de *Eucalyptus saligna* Smith sob o efeito do espaçamento e da fertilização.** 126p. Dissertação (Mestrado em Engenharia Florestal) - Universidade Federal de Santa Maria, Santa Maria, 2000.

BALLONI, E.A., SIMOES, J.W. **O espaçamento de plantio e suas implicações silviculturais.** IPEF, (Série técnica), 1980.

BERGER, R.; SCHNEIDER, P. R.; FINGER, C. A. G.; HASELEIN, C.R. Efeito do espaçamento e da adubação no Crescimento de um Clone de *Eucalyptus saligna* Smith. **Ciência Florestal**, Santa Maria, v. 12, n. 2, p. 75-87.

BERNARDO, A. L. **Crescimento e eficiência nutricional de Eucalyptus spp. sobdiferentes espaçamentos na região do cerrado de Minas Gerais.**Viçosa, 1995. Dissertação (Mestrado em Ciências Florestais) – Universidade Federal de Viçosa.

BINKLEY, D.; STAPE, J.L; RYAN, M. G.; BARNARD, H. Age- related decline in forest ecosystem growth: an individual- tree, stand- structure hypothesis. **Ecosystems**, New York, v.5, p.58-67, 2002.

BOTELHO, S. A. Espaçamento. In: SCOLFORO, J. R. S. **Manejo florestal.** Lavras: UFLA/FAEPE, 1998. p.381-406.

COUTO, L; BRANDI, R,M; CONDÉ, A,R; NETO, F,P. Influência do espaçamento no crescimento do *Eucalyptus urophylla*, de origem híbrida, cultivado na região de Coronel Fabriciano, Minas Gerais. **Revista Árvore**, Viçosa, v.2, n.1, p.57-71, 1978.

DACOSTA, L. P. E. **Relações biométricas em povoamentos jovens de *Pinus taeda* L. na província de Corrientes, República da Argentina.** 128p. Tese (Doutorado em Engenharia Florestal) - Universidade Federal de Santa Maria, Santa Maria, 2008.

ENCINAS, J. I**.** et al. I**dade e crescimento das árvores**. Brasília, UFB, 2005, v.7, 25p (Comunicações Técnicas Florestais, n.1).

HIGA, A. R.; CARVALHO, P. E. R de. Sobrevivência e crescimento de doze espécies de eucalipto em Dois Vizinhos, Paraná. **Silvicultura**, São Paulo, n. 42, pt. 3, p. 459-461; 1990. Edição dos Anais do 6º Congresso Florestal Brasileiro, 1990, Campos do Jordão.

INOUE, M. T;. FIGUEIREDO FILHO, A.; LIMA, R. Influência do espaço vital de crescimento na altura e diâmetro de *Pinus taeda* L. **Scientia Forestalis**. Piracicaba, v. 39, n. 91, p. 377-385, 2011.

KRONKA, F. J. N. et al. **A Cultura do Pinus no Brasil.** São Paulo: Sociedade Brasileira de Silvicultura, 2005.

LATORRACA, J. V. de F.; ALBUQUERQUE, C. E. C de. Efeito do rápido crescimento sobre as propriedades da madeira. **Floresta e Ambiente**. v. 7, n. 1, p. 279-291, jan./dez. 2000.

LELES, P. S dos S.; REIS, G. G dos. FEREIRA REIS, M das G.; MORAIS, E. J de. Crescimento, produção e alocação de matéria seca de *Eucalyptus camaldulenis e E. pellita* sob diferentes espaçamentos na região de Cerrado, MG. **Scientia Forestalis**, n.59, p.77-87,2001.

LIMA, R. **Crescimento de *Pinus taeda* L. em diferentes espaçamentos**. 120p. Dissertação (Mestrado em Ciências Florestais) - Universidade Estadual do Centro – Oeste, Irati, 2010.

MORAIS, V. de M. **Dinâmica de crescimento de Eucalipto clonal sob diferentes espaçamentos, na região noroeste do Estado de Minas Gerais.** 74p. Dissertação (Mestrado em Engenharia Florestal) - Universidade Federal de Lavras, Lavras, 2006.

OLIVEIRA NETO, S. N. et al. Produção e distribuição de biomassa em *Eucalyptus camalduelnsis* Dehn. em resposta à adubação e ao espaçamento.**Revista Árvore,** v.27, n.1, p.15-23, 2003.

OLIVEIRA NETO, S. N de., REIS, G. G dos.; REIS, M das G. F.; LEITE, H. G.; NEVES, J. C. L. Crescimento e distribuição diamétrica de *Eucalyptus camaldulensis* em diferentes espaçamentos e níveis de adubação na região de Cerrado de Minas Gerais. **Revista Floresta**, Curitiba, PR, v. 40, n. 4, p. 755-762, 2010.

PALUDZYSZYN FILHO, E. ; SANTO, P. E. T.; FERREIRA, C. A. **Eucaliptos indicados para plantio no estado do Paraná.** Colombo-PR: Embrapa Florestas, 2006. 45p. (Embrapa Florestas, Documentos, 129).

PAULESKI, D. T. **Influência do espaçamento sobre o crescimento e a qualidade da madeira de *Pinus taeda* L.** 198p. Tese (Doutorado em Engenharia Florestal) – Universidade Federal de Santa Maria, Santa Maria, 2010,

PEREIRA, J. C. D.; STURION, J. A. HIGA, A. R.; HIGA, R. C. V.; SHIMIZU, J. Y. **Características da madeira de algumas espécies de eucalipto plantadas no Brasil.** Colombo-PR: Embrapa Florestas, 2000. 113 p. (Embrapa Florestas. Documentos, 38).

REINER, D. A.; SILVEIRA, E. R.; SZABO, M. S. O uso de Eucalyptus em diferentes espaçamentos como alternativa de renda e suprimento da pequena propriedade na região Sudoeste do Paraná. **Synergismus Scyentifica**. Pato Branco,v.1, 2011.

REZENDE, G. C de.; SUITER FILHO, W.; MENDES, C. J.; MORAIS, T. S de A. Novas técnicas de espaçamentos para ***Eucalyptus*** spp. IPEF,1981.(Circular Técnica Nº 130).

RODRIGUES, A.L. **Dinâmica e correlações ambientais em um remanescente de Floresta Ombrófila Mista aluvial em Guarapuava.** Dissertação (Mestrado em Ciências Florestais), Universidade Estadual do Centro-Oeste, Irati, 2012.

SANQUETA, C. R.; MORA, A. L.; BORSATO, R.; VIDAL, M. A. S.; PEIXOTO, A. M. CHIANDARA, R. Efeito do espaçamento de plantio em reflorestamentos II. *Pinus taeda* L. em Jaguariaíva – PR. **Revista Acadêmica: ciências agrárias e ambientais**, Curitiba, v.1, n.1, p. 55-61, 2003.

SCOLFORO, J. R. S. **Manejo Florestal.** Lavras: Universidade Federal de Lavras – UFLA/FAEPE. 438p. 1998.

SCHNEIDER, P. R. **Introdução ao manejo florestal.** Santa Maria: UFSM, CEPEF, FATEC. 1993. 348p.

SHIMOYAMA, V. R. de S.; BARRICHELO, L. E. G. Densidade básica da madeira, melhoramento e manejo florestal. **IPEF,** p. 1-22, 1989.(Série Técnica).

THOMAZ, E. L.; VESTENA, L. R. **Aspectos Climáticos de Guarapuava – PR**, Guarapuava: UNICENTRO, 2003.

TONINI, H. **Crescimento e produção de Clones de *Eucalyptus saligna* Smith, na Depressão Central e Serra do Sudeste, Rio Grande do Sul.** 214p. Tese (Doutorado em Engenharia Florestal). Universidade Federal de Santa Maria. Santa Maria, 2003