



Revista Árvore

ISSN: 0100-6762

r.arvore@ufv.br

Universidade Federal de Viçosa
Brasil

Alvarenga Alves de, Amauri; Castro, Evaristo Mauro de; Lima Castro, Érico de; Magalhães Murad, Marcelo

Effects of different light levels on the initial growth and photosynthesis of croton urucurana baill. in southeastern Brazil

Revista Árvore, vol. 27, núm. 1, janeiro-fevereiro, 2003, pp. 53-57
Universidade Federal de Viçosa
Viçosa, Brasil

Available in: <http://www.redalyc.org/articulo.oa?id=48827107>

- How to cite
- Complete issue
- More information about this article
- Journal's homepage in redalyc.org

redalyc.org

Scientific Information System
Network of Scientific Journals from Latin America, the Caribbean, Spain and Portugal
Non-profit academic project, developed under the open access initiative

EFFECTS OF DIFFERENT LIGHT LEVELS ON THE INITIAL GROWTH AND PHOTOSYNTHESIS OF *Croton urucurana* Baill. IN SOUTHEASTERN BRAZIL¹

Amauri Alves de Alvarenga², Evaristo Mauro de Castro², Érico de Castro Lima Junior³ e
Marcelo Murad Magalhães⁴

ABSTRACT - Four levels of shading (full sunlight (0%), 30, 50, 70% of solar radiation interception on growth, chlorophyll concentration and photosynthetic rate were studied in *Croton urucurana* Baill., a pioneer plant species. This species seedlings are of potential interest for reforestation projects and recovery of degraded areas. The seedlings were grown in pots containing soil and sand (2:1) and later transferred to plastic bags of 3 dm³ and submitted to different levels of shading (30, 50, 70%) of solar radiation and full sunlight, as control. The experimental design was completely randomized with five replicates and each experimental unit was composed of five plants. The results suggest that plants submitted to 70% shading showed higher dry weight accumulation in leaf and root, and higher plant height and leaf area. However, the seedlings root system showed higher dry biomass under full sunlight. It was observed a tendency to increase chlorophyll concentration and to decrease photosynthetic rate with the increase of the shading level.

Key words: Light, initial growth, photosynthesis and *Croton urucurana* Baill.

EFEITO DE DIFERENTES NÍVEIS DE RADIAÇÃO SOBRE O CRESCIMENTO INICIAL E FOTOSSÍNTESE DE PLANTAS DE *Croton urucurana* Baill. NA REGIÃO SUDESTE DO BRASIL

RESUMO - Estudou-se o efeito de quatro níveis de sombreamento: pleno sol (0%), 30, 50 e 70% de interceptação da radiação solar sobre o crescimento, a concentração de clorofilas e a taxa fotossintética em mudas de *Croton urucurana*, uma espécie pioneira. Esta espécie é considerada como potencial para projetos de reflorestamento e enriquecimento de áreas perturbadas, porém informações ecofisiológicas a seu respeito são escassas. Com o objetivo de caracterizar o seu comportamento diante dessa problemática, mudas desta espécie foram produzidas em tubete contendo substrato constituído de terra e areia (2:1) e, posteriormente, transplantadas para sacos de plástico, sendo, em seguida, submetidas a diferentes níveis de sombreamento (pleno sol, 30, 50 e 70%), com uso de sombrites. O delineamento empregado foi o inteiramente casualizado (DIC), com cinco repetições, sendo cada unidade experimental composta de quatro plantas. Os resultados demonstraram que as mudas submetidas a 70% de sombreamento obtiveram maior acúmulo de biomassa de folha, caule, maior altura e maior área foliar. Todavia, o sistema radicular das mudas apresentou maior acúmulo de biomassa quando submetidas a pleno sol. Foram verificadas também tendência de aumento na concentração de clorofila e queda na atividade fotossintética com o aumento do sombreamento.

Palavras-chave: Luz, crescimento inicial, fotossíntese e *Croton urucurana* Baill.

¹ Recebido para publicação em 19.2.2001.

Aceito para publicação em 19.2.2003.

² Professores do Dep. de Biologia da Universidade Federal de Lavras - UFLA, Caixa Postal 37, 37200-000 Lavras-MG; ³ Estudante de Agronomia da UFLA, Bolsista do PIBIC/CNPq; ⁴ Bolsista Recém-Doutor da FAPEMIG, Dep. de Biologia da UFLA.

1. INTRODUCTION

Brazil has a great flora diversity, but information related to plant cycle propagation system and seedling production is scarce.

Since the last decade, a great emphasis has been given to studies on the preservation of natural resources, mainly riverside forests and other critical sites near river margins and hydroelectric reservoirs, fountains and river upstreams. In such areas, where the anthropic action is negatively present, there is a need to implement ecophysiological studies of native species that can be potentially used in revegetation programs aimed to minimizing the problems caused by indiscriminate deforestation, erosion of river margins and other water sources. Within this context, further research regarding physiology, ecology and forestry is an important step. In order to adopt these practices, seedling formation with high quality is very important.

Among other factors, light plays an important role in the environment, controlling the process associated with dry matter accumulation (Vilela and Ravetta, 2000) and thus contributing to plant growth. The species' adaptative plasticity to solar radiation depends on the adjustment of the photosynthetic apparatus, in order to render radiant energy conversion in carbohydrates highly efficient and, consequently, to promote higher growth (Inoue and Torres, 1980; Engel, 1989; Villela and Ravetta, 2000). Jones and McLeod (1990), using 5, 20, 53 and 100% of daylight, found a higher production and dry matter accumulation in *Sapium sebiferum* Roxb., when the seedlings were submitted to full sunlight; thus, for *Fraxinus caroliniana* Mill., the maximum dry matter accumulation was reached at 53% of sunlight.

Engel (1989) studying four levels of shading (0, 42, 68 and 82%) in four forestry species in Brazil, observed that growth rates of *Tabebuia avellanae* Lorentz ex Griseb. during the seedling phase showed the highest means in height, dry weight of the aerial part and leaf area at 82% shading (18% of luminosity).

Studies on the influence of solar radiation in photosynthesis, morphology and plant development of *Garcinia mangostana* L., developed in Australia during two years, showed that seedling subjected to environment with decreasing shading, showed a decrease in leaf size, increase in leaf thickness and low specific leaf area. Less shaded seedlings showed a higher dry matter partitioning

to root than shaded seedlings and reduced leaf area and increased leaf number, resulting in a more compact appearance in less shaded leaves (Wiebel et al., 1994; Marler et al., 1994).

Leaf area is a commonly used characteristic in evaluating tolerance of shaded species. Generally, the increase of leaf area with shading is one of the ways used to increase photosynthetic surface, ensuring a more efficient yield in low light intensities, and consequently, compensating the low photosynthetic rates per leaf area, a characteristic of shaded leaves (Jones & McLeod, 1990).

Several external and internal factors affect chlorophyll metabolism, thus leaf content can vary considerably. According to some authors, light is considered one of the factors associated with chlorophyll metabolism (Whatley and Whatley, 1982; Brand, 1997). According to Kramer and Kozlowski (1979), chlorophyll is constantly synthesized and destroyed (photooxydation) in the presence of light. Under intense radiation, the degenerative process is very active. On the other hand, chlorophyll leaf concentration seems to increase under shading conditions (Brand, 1997; Alvarenga et al., 1998; Naves, 1993), and balance is established under a relative radiation intensity.

This paper aimed to study the relations between shading levels with photosynthetic behavior and young plant growth of *Croton urucurana*, a pioneer species that can be used in reforestation and revegetation programs.

2. MATERIAL AND METHODS

This study was carried out at the Biology Department of the UFLA, Minas Gerais, Brazil, under nursery conditions. The seeds were collected from a standard crop located in a swamp area nearby Lavras.

The seedlings were grown in pots containing soil and sand (2:1) with 750 g of sulfate ammonia and 375 g of potassium chloride. The seedlings remained in these pots for 110 days, after which time they were transferred to plastic bags with 3 dm³, remaining for more 120 days. The plants were then transferred to a greenhouse providing three distinct shading levels (30, 50, and 70%) and full sunlight as control. The experimental design was completely randomized with five replicates and each plot consisted of four plants. The data obtained was submitted to variance analysis and the means were evaluated by the Tukey test.

The dry matter weight of the different organs was obtained at 70 °C until constant weight was reached. To determine leaf area, the 3rd and 4th pairs of fully expanded leaves were used. The disc method, correlating dry weight of the discs with the dry weight of the leaves (Huerta, 1962) was used. For chlorophyll quantification around 500 mg of leaf discs were removed from the 3rd and 4th fully expanded leaves. The tissue was macerated with 5 ml of acetone (80%); the mixture was centrifuged at 4000 g for 10 min, and the supernatant collected. Two more extractions were conducted in the residue, followed by centrifugation. The total chlorophyll was quantified in the combined extract according to Arnon (1949).

The photosynthetic rate was determined in the 3rd fully expanded leaf from the apex between 10 and 11:30 am, using an infrared gas analyzer IRGA, ADC model.

3. RESULTS

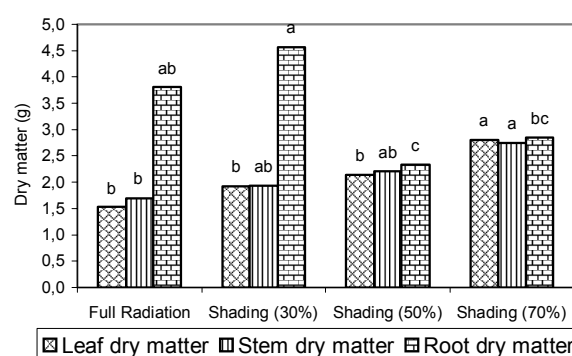
The results shown in Figure 1 suggest that the seedlings submitted to 70% shading accumulated more dry weight in the leaf and stem than those cultivated under full sunlight. However, no differences were observed in the seedlings cultivated under 30 and 50% shading, compared to full sunlight. Less shaded plants tended to concentrate the dry weight in roots in relation to more shaded plants. An increase in leaf area in plants submitted to higher shading levels was observed in relation to plant growth under full sunlight (Figure 2).

In relation to height growth the plantlets were found to have reached higher values under shaded conditions when compared with full sunlight (Figure 3). Regarding leaf chlorophyll concentration, an increment in these photoreceptors was observed with the increase of shading (Figure 4), reaching the highest values in plants cultivated under 50 and 70% shading. The photosynthetic rate was found to be approximately constant under full sunlight and in levels up to 50% of shading, with a drop in higher shading levels (Figure 5).

4. DISCUSSION

Considering the results relating to the development of the aerial part, Figures 1, 2, and 3 show that the “Sangra D’água” seedlings showed the best performance when submitted to 70% shading, compared with those cultivated under full sunlight. This special performance under lower radiation intensities was because the plants showed higher dry matter accumulation in the leaves and

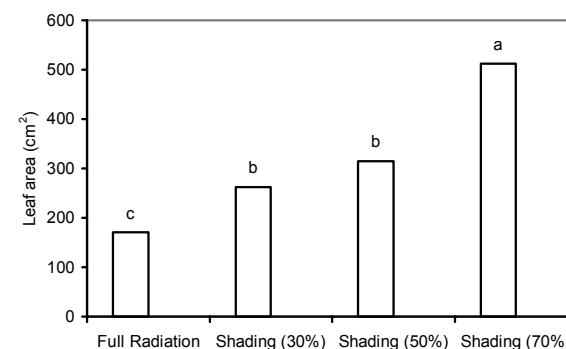
stem, higher height and leaf area values, and better growth of the aerial part. The results obtained showed a tendency similar to those found by Engel (1989) working with four levels of shading (0, 42, 68, and 82%) in four native species in the state of São Paulo. This author also obtained higher growth rates under nursery conditions with 82% shading.



Means followed by the same letter do not differ by the Tukey test at 5%.
Médias seguidas pela mesma letra não diferem entre si pelo teste de Tukey, a 5%.

Figure 1 – Dry matter mean values of *Croton urucurana* Baill., submitted to different levels of shading.

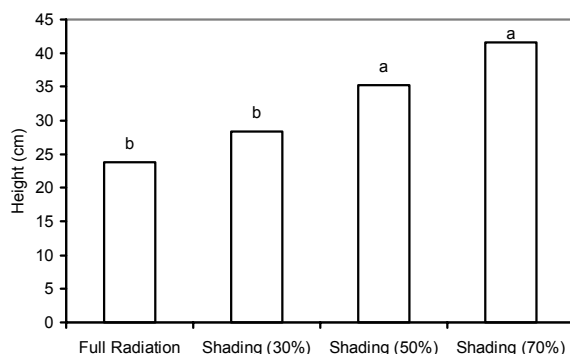
Figura 1 – Valores médios de matéria seca de *Croton urucurana* Baill. submetidas a diferentes níveis de sombreamento.



Means followed by the same letter do not differ by the Tukey test at 5%.
Médias seguidas pela mesma letra não diferem entre si pelo teste de Tukey, a 5%.

Figure 2 – Foliar area mean values of *Croton urucurana* Baill. submitted to different levels of shading.

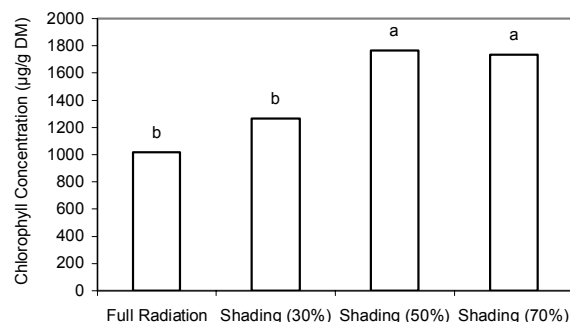
Figura 2 – Valores médios de área foliar de *Croton urucurana* Baill. submetidas a diferentes níveis de sombreamento.



Means followed by the same letter do not differ by the Tukey test at 5%.
 Médias seguidas pela mesma letra não diferem entre si pelo teste de Tukey, a 5%.

Figure 3 – Height mean values of *Croton urucurana* Baill. submitted to different levels of shading.

Figura 3 – Valores médios de altura de *Croton urucurana* Baill. submetidas a diferentes níveis de sombreamento.



Means followed by the same letter do not differ by the Tukey test at 5%.
 Médias seguidas pela mesma letra não diferem entre si pelo teste de Tukey, a 5%.

Figure 4 – Chlorophyll concentration mean values of *Croton urucurana* Baill. submitted to different levels of shading.

Figura 4 – Valores médios de concentração de clorofilas de *Croton urucurana* Baill. submetidas a diferentes níveis de sombreamento.

Regarding seedlings grown under full sunlight compared with those grown under shading, a higher increase in root dry weight was verified in relation to the aerial part (Figure 1). A reduction in leaf area, and a higher photosynthetic efficiency in these plants and higher translocation of photoassimilates to roots (Figures 1, 2 and 5) were observed. Young plants of *Garcinia mangostana* L. showed a similar behavior, reduced leaf area and higher dry weight translocation to root system

under decreasing shading conditions (Wiebel et al., 1994).

Analyzing plant performance related with growth of the aerial part under increasing shading conditions in a nursery house (Figures 1, 2, and 3), one can suggest this species has a morphological mechanism to make a better use of radiation, in addition of being a pioneer species (Lorenzi, 1992).

Leaf chlorophyll was found to increase with the increase of shading (Figure 4), up to 70%. According to Kramer and Koslowisk (1979), leaf chlorophyll levels are controlled by light. In elevated radiation intensities, chlorophyll molecules are susceptible to photo oxidation and the equilibrium is reached in lower radiation levels. Thus, shaded leaves have higher chlorophyll levels than leaves grown under full sunlight. Similar results were obtained by Alvarenga et al. (1998), using native species seedlings of *Guarea guidonia* (L.) Sleumer.

No correlations were verified between chlorophyll concentration and photosynthetic rate, with the plants under shading conditions offsetting the low photosynthetic rates, increasing leaf area, and causing higher accumulation rates of dry weight in the aerial part (Figure 1). In *Kalmia latifolia* L. plants, Brand (1997) obtained similar results for leaf chlorophyll, although plant characteristics such as height, leaf area, leaf and stem reduced linearly. It can be concluded that *Croton urucurana* Baill., besides being considered a pioneer species, showed a better development when exposed to shading at 70%. Further studies are suggested on this plant in mixed crops in degraded areas near hydroelectric plants and on river margins to avoid erosion.

5. ACKNOWLEDGEMENTS

The authors thank FAPEMIG (Minas Gerais State Foundation for Research Development) for the financial support. Prof. Amauri also acknowledges CNPq for his Research Scholarship.

6. REFERENCES

- ALVARENGA, A. A. et al. Desenvolvimento de mudas de *Guarea* [*Guarea guidonea* (L.) Sleumer], **Daphne**, v. 8, n. 3, p. 22-26, 1998.
- ARNON, I. D. Copper enzymes in isolated chloroplasts, polyphenoloxidase in *Beta vulgaris*. **Plant Physiology**, v. 24, n. 1, p. 1-15, 1949.

BRAND, M. H. Shade influences plant growth, leaf color and chlorophyll content of *kalmia latifolia* L. cultivars. **HortScience**, v. 32, n. 2, p. 206-208, 1997.

ENGEL, V. L. **Influência do sombreamento sobre o crescimento de mudas de essências nativas, concentração de clorofila nas folhas e aspecto de anatomia**. 1989. 202 f. Dissertação (Mestrado em Ciências Florestais) – Escola Superior de Agricultura “Luiz de Queiroz”, Piracicaba, 1989.

HUERTA, A. Comparación de los métodos de laboratorio y de campo para medir el área foliar del café. **Cenicafé**, v. 13, n. 1, p. 33-42, 1962.

INOUE, M. T.; TORRES, D. V. Comportamento de mudas de *Araucária angustifolia* (Bert.) O. Ktze, em dependência da intensidade luminosa. **Revista Floresta**, v. 10, n. 1, p. 7-11, 1989.

JOHANSEN, D. A. **Plant microtechnique**. New York: McGraw-Hill, 1940. 523 p.

JONES, R. H.; McLEOD, K. W. Growth and photosynthetic responses to a range of light environments in Chinese tallow tree and Carolina ash seedlings. **Forest Science**, v. 36, n. 4, p. 851-862, 1940.

KRAMER, P. J.; KOSLOWSKI, T. **Physiology of wood plants**. New York: Academic Press, 1979. 811 p.

LORENZI, H. **Manual de identificação e cultivo de plantas arbóreas nativas do Brasil**. Árvores brasileiras. Nova Odessa: Plantarum, 1992. 352 p.

MARLER T. E.; SCHAFFER B.; CRANE J. H. Developmental light level affects growth, morphology, and leaf physiology of young carambola trees. **Journal of the American Society for Horticultural Science**, v. 119, n. 4, p. 711-718, 1994.

NAVES, V. L. **Crescimento, distribuição de matéria seca, concentração de clorofila e comportamento estomático de mudas de três espécies florestais submetidas a diferentes níveis de radiação fotossinteticamente ativa**. 1993. 76 f. Dissertação (Mestrado em Agronomia/Fisiologia Vegetal) – Universidade Federal de Lavras, Lavras, 1993.

VILELA A. E.; RAVETTA, D. A. The effect of radiation on seedling growth and physiology in four species of *Prosopis* L. (Mimosaceae). **Journal Arid Environmental**, v. 44, n. 4, p. 415-423, 2000.

WHATLEY, F.; WHATLEY, F. R. **A luz e a vida das plantas**. Temas de Biologia. São Paulo: EDUSP, 1982. v. 30. 101 p.

WIEBEL, J. et al. Influence of irradiance on photosynthesis, morphology and growth of mangosteen (*Garcinia mangostana* L.) seedlings. **Tree Physiology**, v. 14, n. 3, p. 263-274.