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AVALIAÇÕES MORFOFISIOLÓGICAS EM TRÊS CULTIVARES DE CAFÉ CRESCENDO EM DUAS CONDIÇÕES DE LUMINOSIDADE

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Versão Final

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Abstract

Coffee is one of the main agricultural products traded in the world and species *Coffea arabica* L. and *Coffea canephora* Pierre ex A. Froehner are the most cultivated. They are plants that can be grown in environments of different shading conditions, but with productivity and morphophysiological characteristics that can be altered. The objective of the present study was to evaluate the effect of shading on growth, gas exchange and heat tolerance of photosystem II (PSII) in three coffee cultivars, Mundo Novo and Catuaí Amarelo (*C. arabica*) and Conilon (*C. canephora*). We hope that: I - the varieties are capable of acclimatization to the different shading conditions, with important morphophysiological alterations for photosynthesis; II - plants in sun-exposed environments showed higher tolerance of photosynthetic apparatus to heat; III - Conilon variety will have the most heat tolerant photosynthetic apparatus, as *C. canephora* originates from warm habitat. To test these hypotheses, plants of the three varieties were grown in containers with 3 liters of soil under two light conditions (Sun and Shade), with climate monitoring, constant hydration and nutrient replacement. Plant growth parameters (leaf number, plant growth and stem diameter), gas exchange (from light response curves), stomatal traits, pigment content and PSII heat tolerance were evaluated. Temperature and humidity varied significantly between growing conditions. In general, coffee trees growing in sun-exposed environmental conditions presented higher leaf number, higher density and stomatal index, higher gas exchange rates and other parameters evaluated by light response curves. In Shade condition the plant size, stomata size and chlorophyll content were higher. About the thermotolerance of PSII, Conilon was the most heat tolerant variety, and plants in Shade condition plants were more thermotolerant. Growing in a brighter environment may be beneficial to plant growth and photosynthetic rates of Mundo Novo and Catuaí Amarelo, varieties of C. arabica. However, for Conilon (*C. canephrora*), the microclimate variation in Sun condition can be detrimental to PSII growth and thermotolerance in this variety. According to the morphophysiological responses found, coffee varieties generally exhibit similar adaptations for each growing condition, but each variety has distinct responses even if they belong to the same species. Thus, the cultivation of varieties must respect their adaptive limitations to ensure a good physiological status of the plants and consequently good productivity.

Key-words: *Coffea arabica. Coffea canephora.* Temperature. Gas exchange. Shading. Microclim. Thermotolerance.

Resumo

O café é um dos principais produtos agrícolas comercializados no mundo sendo as espécies *Coffea arabica* L. e *Coffea canephora* Pierre ex A. Froehner as mais cultivadas. São plantas que podem ser cultivadas em ambientes com distintas condições de sombreamento, porém com produtividade e características morfofisiológicas podendo ser alteradas em cada condição de luminosidade. O objetivo do presente estudo foi avaliar o efeito do sombreamento no crescimento, trocas gasosas e tolerância do fotossistema II (PSII) ao calor em três cultivares de café, Mundo Novo e Catuaí Amarelo (*C. arabica*) e Conilon (*C. canephora*). Esperamos que: I - as variedades são capazes de aclimatação às distintas condições de sombreamento, com alterações morfofisiológicas importantes para fotossíntese; II - plantas em ambientes mais ensolarados apresentaram maior tolerância do aparato fotossintético ao calor; III – a variedade Conilon terá o aparato fotossintético mais tolerante ao calor, pois *C. canephora* é originaria de habitat quente. Para testar essas hipóteses, plantas das três variedades foram crescidas em recipientes com 3 litros de terra sob duas condições de luminosidade (Sol e Sombra), havendo monitoramento climático, constante hidratação e reposição de nutrientes. Foram avaliados parâmetros de crescimento das plantas (número de folhas, crescimento e diâmetro do caule), trocas gasosas (a partir de curvas de resposta a luz), características estomáticas, teor de pigmentos e termotolerância do PSII. Temperatura e umidade variaram significativamente entre as condições de crescimento. No geral, cafeeiros crescendo em condição ambiental mais ensolarada apresentaram, maior numero de folhas, maior densidade e índice estomático, maiores taxas de trocas gasosas e demais parâmetros avaliados pelas curvas de resposta a luz. Em condição sombreada o tamanho da planta, tamanho dos estômatos e o teor de clorofila foram maiores. Acerca da termotolerância do PSII, Conilon foi a variedade mais tolerante ao calor, sendo que nessa variedade plantas de ambiente mais sombreados foram mais termotolerantes. Crescer em ambiente mais luminoso pode ser benéfico ao crescimento das plantas e taxas fotossintéticas de Mundo Novo e Catuaí Amarelo, variedades de *C. arabica*. Porem para Conilon (*C. canephrora*), a variação microclimática existente no ambiente mais ensolarado pode ser prejudicial ao crescimento e termotolerância do PSII nessa variedade. De acordo com as respostas morfofisiológicas encontradas, as variedades de café exibem no geral adaptações semelhantes para cada condição de crescimento, porem cada variedade tem respostas distintas mesmo pertencendo a mesma espécie. Sendo assim, o cultivo das variedades deve respeitar suas limitações adaptativas para garantir um bom status fisiológico as plantas e consequentemente boa produtividade.

Palavras-chave: *Coffea arabica. Coffea canephora.* Temperatura. Trocas Gasosas. Sombreamento. Microclima. Termotolerância.

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Figure 3. Example of stomatal structure and epidermis cells in abaxial surface of the coffee varieties growth in the sun (left column) and shade (right column) conditions. Catuaí Amarelo is represented by **(a)** and **(b)**; Mundo Novo is represented by **(c)** and **(d);** Conilon is represented by **(e)** and **(f)**. Letters inside the structures mean: ST, stomatal; EP, epidermis cells. Scale bars = *200 µm*.

Figure 4. Result of SPAD index and DMSO pigments quantification are shown in the following graphs: SPAD readings **(a)**, Total Chlorophylls content **(b)**, Chlorophyll a/b ratio **(c)**, Chlorophyll/Carotenoid ratio **(d)** and Carotenoids content **(e)** in coffee varieties in each shading condition (sun and shade). Vertical bars are mean ± SE. Different letters in columns indicate statistically significant differences in that variety (n = 10, $p < 0.05$, Two-way ANOVA and Tukey test).

Figure 5. Relationship between stomatal traits and gas exchange. Significant relationships are shown for P_{Nmax} and SD (**A**), and P_{Nmax} and SI (**B**), *E* and SD (**C**) and *gs* and SD (**D**). Filled symbols represent the varieties in the shade and open symbols the varieties in the sun. Each symbol represents a variety, square (Conilon), triangle (Mundo

Novo) and circle (Catuaí Amarelo).

Figure 6. PSII thermotolerance of coffee varieties under different shading conditions, using two methodologies, ramping assay with results of T_{50} **(a)** and in static assay with results of H_{50} **(b)**. Means ± SE followed by the same uppercase letter do not differ significantly from one another for sun and shade treatments within varieties. (n = 5, $p < 0.05$, Two-way ANOVA and Tukey test).

Summary

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