Available online at http://www.journalijdr.com

ISSN: 2230-9926

International Journal of Development Research
Vol. 09, Issue, 08, pp. 28911-28914, August, 2019

RESEARCH ARTICLE OPEN ACCESS

ANALYSIS FOSSINTETIC PIGMENTS OF GENOTYPE PS1319 COCOA SEEDLINGS SUBMITTED TO DIFFERENT IRRIGATION DEPTH

Vinicius de Souza Oliveira[1*], Sophia Machado Ferreira da Silva[2], Stefany Sampaio Silveira[2], Robson Prucoli Posse[2], Laís Gertrudes Fontana Silva[2], Carlos Alberto Spaggiari Souza[3], Omar Schmildt[1] and Edilson Romais Schmildt[1]

[1]Federal University of Espírito Santo – Center Noth of Espírito Santo, São Mateus, Espírito Santo, Brazil
[2]Federal Institute of Espírito Santo – Campus Itapina, Colatina, Espírito Santo, Brazil
[3]Cacao Research Station "FilogônioPeixoto" - CEPLAC, Linhares, Espírito Santo, Brazil

ARTICLE INFO

Article History:
Received 08th May, 2019
Received in revised form
17th June, 2019
Accepted 03rd July, 2019
Published online 28th August, 2019

Key Words:
Theobroma cacao L.; Hydrical stress; Water availability; Photosynthetic rate.

ABSTRACT

Water availability is one of the main factors that affect the production of high quality cocoa (*Theobroma cacao* L.) seedlings. Determination of photosynthetic pigment content is important because it changes when plants are subjected to stress. Thus, the objective of this study was to evaluate the effect of different irrigation depths on the photosynthetic pigments content in genotype PS1319 cocoa seedlings. For this, five treatments consisting of different irrigation depths were applied: 4, 6, 8, 10 and 12 mm d^{-1} in a completely randomized experimental design with 20 seedlings per treatment. From leaf discs, photosynthetic pigments were extracted and analyzed by spectrophotometer to obtain the content of chlorophyll *a*, chlorophyll *b* and carotenoid. The total chlorophyll content was obtained by summing the chlorophyll *a* content and chlorophyll *b* content. The irrigation depth of 7.97 mm d^{-1} is the most efficient, since for practical and economic purposes it consumes the least amount of water, being the most recommended for the cocoa genotype PS1319 when it is desired to obtain better yields of pigment contents. photosynthetic.

Citation: Vinicius de Souza Oliveira, Sophia Machado Ferreira da Silva *et al.* 2019. "Analysis fossintetic pigments of genotype ps1319 cocoa seedlings submitted to different irrigation depth", *International Journal of Development Research*, 09, (08), 28911-28914.

INTRODUCTION

Belonging to the Malvaceae family, the cocoa tree (*Theobroma cacao* L.) is a tropical species originating from the Amazon basin. Its economic importance varies in miscellaneous forms, from the production of chocolate from its almonds, as well as other by-products such as honey, pulp, animal feed, fertilizers, jellies, butter and cocoa powder (Lahive*et al*., 2019; Lima *et al*., 2018). Among the main factors that interfere with the production of quality seedlings is water availability (Fontes*et al*., 2008). Thus, water demand in the initial phase of plants is of paramount importance as their survival depends directly on the amount of water available (Damatta; Ramalho 2006). When handled improperly, either too little or too much water can cause problems for plants. In small amounts it reduces cell expansion and nutrient absorption causing limitations in photosynthesis (Taiz*et al*., 2017). In excess, it creates an environment conducive to the onset of disease, promotes nutrient leaching, and generates social and environmental problems due to waste of water resources (Lopes *et al*., 2007). Studies showing the morphological behavior of several plant species such as: *Carica papaya* L. (Oliveira *et al*., 2018); *Theobroma cacao* L. (Posse *et al*., 2018) and *Coffeacanephora*(Pagoto; Oliveira, 2019) have been reported in the literature. However, studies evaluating the physiological conditions of seedlings are excessive. The measurement of photosynthetic pigments is of great importance since the proportion of chlorophyll and carotenoid contents is altered when plants are subjected to some type of stress (Young; Britton, 1990), such as water stress. Water availability is responsible for photosynthetic rate variations, which directly implies plant growth and productivity (Fontes *et al*., 2008). Thus, the objective of this

Corresponding author: Vinicius de Souza Oliveira,
Federal University of Espírito Santo – Center Noth of Espírito Santo, São Mateus, Espírito Santo, Brazil

study was to evaluate the effect of different irrigation depths on the content of photosynthetic pigments, chlorophyll *a*, chlorophyll *b*, total chlorophyll and carotenoids in cocoa seedlings genotype PS1319.

MATERIAL AND METHODS

The study was conducted in the horticultural sector of the Federal Institute of Espirito Santo, Campus Itapina, located in the municipality of Colatina, northern Espírito Santo State, Brazil, with the following geographic coordinates: 19° 32' 22" South latitude and 40° 37' 50' 'west longitude. Between October 20 and December 15 of 2017. The climate of the region according to the köppen classification is tropical AW (humid tropical), with rainfall in the summer and dry winter (Alvares *et al*., 2014). The experiment was carried out in an agricultural greenhouse where five individual environments with 2.20 m long and 1.10 m wide were covered with transparent plastic canvas on the sides. Each of these environments consisted of six GREEN MIST (NaanDanJain®) anti-fog nebulizers, located 1 m above the seedlings and spaced 0.8 m apart. Irrigation frequency was distributed over 10 hours per day, with working pressure of 2 kgf cm^{-2}, individually controlled and 0.5 cv centrifugal pump. The treatments consisted of the application of five irrigation blades: 4, 6, 8, 10 and 12 mm d^{-1}. The experimental design was completely randomized with 20 seedlings per treatment. The seedlings were produced in tubes with a volume of 280 cm^3. Each tube was filled with commercial substrate Tropstrato HT® Vegetables and Osmocote Plus® 15-9-12 (3M) at a dosage of 3 g $tube^{-1}$, with the following chemical composition: N = 15% (7% ammoniacal and 8% nitrate), P_2O_5 = 9%, K_2O = 12%, Mg = 1,3%, S = 5,9%, Cu = 0,05%, Fe = 0,46%, Mn = 0,06% and Mo = 0.02%. The seeds used were from the genotype PS1319 cocoa, obtained from the experimental station of the "FilogônioPeixoto" Cocoa Plantation Executive Committee, located in the municipality of Linhares, state of Espirito Santo, Brazil.

At 55 days after sowing, photosynthetic pigment contents were extracted and quantified from leaf discs of known area of the middle region of leaf D and placed in a test tube containing 3 mL of Dimethyl Sulfoxide, incubated at 70 °C for 20 minutes based on the methodology proposed by Porra*et al*. (1989), After specimen cooling, spectrophotometer readings were taken at 480, 649 and 665 nm to determine chlorophyll *a*, chlorophyll *b* and carotenoid based on the equations of Wellburn (1994). The total chlorophyll content was obtained by summing the chlorophyll *a* content and chlorophyll *b* content. The results were subjected to analysis of variance by the F test at 5% probability. When significant, regression models were adjusted to better explain the effect of the irrigation depth on the characteristics analyzed. The maximum points were obtained from the primary derivative of the regression equations. All statistical analyzes were performed with the aid of R software (R Core Team, 2018).

RESULTS AND DISCUSSION

After the analysis of variance, it was verified that there was a statistical difference ($p < 0.05$) for all the evaluated characteristics, attesting that the irrigation depths interfered with the photosynthetic pigment values present in leaves of cocoa genotype PS1319. Chlorophyll *a* content presented quadratic effect, with R^2 of 0.9264 and maximum point of 572.44 µmol m^{-2} in the irrigation depth of 8.04 mm d^{-1}(Figure 1a). Chlorophyll *b* content had a quadratic behavior and maximum point of 250.35 µmol m^{-2} in the irrigation depth of 7.97 mm d^{-1}, with R^2 of 0.9415 (Figure 1b).

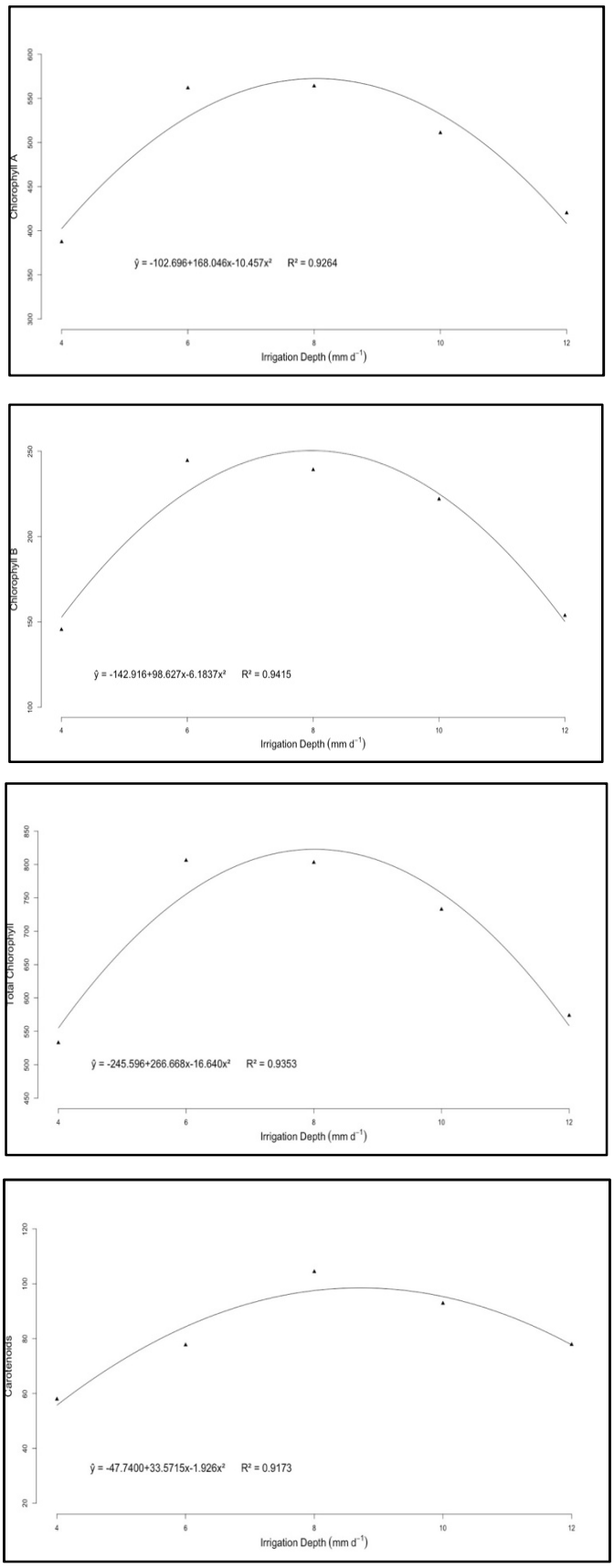

Fig. 1. Chlorophyll *a* content (µmol m^{-2}) (a), chlorophyll *b* content (µmol m^{-2}) (b), total chlorophyll content (µmol m^{-2}) (c) and carotenoids (d) of PS1319 genotype cocoa seedlings submitted to different irrigation depths

Regarding the total chlorophyll content, the adjustment observed was the quadratic model, with a higher value of 822.79 µmol m^{-2} in the irrigation depth of 8.01 mm d-1 and R^2 of 0.9353 (Figure 1c), showing that 93% of the total chlorophyll present in the leaves is influenced by the applied irrigation depth. The carotenoid content presented quadratic effect with maximum point of 98.55 in the irrigation depth of 8.71 mm d^{-1} and R^2 of 0.9173 (Figure 1d). Chlorophyll *a*, chlorophyll *b* and carotenoids, are pigments that are directly involved in photosynthesis. Chlorophyll *a* is related to the photochemical phase of the photosynthesis process, while chlorophyll *b* and carotenoids help in the absorption of light necessary for plant metabolism (Streit*et al*., 2005). As they are essential pigments, higher values for these characteristics are desirable because they are related to the photosynthetic capacity of plants (Cavalcanti Filho, 2017). In general, the largest and smallest irrigation depths were detrimental to the levels of photosynthetic pigments present in leaves of cocoa genotype PS1319. This is because on the fewer irrigation slides the plants have insufficient water availability leading to non-transfer of electrons in the reaction center which results in free radical formation, which in excess damage photosynthetic pigments. In contrast, when the amount of water available to plants exceeds what is needed, an environment of root oxygen deficiency (anoxia) is created, under these conditions plant metabolic activities may be altered (Taiz *et al*., 2017). In such environments, plants change their drain source relationship and reduce the production of photosimilates (Bertolde *et al*., 2012). This reduction in photosynthesis may be related to the decrease in photosynthetic pigments present in the leaves.

The decrease in chlorophyll *a*, chlorophyll *b* and total chlorophyll content in the smallest irrigation depth is related to the limited availability of plant nutrients, mainly nitrogen, which is a fundamental part of the constitution in the chlorophyll molecule. Lack of water creates a stressful environment for plants by limiting nutrient absorption. Similarly, in the largest irrigation depths this decrease in observed values may be associated with a lack of nitrogen, but in this case the cause would be nutrient leaching (Taiz*et al*., 2017). According to Fagundes*et al*. (2015) the misuse of water resources is very common and prolongs the development time of the seedlings, as it directly interferes with the use of fertilizers by the plant. Thus, the establishment of the best amount of water to be used for the formation of cocoa seedlings would increase the availability of this nutrient positively interferes in the production of assimilates by the plant (Correia*et al*., 2005), and consequently improving its performance. Regarding carotenoids, in addition to being advisory pigments for the photosynthesis process, they play a fundamental role as photoprotectors, and their measurement is very important because the excess of light energy is dissipated by these pigments (Taiz*et al*., 2017). They are still responsible for capturing different wavelengths than those received by chlorophyll *a* and chlorophyll *b*, thus, they make the plant more efficient in light uptake (Taiz; Zeiger, 2009). In summary, leaf pigments are linked to the ability of the plant to photosynthesis which consequently leads to its growth and development, as well as the ability to adapt in different environments, thus the combination of advisory pigments such as carotenoids, chlorophyll *a* and chlorophyll *b* give the plant the ability to capture the required amount of solar radiation for the photosynthesis process (Engel;Poggiani, 1991). Thus, the irrigation depths between 7.97 and 8.71 mm d^{-1} presented the best performance for the analyzed characteristics. Therefore, the 7.97 mm d^{-1} depth was the most efficient, since for practical and economic purposes it consumes the smallest amount. being the most recommended when the analyzed characteristics of genotype PS1319 cocoa seedlings are the photosynthetic pigments.

Conclusion

The application of the 7.97 mm d^{-1} irrigation depth is the most efficient for the production of genotype PS1319 cocoa seedlings when it is desired to obtain better yields of photosynthetic pigment contents, as it meets all characteristics analyzed, besides being the one that consumes the lowest. amount of water.

REFERENCES

Alvares, C.A., Stape, J.L., Sentelhas, P.C., Gonçalves, J.L.M. andSparovek, G. 2014. Köppen'sclimateclassificationmap for Brazil. MeteorologischeZeitschrift. 22, pp. 711-728.

Bertolde, F.Z., Almeida, A.A.F., Pirovani, C.P., Gomes, F.P., Ahnert, D., Baligar, V.C. and Valle, R.R. 2012. Physiological and biochemical responses of *Theobromacacao* L. genotypestoflooding. *Photosynthetica*. 50, pp. 447-457.

Cavalcanti Filho, P.F.M. 2017. Silicato de potássio na aclimatação de mudas de *Coffeaarabica* L. Dissertação (Mestrado em Produção Vegetal) – Universidade Estadual do Norte Fluminense Darcy Ribeiro, Centro de Ciências e Tecnologias Agropecuárias.

Core Team. R. 2018. R: a languageandenvironment for statisticalcomputing. Vienna: R Foundation for StatisticalComputing. Vienna, Austria

Correia, C.M., Pereira, J.M.M., Coutinho, J.F., Björn, L.O. and Pereira, J.M.G.T. 2005. Ultraviolet-B radiation and nitrogen affect the photosynthesis of maize: a Mediterraneanfield study. *EuropeanJournalofAgronomy*. 22, pp. 337-347.

Damatta, F.M. and Ramalho, J.D.C. 2006. Impacts of drought and temperature stress oncoffeephysiologyandproduction: a review. *BrazilianJournalofPlantPhysiology*. 18, pp. 55-81.

Engel, V.L. and Poggiani, F. 1991. Estudo da concentração de clorofila nas folhas e seu espectro de absorção de luz em função do sombreamento em mudas de quatro espécies florestais nativas. *Revista Brasileira de Fisiologia Vegetal*. 3, pp. 39-45.

Fagundes, M.C.P., Cruz, M.C.M., Carvalho, R.P., Oliveira, J. and Soares, B.C. 2015. Polímero hidroabsorvente na redução de nutrientes lixiviados durante a produção de mudas de Maracujazeiro amarelo. *Revista Caatinga*. 28, pp. 121-129.

Fontes, R.V., Santos, M.P., Falqueto. A.R., Silva. D.M. and Bacarin, M.A. 2008. Photosynthesisandgrowthchanges in papayaplantsunderdifferentwatersupplyconditions. *Revista Brasileira Agrociência*. 14, pp. 182-187

Lahive, F., Hadley, P. andDaymond, A.J. 2019. The physiological responses of cacao to the environment and the implications for climatechangeresilience. A review. *Agronomy for Sustainable Development*. 39, pp. 1-22.

Lima, S.S., Spaggiari. C.A., Patrocínio. N.G.R.B., Silva. R.A., Santos. R.S.G. andGramacho, K.P. 2018. Favorabilidade, distribuição e prevalência da vassoura-de- bruxa do cacaueiro no estado do Espírito Santo, Brasil. *Agrotrópica.* 30, pp. 5-14.

Lopes, J.L.W., Guerrini, I.A. and Saad, J.C.C. 2007. Qualidade de mudas de eucalipto produzidas sob diferentes lâminas de irrigação e dois tipos de substrato. *Revista Árvore.* 31, pp. 835-843.

Oliveira, V.S., Posse, R.P., Pinheiro, A.P.B., Costa, G.S., Malikouski, R.G., Morais, A.L. andSchmildt, E.R. 2019. Effectofirrigationdepthsonthegrowthofpapayaseedlings. *Journalof Experimental AgricultureInternational*. 29, pp. 1–9.

Pagoto, A.L.R. and Oliveira, V.S. 2019. Initial Development of Clonal Seedlings of Coffeacanephora Submittedto Different Irrigation Depth. *International Journal of Plant & Soil Science*. 28, pp. 1–9.

Porra, R.J., Thompson, W.A. andKriedemann, P.E. 1989 Determinationofaccurateextinctioncoefficientsandsimultaneousequations for assayingchlorophylls a and b extracted with four different solvents: verification of the concentration of chlorophyll standards by atomicabsorptionspectrometry. *Biochimica et Biophysica Acta*. 975 pp. 384-394.

Posse, R.P., Valani, F., Souza, C.A.S., Silveira, S.S., Silva, S.M.F., Partelli, R.L., Trindade, I.M. and Costa, G.S. 2018. Growth and quality of geno type TSH1188 cacaotree seedlings produced under different seasonsandirrigation depths. *Journalof Experimental AgricultureInternational.* 28, pp. 1-17.

Streit, N.M., Canterle, L.P., Canto, M.W. andHecktheuer, L.H.H. 2005. As Clorofilas. *Ciência Rural.* 35, pp. 748-755.

Taiz, L. andZeiger, E. 2009. Fisiologia vegetal. 4. ed. Porto Alegre: Artmed. pp. 722.

Taiz, L., Zeiguer, E., Moller, I.M. and Murphy, A. 2017. Physiologyandplantdevelopment. 6. Ed. Porto Alegre: Artmed. pp. 858.

Wellburn, A.R. 1994. The spectraldeterminationofchlorophylls a and b, as weelas totalcarotenoids, usingvarious solvents with spectrophotometers of different resolution. *Journal of Plant Physiology*. 144 pp. 307-313.

Young, A. and Britton, G. 1990. Carotenoidsand stress. In: Alscher RG, Cummings JR. Stress responses in plants: Adaptationandacclimationmechanisms. NewYork:Wiley-Liss. Pp. 87-112.

****