ISSN 1808-8546 (ONLINE) 1808-3765 (CD-ROM)

PRODUCTIVITY AND QUALITY OF GREEN COCONUT FRUITS UNDER DEFICITIVE IRRIGATION LAGES

AMANDA SORAYA FREITAS CALVET [1]; KARINE SILVA PIMENTEL VIDAL [2]; CLINTON GONÇALVES MOREIRA [3]; FÁBIO RODRIGUES DE MIRANDA [4]; MARLOS ALVES BEZERRA [5]

[1] *PhD in Agronomy/Phytotechnics was obtained from the Federal University of Ceará (UFC). Embrapa Tropical Agroindustry Scholarship. Av. Humberto Monte, s/n, Pici, Fortaleza, Ceará, CEP: 60440-593, Brazil; Email: amandasmfc@gmail.com.*
[2] *Graduate in Biological Sciences, Master's student in Agricultural Engineering, Federal University of Ceará (UFC), Av. Humberto Monte, s/n, Pici, Fortaleza, Ceará, CEP: 60440-593, Brazil; Email: karine3pimentel@gmail.com.*
[3] *Master in Agricultural Engineering, Federal University of Ceará (UFC), Av. Humberto Monte, s/n, Pici, Fortaleza - Ceará, CEP: 60440-593, Fortaleza, Ceará, Brazil; Email: clinton-paraipaba@hotmail.com.*
[4] *PhD in Irrigation and Drainage, Researcher, Embrapa Agroindústria Tropical, Fortaleza, Ceará, Rua Pernambuco, 2270, Pici, Fortaleza, Ceará, CEP: 60511-110, Brazil; E-mail: fabio.miranda@embrapa.br.*
[5] *PhD in Plant Physiology, Researcher, Embrapa Agroindústria Tropical, Fortaleza, Ceará, Rua Pernambuco, 2270, Pici, Fortaleza, Ceará, CEP: 60511-110, Brazil; E-mail: marlos.bezerra@embrapa.br.*

1 RESUMO

A demanda por coco verde tem aumentado bastante nos últimos tempos e como consequência a área cultivada com coqueiro anão irrigado no Brasil e em particular na região Nordeste teve um aumento significativo. Porém o coqueiro é considerado uma das frutíferas que mais consomem água e seu cultivo no nordeste Brasileiro pode ser comprometido, em função da escassez de água na região. Assim, o presente trabalho teve como objetivo determinar a lâmina de irrigação que permita aumentar a eficiência de utilização da água na irrigação do coqueiro verde em relação à produtividade e qualidade do fruto. O número de cachos, número de frutos e volume de água de coco por planta/ano sofreram influências das lâminas de irrigação, onde a menor lâmina teve o pior desempenho em relação a estas variáveis. Já o teor de sólidos solúveis aumentou conforme diminuiu a quantidade de água disponibilizada para a planta do coqueiro. Quando comparado os dois períodos (chuvoso e seco), no período sem chuva a quantidade de água de coco (ml de água de coco por planta) foi maior nas duas maiores lâminas (100 e 75%), já para o teor de sólidos solúveis ocorreu o inverso, com o melhor valor sendo 4,9 () na lâmina 0% em que não ocorreu irrigação.

Palavras-chave: *Cocos nucifera* L., estresse hídrico, produção.

CALVET, ASF; VIDAL, KSPL; MOREIRA, GC; MIRANDA, FR; MARLOS ALVES BEZERRA
YIELD AND QUALITY OF GREEN COCONUT FRUITS UNDER DEFICIENT IRRIGATION

Recebido em 05/09/2023 e aprovado para publicação em 11/09/2023
DOI: http://dx.doi.org/10.15809/irriga.2023v28n3p521-527

2 ABSTRACT

The demand for green coconut has increased substantially in recent years, and as a consequence, the cultivated area of irrigated dwarf coconut palm in Brazil, particularly in the Northeast region, has significantly increased in recent years. However, coconut trees are considered to consume the most water during irrigation. Thus, the objective of the present work was to determine the irrigation depth that allows us to increase the efficiency of water use in the irrigation of green coconut trees in relation to the productivity and quality of the fruit. The number of bunches, number of fruits and volume of coconut water per plant/year were influenced by the irrigation depth, where the lowest depth had the worst performance in relation to these variables. The soluble solids content (o Brix) increased as the amount of water available to the coconut plant decreased. When comparing the two periods (rainy and dry), in the period without rain, in relation to the amount of coconut water (ml of coconut water per plant), the highest amount was observed at the two largest depths (100 and 75%), whereas for the soluble solids variable, the opposite occurred; the best solute contents were observed at the 0% depth.

Keywords: *Cocos nucifera* L., Water stress, Yield.

3 INTRODUCTION

The coconut tree (*Cocos nucifera* L.) is a plant that predominantly has a tropical climate and is preferably cultivated on the coast and at low latitudes, where the ideal soil and climatic conditions for its cultivation are found, favoring all stages of development of this crop until the maturation of the fruits. (Cavalcante, 2012). This is one of the reasons why it is cultivated on a large scale on the northeastern coast of Brazil. Despite the favorable climatic conditions for planting coconut trees in the Northeast, as a disadvantage, we can mention that this species is one of the fruit trees with the highest water consumption since, once the production phase has started, the plant remains throughout the year with developing inflorescences and fruits.

Depending on climatic conditions, dwarf coconut plants can consume up to 240 L of water per plant $^{-1}$ day $^{-1}$, with reports of coconut producers using even greater daily irrigation volumes, reaching up to 350 L per plant $^{-1}$ day $^{-1}$ (Carr, 2011; Miranda *et al.*, 2019). Due to climate change, a problem observed throughout the world in recent years, there has been a reduction in water availability for irrigation in several regions where coconut cultivation is an important economic activity. Furthermore, there is a tendency toward an increase in temperature and potential evapotranspiration and a reduction in precipitation and water supply for irrigation in the NE region of Brazil. In view of the above, there is great concern about the future of this crop since there are negative responses in the development and productivity of plants when they are subjected to abiotic stresses (Furlan *et al.*, 2012). Thus, the present work aimed to determine a rational irrigation depth that prevents losses due to excess water applied to plants without compromising productivity, allowing us to increase the efficiency of water use in irrigating green coconut trees.

4 MATERIALS AND METHODS

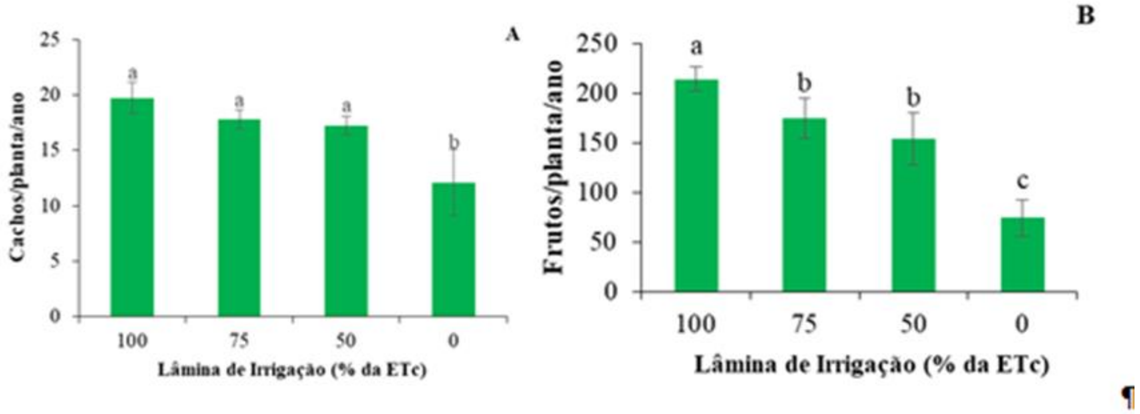
The experiment was conducted at Campo Experimental do Curu, owned by Embrapa Agroindústria Tropical in the municipality of Paraipaba, Ceará, Brazil, with geographic coordinates of 3° 29' S and 39° 09' W and a 30.0 m altitude above sea level. Planting took place in November 2016, with 255 dwarf coconut plants of the Verde Brasil de Jequi variety spaced 8.0 × 8.0 m apart. The plants were distributed in a randomized block design (DBC) with 4 treatments and 4 replications, with 8 plants per plot. The experiment was irrigated daily at a level equivalent to that of the crop evapotranspiration treatments (ETc), thus resulting in the differentiation of treatments by varying the irrigation time, which was controlled automatically. The treatments consisted of four irrigation depths corresponding to 100%, 75%, and 50% of the crop's evapotranspiration (ETc), in addition to a fourth depth equivalent to 0% of the ETc. The data analyzed corresponded to the year 2022 in 6-year-old plants, which were initially subjected to analysis of variance (ANOVA) using the F test, and those that showed a significant difference were compared using the Tukey test. For the analyses, the statistical analysis program SISVAR version 5.0 was used. The number of bunches and fruits per plant were quantified by evaluating their average throughout the year, the amount of water produced per fruit and the amount of coconut water produced per plant; the average amount of water produced by each coconut was measured, and this value was multiplied by the number of coconuts produced by each plant during the year. The average evaluation interval was 28 days. The number of fruits per bunch was obtained by manual and direct counting of the fruits in the bunch. After determining the weight, the fruit was pierced, and an “aluminum perforator” was used to extract the water. The water was collected in a beaker and transferred to a beaker, after which the amount of water was measured. volume in mL, and the soluble solids content (°Brix) was measured in an aliquot of coconut water using a field refractometer (model PAL-3, brand Atago).

5 RESULTS AND DISCUSSION

As expected, since there was a treatment without irrigation, significant differences were observed for all the parameters evaluated, demonstrating that the amount of water applied to the plant influences the development and quality of the coconut fruit. The number of bunches per plant was not affected by the presence of blades, with the difference occurring only in relation to nonirrigated plants (Figure 1A). This difference in the number of bunches per plant can be explained by the physiology of the coconut tree and the edaphoclimatic conditions of the region, where the coconut tree exhibits intense flowering activity and can emit approximately 18 to 19 panicles per year, resulting in a shortened period of flowering. panicle emission in the driest months and consequent harvest in the rainy months (Moreira, 2021). On the other hand, the number of fruits per plant was reduced in the treatments with deficient irrigation and was more severely affected in the plants without irrigation (Figure 1B). Souza *et al.* (2006), working with different irrigation levels with the same crop, reported that the number of bunches per plant and the number of fruits per plant were not significantly influenced by the volume of water applied. Araújo (2019) reported that the number of fruits on dwarf coconut trees increased linearly with increasing irrigation depth, corroborating the results of this research.

This reduction in the number of fruits seems to be more related to the increase in fruit abscission with the reduction in applied water (Ohler, 1999). According to several authors, water deficit has a direct effect on decreasing coconut production and reducing leaf area, favoring the closure of stomata and accelerating the senescence process and leaf abscission (Taiz; Zeiger, 2013; Lecoeur; Sinclair, 1996).

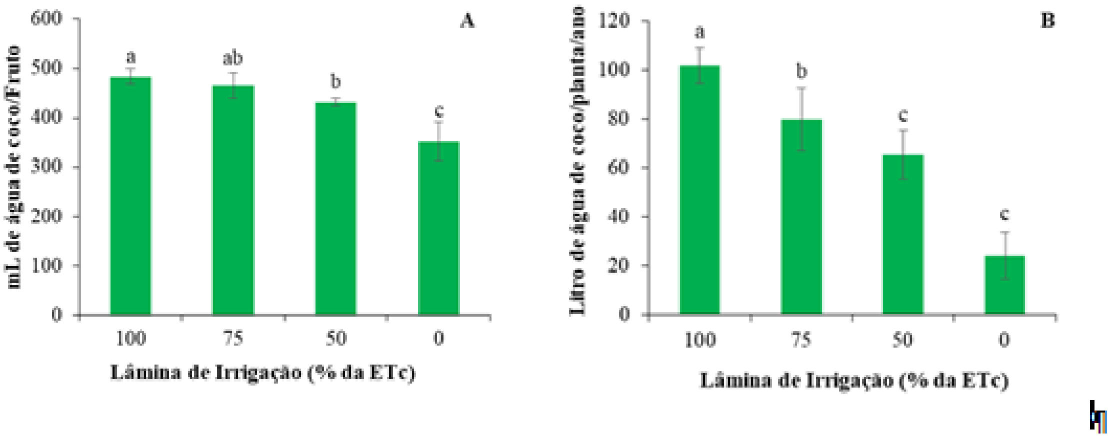
Figure 1. Number of bunches per plant per year (A) and number of fruits per plant per year depending on the irrigation level applied (B).



Source: Authors (2023).

In relation to the volume of coconut water produced per fruit, the impact of deficient irrigation was only associated with a 50% reduction in the irrigation depth, with once again, the treatment without irrigation being the most affected (Figure 2A), unlike the production of coconut water per plant, where the reduction progressed with decreasing irrigation depth (Figure 2B). Araújo (2019), working with the cultivation of green dwarf coconut trees in the coastal region of Ceará under conditions of water deficit, reported a high demand for water by the plants, confirmed by the positive correlation between the volume of water applied to the plants and the volume of water in the coconut palm fruits. Miranda *et al.* (2019) reported that deficient irrigation caused a significant reduction in the water volume of fruits as an effect of the water stress suffered by coconut crops during the dry period. According to Cintra *et al.* (2009), the coconut tree is an extremely sensitive species to water deficit conditions. A possible explanation for this correlation is that the dwarf coconut tree has a high rate of transpiration and, as a result, is a crop that consumes a large amount of water. Therefore, under limited irrigation conditions, plants experience water stress (Santos *et al.*, 1992), which impacts the production of coconut water.

Figure 2. Volume of coconut water per fruit (A) and volume of water per plant per year depending on the irrigation depth applied (B).



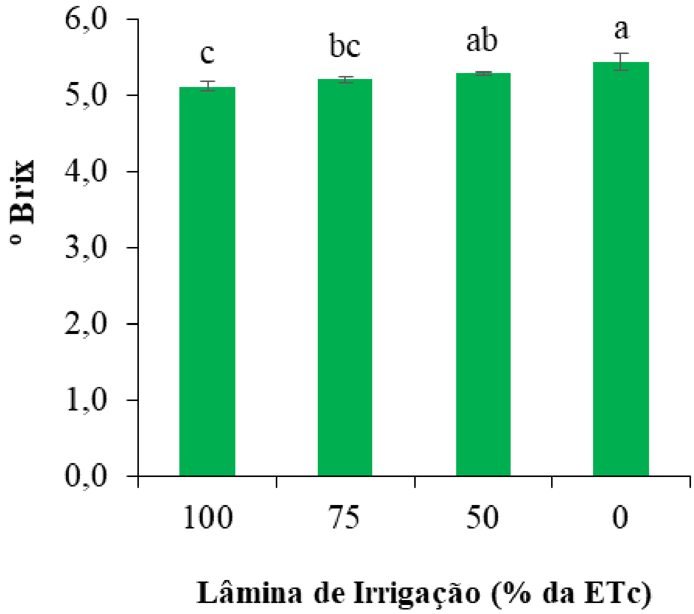
Source: Authors (2023).

When analyzing the quality of the water produced, it appears that the highest value of total soluble solids (°Brix) occurred in the 0% ETc treatment, the opposite result to that observed for the volume of coconut water produced, showing a concentration effect due to the decrease in the amount of coconut water produced. These findings corroborate the results obtained by Gomes do Ó *et al.* (2017), who worked with dwarf coconut trees in Camocim-CE. The authors observed that there was a decrease in the °brix value of water during the same period when a greater volume of water was produced. In the treatments with deficient irrigation, the increase was observed only in the treatment with a 50% reduction in ETc (Figure 3). However, all the treatments presented a brix above 5.0, which is fully accepted by the coconut water processing industry and for fresh consumption.

In research related to coconut production under water deficit, Cintra *et al.* (2009) reported that the volume of irrigation water, when lower than 100 L day $^{-1}$, compromised fruit production, and on a larger scale, the volume of coconut water per fruit increased.

In the present work, fruit production and the amount of water produced by plants were reduced, with an average application of 24.7 m3/plant. However, this reduction can be considered satisfactory if the cost × revenue × water availability relationship is taken into account.

Figure 3. Total soluble solids in coconut water, depending on the irrigation depth applied.



Source: Authors (2023).

6 CONCLUSIONS

An applied irrigation depth of 100% of the ETc provided a greater quantity of fruits and volume of coconut water produced, with differences between depths of 75% and 50% of the ETc occurring only in the volume of water produced.

The quality of the water produced was little affected by the reduction in the irrigation depth to 50% of the ETc.

The production of green coconut without irrigation in the study region is not economically recommended.

7 ACKNOWLEDGMENTS

THE Chief Scientist Program in Agriculture of the State of Ceará (Agreement 14/2022 SDE/ADECE/FUNCAP and Process 08126425/2020/FUNCAP) for granting an innovation grant and financial support to carry out the research.

8 REFERENCES

ARAÚJO, BA **Physiological responses of green dwarf coconut trees under different irrigation depths** . 2019. Dissertation (Master’s in Agricultural Engineering) – Center for Agricultural Sciences, Federal University of Ceará, Fortaleza, 2019.

CARR, MKV The water relations and irrigation requirements of coconut (*cocos nucifera)*: A review. **Experimental Agriculture** , Cambridge, vol. 47, no. 1, p. 27-51, 2011.

CAVALCANTE, LV **Space-space circuits and cooperation circles in coconut production on the West Coast** . 2012. Course Completion Work (Graduation in Geography) – State University of Ceará, Fortaleza, 2012.

CINTRA, FLD; RESENDE, RS; LEAL, MLS; PORTELA, JC Effect of irrigation water volumes on the water regime of cohesive soil in trays and on coconut production. **Brazilian Journal of Soil Sciences** , Viçosa, v. 33, no. 1, p. 1041-1051, 2009.

FURLAN A.; LLANES, A.; LUNA, A.; CASTRO, S. Physiological and Biochemical Responses to Drought Stress and Subsequent Rehydration in the Symbiotic Association Peanut-*Bradyrhizobium* sp. **ISRN Agronomy** , New York, v. 2012, p. 1-8, 2012.

GOMES do Ó. L.; HEIFER; BAD; FARIAS, LFL; MIRANDA, FR; LIMA, RE M
CALVET, ASF Production and characteristics of dwarf coconut fruits under different irrigation depths. *In* : INOVAGRI INTERNATIONAL MEETINGE, 4., 2017, Fortaleza. **Annals** [...]. Fortaleza: Inovagri Meeting Virtual, 2017. p. 1-8. Available at: https://icolibri.com.br/public/biblioteca/iv-inovagri-meeting/RES4890875. Accessed on: 07 Mar. 2023.

LECOEUR, J.; SINCLAIR, RT Field pea transpiration and leaf growth in response to soil water deficits. **Crop Science** , Madison, vol. 36, p. 331-335, 1996.

MIRANDA, FR; ROCK, ABS; GUIMARÃES, VB; SILVA, ESD; LIMA, GDCM; SANTOS, MMS Efficiency of Water Use in Irrigating Dwarf Coconut Trees. **Irriga** , Botucatu , v. 24, no. 1, p. 109-124, 2019.

MOREIRA, **CG Coconut production and physiology dwarf under different irrigation blades** . _ 2021. Dissertation (Master's in Agricultural Engineering) – Science Center Agrarias , Federal University of Ceará , Fortaleza, 2021.

OHLER, JG **Modern coconut management** : palm cultivations and products. London: FAO, 1999. 458 p.

SANTOS, GA; CARPIO, CB; ILAGAN, MC; CANO, SB; DELACRUZ, BV
IRHO Coconut : Water supply and drought tolerance . **Oléagineux** , Paris, v. 47, no. 13, p. 334-337, 1992.

SOUZA, IF; SILVA, VPR; AZEVEDO, PV; SILVA, BB; SOUZA, FLDC
Estimation of Evapotranspiration from coconut trees irrigated using the soil water balance method. **Brazilian Journal of Agrometeorology** , Santa Maria, v. 14, no. 1, p. 33-42, 2006.

TAIZ, L.; ZEIGER, E. **Plant Physiology** . Porto Alegre: Artmed, 2013. 918 p.