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Simulation of irrigation water requirements for Arabica coffee in traditional growing regions of São Paulo State, Brazil

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Introduction

Brazil is the world's leading producer of Arabica coffee, positioning the sustainable cultivation of this crop as a matter of global significance. Irrigation plays a crucial role in coffee productivity, regulating the flowering period of coffee plants, especially in response to spatial and temporal variability of rainfall, the severity of dry seasons, and soil physical characteristics. This study aims to simulate the irrigation water requirements for Arabica coffee in three traditional coffee-growing municipalities in the state of São Paulo: Caconde, Mococa and Franca.

Figure 1: Irrigated coffee experimental area in Mococa, SP, Brazil, September 2015.

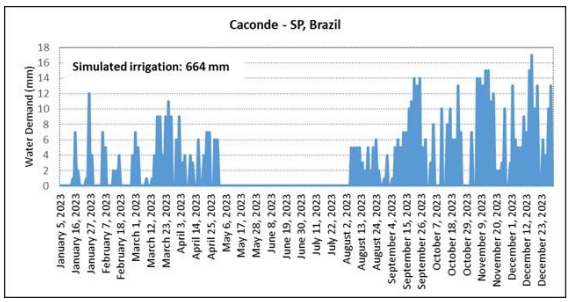

Figure 2: Water demand for coffee in Caconde – SP, Brazil.

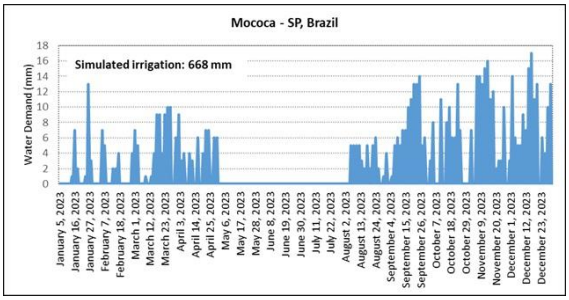

Figure 3: Water demand for coffee in Mococa – SP, Brazil.

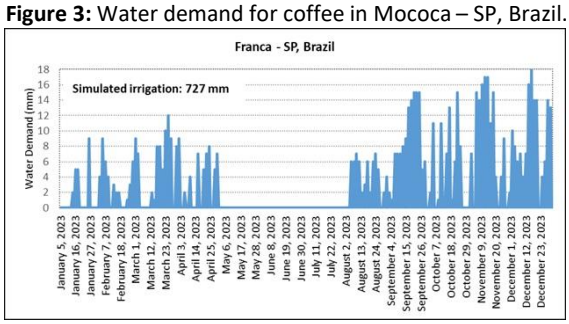

Figure 4: Water demand for coffee in Franca – SP, Brazil.

Materials/Methods

Irrigation water demand was estimated using the *CropWaterBalance* R-package [1]. To calculate the water balance, daily data on precipitation, maximum, average, and minimum temperatures, relative humidity, wind speed, and solar radiation at the top of the atmosphere were used. These data were obtained from the NASA-POWER project, with a spatial resolution of 0.5° latitude and 0.625° longitude. The data are open-access and were obtained using an R software package [2]. Based on the water balance results for each location, along with the crop coefficient and root system depth, irrigation requirements were determined, indicating the amount and timing of irrigation of the coffee crop.

Results/Discussion

In the simulation, accounting for water inputs and outputs in the root zone was required. The results indicated irrigation depths of 664 mm, 668 mm, and 727 mm for the locations of Caconde, Mococa, and Franca, respectively. These irrigation depths were well distributed throughout the crop cycle, except during the period from May to July, when coffee plants are traditionally not irrigated. Previous studies on coffee irrigation in Mococa reported that, in the year 2010, the applied irrigation depth was 440 mm [3]. Therefore, the simulated irrigation depth was higher than the applied one, indicating a significant increase in the crop's water demand.

Conclusion/Perspectives

Irrigation has become essential for coffee cultivation, even in regions previously considered suitable for non-irrigated coffee cultivation. This approach represents a crucial tool for efficient water management on agricultural properties. Also, it provides a foundation for future studies aimed at enhancing water use efficiency in coffee irrigation, particularly in light of potential impacts from climate change.

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References:

[1] *Blain et al. CropWaterBalance: Climate Water Balance for Irrigation Purposes. 2024 (R package version 0.2.0.9000).* **[2]** *R Core Team R: A language and environment for statistical computing. R Foundation for Statistical Computing, 2021, Vienna, Austria. https://www.R-project.org/* ***[3]*** *Sakai et al. Coffee productivity and root systems in cultivation schemes with different population arrangements and with and without drip irrigation, Agricultural Water Management, Volume 148, 2015, Pages 16-23, ISSN 0378-3774, https://doi.org/10.1016/j.agwat.2014.08.020.*