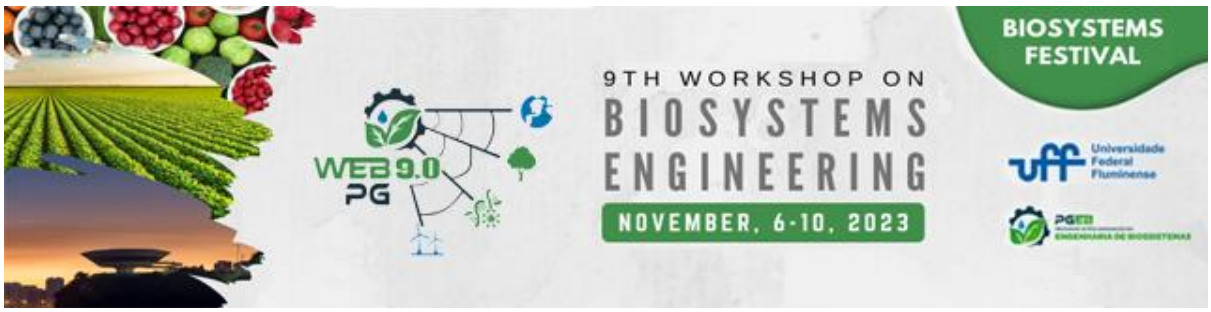

PHOTOCHEMICAL EFFICIENCY OF BRACHIARIA BRIZANTHA UNDER EUCALYPTUS CANOPIES IN AN ILF SYSTEM

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Abstract

Brazilian livestock farming is an essential part of the country's economy, standing out as one of the largest sectors of national agribusiness. Challenges such as the search for environmental sustainability require appropriate management for soil conservation and the development of the livestock sector. The integrated livestock-forestry (ILF) system is a sustainable technique that aims to integrate different production systems in the same area, making better use of natural resources. The choice of tree species to be implemented in the system is highly relevant, as it affects the luminosity available to the species that grow under its canopy, affecting determining characteristics associated with the productivity and quality of the pasture. The aim of this study was to evaluate the influence of luminosity in the understory of an ILF system on the photosynthetic activity of the *Brachiaria brizantha* species in an Atlantic Forest region. To do this, chlorophyll a fluorescence analyses were carried out on forage plants grown in a consortium with *Eucalyptus urograndis* (Clone 1407), with spacing between the trees of 4m and 24m between the crop rows. The treatments were established according to two lighting conditions: the control treatment corresponding to the condition with the highest lighting (between the planting rows) and the treatment with the lowest lighting corresponding to the area under the canopy of the eucalyptus trees (in the crop row). The results show that the low light supplied to the B. brizantha forage promotes low efficiency in the electron transport chain, indicating a possible stress situation.

Keywords: livestock, forage, photosynthesis, light stress

INTRODUCTION

Livestock farming plays an extremely important role in the Brazilian economy, achieving significant gains every year. In 2022, fresh beef exports recorded growth compared to the previous year, with a 27.6% increase in volume and a 48.2% increase in turnover (IBGE, 2023). A significant aspect of Brazilian livestock farming is that most of the animals are raised on pasture, which is a practical and economical way of feeding the bovines (CARVALHO et al., 2017). Inadequate pasture management, coupled with the lack of soil conservation techniques, leads to degradation (DIAS et al., 2016), making it necessary to use sustainable practices.

The integrated livestock-forestry (ILF) technique is a strategy that aims to optimize land use by implementing different agricultural, livestock and forestry production systems within the same section. The search for synergy within this agroecosystem positively influences productivity, production diversity and job creation (NOBRE and OLIVEIRA, 2018).

The choice of arboreal species to be used must be made in such a way as to ensure compatibility with livestock and the growth of forage plants for pasture formation (SILVA et al., 2008). Trees affect the luminosity available to the species growing under their canopies, influencing morphophysiological aspects that determine

pasture productivity (PACIULLO et al., 2008).

With this in mind, the purpose of this study was to evaluate the influence of the understory luminosity of a integrated livestock-forest system with eucalyptus in an ILF system on the photochemical activity of the forage *Brachiaria brizantha*, in an Atlantic Forest region.

MATERIALS AND METHODS

The experiment was carried out at the Santa Mônica Experimental Field (CESM) belonging to Embrapa Gado de Leite, located in the municipality of Valença-RJ. Data was collected in May 2023 at the following location: 22°21'31"S and 43°41'42"W, with an altitude of 356 m. The region's climate, according to the Köppen classification, was identified as Cwa, characterized by dry winters and rainy summers.

The analyses were carried out in an integrated livestock-forestry (ILF) system containing *B. brizantha* forage in consortium with a 4-year-old clone of the *Eucalyptus urophylla x E. grandis hybrid* (Clone 1407), in three blocks. The spacing adopted was single rows spaced 25 meters apart with 4 meters between trees, totaling 100 trees per hectare. The average height of the trees is 20 meters with a
site occupancy of 2.85 m^2 ha^{-1}.

The treatments were established according to two light conditions. Treatment T1 (control) corresponds to the highest luminosity, as seen between the crop rows. At the opposite end of the spectrum, treatment T2 (in the crop row) corresponds to the lowest luminosity, found in the area under the canopy of the eucalyptus trees, in the planting row.

To analyze the chlorophyll *a* fluorescence, the leaves were previously adapted to the dark using a closed clip for a period of 30 minutes. A Handy PEA portable fluorometer (Hansatech Instruments, King's Lynn, Norfolk, UK) was used for measurement and the parameters were calculated based on the methodology proposed by Strasser & Strasser (1995) and Tsimilli-Michael & Strasser (2008).

RESULTS AND DISCUSSION

The data obtained through the analysis of transient chlorophyll *a* fluorescence showed that the reduction in luminosity in the understory caused significant changes in the electron transport chain of the forage *B. brizantha*, as shown in Figure 1, for the plants grown in line with the eucalyptus trees.

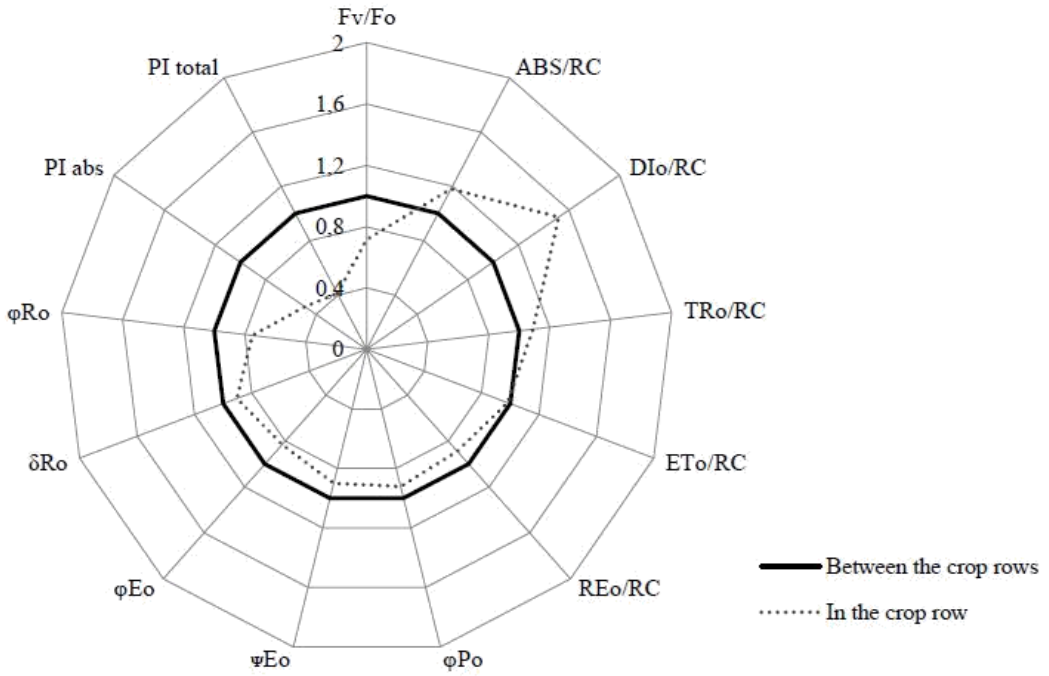

Figure 1: Transient chlorophyll a fluorescence parameters of brachiaria (B. brizantha) between crop rows and in the crop row when cultivated in an iPF system in the Atlantic Forest region, in Vassouras-RJ.

The ratio between variable fluorescence and minimum fluorescence (Fv/Fo), which corresponds to the effective quantum yield of photochemical energy conversion, showed a lower rate in the treatment equivalent to the growing line when compared to the normalized one, which indicates a reduction in the maximum efficiency of the photochemical process and lower activity of photosystem II (PSII).

As for yields and flux ratios, the maximum primary photochemical quantum yield (φPo) was lower than the normalized level, as was the probability that a captured exciton would move an electron in the electron transport chain after Quinone A (ΨEo) and the quantum yield of electron transport from Quinone A (Q_A) to the electron acceptor intersystem (φEo), showing a failure in PSII.

The quantum yield of reduction of the final electron acceptors of the photosystem I (PSI) per photon absorbed (φRo) and the efficiency with which an electron can move from the reduced intersystem electron acceptors to the final electron acceptors of photosystem I (δRo) showed lower values than the control, which demonstrates the lower efficiency of electron transport between the two photosystems and, consequently, less success in the formation of NADPH, affecting carbon fixation.

Regarding the specific flow parameters or activities expressed per reaction center, the absorption flow per reaction center (ABS/RC) was higher than the control treatment, as well as the energy dissipation per reaction center (DIo/RC) corresponding to the total excitation energy not captured by the reaction center, so despite showing greater absorption, dissipation also increased, not conserving the energy received and affecting the reduction in PSI. The flow of energy captured by the reaction center (TRo/RC) was higher when compared to the control. The flow of electron transport beyond Q_A per active reaction center represented by (ETo/RC) did not differ from the normalized one, while the specific flow of electrons capable of reducing the final electron acceptors in the electron acceptor portion of the PSI per active reaction center (REo/RC) remained lower than the normalized one, impairing NADPH production.

In terms of performance indices, the total performance index (PIabs), linked to the conservation of energy from the photons absorbed by the PSII until the reduction of the intersystem electron acceptors, was lower than the normalization, confirming the low efficiency of the PSII. Similarly, the performance index up to the final electron acceptors of the PSI (PItotal) was also lower than the inter-row treatment, indicating a complication in the transport of electrons in the intersystem, showing that this species has little available light, affecting its growth and proper development, which could lead to the loss of this species in the environment.

CONSIDERATIONS

The lighting conditions provided to the forage plants located under the canopy of the eucalyptus trees cultivated in an ILF system in an Atlantic Forest environment promote changes in the intensity of chlorophyll *a* fluorescence and low efficiency in the electron transport chain, indicating a possible stress situation. In this way, the spacing between eucalyptus trees used in cultivation limits the production of more biomass from the *B. brizantha* forage, which can affect its quality and nutritional value. This situation indicates the need to manage the forest component through thinning in order to increase the transmission of light to the understory.

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PRESENTATION: https://youtu.be/RGDUC7V7sXY