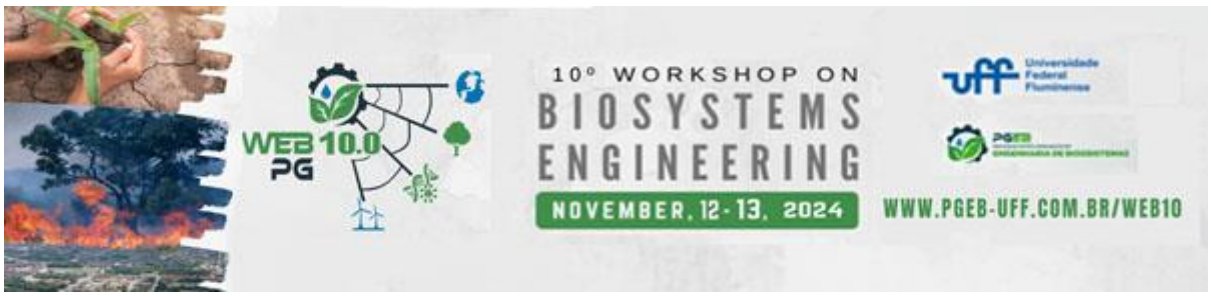

PHOTOCHEMICALANALYSIS OF BRACHIARIA BRIZANTHA GROWN AT DIFFERENT LEVELS OF SOIL DEGRADATION

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Abstract

After the collapse of the coffee cycle, coffee fields were replaced by pastures, driving the expansion of extensive livestock farming in Brazil due to the low cost and reduced demand for labor required for the new economic activity. Livestock farming became dominant because it offered versatile products, and still has a central role in the economy today, as Brazil is currently the world's second largest producer and largest exporter of beef. However, the extensive livestock farming that is highly prevalent in the country, characterized by livestock raised on pastures and inadequate management, has led to around 62% of Brazilian pastures suffering some level of degradation, compromising their productivity. With this in mind, this study sought to assess the photochemical capacity of *Brachiaria brizantha* plants when grown at different levels of soil degradation. To this end, the treatments consisted of pasture areas formed by the *Brachiaria brizantha* forage species and were delimited according to levels of degradation: N1 - low level of degradation; N2 - moderate level of degradation; and N3 - high level of degradation. To measure transient chlorophyll *a* fluorescence, 15 *B. brizantha* leaves were randomly selected from each treatment, totaling 15 repetitions for each treatment. The results indicate that the levels of pasture degradation have a significant impact on the photochemical activity of *Brachiaria brizantha*, requiring the plant to develop specific adaptive mechanisms.

Keywords: livestock, forage, photosynthesis, abiotic stress

INTRODUCTION

The 19th century gave rise to the coffee cycle in Brazil, especially in the Paraíba do Sul River region, due to the favorable climatic conditions found in the Atlantic Forest (CARRIELO, 2023). Coffee production boomed in the Paraíba do Sul Valley between the 1850s and 1860s, reaching a production of 2.73 million arrobas, mainly in the plantations located in Vassouras and Rio Claro(RUÍZ et al., 2018). With the success of the new economy, the region was nicknamed the “Coffee Valley” (RODRIGUES et al., 2020).

After the collapse of the coffee cycle, the crop areas were gradually replaced by pastures, giving way to extensive livestock farming, which was seen as an alternative that required low capital and a small amount of labor (MEDEIROS et al., 2016).

Livestock farming stood out among the possible options due to various functional and productive factors, since cattle provide a versatile range of products and by-products, making them attractive for subsistence or commercialization (REIS, 2017). Since then, livestock farming has played a central role in the Brazilian economy, as the country is the world's second largest producer and largest exporter of beef (FREITAS JUNIOR & BARROS, 2021).

The vast expanse of land available for pasture has encouraged the development of extensive livestock farming, a defining characteristic of Brazilian livestock farming, where most of the herd is raised on pasture, the most practical and economical way of feeding cattle (CARVALHO et al., 2017). Brazil has approximately 160 million hectares, where 62% of Brazilian pastures have some level of degradation (IBGE, 2017). Degraded pastures are those with reduced productive potential considering the local soil and climate conditions (LASCANO & SPAIN, 1991).

Different parameters can be used as indicators of soil quality and are directly associated with the management practices adopted. Lack of main nutrients affect photosynthetic functions at different levels, including photosystem II photochemistry (KALAJI et al., 2014). The aim of this study was to evaluate the photochemical capacity of *Brachiaria brizantha* plants when grown at different levels of soil degradation.

MATERIALS AND METHODS

The experiment was conducted in areas of the Santa Mônica Experimental Field (CESM), which belongs to Embrapa Gado de Leite, in the district of Valença/RJ. The Paraíba do Sul Valley has a "sea of hills" relief with numerous hills and is part of the Atlantic plateau. With a Köppen climate classification of Cwa, characterized by dry winters and rainy summers, the region has average temperatures of 20°C and average precipitation of 1,400 mm.

The treatments consisted of pasture areas formed by the forage species *Brachiaria brizantha* and were delimited according to the preliminary classification of degradation levels according to visual assessment, adapting the criteria proposed by Spain and Gualdrón (1991), considering the lowest level of degradation to be that with predominantly forage cover and the highest level to be that with predominantly exposed soil, with no or little evidence of erosion. Therefore, three treatments were established, with each treatment representing a degradation level: N1 - low degradation level; N2 - moderate degradation level; and N3 - high degradation level.

To measure transient chlorophyll *a* fluorescence, 15 *B. brizantha* leaves were randomly selected from each treatment, totaling 15 repetitions for each treatment. 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 to read the data and the parameters were calculated based on the methodology proposed by Strasser & Strasser (1995) and Tsimilli-Michael & Strasser (2008).

RESULTS AND DISCUSSION

Areas subjected to some level of degradation have their soil's physical-chemical and biological attributes compromised, which in turn compromises the process of morphogenesis and growth of forage plants (BEZERRA et al., 2020). The data obtained through transient chlorophyll ***a*** fluorescence analysis showed that increasing the level of degradation caused significant changes in the electron transport chain of the *B. brizantha* forage plant, as shown in Figure 1, with treatment N1 (lowest level of degradation) used for normalization.

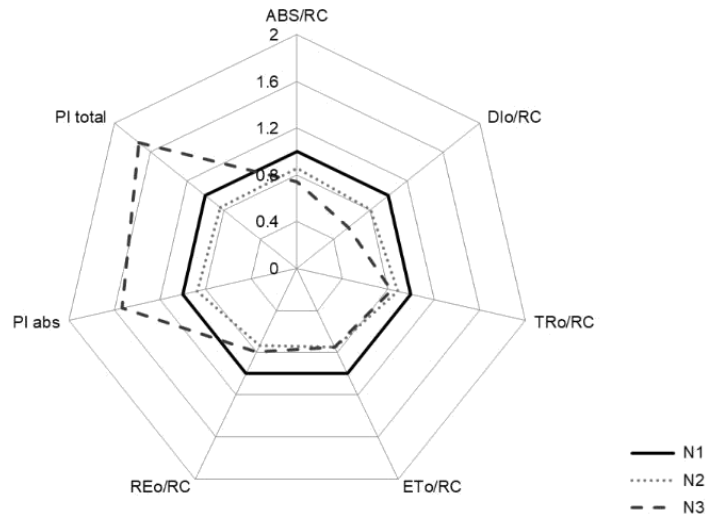

Figure 1: Transient chlorophyll ***a*** fluorescence parameters of brachiaria (*B. brizantha*) when cultivated in pastures located in the Atlantic Forest region, under different degradation levels: N1 - low degradation level; N2 - moderate degradation level; and N3 - high degradation level.

With regard to the specific flow parameters or activities expressed per reaction center, the absorption flow per reaction center (ABS/RC) was lower than the control at the highest levels of degradation. However, the dissipation of energy per reaction center (DIo/RC), which corresponds to the total excitation energy not captured by the reaction center, was lowest in treatment N3, at the highest level of degradation, and may be a mechanism generated by the species to conserve the energy obtained, as will be discussed later.

The flow of captured energy per reaction center (TRo/RC), the flow of electron transport in addition to Quinone A per active reaction center represented by (ETo/RC) and the specific flow of electrons capable of reducing the final electron acceptors in the electron acceptor portion of photosystem I (PSI) per active reaction center (REo/RC), showed lower rates than the control in the treatments with the highest levels of degradation, impairing NADPH production.

In terms of the performance indices, the total performance index (PIabs), associated with the conservation of energy from the photons absorbed by photosystem II (FSII) up to the reduction of the electron acceptor intersystem, was higher than the normalization in N3 and lower in N2. Similarly, the performance index up to the final electron acceptors of the PSI (PItotal) was also higher than the normalized value at N3 and lower than the normalized value at N2.

The increase in performance indices at the highest level of degradation reflects an adaptation and protection mechanism by the plant under stressful conditions, in order to optimize the use of light and minimize the risk of damage from excess light or excessive production of reactive oxygen substances. Furthermore, under intense light conditions, the antenna system causes an excessive influx of photons into the RC of the PSII, decreasing electron transport as a protective mechanism that causes photoinhibition on the acceptor side of the PSII (KALAJI et al., 2012).

CONSIDERATIONS

As the results show, the different levels of pasture degradation have a significant impact on the parameters related to the photochemical activity of *Brachiaria brizantha*, requiring the plant to develop specific adaptive mechanisms. Plants under lighting stress improve the ability of the light-harvesting complex (LHC) to absorb and distribute light in a more controlled manner. Performance indices, which include the quantum efficiency and quantum yield of PSII, reflect how efficient the plant is at using light for photosynthetic processes or dissipating it safely. In this way, even if the reaction center is less active, the plant maintains a high efficiency in managing light energy.

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PRESENTATION: https://youtu.be/sr9EYISBQrs