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TRANSPIRAÇÃO E CONTEÚDO RELATIVO DE ÁGUA DO FEIJÃO-CAUPI CONSORCIADO COM CAPIM MOMBAÇA

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RESUMO: Conhecer como as relações interespecíficas que afetam o desenvolvimento das plantas em sistemas consorciados serve de base para traçar estratégias de manejo agrícola que visem aumento na qualidade e na produtividade das culturas. O objetivo do trabalho foi avaliar ao longo do tempo a transpiração e o conteúdo relativo de água do feijão-caupi em cultivo consorciado com o capim Mombaça. O estudo foi desenvolvido na área experimental do Centro de Ciências Agrárias e da Biodiversidade (CCAB) da Universidade Federal do Cariri (UFCA), no Crato, CE, no período de maio a gosto de 2024. As espécies utilizadas foram o feijão-caupi e o capim Mombaça. O delineamento empregado foi em blocos ao acaso, com parcela subdivida no tempo com três repetições, sendo o primeiro fator o sistema de cultivo (solteiro e consorciado) e segundo fator o tempo (28, 35, 42, 49, 56, 63, 70, 77 e 84 dias após a semeadura). A transpiração e o conteúdo relativo de água do feijão-caupi reduziram com o tempo, refletindo o aumento do estresse pela restrição hídrica devido ao cultivo em sequeiro, bem como ao aumento da competição interespecífica com o capim Mombaça.

Palavras-chaves: Cultivo integrado, estresse hídrico, complementariedade interespecífica.

TRANSPIRATION AND RELATIVE WATER CONTENT OF COWPE BEANS INTERCEDED WITH MOMBAÇA GRASS

ABSTRACT: Understanding how interspecific relationships affect plant development in intercropping systems serves as a basis for designing agricultural management strategies aimed at increasing crop quality and productivity. The objective of this study was to evaluate the transpiration and relative water content of cowpea intercropped with Mombaça grass over time. The study was conducted in the experimental area of the Center for Agricultural Sciences and Biodiversity (CCAB) of the Federal University of Cariri (UFCA), in Crato, CE, from May to August 2024. The species used were cowpea and Mombaça grass. The design used was randomized blocks, with a split plot in time with three replications. The first factor was the cultivation system (single and intercropped), and the second factor was time (28, 35, 42, 49, 56, 63, 70, 77 and 84 days after sowing). The transpiration rate and relative water content of cowpea decreased over time, reflecting the increase in stress due to water restriction due to rainfed cultivation, as well as the increase in interspecific competition with Mombasa grass.

Keywords: Integrated cultivation, water stress, interspecific complementarity.

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1 INTRODUCTION

The quest for food security for the world's population is one of the major challenges facing the agricultural sector, particularly with respect to sustainability and the conservation of natural resources. Therefore, it is important to explore sustainable intensification options that aim to increase production while also offering crop diversification (Namatsheve *et al.*, 2021). In this context, intercropping is an essential component of sustainable agriculture, which responds to the growing demand for resilient practices in the face of food security challenges (Pierre *et al*., 2024).

In intercropping systems, the integration of legumes and grasses is common, mainly due to the addition of nitrogen to the system through biological N2 fixation, which helps to increase soil productivity (Namatsheve *et al*., 2021) and contributes to increased crop and livestock productivity (Silva *et al*., 2022). Among the legumes most commonly used in intercropping, cowpea (*Vigna unguiculata* L. Walp.) Stands out for its versatility as a source of nutrition for humans, cattle, soils, and even other plants (Silva *et al*., 2018), in addition to having a high capacity for fixing atmospheric nitrogen through the formation of root nodules in association with rhizobia (Kebede; Bekeko, 2020). Mombaça grass, in turn, is a grass with an erect and cespitose habit (Schimidt *et al*., 2022), which stands out for its potential to provide high animal and plant productivity, especially during dry periods (Peixoto; Santos, 2022).

However, it is important to understand the adverse competitive effects that may occur between intercropped species so that appropriate management can be defined.

According to Mwamlima, Cheruiyot and Ouma (2020), intercropping can reduce plant photosynthetic rates due to shading, reducing the production of photoassimilates necessary for growth and productivity. Pierre *et al*. (2024) reported that monitoring and understanding interspecific competition, as well as the physiological characteristics associated with plant growth, constitute the basis for effectively optimizing intercropping systems. Understanding how species interactions occur and their impact on plant development in intercropping systems is crucial for developing effective strategies to optimize production areas and maximize cowpea yield. Therefore, the objective of this study was to evaluate the transpiration and relative water content of cowpea intercropped with Mombaça grass over time.

2 MATERIALS AND METHODS

The research was developed in the experimental area of the Center for Agricultural Sciences and Biodiversity (CCAB) of the Federal University of Cariri (UFCA), in Crato, CE (7°14'03" S and 39°24'34" W, altitude of 420 m), from May to August 2024. The climate of the region is classified as hot tropical, mild semiarid or hot subhumid tropical (Sousa, 2018). The soil of the experimental area is an abrupt and typical dystrophic Red–Yellow Argisol type (FUNCEME, 2012).

The design used was randomized blocks, with a split plot in time with three replications, with the first factor being the cultivation system (single and intercropped) and the second factor being time (analyses carried out at 28, 35, 42, 49, 56, 63, 70, 77 and 84 days after sowing (DAS)). Cowpea seeds (*Vigna unguiculata* L. Walp.) of a Creole variety with the popular name costelão and guinea grass seeds (*Panicum maximun*) of the cultivar Mombaça. The cowpea was grown in a single cropping system and intercropped with Mombaça grass. Three experimental plots were established for each system and crop, measuring 4.8 × 3 m in length and width, respectively, with an area of 14.4 ^{m2}, containing five rows of plants spaced 0.60 m and 0.45 m apart, totaling 60 plants per plot. For intercropping, the different species were interplanted within the plant row, totaling 30 plants of each species per plot. The useful area of the plot consisted of three central rows of plants, disregarding the border.

Sowing took place on May 7, 2024, with three seeds per hole to ensure germination. Thinning was subsequently performed, leaving one plant per hole. Nutrients were provided by applying 21 kg ha $^{-1}$ nitrogen, 72 kg ha $^{-1}$ phosphorus, and 63 kg ha $^{-1}$ potassium. The following sources were used: urea (45 kg ha $^{-1}$) applied at 15 DAS; potassium chloride (105 kg ha $^{-1}$) applied 50% at planting and 50% as a side dressing at 15 DAS; and simple superphosphate (400 kg ha $^{-1}$) applied entirely at planting. Water was supplied through a localized drip irrigation system solely to maintain plant stand stability. This constitutes life-saving irrigation, which is used by local producers who produce under rainfed conditions.

The variables analyzed were the relative water content (RWC) and leaf transpiration rate (*E*). The RWC was obtained by dividing the difference in fresh weight and dry weight by the difference in turgid weight and dry weight of 10 leaf discs collected with a paper punch. The turgid weight of the leaf discs was obtained after being fully hydrated in distilled water for 24 hours, and the dry weight of the discs was obtained in a forced-air circulation oven at 65 °C for a period of 48 hours. *E* was obtained via a porometer. Analyses were performed at 28, 35, 42, 49, 56, 63, 70, 77, and 84 DAS, always on the second fully expanded leaf of three plants in the useful area, randomly.

The data were subjected to normality, homoscedasticity and analysis of variance (ANOVA) tests via the F test ($p < 0.05$) via SISVAR statistical software (Ferreira, 2019). The time factor was compared via polynomial regression analysis ($p < 0.05$), whereas the cultivation systems (single and intercropped) were compared via Tukey's mean test at 5% probability.

3 RESULTS AND DISCUSSION

According to the analysis of variance (Table 1), for the transpiration variable (*E*), there was only a significant effect of the time factor (DAS), whereas for the relative water content (CRA), there was a significant effect of the factors in isolation.

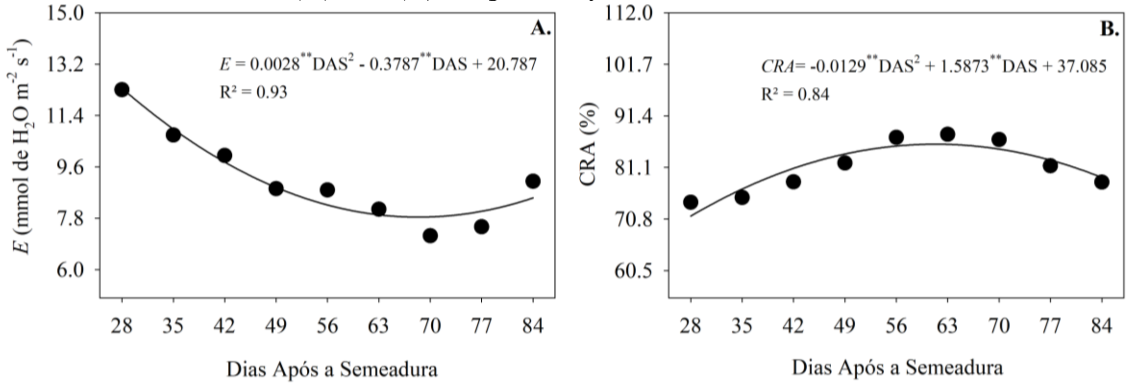
Table 1. Analysis of variance for transpiration (*E*) and relative water content (WC) of cowpea as a function of different cultivation systems (single and intercropped) and time (28, 35, 42, 49, 56, 63, 70, 77 and 84 DAS).

Source of Variation	Degrees of Freedom	Mean Square	
		AND	CRA
Cultivation System (Sc)	1	11,344 ^{ns}	143,603 *
Time (DAS)	8	15,749 **	159,852 **
Sc x DAS	8	0.611 ^{ns}	37,794 ^{ns}
Repetition	2	13,788	2,402
Residue	34	2,899	34,954
CV	%	18.57	7.29

^{ns}: not significant; * * and *: significant at 1% and 5% probability, respectively.

E had its maximum peak at 28 DAS, presenting a maximum value of 12.4 mmol of H_2O m $^{-2}$ s $^{-1}$, with a minimum value of 8.0 H_2O m $^{-2}$ s $^{-1}$, at 68 DAS, corresponding to a reduction of 35% between these dates (Figure 1).

Figure 1. Transpiration (E) and relative water content (WRC) for cowpea and Panicum grass crops as a function of time (A) and (B), respectively.



Freitas *et al*. studied the physiology of cowpea in an integrated cropping system with buffelgrass and eucalyptus. (2023) obtained *E values* of 0.52 to 1.13 mmol H_2O m^{-2} s^{-1}, depending on the spacing adopted between species. The authors associated the low transpiration values with shading caused by the larger species. Notably, cowpea transpiration decreased over time, which also represents the growth of Mombaça grass and, consequently, an increase in the shaded area, mainly limiting the photosynthetic activity of the leaves. Shading reduces the incidence of sunlight directly on the leaf, thus reducing the interception of photosynthetic photon flux and limiting the photosynthetic rate, stomatal conductance, and plant transpiration (Alam *et al*., 2018; Pierre *et al*., 2024). With respect to the CRA (Figure 1B), the highest value obtained was 85.9% at 62 DAS, which was an increase of 21% in relation to the first date analyzed (28 DAS) and decreased again until the end of the crop cycle. This result may be related to the increased competition for water between species due to the growth of Mombaça grass and to the increased water limitation imposed by dryland cultivation.

Notably, cowpea preserves and even increases the WRC until a certain period of the cycle; this behavior may be related to the ability of this species to reduce the consumption of intracellular water under conditions of water limitation (Iseki *et al*., 2018). According to Gomes *et al*. (2020), a low water supply leads to a significant reduction in the relative water content of cowpea plants. The authors obtained WRC values below 80% under severe water stress. A low WRC may be associated with a reduction in cell turgor pressure, which results in leaf chlorosis and damage to the photosynthetic apparatus (Singh; Reddy, 2011). Therefore, the WRC is a parameter of plant cellular health and is capable of maintaining and preserving the chlorophyll content of whole plants (Olorunwa; Shi; Barickman, 2021).

4 CONCLUSIONS

The transpiration and relative water content of cowpea tended to decrease over time, reflecting increased stress from water restriction due to rainfed cultivation, as well as increased interspecific competition with Mombaça grass.

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