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RESPOSTAS DO TOMATE CEREJA SOB ESTRESSE HÍDRICO AO LONGO DE SUAS FASES FENOLÓGICAS

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1 RESUMO

A expectativa de expansão das áreas afetadas pelo aumento do estresse hídrico, é essencial implementar medidas que possam mitigar essas consequências. Este estudo visa avaliar o tomate cereja sob estresse hídrico em diferentes estágios fenológicos, considerando a aplicação de água adequada para maximizar a produção, especialmente em regiões semiáridas. O experimento foi conduzido em ambiente protegido no IFCE – *campus* Sobral – CE, entre setembro de 2023 a janeiro de 2024, onde foram estabelecidos oito tratamentos, consistindo na reposição de 100% e 50% da evapotranspiração da cultura (ETc) nos estágios vegetativo, floração e frutificação. Foram realizadas avaliações de altura da planta, diâmetro do caule, número de folhas e área foliar. Os resultados indicaram que os tratamentos que receberam 100% da ETc na fase de frutificação apresentaram melhor desenvolvimento em altura da planta. No entanto, as diferenças no número de folhas e diâmetro do caule foram insignificantes entre os tratamentos. A aplicação de 50% da ETc na fase de floração resultou em variações significativas na área foliar.

Palavras-chaves: semiáridas, tratamentos, altura da planta, produção.

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RESPONSES OF CHERRY TOMATOES UNDER WATER STRESS THROUGHOUT THEIR PHENOLOGICAL PHASES

2 ABSTRACT

Cherry tomatoes are a cultivar valued for their flavor and attractive color, serving as an alternative source of income for small and medium–sized farmers. With the expectation of the

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expansion of affected areas and the negative effects caused by water stress, it is essential to implement measures that can mitigate these consequences. This study focused on cherry tomatoes under water stress at different phenological stages, considering the application of adequate water to maximize production, especially in semiarid regions. The experiment was conducted in a protected environment at IFCE – Sobral *campus* - CE between September 2023 and January 2024, where eight treatments were established, consisting of the replacement of 100% and 50% of crop evapotranspiration (ETc) in the vegetative, flowering and fruiting stages. The plant height, stem diameter, number of leaves and leaf area were evaluated. The results indicated that the treatments that received 100% Etc during the fruiting stage resulted in greater increases in plant height. However, differences in leaf number and stem diameter were not significant among the treatments. The application of 50% ETc at the flowering stage resulted in significant variations in leaf area.

Keywords: semiarid, treatments, plant height, production.

3 INTRODUCTION

Among tomato cultivars, cherry tomatoes (*Solanum lycopersicum var. cerasiforme*) stand out for their high added value and for serving as an alternative source of income for SMEs (Soldateli et al., 2020). According to Silva et al. (2011), fruits from cherry groups are widely used to decorate dishes and are appreciated for their excellent flavor and attractive red color due to their high lycopene content.

In Brazil, although current water stress is considered medium to low, projections indicate that water availability in river basins in the North, Northeast, Central-West, and Southeast Regions could decrease by more than 40% by 2040. This scenario, presented by the National Water and Sanitation Agency (2024), highlights the urgent need for effective strategies for the sustainable management of water resources and adaptation to climate change. In this context, the adoption of practices that minimize the impacts of water scarcity becomes essential. Among these strategies, the use of controlled water deficit in irrigation management stands out, considering the phenological stages of crops as an alternative to guarantee agricultural productivity in a sustainable manner. Sousa et al. (2022) emphasized that this practice can contribute significantly to the efficiency of water use in agriculture without compromising production.

Thus, deficit irrigation is an important method for the efficient use of water resources in agricultural production (Cui *et al.* , 2020 ; Liu *et al.* , 2021). Therefore, the imposition of controlled water scarcity at certain stages of crop development is expected to benefit and save water, especially in semiarid areas.

However, vegetable production may be limited in regions characterized by a high incidence of solar radiation and, consequently, high temperatures, as is the case in the semiarid region of Northeast Brazil (Santiago et al., 2018). According to Franca, Leitão and Campeche (2017), in hot regions, the best tomato yields are obtained in autumn–winter.

In general, extreme weather conditions trigger responses from vital plant mechanisms, especially those associated with photosynthesis and efficient water use, and can result in significant yield losses (Santiago et al., 2018).

Thus, the present study aims to evaluate the behavior of cherry tomatoes subjected to water stress conditions applied at different phenological stages, vegetative, flowering and fruiting, with the goal of defining the water supply that promotes better development of the crop.

4 MATERIALS AND METHODS

The experiment was carried out in a protected environment (Agricultural Telado) on the IFCE campus - Sobral - CE, between September 2023 and January 2024, located under the geographic coordinates of 3°41'03"W, 40°20'24"S and 70 m. According to the Köppen climate classification, the climate of the region is of the Aw 'type, characterized by a dry season and a rainy season. The average annual precipitation is 896.7 mm, with most of the rainfall concentrated between the months of January and May. The average annual temperature varies between a maximum of 34.1 °C, with an average of 27.2 °C, and a minimum of 22.4 °C. The relative humidity of the air, in turn, has an annual average of 68.5%. The region also records an average sunshine duration of 2,648 hours per year (Brazil, 1990).

The 261.21” cherry tomato seedlings (Isla®) were produced in polypropylene trays, with three seeds per cell sown on September 25. Emergence occurred between 5 and 9 days, and transplanting was carried out 24 days after sowing (DAS). Thinning was carried out after the emergence of the first definitive leaves, resulting in one plant per cell. Transplanting was carried out in 20 dm³ pots spaced 1.0 m between rows and 0.6 m between plants. The pots, which had a drainage mechanism at the bottom, received a layer of gravel at the base, and the substrate composition consisted of two parts of sand to one part of cured cattle manure. The soil fertility and physical characteristics were analyzed by the Soil and Water Laboratory of the IFCE; deformed samples of the soil mixture that composed the pots were used before the crop was planted. (Tables 1 and 2).

Table 1. Results of the soil fertility analysis used for cherry tomato cultivation under different irrigation management practices. The table is divided into two parts, leaving only one

Sample Identification							
Carbon	Org. Mat.	Match	Potassium	Calcium	Magnesium	Sodium	pH
dag/kg		mg/kg	cmol c /kg				-
1.15	1.98	506.85	0.512	5.55	1.45	0.35	7.8
		Very High	Very High	High	High		
Sample Identification							
Aluminum	$H^+ + Al^{3+}$	SB	CTC	V	PST	m	EC
cmol c /kg					%		dS/m
0.00	0.00	7.86	7.86	100.00	4.43	0.00	0.72

Extractants: Mehlich1: P, Na and K; Potassium chloride: Ca, Mg and Al; Calcium acetate: H+Al. pH in water (1:2.5). $H^+ + Al^{3+}$ = potential acidity (hydrogen + aluminum); SB = sum of base; CEC = total cation exchange capacity; Org. Mat. = Organic matter; V = percentage of base saturation; PST = percentage of sodium saturation; m = percentage of aluminum saturation; CE = electrical conductivity.

Table 2. Results of the physical analysis of the soil used in the cultivation of cherry tomatoes subjected to different irrigation management practices.

Sample Identification				
Granulometric Composition (g/kg)			**Classification**	
Sand	Silt	Clay	Textural	
922.91	48.29	28.80	Sand	
Sample Identification				
Natural Clay	**Degree of Flocculation**	**Density (g/cm3)**		**Total Porosity**
g/kg	%	From the Ground	From Particle	%
8.28	71.24		2.65	

Method: - Granulometric = pipette method; -total porosity = indirect; -particle density = volumetric balloon; -soil density = test tube method; -textural classification = adapted from Santos et al. (2013).

A randomized block design was adopted, in which eight treatments were established and distributed in four blocks with two replications in each block, which resulted in a stand of 64 plants. The treatments, as presented in Table 3, consisted of replacing 100% and 50% of crop evapotranspiration (ETc) at the different phenological stages of the crop, vegetative 0–30 days after germination (DAG), flowering 31–65 DAG, and fruiting after 65 DAG (Sá, 2013).

Table 3. Definition of treatments (Treat.) with respect to water restriction in the different phenological stages of cherry tomato crops grown in pots and in a protected environment.

Treat	**Phenological stages**			**Treat**	**Phenological stages**		
	Vegetative	**Flowering**	**Fruiting**		**Vegetative**	**Flowering**	**Fruiting**
T1	100%	100%	100%	T5	100%	50%	50%
T2	100%	100%	50%	T6	50%	100%	50%
T3	100%	50%	100%	T7	50%	50%	100%
T4	50%	100%	100%	T8	50%	50%	50%

Source: Prepared by the authors.

The ETc was estimated via the software “Sistema Ômega de Manejo da Microrigação ” (VALNIR JÚNIOR et al., 2017), which is based on the daily evaporation of a minitank evaporimeter. The cultivation coefficients (kc) adopted were those suggested by Silva et al. (2013), which are 0.6, 1.1, and 0.8 for the vegetative development, flowering, and fruiting stages, respectively.

During the hottest period of the day of the experiment, a nebulization system was activated with the intention of controlling the temperature so that it did not exceed 35 °C, which would be harmful to the crop. The nebulizations occurred every half hour, starting at 10 am and ending at 3 pm, with each cycle operating for 3 minutes.

trained with a string to a height of 1.5 m, and the lateral shoots were removed weekly, leaving only the main branch intact. Cultural practices such as weeding, fertilization, and phytosanitary control were equally applied to all the treatments, with differences only in the amount of water applied for each treatment. The water requirements for each treatment were determined manually. In the treatments where the plants experienced water deficit at a given phenological stage, the water depth applied was equal to half (50%) of the average depth of the replicates in Treatment 1. On the other hand, in stages where the crop was not subjected to water deficit, the water depth applied was calculated on the basis of evaporation from the Class A tank.

At 86 DAG, the plant height (AP), stem diameter (DC), number of leaves (NL) and leaf area (LA) of the plants were determined. The AP was obtained via a tape measure, which was measured from the ground level to the first branch of the main stem. The NL was determined at three centimeters above the ground using a caliper. The NL in each of the plant branches was counted, and leaves with at least 50% of the leaf area being green were considered green. The LA (cm²) was determined via equation (1):

$$AF = C * L * f \qquad (1)$$

where C is the length, defined as the distance between the insertion point of the petiole in the leaf blade and the opposite end of the leaf, cm; L is the width, adopted as the largest dimension perpendicular to the length axis; and ef is the shape factor, adopted as 0.59 (Reis et al., 2013).

Durbin–Watson error independence test and the Bartlett homogeneity of variances test. When normality, error independence and homogeneity of variances were observed, analysis of variance (ANOVA) was applied. When a significant effect ($p<0.05$) was observed by the ANOVA F test, the data were subjected to the Scott–Knott mean comparison test at 5% significance. All analyses were performed via R software, version 4.3.2 (R Core Team, 2023; Shimizu; Marubayashi, 2023).

5 RESULTS AND DISCUSSION

The summary of the analysis of variance (ANOVA) results presented in Table 4 shows that only plant height ($p < 0.001$) and leaf area ($p < 0.5$) significantly differed between the treatments with water restriction.

The treatments T3, T4, and T7, with 100% ETc in the fruiting phase, presented the highest AP (Figure 1a). Factors such as greater availability of nutrients and greater cell turgor caused by an adequate amount of water may be justifications for the good performance of the plants in this variable. Brito et al. (2015) reported contrary results for plant height, considering that, in their work, when there was an increase in the irrigation depth in the vegetative phase, it led to a decline in plant growth, which can be explained by water stress caused by excess water, saturating the soil, thus reducing the absorption of nutrients through the roots, in addition to resulting in a lack of oxygen available for the roots to function properly. By relating treatments T3 and T7 with T4, it is possible to see that the plants actually obtained a greater growth response with increasing irrigation depth from 50% to 100%.

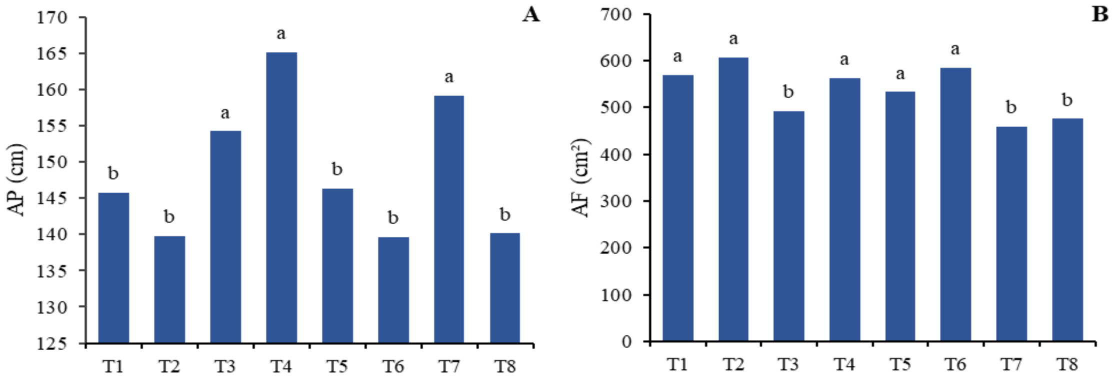
Table 4. Analysis of variance of plant height (AP), stem diameter (DC), number of leaves (NF) and leaf area (AF) of cherry tomatoes after 86 days of emergence subjected to water restriction at different phenological stages.

Source of Variation	Degrees of Freedom	mean square			
		AP (cm)	DC (mm)	NF	AF (cm^2)
Treatments	7	376.1 ***	0.5 ns	11909 ns	7.0 *
Block	3	251.6 ns	0.3 ns	10909 ns	1.4 ns
Errors	21	92.9	0.3	3916	4.1
CV(%)		6.5	4.8	11.7	7.6

***, * indicate significance at 0.001 and 0.05 probabilities, respectively; ns – not significant; CV – coefficient of variation.

As shown in Figure 1B, the leaf area differed significantly among the treatments, as the T3, T7 and T8 treatments, which had 50% Etc applied in the flowering phase, presented lower AFs than did the other treatments. This result differs from that observed by Sobrinho et al. (2020), which indicates that there was no difference in leaf area values under the application of different irrigation depths for tomato plants (*Solanum lycopersicum* L.). The availability of water, when sufficient, favors the performance of physiological processes in plants, resulting in leaf growth and consequently leaf area.

Figure 1. Plant height - AP (A), leaf area - AF (B) at 86 days after emergence, subjected to water restriction at different phenological stages of cherry tomato cultivation in a protected environment.



Data followed by the same letters in the columns do not differ from each other according to Scott–Knott, with 5% significance.

No significant differences were observed in the parameters of leaf number and stem diameter, resulting in averages of 26 leaves and 12.2 mm, respectively. According to Brito et al. (2015), given that the main resource drain for tomato plants is fruit, variability in the growth rate of stem diameter is expected. However, this variability was not observed in the present study, since water stress was applied at all phenological stages and stem growth occurs throughout the crop cycle.

6 CONCLUSIONS

T3 (water deficiency during the flowering stage) and T7 (water deficiency in the vegetative and flowering stages) presented a 50% reduction in the number of blades during the flowering period, which resulted in greater values of both plant height and leaf area.

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