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PRODUTIVIDADE DA MELANCIA CULTIVADA COM LÂMINA REDUZIDA DE IRRIGAÇÃO EM CLIMA AMENO

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1 RESUMO

O objetivo do trabalho foi avaliar no Cerrado Goiano o desempenho produtivo da melancia quando submetida a uma lâmina reduzida de irrigação durante a estação de baixa pluviosidade e clima ameno. O experimento foi conduzido no período de abril a julho de 2021 no campo experimental da Fazenda Escola do Instituto Federal Goiano, Campus Iporá, o qual apresenta solo classificado como Neossolo Litólico distrófico. Empregou se o delineamento experimental em blocos casualizados com dois tratamentos: 100 % e 50% da evapotranspiração de referência (ET_0) calculada pelo método de Penman-Monteith. As variáveis morfológicas produtivas avaliadas após a colheita dos frutos, foram: massa dos frutos, diâmetro equatorial, espessura da casca, espessura da polpa, teor de sólidos solúveis e produtividade. Os resultados indicaram não haver interação estatisticamente significativa entre os parâmetros avaliados e o tipo de lâmina de irrigação aplicada (100% ou 50% da ET_0). Também não foram observados efeitos negativos nas características morfológicas dos frutos ao se utilizar a lâmina de irrigação reduzida (50% da ET_0) no cultivo da melancia em clima ameno, sendo assim é recomendada o seu uso em situações semelhantes de cultivo.

Palavras-chave: manejo da água, evapotranspiração, Cerrado, microirrigação.

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YIELD OF WATERMELON GROWN UNDER REDUCED IRRIGATION DEPTH IN A MILD CLIMATE

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2 ABSTRACT

The aim of this work was to evaluate the production performance of watermelon under reduced irrigation depth during the low-rainfall season and under a mild climate in the Cerrado Goiano. The experiment was conducted from April to July 2021 in the experimental field of the Fazenda Escola of the Goiano Federal Institute, Campus Iporá, which presents soil classified as dystrophic Lithic Entisols. A randomized block experimental design was used with two treatments: 100% and 50% of the reference evapotranspiration (ET_0) was calculated via the Penman–Monteith method. The productive morphological variables assessed after fruit harvest were fruit mass, equatorial diameter, skin thickness, pulp thickness, soluble solids content, and yield. The results revealed no statistically significant interaction between the parameters evaluated and the type of irrigation applied (100% or 50% of the ET_0). Additionally, there were no negative effects on the morphological characteristics of the fruit when a reduced irrigation depth (50% of the ET_0) was used when watermelon was grown in a mild climate, so its use is recommended under similar growing conditions.

Keywords: water management, evapotranspiration, Cerrado, microirrigation.

3 INTRODUCTION

Watermelon (*Citrullus lanatus* (Thunb.) Matsun & Nakai) has great economic and social importance. In 2017, Brazil produced 2.24 million tons, with an average productivity of 22.0 t ha $^{-1}$ (Resende; Yuri, 2021). In 2020, the state of Goiás, located in the Central-West region, had the highest national productivity, at 41.3 t ha $^{-1}$ (IBGE, 2021).

Among the different species that make up the Cucurbitaceae family, watermelon is the one that least tolerates low temperatures and is typically a hot climate crop (Resende; Yuri, 2021). Its cultivation system can be either irrigated or rainfed (without irrigation), with the advantage that in irrigated systems, production can be obtained throughout the year.

However, irrigated agriculture is dependent on the amount of water resources available, and in some regions, there is a scarcity of water in springs due to climatic conditions (Nascimento *et al.*, 2021).

The lack of water is a factor related to environmental stress that can affect the full development of agricultural crops (Vidal *et al.*, 2013; Marouelli *et al.*, 2017), consequently influencing their productivity. In recent years, water resources, which are of adequate quality and/or quantity, have become increasingly limited, but at the same time, they continue to play an important role in economic and social development in rural areas. In this way, its conscious use minimizes the possibility of a water crisis and allows the achievement of more sustainable socioeconomic development (Turco; Araújo Júnior, 2021).

In regions where there are months with low rainfall due to the local climate pattern, there are conflicts between multiple users over the use of water (Nascimento *et al.*, 2021). In this context, agriculture can suffer strong impacts, as in prolonged periods of drought, water scarcity is worsened, which decreases crop productivity (Pellegrino; Assad; Marin, 2017). In this scenario of climate change, the use of irrigation with reduced water depths can be an ally to the rational use of water without a significant reduction in crop productivity.

In Goiás, watermelon is cultivated the most in the warmer months. However, in addition to productivity, it is interesting to consider its cultivation at alternative planting times to traditional ones, providing the farmer with greater possibilities for competitiveness and profitability owing to the low availability of the product on the market. Therefore, it is interesting to study crop productivity at alternative planting times to take advantage of the market window resulting from seasonality in product supply.

In view of the above, the objective of this work was to evaluate the productive performance of watermelon when subjected to a reduced irrigation depth during the season of low rainfall and a mild climate in the Cerrado of Goiano.

4 MATERIALS AND METHODS

The experiment was conducted under mild temperature conditions (Resende; Yuri, 2021) from April to July 2021 in the experimental field of the Fazenda Escola do Instituto Federal Goiano, Campus Iporá (16°25' 29” S, 51°09' 04” W and an altitude of 584 m). According to the Koppen classification, the climate is type AW, savanna, with a drier season in winter. The soil in question was classified as Neossolo Dystrophic litholic (EMBRAPA, 2018), with a predominance of quartz gravel (20.0–2.00 mm) in its mineral fraction.

The Plugfield model WS18 meteorological station was installed close to the experimental site. Table 1 presents the averages for the following variables: air temperature, relative humidity, wind speed, precipitation and reference evapotranspiration.

Table 1. Average monthly data of climate variables measured during the experiment, Iporá, Goiás, 2021

Month	Temperature of air (C°)	Relative humidity donate (%)	Speed of Wind (ms $^{-1}$)	Precipitation (mm)*	Et $_0$ (mm)
April	24.1	72.2	2.7	3.7	3.7
May	23.1	67.1	3.0	1.0	3.6
June	22.2	61.7	3.3	0.1	4.4
July	21.3	45.5	4.0	0.0	4.2
Average	22.7	61.6	3.2	1.2	4.0

*Total monthly rainfall values; ET $_0$ = reference evapotranspiration.
Source: Survey data (2021)

The experimental design was randomized blocks, with two treatments: 100 and 50% of reference evapotranspiration (ET $_0$), with three replications. Reference evapotranspiration was determined via the standard Penman–Monteith method parameterized by the United Nations Agriculture Organization (Allen *et al*., 1998), with data provided by an agrometeorological station installed 50 m from the experimental area (Plugfield, WS-18).

The experimental area was composed of five watermelon lines from the crimson cultivar sweet, with a spacing of 1.0 × 2.0 m between plants and between rows. To avoid border effects, the two lines at each end and the plants at the ends of each line were disregarded when the samples were taken. Within the blocks, the treatments were randomly distributed according to the proposed treatments.

The soil was prepared conventionally (plowing and harrowing). Thirty days before the seedlings were transplanted, the area was fertilized with cattle manure at a dosage of 5 liters per hole, together with chemical fertilizer, and then both were turned over with the soil for later planting of the seedlings. Sowing was carried out on April 21st in 180 ml disposable cups, which remained in a nursery with irrigation until transplanting, which occurred thirteen days after seedling emergence. Transplanting took place in soil with moisture close to field capacity. The fertilization carried out on the crop followed the recommendations of Embrapa (2007), as did the cultural treatments carried out, thinning and weeding, which were carried out manually according to need. Phytosanitary treatments common to the crop were also carried out.

For irrigation, a drip system was used. The pumping system consisted of a 120 W solar motor pump, which worked with a 150 Wp photovoltaic panel and pumped the water into a reservoir with a capacity of 10,000 liters, which fed the gravity irrigation system. The irrigation system consisted of a 40 mm main pipe and 16 mm lateral lines, with drippers and a flow rate of 8 L h $^{-1}$. After the irrigation system was assembled and distributed, the Christiansen uniformity coefficient (CUC) was determined for each lateral line, obtaining a value of 91%. One lateral line was installed per plant row, each 15 m long and spaced 2.0 m apart. Irrigation management consisted of daily irrigation.

To allow the initial homogeneous establishment of the crop, all lines were irrigated uniformly during the first 7 (seven) days of the crop in the field, increasing the soil moisture to field capacity. Irrigation management was carried out with the aid of an electronic spreadsheet, which took into account the crop coefficient (Kc) and the coverage coefficient (Kr) to calculate evapotranspiration in drip-irrigated systems. The crop coefficients used were 0.39 up to 22 days after emergence (DAE), 1.31 from 23 DAE to 56 DAE and 0.7 from 57 DAE until fruit harvest (Doorenbos; Kassam, 1979). The coverage coefficients used were 0.45 when the crop had only 20% soil coverage, 0.55 when it had 30% soil coverage, 0.71 when there was 50% soil coverage and 1 when there was 100% soil coverage (Keller; Bliesner, 1990).

The fruits were harvested 87 days after planting (DAP). After harvest, the following productive variables were evaluated: fruit mass (kg), equatorial diameter (cm), peel thickness (cm), pulp thickness (cm), soluble solids content (°Brix) and productivity (kg ha $^{-1}$). Water productivity (kg L $^{-1}$) was also calculated, that is, how much water was needed to produce 1 kg of fruit in 1 m². For this purpose, the value of the ratio between crop productivity (kg m $^{-2}$) and total water consumption (irrigation and precipitation) in the crop cycle (L m $^{-2}$) was determined.

The results were subjected to analysis of variance, and the means were compared via the Tukey test at a 5% probability level via the SISVAR statistical analysis program (Ferreira, 2011).

5 RESULTS AND DISCUSSION

According to Table 2, which presents the results of the analysis of variance for the evaluations of the fruits after harvest, there was no significant effect ($p < 0.05$) for the factors evaluated in isolation or for the analysis of their interaction.

Table 2. Summary of the analysis of variance of the general means of the factors: fruit mass (MF) in kg, equatorial diameter (DE) in cm, peel thickness (EC) in cm, pulp thickness (EP) in cm, content of soluble solids (SS) in °Brix and productivity (kg ha $^{-1}$) in irrigated watermelon cultivated with reduced depth in a drip system.

	Medium Squares						
	GL	MF	IN	EC	EP	SS	Productivity
Blade	1	0.50 ^{ns}	3.55 ^{ns}	0.00 ^{ns}	17,01 ^{ns}	0,00 ^{ns}	1,80 x 10^{7} ^{ns}
Bloco	2	3,73 ^{ns}	119,35 ^{ns}	0,83 ^{ns}	5,25 ^{ns}	8,22 ^{ns}	3,14 x 10^{8} ^{ns}
Repetição	2	0,58 ^{ns}	15,26 ^{ns}	0,46 ^{ns}	5,28 ^{ns}	1.05 ^{ns}	1.57 x 10^{8} ^{ns}
Residue	12	1.05	27.14	0.18	6.46	2.55	3.02 x 10^{7}
Total	17						

*significant in the F test at the 5% probability level; ^{ns} not significant; GL= degrees of freedom.

As shown in Table 3, there was no statistically significant difference between the total lamina (100% of ET $_0$) and reduced lamina (50% of ET $_0$) treatments according to the Tukey test at a significance level of 5%. This finding shows that it is possible to produce watermelon crops with positive results by using a smaller amount of water, which is quite advantageous both in terms of saving water and reducing energy consumption.

Table 3. Test of means for fruit mass (MF) in kg, equatorial diameter (DE) in cm, peel thickness (EC) in cm, pulp thickness (EP) in cm, soluble solids content (SS) in °Brix and productivity in kg ha $^{-1}$ with two treatments: 100% of the reference evapotranspiration and 50% of the reference evapotranspiration (ET $_0$) calculated by Penman–Monteith for the city of Iporá.

ET $_0$	MF	Productivity	IN	EC	EP	SS
100	2.82 to	19,916.67 a	25.61 a	1.32 to	12.42 a	8.78 to
50	3.15 to	17,915.55 a	26.50 to	1.32 to	14.37 a	8.78 to

*Averages followed by the same letter do not differ statistically according to the Tukey test at the 5% probability level.

Similar results were reported by Silva *et al*. (2015), when studying watermelon cultivation in the summer of Pernambuco, the authors reported the highest results for the average fruit mass parameter, equal to 7.03 and 6.45 kg, in treatments with reduced irrigation depths, equivalent to 60% and 80% crop evapotranspiration, respectively. In contrast, Teodoro *et al.* (2004), when studying the Crimson Sweet watermelon cultivar in the Minas Gerais winter, reported different results, verifying that the highest average fruit mass, equal to 7.9 kg, was obtained for the treatment with an irrigation depth corresponding to 120% evaporation. of the Class A tank.

In the present study, the entire experiment took place with minimum temperatures below 18°C, and on 7 (seven) days, temperatures below 10°C were observed. The average temperature was less than 25°C for all months, as shown in Table 1. The Cucurbitaceae family adapts better to hot and semiarid areas, which have greater luminosity and average temperatures between 18°C and 30°C and do not develop well at temperatures below 10°C. Among the different species that make up cucurbits, watermelon is the one that tolerates the lowest temperatures, especially during the germination and emergence periods; that is, watermelon is a hot climate that is strongly influenced by environmental conditions, especially temperature (Resende; Yuri, 2021). The most suitable average air temperature for its growth and development should be approximately 25°C (Resende; Yuri, 2006).

Oliveira *et al*. (2015) reported that fruit productivity and quality are significantly affected by planting time. In this context, Resende and Yuri (2021) reported that growing watermelon in warmer months, such as August, can result in greater fresh fruit mass and productivity.

In general, low temperature limits both growth and photosynthesis (Taiz *et al., 2017) by reducing the CO2 (A)* assimilation rate. However, one of the causes reported in the literature for some crops, related to the reduction in the $CO2_{\text{assimilation rate}}$ under low temperatures, is the restriction of the growth activity of the drains (Boese; Huner, 1990). Cucurbits allow several ways to manipulate the source and sink relationship, and these modifications directly influence the productivity and quality of fruits at harvest. Thus, it appears that in Cucurbitaceae, the fruit constitutes a large drain in relation to the plant as a whole, altering the distribution of assimilates between the plant's organs (Valantin *et al*., 2006).

Competition for photoassimilates between sinks affects plant growth and fruit setting in many species, and in watermelon, fruits are considered preferential sinks after pollination in relation to vegetative growth, potentially altering the source and sink relationships during plant development. plant (Lins *et al*., 2013).

$_2$ assimilation rates and growth during winter are significantly lower than those in spring and summer (Habermann; Rodrigues, 2009). Thus, the reduction in the rate of $CO2_{\text{assimilation}}$ in winter compared with that in summer is generally not associated with daytime temperature but rather with low nighttime air and soil temperatures (Machado *et al.*, 2010). During the winter months, in addition to cold nights, days with mild temperatures are often observed, which influences the development of crops such as watermelon.

It is also important to consider the photoperiod that benefits the growth and flowering of the plant, in which long hot days and hot nights (hot, dry summer) are ideal for watermelon cultivation (Resende; Yuri, 2006). Owing to its hot climate and low relative humidity, the plant produces high-quality fruits with a high sugar content and flavor, which does not occur in areas with a cold climate (Filgueira, 2000). However, as previously discussed, mild temperature influences crop performance in the field, reducing productivity according to the results presented in Table 3. The relative humidity during the experiment (Table 1) was possibly not a limiting factor, as the suitable range for watermelon cultivation is approximately 60--80% (Resende; Yuri, 2006).

With respect to water consumption, when watermelon plants were managed at a 100% depth, that is, with 199.3 mm of water, the water productivity was 0.010 kg L^{-1}, whereas at a 50% depth, a water productivity of 0.017 kg $L^{-1 \text{ was achieved}}$. Therefore, under dry climate conditions and mild temperatures, the use of a reduced irrigation depth (50% of ET_0) may be viable for watermelon cultivation without significantly affecting watermelon productivity or fruit quality, since the aforementioned results demonstrate that, with 50% less water, it was possible to obtain 57% greater water productivity, guaranteeing an average productivity equivalent to 90%, equal to 17,915.55 kg ha^{-1}, of that achieved with 100%, equal to 19,916.67 kg ha^{-1} (Table 3), which translates into savings in water resources and energy resources.

Notably, the careful choice of cultivar with the definition of the best materials that adapt to local cultivation conditions is fundamental to the success of the adopted cultivation system in terms of the profitability of the crop between harvests, providing greater competitiveness for the farmer. .

6 CONCLUSIONS

Cultivating watermelon in a mild climate and with an irrigation depth equivalent to 50% of the reference evapotranspiration does not imply significant losses in production variables, presenting results superior to or similar to those with an irrigation depth equivalent to 100% of the reference evapotranspiration.

Future studies are necessary to verify the economic viability of installing irrigation systems since the vast majority of local producers are small producers. With this, it would be possible to increase watermelon production beyond rainfed planting in the municipality of Iporá, especially when there is a more competitive price on the market, thus contributing to the development of local agriculture.

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