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DETERMINAÇÃO DAS NECESSIDADES HÍDRICAS DO MELOEIRO PARA DUAS ÉPOCAS DE PLANTIO, NA REGIÃO DO SUBMÉDIO DO VALE DO SÃO FRANCISCO

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1 RESUMO

O objetivo deste estudo foi determinar a evapotranspiração da cultura (ETc) e o coeficiente de cultura (Kc) do meloeiro para duas épocas de plantio na região do Submédio do Vale do São Francisco. A pesquisa foi realizada na área experimental com estrutura de evapotranspirômetros de lençol freático constante, da Universidade do Estado da Bahia-UNEB em Juazeiro-BA. Foram realizados dois experimentos, (outubro a dezembro de 2019 e o outro de junho a agosto de 2020). Utilizou-se duas cultivares de melão, a Gladial e a Cantaloupe. O Kc foi determinado com base na ETc, obtidos nos evapotranspirômetros, e na evapotranspiração de referência (ETo) estimada pelo método Penman-Monteith. O consumo hídrico médio das cultivares de melão Gladial e Cantaloupe em 2019 foram respectivamente, 323,5 e 292,0 mm e em 2020 179,7 e 179,3 mm. O Kc foi em média de 0,81 para cv. Gladial e 0,77 para a cv. Cantaloupe (2019) e de 0,68 e 0,66 para as cultivares Gladial e Cantaloupe, respectivamente, em 2020. Diferenças no requerimento hídrico de cultivares de meloeiro estão associadas às características genéticas, condições climáticas e técnicas de cultivo.

Palavras-chave: *cucumis melo* L, coeficiente de cultura, evapotranspiração da cultura.

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DETERMINATION THE WATER NEEDS OF MELON FOR TWO PLANTING SEASONS, IN THE SUBMEDIUM REGION OF VALE DO SÃO FRANCISCO

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2 ABSTRACT

The objective of this study was to determine crop evapotranspiration (ETc) and crop coefficient (Kc) of melon for two planting times in the Sub-Medium region of the São Francisco Valley. The research was carried out in the experimental area with a constant water table evapotranspirometer structure, at the State University of Bahia-UNEB in Juazeiro-BA. Two experiments were carried out, (October to December 2019 and the other from June to August 2020). Two melon cultivars were used, Gladial and Cantaloupe. Kc was determined based on ETc, obtained from evapotranspirometers, and on reference evapotranspiration (ETo) estimated by the Penman-Monteith method. The average water consumption of Gladial and Cantaloupe melon cultivars in 2019 were, respectively, 323.5 and 292.0 mm, and in 2020, 179.7 and 179.3 mm. Kc averaged 0.81 for hp. Gladial and 0.77 for cv. Cantaloupe (2019) and 0.68 and 0.66 for the Gladial and Cantaloupe cultivars, respectively, in 2020. Differences in the water requirement of melon cultivars are associated with genetic characteristics, climatic conditions and cultivation techniques.

Keywords: *cucumis melo* L, crop coefficient, culture evapotranspiration

3 INTRODUCTION

The Northeast Region stands out as the main producer and exporter of melon, accounting for approximately 95% of national production, with an emphasis on Rio Grande do Norte, which in 2020 accounted for approximately 61.2% of national production (BELING, 2022). The Submiddle São Francisco Valley has edaphoclimatic and logistical characteristics favorable for vegetable production; it is a pioneering region in melon cultivation in Brazil, occupying an area of 3,000 hectares with an average productivity of 20 tons/ha (ARAÚJO; LIMA, 2019).

Localized irrigation, in addition to increasing crop productivity, can increase the total biomass production of cultivated areas (MAGALHÃES *et al.*, 2021). However, water waste is frequent due to several factors, such as inadequate management, excessive or restrictive water availability, and inadequate control of surface runoff, generating opportunities to improve water efficiency and productivity (IBIDHI; SALEM, 2020), which requires efficient management in irrigated agriculture for rational use of water resources (HAN *et al.*, 2018; CETIN; KARA, 2021).

When using localized irrigation, it is important that irrigation management be based on technical parameters, especially given the global concern for water conservation. In this context, knowing the correct amount and timing of water replenishment for melon plants is not easy, as several factors are involved, such as the region's climate conditions and the plant's physiological characteristics (CARVALHO; OLIVEIRA, 2012).

One way to manage irrigation is based on the replacement of ETc, which consists of the product between ETo and Kc. To determine the cultivation coefficient for a crop in a given region, ETc is normally used, which can be determined through direct methods such as the use of lysimeters and the estimation of ETo via various methods via empirical equations (Alves *et al.* (2018)).

As ETo represents an indicator of climatic demand, Kc varies primarily as a function of crop characteristics, varying only slightly with climate. Because climate influences Kc variation in a small way, the transfer of standard crop coefficient values between different geographic areas and climates constitutes the primary acceptance and use of Kc values developed in previous research (ALLEN *et al.*, 2006).

However, because evaporation and transpiration are highly sensitive to microclimatic variations, the magnitude of evapotranspiration varies over time and space. Therefore, it is extremely important to verify the accuracy of models before they are used under climatic and agronomic conditions different from those for which they were originally designed, as well as the accuracy of the measurements of the climatic variables included in the models (DOORENBOS; PRUITT, 1997).

In this context, determining the water supply required for crop development through crop evapotranspiration (ETc) is very important for adequate irrigation management, an indispensable technology, especially for regions with high atmospheric demand, with the aim of providing productivity with water efficiency (SOUZA *et al.*, 2019).

Given the above, the objective of this study was to determine the evapotranspiration and crop coefficient of melon for different planting seasons in the submiddle region of the São Francisco Valley.

4 MATERIALS AND METHODS

The study was conducted in an experimental area of the Department of Technology and Social Sciences (DTCS) of the State University of Bahia-UNEB in the municipality of Juazeiro (Lat. 09° 24' 50” S; Long. 40° 30' 10” W; Alt. 368 m), in two seasons: from October to December 2019 (hot period) and from June to August 2020 (cold period).

According to the Köppen classification, the region's climate is Bswh, semiarid, characterized by high temperatures with average maximums of 29.3 to 33.9°C (SANTIAGO *et al.*, 2021) and low relative humidity, with a dry season between the months of May and October and a rainy season between the months of November and April.

The soil in the experimental area was classified as Neosol Fluvic with a loamy sand texture, an average pH value, adequate base saturation for its texture and high levels of phosphorus (P) $^{\text{and } Mg2+}$ and low levels of $^{K+}$, $^{Ca2+}$ and organic matter (Tables 1 and 2).

Table 1 Physical-hydric characterization of the soil cultivated with melon, cv. Gladial and cv. Cantaloupe, in Juazeiro-BA .

Granulometry g kg $^{-1}$			**Clay dispersed in water g kg $^{-1}$**	**Density kg dm $^{-3}$**		
Sand	**Silt**	**Clay**		**Real**	**Apparent**	**Textural class**
861	107	32	14	2.74	1.50	Loamy sand

Table 2 Chemical characterization of the soil in the area cultivated with melon, cv. Gladial and cv. **Cantaloupe**, in Juazeiro-BA.

pH	**EC/25°C**	**Assortative complex (cmol c dm -³/TFSA .)**								**V%**	**mg dm -³**		**g kg $^{-1}$**	
01:02.5 H_2O	dS m $^{-1}$ Ext.Sat	Ca $^{2+}$	Mg $^{2+}$	In the $^{+}$	K $^{+}$	SB	H+Al	CTC	Al $^{3+}$	-	S	P	W	MO
6.9	0.5	2.8	1	0.1	0.2	4.1	0.66	4.72	0	86	*	61.12	3	5.8

* – not requested.

Evapotransrometers (5.0 m² and 1.30 m deep) are installed in the center of the experimental area to determine the water consumption of the crops.

Figure 1. Constant water table evapotranspiration

Two melon cultivars were used: gladial from the Inodorus group and Caribbean gold from the Cantalupensis group, both of which are widely produced in the semiarid region of Northeast China. The melon cultivars were sown in polyethylene trays containing Plantmax® substrate. During the warm season, sowing took place on the first day of October 2019, and transplanting took place on the eighteenth day of the same month and year. During the cold season, planting took place on the third day of June 2020, and transplanting took place on the seventeenth day of the same month and year.

To obtain the crop coefficient (Kc), the daily evapotranspiration values (ETc in mm day $^{-1}$) observed in the constant water table evapotranspiration meters were divided by the respective daily reference evapotranspiration values (ETo) obtained from the Penman–Monteith method parameterized by the FAO (ALLEN *et al.*, 1998). To estimate ETo, the following expressions were used:

The Penman–Monteith method is parameterized by the FAO (ALLEN *et al.*, 1998) (Eq. 1):

$$ETo = \frac{0,408\Delta(Rn-G)+\frac{\gamma 900 U_2(e_s-e_a)}{t+273}}{\Delta+\gamma(1+0,34U_2)} \qquad (1)$$

where ETo is the reference evapotranspiration (mm day $^{-1}$); Rn is the total daily net radiation (MJ m $^{-2}$ day $^{-1}$); G is the soil heat flux (MJ m $^{-2}$ day $^{-1}$); γ is the psychrometric parameter (kPa °C $^{-1}$); U_2 is the wind speed at 2 m height (m $^{-1}$); es is the saturation vapor pressure (kPa); ea is the partial vapor pressure (kPa); T is the average daily air temperature (°C); and Δ is the slope of the vapor pressure curve in relation to the air temperature (kPa °C $^{-1}$).

The input climate data for the ETo estimation methods were obtained from the DTCS/UNEB automatic meteorological station, which was installed in front of the experimental area.

Considering that the occurrence of rainfall implies an increase in soil moisture and even draining excess water in the evapotranspiration system, the soil remains at field capacity, with no or small variations in the ETc values, consequently affecting the Kc values, a simple moving average was applied, as described by Smail *et al.* (2019) in equation 2, to smooth the daily behavior of the crop coefficients obtained throughout the cycle of melon cultivars.

$$Mv_i = \frac{1}{k} \sum_{j=i-k+1}^{i} \left(Kc\right)_j \quad (2)$$

k is the length of the moving window. For the two study periods and melon cultivars, moving windows of 5 (five) days were adopted; M *vi* is the moving average for each time period i, with the initial day j greater than zero.

For the phenological description of melon cultivars, four stages were considered, as proposed by Allen *et al.* (2006): I - initial phase: from transplanting to 10% soil cover; II - growth phase: from the end of the initial phase to 80% soil cover; III - reproductive phase - from 80% soil cover to the beginning of fruit ripening; IV) final phase: from the beginning of ripening to fruit harvesting.

All the statistical analyses were performed via RStudio Software version 2022.02.2 with R core version 4.2.0 (R FOUNDATION TEAM, 2022).

5 RESULTS AND DISCUSSION

In the first trial, 82 days elapsed from sowing to harvest, corresponding to the period from 10/01/2019 to 12/21/2019 (hot period); the fruits of cv. Gladial reached maturity at 64 days after transplanting (DAT), whereas those of cv. Cantaloupe reached maturity earlier, at 61 DAT (Table 3).

In the second trial, sowing was carried out on June 3, 2020, and harvesting was carried out on August 24, 2020 (cold period), totaling 83 days. In this last period, when temperatures were relatively mild, there was practically no difference in the number of days for the cycle of the two melon cultivars, 68 and 67 days, for cv. Gladial and Cantaloupe, respectively. Costa *et al.* (2017) reported that the fruits of cv. Cantaloupe have a small internal cavity and a firm, orange-colored pulp, with the beginning of harvest close to 65 days. The number of days to maturation reported in the present study for the two melon cultivars was very close to that reported by Oliveira, Leitão, and Almeida (2010) for cv. Amarelo ouro (62 days), which was grown without mulching in the second half of the year and in the same study region. This suggests that the use of mulching did not influence the cultivar cycle compared with cultivation without the use of such technology.

The highest average daily temperature (28.7°C) was observed for the different crop development stages at stage III (reproductive) for the Gladial cultivar and at stage IV for the Cantaloupe cultivar. Rainfall was observed at all phenological stages of the crop, with the highest rate recorded at stage III for both cultivars, totaling 42.4 mm. Notably, this precipitation occurred on only one day (DAT 38); the total precipitation throughout the experiment was 57.5 mm.

Considering the entire crop cycle, the following average temperature values were observed: a maximum of 35.4°C, an average of 28.5°C, and a minimum of 22.4°C. The global solar radiation ranged from 14.0 MJ m^{-2} d^{-1} to 23.7 MJ m^{-2} d^{-1}, with an average of 20.9 MJ m^{-2} d^{-1}. The relative humidity averaged 48.9%, and the wind speed was 1.8 ms^{-1}.

Table 3. Duration in days of the different development stages of the melon crop and average values of the meteorological variables for the different development stages of the Gladial and Cantaloupe melon cultivars. Warm period: October to December 2019.

Gladial Melon								
Stadiums	Duration	Air temperature (°C)			UR	Rg	U	PP
-	(days)	Med	Max	Min	(%)	($Mjm^{-2}day^{-1}$)	(ms^{-1})	(mm)
I	7	28.4	35.4	22.4	52.2	22.4	1.5	8.9
II	19	28.4	35.1	22.3	46.4	21.6	2.1	1.1
III	21	28.7	35.8	22.4	49.7	20.3	1.6	42.4
IV	17	28.5	35.2	22.5	49.4	20.2	1.9	5.1
TOTAL	64	-	-	-	-	-	-	57.5
Cantaloupe melon								
Stadiums	Duration	Air temperature (°C)			UR	Rg	U	PP
-	(days)	Med	Max	Min	(%)	($Mjm^{-2}day^{-1}$)	(ms^{-1})	(mm)
I	7	28.4	35.4	22.4	52.2	22.4	1.5	8.9
II	17	28.3	35.1	22.3	46.8	21.7	2.1	1.1
III	20	28.5	35.5	22.6	49.9	20.2	1.7	42.4
IV	17	28.7	35.6	22.1	49.8	20.3	1.7	5.1
TOTAL	61	-	-	-	-	-	-	57.5

Initial; II- Growth; III – Reproductive; IV- Final. Temperatures: average (Med), maximum (Max), minimum (Min), relative humidity (RH), global solar radiation (Rg), wind speed (U) and rainfall (PP).

An analysis of the climatic conditions for the cold period (Table 4) revealed that the highest average temperature was 24.1°C, occurring in stages II (growth) and IV (final) for both melon cultivars. Rainfall was also observed in all phenological stages of the crop, with the highest index recorded in Stage IV for both cultivars, totaling 3.0 mm. Notably, the total precipitation in this period throughout the crop cycle was 7.8 mm.

Considering the entire crop cycle, the following average temperature values were observed: a maximum of 30.0°C, an average of 23.7°C, and a minimum of 18.4°C. The global solar radiation ranged from 8.7 MJ m^{-2} d^{-1} to 19.7 MJ m^{-2} d^{-1}, with an average of 14.2 MJ m^{-2} d^{-1}. The average relative humidity was 65.2%, and the wind speed was 2.1 ms^{-1}.

Table 4. Duration in days of the different development stages of the melon crop and average values of the meteorological variables for the different development stages of the Gladial and Cantaloupe melon cultivars. Cold period: June to August 2020.

Gladial Melon								
Stadiums	Duration	Air temperature (°C)			UR	Rg	U	PP
-	(days)	Med	Max	Min	(%)	(Mjm^{-2}day^{-1})	(ms^{-1})	(mm)
I	9	23.6	29.1	19.2	72.2	11.5	2.3	1
II	20	24.1	30.4	18.8	65.4	14	1.8	2
III	20	23.2	29.1	18.2	64.8	13.5	2.3	1.8
IV	19	24.1	30.8	17.9	62	16.4	2.1	3
TOTAL	68	-	-	-	-	-	-	7.8
Cantaloupe melon								
Stadiums	Duration	Air temperature (°C)			UR	Rg	U	PP
-	(days)	Med	Max	Min	(%)	(Mjm^{-2}day^{-1})	(ms^{-1})	(mm)
I	9	23.6	29.1	19.2	72.2	11.5	2.3	1
II	18	24.1	30.5	18.7	64.6	14.2	1.8	2
III	21	23.3	29.2	18.2	64.8	13.6	2.3	1.8
IV	19	24.1	30.8	17.9	62	16.4	2.1	3
TOTAL	67	-	-	-	-	-	-	7.8

Initial; II- Growth; III – Reproductive; IV- Final. Temperatures: average (Med), maximum (Max), minimum (Min), relative humidity (RH), global solar radiation (Rg), wind speed (U) and rainfall (PP).

Climatic factors such as temperature and relative humidity, precipitation, and solar radiation influence melon growth, development, fruit quality, and productivity (ANGELOTTI; COSTA, 2010). The average temperatures observed during the two periods studied (warm and cold) were within the range considered optimal for crop development, i.e., 20 to 30°C (CRISÓSTOMO *et al.*, 2002); however, the average temperatures found for the different stages of crop development during the cold period were below the range considered ideal for good melon development, as indicated by Angelotti and Costa (2010). These authors described that the ideal temperature should be between 25 and 30°C; they also explained that temperatures above 35°C stimulate the formation of male flowers, and temperatures above 38°C cause problems with fruit ripening. Temperatures below 12°C and above 40°C harm the vegetative development of melons (OLIVEIRA *et al.*, 2017).

Cavalcante Neto *et al.* (2020) reported that melon cultivation in semiarid regions has been successful, mainly because of environmental conditions such as low annual precipitation, high temperatures, and intense solar radiation. Dalastra (2014) reported that melons produced under conditions of high relative humidity are generally small and have low sugar contents due to the occurrence of fungal diseases that cause leaf drop. Therefore, on the basis of the data presented in Tables 3 and 4, the most favorable climatic conditions for melon cultivation were those observed during the warm season.

Table 5 shows that, with the exception of stage IV, the evapotranspiration of cv. Gladial was greater than that of cv. Cantaloupe, with the greatest difference observed in stage II (20%). This greater difference is certainly justified by crop characteristics, such as larger size and the requirement for the number of days to complete the phenological stage. Notably, at this stage, the climatic conditions were favorable for greater transfer of water vapor to the atmosphere: low relative humidity (46.4%), high incidence of solar radiation (21.6 MJ m^{-2} d^{-1}), and high wind speed (2.1 m s^{-1}) (Table 3). Allen *et al.* (1998) reported that the water requirements differ for different types of melon and that the cantaloup cultivar requires approximately 25% less water than the yellow melon cultivar does, in addition to tolerating lower soil water contents. Despite the lower water requirement of the Cantaloupe cultivar, as reported by the authors, Table 5 shows that at stage IV, the ETc of this cultivar exceeded the ETc of Gladial by approximately 9%. The higher ETc of the cantaloup cultivar at this stage is probably associated with the greater number of fruits of the cultivar, as well as greater soil exposure.

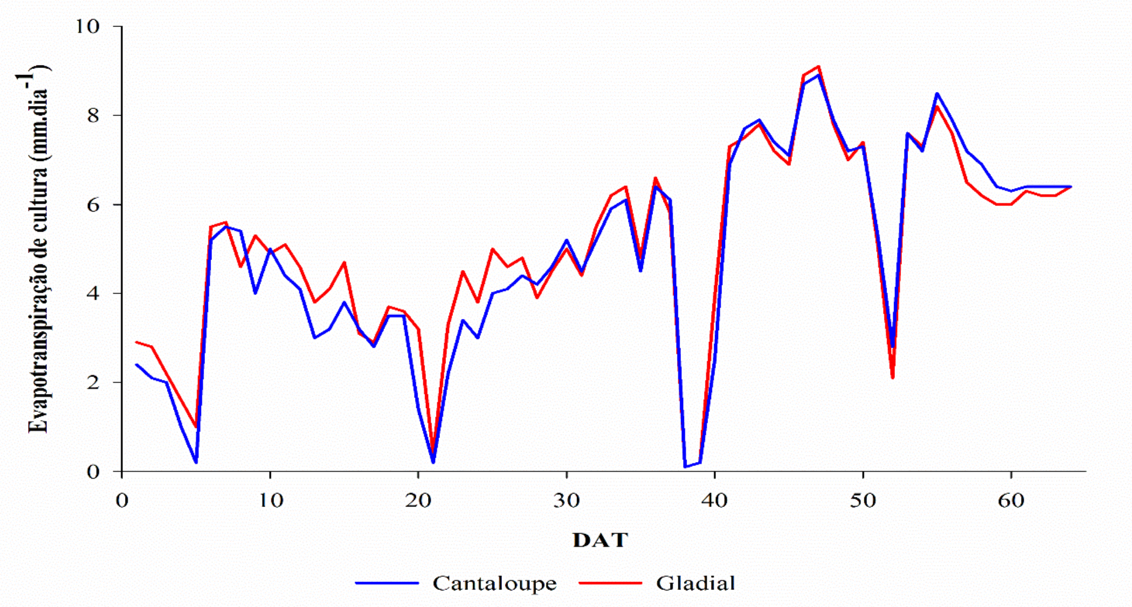
Table 5. Duration in days of the different development stages of the melon crop, Gladial and Cantaloupe cultivars, average evapotranspiration values and crop coefficients for the hot period: October to December 2019.

	Gladial Melon				**Cantaloupe melon**			
Stadiums	Duration (days)	ETo (mm d^{-1})	Etc (mm d^{-1})	Kc	Duration (days)	ETo (mm d^{-1})	Etc (mm d^{-1})	Kc
I	7	5.78	3.09	0.53	7	5.78	2.63	0.46
II	19	6.34	3.96	0.62	17	6.32	3.3	0.52
III	21	5.65	5.56	0.98	20	5.67	4.9	0.86
IV	17	5.82	6.46	1.11	17	5.75	7.04	1.22
TOTAL	64	-	-	-	61	-	-	-

I – Initial; II- Growth; III – Reproductive; IV- Final. Reference evapotranspiration (ETo); Crop evapotranspiration (ETc); Crop coefficient (Kc).

Considering the crop cycle, the evapotranspiration of cv. Gladial presented average daily values ranging from 0.10 to 9.10 mm day^{-1}, with an average of 5.05 mm day^{-1}, whereas that of cv. Cantaloupe ranged from 0.10 to 8.90 mm day^{-1}, with an average of 4.79 mm day^{-1} (Figure 2). For each cycle, the ETc was 323.5 mm for cv. Gladial and 292.0 mm for cv. Cantaloupe. The ETc of cv. Gladial exceeded the ETc of cv. Cantaloupe by 10.8%. The total ETc values found in the present study for the two melon cultivars exceeded those reported by Oliveira, Leitão and Almeida (2010) for the melon cultivar Amarelo Ouro in studies conducted in autumn and summer in the same region and exceeded the ETc values reported by Miranda and Bleicher (2001) for the yellow hybrid melon Gold Mine in the coastal region of Ceará. These differences may be the result of the use of mulching in the present study, which may have contributed to an intensification of ETc and confirmed its dependence on specific characteristics of the crop and climatic conditions.

Figure 2. Crop evapotranspiration (ETc) behavior throughout the development cycle of the cantaloup and gladial melon cultivars. Warm period: October to December 2019 .



With respect to the crop coefficient (Kc), with the development of melon, water consumption (ETc) increased, and consequently, the Kc values reached the maximum value for both cultivars at stage IV (Table 3), which corresponds to the fruit maturation stage. A comparison of the Kc values obtained in the present study for the different stages of crop development with those reported by Oliveira, Leitão and Almeida (2010), considering ETo estimated via the Penman–Monteith method (I- 0.54; II-0.84; III-0.60; IV-0.66), revealed that, with the exception of stage I, for cultivar Gladial, in the other stages, the values differed, mainly in Stages III and IV. Notably, not only the specific characteristics of the different melon cultivars but also the soil mulching coverage, as well as the climatic conditions, were decisive for the differences observed in the Kc values, corroborating the statement by Allen *et al.* (1998) that Kc values should be adjusted through experiments for each region, according to the variety planted, climatic conditions and cultivation techniques used.

Figure 3 shows the behavior of the crop coefficients (Kc) for the two melon cultivars throughout the crop cycle. The Kc for cv. Gladial ranged from 0.03 to 1.47, with an average of 0.85; for cv. Cantaloupe, it ranged from 0.03 to 1.44, with an average of 0.81. The lowest Kc values were recorded on days with rainfall. On the other hand, the highest daily Kc values observed throughout the experiment correspond precisely to days with high atmospheric demand, i.e., low relative humidity (average for the entire crop cycle of 48.9%), high wind speed, and high incidence of solar radiation (Figure 4). These factors contribute to greater water vapor transfer to the atmosphere, increasing ETc and, consequently, the Kc value. Carvalho *et al.* (2017) reported a positive correlation between Kc values and atmospheric demand.

Figure 3. Daily behavior of the crop coefficients (Kc) of the cantaloup and gladial melon cultivars and total rainfall throughout the crop development cycle. Warm period: October to December 2019 .

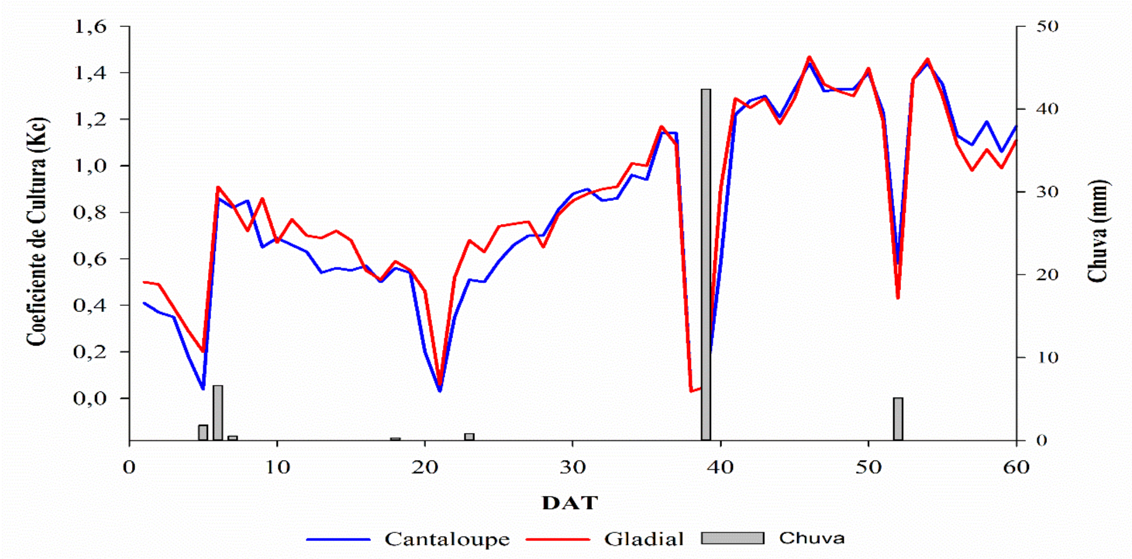
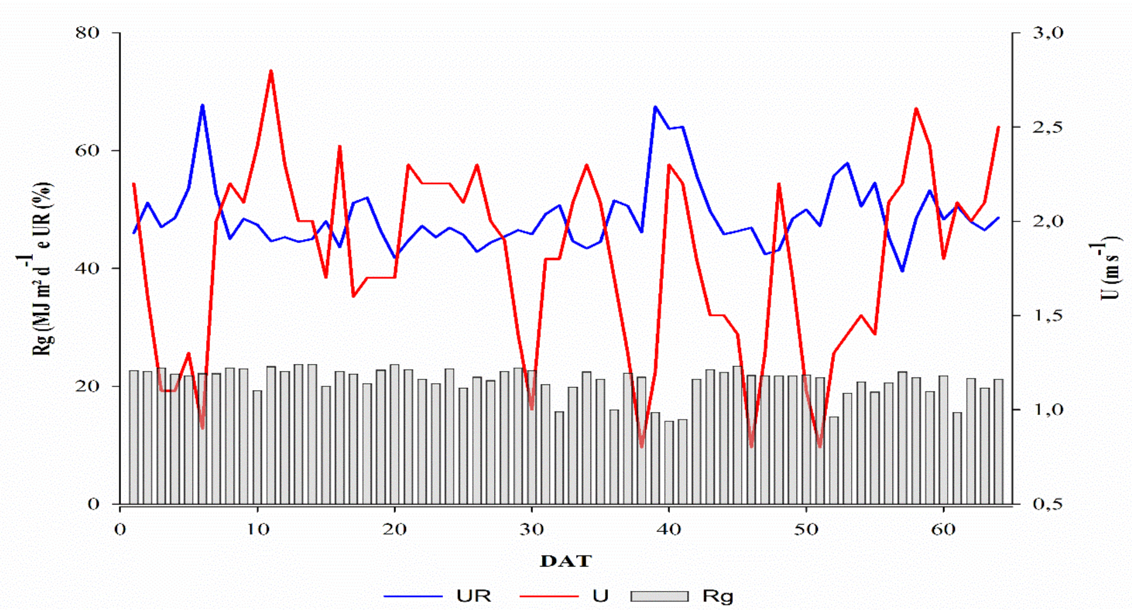


Figure 4. Daily behavior of global solar radiation (Rg), relative humidity (RH) and wind speed (U) throughout the melon crop development cycle. Warm period: October to December 2019 .



For the cold period, as shown in Table 6, in Stages I and II, the evapotranspiration of cv. Gladial was greater than that of cv. Cantaloupe, with the greatest difference occurring in Stage I (12.96%); in Stages III and IV, the evapotranspiration of cv. Cantaloupe exceeded that of cv. Gladial, with the greatest difference observed in Stage III (6.86%); in Stage IV, the difference was only 0.82%. During this period, with milder temperatures, in stages I and II, greater development of cv. Gladial was observed in relation to that of Cantaloupe, contributing to higher ETc values; for cv. Cantaloupe, the largest number of fruits of this cultivar, compared with the number of fruits of Gladial, as well as senescence of the leaves in the last stage, with greater soil exposure and a consequent increase in soil evaporation, contributed to higher ETc values in stages III and IV.

For Melo *et al.* (2013), the increase and reduction in ETc throughout the melon crop cycle can be attributed to climatic conditions and plant development. According to Lemos Filho *et al.* (2010), the main climatic variables that affect ETc are air temperature, relative humidity, solar radiation, and wind. The data presented in Table 4 indicate that, in terms of the climatic conditions during this period, they were practically the same for the different development stages of the melon cultivars.

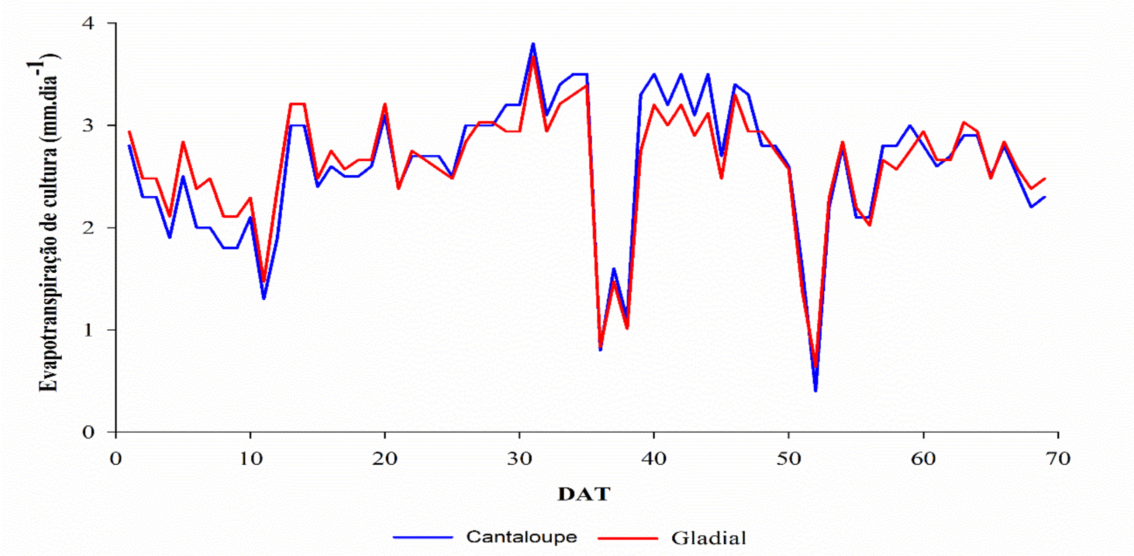
Table 6. Duration in days of the different development stages of the melon, Gladial and Cantaloupe cultivars, average evapotranspiration values and crop coefficients. Period: June to August 2020.

	Gladial Melon				**Cantaloupe melon**			
Stadiums	Duration (days)	ETo (mm d $^{-1}$)	Etc (mm d $^{-1}$)	Kc	Duration (days)	ETo (mm d $^{-1}$)	Etc (mm d $^{-1}$)	Kc
I	9	3.29	2.44	0.74	9	2.16	2.16	0.65
II	20	3.77	2.68	0.71	18	2.61	2.61	0.69
III	20	3.88	2.77	0.71	21	2.96	2.96	0.76
IV	19	4.38	2.44	0.56	19	2.46	2.46	0.55
TOTAL	68	-	-	-	67	-	-	-

I – Initial; II- Growth; III – Reproductive; IV- Final. Reference evapotranspiration (ETo); Crop evapotranspiration (ETc); Crop coefficient (Kc).

Considering the entire crop cycle, the evapotranspiration of cv. Gladial presented average daily values ranging from 0.60 to 3.70 mm day $^{-1}$, with an average of 2.60 mm day $^{-1}$, whereas that of cv. Cantaloupe ranged from 0.40 to 3.80 mm day $^{-1}$, with an average of 2.60 mm day $^{-1}$ (Figure 5). Therefore, there are small differences in the ETc values of the two melon cultivars; in total terms, the values are 179.7 mm and 179.3 mm for Gladial and Cantaloupe, respectively. A comparison of the average daily values observed for the entire cycle of the melon cultivars with those reported by Oliveira, Leitão and Almeida (2010) for yellow gold melon grown in autumn in the same region (2.4 mm day -1) revealed that the difference was 8.3%. These differences are justified by the specific characteristics of the cultivars, as well as their climatic conditions and cultivation techniques. Importantly, knowledge of crop evapotranspiration (ETc) is essential for adequate irrigation management, especially in regions such as the semiarid Northeast, where scarcity and irregular rainfall are limiting factors for agricultural production (OLIVEIRA; LEITÃO; ALMEIDA, 2010).

Figure 5. Crop evapotranspiration (ETc) behavior throughout the development cycle of the cantaloup and gladial melon cultivars. Cold period : June to August 2020.



An analysis of the values of the crop coefficients (Kc) (Table 6) revealed that, whereas for cv. Gladial, the highest value was observed in Stage I (0.74), for cv. Cantaloupe, it was observed in Stage III (0.76). In stages II and III, the Kc values were the same for the Gladial cultivar (0.71). The Kc value observed for the Gladial cultivar in stage I (0.74) was certainly due to the greater development of the cultivar in this stage, compared with the development of the Cantaloup cultivar, as well as the climatic conditions, especially high wind speed (2.3 ms $^{-1}$). Notably, in the region, during the second experiment (cold period), the wind speed is much higher than that during the hot period. As shown in Tables 3 and 4, for Stage I, the WS during the cold period was 53.33% higher than the WS during the warm period. The effect of wind speed likely resulted in a lower horizontal arrangement of the melon plants during the cold period than during the warm period.

Wind speed is one of the factors that most affects evapotranspiration (FALAMARZI *et al.*, 2014). According to Monteith (1981) and Jarvis and Mcnaughton (1986), the stomatal control of crop transpiration depends on the coupling between leaves and the surrounding atmosphere. Well-exposed cropping systems are well coupled to the atmosphere and respond sensitively to small changes in stomatal conductance, especially in the presence of wind (ZANOTELLI *et al.*, 2019).

A comparison of the Kc values found in the present study for the two melon cultivars with those proposed by the FAO (ALLEN *et al.*, 1998) revealed that, with the exception of Stage II, in which the values are within the range presented by the FAO, for the other stages, the values differed, with the greatest difference found in Stage I; the Kc values found for the Gladial and Cantaloupe cultivars exceeded the Kc values proposed by the FAO by 48% and 30%, respectively. Additionally, when the Kc values obtained in the present study for the different stages of crop development were compared with those reported by Oliveira, Leitão and Almeida (2010) in autumn, considering the ETo values estimated via the Penman–Monteith method (I–0.52; II–0.90; III–0.58; IV–0.43), it was observed that, for all stages, the values differed. These differences are certainly associated with the climatic conditions recorded during the experiment, as well as the characteristics of the melon cultivars studied and the cultivation techniques used (mulching). Oliveira, Leitão, and Almeida (2010) focused on the importance of conducting studies that consider local conditions when determining Kc. Doorenbos and Pruitt (1997) emphasize that using a methodology in an area other than where it was conceived is problematic.

The behavior of the crop coefficients (Kc) for the two melon cultivars throughout the cycle (Figure 6) revealed that the Kc for cv. Gladial ranged from 0.19--0.93, with an average of 0.67; for cv. Cantaloupe, the Kc ranged from 0.12--0.88, with an average of 0.67. The lowest Kc values were observed on days when rainfall occurred or on the following days. This is justified by the increase in soil moisture and decrease in atmospheric demand. On the other hand, the highest Kc values were observed on days when the atmospheric demand was high, characterized by low relative humidity, high wind speed, and greater incidence of solar radiation (Figure 7), corroborating the findings of Carvalho *et al.* (2017) that the highest daily Kc values are observed under high atmospheric demand conditions.

Figure 6. Daily behavior of the crop coefficients (Kc) of the cantaloup and gladial melon cultivars and total rainfall throughout the crop development cycle. Cold period: June to August 2020.

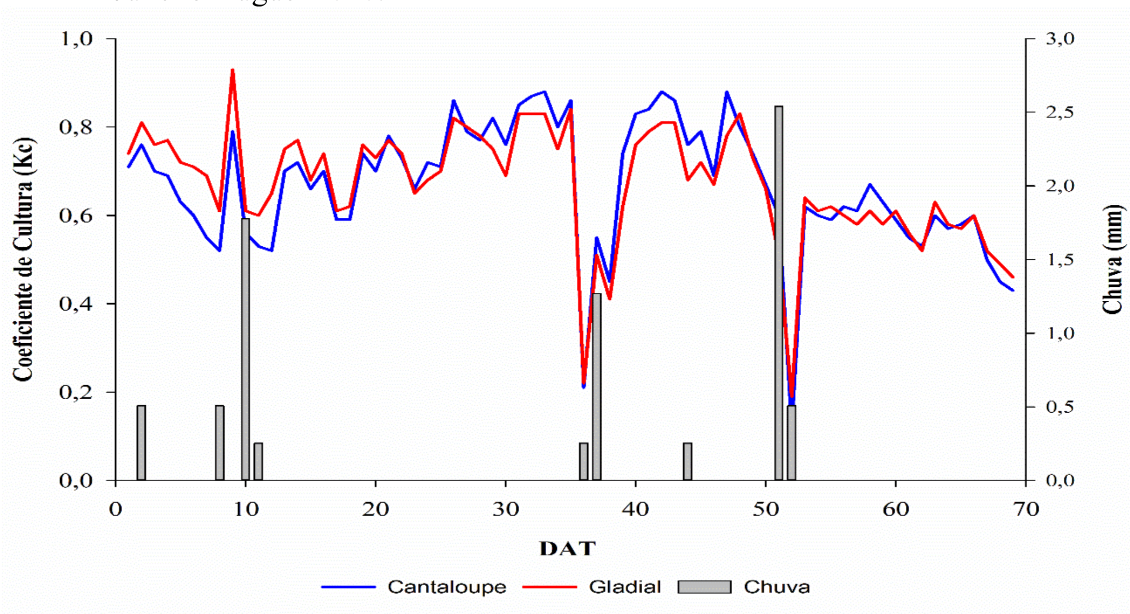


Figure 7. Daily behavior of global solar radiation (Rg), relative humidity (RH) and wind speed (U) throughout the melon crop development cycle. Cold period: June to August 2020
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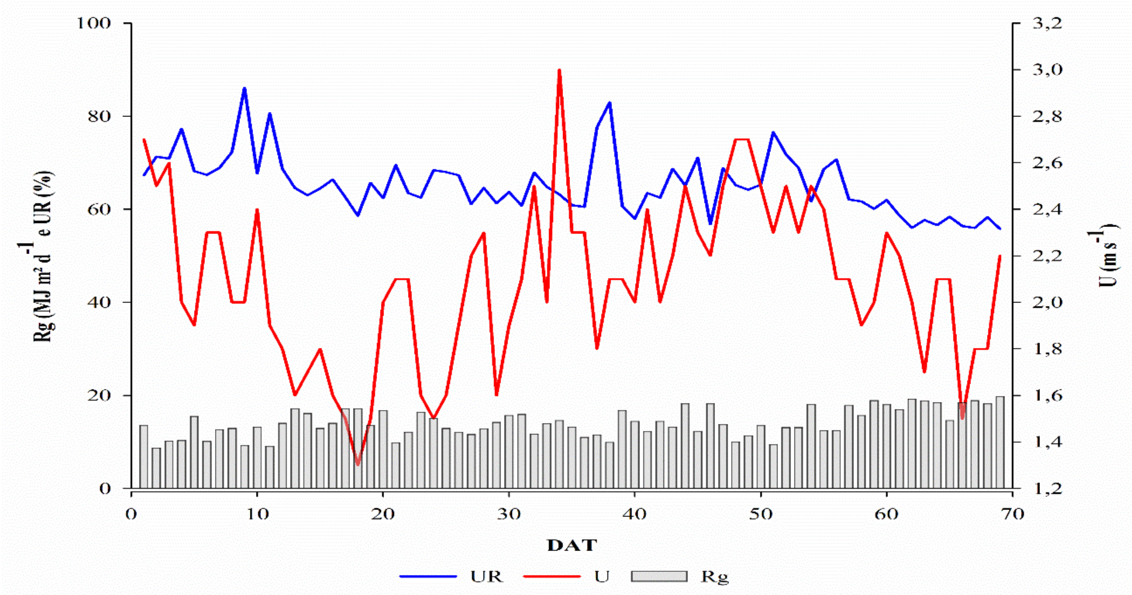
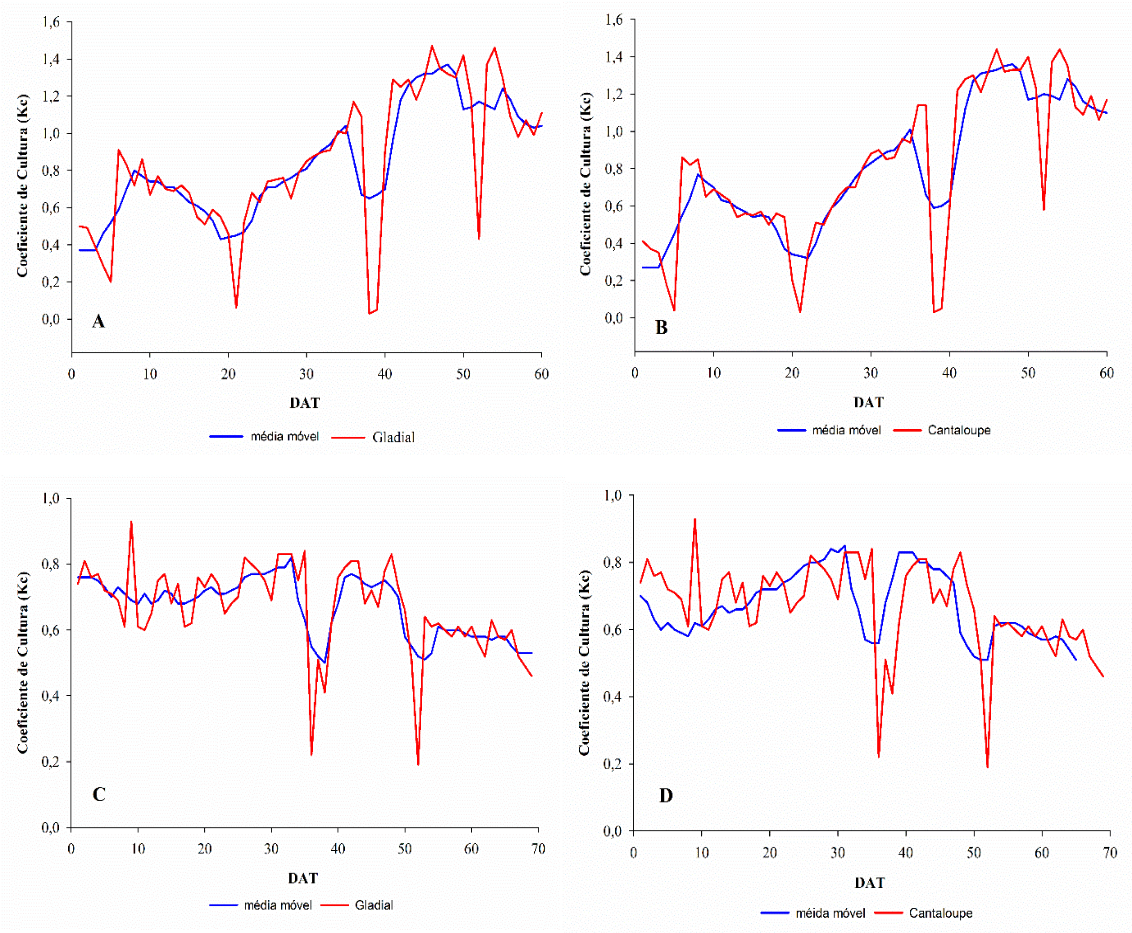


Figure 8 shows the behavior of the crop coefficient (Kc) of the two cultivars, with their respective moving averages. Smoothing of the Kc curve was observed when the moving average was considered, especially for the low Kc values observed due to rainfall. According to Yang, Zhang, and Hao (2016), crop evapotranspiration is closely related to precipitation and decreases with increasing precipitation. Therefore, if evapotranspiration decreases, Kc also decreases, corroborating the results of this study.

Figure 8. Daily behavior of the crop coefficient (Kc) and its moving average for the Gladial and Cantaloupe cultivars throughout the development cycle. Warm periods (A) and (B) and cold periods (C) and (D).



6 CONCLUSIONS

The total water consumption of the melon plants for the Gladial and Cantaloupe melon cultivars for the hot and cold periods were 323.5 mm and 292.0 mm and 179.7 mm and 179.3 mm, respectively.

Throughout the melon cycle, in the hot period, the crop coefficients for the Gladial and Cantaloupe cultivars were, on average, 0.85 and 0.81, respectively; for the cold period, the average Kc was the same for both melon cultivars, 0.67.

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