ISSN 1808-8546 (ONLINE) 1808-3765 (CD-ROM)

SAZONALIDADE DA PRODUTIVIDADE E PÓS-COLHEITA DE MELÃO 'PELE DE SAPO' SUBMETIDO À LÂMINAS DE IRRIGAÇÃO E DOSES DE BIOESTIMULANTE

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1 RESUMO

Buscando minimizar os efeitos sazonais nas plantas cultivadas em diferentes épocas, o presente estudo objetivou avaliar as respostas de produtividade e pós-colheita do melão ‘pele de sapo’ submetido à lâminas de irrigação e doses de bioestimulante em diferentes períodos no Semiárido brasileiro. As parcelas foram as lâminas de irrigação: 60; 80; 100; e 120% da evapotranspiração da cultura (ETc), as subparcelas foram cinco doses do bioestimulante Stimulate®: 0; 0,6; 1,2; 2,4 e 4,8 L ha^{-1}, e as subsubparcelas foram dois períodos de cultivo: quente e frio. Foram avaliadas as variáveis produtividade total e comercial, peso médio do fruto comercial, sólidos solúveis totais (SST), pH, acidez total titulável (ATT) e firmeza de polpa (FP). A dose de 4,8 L ha^{-1} com a lâmina de 120% da ETc, no período quente, promoveram melhores condições de desenvolvimento e, consequentemente, um maior incremento na produtividade quando comparado com o período frio do semiárido brasileiro. A qualidade dos frutos foi influenciada pelo maior teor de SST no período quente e ATT no período frio, submetida à dose de 4,8 L ha^{-1} do Stimulate® e às lâminas abaixo de 100% da evapotranspiração da cultura.

Palavras-chave: períodos, irrigação, *Cucumis melo* L., produtividade, qualidade do fruto.

LIMA, D. S. R.; SIMÕES, W. L.; SILVA, J. A. B. da; AMORIM, M. DO N.; SILVA, J. S. da
SEASONALITY OF PRODUCTION AND POST-HARVEST OF 'TOAD SKIN MELON' UNDER IRRIGATION DEPTHS AND DOSES OF BIOESTIMULANT

Recebido em 16/11/2020 e aprovado para publicação em 21/01/2021
DOI: http://dx.doi.org/10.15809/irriga.2021v1n1p221-236

2 ABSTRACT

Seeking to minimize seasonal effects on plants grown at different times, this study aimed to evaluate the productivity and post-harvest responses of melon ‘'toad skin' melon submitted to irrigation depths and doses of biostimulant in different periods in the Brazilian Semiarid. The plots were the irrigation depths: 60; 80; 100; and 120% of the culture evapotranspiration (ETc), the subplots were five doses of the Stimulate® biostimulant: 0; 0.6; 1.2; 2.4 and 4.8 L ha-1, and the sub-plots were two growing periods: hot and cold. The variables total and commercial productivity, the average weight of the commercial fruit, total soluble solids (SST), pH, total titratable acidity (ATT) and pulp firmness (FP) were evaluated. The dose of 4.8 L ha-1 with a depth of 120% of ETc, in the hot period, promoted better conditions of development and, consequently, a greater increase in productivity compared to the cold period of the Brazilian semiarid region. The quality of the fruits was influenced by the higher SST content in the hot period and ATT in the cold period, submitted to a dose of 4.8 L ha-1 of Stimulate® and to the depths below 100% of the crop evapotranspiration.

Keywords: periods; irrigation, *Cucumis melo* L., productivity, fruit quality

3 INTRODUCTION

Melon (*Cucumis melo* L.) is highly appreciated for its sweet flavor and nutritional and functional characteristics. Among the most cultivated varieties in the semiarid region of Brazil, the 'pele de sapo' melon is the second most sought after, followed by cantaloupe, orange, and galia (PADUAN; CAMPOS; CLEMENTE, 2007). Also known as Spanish green or 'pele de sapo', it stands out for its large, firm fruits and greenish flesh (MENEZES et al., 2000).

The main climatic factors that affect crop production are temperature and relative humidity. The optimal range for melon development is 25–35°C, with a relative humidity of approximately 65–75%. Plants may experience phytosanitary problems with pests, reduced photosynthetic rates, and reduced fruit size and quality (ARAÚJO; CAMPOS, 2011; COSTA, 2008).

Yuri, Resende, and Costa (2020), when evaluating different genotypes of 'skin of the frog' and yellow melon types grown in the summer (2017) and winter (2018) periods, reported greater productive performance in all genotypes grown in the summer. Given climate change and the competitiveness of the production market, the use of the ideal water depth for melon cultivation in the irrigated perimeter of the Brazilian semiarid region can be an important tool for the sustainability of agricultural properties (YURI; RESENDE; COSTA, 2020).

The water depth to be applied must be in accordance with the water needs of the crop according to the phase of its development cycle to increase its dry mass and productivity levels, as well as fruit quality (SIQUEIRA et al., 2009; VALNIR JÚNIOR et al., 2013). Owing to the high evapotranspiration rates and low rainfall in this region, the supply of water through irrigation becomes essential to maintain the availability of water in the soil to meet the daily water needs of the crop and, consequently, increase productivity (SIMÕES et al., 2016).

Costa et al. (2002), when studying irrigation depths of 100, 84 and 67% of the ETC, reported a decline in the productivity of “Cantaloupe” melons when the irrigation depths were reduced. Sousa et al. (2010), when testing irrigation depths in yellow melon in the Ceará region, reported an increase in productivity of 82% when the maximum depth of 150% crop evapotranspiration (ETc) was used.

In addition to proper water management, some studies (VENDRUSCOLO et al., 2016; VENDRUSCOLO, MARTINS, SELEGUINI, 2016; SANTOS et al., 2015) have highlighted the use of biostimulants, which are mixtures of plant growth regulators, minerals, amino acids, and other substances that have been tested, as promising technologies for agriculture. These products can affect plant metabolism and structure, increasing their water and nutrient absorption capacity and tolerance to water stress.

Horgos et al. (2013) reported a 24.32% increase in the yield of watermelon hybrids treated with foliar applications of the biostimulant Bionex (0.5%), which is based on natural amino acids and nutrients.

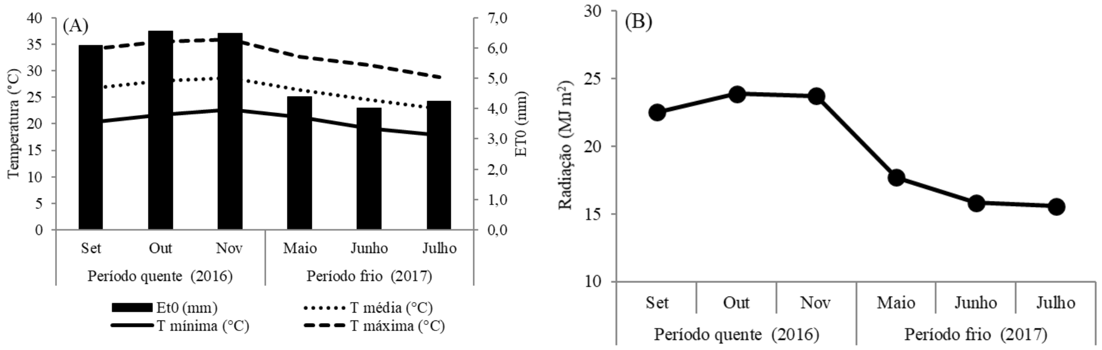
Given the lack of information regarding the use of biostimulants and their relationship with crop water demand during the growing season, this study aimed to evaluate the production and postharvest responses of 'pele de sapo' melons subjected to different irrigation levels and biostimulant doses during different seasonal periods in the semiarid region of Brazil.

4 MATERIALS AND METHODS

The experiment was conducted at the Embrapa Semiárido Experimental Farm in the Mandacaru Irrigation Project, which is located in the city of Juazeiro, Bahia, with geographic coordinates of 09°24' south latitude and 40°26' west longitude. According to the Köppen climate classification, the climate of the region is BSwh-type, hot semiarid, with high air temperatures, scarce and poorly distributed rainfall concentrated from November to April and average annual rainfall of approximately 500 mm distributed irregularly throughout the year.

Two experiments were conducted, the first during a warmer period (September--December 2016) and the second during a colder period (May--July 2017), according to climatological data (Figure 1) obtained from a meteorological station located close to the cultivation site.

Figure 1. Reference evapotranspiration (ETo); average, maximum and minimum air temperatures (A) and monthly solar radiation (B) at the experimental site during the growing season in Juazeiro, BA.



After chemical analysis of the soil (Table 1), fertilization was carried out via fertigation; 145 kg ha $^{-1}$ N, 60 kg ha $^{-1}$ P_2O_5 and 125 kg ha $^{-1}$ K_2O were applied during the cold period, and 184 kg ha $^{-1}$ N, 60 kg ha $^{-1}$ P_2O_5 and 155 kg ha $^{-1}$ K_2O were applied during the hot period. Urea, MAP (monoammonium phosphate) and potassium sulfate were used as sources of nutrients. Topdressing fertilization began 22 days after the seedlings were transplanted and was divided into two weekly applications for five weeks.

Table 1. Chemical characteristics of the Juazeiro hybrid 'pele de sapo' melon soil profile during two growing seasons, the hot season (September–November 2016) and the cold season (May–July 2017). Embrapa Semiárido, Projeto Mandacaru, Juazeiro, BA.

	Parameters						
	pH	**MO**	**P**	**In the +**	**K^+**	**Ca^{2+}**	**Mg^{2+}**
Depths (cm)		$g\ kg^{-1}$	$mg\ dm^{-3}$	-------- $cmol_c\ dm^{-3}$ --------			
0-20 * P1	7.4	12.6	17	0.39	1.76	35.1	8.1
20-40 P1	7.5	6.8	11	0.30	0.31	35.8	8.3
0-20 ** P2	7.2	8.4	19	0.19	0.23	30.0	9.3
20-40 P2	7.5	6.2	15	0.22	0.17	32.4	7.6

* P1 = warm period; ** P2 = cold period; MO = organic matter.

The area was prepared by medium plowing, harrowing, separating the planting rows, and opening furrows for preplanting fertilization. After the initial fertilization, the ridges were mechanized with the help of a ridgerator and adjusted manually. Soon after, the irrigation system was installed, and the soil was covered with black *mulch*. During the experiment, culture treatments and spraying were carried out to control plant pathogens, in addition to cleaning the area when necessary.

Seeds of the Juazeiro hybrid melon variety 'pele de sapo' were sown in 200-cell polyethylene trays. After 10 days, the seedlings were transplanted to the experimental area, with a spacing of 2.0 m by 0.3 m.

The irrigation system was a localized drip irrigation system, with hoses distributed along the planting lines containing emitters spaced 0.3 m apart and a flow rate of 2.5 L h^{-1}. The irrigation depth was calculated via the Penman method. Monteith, which is based on climate data from 2016 and 2017 from the meteorological station near the experimental site. The crop coefficients (Kcs) adopted to determine crop evapotranspiration (ETc) were 0.35, 0.7, 1.0 and 0.8 for the initial, vegetative, fruiting and maturation stages, respectively, which were adapted to the growing conditions of the area, as recommended by Miranda and Bleicher (2001).

randomized blocks in subsubdivided plots, with the plots having four irrigation depths (60, 80, 100, and 120% of ETc), the subplots having five doses of the biostimulant (0, 0.6, 1.2, 2.4 and 4.8 L ha^{-1}), and the subsubplots having two cultivation periods (hot and cold), with four replicates. The experimental subplots were composed of six plants, with the four central plants being considered useful.

The plant biostimulant Stimulate®, which was produced by Stoller do Brasil Ltd., was used in liquid form. It contains three plant regulators: 90 mg/L kinetin (cytokinin), 50 mg/L indolebutyric acid (auxin), and 50 mg/L gibberellic acid (GA). Three applications of the product were made during the cycle, which occurred at the beginning of male flowering, at the end of female flowering, and when the fruits were approximately 54 mm in diameter.

Evaluations were carried out by collecting data from the four useful plants in the subplot. The production parameters analyzed were total productivity (TP), estimated by weighing the total fruits in each plot; commercial productivity (CP), estimated by selecting commercial fruits identified by their best appearance and individual mass; and average fruit weight (PMF), estimated by the ratio between the mass and the number of commercial fruits. Water use efficiency was also evaluated by the relationship between productivity and the amount of water used.

For postharvest analyses, two fruits were selected and characterized according to their pulp firmness (FP) via a penetrometer, in which the results were obtained in pounds (Lbf) and subsequently expressed in Newtons (N), with a conversion factor of 4.445.

Chemical characteristics were obtained by homogenizing the pulp through processing it via a domestic grinder. Total soluble solids (TSS) readings were taken via a handheld refractometer (Pocketpal model). $^{-1}$). The pH was determined via a digital pH meter. To obtain the total titratable acidity (TTA), the sample was titrated in NaOH solution. In addition to these parameters, a profit estimate was also made, which was calculated via commercial productivity data.

Variable data were subjected to analysis of variance (ANOVA) via the F test ($p<0.05$). The effects of the quantitative factors, slides and biostimulant doses were evaluated through regression analysis, with linear and quadratic models ($p<0.05$). When there was no interaction between the cultivation period and the other factors, the Tukey test was used to compare data between periods ($p<0.05$). All analyses were performed via Sisvar software, version 7.7.

5 RESULTS AND DISCUSSION

The results obtained for the irrigation depths used during the experiment revealed that, during the cold period, the total volume of water applied was reduced by 45% because of the low reference evapotranspiration and relative air humidity (Figure 1) recorded at that time, which conditioned the need for a smaller amount of water by the plants (Table 2).

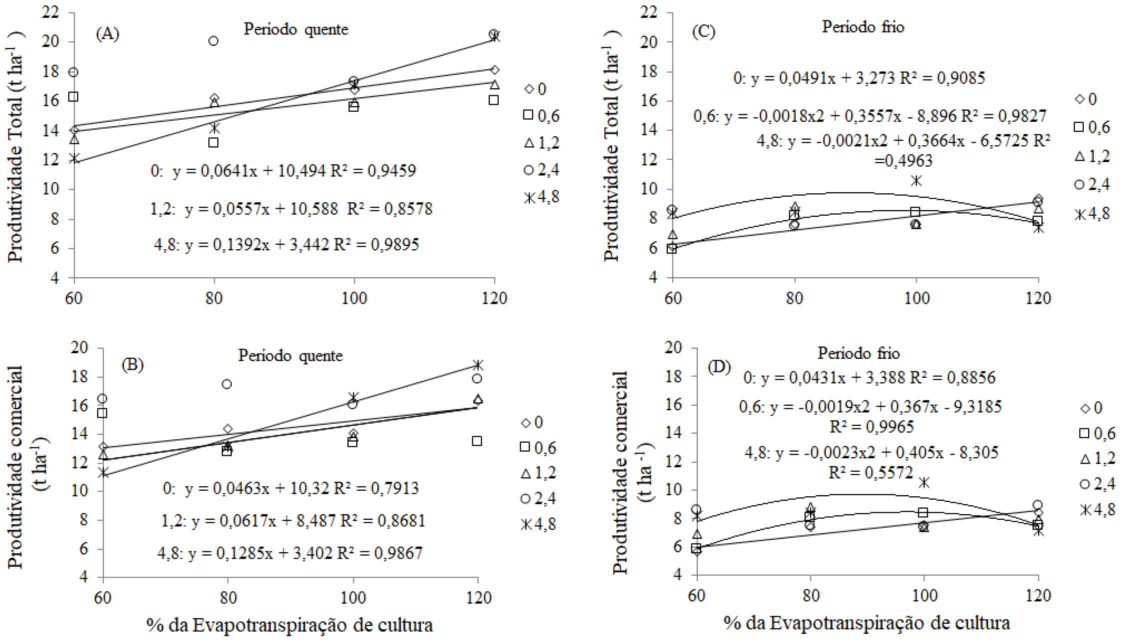
Table 2. Water depths applied in different treatments for melon cultivation during the hot period (September–November 2016) and cold period (May–July 2017).

Treatment (% of ETc)	Hot period mm	Cold period mm
60	208.85	114.75
80	278.46	153.00
100	348.08	191.25
120	417.70	229.50

The results of the analysis of variance for the analyzed variables revealed that the variables average fruit weight (PMF) and pH, which are related to the plant yield characteristics and fruit quality of 'pele de sapo' melon, were the only variables that did not significantly interact with the plant biostimulant dose or irrigation depth. In the comparison analysis between the growing periods, all the variables were significant, according to the t test ($p> 0.05$).

When the plants cultivated during the hot period were evaluated (Figures 2A and 2B), there was an increase in total productivity (TP) and commercial productivity (CP) with increasing irrigation depth, with the highest values obtained for the treatment with an irrigation depth of 120% of the ETc and a biostimulant dose of 4.8 L ha $^{-1}$, which presented average PT and CP values of 20.42 and 18.8 t ha $^{-1}$, respectively. However, when subjected to water stress, the plants presented a reduction in productivity.

Figure 2. Total (A, C) and commercial (B, D) productivity of 'pele de sapo' melon subjected to different irrigation levels and doses of plant biostimulant in the hot (September–November 2016) and cold (May–July 2017) growing seasons.



Thus, the higher dose of the product (4.8 L ha $^{-1}$) may have led to increased root system development. Furthermore, the expansion of cells in the plant roots consequently promoted greater water absorption and nutrient storage in the vacuole, which may have also enabled increased photosynthetic rates and productive development. Sousa et al. (2020) reported an increase in the volume and dry mass of Crinson watermelon roots. Sweet, who underwent the application of the biostimulant Viusid-Agro. Lima et al. (2020) reported significant increases in the biochemical and physiological parameters of 'pele de sapo' melon subjected to doses of the biostimulant Stimulate®.

The biostimulant dose provided a 12.54% increase in profit, equivalent to R$5125.00 ha $^{-1}$, considering that the value of the melon is equal to R$2.50 kg $^{-1}$. Furthermore, the productivity reported in the present study is in agreement with the results of Nunes et al. (2011a), who evaluated twelve lines of 'pele de sapo' melon and reported a productivity ranging from 14.18 to 48.37 t ha $^{-1}$.

In the cold period, the highest values were 10.62 and 10.54 t ha $^{-1}$ for PT and PC (Figures 2C and 2D), respectively, which were obtained when a dose of 4.8 L ha $^{-1}$ was used, with estimated depths of 87.24 and 88.03% of ETc, respectively. This lower productivity in the colder period may be related to the climatic conditions of the period, since, at temperatures below 25°C, a series of problems already occur that may have limited the development rate of the studied variety, even with the use of the biostimulant.

In terms of the economic use of commercial fruits, this productivity corresponds to a 34.12% increase in profit, considering the sale of the kg for R$2.50, which corresponds to a total value of R$6,450.00 ha $^{-1}$. These results show that, in the present study, the use of the biostimulant can be an alternative to increase the productivity of the Juazeiro hybrid 'pele de sapo' melon, since in both growing periods, the doses promoted higher values than those of plants that did not receive doses of the product.

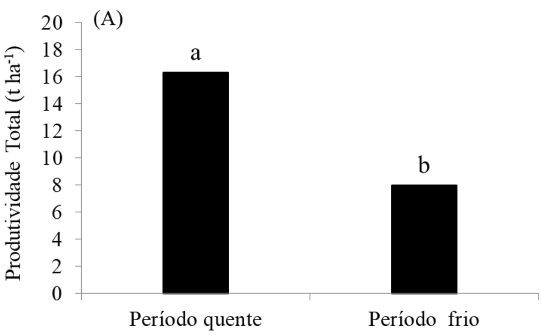
Mazuela, Cepeda, and Cubillos (2012) reported that the application of biostimulants promoted an increase in the total production of tons of tomatoes. Araújo et al. (2010), when testing irrigation with different volumes of water, reported a 31% increase in the final yield of lace melon irrigated with a depth of 120% replacement of ETc. Similar to the results observed in the hot period of this work, Teodoro et al. (2004), when testing six irrigation depths in watermelon cultivation, also reported a growing increase in productivity with increasing irrigation depth.

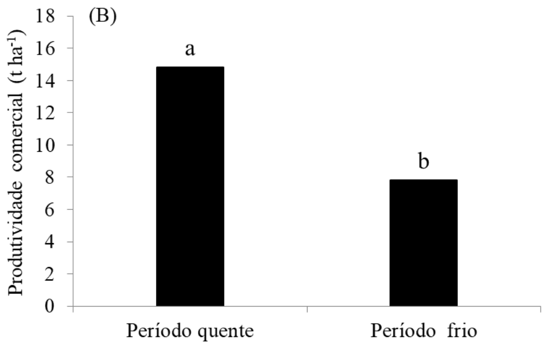
Higher productivity values were reported by Nunes et al. (2004), who reported a PT of 28.58 t ha $^{-1}$ for the Tendency hybrid melon of the 'skin of frog' type.

As highlighted by Dantas et al. (2011), differences in yield are common among melon varieties, even when they are of the same type. According to the authors, this is due to the characteristics of the hybrids' genetic material, which can give them high or low production capacity, and other characteristics, such as post-harvest fruit quality, resistance to pests and diseases, and adaptability to different growing environments.

With respect to the productivity comparison between the growing seasons shown in Figure 3, there was a reduction of more than 50% for the cold season, both in PT and PC. Furthermore, only PT and PC during warm season cultivation met the production expectations for the Northeast Region, which should range from 17 to 30 t ha $^{-1}$ (DIAS, 1998). Therefore, the cultivation of 'pele de sapo' melon in the colder season will only be viable when its value is higher for the producer, making it more sustainable.

Figure 3. Total (A) and commercial (B) productivity of 'pele de sapo' melon according to the cultivation periods : hot (September--November 2016) and cold (May--July 2017) periods.

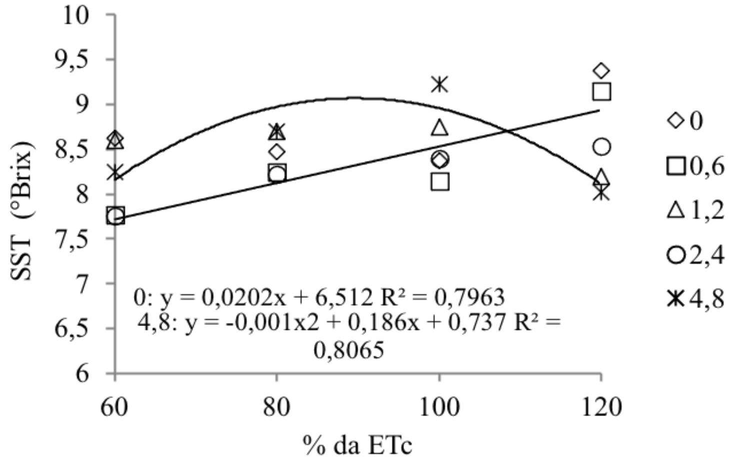




An analysis of the postharvest variables revealed that, for the total soluble solids content (TSS) variable, a significant interaction between treatments was observed only during the hot period (Figure 4). With the use of the biostimulant, the TSS content was 9.23°B for the irrigation depth, which was estimated as 93% of the ETc replacement associated with a biostimulant dose of 4.8 L ha $^{-1}$, whereas a depth of 120% of the ETc associated with the nonapplication of the biostimulant (dose of 0 L ha $^{-1}$) promoted a maximum content of 9.37°Brix.

Although these values do not differ significantly from each other according to the Tukey test ($p<0.05$), with the use of the biostimulant, the ideal amount of water to obtain the highest TSS value is lower than that used in conventional cultivation. Notably, these TSS values are within the standard required by the consumer market, which is 9°Brix (MENEZES et al., 2000).

Figure 4. Total soluble solids content (TSS) of 'pele de sapo' melon subjected to different irrigation levels and biostimulant doses during the warm period (September–November 2016).

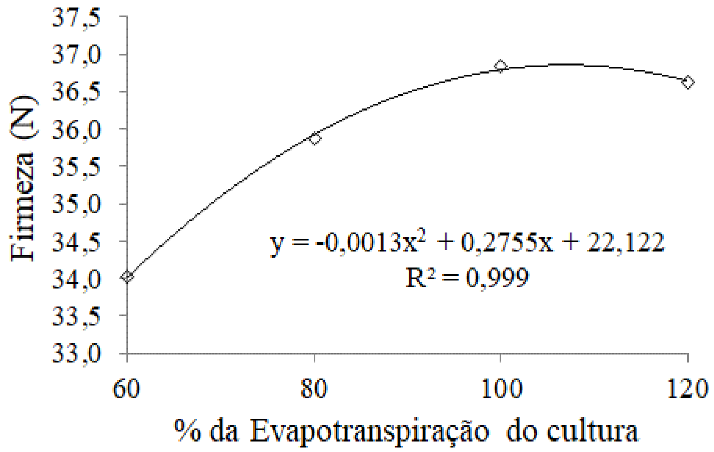


This result differs from that of the study carried out by Vendruscolo et al. (2017), who reported that the application of 20 mL/L of a biostimulant based on plant growth regulators (kinetin, cyberellic acid, and indolebutyric acid) increased the TSS up to 11°Brix in lace melon fruits. Lozano et al. (2018) also reported a relatively high TSS content (11.20°Brix) when a water layer with 100% ETc was applied to Sunrise hybrid yellow melon plants. Nunes et al. (2011a), when evaluating genetic lines of 'pele de sapo' melon, reported values higher than the minimum content of 8.7°brix.

According to Calvo, Nelson, Kloepper (2014), the use of biostimulants can increase the TSS content, depending on the species studied, owing to their action on cell elongation and division promoted by the phytohormones present in their composition, which induce plants to increase the leaf area, photosynthesis and, consequently, the quantity of photoassimilates available for the fruits.

Pulp firmness (FP) was significant only during the cold season in plants treated only with different irrigation depths (Figure 5). An increase was observed up to the 100% ETc depth, which presented a maximum value of 36.84 N, whereas when the 120% ETc depth was used, there was a reduction in the FP. This is an expected result, since pulp consistency tends to decrease with increasing water volume (ARAGÃO et al., 2020).

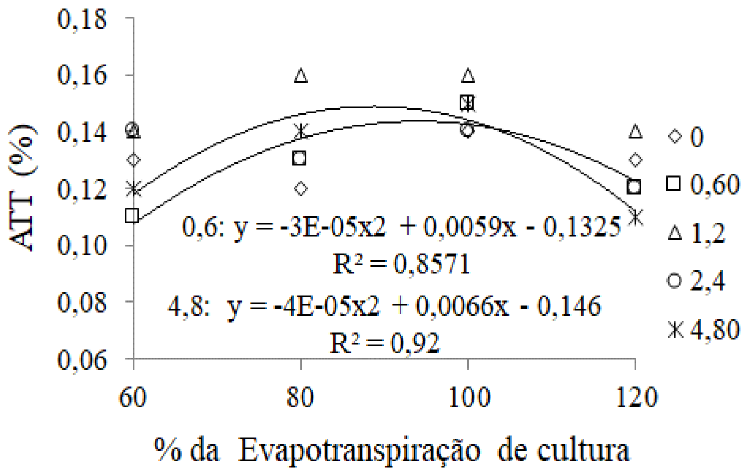
Figure 5. Pulp firmness (FP) of 'pele de sapo' melon subjected to different irrigation levels during the cold period (May–July 2017).



When 'pele de sapo' melon was cultivated at three irrigation depths, Medeiros et al. (2012) reported that as the irrigated water depth increased from 281 mm to 423 mm, the FP decreased from 15.26 N to 14.81 N; the same behavior was observed in the present study when the maximum depth was used, which promoted a reduction in the FP. Godoy et al. (2010) highlighted that the FP is an indicator of the useful life of the fruit, since firmer fruits have greater resistance to mechanical damage and postharvest conservation.

The total titratable acidity (TTA) was also not significant during the warm season. This result may be related to the increase in TSS observed during this period, as the high sugar content in the fruits may have stabilized the reactions of the soluble acids. For the levels obtained during the cold season (Figure 6), the highest value of 0.15 g $^{100-1}$ mL of ATT was verified when the irrigation depth estimated as 82.5% of the ETc associated with the dose of 4.8 L ha $^{-1}$ of the biostimulant was used.

Figure 6. Total titratable acidity (TTA) of 'pele de sapo' melon subjected to different irrigation levels and doses of plant biostimulant during the cold period (May–July 2017).

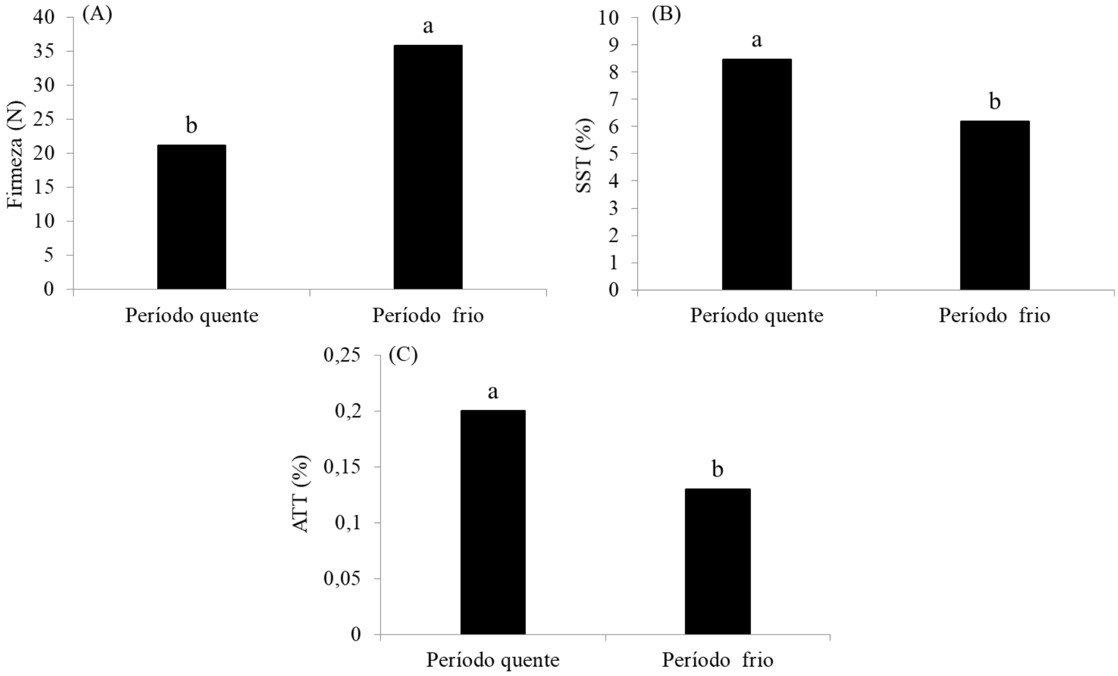


This result was expected since reducing the irrigation depth decreases the dissolution of organic acids and promotes a relatively high acidity concentration in the fruit. However, this ATT content is in accordance with the general standard of 0.05 to 0.35% established by Mendlinger and Pasternak (1992) for melon fruits.

Similar results were obtained by Martins et al. (2013), who also reported an increase in the total soluble solids content and total titratable acidity in watermelons subjected to the application of the Crop Set® product, which is composed of plant and mineral extracts complexed with amino acids. These findings indicate that in the present study, the biostimulant may have promoted a small increase in the synthesis of organic acids, possibly because the hormones gibberellin and cytokinin can cause changes in the ATT of the fruit (TAIZ et al., 2017).

In the comparison analysis between the periods presented in Figure 7, the TSS (Figure 7B) and ATT (Figure 7C) contents were lower in the cold period, with percentage reductions of 27% and 35%, respectively. This result may be related to the harvest point of the fruits, which did not reach the same maximum ripeness point as that obtained for the warm period during the cold period. However, despite the reduction, the average ATT content of 0.13 g 100^{-1} mL in the cold period (Figure 7C) was within the previously mentioned commercialization standards.

Figure 7. Pulp firmness (A), total soluble solids (SST) (B) and total titratable acidity (ATT) (C) of 'pele de sapo' melon according to the cultivation periods: hot (September–November 2016) and cold (May–July 2017).



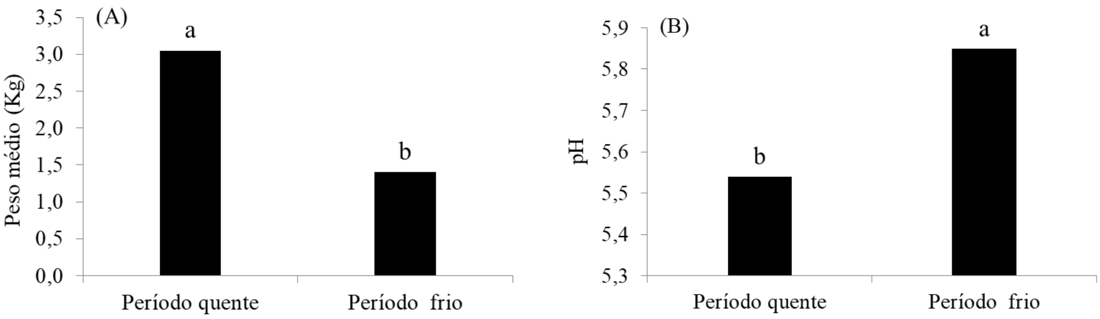
However, the average SST of 6.20°B (Figure 7B), which was found for the cold period, is well below the recommended level for commercialization, which is 9°B. Nunes et al. (2008) emphasized that SST is a quality parameter and that its concentration in fruits determines the flavor *that* is conferred to the fruit. Thus, during the cold period, the fruits were not suitable for commercial use.

Pulp firmness (FP) was the only parameter that was superior in the cold period, possibly indicating the need to change the parameter for choosing the harvest time, since the results show that the fruits were probably not fully ripe, resulting in greater resistance and storage time, thus requiring further studies.

The results of these three variables are important because they influence harvesting, as they determine the characteristics that impart flavor to the fruit, which will meet the organoleptic standards required for each variety. Therefore, in the case of the 'pele de sapo' melon, for cultivation in the cold season, aiming for higher fruit quality, it would be suggested that harvesting be carried out later than in the warm season.

In the evaluation of the variations in average fruit weight (PM) shown in Figure 8A, averages of 3.06 and 1.4 kg fruit $^{-1}$ were observed for the hot and cold periods, respectively, indicating that, in the latter, there was a reduction in fruit size, probably due to the temperature and humidity conditions that also influenced fruit development. Therefore, these values corroborate the productivity results shown in Figure 2, which presented higher values in the hot period.

Figure 8. Average fruit weight (A) and pH (B) of 'pele de sapo' melon subjected to different irrigation levels and doses of plant biostimulant in the hot (September–November 2016) and cold (May–July 2017) periods.



With respect to marketing, Nunes et al. (2011b) highlighted that melons of the 'pele de sapo' variety are exported from the port of Natal to Europe, with masses between 2.5 and 3.5 kg. Thus, we can infer that, in the present study, only in warm season cultivation were the fruits suitable for the market, since Rio Grande do Norte is a reference in melon production and the European market is the largest consumer of the evaluated variety.

For pH (Figure 8B), the differences observed between the periods are related to the results observed for acidity (Figure 7C), which was lower in the cold period and, consequently, the pH increased. The pH results were related to the FP and SST parameters (Figure 7), which also differed between the growing periods. In the cold period, the fruits clearly presented slower physiological ripening than those in the warm period did. This may have occurred as a result of the lower temperature recorded for that period (Figure 1).

Compared with other studies carried out with the 'pele de sapo' melon crop, Medeiros et al. (2012) reported pH values between 6.58 and 6.92 for the Sancho cultivar, whereas Silva et al. (2011) reported a pH value of 6.17 for the same variety. These results were greater than those reported in the present study, indicating that the pH can vary among different hybrids of the same variety and that the Juazeiro hybrid has more acidic characteristics, which can result in a shorter shelf life after harvest.

The differences in productivity and postharvest variables observed in the analysis between growing seasons may have been due to the different planting seasons. Costa et al. (2012) reported that this is common, as ripening and maturation, as well as the various physiological and biochemical reactions of fruits and the synthesis of enzymes and hormones, are significantly influenced by environmental factors that vary at different times of the year.

Among the environmental factors that may have influenced the low production and quality of the fruits during the cold season, high humidity was observed, with an average RH of 78.75% (Figure 1), which is above the optimal range of 65--75% RH. Increased relative humidity can interfere with transpiration and limit stomatal opening and photosynthetic activity.

The temperature remained between 17.9°C and 31.0°C, with the lowest temperature also being below the minimum temperature recommended for melon cultivation, which is 25°C. Furthermore, Cardoso and Silva (2003) reported that although some species of cucurbits develop at relatively low temperatures, melon plants require relatively high temperatures.

6 CONCLUSIONS

In the hot period of the semiarid region of Brazil, a dose of 4.8 L ha $^{-1}$ of the biostimulant Stimulate®, which is associated with an irrigation depth with 120% ETc replacement, promoted better development conditions for the 'pele de sapo' melon and, consequently, a greater increase in productivity compared with the cold period.

When the 'pele de sapo' melon was subjected to a dose of 4.8 L ha $^{-1}$ Stimulate® and irrigation levels below 100% of crop evapotranspiration, fruit quality was influenced by the higher TSS content in the hot period and ATT in the cold period.

7 REFERENCES

ARAGÃO, MF; PINHEIRO NETO LG; ARAGÃO, MF; VIANA, TVA; GOMES, SKA Effect of soil cover and irrigation depth on postharvest variables of yellow melon. **Brazilian Journal of Irrigated Agriculture** , Fortaleza, v. 13, n. 6, p. 3749-3756, Nov./Dec. 2020.

ARAÚJO, VFS; CAMPOS, DFA Logistics Chain of Melon Produced in the Mossoró/Açu Fruit Growing Agropole . **Northeast Economic Journal** , Fortaleza, v. 42, n. 3, p. 505-530, Jul./Sept. 2011.

ARAÚJO, WF; OLIVEIRA, GA; CARVALHO, FK; SILVA, WM; CRUZ, PLS; MACIEL, FCS Melon irrigation management based on class A tank evaporation. **Horticultura Brasileira** , Brasília, DF, v. 28, n. 4, p. 495-499, Oct./Dec. 2010.

CALVO, P.; NELSON, L.; KLOEPPER, JW Agricultural uses of plant biostimulants . **Plant and Soil** , Crawley , vol. 383, no. 1-2, p. 3-41, May 2014.

CARDOSO, AII; SILVA, N. Evaluation of Japanese cucumber hybrids under protected environment in two growing seasons. **Horticultura Brasileira** , Brasília, DF, v. 21, n. 2, p. 171-176, Apr./Jun. 2003.

COSTA, FA; MEDEIROS, JF; NEGREIROS, MZ; BEZERRA NETO, F.; PÔRTO, DRQ; CHAVES, SWP; DANTAS, KN Cantaloupe melon yield under different soil covers and irrigation depths. **Caatinga Journal** , Mossoró, v. 15, n. 1-2, p. 49-55, 2002.

COSTA, ND **Melon culture** . 2nd ed. Brasília, DF: Embrapa Technological Information, 2008.

COSTA, ND; RESENDE, GM; YURI, JE; PETRETE, VG; PINTO, JM; FERREIRA, TSD Productivity and quality of melon fruits under two irrigation methods in the Submiddle São Francisco. **Brazilian Horticulture** , Vitoria da Conquista, v. 30, n. 2, p. S2605-S2611, Jul. 2012.

DANTAS, DJ; MENDONÇA, V.; NUNES, GHS; GUIMARÃES, IP; DANTAS, DJ Evaluation of production and quality of cantaloupe melon hybrids . **Green Journal of Agroecology and Sustainable Development** , Mossoró, v. 6, n. 4, p. 132-136, Oct./Dec. 2011.

DIAS, RC **The melon agribusiness in the Northeast** : prospective analysis of natural production chain systems. Brasília, DF: Embrapa, 1998.

GODOY, AE; JACOMINO, AP; CERQUEIRA-PEREIRA, EC; GUTIERREZ, ASD; VIEIRA, CEM; FORATO, LA Mechanical injuries and their effects on the quality of Golden papayas. **Journal Brazilian Fruit Growing Association ,** Jaboticabal , v. 32, n. 3, p. 682-691, Sept. 2010.

HORGO S, A.; ALEXANDRA, B.; POPA, D.; ANCA, D., A. Study on the productive and qualitative potential of some watermelon hybrids under the impact of biostimulating treatments. **Journal of Horticulture, Forestry and Biotechnology** , Timisoara, v. 17, no. 1, p. 81-87, 2013.

LIMA, DSR; SIMÕES, WL; SILVA, JAB; AMORIM, MN; SALVIANO, AM; COSTA, ND 'Pele de sapo'melon grown under different irrigation depths and biostimulant rates in the Semiarid region of Brazil. **Communicate Scientiae** , Bom Jesus, v. 11, no. 1, p. e3303, Jan./Dec. 2020.

LOZANO, CS; REZENDE, R.; HACHMANN, TL; SANTOS, FAS; LORENZONI, MZ; SOUZA, AHC Productivity and quality of melon under silicon doses and irrigation depths in a protected environment. **Tropical Agricultural Research** , Goiânia, v. 48, n. 2, p. 140-146, Apr./Jun. 2018.

MARTINS, JCP; AROUCHA, EM; MEDEIROS, JF; NASCIMENTO, IB; PAULA, VS Postharvest characteristics of watermelon cultivars fruits subjected to biostimulant application . **Caatinga Journal** , Mossoró, v. 26, n. 2, p. 18-24, Apr./Jun. 2013.

MAZUELA, P.; CEPEDA, B.; CUBILLOS, V. Effect of graft and del Fartum® biostimulant producción y calidad in cherry tomatoes. **Ideas** , Arica , v. 30, n. 3, p. 77-81, Sep./Dec. 2012.

MEDEIROS, JFD; AROUCHA, EM; DUTRA, I.; CHAVES, SWP; SOUZA, MS Effect of irrigation depth on postharvest conservation of Pele de Sapo melon. **Brazilian Horticulture** , Vitoria da Conquista. v. 30, n. 3, p. 514-519, Jul./Sept. 2012

MENDLINGER, S.; PASTERNAK, D. Effect of time salination of flowering, yield and quality factors in melon, Cucumis melo L. **Journal of the American Society for Horticultural Science** , Alexandria, v. 67, no. 4, p. 529-534, 1992.

MENEZES, JB; FILGUEIRAS, HAC; ALVES, RE; MAIA, CE; ANDRADE, GD; ALMEIDA, JD; VIANA, FMP **Characteristics of melon for export** . Postharvest melon. Brasília, DF: Embrapa Communication for Technology Transfer, 2000.

MIRANDA, FR; BLEICHER, E. **Evapotranspiration and cultivation and irrigation coefficients for melon (Cucumis melo L.) cultivation in the coastal region of Ceará** . Fortaleza: Embrapa Agroindústria Tropical, Dec. 2001. (Research and Development Bulletin, 2).

NUNES, GHS; COSTA FILHO, JH; SILVA, DJH; CARNEIRO, PCSC; DANTAS, MSM Genetic divergence among melon lines. **Agronomic Science Journal** , Fortaleza, v. 42, n. 3, p. 765-773, Jul./Sept. 2011a.

NUNES, GHS; MELO, DRM; DANTAS, DJ; ARAGÃO, FAS; NUNES, EWLP Genetic divergence among melon lines of the Inodorus group . **Agronomic Science Journal** , Fortaleza, v. 42, n. 2, p. 448-456, Apr./Jun. 2011b.

NUNES, GHS; PEREIRA, EWL; SALES JUNIOR, R.; BEZERRA NETO, F. OLIVEIRA, KC; MESQUITA, LX Productivity and quality of pele-de-sapo melon fruits at two planting densities. **Horticultura Brasileira** , Brasília, DF, v. 26, n. 2, p. 236-239, Apr./Jun. 2008.

NUNES, GHS; SANTOS JUNIOR, JJ; ANDRADE, FV; BEZERRA NETO F.; ALMEIDA, AHB; MEDEIROS. DC Productive and quality aspects of melon hybrids grown in the Mossoró- Assu agropole . **Brazilian Horticulture** , Brasília, DF, v. 22, n. 4, p. 744-747, Oct./Dec. 2004.

PADUAN, MT; CAMPOS, RP; CLEMENTE, E. Fruit quality of melon types produced in a protected environment. **Brazilian Journal of Fruit Growing** , Jaboticabal, v. 29, n. 3, p. 535-539, Dec. 2007.

SANTOS, VM; CARDOSO, DP; FERREIRA, EA; SILVA, AR; SOUSA, DCV Action of biostimulants on soybean crop performance under two phosphate fertilization conditions. **Green Journal of Agroecology and Sustainable Development** , Pombal, v. 10, n. 3, p. 1-8, Jul./Sept. 2015.

SILVA, LM; FIGUEIREDO, RMF; SOUSA, FC; SOUSA, EP; LIMA, AKVO Chemical, physical and physicochemical parameters of three melon varieties. **Green Journal of Agroecology and Sustainable Development** , Mossoró, v. 6, n. 5, p. 242-246, Dec. 2011.

SIQUEIRA, WC; FARIAS, LA; LIMA, EMC; REZENDE, FC; GOMES, LAA; CUSTÓDIO, TN Quality of yellow melon fruits grown in a greenhouse under different irrigation depths. **Science and Agrotechnology** , Lavras, v. 33, n. 4, p. 1041-1046, Jul./Aug. 2009.

SIMÕES, WL; COELHO, DS; SOUZA, MA; DRUMOND, MA; ASSIS, JS; LIMA, JA Morphophysiological aspects of sunflower irrigated by drip in the Submiddle São Francisco. **Irriga Magazine** , Botucatu, v. 1, n. 1, p. 66-66, Feb./Mar. 2016.

SOUSA, AEC; BEZERRA, FML; SOUSA, CHC; SANTOS, FSS Melon production under effect of irrigation blades and potassium fertilization . **Agricultural Engineering Journal** , Jaboticabal, v. 30, n. 2, p. 271-278, Mar./Apr. 2010.

SOUSA, CAA; COSTA, CC; SANTOS, JB; MEDEIROS, AC Use of biostimulant in the initial development of watermelon in saline soil. **Research, Society and Development** , Vargem Grande, v. 9, n. 9, p. e92996837, Aug. 2020.

TAIZ, L.; ZEIGER, E.; MOLLER, IM; MURPHY, A. **Plant physiology and development** . 6th ed. Porto Alegre: Artmed , 2017.

TEODORO, REF; ALMEIDA, FP; LUZ, JMQ; MELO, B. Different drip irrigation depths in watermelon (Citrullus lanatus). **Bioscience Journal** , Uberlândia, v. 20, n. 1, p. 29-32, Jan./Apr. 2004.

VALNIR JÚNIOR, M.; LIMA, VLA; GOMES FILHO, RR; CARVALHO, CM; SOARES, FAL; LIMA, SCRV Irrigation depths and frequency of application on melon growth. **Brazilian Journal of Irrigated Agriculture** , Fortaleza, v. 7, n. 1, p. 42-53, Jan./Feb. 2013.

VENDRUSCOLO, EP; MARTINS, APB; CAMPOS, LFC; SELEGUINI, A.; SANTOS, MM Thermal stress mitigation via biostimulant application in cantaloupe melon seeds . **Brazilian Journal of Biosystems Engineering** , Tupã, v. 10, n. 3, p. 241-247, Jul./Sept. 2016.

VENDRUSCOLO, EP; MARTINS, APB; SELEGUINI, A. Promotion of vegetable seedling development using biostimulant . **Journal of Agronomic Sciences** , Umuarama , v. 5, n. 2, p. 73-82, Jul./Dec. 2016.

VENDRUSCOLO, EP; RABELO, RS; CAMPOS, LFC; MARTINS, APB; SEMENSATO, LR; SELEGUI NI, A. Physical-chemical changes in muskmelon fruits under biostimulant applications. **Revista Colombiana de Ciencias Hortícolas** , Bogotá, v. 11, no. 2, p. 459-463, Jul./Dec. 2017.

YURI, JE; RESENDE, GM; COSTA, ND Productive characteristics of yellow melon and pele de sapo melon genotypes in two planting seasons in the Submiddle São Francisco Valley. **Brazilian Journal of Irrigated Agriculture** , Fortaleza, v. 14, n. 2, p. 3897-3905, May/Aug. 2020.