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CRESCIMENTO VEGETATIVO, PRODUTIVIDADE E QUALIDADE DOS FRUTOS DO ABACAXIZEIRO 'BRS IMPERIAL' SOB LÂMINAS DE IRRIGAÇÃO

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1 RESUMO

Conhecer a demanda hídrica de uma cultura em uma região possibilita um melhor manejo da irrigação e desenvolvimento da cultura. Diante disso, objetivou-se avaliar o crescimento vegetativo, qualidade físico-química dos frutos e a produtividade do abacaxizeiro 'BRS Imperial' sob lâminas de irrigação nas condições de tabuleiro costeiro, no estado do Espírito Santo (ES). O experimento foi realizado na Universidade Federal do Espírito Santo, município de São Mateus, em um delineamento em blocos casualizados, com sete lâminas de irrigação (0%, 25%, 50%, 75%, 100%, 125% e 150% da evapotranspiração de cultura-ETc), quatro repetições e seis plantas úteis por parcela. Foram avaliadas características vegetativas da planta e físico-químicas dos frutos e a produtividade. Os resultados obtidos foram submetidos à análise de variância. Para as condições em estudo, a maior altura de planta e diâmetro do caule observado foi de 28,8 cm e 65,1 mm, respectivamente, ambos na lâmina aplicada referente a 69% da reposição da ETc. Para as características físico-químicas analisadas, as lâminas de irrigação aplicadas não influenciaram significativamente a cultura. A produtividade obtida foi de 40,41 t ha^{-1}, com teor médio de sólidos solúveis totais de 16,46 ºBrix, valor superior ao mínimo exigido para a colheita e comercialização.

Palavras-chave: *Ananas comosus* (L.) Merril, características físico-químicas, massa do fruto, manejo da irrigação.

SANTANA, W. do R.; ROSA, L. V. C. A. F.; SOUZA, J. M. de; BONOMO, R. VEGETATIVE GROWTH, YIELD AND FRUIT QUALITY OF PINEAPPLE CROP 'BRS IMPERIAL' UNDER IRRIGATION DEPTHS

2 ABSTRACT

Knowing the hydric demand of a crop in a region enables better irrigation management and crop development. Thus, this study aimed to evaluate the vegetative growth, physical-chemical quality of the fruits and the yield of the pineapple crop 'BRS Imperial' under irrigation depths in coastal conditions, in the state of Espírito Santo (ES). The experiment was conducted at the Federal University of Espírito Santo, municipality of São Mateus, in a randomized block design, with seven irrigation depths (0%, 25%, 50%, 75%, 100%, 125% and 150% of the evapotranspiration of the crop (ETc)), four replications and six useful plants per plot. The vegetative characteristics of the plant and the physicochemical characteristics of the fruits were

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evaluated, as well as the yield. The results were subjected to analysis of variance. For the conditions under study, the highest plant height and stem diameter observed were 28.8 cm and 65.1 mm, respectively, both in the applied irrigation depth referring to 69% of the replacement of the ETc. For the physical-chemical characteristics analyzed, the applied irrigation depths did not significantly influence the crop. The yield obtained was 40.41 t ha^{-1}, with an average content of total soluble solids of 16.46 ºBrix, higher than the minimum required for harvest and commercialization.

Keywords: *Ananas comosus* (L.) Merril, physicochemical characteristics fruit, fruit mass, irrigation management.

3 INTRODUCTION

Fruit farming in Espírito Santo is an activity developed in all regions of the state and is of great economic importance. Pineapple cultivation, for example, in 2019, resulted in a harvested area of 2,400 hectares in the state, producing 50,300 tons (BRAZILIAN INSTITUTE OF GEOGRAPHY AND STATISTICS, 2019). Its production fosters job creation and includes family farmers (GALEANO et al., 2018). Furthermore, pineapple farming has become an alternative not only for small but also for large producers, mainly because it is a fruit crop with good potential for financial gains (COMÉRIO et al., 2019).

Although pineapple is a CAM plant (creacean acid metabolism), which has a CO_2 fixation mechanism called crassulacean acid metabolism and is therefore more resistant to rainfed cultivation, some areas have been introduced with irrigated systems, both in traditional regions and in new planting areas. In tropical regions, irrigation has been used to supplement water demand in seasons with lower rainfall (SILVA et al., 2017).

Irrigation has several benefits for pineapple plants, including contributing to vegetative development, increasing flowering and fruit yield (ALMEIDA et al., 2002; MELO et al., 2006), and increasing fruit weight gain. These benefits provide a satisfactory additional financial gain for producers when pineapple is sold fresh (SOUZA; SILVA; AZEVEDO, 2007). In addition to enabling a stable supply of high-quality fruit throughout the year, this aspect is important for acquiring and maintaining the product, as it results in smaller price fluctuations for the producer and consumer (FRANCO et al., 2014). Therefore, good water distribution throughout the crop cycle becomes essential to meet pineapple plant requirements and allow for economical production (MELO et al., 2006).

Although the domestic market is still not very demanding in terms of quality, consumers are increasingly demanding differentiated products, so producers must seek to improve their quality standards to remain competitive (BARKER et al., 2018).

The internal quality and physical properties of fruits are conferred by a set of physicochemical constituents of the pulp, which are responsible for the characteristic flavor and aroma and are important for their final acceptance. Factors such as climatic conditions, ripening stages, varietal differences and the mineral nutrition of plants strongly influence the physicochemical composition of fruits (BENGOZI et al., 2007).

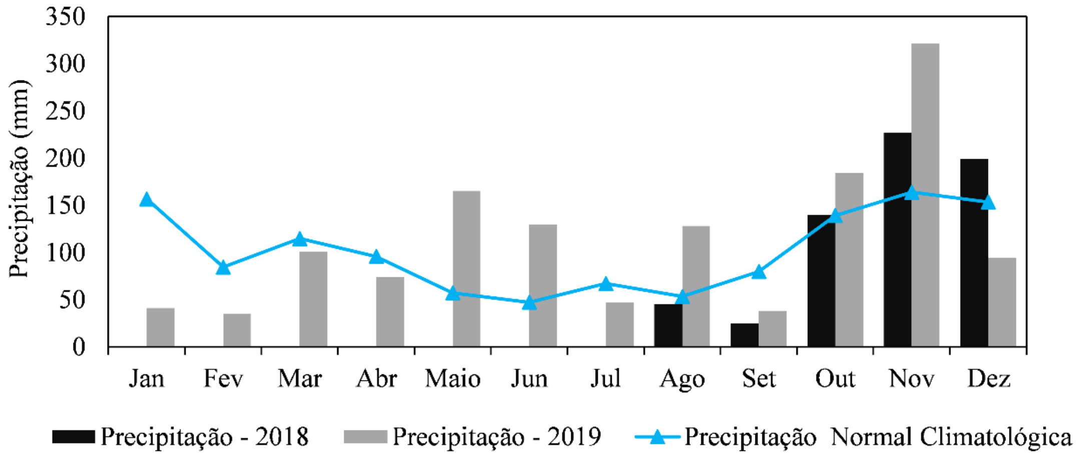
Understanding a crop's water demand in a given region enables better irrigation management and crop development. Therefore, this study aimed to evaluate the vegetative growth, physical and chemical quality of the fruit, and productivity of 'BRS Imperial' pineapple under irrigation depths in coastal tableland conditions in the state of Espírito Santo.

4 MATERIALS AND METHODS

The experiment was conducted at the Experimental Farm of the North Espírito Santa University Center (CEUNES), belonging to the Federal University of Espírito Santo (Ufes), São Mateus campus, latitude 18° 43' S, longitude 39° 51' W, and average altitude of 39 meters. The climate of the region, according to the Köppen classification, is Aw (humid tropical), with rain in summer and dry winter (ALVARES et al., 2013).

The monthly precipitation values during the evaluation period (August 2018--December 2019) and the climatological normal of the region from 1961--1990 were obtained from a station located approximately 200 m from the experimental area (Figure 1).

Figure 1. Climatological normal data for the period of 1961--1990 and monthly precipitation data for the months of August 2018--December 2019 were obtained from the Meteorological Station A616 of the National Institute of Meteorology in São Mateus, ES.



Source: Authors

The pineapple cultivar used was BRS Imperial, which was planted on August 10, 2018. Seedlings measuring between 5 and 6 cm were selected and standardized according to mass, size, and phytosanitary status. The seedlings were obtained from an experiment conducted in an adjacent area during the previous year. The total area occupied by the experiment was 1,680 m^2. The planting spacing adopted was 0.90 × 0.30 × 0.40 m in a double row.

The soil of the experimental area is classified as yellow argisol with a sandy loam texture (EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA, 2006) and was prepared conventionally (plowing and harrowing); subsequently, the holes were opened, in which 4.5 g of P_2O_5 was applied. Soil samples were collected at a depth of 0.00–0.20 m, and chemical analysis was subsequently performed, which revealed the following soil characteristics: pH in water (1: 2.5) = 6.0; P = 8.0 mg dm^3; K^+ = 41 mg dm^3; Na^+ = 19.0 mg dm^3; $H^+ + Al^{+3}$ = 1.9; Al^{+3} = 0.0; Ca^{+2} = 2.2; Mg^{+2} = 0.5; SB (sum of bases) = 2.9; CEC (cation exchange capacity) = 4.8 cmolc dm^3; V (percentage of base saturation) = 50.3%; m (percentage of aluminum saturation) = 0.0%; and OM (organic matter) = 2.5 dag kg^{-1}. The soil granulometric analysis revealed 836, 30 and 135 g kg^{-1} of sand, silt and clay, respectively (TEIXEIRA et al., 2017).

Topdressing fertilization was split into 16 applications, from the 2nd to the 10th month after planting, and was carried out via fertigation and manually (for the nonirrigated treatment). Urea (44% N) was used as the N source, and potassium chloride (60% K_2O) was used as the potassium source. The applications were divided into the following dosages: 90 kg ha $^{-1}$ of urea and KCl from the 2nd to the 3rd months, with 2.6 g of urea and 2.16 g of KCl per plant; 120 kg ha^{-1} of urea and KCl from the 4th to the 5th months, with 2.88 g of urea and 2.88 g of KCl per plant; 120 kg ha^{-1} of urea and 135 kg ha^{-1} of KCl from the 6th to the 7th months, with 2.88 g of urea and 3.24 g of KCl per plant; and 135 kg ha^{-1} of N and KCl from the 8th to the 9th months, with 3.24 g of urea and 3.24 g of KCl per plant.

Throughout the cycle, all necessary culture treatments, including weed control and phytosanitary measures, were carried out.

The experiment was conducted in a randomized block design with seven treatments and four replicates, totaling 28 plots. The treatments consisted of six irrigation depths, based on the replacement of crop evapotranspiration (ETc), and were arranged as follows: T1 = irrigation depth corresponding to 25% of ETc; T2 = irrigation depth corresponding to 50% of ETc; T3 = irrigation depth corresponding to 75% of ETc; T4 = irrigation depth corresponding to 100% of ETc; T5 = irrigation depth corresponding to 125% of ETc; T6 = irrigation depth corresponding to 150% of ETc; and T7 = nonirrigated (0% of ETc). In the first 30 days after planting (DAP), all the treatments received the same amount of water, considering the precipitation during the period, corresponding to 100% of ETc so that the seedlings would have greater success in establishing themselves.

The experimental plots were 8.0 m long by 4.8 m wide, totaling 38.4 ^{m2}. The plots consisted of four rows, with 20 plants per row, for a total of 160 plants per plot. Six central plants within the useful plot were used for growth evaluations, with the tip of one leaf of each plant being painted to standardize the plants used in the evaluations.

The irrigation system used was the localized drip type, with turbulent regime drip tubes from the Azud brand, with a spacing between drippers of 0.20 m and a flow rate of 1.4 Lh^{-1} at 10 mca. The drip tube lines were positioned so that they were between the rows of pineapple seedlings.

Irrigation management was carried out daily to replenish crop evapotranspiration, taking into account the precipitation that occurred in the area between consecutive irrigations. When precipitation was greater than or equal to ETc, irrigation was not applied. However, when precipitation was less than ETc, irrigation was applied to meet the plant's water demand according to the treatments. Precipitation data were obtained from the Meteorological Station of the National Institute of Meteorology. Reference evapotranspiration was estimated via the Penmann–Monteith equation according to Allen et al. (1998).

The ETc was calculated via Equation 1, and the irrigation depths corresponding to the T4 treatment (100% of the ETc) were calculated via Equation 2. The crop coefficients (Kc) used followed the values proposed by Santana et al. (2013), the replacement depths for each treatment and the Kc values are presented in Table 1.

$$\mathrm{ETc} = \mathrm{ETo} * \mathrm{Kc} (1)$$

$$L_{100} = \mathrm{ETc} - \mathrm{P} (2)$$

where ETc represents crop evapotranspiration (mm d^{-1}); the Kc crop coefficient; L $_{100}$ represents the irrigation depth applied for 100% of ETc (mm d^{-1}); and P represents precipitation (mm d^{-1}).

Table 1. Precipitation (P), crop coefficient (Kc), crop evapotranspiration (ETc), reference evapotranspiration (ETo) and gross monthly irrigation water consumption for each of the irrigation depth treatments.

Months	P	Kc	Etc	Eto	Irrigation blades (mm)					
					25%	50%	75%	100%	125%	150%
Aug/18	45	0.55	40	72	20	20	20	20	20	20
Sep/18	25	0.63	70	115	15	30	46	61	76	91
Oct/18	140	0.59	74	123	6	12	19	25	31	37
Nov/18	227	0.75	95	134	6	12	19	25	31	37
Dec/18	199	0.91	119	135	14	29	44	59	73	88
Jan/19	41	0.99	185	189	41	81	121	162	202	243
Feb/19	35	0.50	98	164	19	38	57	75	94	113
Mar/19	101	0.63	91	152	12	25	37	49	62	74
Apr/19	74	0.57	71	121	9	18	28	37	46	55
May/19	165	0.71	61	89	8	15	23	31	39	46
Jun/19	129	0.73	57	79	8	15	23	31	39	46
Jul/19	47	1.13	93	88	18	36	53	71	89	106
Aug/19	128	0.75	74	91	11	22	33	44	55	66
Sep/19	38	0.84	94	112	16	33	49	66	82	124
Oct/19	184	0.84	115	136	13	27	40	54	67	84
Nov/19	321	0.84	114	135	13	25	37	50	62	75
Dec/19	94	0.84	136	161	15	30	44	59	74	89
Totals	1993	-	1587	2096	244	468	693	919	1142	1394

Source: Authors

In July 2019, the plants were in the initial stage of natural flowering, with a sufficient number of plants per plot to carry out the experimental evaluation. Therefore, artificial induction of flowering was not performed. To identify the beginning of flowering, the emergence of the inflorescence within the leaf rosette was considered, as described by Kist et al. (2011a).

At 90, 150, 210 and 300 DAP, the following characteristics were analyzed: plant height, measured via a tape (in cm), and stem diameter, measured at the height of the plant neck with the aid of a digital caliper (in mm).

At 385 DAP (time of floral induction), the characteristics of 'D' leaves were evaluated. These characteristics included the maximum length and width, which were measured via a measuring tape (in cm), and the dry mass (in g plant^{-1}), which was measured by drying in an oven at 72°C for 4 days. To estimate the dry mass of leaf 'D', four leaves were collected from plants in the useful plot. To identify the leaf 'D', the leaf that formed a 45° angle between the soil level and an imaginary axis passing through the center of the plant was observed (KÜSTER et al., 2017).

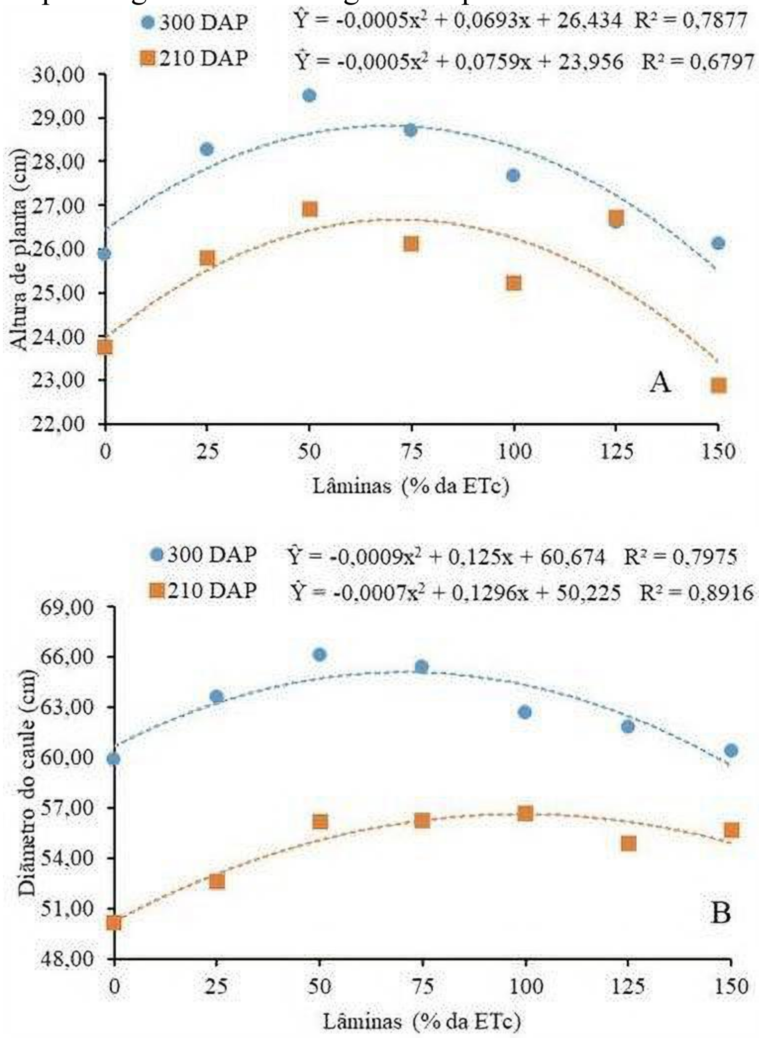
At 485 DAP, the fruits were harvested at the harvest point known as "colorido", which presents up to 50% yellow fruits, and were selected on the basis of size and absence of pests and diseases. They were then packaged and transported to the Laboratory of the Centro Universitário Norte do Espírito Santo, where they were washed in running water to remove residues, as recommended by Antoniolli et al. (2005). The following physicochemical parameters were evaluated: fruit and crown size (cm), using a graduated ruler; total fruit mass (kg) and fruit mass without crown (kg), using an analytical balance; fruit circumference (cm), using a tape measure in the central region of the fruit; and total soluble solids (°Brix), using a digital refractometer, which collects samples from the middle third of the fruit.

The results obtained were subjected to analysis of variance, with the effects being broken down according to their significance. The choice of the regression model was based on the model with the highest degree of significance according to the F test, whose regression deviation was nonsignificant.

5 RESULTS AND DISCUSSION

For plant height and stem diameter at 90 and 150 DAP, there was no regression adjustment. The plant height varied quadratically at 210 and 300 days after planting, with a maximum height value of 26.8 cm at 210 DAP at the 76% ETc replacement level, and at 300 DAP, the maximum height value of 28.8 cm occurred at the 69% ETc replacement level (Figure 2A). These results differ from those of Souza, Silva, and Azevedo (2007), who evaluated the development and yield of pineapple cv. Pérola under the climate and soil conditions of the Santa Rita tablelands, PB, and reported plant height values of 115 cm, using seedlings with lengths between 40 and 50 cm at 308 days after planting. The smaller plant heights obtained in this work may be a characteristic of the BRS Imperial cultivar, whose plant is of medium size (CABRAL; MATOS, 2005), and/or may have been influenced by the size of the seedlings used in planting.

Figure 2. Height (A) and stem diameter (B) of 'BRS Imperial' pineapple plants at 210 and 300 days after planting at different irrigation depths.

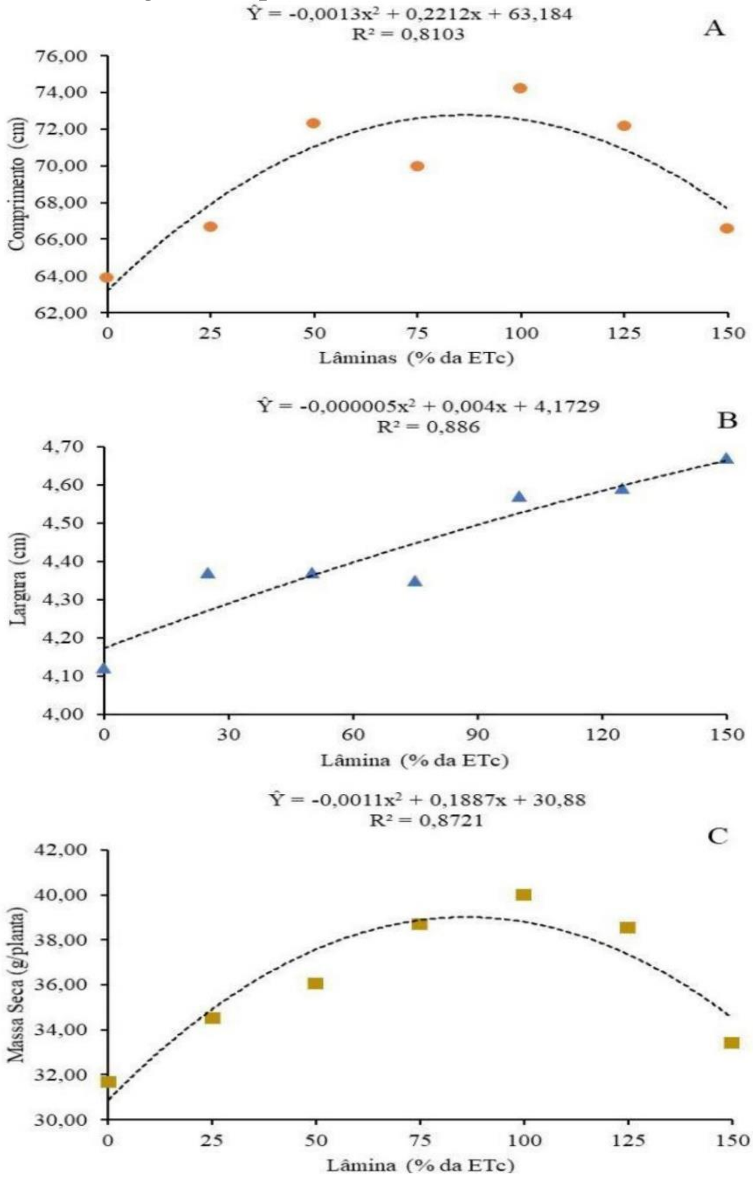


Coefficient of variation (%): height = 9.40% (210 DAP) and 8.15% (300 DAP); diameter = 6.87% (210 DAP) and 6.34% (300 DAP).
Source: Authors

Stem diameter also showed quadratic behavior at 210 and 300 days after planting, reaching a maximum diameter of 56.2 mm at the 93% ETc level at 210 DAP and, at 300 DAP, a maximum diameter of 65.1 mm at the 69% ETc level (Figure 2B). These results are similar to those reported by Sampaio, Fumis, and Leonel (2011), who, when studying the vegetative growth and fruit characteristics of five pineapple cultivars, reported diameter values ranging from 65.25 to 77.25 mm.

For leaf 'D', there was regression adjustment for all evaluated characteristics (Figure 3). The length varied quadratically, reaching a maximum value of 73 cm at the 85% ETc blade (Figure 3A). This result was lower than those reported by Kist et al. (2011b) for the cultivar Pérola, who reported values ranging from 104.8 to 118.7 cm, and the values reported by Sampaio, Fumis and Leonel (2011) for the cultivars Gold (75.75 cm) and Jupi (93.75 cm) were higher than those reported by Sampaio, Fumis and Leonel (2011) for the cultivars BRS Imperial (63.25 cm) and Gomo de Mel (58.75 cm).

Figure 3. Length (A), width (B) and dry mass (C) of leaf D of pineapple cultivar BRS 'Imperial' under different irrigation depths.



Coefficient of variation (%): length = 5.96%; width = 6.99%; dry mass = 7.84%.
Source: Authors

The width showed quadratic polynomial variation in relation to the irrigation depth (Figure 3B). In response to the 150% ETc depth, with a maximum value of 4.66 cm, there was a 12% increase in the width of the 'D' leaf compared to the response to the treatment without irrigation, whose value was 4.17 cm. Pereira et al. (2015) also reported an increase in the width of 'D' leaves in response to an increase in irrigation depth. Quadratic behavior was also observed for dry mass, which reached a maximum value of 39 g plant $^{-1}$ at the 85% ETc depth (Figure 3C). This behavior is similar to that observed by Rufini et al. (2019) for the dry mass of leaves in response to different irrigation levels.

The application of irrigation depths above the maximum point resulted in lower development for the variables plant height, stem diameter, and length and dry mass of 'D' leaves. This decrease may have been caused by the leaching of soil nutrients, which occurred at greater irrigation depths, preventing the absorption of nutrients by the pineapple root system, which is superficial and not very expansive in the soil profile, consequently resulting in smaller plants (FRANCO et al. 2014). Furthermore, the fact that the soil in which the pineapple plant was planted is sandy and has a low CEC may also have contributed to greater percolation of water and nutrients into the soil profile.

For the evaluated physical-chemical parameters and productivity, no significant responses were observed in relation to the different replacement depth levels evaluated, as shown in Table 2. These results were significantly influenced by the high rainfall during the evaluated period, which resulted in a lower need for irrigation. The accumulated precipitation during the experimental period was greater than the crop evapotranspiration, reaching values of 1993 and 1587 mm, respectively. The months of August, October, November, and December 2018 and March, April, May, June, August, October, and November 2019 presented precipitation above the ETc (Table 1). The region's rainfall index differed from the climatological normal (Figure 1). This set of conditions directly and significantly impacted the treatments because of the interference in the amount of replacement depth required to be applied.

Table 2. Analysis of variance and means of fruit length (CF), crown length (CC), total fruit mass (MF) and mass without crown (MFSC), fruit circumference (CF), total soluble solids (TSS) and productivity (Prod.) of 'BRS Imperial' pineapple under irrigation depths in São Mateus, ES.

Irrigation Blades (% ETc)	**CF**	**CC**	**CF**	**MF**	**MFSC**	**SST**	**Prod**
		(cm)		**(kg)**		**(°Brix)**	**t ha $^{-1}$**
0	13.29	14.93	36.07	0.96	0.86	16.65	39.75
25	13.81	15,19	36.40	1.00	0.90	15.98	41.47
50	14.11	16.02	36.48	1.04	0.93	16.69	43.11
75	13:31	15.36	35.41	0.92	0.83	16.81	38,37
100	13.86	15.70	35.93	0.96	0.87	17.06	40.15
125	13.87	15.31	36.21	1.00	0.89	16.46	41.45
150	13.29	16.38	35.87	0.98	0.86	15.54	40.58
Overall Average	13.65	15.54	36.05	0.977	0.87	16.46	40.69
Blocks	0.5^{ns}	2.24^{ns}	1,924^{ns}	0.19^{ns}	0.142^{ns}	0.334^{ns}	34.31^{ns}
Blades	0.463^{ns}	0.984^{ns}	0.53^{ns}	0.052^{ns}	0.0041^{ns}	1.10^{ns}	9.07^{ns}
CV (%)	5.27	6.23	3.64	12.27	13,14	7.17	12.21

CV (%) = coefficient of variation; ETc = crop evapotranspiration; ns - not significant at the 5% probability according to the F test.
Source: Authors

Similar results were reported by Souza and Torres (2011) in a study with the smooth cultivar Cayenee, in which the accumulated precipitation during the experiment was also greater than the ETc. Both results were opposite those reported by Silva et al. (2020) in a study carried out with Vitória pineapple. In this study, the authors found satisfactory responses at all levels and parameters, which were in increasing order of blade increase up to the replacement value equivalent to 100% of ETc, with a decrease in productivity being observed at levels of 125, 150 and 175% of ETc.

The average masses of fruits with and without crowns were 0.97 and 0.87 kg, respectively, which were higher than those reported by Sampaio, Fumis and Leonel

(2011), which were 0.67 and 0.60 kg, respectively. However, the values were close to the maximum values found by Oliveira, Natale and Dória (2013) of 1.08 and 0.97 kg, respectively, for the BRS Imperial cultivar. According to the results, the fruit mass is within the established range for the foreign market, in which the pineapple mass should be between 0.7 and 2.3 kg. Very small fruits (mass less than 0.7 kg) and very large fruits (greater than 2.3 kg) have low commercial value for *fresh consumption* and can be processed in the juice or candy industry (VILELA; PEGORARO; MAIA, 2015).

For the estimated fruit circumference and length, average values of 13.65 cm and 36.05 cm were obtained, respectively. These values are greater than those reported by Cabral and Matos (2005), who characterized Imperial cv. fruits as 18.50 cm in length and 13.50 cm in fruit circumference. A comparison of the two studies revealed dissimilarity in terms of the crown length variable, with an average of 15.54 cm obtained. This value is lower than that reported by Cabral and Matos (2005), in which the Imperial cv. presented approximately 120 g and a length of 17.80 cm. However, for fruits destined for export, owing to packaging standardization, the ideal crown is 5–13 cm in length (RIOS et al., 2018).

With respect to the total soluble solids (TSS) content, the irrigation depth did not significantly influence the total soluble solids (TSS) content in any of the treatments evaluated. The average value was 16.46 °Brix, which is lower than the value of 17.9 °Brix reported by Oliveira et al. (2015). However, this result is within the standards for classifying pineapple fruits, which define that for a fruit to be considered ripe, the minimum TSS must be equal to 12 °Brix. This value, according to Pereira et al. (2009), is in accordance with national values for good-quality fruits, which are generally consumed *fresh*.

The average productivity obtained was 40.4 t ha^{-1}, which is well above the national average in 2019, which was 24.1 t ha^{-1} (BRAZILIAN INSTITUTE OF GEOGRAPHY AND STATISTICS, 2019).

6 CONCLUSIONS

Vegetative characteristics are influenced by irrigation depth. The application of 69% ETc resulted in greater stem height and diameter, and the application of 85%, 150%, and 85% ETc resulted in greater length, width, and dry mass of the 'D' leaf in 'BRS Imperial' pineapple plants, respectively, under the studied soil and climate conditions.

The production components of 'BRS Imperial' pineapple under the experimental conditions were not influenced by the irrigation depth due to the high amount of rainfall that occurred during the experiment.

7 REFERENCES

ALLEN, RG; PEREIRA, LS; RAES, D.; SMITH, M. **Guidelines for computing crop water requirements** . Rome: FAO, 1998. (FAO Irrigation and Drainage, 56).

ALMEIDA, OA; SOUZA, LFS; REINHARDT, DH; CALDAS, RC Influence of irrigation on the cycle of pineapple cv. Pérola in the coastal tableland of Bahia. **Brazilian Journal of Fruit Growing** , Jaboticabal, v. 24, n. 2, p. 431-435, 2002.

ALVARES, CA; STAPE, JL; SENTELHAS, PC; GONÇALVES, JLM; SPAROVEK, G. Köppen's climate classification map for Brazil. **Meteorologische Zeitschrift** , Stuttgart , vol. 22, no. 6, p. 711-728, 2013.

ANTONIOLLI, LR; BENEDETTI, BC; SOUZA FILHO, MSM; BORGES, MF Effect of sodium hypochlorite on the microbiota of minimally processed 'Pérola' pineapple. **Journal Brazilian Fruit Growing Association ,** Jaboticabal , v. 27, n. 1, p. 157-160, 2005.

BARKER, DL; ARANTES, SD; SCHMILDT, ER; ARANTES, LO; FONTES, PSF; BUFFON, SB Postharvest quality of 'Vitória' pineapple as a function of the types of shoots and age of the plant for floral induction. **Revista Brasileira de Fruticultura** , Jaboticabal , v. 40, n. 4, p. e-297, 2018.

BENGOZI, FJ; SAMPAIO, AC; SPOTO, MHF; MISCHAN, MM; PALLAMIN, ML Physical and chemical qualities of pineapples sold at CEAGESP - São Paulo. **Brazilian Journal of Fruit Growing** , Jaboticabal, v. 29, n. 3, p. 540-545, 2007.

CABRAL, JRS; MATOS, AP **Imperial, new pineapple cultivar** . Cruz das Almas, BA: Embrapa Cassava and Fruit Growing, 2005. 4 p. (Technical communication, 114), Available at: https://ainfo.cnptia.embrapa.br/digital/bitstream/item/125083/1/Comunicado-114.pdf . Accessed on: March 28, 2020.

COMÉRIO, M.; BERILLI, SS; LIMA, CF; PINHO, LGR; PEREIRA, LC; PINHEIRO, APB; BERILLI, APCG; OLIVEIRA, EC; ARAUJO, FO Effect of foliar fertilization with tannery sludge on sprouting of pineapple stem sections for seedling production. **Ifes Science Journal** , Vitória , v. 5, n. 1, p. 170-179, 2019.

EMBRAPA . **Brazilian soil classification system** . 2nd ed. Rio de Janeiro: CNPS, 2006.

FRANCO, LRL; MAIA, VM; LOPES, OP; FRANCO, WTN; SANTOS, SR Growth, production and quality of 'pearl' pineapple under different irrigation depths. **Caatinga Magazine** , Mossoró, v. 27, no. 2, p. 132-140, 2014.

GALEANO, E.; SPERANDIO, F.; ROCHA, J.; FERRAO, L.; CAETANO, L.; GODINHO, T. **Summary of agricultural production in Espírito Santo 2016/2017** . Vitória: Incaper , 2018.

IBGE. **Municipal Agricultural Production**. Table 1612. Rio de Janeiro: SIDRA, 2019. Available at: https://sidra.ibge.gov.br/tabela/1612#resultado. Accessed: February 22, 2021.

KIST, HGK; RAMOS, JD; SANTOS, VA; RUFINI, JCM Phenology and production scheduling of the ' Smooth ' pineapple Cayenne in the Cerrado of Mato Grosso. **Brazilian Agricultural Research** , Brasília , DF, v. 46, n. 9, p. 992-997, 2011a.

KIST, HGK; RAMOS, JD; PIO, R.; SANTOS, VA Diquat and urea in the management of natural flowering of 'pérola' pineapple. **Brazilian Journal of Fruit Growing** , Jaboticabal , v. 33, n. 4, p. 1048-1054, 2011b.

KÜSTER, IS; ALEXANDRE, RS; ARANTES, SD; SCHMILDT, ER; ARANTES, LO; BONOMO, R.; KLEM, DLB Influence of planting time and floral induction on the quality of 'Vitória' pineapple fruits. **Ifes Science Journal** , Vitória , v. 3, n. 2, p. 29-53 , 2017.

MELO AS; NETTO, AOA; NETO, JD; BRITO, MEB; VIÉGAS, PRA; MAGALHÃES, LTS; FERNANDES, PD Vegetative development, fruit yield and optimization of pineapple cv. Pérola at different irrigation levels. **Ciência Rural** , Santa Maria , v. 36, n. 1, p. 93-98, 2006.

OLIVEIRA, AMG; NATALE, W.; DÓRIA, JO Production of 'Imperial' pineapple in the extreme south of Bahia, as a function of nitrogen and potassium doses. *In* : BRAZILIAN CONGRESS OF SOIL SCIENCE, 34th, 2013, Florianópolis. **Proceedings** [. ..]. Florianópolis: Brazilian Society of Soil Science, 2013. p. 1-4, CD-ROM.

OLIVEIRA, A.; GOMES, M.; PEREIRA, MEC; NATALE, W.; NUNES, WS; LEDO, CADS Quality of 'BRS Imperial' pineapple as a function of NK doses. **Brazilian Journal of Fruit Growing** , Jaboticabal , v. 37, n. 2, p. 497-506, 2015.

PEREIRA, MAB; SIEBENEICHLER, SC; LORENÇONI, R.; ADORIAN, GC; SILVA, JC; GARCIA, RBM; PEQUENO, DNL; SOUZA, CM; BRITO, RFF Quality of pineapple fruit marketed by Cooperfruto – Miranorte – TO. **Brazilian Journal of Fruit Growing** , Jaboticabal , v. 31, n. 4, p. 1048-1053, 2009.

RIOS, ESC; MENDONÇA, RMN; CARDOSO, EA; COSTA, JP; SILVA, SM Quality of 'Imperial' pineapple infructescence in function of nitrogen and potassium fertilization . **Brazilian Journal of Agricultural Sciences** , Recife , v. 13, n. 1, p. 1-8, 2018.

RUFINI, JCM; FAGUNDES, MCP; BORGES JUNIOR, JCF; ALENCAR, CAB; MOURA, MM; MAGALHÃES, DS Vegetative growth, yield and quality of pineapple fruits under irrigation depths. **Scientia Agraria Paranaensis** , Marechal Cândido Rondon , v. 18, n. 3, p. 289-296, 2019.

SAMPAIO, AC; FUMIS, TF; LEONEL, S. Vegetative growth and fruit characteristics of five pineapple cultivars in the Bauru-SP region . **Brazilian Journal of Fruit Growing** , Jaboticabal , v. 33, n. 3, p. 816-822, 2011.

SANTANA, MJ; SOUZA, OP; CAMARGOS, AEV; ANDRADE, JPR Pineapple crop coefficients under the soil and climate conditions of Uberaba, MG. **Brazilian Journal of Agricultural and Environmental Engineering** , Campina Grande , v. 17, n. 6, p. 602-607, 2013.

SILVA, TRG; SILVA, JC; LIMA, DF; SANTOS, LJS; JUNIOR, MRB; SANTOS, MAL Productivity and fruit quality of 'pérola' pineapple as a function of irrigation depths. **Brazilian Journal of Plant Science Journal of Development** , Curitiba , v. 6, no. 6, p. 40140-40152, 2020.

SILVA, RR; PAROLIN, LG; MINGOTTE, FLC; FUZETO, AP Vegetative development of pineapple varieties in the Bebedouro region-SP . **Science and Technology Innovation in Agronomy** , Bebedouro , v. 1, n. 1, p. 13-21, 2017.

SOUZA, OP; TORRES, JLR Physical and chemical characterization of pineapple under planting densities and irrigation levels in the Triângulo Mineiro region. **Magistra** , Cruz das Almas , v. 23, n. 4, p. 175-185, 2011.

SOUZA, CB; SILVA, BB; AZEVEDO, PV Growth and yield of pineapple under the climatic conditions of the Coastal Tablelands of Paraíba State. **Brazilian Journal of Agricultural and Environmental Engineering** , Campina Grande , v. 11, n. 2, p. 134-141, 2007.

TEIXEIRA, PC; DONAGEMA, GK; FONTANA, A.; TEIXEIRA, WG **Manual of soil analysis methods** . 3rd rev. ed. Rio de Janeiro: Embrapa Solos, 2017.

VILELA, GB; PEGORARO, RF; MAIA, VM Production prediction of 'Vitória' pineapple through phytotechnical and nutritional characteristics. **Agronomic Science Journal** , Fortaleza , v. 46, n. 4, p. 724-732, 2015.