Original Research Article

Vegetative Development and Productivity of the Watermelon Under Different Irrigation Depths in the Northwest Region of Espírito Santo

.

ABSTRACT

Brazil is one of the main producers of watermelon crops (*Citrullus lanatus*), which present great water requirement and offer in their irrigated cultivation, when well managed, the possibility of productive gains and fruit quality. The objective of this study was to evaluate the productivity and the vegetative development of the plant and the watermelon fruits of the 'Top Gun' cultivar submitted to different irrigation depths in the northwestern region of Espírito Santo. The experiment was carried out in the horticulture sector of the Federal Institute of Espírito Santo - Campus Itapina, from September 30, 2017 to December 15, 2017. A Completely Randomized Design (CRD) was used consisting of six treatments corresponding to 50%, 75%, 100%, 125%, 150% and 175% of the reference evapotranspiration (ETo) calculated daily, with four repetitions of each treatment. The length of the branches of all the selected plants and the longitudinal and transverse lengths of their fruits were evaluated weekly. In the last analysis, the fruit weight was also collected and the productivity was estimated. Development and differentiated production responses were verified with the different depths applied. Water replacements corresponding to the 125% ETo leaf gave the best vegetative and productive development of the watermelon 'Top Gun' cultivar, cultivated in the northwestern region of Espírito Santo.

Keywords: Citrullus lanatus; 'Top Gun' cultivar; yield; irrigation management; evapotranspiration; water replenishment.

UNDER PEER REVIEW

1. INTRODUCTION

Considered a cosmopolitan culture, watermelon (*Citrullus lanatus*) is cultivated in almost all tropical and subtropical regions of the planet. In Brazil, the Northeast region was historically the largest producer of this vegetable, however, it lost expressiveness because of its irrigated crop, pioneered adopted by the most technologically developed regions of the country. This way of cultivation stands out for the possibility of choosing the time of planting and the control of the water offered to the detriment of the phenological stage of the crop, interfering in the production [1].

Brazil is one of the main producers of watermelon, producing, in 2013, about 2.16 million tons of fruit, thus occupying the 4th position in the world ranking and, in the same year, the state of Espírito Santo produced 8,107 tons of this fruit [2]. Although still small, such production has been helping and gaining ground in the process of agricultural production diversification in the state of Espírito Santo, which presents coffee production as a production base [3].

The culture still presents few studies about the factors responsible for the productivity and quality of its fruits, even being one of the most important national vegetables [4]. It is known, however, that it presents a great demand and water application management, and that even small periods of water shortage can lead to a compromise in the quality and productivity of its fruits [5].

In regions with monthly rainfall less than 100 mm and the ones that undergo summer periods, irrigation becomes a practice of great relevance, allowing gains in productivity and quality. This practice still stands out as making production viable during the off-season, allowing greater profitability to producers, due to the generally higher prices achieved in the commercialization of fruits [6].

The watermelon culture presents a demand for quantity and frequency of variable irrigation according to its phenological stage, and its response to them is very relevant in irrigation planning, seeking a productive maximum in the face of a good use of available water resources, one of the main limiting factors for its production [7]. The watermelon culture presents a need for efficient water management when seeking productive gains [6].

Because of the few studies on the physiological and productive responses of the watermelon crop and aiming at assisting farmers in the adoption of adequate irrigation management based on the reference evapotranspiration (ETo), in order to increase production in the region, this work had as an objective to evaluate the productivity and the vegetative development of the plant and the watermelon fruits of the ‘Top Gun’ cultivar submitted to different irrigation depths in the northwestern region of Espírito Santo.

2. MATERIAL AND METHODS

This work was carried out at the Federal Institute of Espírito Santo - Campus Itapina, located in Colatina – ES, Brazil (19°32'22" South, 40°37'50" West, 62 m altitude), from September 30^{th}, 2017 to December 15^{th}, 2017, in the sector of Horticulture. The climate of the region is classified as Tropical Aw [8]. The region is characterized by irregular rainfall and high temperatures. The soil of the experimental area is classified as Dystrophic Red-Yellow Latosol [9].

The experimental design was Completely Randomized (CRD) with six treatments: 50% (T1), 75% (T2), 100% (T3), 125% (T4), 150% (T5) and 175% (T6) of the reference evapotranspiration (ETo) calculated daily, with four repetitions of each treatment. Each treatment consisted of 4 lines of 30.0 m long by 2.0 m wide, where the watermelon plants, double hybrid 'Top Gun', were conducted in spacing 2.0 x 1.5 m, totaling 20 plants per repetition, 80 plants per treatment and 480 plants throughout the experiment.

Only six central plants of the planting lines were evaluated in each treatment, totaling 24 useful plants per treatment, remaining the other ones as border.

In the experimental area, an automated drip irrigation system, micro spray type, was used, using an emitter per plant, with an average flow rate of 20 $l.h^{-1}$, at a service pressure of 2.0 $kgf.cm^{-2}$.

The reference evapotranspiration (ETo) was estimated daily (Equation 1) by the Penman-Monteith method FAO-56 Standard [10], through data obtained from a complete ONSET® weather station, consisting of air temperature sensors (ºC), wind direction (º), wind speed

UNDER PEER REVIEW

($m.s^{-1}$), relative humidity (%) and global solar radiation ($W.m^{-2}$), located near the experimental area.

$$ETo = \frac{0.408\Delta(Rn - G) + \gamma \frac{900}{T + 273} u_2(e_s - e_a)}{\Delta + \gamma(1 + 0.34\, u_2)} \quad \textbf{(Eq.1)}$$

in which ETo is the daily reference evapotranspiration ($mm.d^{-1}$); Rn is the daily radiation balance ($MJ.m^{-2}.d^{-1}$); G is the daily flow of heat in the soil ($MJ.m^{-2}.d^{-1}$); T is the daily average air temperature (ºC); u_2 is the daily average wind speed at 2 m in height ($m.s^{-1}$); e_s is the saturation pressure of the daily average water vapor (kPa); e_a is the daily average water vapor pressure (kPa); Δ is the slope of the vapor pressure curve at the point of T ($kPa.ºC^{-1}$) and γ is the psychrometric coefficient ($kPa.ºC^{-1}$).

The daily evapotranspiration estimate of the crop (ETc) was determined by Equation 2. The values of the crop coefficients (Kc) used were about the days after transplanting (DAT) for the crop: 0.4 (1-18 DAT); 0.5 (19-26 DAT); 0.7 (27-30 DAT); 0.8 (31-35 DAT); 0.95 (36-40 DAT); 1.05 (41-50 DAT); 0.9 (51-54 DAT); 0.8 (55-60 DAT) and 0.7 (61-64 DAT) [5].

$$ETc = ETo\; x\; Kc \quad \textbf{(Eq. 2)}$$

where: ETc = evapotranspiration of the crop for the day (mm); Kc = crop coefficient of the day (dimensionless); ETo = reference evapotranspiration for the day (mm);

In order to calculate the volume of water to be applied daily in each treatment (V), Equation 3 was used in which the evapotranspiration of the crop is multiplied by the factor (F), according to the percentage of each treatment (T1 = 0.50, T2 = 0.75, T3 = 1.0, T4 = 1.25, T5 = 1.50 and T6 = 1.75), by the location coefficient (wet or shaded area, whichever is higher) and by area of the plant, then, the result was divided by the application efficiency of the irrigation system adopted.

$$V = \frac{ETc \times F \times Kl \times A}{Ea} \quad \textbf{(Eq. 3)}$$

where: V = volume of water to be applied daily in each treatment (mm); ETc = evapotranspiration of the crop for the day (mm); F = percentage of treatments (decimal); Kl = location coefficient (%); A = area of the plant (3 m^2); Ea = efficiency of application of the irrigation system (90%).

Soil preparation was carried out by plowing, sorting and opening of pits 20 days before planting. Fertilization was done based on soil analysis (Table 1), according to the need of the watermelon crop, according to Prezotti *et al.* [11], following the manual of recommendation of liming and fertilization for the state of Espírito Santo, for a productivity of 25 tons per hectare. 150 $g.pit^{-1}$ of NPK 08-28-10 (pit fertilization) were applied; 100 $kg.ha^{-1}$ of N and 100 $kg.ha^{-1}$ of K_2O, weekly applied by sowing before irrigation (cover fertilization).

Table 1. Chemical characteristics of the soil in the 0-20 cm layer

UNDER PEER REVIEW

pH	O.M.	P	K	Na	Ca	Mg	Al	SB	t	CEC	V
(water)	(%)	----- mg dm^3 -----			--------------------- cmolc dm^3 ----------------						%
6.5	1.84	179.9	244	14	4.60	1.46	0.00	6.74	6.74	7.94	84.9

pH: potential of Hydrogen; OM: organic matter; P: phosphorus; K: potassium; Na: sodium; Ca: calcium; Mg: magnesium; Al: aluminum; SB: sum of bases; t: effective cation exchange capacity; CEC: cation exchange capacity at pH 7; V: percentage base saturation.

The watermelon seeds, 'Top Gun' cultivar Chinese double hybrid, used in the production of seedlings were purchased locally and individually seeded on September 30th, 2017, in polyethylene bags with dimensions of 10 x 20 x 0.5 cm, filled with a conventional substrate composed of 70% of subsoil soil and 30% of sifted and sieved cattle manure. For each 1000 kg of this mixture (subsoil soil plus manure) were added 2 kg of dolomitic limestone, 4 kg of single superphosphate and 0.3 kg of potassium chloride [11].

The seedlings were produced in a greenhouse and transplanted directly into the field on the 16th day after sowing (October 15th, 2017), when they presented two well-formed leaves. In the first five days after transplanting (DAT), an irrigation depth corresponding to 100% of the ETo was used for all treatments, thus maintaining the soil in the field capacity in all treatments, providing uniform initial development and adaptation of the seedlings to the planting site. The treatments with the different irrigation depths started at the 6th DAT.

Weekly evaluations of the length of all branches of the plants, selected in each treatment, and of the longitudinal and transverse length of all fruits were carried out using a measuring tape graduated in centimeters. Through the sum of the length of all the branches of the selected ones, starting from their base, the average length of the branches was calculated for each treatment.

The experiment was finalized on December 15th, 2017, when the fruits were submitted to the last measurement and weighed in a digital scale with an accuracy of 0.05 grams, with the average weight of the fruits per treatment, the production was then estimated per the corresponding hectare.

The data of the components, length of branches, length and transverse length circumference of the fruits, fruit weight and yield were submitted to analysis of variance of the regression by the F test ($P < 0.05$), using R software [12]. When significant, regression models were adjusted to better explain the effect of treatments, higher coefficient of determination (R^2). The maximum points were determined through the first derivative of the regression equations.

3. RESULTS AND DISCUSSION

The relative humidity during the field cultivation period presented a maximum value of 99.2% and a minimum of 29.7%, making an average value of 76.5%. The average values recorded for the maximum and minimum air relative humidity were 88.0% and 27.9%, respectively, with an average of 56.2% (Figure 1). Relative humidity is considered to be one of the factors that most affect the growth and productivity of the watermelon crop, with the range of 60 to 80% suggested for most vegetables [13]. High relative air humidity indexes may compromise fruit quality, favoring the incidence of foliar diseases, while low moisture favors the production of sweeter fruits [14].

UNDER PEER REVIEW

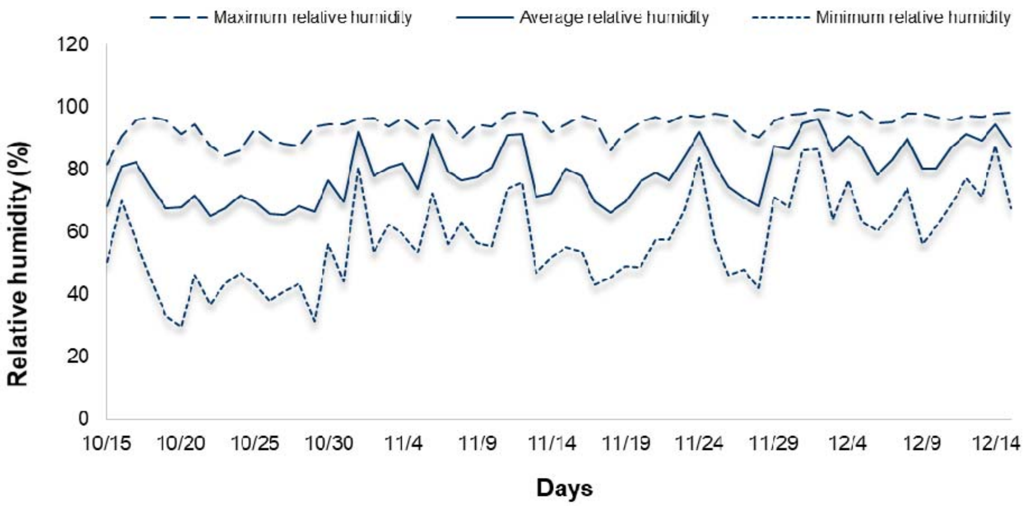


Fig. 1. Daily variations of maximum, minimum and average relative humidity during the growing season (10/15/2017 to 12/15/2017) of the watermelon crop, Top Gun cultivar

During the experimental period of watermelon cultivation, the maximum temperature recorded was 40.2°C (14th DAT) and the minimum temperature recorded was 16.8°C (4th DAT), with an average value of 25.3°C (Figure 2). These climatic conditions, observed during the experiment, fit the ideal conditions of production of the crop, which consists of hot and mild climate, long days and low relative humidity, optimum temperature range of 23 to 28ºC [15].

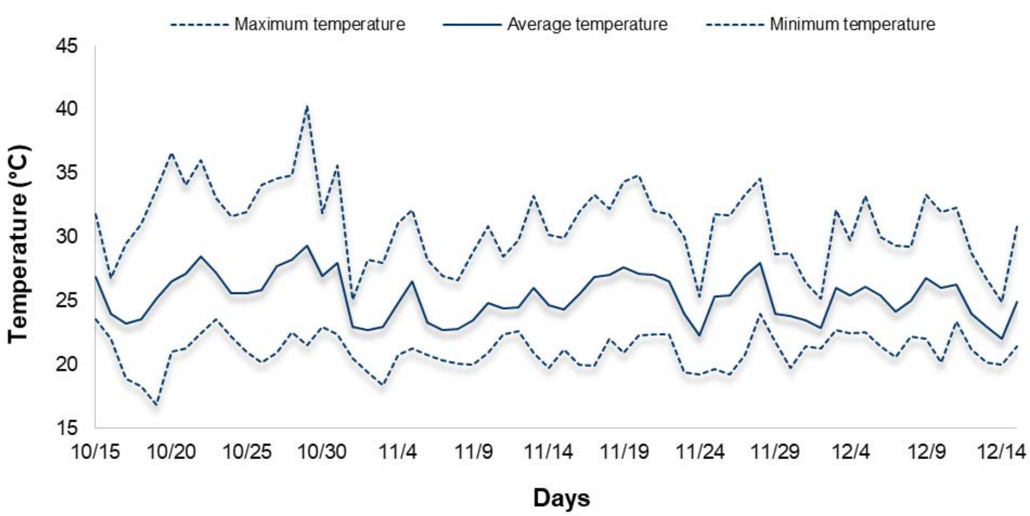


Fig. 2. Daily variations of the maximum, minimum and average temperature during the growing period (10/15/2017 to 12/15/2017) of the watermelon crop, Top Gun cultivar

The development of watermelon in the experiment period occurred in an environment with climatic conditions satisfactory to the crop. Being a typically tropical, its development is paralyzed under temperatures below 13°C and, below 15°C, its germination is not favored. However, under very high air temperatures there is a larger production of male flowers (above 35°C), which is not desirable and, above 39°C, pollination carried out mainly by bees is damaged because it affects the insects [13].

During the growing period, the cumulative volume of rainfall was 270.6 mm, whose distribution can be observed in Figure 3. The reference evapotranspiration (ETo) reached a maximum value of 6.63 $mm.d^{-1}$ and a minimum of 1.34 $mm.d^{-1}$, presenting an average value during the field experiment of 3.55 $mm.d^{-1}$ in the growing period.

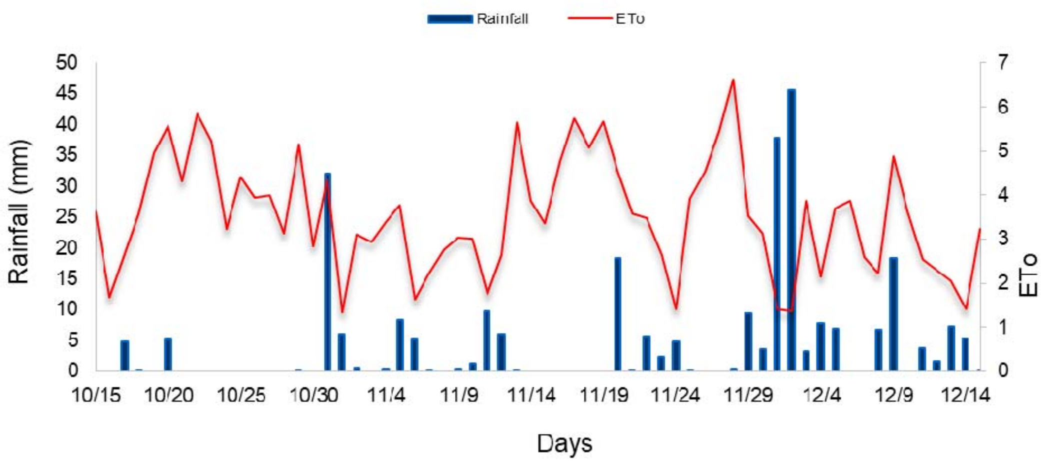


Fig. 3. Daily variations of reference evapotranspiration (ETo) and rainfall, during the growing season (10/15/2017 to 12/15/2017) of the watermelon crop, Top Gun cultivar

The applied depths had their volume calculated based on the percentage of ETo (50; 75; 100; 125;150 and 175%), estimated daily. The total volume applied (effective rainfall plus volume of the calculated depth corresponding to each treatment) was 598.26 mm; 628.79 mm; 659.69 mm; 690.91 mm; 722.79 mm and 755.79 mm for the treatments T1, T2, T3, T4, T5 and T6, respectively (Figure 4).

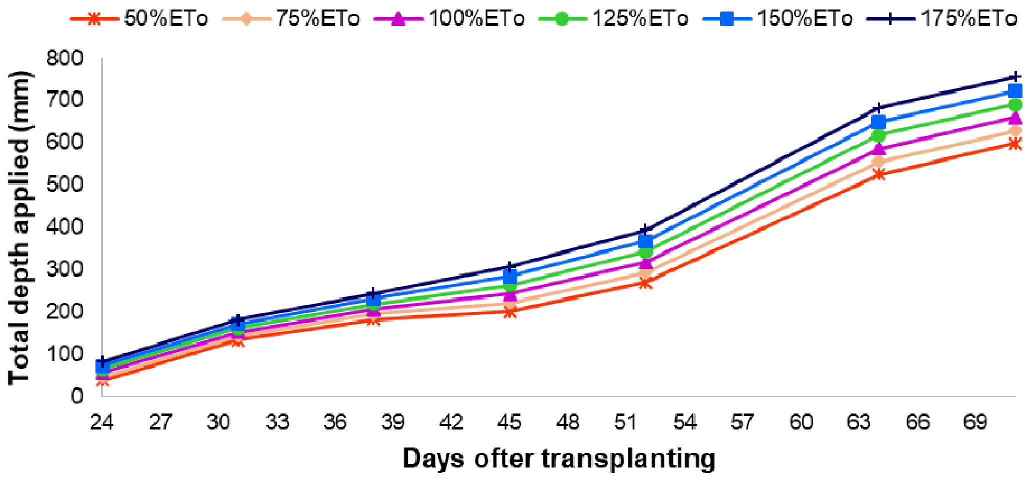


Fig. 4. Total water applied for treatment (effective rainfall plus depth of each treatment) provided in each treatment during the growing period (10/15/2017 to 12/15/2017) of the watermelon crop, Top Gun cultivar

The behaviors presented by the average growth of the watermelon branches in each treatment (Figure 5) show different responses of the development of the plants to the treatments used. Good developmental responses were observed in the treatments corresponding to 75%, 100%, 125% and 150% of ETo. The treatment of 175% of the ETo showed an initial average growth of the branches similar to the treatments of 75% to 150%, but, from the 45 DAT, it was not able to provide the same average growth rate of the branches, probably due to the effect of the higher volume of water applied. The treatment corresponding to 50% of the ETo gave the lowest development during the whole cycle, reaching 0.8 m at the end of it.

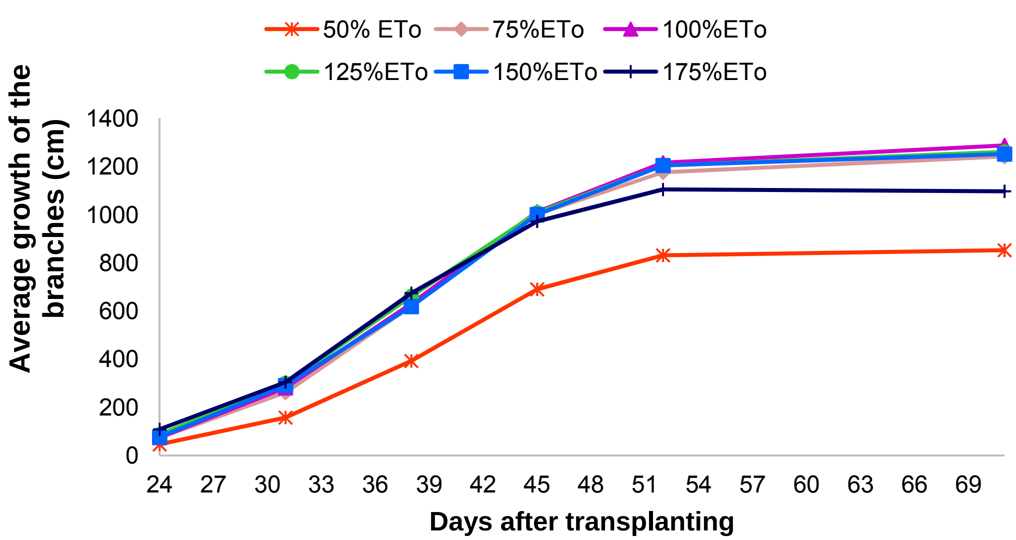


Fig. 5. Average accumulated growth of the branches of the watermelon plant under different irrigation depths

These responses indicate that volumes below and above the water supply range of 75% to 150% of ETo are detrimental to the average development of the branches in the watermelon crop, evidencing in the case of higher volumes, a later loss. According to Pereira [16], water stress acts by causing a reduction in the rate of evapotranspiration in plants and in the physiological functions that are related to it, such as nutrient assimilation, photosynthesis and respiration.

Under favorable conditions of soil characteristics, the excess irrigation applied to the watermelon crop suffers percolation, which results in damage to the irrigant [17]. This damage is not exclusively linked to the costs of this unnecessary volume of irrigation, but also to the leaching of nutrients that such percolation favors, even affecting the development of the crop.

Under unfavorable conditions of soils with reduced drainage, excess water compromises the respiration of the roots, causing the yellowing of the plants, which may lead to their death, due to the low tolerance to low aeration of the soil [6].

Analyzing the results of the final average length of the branches in the accumulated volumes of water applied in each treatment (Figure 6), we can observe that these values present a regression with quadratic behavior and coefficient of determination of 0.87. The highest estimated average length for the branches, 1321.64 cm, was attributed to the total depth of 687.36 mm, only 3.51 mm less than the accumulated value attributed to that one studied corresponding to 125% of the ETo. Higher yields of watermelon production were observed by Eltz *et al.* [18], in plants that presented the highest branch lengths, attributing such occurrence, probably to a larger leaf area for photosynthesis and higher speed of soil cover.

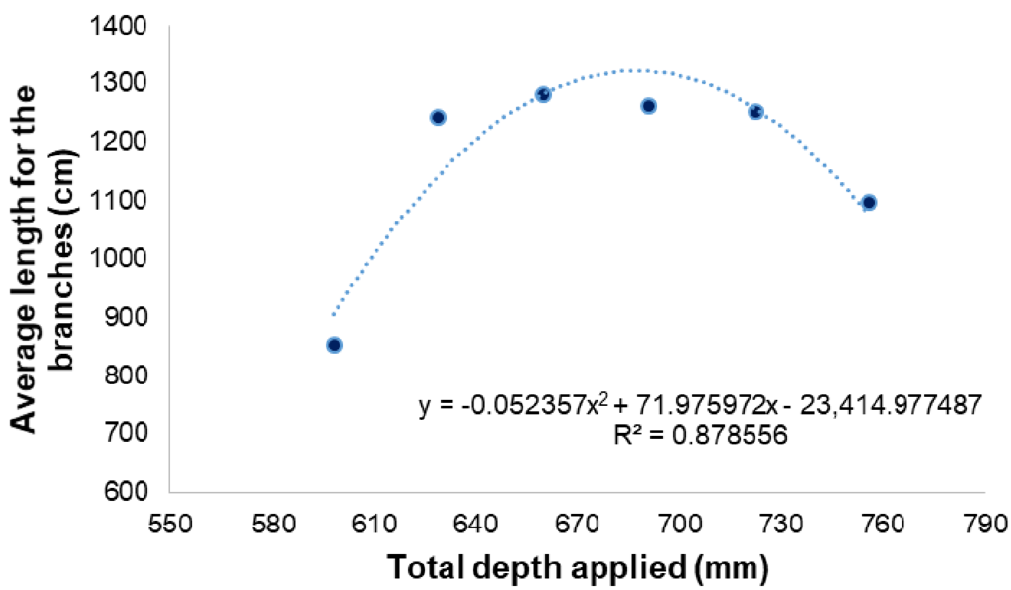
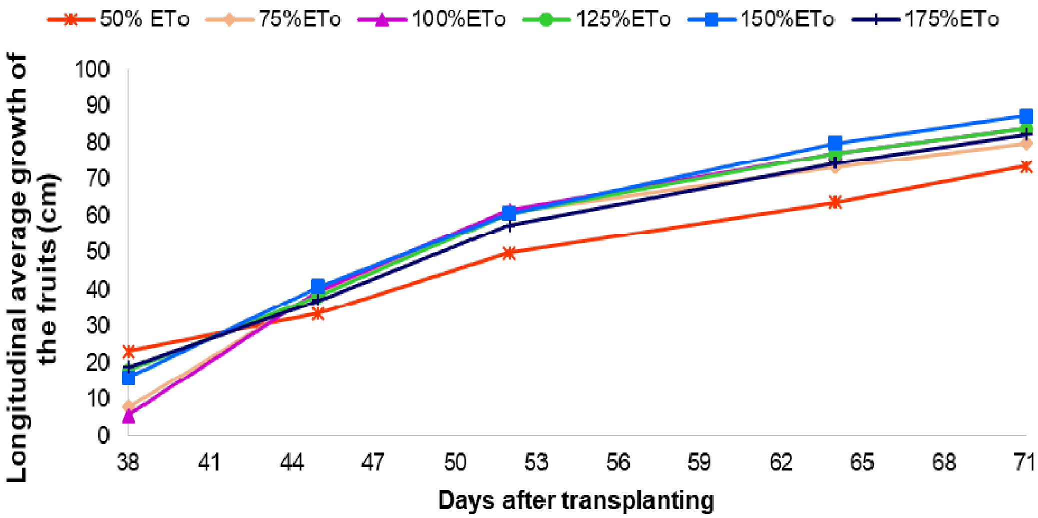


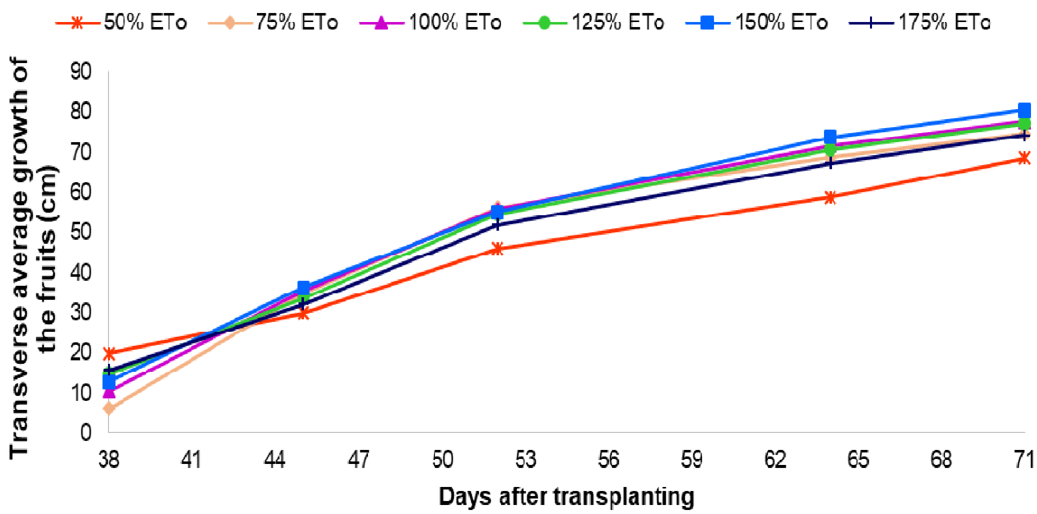
Fig. 6. Final average length of the watermelon branches, Top Gun cultivar, submitted to different irrigation depths

By the behavior of the fruit growth, both in the longitudinal (Fig. 7A) and transverse (Fig. 7B) directions, it is possible to verify that from the 45^{th} DAT, in the treatment corresponding to 50% of the ETo, that the water deficiency compromised the development of the fruits, directly reflecting on their productivity.

UNDER PEER REVIEW



A



B

Fig. 7. Average accumulated growth of the longitudinal (A) and transverse (B) circumference of the watermelon fruits, Top Gun cultivar

The values corresponding to the final length of the fruits, longitudinal and transverse, obtained by the treatments of irrigation depths presented a quadratic regression model, with determination coefficients of 0.94 and 0.89 respectively (Figure 8). The maximum development in the longitudinal length of the watermelon fruit, 85.84 cm, was reached in the total depth of 705.52 mm, with only 0.21 cm more than that estimated for the studied depth of 125% of the ETo, while the maximum development in the transversal length of the fruit, 78.80 cm, occurred in the that one of 695.75 mm, with approximately 0.02 cm less than that estimated for the studied depth corresponding to 125% of ETo.

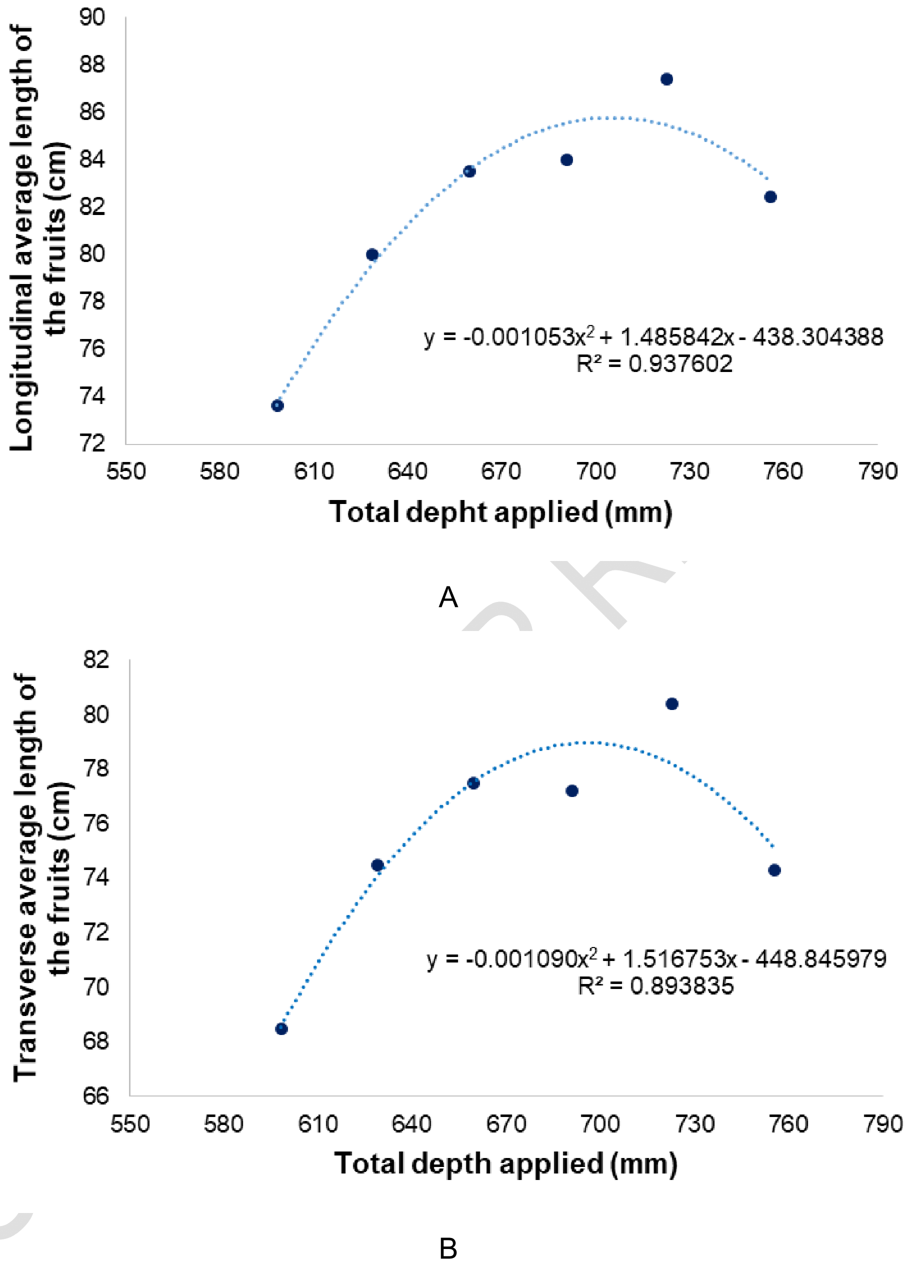


Fig. 8. Final, longitudinal (A) and transverse (B) average length of the watermelon fruits, Top Gun cultivar, submitted to different irrigation depths

The average weight of the watermelon fruit (Figure 9) presented a quadratic behavior, with a determination coefficient (R^2) of 0.868, reaching its maximum on a 698.96 mm depth (only 8.05 mm more than the accumulated volume in the 125% of the ETo), with an average weight of 9.006 kg, a value higher than the 5.45 kg found for Top Gun cultivar by Cardoso *et* *al.* [19], when evaluating watermelon cultivars in Manaus region in the state of Amazonas and 6.028 kg found by Pinho *et al.* [20], for Top Gun watermelon fruits when evaluating the production and quality of watermelon under daily irrigation equivalent to 100% replacement of the ETo by dripping in Teresina region in the state of Piauí.

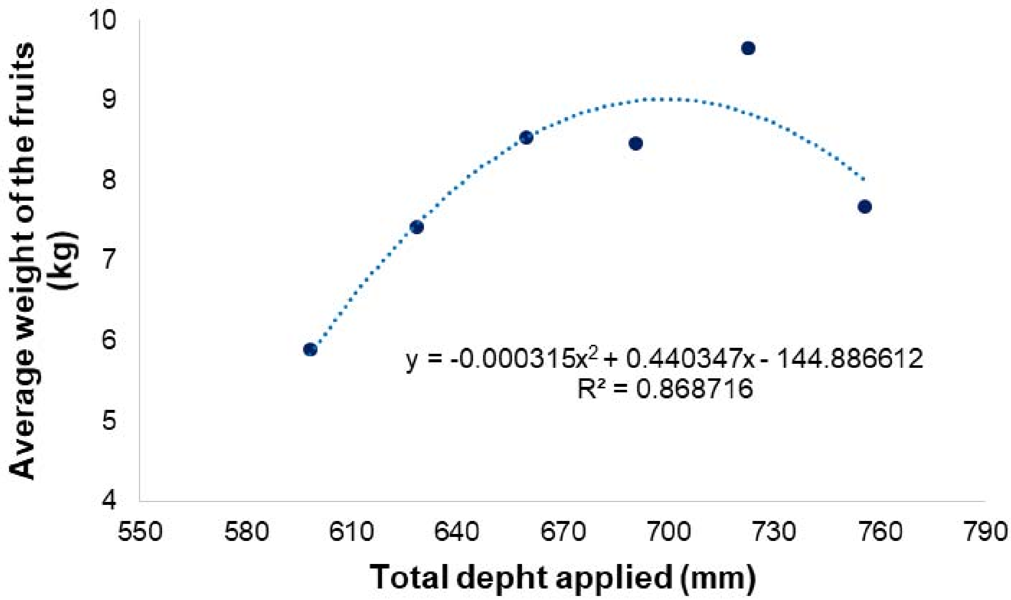


Fig. 9. Average final weight of the watermelon fruits, Top Gun cultivar, submitted to different irrigation depths

The productivity of watermelon also showed a quadratic behavior, with a determination coefficient (R^2) of 0.868 and maximum estimated yield, 29.97 ton.ha^{-1}, being reached in the accumulated depth of 699.01 mm, only 0.08 tons more than the estimated for the studied one corresponding to 125% of ETo (Figure 10). This estimated maximum production is about 4.13 tons lower than that found by Pinho *et al.* [20] for Top Gun cultivar under drip irrigation in Teresina, adopting a smaller spacing of 2.0 meters between rows by 1.0 meter between plants.

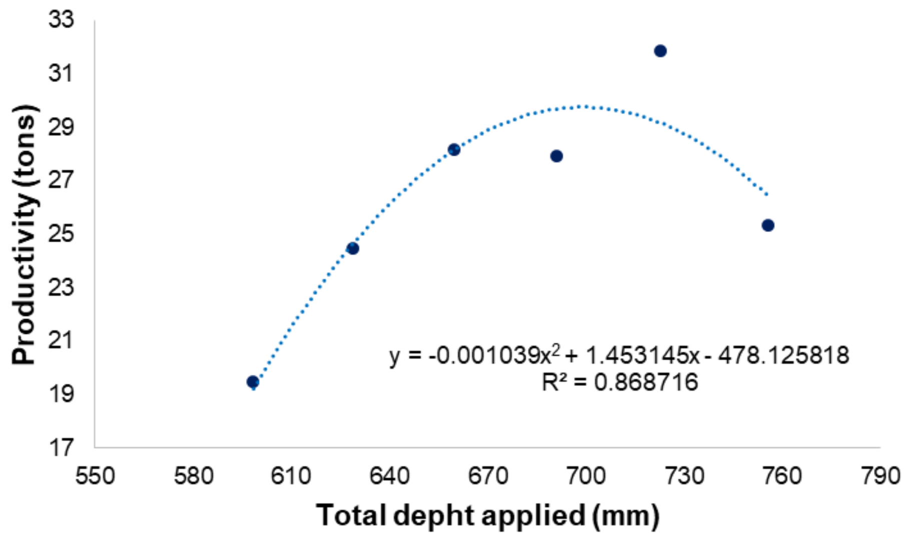


Fig. 10. Average productivity of the watermelon, Top Gun cultivar, submitted to different irrigation depths

The water deficit, especially in the more critical stages of flowering and fruiting, promotes a considerable reduction in fruit quality and production as a whole [6]. Excess water, especially in poorly drained soils and irrigation systems that promote leaf wetting, contributes to the recurrent occurrence of soil diseases. When this excess occurs in the maturation stage, the damage caused is more harmful than when there is the deficit, leading to a reduction of sugar in the fruits and, in some situations, cracking [21].

All the evaluated parameters evidenced the occurrence of developmental responses and differentiated production of the watermelon crop, related to the irrigation depths used. The 125% ETo (T4) depth provided the best vegetative growth response, fruit size and productivity, and it (125% of ETo) should be considered in irrigation management for the producers from the northwestern region of Espírito Santo.

4. CONCLUSION

Irrigation management performed with water replacements equivalent to the irrigation depth of 125% of the ETo presented the best development in the average length of the branches, fruit growth, higher average weight of the fruit, as well as the higher productivity of the watermelon Top Gun cultivar, cultivated in the northwestern region of Espírito Santo

UNDER PEER REVIEW

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Dias RCS, Rezende GM. Watermelon production system: socioeconomics. Embrapa Semiárido Sistema de produção. 2010. Electronic version ISSN 1807-0027. Available: https://sistemasdeproducao.cnptia.embrapa.br/FontesHTML/Melancia/SistemaProducaoMelancia/socioeconomia.htm

2. AGRIANUAL – Anuário da Agricultura Brasileira. São Paulo: FNP, Business Consulting. 2017;321-324.

3. Varejão P. Watermelon is an alternative income for producers in Marilândia. Portal Campo Vivo. 2010. Available: https://campovivo.com.br/sem-categoria/Melancia-e-alternativa-de-renda-para-produtores-de-Marilandia/

4. Figeirêdo VB, Medeiros JF, Zocoler JL, Sobrinho JE. Evapotranspiration of watermelon irrigated with different salinity waters. Engenharia agrícola. 2009;29(2):231-240. Available: https://repositorio.unesp.br/bitstream/handle/11449/10318/S0100-69162009000200006.pdf?sequence=1&isAllowed=y

5. Braga MB, Calgaro M. Watermelon production system: irrigation. Embrapa Semiárido Sistema de produção. 2010. Electronic version ISSN 1807-0027. Available: https://sistemasdeproducao.cnptia.embrapa.br/FontesHTML/Melancia/SistemaProducaoMelancia/irrigacao.htm

6. Marouelli WA, Braga MB, Andrade Junior AS. Irrigation in watermelon culture. Technical circular 108. Ministério da Agricultura, Pecuária e Abastecimento. 2012. ISSN 1415-3033. Available: https://www.infoteca.cnptia.embrapa.br/infoteca/handle/doc/942564?locale=es

7. Andrade Junior AS, Frizzone JA, Bastos EA, Cardoso MJ, Rodrigues BHN. Optimal irrigation strategies for watermelon crop. Pesquisa agropecuária brasileira. 2001;36(2):301-305. Available: http://www.scielo.br/pdf/%0D/pab/v36n2/a13v36n2.pdf

8. Köppen, W. Das geographische system der klimate. In: Köppen GW.; Geiger MR. (eds.), Handbuch der Klimatologie, Berlin. 1936; 44p.

9. Santos HG, Jacomine PKT, Anjos LHC, Oliveira VAV, Lumbreras JF, Coelho MR, Almeida JA, Cunha TJF, Oliveira JB. Brazilian system of soil classification. Revista ampliada – Brasília, DF: Embrapa. 2013;3:353.

10. Allen RG, Pereira LS, Raes D, Smith M. Crop evapotranspiration: guidelines for computing crop water requirements. (Irrigation and Drainage Paper, 56) Rome: FAO. 1998;1-300.

11. Prezotti LC, Gomes JA, Dadalto GG, Oliveira JA. Liming and Fertilization Recommendation Manual for the State of Espírito Santo - 5th approach. SEFA/INCAPER/CEDAGRO. Vitória, ES. 2007;1-305.

UNDER PEER REVIEW

12. R Core Team. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. 2017. Available: URL https://www.R-project.org/

13. Rezende GM, Dias RCS, Costa ND. Watermelon production system: Climate. Embrapa Semiárido, Sistemas de Produção. Electronic version ISSN 1807-0027. 2010. Available: https://sistemasdeproducao.cnptia.embrapa.br/FontesHTML/Melancia/SistemaProducaoMelancia/clima.htm#precipitacao

14. EMBRAPA – Empresa Brasilera de Pesquisa Agropecuária. The culture of watermelon. 2nd ed. Brasilia, DF: Embrapa Information Technology. 2007;85. ISBN 978-85-7383-407-9. Available: https://ainfo.cnptia.embrapa.br/digital/bitstream/item/11919/2/00081320.pdf

15. Costa ND, Leite WM. Soil and water management: soil potential for watermelon cultivation. Embrapa Semi-Árido.2007:15. Available: https://www.alice.cnptia.embrapa.br/bitstream/doc/159191/1/OPB1322.pdf

16. Pereira LS. Water Requirements and Irrigation Methods. Lisboa: Publicações Europa-América. 2004:313.

17. Saraiva KR, Bezerra FML, Souza F, Camboim Neto LF. Using "ISAREG" on irrigation management in watermelon cultivation in the Baixo Acaraú, Ceará. Revista Ciências Agronômica. 2013;44(1):53-60. ISSN 1806-6690. Available: http://dx.doi.org/10.1590/S1806-66902013000100007

18. Eltz FLF, Böck VD, Amado TJC. Effects of soil and leaf diseases management on watermelon yield and quality. Revista brasileira Agrociencias. 2005;11(2):201-206. Available: https://periodicos.ufpel.edu.br/ojs2/index.php/CAST/article/view/1212/1007

19. Cardoso MO, Antonio IC, Batista AC. Production and fruit quality of watermelon cultivars in the ecosystem of "upland" of the State of Amazonas. Horticultura Brasileira. 2011, 29(2):1630-1636. Available: http://www.abhorticultura.com.br/EventosX/Trabalhos/EV_5/A3687_T5412_Comp.pdf

20. Pinho RC, Ferreira VM, Andrade Junior AS, Andrade FN, Ribeiro VQ. Production and fruit quality of watermelon cultivars under drip irrigation. XL Brazilian Congress of Agricultural Engineering – CONBEA, Cuiabá, 2011. Available: https://ainfo.cnptia.embrapa.br/digital/bitstream/item/39560/1/TR0366-2.pdf

21. Santos FJS, Lima RN, Rodrigues BHN, Crisostomo LA, Sousa F, Oliveira JJG. Management of watermelon irrigation: use of tank class "A". Embrapa. Technical Circular 20. 2004:13. Available: http://www.ceinfo.cnpat.embrapa.br/arquivos/artigo_3056.pdf

UNDER PEER REVIEW