

RESEARCH COMMUNICATION

Response of oranje Natal Folha Murcha (*Citrus sinensis* (L.) Osbeck) at different levels of irrigation

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Abstract

With the aim of studying the effect of the irrigation rate on the yield and fruit quality of sweet orange (*Citrus sinensis* (L.) Osbeck) cv. Folha Murcha, an experiment was conducted in Jacutinga site located in the county of Jeronimo Monteiro, Espirito Santo, Brazil, using orange variety Folha Murcha grafted on mandarin cleopatra, with five years of age, spaced 5 m between rows and 4 m between plants within the line. Five treatments were implemented each with a different irrigation regime (L0 = without irrigation; L1 = 50% of PET; L2 = 75% of PET; L3 = 100% of PET and L4 = 125% of PET), defined based on potential evapotranspiration estimated by the method of Tank Class A. The experimental design was a randomized block with three replications consisting of nine plants in each repetition. In this study, yield per plant (kg), diameter and height of the fruit were evaluated. The irrigation regime 125% of the PET promoted the highest yield of orange Folha Murcha, under the conditions of this study.

Keywords: *Citrus*; Espirito Santo; fruit quality; irrigation; yield

Introduction

The orange is the most popular fruit tree grown in the world, being native to East Asia, a region that today

includes India, China, Bhutan, Burma and Malaysia. The most productive orchards are located in regions of tropical and subtropical climate, with Brazil standing out as the biggest producer of oranges in the world, expecting to collect 16,452,150 tons (403.2 million boxes of 40.8 kg) in 2014, a 1.0 % higher yield than that obtained in 2013 (IBGE, 2014). In order to maintain this scenario, it is worth studying farming techniques that not only improve the productivity but also the quality of citrus fruits produced in Brazil, and thus provide conditions for the grower to participate and act in this market.

Among the agricultural techniques of importance within the citrus industry, water management is a practice that can directly influence the productivity of this crop. Alternating dry period during winter and rainy periods during early spring induces the flowering of citrus trees. However, the occurrence of water deficit during flowering and early fruiting causes the fall of flowers and fruits, reducing their productivity (Bertonha *et al.*, 2004). Besides the yield of fruit, the orange tree should be maintained in continuous growth in order to have young branches and ensure the next flowering. The decrease in water uptake by rootlets affect leaf water potential, which results in deterioration of water status of the plant, causing an imbalance in the uptake and transpiration of water and leaf expansion of citrus (Castro, 1994), resulting in periods of leaf wilting and intense competition for water between leaves and fruits (Cohen and Goell, 1984; Madore, 1994). Under this circumstance, the increased water deficit leads to leaf and fruit loss, and may cause late or early flowering (Castro, 1994).

Water deficit decreases the productivity of citrus, especially if it occurs during flowering and fruiting, therefore irrigation is considered good practice (Silva *et al.*, 2006). Variation in irrigation regimes, at different phenological stages of crop development, will result in changes of the quality of the fruit quality, as measured by the concentration of soluble solids, the acidity and brix of citrus juice (Pereira *et al.*, 2009).

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Table 1. Summary of the analysis of variance, in fruit diameter (FD), fruit height (FH) and yield (Y), of orange Folha Murcha plants grafted on Cleopatra mandarin submitted to different irrigation regimes. Jeronimo Monteiro - ES, Brazil, 2013.

SV	DF	Mean square and significance		
		FD	FH	Y
Treatment	4	72.040**	43.300**	604.91**
Block	2	0.027 ^{ns}	0.016 ^{ns}	2.32 ^{ns}
Residue	8	0.016	0.029	1.90
VC (%)		0.19	0.26	2.47

** , * and ns, indicate significance of 1%, 5% and not significant respectively; by F test, at 5% probability; SV: source of variation; DF: degrees of freedom.

Table 2. Mean values for the characteristics fruit height (FH) expressed in cm, fruit diameter (FD) in cm and yield (Y) in Kg per plant, evaluated in orange *cv.* Folha Murcha plants treated with different irrigation regimes. Jeronimo Monteiro - ES, Brazil, 2013.

Treatments	0% PET	50% PET	75% PET	100% PET	125% PET
FH (cm)	58.05 d	62.97 c	66.35 b	66.67 ab	66.96 a
FD (cm)	58.95 d	64.17c	68.68 b	70.23 a	70.36 a
Y (kg)	27.50 d	32.10 c	36.70 b	37.25 b	52.5 a

Means with the same letter, within each row, do not differ significantly between each other, by Tukey test at 5% probability.

The aim of the study was to evaluate the appropriate irrigation regime for fruit development and yield of the variety of orange *cv.* Folha Murcha, in the conditions of the county of Jeronimo Monteiro, Espirito Santo, Brazil.

Materials and Methods

The work was carried out from August 2012 to May 2013 in a private orchard, located in the county of de Jeronimo Monteiro, state of Espirito Santo, Brazil, located at an altitude of 109 m, geographic coordinate's 20°47'8" S e 41°23'52" W. For this experiment orange plants of the variety *cv.* Folha Murcha (*Citrus sinensis* L. Osbeck) grafted on Cleopatra mandarin (*Citrus reshni* Hort.) were used, with five years of age, spaced 5 m between rows and 4 m between plants within the line. The experiment was installed in a 6 year old commercial orchard, with a soil characterized as Red-Yellow Latosol. The fertilizations carried out, during the experimentation period, were: 3 tons/ha of dolomitic limestone in September of 2012, 750 g/plant hiperfós G brand Fertipar (source of phosphorus) + 333 g/plant hiperfós 20-00-15 (source of nitrogen and potassium) in October of 2012, 750 g/plant hiperfós G + 333 g/plant hiperfós 20-00-15 in December of 2012 and lastly, 333 g/plant hiperfós 20-00-15 n in March of 2013. The agrochemicals applied during experimentation were: Savey in the dose 0.03 g/l (control of sucking insects) in August of 2012, Envidor in the dose 0.2 ml/l (control of Rust Mite) + Native in the dose 0.75 ml/l (control of Postbloom Fruit Drop of Citrus and Citrus Black Spot) in October of 2012, Envidor at a dose of 0.2 ml/l (control of Rust Mite) in February of 2013 and lastly Envidor at a dose of 0.2 ml/l (control Snow Scale) + Cobre Atar BR in the dose 1.5 g/l (control of Root Rot, Scab and Melanose) in May of 2013.

The orange *cv.* Folha Murcha plants were submitted to five treatments each with a different irrigation regime (L0 = without irrigation; L1 = 50% of PET; L2 = 75% of PET; L3 = 100% of PET and L4 = 125% of PET), defined based on potential evapotranspiration estimated by the method of Class A pan. The watering of the plants occurred in 7 days intervals using the predefined irrigation regimes. The experimental design was a randomized block with three replications consisting of nine plants in each repetition, totaling 135 plants evaluated in experimentation. The yield per plant (kg) was measured *via* direct weighing of all fruits harvested. The height and diameter of the fruits, radial and longitudinal measurement, were performed with a caliper rule. During the experiment all cultural practices required in cultivation, such as weeding, fertilizing, applying pesticides and pruning were performed.

Data were subjected to analysis of variance, and means were compared with Tukey test, using the statistical program R.

Results and Discussion

According to the analysis of variance, for all traits there is a significant difference between treatments implemented in this study. No significant difference was found between the blocks, in all evaluated traits (Table 1).

For the characteristic fruit height, the smallest average (58.05 cm) was observed in treatment with irrigation regime 0% of PET, in other words without irrigation. The irrigation regime that resulted in the highest average fruit height (66.96 cm) was 125% of PET, though it did not significantly differ from 100% of PET. The irrigation regime 75% of PET did not significantly differ from 100% PET (Table 2).

With respect to the diameter of the fruit, it was observed that the highest means were 70.23 cm and 70.36 cm, respectively obtained from the application of irrigation regime 100% and 125% PET. The lowest average fruit diameter was verified when the orange plants were subjected to treatment without irrigation, 0 of PET (Table 2).

For the characteristic orange yield the highest mean of 52.5 kg per plant was obtained from the application of irrigation regime 125% of PET, it is worthy to note that the use of this irrigation regime promoted an increase of 52% in orange yield, when compared to the treatment showing the lowest average of 27.5 kg per plant.

Irrigation exerted an enormous importance to ensure increased yield of oranges, since, for all traits, the lowest means were always observed when the plants were placed in the treatments without irrigation and the highest means were obtained with irrigation regime 125% of PET.

These findings are the opposite of what was found by Amaral (2013) that studied the effect of irrigation on the yield of oranges *cv.* Folha Murcha and found that the treatment without supplementary irrigation produced the highest number of fruit and the highest yield. Bertonha *et al.* (2004), found a statistically significant quadratic relationship between irrigation rate and average fruit weight. These results differ from those obtained by Silva *et al.* (2009), where different irrigation regimes applied and equipment used did not differ in the mass of the fruit. Duenhas *et al.* (2002) analyzed the effect of irrigation on the average weight of the fruit of "Valencia" orange finding no significant differences between treatments.

Conclusions

The irrigation regime 125% of PET is recommended for orange (*Citrus sinensis* Osbeck) *cv.* Folha Murcha growth. For the majority of the evaluated characteristics, the irrigation regime 125% of PET, is the most suitable for the commercialization of fruits classified and allocated in boxes of 25 Kg.

Competing interests

The authors declare that they have no competing interests.

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