TECHNICAL PAPER

QUALITY OF PAPAYA HYBRID GROWN UNDER DIFFERENT IRRIGATION DEPTHS

MÔNICA S. DA SILVA[1], ALBERTO S. DE MELO[2], JUAREZ P. PEDROZA[3], JOSIVANDA P. GOMES[3], SEBASTIÃO DE OLIVEIRA M. JÚNIOR[1]

ABSTRACT: Irrigation is a practice widely used in fruit production in the Brazilian Northeast region, including in the papaya crop in order to increase their productivity. For the purpose of knowing the productive potential of papaya hybrid irrigated, an experiment was carried out in order to evaluate the performance of a papaya hybrid under different irrigations depths. Four irrigation depths (50, 75, 100 and 125% of ETo) were tested and the reference evapotranspiration was calculated by the Penman-Monteith model. The hybrid papaya used was UENF/Caliman 01, which was planted in single rows, spaced 4 x 2m from each other, and irrigated by dripping. The experimental design in randomized blocks was used with six replications and three plants per plot. The following variables were evaluated: transversal diameter, longitudinal diameter, pulp thickness, external and internal appearances, soluble solids, titratable acidity, pulp pH and soluble solids/titratable acidity relation. The higher transversal and longitudinal diameters of the fruit were obtained applying an irrigation depth of about 108% of evapotranspiration. The UENF/Caliman 01 hybrid can be cultivated in the semiarid region of the State of Paraiba, Brazil, with replacement rate of 100% ETo, without compromising the quality of the fruits.

KEYWORDS: *Carica papaya* L., irrigation, water consumption, fruit production.

QUALIDADE DE HÍBRIDO DE MAMOEIRO CULTIVADO SOB DIFERENTES LÂMINAS DE IRRIGAÇÃO

RESUMO: A irrigação é uma prática muito utilizada na fruticultura no Nordeste brasileiro, inclusive no cultivo do mamoeiro, a fim de aumentar sua produtividade. Desejando-se conhecer o potencial produtivo de híbridos de mamoeiro irrigado, realizou-se experimento com o objetivo de avaliar a qualidade de frutos de mamoeiro (*Carica papaya* L.) híbrido em função de diferentes lâminas de irrigação. Foram testadas quatro lâminas de irrigação (50; 75; 100 e 125% da ETo), sendo a evapotranspiração de referência calculada pelo modelo de Penman-Monteith. Utilizou-se o mamoeiro UENF/Caliman 01, que foi plantado em fileiras simples, sendo o plantio realizado no espaçamento de 4 m x 2 m, irrigado por gotejamento. O delineamento experimental foi em blocos ao acaso, com seis repetições e três plantas úteis por parcela. As variáveis estudadas foram: diâmetro transversal, diâmetro longitudinal, espessura da polpa, aparências externa e interna, sólidos solúveis, acidez titulável, pH e relação sólidos solúveis/acidez titulável. Os maiores diâmetros transversal e longitudinal dos frutos foram obtidos nas lâminas de irrigação de cerca de 108% da evapotranspiração. O híbrido UENF/Caliman 01 pode ser cultivado na região do sertão paraibano com taxa de reposição de 100% da ETo, sem comprometer a qualidade dos frutos.

PALAVRAS-CHAVE: *Carica papaya* L., consumo hídrico, fruticultura.

[1] MsC, Doutorando do Programa de Pós-Graduação em Eng. Agrícola daUAEA/CTRN/UFCG.
[2] Prof. Dr. da Universidade Estadual da Paraíba/UEPB.
[3] Prof. Dr. da Universidade Federal de Campina Grande/UFCG.
Recebido pelo Conselho Editorial em: 11-1-2012
Aprovado pelo Conselho Editorial em: 20-2-2013

INTRODUCTION

Papaya (*Carica papaya* L.) is widespread in regions of tropical and subtropical climates, and in 2005 was grown in 54 countries. Brazil is the largest producer, with 1.65 million tons, followed by Mexico and Nigeria, with 955,694 and 755,000 tons, respectively (FAO, 2010).

This fruit are present in almost all Brazilian states, with a concentration of production in the states of Bahia, Espírito Santo, Ceará, Paraíba, Pará and Amazonas, which account for around 75% of national production (COELHO et al., 2005).

On the national scene, the Northeast region has the largest papaya production, 879,288 tons, which represents 55.9% of the national production, followed by the Southeast region. The states of Bahia and Espírito Santo were responsible for 86% of national production, while Rio Grande do Norte had the highest growth (47.4%), followed by Espiríto Santo and Ceará, with 33.2 and 16.5%, respectively (FAO, 2010).

Among the problems related to the papaya crop stand out alternatives for the selection of cultivars for planting that meet both the requirements of the national and international market. Moreover, the high price of hybrid seeds has led many fruit producers to use successive plantings with F_2, F_3 and F_4 generations, which causes various problems, especially the loss of force and segregation for fruit shape (YAMANISHI et al., 2006). In this context, Brazil developed the papaya hybrid UENF/Caliman 01 (MORAIS et al., 2007), obtained from the cross between a progenitor of the Formosa group and a progenitor of the Solo group. The cultivation of this hybrid in the State of Paraiba is still restricted. However, studies on the productive potential are essential for the generation of knowledge that have validity and local proof, to obtain technological improvements for each state of cultivation.

Another relevant aspect in the successful production of papaya is irrigation. Although the vast majority of commercial crops of papaya are irrigated, information on the water demand of the culture and its effect on productivity are scarce, highlighting the need for researches to recommend the producers the correct alternative for crop irrigation management.

In this context, report that the amount of water stored in the soil during the period of papaya development affects their productivity, and both the excess and lack of water are prejudicial for the crop. The deficiency of water can impair the development of the plants and consequently the yield. On the other hand, the excess of water in the soil decreases the aeration of the root zone, leading to a decrease in productivity by reducing the number of fruit, in addition to inducing poor fruit formation (ALMEIDA et al., 2002). MONTENEGRO et al. (2004) state that the water depth estimates to be applied and the frequency of irrigation are important to avoid a reduction in income, caused by excess or deficit of moisture in the soil.

It is known that water is a limited natural resource in the semi-arid region of northeastern Brazil, and its use in irrigated fruit production should be focused on improving the efficiency of its use in farming systems in regions, notably, of high evapotranspiration demand. The knowledge of the physiological behavior and crop yield potential can bring an indicator of the state of the plant and help in decision making, providing an improvement in the use of natural resources.

Therefore, this study aimed to evaluate the performance of the papaya hybrid UENF/Caliman 01 in terms of different irrigation depths.

MATERIAL AND METHODS

The hybrid used was developed jointly by the State University of Norte Fluminense and the Company Caliman Agrícola S/A, in the municipality of Linhares, state of Espírito Santo - ES, resulting from the cross of 'Sunrise Solo 72/12' with 'JS12'. The hybrid features an insertion height of the first fruit of approximately 75cm, and nine months after the transplant, it can reach a size of around 4.2m.

Caliman/UENF 01 fruit is elongated, weighing on average 1.18kg, with smooth and bright skin and red-orange, thick, consistent and good-quality pulp (TORRES NETTO et al., 2009). One of its features is its excellent flavor, due to the high sugar content (°Brix), with an average diameter of 10cm and 21cm long.

Treatments and experimental design

The studied treatments were four water depths (L_1 = 50%, L_2 = 75%, L_3 = 100% and L_4 = 125% of ETo) and the reference evapotranspiration was calculated by the Penman-Monteith method standardized by ALLEN et al. (1998) (Equation 1).

The experimental design was a randomized block with six replications, each plot with three plants.

The applied water depths (irrigation + effective precipitation) in each treatment during the studied cycle were: 986.7; 1480, 1973.4 and 2466.7mm, respectively, for the treatments L1, L2, L3 and L4, as can be seen in Table 1. Figure 1 shows a detailed view of the irrigation method and cultivation field of papaya trees.

TABLE 1. Reference evapotranspiration (ETo), total precipitation, usable precipitation and applied depths of irrigation in the different replacement rates studied.

Treatment	ETo *	Total precipitation	Usable precipitation	Irrigation depth
	----------mm----------			
50% of ETo	986.7	441.2	330.9	655.8
75% of ETo	1480	441.2	330.9	1149.1
100% of ETo	1973.4	441.2	330.9	1642.5
125% of ETo	2466.7	441.2	330.9	2135.8

A. B.

FIGURE 1. Dripper operation (a) and partial view of the experiment of hybrid papaya tree. (B).

Sowing and cultivation methods

The seedlings were grown in a protected environment and then transplanted into a field obeying the spacing of 4m between furrows and 2m between plants. UENF/Caliman 01 hybrid seeds from the State University of Norte Fluminense were used, which showed 99% of germination.

Soil preparation was done by plowing followed by harrowing. Later, marks and holes of 40 x 40 x 40cm of length, width and depth, respectively, were made. The plants were arranged in twelve single furrows, each furrow consisting of twenty-two plants.

The control of weeds was performed according to the area, through the application of glyphosate using a backpack sprayer at a dosage of 80mL of the herbicide and 20L of water. Pests

and diseases were controlled chemically as soon as the threshold level has reached so avermectin insecticide (80mL/100L of water) and strobilurin (40mL/100L of water) and benzimidazole (100g/100L of water) fungicides were sprayed. For mite control, preventive chemical spraying with avermectin were used.

Senescent leaves were pruned ten centimeters from the stem, which are then incorporated into the soil along with the cultural rests of weeding. Concomitantly, doubly or triply conjugated fruit in the same petiole, as well as the imperfect ones, was removed – those from intermediate and pentandric hermaphroditic flowers.

As recommended by SOBRAL et al. (2007), fertilizations were made weekly using urea fertigation (300g/plant of N), potassium chloride (360g/plant of K_2O), and 300g/plant of P_2O_5 in the form of phosphoric acid. These values were divided according to nutritional demand, being 10% by the 4th month after transplant, 40% from flowering to fruiting and 50% from the production stage until harvest. Concurrently, a Vitan® cocktail of nutrients was applied with the following composition: 6.0% of Nitrogen; 8.0% of Phosphorus, 8.0% of Potassium, 1.0% of Calcium, 2.4% of Sulfur; 0.5% of Magnesium, 0.6% of Boro, 0.2% of Copper, 0.5% of Manganese, 0.2% of Molybdenum, 1.0% of Zinc, and 12.0% of Total Organic Carbon.

Irrigation Management

Seedlings were transplanted 45 days after emergence (DAE) and irrigated based on 100% of ETo until settlements of seedlings in the field (10 days after transplanting). After this time, treatments began to be applied. The data obtained in the calculations of irrigation were collected daily from the Automated Meteorological Station, located near the experimental area.

ETo Calculation (Penman-Monteith)

$$ETo = \frac{0.48\Delta(R_n - G) + \gamma\left(\frac{900U_2}{T+273}\right)(e_s - e_a)}{\Delta + \gamma(1 + 0.34U_2)} \quad (1)$$

where:

ETo - Reference evapotranspiration, mm day^{-1};
Rn - net radiation at crop surface, MJ m^{-2} day^{-1};
G - soil heat flow, MJ m^{-2} day^{-1};
Δ - slope of the curve "steam pressure vs. air temperature", kPa.^{o}C^{-1};
U_2 - wind speed measured 2m from the ground, m s^{-1};
T - temperature, ^{o}C;
e_s - water steam saturation pressure, kPa;
e_a - water steam real pressure, kPa;
γ - psychrometric factor, MJ kg^{-1}.

The gross depth, the intensity of water application and the time of irrigation were determined by Equations 2, 3 and 4, respectively, as proposed by MANTOVANI et al. (2006).

Gross depth calculation

$$GD = \frac{ETo.Ks}{Ef} - Pe \quad (2)$$

where:

GD - gross depth, mm day^{-1};
ETo - reference evapotranspiration according to Penman-Monteith, mm day^{-1};
Ks – percentage of area wet by emitter;
Pe - effective precipitation of a period of time, mm;
Ef - irrigation efficiency.

During the period in which the treatments were applied, from the total precipitation occurred, 75% was considered as effective precipitation, according to the method adopted by MONTENEGRO et al. (2004).

Irrigation intensity calculation

$$Ia = \frac{n \times v}{ec} \quad (3)$$

where:

Ia – application intensity, mm h^{-1};
n – number of emitters per plant, dimensionless;
v- emitter flow, L h^{-1};
ec- area occupied by the plant, m^2.

Daily irrigation time calculation

$$Ti = \frac{GD}{Ia} \quad (4)$$

where:

Ti – irrigation time, h;
GD - gross depth, mm day^{-1};
Ia – application intensity, mm h^{-1}.

The irrigation system used in the experiment was the located by dripping, consisting of two tapes per furrow with emitters with flow of 1.3L h^{-1}, distant 0.30m from each other, with equivalence of 12 emitters per plant.

The management of the application of different depths was done by varying the irrigation time being controlled through records, properly identified, placed laterally to the main pipeline that was distributing water to the drip tapes.

The transversal diameter was determined in the median region of the fruit (Figure 2A) and longitudinal diameter considered the base of the stalk to the central region of the fruit apex (Figure 2B), and a digital caliper graduated in millimeters was used for both evaluations.

The thickness of the pulp was observed seven days after harvest, when the fruit was at full maturity stage. For this study, a transversal cut was made in the midline and subsequently the pulp thickness determined by a digital caliper (mm) (Fig. 2C).

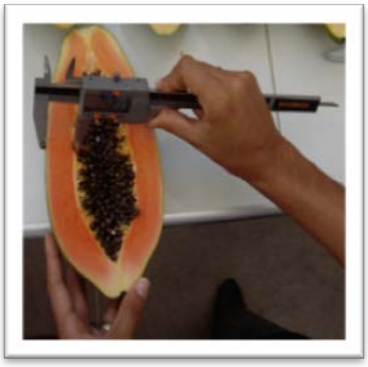
A.  B.  C. 

FIGURE 2. Longitudinal diameter (A), transversal diameter (B) and thickness of the pulp (C) of hybrid papaya.

To determine the external and internal appearances, subjective scale corresponding to notes: 0 - very severe intensity (more than 61% of fruit affected), 1 - severe intensity (51to 60%), 2 - medium intensity (31to 50%), 3 - mild intensity (11 to 30%), 4 – slight intensity (1 to 10%) and 5 - absent (less than 1%), considering fruit with a grade lesser than 3 unfit for commercialization.

Regarding the chemical attributes of the fruit, soluble solids (SS, in °Brix) tests were carried out through manual extraction of juice from a pulp tissue sample. Data were collected by digital refractometer (Model PR - 100, Palette, Atago Co., LTD., Japan); titratable acidity (TA, % of citric acid), determined in duplicate by titration using 1g of pulp (AOAC, 1992); pH, determined by extracting the juice of a pulp tissue sample of tissue from the pulp using a digital pH meter; SS/TA ratio, obtained by the results of the levels of total soluble solids (°Brix) and titratable acidity (% of citric acid). It is noteworthy that, for each variable, samples composed by different parts of the fruit were evaluated.

When all these data were gathered, an analysis of variance for each variable was carried out in accordance with the F test ($\alpha = 1\%$) and their respective regression models were adjusted according to the coefficient of determination (R^2) (STORCK et al., 2000), using the software SAEG 9.1.

RESULTS AND DISCUSSION

The quality characteristics of fruit showed no significant differences between the treatments, except for transversal (TD) and longitudinal (LD) diameters, according to the interpretation of the data contained in Table 2 below.

TABLE 2. Summary of the variance analysis for: transversal diameter (TD), longitudinal diameter (LD), thickness of the pulp (TP), external appearance (EA), internal appearance (IA) of hybrid papaya fruit grown in conditions of field under water depths in the microregion of Catolé do Rocha, state of Paraína.

FV	GL	QM				
		TD	LD	TP	EA	IA
Water levels	3	1.08**	15.57**	0.010^{ns}	0.597^{ns}	0.229^{ns}
Residue	36	0.23	2.11	0.039	0.189	0.055
CV %		4.52	6.34	7.03	12.84	4.81

Note: **, ns Significant at level 1% of probability by the F test and non-significant, respectively.

The transversal diameter underwent significant changes at the 1% level of probability by F test, due to the application of irrigation. Reduction of their values when the level of irrigation was increased (Figure 3) were verified. The maximum transversal diameter of fruit (10.9 cm) was obtained at the 107.5% of ETo estimated water depth. The lowest value of the transversal diameter (10.22) was obtained by applying 50% of ETo, noting an increase of 6.2% when the depth ranged from 50 to 100% of ETo.

The transversal diameter values found in this experiment are similar to those found by RODOLFO JÚNIOR et al. (2007) in Formosa papaya of 10.95 cm.

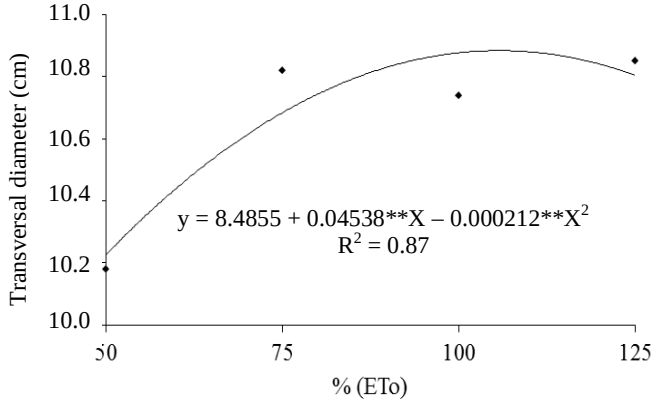


FIGURE 3. Transversal diameter (TD) (cm) of papaya UENF/Caliman 01 hybrid cultivated in conditions of field under water depths in the microregion of Catolé do Rocha, state of Paraíba.

Second degree polynomials, significant at the 1% of probability for longitudinal diameter of fruit data versus water depth applied, were adjusted and the value of coefficient of determination (R^2) was equal to 0.87. It was found that the longitudinal diameter results obtained at different replacement rates of ETo increased from 21.31cm to 23.8cm, which corresponded to an increase of 10.4% when the depth ranged from 50 to 100% of ETo, showing a reduction after that level. These values are higher than those found by ROCHA et al. (2005), that were 22.7, and lower than those mentioned by RODOLFO JÚNIOR et al. (2007) (25.6 cm), both in Formosa papaya. Deriving the regression equation of Figure 3 and equating it to zero, it is found that the irrigation depth of 108.8% of ETo produced fruit with greater transversal diameter.

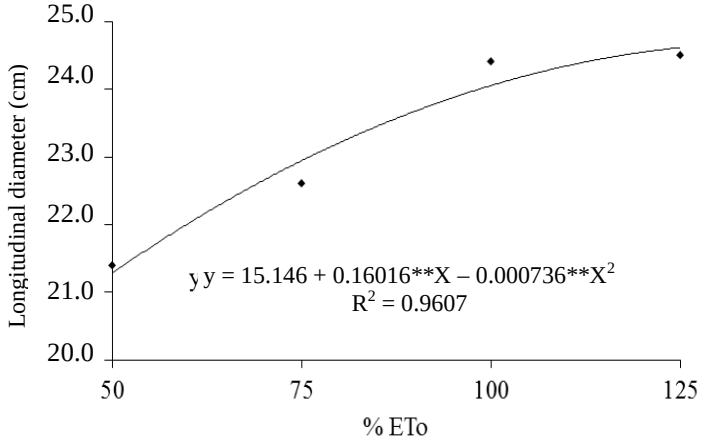


FIGURE 3. Longitudinal diameter (LD) (cm) of papaya UENF/Caliman 01 hybrid cultivated in conditions of field under water depths in the microregion of Catolé do Rocha, state of Paraíba.

The size of raw fruit depends on the consumer market. Thus, RUGGIERO et al. (2011) state that large consumer markets prefer a more elongated and cylindrical fruit. For the variable thickness of the pulp, no significant statistic differences were found between the irrigation depths (Table 2), and the maximum value found was 2.87cm with application of 125% of ETo and the minimum value was 2.80cm with the application 50% ETo (Figure 4).

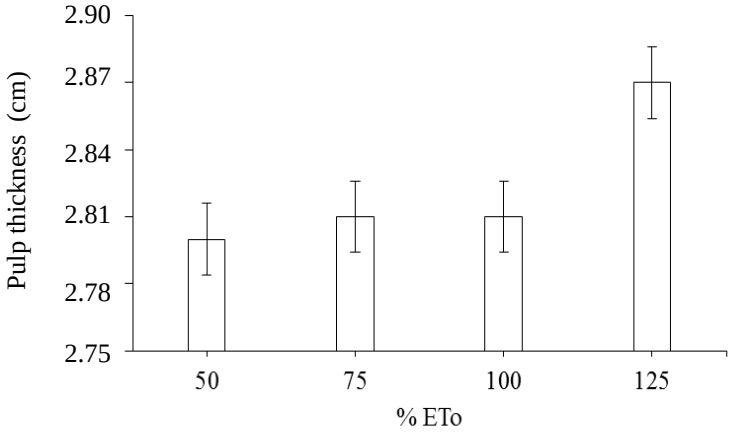


FIGURE 4. Pulp thickness (cm) of fruit of papaya UENF/Caliman 01 hybrid cultivated in conditions of field under water depths in the microregion of Catolé do Rocha, state of Paraíba.

A higher grade of the external appearance of the fruit (3.63) with the application of 100% of ETo was found, and showed a reduction after this level (Figure 5). An increase in internal appearance related to quality was found with an increase of water. The best internal appearances

were obtained (5) with the application of 125% of ETo, with lower grades (4.66) with the application of 75% of ETo (Figure 6). The appearance of fruit is the first criterion used by consumers in judging the quality and it is characterized by the size, shape, color, conditions and absence of mechanical, physiological and pathological disorders (RUGGIERO et al., 2011).

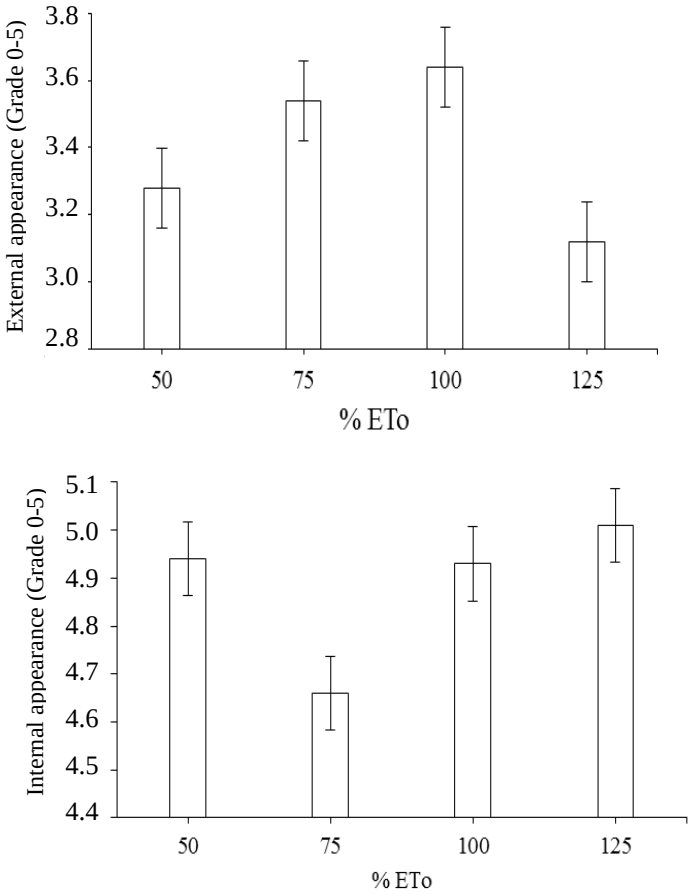


FIGURE 5. External appearance (EA) (A) and internal appearance (IA) (B) of papaya UENF/Caliman 01 hybrid cultivated under different water depths in the microregion of Catolé do Rocha, state of Paraíba.

Fruit chemical attributes

Table 3 has a summary of analyses of variance for soluble solids (SS) (°Brix), titratable acidity (TA), pulp pH and SS/TA relation.

TABLE 3. Summary of the analysis of variance for soluble solids (SS, °Brix), titratable acidity (TA, % of citric acid), pulp pH and TSS/TTA relation of papaya UENF/Caliman 01 hybrid fruit cultivated under different water depths in the microregion of Catolé do Rocha, state of Paraíba.

FV	GL	QM			
		SS	TA	pH	SS/TA
Water levels	3	0.225^{ns}	0.000618^{ns}	0.825**	187.297^{ns}
Residue	36	1.669	0.000920	0.091	353.259
CV %		5.85	9.18	19.33	20.36

Note: ^{ns} non-significant and ** significant at level 1% of probability by the F test.

Treatments shown in Table 3 did not exert significant effects on the chemical characteristics of the fruit, except the pulp pH. There was no significance for the soluble solids, corroborating with SILVA et al. (2001), who also observed no effect of irrigation in the SS content in papaya.

Although no significant difference occurred, it can be seen decreases for that variable with the increasing of water depths (Figure 6). The higher soluble solids values (14.20 °Brix) were obtained with the application of 50% and 75% of ETo, whereas lower values (13.9 °Brix) were obtained in water depth of 100% ETo (Figure 5). BRON et al. (2006) and MARINHO et al. (2008) obtained the value of 11.9 ºBrix of SS in papaya fruit cv. Golden, during the stage I of maturity, in growing conditions of the commercial area of the Caliman Agrícola Farm.

Statistically, the values of TA as a function of depth did not show significant difference (Table 3). The application of 100% of ETo provided a higher value of TA (0.166), whereas smaller values (0.149) was found with the use of 125% of ETo. The SS/AT ratio did not vary significantly as a function of different water depths. Larger values (96.92) were obtained in 75% of ETo depth. Lower values (86.89) were found with the application of 100% of ETo (Figure 6). RODOLFO JÚNIOR et al. (2007) found higher values of SS/TA for Formosa cultivar (100.10) and 125.90 for the Sunrise Solo cultivar.

Regarding the pulp pH, higher values (5.6) were recorded in 75% of ETo depth, resulting in lower values (5) with the application of 50% and 125% of ETo. (Figure 6). According to CHAN JUNIOR et al. (1971) papaya has a pH between 4.5 and 6.0, and, based on this, it can be said that the fruit produced in this study had a pH in the range considered for *in natura* consumption.

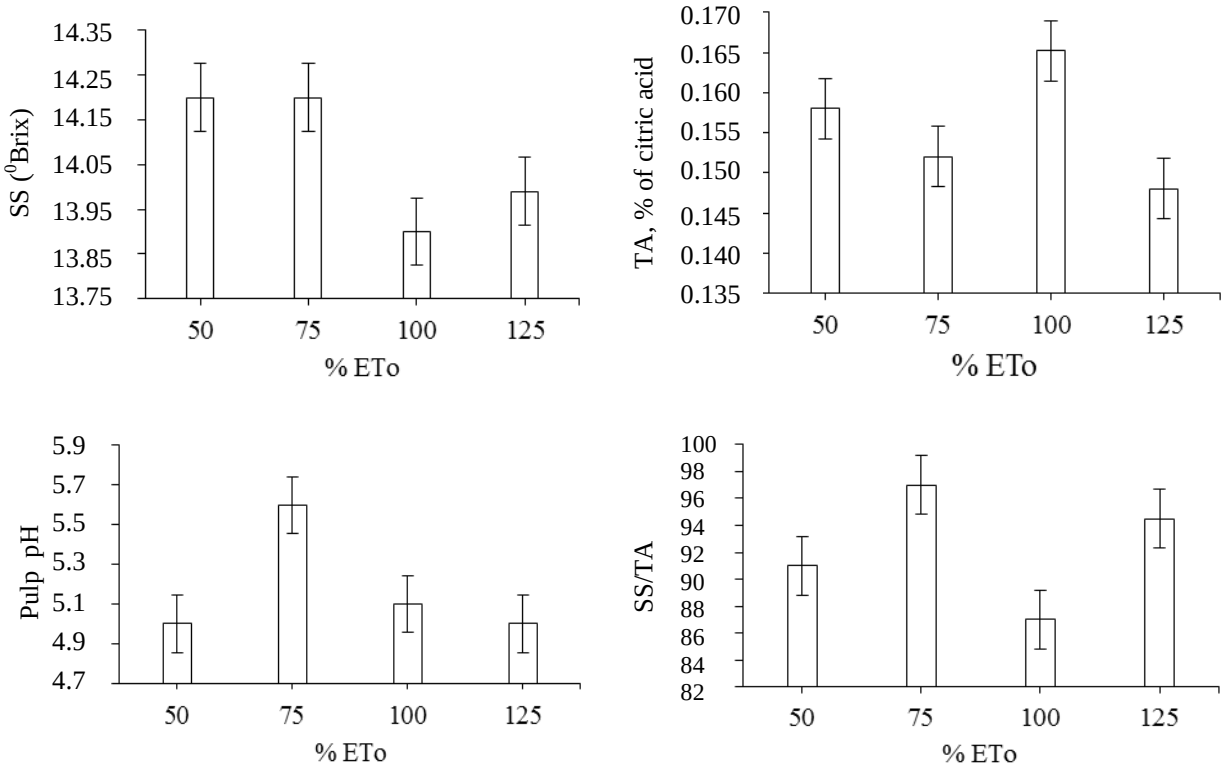


FIGURE 6. Soluble solids (SS, °Brix) (a), titratable acidity (TA, % of citric acid) (b), pulp pH (C) and TSS/TTA relation (d) of papaya UENF/Caliman 01 hybrid fruit cultivated under different water depths in the microregion of Catolé do Rocha, State of Paraíba.

CONCLUSIONS

1. Irrigation depths presented significant effects on transversal and longitudinal diameters and fruit pH.

2. The higher transversal and longitudinal diameters were obtained with irrigation depths of about 108% of ETo.

3. The UENF/Caliman 01 hybrid can be cultivated in the semi-arid region of the state of Paraíba, Brazil, with reposition rate of 100% of ETo without compromising the fruit quality.

ACKNOWLEDGEMETS

To Dr. Alexandre Pio Viana (UENF), for giving us the seeds used in this experiment; to the Conselho Nacional de Desenvolvimento Científico e Tecnológico, for granting a Graduation scholarship to the first author and to the Programa de Apoio à Pesquisa e Pós-graduação da UEPB, for the financial support.

REFERENCES

ALLEN, R.G.; PEREIRA, L.S.; RAES, D.; SMITH, M. *Crop evapotranspiration: guidelines for computing crop water requirements.* Roma: FAO, 1998. 300p. (Irrigation and Drainage Paper, 56).

ALMEIDA. F. T. de; BERNARDO, S.; MARINHO, C.S.; MARIN, S.L.D.; SOUSA, E.F. Teores de nutrientes do mamoeiro Improved Sunrise Solo 72/12 sob diferentes lâminas de irrigação no norte fluminense. *Revista Brasileira de Fruticultura*, Jaboticabal, v. 24, n. 2, p. 547-551, 2002.

BRON, I.U.; JACOMINO, A.P. Ripening and quality of Golden papaya fruit harvested at diferent maturity stages. *Brazilian Journal of Plant Physiology*, Londrina, v. 18, n. 3, p. 389-396, 2006.

CHAN JÚNIOR. H.T.; CHANG, T.S.K.; STAFFORD, A.E.; BREKKE, J.E. Nonvolatile acids of papaya. *Journal of Agricultural and Food Chemistry*, London, v. 19, p. 263-265. 1971.

COELHO, E.F.; SANTOS, M.R.; COELHO FILHO, M.A. Distribuição de raízes de mamoeiro sob diferentes sistemas de irrigação localizada em latossolo de tabuleiros costeiros. *Revista Brasileira de Fruticultura*, Jaboticabal, v. 27, n. 1, p. 175-178, 2005.

FAO - Food and Agriculture Organization of the United Nations. *Estatistical databases agriculture*. Disponível em: <http://faostat.fao.org/>. Acesso em: 26 de nov. 2010.

MARINHO, A.B.; BERNARDO, S.; SOUSA, E. F. de.; PEREIRA, M.G.; MONNERAT, P.H. Produtividade e qualidade de frutos de mamão cultivar 'Golden' sob diferentes lâminas de irrigação e doses de potássio no norte de Espírito Santo. *Engenharia Agrícola,* Jaboticabal, v. 28, n. 3, p. 417-426, 2008.

MANTOVANI. E. C.; BERNARDO, S.; PALARETTI, L.F. *Irrigação:* princípios e métodos. Viçosa: UFV, 2006. 318p.

MONTENEGRO, A. A. T.; BEZERRA, F. M. L.; LIMA, R. N. Evapotranspiração e coeficientes de cultura do mamoeiro para a região litorânea do Ceará. *Engenharia Agrícola***,** Jaboticabal, v. 24, n. 2, p. 464 – 472, 2004.

MORAIS, P.L.D. de; SILVA, G.G. da; MENEZES, J.B.; MAIA, F.E.N.; SALES JÚNIOR, D.J.; SALES JÚNIOR, R. Pós-colheita de mamão híbrido UENF/Caliman 01 cultivado no Rio Grande do Norte. *Revista Brasileira de Fruticultura*, Jaboticabal, v. 29, n. 3, p. 666-670, 2007.

ROCHA, R. H. C.; NASCIMENTO, S.R.C.; MENEZES, J.B.; NUNES, G.H.S.; SILVA, E.O. Qualidade pós-colheita do mamão Formosa armazenado sob refrigeração. *Revista Brasileira de Fruticultura***,** Jaboticabal, v. 27, n. 3, p. 386-389, 2005.

RODOLFO JÚNIOR, F.; TORRES, L. B. V.; CAMPOS, V. B.; LIMA, A. R.; OLIVEIRA, A.D.; MOTA, J. K. M. Caracterização físico-química de frutos de mamoeiro comercializados na EMPASA de Campina Grande- PB. *Revista Brasileira de Produção Agrícola*, Campina Grande, v. 9, n. 1, p. 53-58, 2007.

RUGGIERO, C.; MARIN, S.L.D.; DURIGAN, J.F.; Mamão, uma história de sucesso. *Revista Brasileira de Fruticultura*, p.76-82, 2011. V. Especial.

SILVA, J.G.F.; FERREIRA, P.A.; COSTA, L.C.; MELENDES, R.V; CECOM, P.R. Efeitos de diferentes lâminas e frequência de irrigação sobre a produtividade do mamoeiro (*Carica papaya* L.). *Revista Brasileira de Fruticultura*, Jaboticabal, v. 23, n. 3, p. 597-601, 2001.

SOBRAL, L. F.; VIEGAS, P. R. A.; SIQUEIRA, O. J. W.; ANJOS, J. L.; BARRETTO, M. C. V.; GOMES, J. B. V. *Recomendações para o uso de corretivos e fertilizantes no Estado de Sergipe*. Aracaju: Embrapa Tabuleiros Costeiros, 2007. 250p.

STORCK, L.; GARCIA, D.C.; LOPES, S.J.; ESTEFANEL, V. *Experimentação agrícola*. Santa Maria: Editora da UFSM, 2000. 198p.

TORRES NETTO, A.; CAMPOSTRINI, E.; AZEVEDO, L. da C.; SOUZA, M.A. de; RAMALHO, J.C.; CHAVES, M.M. Morphological analysis and photosynthetic performance for improved papaya genotypes (*Carica papaya* L.). *Brazilian Journal of Plant Physiology*, Londrina, v.21, p. 209-222, 2009.

YAMANISHI, O. K.; MELLO, R. M.; MARTINS, V. A.; LIMA, L. A.; FAGUNDES, G. R. Comportamento do mamoeiro Sekati nas condições do oeste da Bahia. *Revista Brasileira de Fruticultura*, Jaboticabal, v. 28, n.1, p. 79-82, 2006.