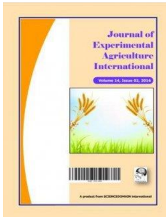

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Yield and Physical Quality of the Yellow Passion Fruit under Spacing within Plants and Water Salinity

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Authors' contributions

This work was carried out in collaboration among all authors. Authors JPSM and LFC designed the study. Authors JPSM, LFC and FTCB managed the analyses of the study. Author FTCB performed the statistical analysis. Authors JTL and MBP wrote the manuscript. Authors ADALM and MAFB managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: The aim of this work was to evaluate the yield and the physical quality of the yellow passion fruit accession 'Guinezinho' as a function of the within-row plant spacing, with saline irrigation water in consecutive growing seasons.
Study Design: The experiment was arranged in randomized blocks, with four replicates and 12 plants per parcel, in a 4 x 2 factorial arrangement, referring to the spacing in the planting lines of 3, 6, 9 and 12 m, and two consecutive growing seasons.
Place and Duration of Study: The experiment was developed in the municipality of Coronel Ezequiel, Rio Grande do Norte state, Brazil, within the months of April 2013 and October 2014.
Methodology: The seedings were transplanted in the spacings of 3, 6, 9 and 12 m, and distant 2

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m within lines according to the treatments; they were conducted in a vertical shoot position (VSP) training system, and daily irrigated during the arid period with saline water (ECiw = 3.4 dS m^{-1}). The following characteristics were evaluated: fruit yield, fruit mass, longitudinal and transversal fruit diameter, pulp yield, peel mass and peel thickness.
Results: The interaction between spacing and growing season exercised a significant effect on the fruit yield, longitudinal fruit diameter, pulp yield, thickness and mass of the peel (P = .05). The variables transversal diameter and fruit mass only varied within the growing seasons (P = .05). The plants cultivated in the 3 m spacing were the most productive in the two seasons, with 23.7 and 36.3 t ha^{-1}, in the first and second seasons, respectively.
Conclusion: The highest yield of the yellow passion fruit accession 'Guinezinho' was obtained in the smaller plant spacing in the lines. Except for the pulp yield, the yield and physical quality of the fruits were superior in the second growing season. The irrigation with highly saline water, in this type of soil, did not compromise the productive ability of the passion fruit accession 'Guinezinho'.

Keywords: Passiflora edulis; accession Guinezinho; planting density; Brazilian northeast.

1. INTRODUCTION

The yellow passion fruit (*Passiflora edulis* Sims) is a crop of relevant socioeconomic importance in the Brazilian agricultural sector, being widely cultivated especially due to the favorable edaphoclimatic conditions to its development and to the high demand for the *in natura* fruit consumption and for its processed juice [1]. Brazil is the largest passion fruit world producer, in 2017 the production was of 554,598 t in a cultivated area of 41,090 hectares, and the Northeast region was responsible for 60.92% of this total. The Rio Grande do Norte state emerges as the third largest producer of this region, with 29,182 t produced in 2,551 hectares [2].

There are several management alternatives aiming to optimize the passion fruit production; the high-density planting has been performed in several Brazilian regions, allowing the increase in the volume of productive branches per area, what may consequently provide an increase in production [3,4]. The planting density might be influenced by innumerable factors, such as the topography, the plant trellis system, the training and vigour of the plants and, especially, the edaphoclimatic conditions of the cultivation region [5,6].

In a study performed in the municipality of Adamantina, in the region of Nova Alta Paulista, Brazil, it was verified that the decrease in the spacing of the yellow passion fruit planting line grafted over the winged-stem passion fruit (*Passiflora alata* Curtis) interfered in the number of fruits per plant, but not the in average fruit mass or in the fruit yield [7]. Conversely, Alvarez et al. [8] obtained an increase in the yield of the passion fruit variety INIAP 2009 with the increase in the planting density, in Ecuador. In the Southern region of Brazil, Weber et al. [4] did not identify influence of the planting density over fruit quality in the selection 'Ovalado Grande', although the productive yield was maximized by the density of 3,200 plants ha^{-1}, the highest evaluated density.

In spite of the adequate climatic conditions for passion fruit production in the Brazilian Northeast, the region is the most compromised in the country by salinity issues, a phenomenon that affects an average of 60 million hectares of irrigated area in the world, and entails severe damages to agricultural production [9]. In the Northeast, the accumulation of ions in the soil is favored by the edaphoclimatic conditions, conferring it a saline character [10]. In this manner, the quality of the irrigation water, in the main passion fruit cultivation areas of the semiarid region is, in most cases, originated from superficial and subterraneous water springs that present electrical conductivities superior to 1.5 dS m^{-1} [11]. The effects of salinity reflect on production losses. Souza et al. [12] verified that the increase in the salinity of the irrigation water, of 0.35 and 4.0 dS m^{-1} reduced in 9% the fruit mass of the passion fruit plant. Dias et al. [13], verified that the water salinity led to the inhibition of the pulp yield, but there are also registers of economically viable production under irrigation with water of average salinity (> 3.0 dS m^{-1}) [14,15].

Therefore, the aim of this work was to evaluate the yield and the physical quality of the fruits of the yellow passion fruit accession 'Guinezinho' as a function of the within-row plant spacing with saline water, in consecutive growing seasons.

2. MATERIALS AND METHODS

2.1 Plant Material and Growing Conditions

The experiment was developed in the municipality of Coronel Ezequiel (06°23' 00'' of latitude South, 36°12' 47'' of longitude West, 561 m of elevation), Rio Grande do Norte state, Brazil, within the months of April 2013 and October 2014. According to the classification of Köppen the climate of the region is As' [16], hot and dry, with rainy period from March to July. The meteorological data in the experimental period are in Table 1.

The soil of the experimental area was classified as dystrophic red-yellow latosol [17] of loam sandy clay texture, with the following chemical attributes in the layer of 0-40 cm depth: fertility - pH (H_2O) = 4.50, organic matter = 12.50 g kg^{-1}, P = 6.00 mg kg^{-1}, Ca^{2+} = 0.95 $cmol_c$ kg^{-1}, Mg^{2+} = 0.65 $cmol_c$ kg^{-1}, K^+ = 0.08 $cmol_c$ kg^{-1}, Na^+ = 0.34 $cmol_c$ kg^{-1}, total exchangeable bases - TEB = 2.02 $cmol_c$ kg^{-1}, H^++Al^{3+} = 3.96 $cmol_c$ kg^{-1}, Al^{3+} = 0.43 $cmol_c$ kg^{-1}, cation exchange capacity - CEC = 5.98 $cmol_c$ kg^{-1}, base saturation - BS = 33.8 % and; salinity (determined in the saturation extract) – pH in saturated paste - pHsp = 5.5, ECse = 0.41 dS m^{-1}, Exchangeable Sodium Percentage - ESP = 5.68 %, Ca^{2+} = 0.28 $mmol_c$ L^{-1}, Mg^{2+} = 0.41 $mmol_c$ L^{-1}, K^+ = 0.02 $mmol_c$ L^{-1}, Na^+ = 3.32 mmolc L^{-1}, Sum of cations - Sc = 4.03 $mmol_c$ L^{-1}, Cl^- = 3.76 $mmol_c$ L^{-1}, CO_3^{2-} = 0.08 $mmol_c$ L^{-1}, HCO_3^- = 0.15 $mmol_c$ L^{-1}, SO_4^{2-} = 0.09 $mmol_c$ L^{-1}, Sum of anions - Sa = 4.08 $mmol_c$ L^{-1} and Sodium adsorption ratio - SAR = 7.09 $mmol_c$ L^{-1}.

Yellow passion fruit plants (*Passiflora edulis* Sims), accession 'Guinezinho' were utilized, a biological material thus named by producers of the municipalities of Cuité, Nova Floresta and Remígio, Paraíba state, and Coronel Ezequiel, Jaçanã and Santa Cruz, Rio Grande do Norte state, in a semiarid region of Brazil. The plants were originated from seed-formed seedlings and irrigated with non-saline water of ECiw = 0.3 dS m^{-1}.

In the experimental area, calcitic limestone was applied (PRNT 80%) being incorporated with a disc harrow and irrigated for 30 days. Afterwards, the grooves were opened with dimensions of 0.40 x 0.40 x 0.40 m (64 dm^3) in the same distance within 2 m rows and in the distances of 3, 6, 9 and 12 m between plants within the rows. The groove was prepared with the soil material of the first half of the upper layer, along with 15 dm^3 of bovine manure (relation C/N 20:1) and 120 g $groove^{-1}$ of single superphosphate (20% P_2O_5, 20% Ca^{2+} and 12% S).

The transplantation of the seedlings was performed in the fourth week of April 2013, and conducted until the end of October 2014, utilizing a plant trellis system of vertical shoot position with smoot wire N°12 installed on top of the poles, at 2.2 m height from the soil level. When the main stalk reached 10 cm over the VSP, it was pruned for emission of two lateral branches, and were pruned when grown 1.5; 3.0; 4.5 and 6.0 m, respectively in the plants spaced in 3, 6, 9 and 12 m in the rows.

Table 1. Monthly pluviosity, temperature and air relative humidity in Coronel Ezequiel, Rio Grande do Norte state, Brazil

Month	Pluviosity (mm)		Temperature (ºC)		Relative humidity (%)	
	2013	2014	2013	2014	2013	2014
January	0	34	27	28	58	54
February	0	5	25	26	61	59
March	52	54	24	25	70	67
April	108	13	23	24	86	82
May	98	76	23	24	81	79
June	122	45	22	22	89	84
July	78	28	22	22	71	68
August	13	2	21	21	63	61
September	25	54	24	25	70	66
October	0	12	24	24	61	58
November	3	0	26	27	62	60
December	24	0	27	28	68	65
Total/average	523[1]	323[1]	24,0[2]	24,6[2]	70[2]	67[2]

[1]*sum;* [2]*average*

The plants, in the arid periods, were daily irrigated with saline water from a cylindrical well with effective depth of 64 m, average electrical conductivity in the period of 3.4 dS m^{-1}, sodium adsorption ration of 9.2 (mmol $L^{-1})^{1/2}$, pH, Ca^{2+}, Mg^{2+}, Na^{+} and K^{+} of 3.7; 1.60; 3.70; 28.82 and 0.18 $mmol_c$ L^{-1}, respectively and Cl^{-}, CO_3^{2-}, HCO_3^{-} and SO_4^{2-} with the respective values of 32.94; 0.00; 0.05 and 0.87 mmolc L^{-1}, classified as of elevated risk of salinization and average risk of soil sodification [18]. The utilization of saline water for irrigation is a commonly performed practice in the locality where the experiment was conducted, for being the only available water source for this end.

The water supplying, as a function of the distances between the plants in the rows was performed with four distribution networks, one for each plant spacing in the row. Two Katife drippers were utilized per plant, with a flow of 3.8 L h^{-1}; in this case, the crop coefficient was the same, but the working period of the water distribution network varied with the spacing within the plants, due the increasing hydric demand of the crop with the increase in the number of emitted branches.

The water sheet referring to the evapotranspiration of the crop ($ETc = ET_0 \times Kc$), in each phenological phase, was calculated based on the reference crop (ET_0) through the Class A pan method (Et), installed near to the experimental area, by adopting the pan coefficient of 0.75 ($ET_0 = Et \times 0.75$). The crop coefficients (Kc) in the first year were 0.4 until the first 60 days after transplantation of the seedlings (DAT); from 60 to 80 DAT, of 0.6; from 80 to 110 DAT, when the plants were in full bloom, of 0.96; from 110 DAT until half of the fruits growth, of 1.17, and reduced to 1.02 until the end of the first harvest, as proceeded by Freire et al. [19] when irrigating the yellow passion fruit plant with non-saline and saline waters (0.5 and 4.5 dS m^{-1}). At the end of the first harvest, the plants were subjected to a pruning of the branches, and the utilized kc values were 0.6, 1.0; 1.3 and 0.9 in the intervals referring to the emission and formation of new branches, flowering and fruit growth from the beginning to the end of the second harvest of the first year. In the second year, the plants were irrigated by adopting the crop coefficients of 1.0 after the pruning of the branches at the end of first harvest of the first year, and of 1.3 during the flowering and production of the second year.

The fertilizations of growth and production were performed based on the soil analysis, following the suggestions of Borges and Souza [20]. The phosphate fertilization, in the plants distanced 3 m in the rows, consisted of 120 g $plant^{-1}$ of single superphosphate, in two equal applications of 60 g $plant^{-1}$ in the beginning of the flowering and 60 days after it. This value was added of 15, 30 and 45% for every 3 m of distance within the plants in the remaining treatments, in the first and second growing years. Nitrogen (Urea 45% N) and potassium (KCl 50% K) were applied every two months, from 60 DAT, at the N:K levels of 1:1, 1:2 and 1:3 in the amounts of 10-10, 15-30 and 20-60 g per plant at 60, 120 and 180 DAT. After this age, the N:K proportion of 1:3 was maintained until the end of the first harvest. As in the phosphate fertilization, were added 15, 30 and 45% extra for the plants spaced 6, 9 and 12 m in the rows, in relation to those distanced 3 m. Considering that most than half of the active root system of the yellow passion fruit, at the end of the first harvest, reaches at least 40 cm of the stem and 40 cm depth [21], and that with the increase of the distances within the plants the number of branches increases, the fertilizations with NK from the second harvest of the first year were added of the same proportions adopted for the phosphorus fertilization.

2.2 Treatments and Experimental Design

The experimental design was in randomized blocks, with four replicates and 12 plants per parcel, using a 4 x 2 factorial scheme, referring to the within-row plant spacing of 3, 6, 9 and 12 m in two consecutive growing seasons. The distance within planting rows was 2 m, referring to the populations of 1,666, 833, 555 and 416 plant ha^{-1} for the spacings of 3, 6, 9 and 12 m within rows, respectively.

2.3 Evaluations and Statistical Analysis

Fruit harvest was started at six months, and extended until 18 months after the planting. The fruits were removed from the plants in the beginning of the yellowing, being harvested from two to three times a week according with the peak production. After the harvest, the fruits were weighed, and the yield was estimated based on the planting density. For measuring the longitudinal and transversal diameter of the fruits, as well as the thickness of the peel in the four quadrants, a precision pachymeter was utilized. The weighing of the peel was performed after removal of peel and seeds. The pulp yield was obtained as the difference between the mass of the fruit, peel and seeds divided by the total weight of the fruit.

The results were subjected to likelihood analysis, with the F test ($P \leq .05$) for observing the significance of the factors. The means were compared by Tukey's test ($P \leq .05$). The statistical analyses were performed in the software SAS® University Edition by utilizing a mixed model and the PROC Mixed.

3. RESULTS

3.1 Fruit Yield and Fruit Mass

Except over the transversal diameter and the average mass of the fruits, which varied within the two growing seasons, the interaction between plant spacing and growing season exercised significant effects over the remaining variables (Table 2).

In spite of the higher yield of the plants per area in the second season, in relation to the first, independently of the spacing in the rows, in both situations the highest yields were harvested in the plants spaced 3 m in the rows (Fig. 1A). The yield losses with the increase in the distances were 32, 44 and 51% and of 14, 49 and 63%, respectively in growing seasons 1 and 2, within the plants spaced 6, 9 and 12 m in comparison to those spaced 3 m in the rows (Fig. 1A). In the growing season 2, the plants produced fruits with an average mass of 220 g and, therefore, 19% superior to the same plants in season 1 (Fig. 1B).

Table 2. Values of the F test of the likelihood analyses for the variables fruit yield (FY), fruit mass (FM), longitudinal diameter (LD), transversal diameter (TD), pulp yield (PY), peel mass (PM) and peel thickness (PT) of the yellow passion fruit as a function of the spacing within plants (SP) and growing season (GS)

FV	DF[1]/DF[2]	F-Value						
		FY (t ha^{-1})	FM (g)	LD (mm)	TD (mm)	PY (%)	PM (g)	PT (mm)
SP	1/6	785.92**	349.03**	5.89^{ns}	9.5*	179.57**	403.66**	7.89*
GS	3/18	200.98**	0.00^{ns}	33.47**	1.26^{ns}	7.83**	4.57*	6.21**
SP x GS	3/18	31.01**	0.00^{ns}	33.47**	1.26^{ns}	7.83**	4.57*	6.21**
Mean		20.5	202.4	86.1	74.4	42.7	107.8	9.1
CV (%)		7.61	5.53	1.30	3.83	6.03	5.28	5.24

*[1]Degrees of freedom of the variation source; [2]Degrees of freedom of the residues; ns, ** and *: not significant and significant at 1 and 5% of probability, respectively*

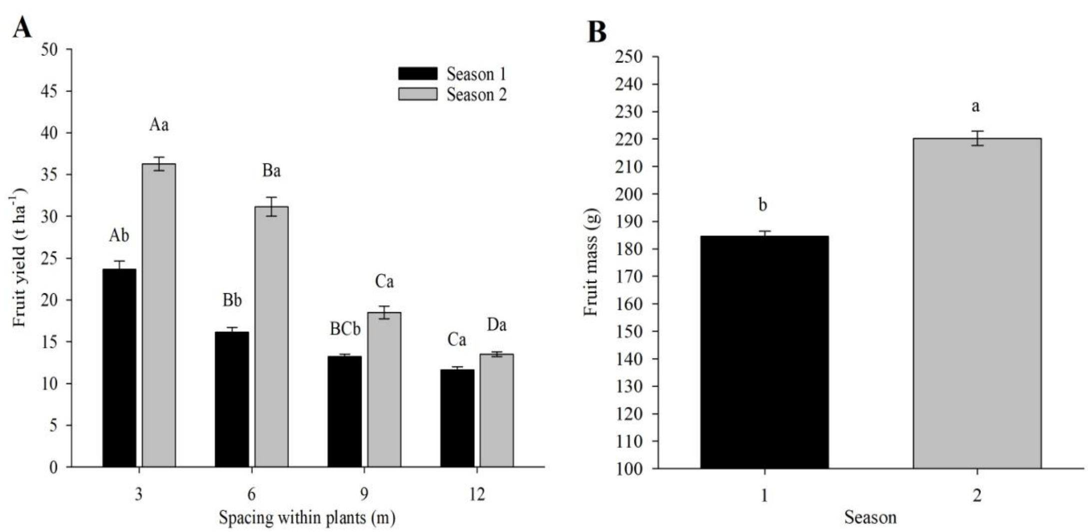

Fig. 1. Yield of the yellow passion fruit 'Guinezinho' as a function of the interaction between spacing and growing season (A) and mass of yellow passion fruits 'Guinezinho' in growing seasons 1 and 2 (B)

Means followed by the same letter, uppercase on the spacings and lowercase on the growing seasons do not differ within each other by Tukey's test (P ≤ .05). Error bars point the standard error of the mean

3.2 Longitudinal and Transversal Diameter

In the first growing season, the plants cultivated in the 6 m spacing produced fruits with higher longitudinal diameter (89 mm), overcoming in 11 mm the diameter of the plants distanced 3 m (Fig. 2A). The longitudinal diameters of the fruits on the plants stablished in the 9 and 12 m spacings were equal, but significantly inferior to the fruits of the plant maintained in the 6 m and superior to those distanced 3 m. In the second growing season, no differences were verified within the fruit diameters of the plants developed in the different spacings, with average of 89 mm. Within growing seasons, it is verified that in the second season, the plants stablished in the spacings of 3, 9 and 12 m produced fruits with longitudinal diameter of 11.0; 7.0 and 5.0 mm, superior to those of the first season, and the plants distanced 6m produced fruits with similar diameters in the two seasons. As to the transversal diameter, the plants in the second season produced fruits with diameter 5 mm superior, and supremacy of 7% over the average of 72 mm of the first season (Fig. 2B).

3.3 Pulp Yield

For the pulp yield, in the first growing season, the highest values were obtained in the fruits of the plants of the 6 and 9 m spacings, with averages of 49.4 and 51.1% equal within each other, but superior to those obtained in the plants spaced 3 and 12 m, respectively, with equal values of 43.0% (Fig. 3B). In the second season, the values were inferior to those of the first season, without differing within the spacings, with average pulp yield of 38.4%.

3.4 Peel Mass and Thickness

The fruit peel mass did not vary within the plants of the 3 and 12 m spacings, with average of 97.2 g, but was significantly superior to the plants developed in the distances of 6 and 9 m in the rows, with average value of 82.6 g in the first season (Fig. 4A). The results of the second season did not differ within the spacings, with average of 125.8 g. When comparing the seasons, it might be verified that in all spacings the results of the second season surpass those of the first season, with increases of 28.2; 41.3; 45.2 and 29.0 g, respectively in the plants stablished in the distance rows of 3, 6, 9 and 12 m.

In the first season, no differences were registered in the thickness of the fruit peels of the plants cultivated in the spacings of 3, 6 and 9 m, with average of the three values of 8.5 mm and significantly, inferior to the 10.2 mm of the plants stablished with 12 m in the rows (Fig. 4A). In the season 2, the spacings within the plants did not results in peel thickness differences in the passion fruits, with 9.2 mm. As to the growing seasons, except for the plants spaced 12 m, the peel thickness was smaller in the fruits of the first season.

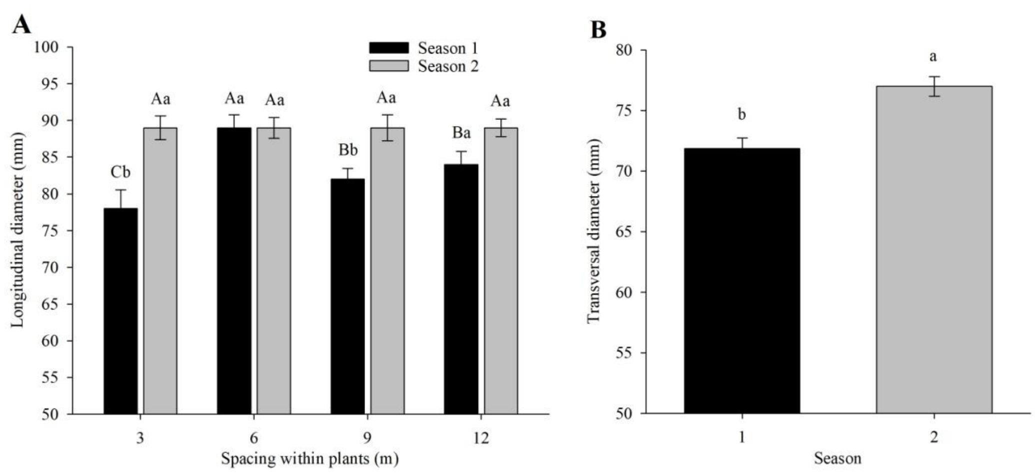

Fig. 2. Longitudinal diameter of yellow passion fruits 'Guinezinho', as a function of the interaction between spacing and growing season (A) and transversal fruit diameter of yellow passion fruits 'Guinezinho' in growing seasons 1 and 2 (B).

Means followed by the same letter, uppercase on the spacings and lowercase on the growing seasons do not differ within each other by Tukey's test (P ≤ .05). Error bars point the standard error of the mean

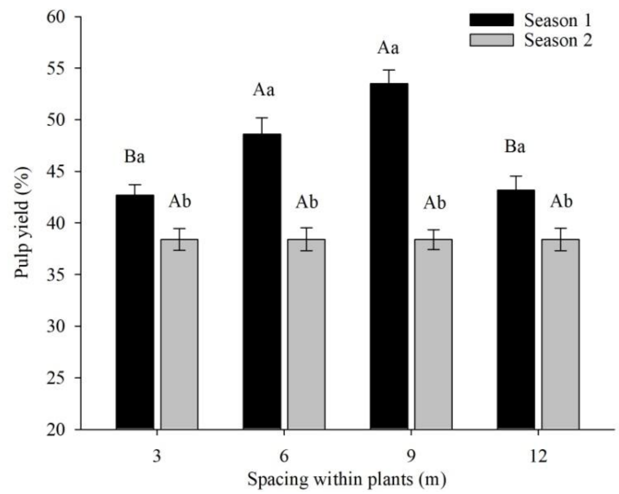

Fig. 3. Pulp yield of yellow passion fruits 'Guinezinho', as a function of the interaction between spacing and growing season

Means followed by the same letter, uppercase on the spacings and lowercase on the growing seasons do not differ within each other by Tukey's test (P ≤ .05). Error bars point the standard error of the mean

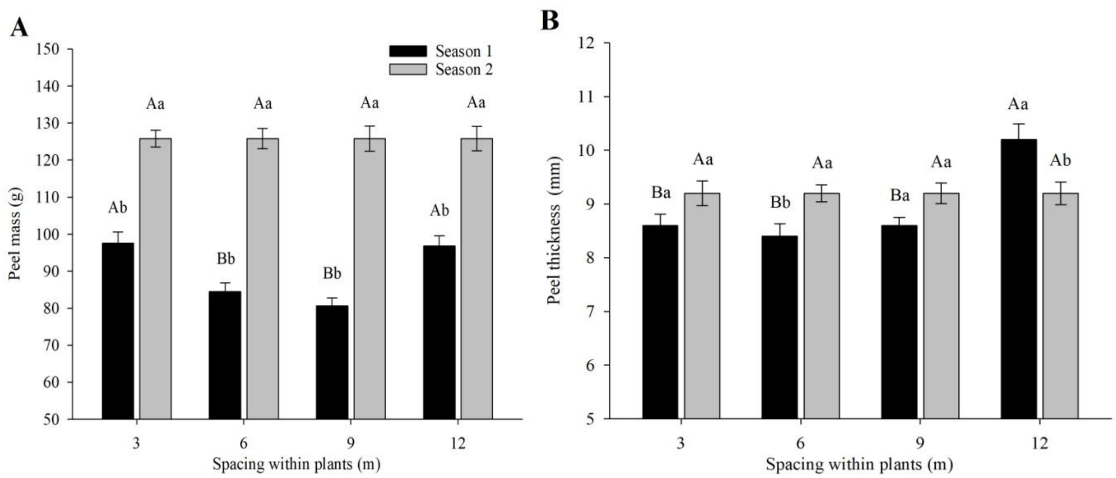

Fig. 4. Peel mass (A) and peel thickness (B) of the yellow passion fruit 'Guinezinho', as a function of the interaction between plant spacing and growing season

Means followed by the same letter, uppercase on the spacings and lowercase on the growing seasons do not differ within each other by Tukey's test (P ≤ .05). Error bars point the standard error of the mean

4. DISCUSSION

According to Cavichioli et al. [4] the largest spacing within plants increases the number of fruits per plant; for the referred authors, the smaller spacing promotes a reduction of the number of flowers per plant, of the pollination efficiency, of the photosynthetic rate by the high shading and reduction in the development of its branching; however, when evaluating the productive development of the yellow passion fruit cv. Sul Brasil in different spacings, it was verified that the difference in the number of fruits per plant did not reflect in difference in the yield, that because the reduction in the individual development was compensated by the larger plant population. In the present experiment, however, it was verified that when decreasing the spacing within plants, a significant yield increase occurred for the two growing seasons, thus revealing that the passion fruit 'Guinezinho', at the contrary of the cv. Sul Brazil, does not present a significant reduction in the individual development when cultivated in a dense system of until 1,666 plants ha^{-1}. In the first season, the yield result for the plants in the smaller spacing (3 m within plants) was superior to the average Brazilian yield of 13.4 t ha^{-1} [2].

In a study evaluating the influence of planting densities in the sour passion fruit in different seasons, Weber et al. [4] observed that hand-pollinated plants in the first production cycle presented a lower yield than the same plants in the second cycle pollinated in natural manner. The hand-pollination is responsible for increasing the fecundation of the flowers and consequently increasing the productive yields, however it was not sufficient for overcoming the plant yield in the second cycle. Depending of the technological level, the average yield of the yellow passion fruit, in the first season, varies within 12 and 20 t ha^{-1}, with an increase occurring in the second season, when normally the maximum productivity is obtained, followed by reduction of the following seasons [22].

Corroborating with this research, Alvarez et al. [8], in a study performed in Manabí, Ecuador, with the passion fruit 'INIAP 2009', verified an increase in the yield with the reduction of the spacing within the plants; in their studies, the highest evaluated density of 833 plants ha^{-1} (3m x 6 m) obtained the highest fruit yield, corresponding to 15 t ha^{-1}. There was not variation, although, of the production per plant in the different evaluated spacings. For Weber et al. [4], in plants VSP-trained plants, the increase in the planting density improves the covering and interception of the sunlight, increasing the productive exploitation of the plants and, consequently, the economic return of the investment.

The yields obtained in the treatments for both seasons, except in the plants conducted with a 12 m spacing in growing season 1, are superior to the passion fruit yields registered in a study performed by Monzani et al. [23], utilizing good-quality water in the evaluation of different training systems in Araquari, Santa Catarina state, Brazil, in which a maximum yield of 12.6 t ha^{-1} was registered for the VSP system in second growth season. It is evident that the saline water did not compromise the productive ability of the 'Guinezinho' accession.

In accordance with that, the fruit mass obtained by the biological material 'Guinezinho' in the second season is superior to the masses obtained by the cultivars BRS Ouro Vermelho (193.35 g) and BRS Gigante Amarelo (186.73 g) in an experiment performed by Dias et al. [24] in Janaúba, Minas Gerais state, Brazil, utilizing free water for the agriculture. Aguiar et al. [25] when studying the effect of the bovine biofertilizer diluted in water of average salinity (1.4 dS m^{-1}) over the productive attributes of three yellow passion fruit genotypes, observed for the 'Guinezinho' the average fruit mass value of 225.88g. In spite of the similarity between the results by Aguiar et al. [25] and those obtained in the second season of the present experiment, it is noted that in the present conditions there was no utilization of the biofertilizer as an attenuator of salinity, only the application of the bovine manure in the preparing of the grooves and, furthermore, the water utilized for irrigation did not possess superior electrical conductivity (3.4 dS m^{-1}).

As to the longitudinal diameter, the highest registered value in the first season (89 mm) was equal to the remainder of season 2, in which they are similar to the highest value obtained by Jesus et al. [26], when they evaluated yellow and sweet passion fruit plants in Bebedouro, São Paulo state, Brazil. The hybrid GP09-02 produced fruits with maximum longitudinal diameter of 90 mm, and the similarity with the value obtained by the 'Guinezinho' accession irrigated with saline water draws atention to the ability of the genotype in producing quality fruits in restrictive conditions of water for irrigation.

According to the Brazilian Program for the Improvement of the Commercial Standards and Packages of Horticultural Workers [27], the passion fruits are classified as to the measure of the equatorial diameter (transversal, TD). When considering this criterium the fruits of the first season are classified as caliber 3 ($65 \leq DT < 75$ mm) and those of the season 2 as caliber 4 ($75 \leq DT < 85$ mm), being, therefore, satisfactory for commercialization. Moreira et al. [28] worked with yellow passion fruit in the Jequitinhonha Valley, Minas Gerais state, Brazil, and also did not verify difference for the transversal diameter of fruits cultivated in different planting densities, although they verified difference within seasons; the values in the first and second growing seasons were 7.27 and 6.81 cm, respectively, both classified as caliber 3. In a work performed by Costa et al. [14] in Santa Cruz, Rio Grande do Norte state, semiarid area of Brazil, where they evaluated the passion fruit accession

'Guinezinho' irrigated with saline water (3.2 dS m^{-1}), were harvested fruits with transversal diameter varying from 61 to 68 mm, an inferior result to those obtained in both seasons of the present work.

The average mass and the transversal diameter of the fruits, in a similar manner to that presented by Cavichioli et al. [29] in yellow passion fruit grafted over wild passion fruit (*Passiflora gibertii* N.E. Brown), did not vary as a function of the increase of plant density, with average mass of 182.89 g and measures within 77 and 81 mm. The same variables were evaluated by Cavichioli et al. [7] and presented a similar behavior for the yellow passion fruit grafted over the sweet passion fruit (*Passiflora alata curtis*) when evaluated by densities which varied from 625 to 3,125 plants ha^{-1}; the longitudinal diameter of the fruits, however, responded to the spacings, in which the largest diameter was obtained in the plants spaced in 5 m (625 plants ha^{-1}), whereas in the present work the 6 m spacing resulted in the highest longitudinal diameter of fruits.

In a study evaluating 32 passion fruit genotypes cultivated in Vargem Bonita, Brasília, Brazil, the occurrence of correlation between the peel mass and the pulp mass was verified (r = 0,8655) [30]. In the present experiment, the pulp yield exhibited an inverse behavior to the data of peel mass; this is due to the fact that the fruit mass did not vary within the evaluated planting densities. The treatments with the smallest peel masses corresponded to the row spacings of 6 and 9 m, and consequently with the highest pulp yields. For the first growing season, only the 9 m spacing fruits presented pulp yield superior to 50%, whereas the remainder of the same season and all others of the season 2 were inferior. These results are in accordance with Meletti et al. [31] when they concluded that the yellow passion fruit pulp yield must be next to 50% so that the yellow passion fruits might be destined for the consuming market.

Works do evidence the inverse relation between the peel thickness and the pulp yield; less thick peels tend to present a completely filled bigger internal cavity [32,28]. When considering that the fruit mass did not respond to the effects of the spacings (Table 2), the difference existing within peel thicknesses should reflect in an inverse manner over the pulp yield of fruits, however, in the present work, it was evident that this relation might vary. When observing Fig. 2A, it may be noted that in the first season the plants spaced in 3, 6 and 9 m presented similar averages of fruit peel thickness, however, in Fig. 3, the difference between the fruit pulp yield of the plants of the referred spacings is perceptible. The plants distanced 3 m, even with reduced peel thickness, presented low pulp yield, whereas those of the 9 m spacing have positively emerged on this variable. In the commercial point of view, this result is interesting, since the accession 'Guinezinho' demonstrates potential in obtaining an elevated pulp yield and a thicker peel in the same fruit, a characteristic which confers higher resistance to long distance transport, and minimizes post-harvest losses as a result of physical lesions [33].

5. CONCLUSION

The highest yield of the yellow passion fruit accession 'Guinezinho' was obtained in the smaller within-row plant spacing. The order of the yields as a function of the spacings was: 2 x 3 > 2 x 6 > 2x 9 m > 2 x 12 m. Except for the pulp yield, the yield and physical quality of the fruits were superior in the second growing season. The irrigation with strongly saline water, in this type of soil, did not compromise the productive ability of the passion fruit accession 'Guinezinho'.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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