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Irrigation Depth and Potassium Doses Affect Fruit Yield and Quality of Figs (*Ficus carica* L.)

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Abstract: The need to diversify agricultural production has fostered the cultivation of several crops under environmental conditions atypical to their origin, justifying the extreme importance of studies on the agricultural management of crops in semiarid regions. In this context, this study aimed to evaluate the effects of irrigation depth and potassium doses on fig quality under semiarid conditions. The experiment was conducted in a 4 × 4 split-split-plot design, in randomized block design, with three replicates. The plots corresponded to four irrigation levels (50%, 75%, 100%, and 125% ETc), the subplots consisted of four potassium doses (0, 60, 120, and 240 g K_2O plant^{-1}), and the sub-subplot corresponded to the crop years (2018/19 and 2019/20). Results showed that water deficit reduced fig productivity, and the irrigation levels equal to or greater than 100% ETc performed cumulatively throughout the growing cycles. Therefore, irrigation depths from 85.19% to 95.16% ETc are recommended for greater water-use efficiency and fruit quality. Furthermore, potassium fertilization mitigated water stress in fig plants, allowing for reduced irrigation levels, especially in the second year, without compromising fruit traits.

Keywords: crop evapotranspiration; mineral fertilization; organoleptic qualities; semiarid conditions; water deficit

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1. Introduction

The cultivation of figs (*Ficus carica* L.) in semiarid conditions is highly favorable. The high temperature and low relative humidity in the semiarid region reduce the incidence of fungal diseases, in addition to improving the organoleptic characteristics of the fruits [1]. However, the region suffers from water scarcity, and difficult-to-manage water resources face increased water demand [2]. Water deficit is one of the main factors that limit plant growth by reducing cell turgor and extension [3]. In addition, the growth rate and crop yield are negatively affected due to impaired photosynthesis and enzymatic activity and the excessive production of reactive oxygen species (ROS) [4,5].

In 'Abboudi' and 'Gizy' fig cultivars, irrigation below 100% ETc caused a water deficit that significantly reduced the plant morphometric and physiological traits [6]. In 'Roxo-de-Valinhos' cultivars, irrigation at 100% ETc increased production and improved the morphological characteristics of fruits during the rainy period [7]. In this sense, the irrigation must supply the plant's physiological demand, because in conditions of water stress, the fig tree can suffer from severe stress [8,9], impairing nutrient absorption and causing physiological [4,10], productive, and qualitative damage to the plant [7,11,12].

Potassium (K) plays a key role in vegetative growth [13], production, and fruit quality [14,15]. Furthermore, in sufficient quantity in plants, K is an important mitigant of the deleterious effects of water stress due to its contribution to the prevention of oxidative stress, osmotic regulation, protein synthesis, and photosynthesis [16,17]. However, under water deficit conditions, K uptake is reduced, drastically reducing photosynthesis and productivity, causing leaf senescence and increasing the synthesis of reactive oxygen species (ROS) responsible for oxidative stress [18,19].

Thus, finding a balance between the ideal irrigation blade and potassium doses that mitigate the deleterious effects on plants and increases fruit productivity and quality under semiarid conditions is a key factor for efficient production. Controlling biotic and abiotic stress and accurately estimating water demand are essential for the sustainable management of water resources in fig trees. Therefore, the objective was to evaluate the effects of irrigation levels and potassium doses on the production and quality of fig fruits cultivated in semiarid climatic conditions.

2. Materials and Methods

2.1. Characterization of the Experimental Area

The experiment was carried out in the municipality of Mossoró, in the west region of the state of Rio Grande do Norte, Brazil (5°11′15′′ S, 37°20′39′′ W, 18 m above the sea level, flat relief). The climate of the region is 'BShw' according to the Köppen classification [20], with a 673.9 mm average annual rainfall and a 27.4 °C average annual temperature, featuring two well-defined seasons: dry and hot summer (from June to January) and dry winter (from February to May).

During the experiment, temperature, minimum and maximum air relative humidity (Figure 1A,B), solar radiation and rainfall (Figure 1C), and average wind speed (Figure 1D) were collected from the automatic weather station (EMA) of UFERSA.

2.2. Cultivation Conditions

Fig plants from the 'Roxo de Valinhos' cultivar, 5 years old and spaced 2.0 m × 1.5 m apart, were evaluated during two production cycles: the first from September 2018 to February 2019 and the second from August 2019 to February 2020. The plants were pruned on 25 September 2018 in the first cycle (18/19) and on August 10, 2019 in the second (19/20). The productive branches were pruned to 5 cm long, leaving two to five vegetative buds. At 15 days after pruning, the budding branches were thinned so that the plants remained with only ten productive branches each. During the first 30 days, all plants received the same irrigation depth (100% ETc) with the aim of inducing sprouts to develop equally. Afterwards, the plants received the different irrigation depths as treatments.

After production pruning, each plant was fertilized with 200 g of phosphorus and 160 g of nitrogen, split into three applications. Monoammonium phosphate (10% N, 46% P_2O_5) was used as phosphorus source, while urea (46% N) was used as nitrogen source. In both production cycles, fertilizers were applied under the canopy of the trees and incorporated superficially into the soil with the aid of a shovel [21]. In addition, 10 kg of organic compost with previously determined chemical characteristics was applied, as recommended by [12] (Table 1).

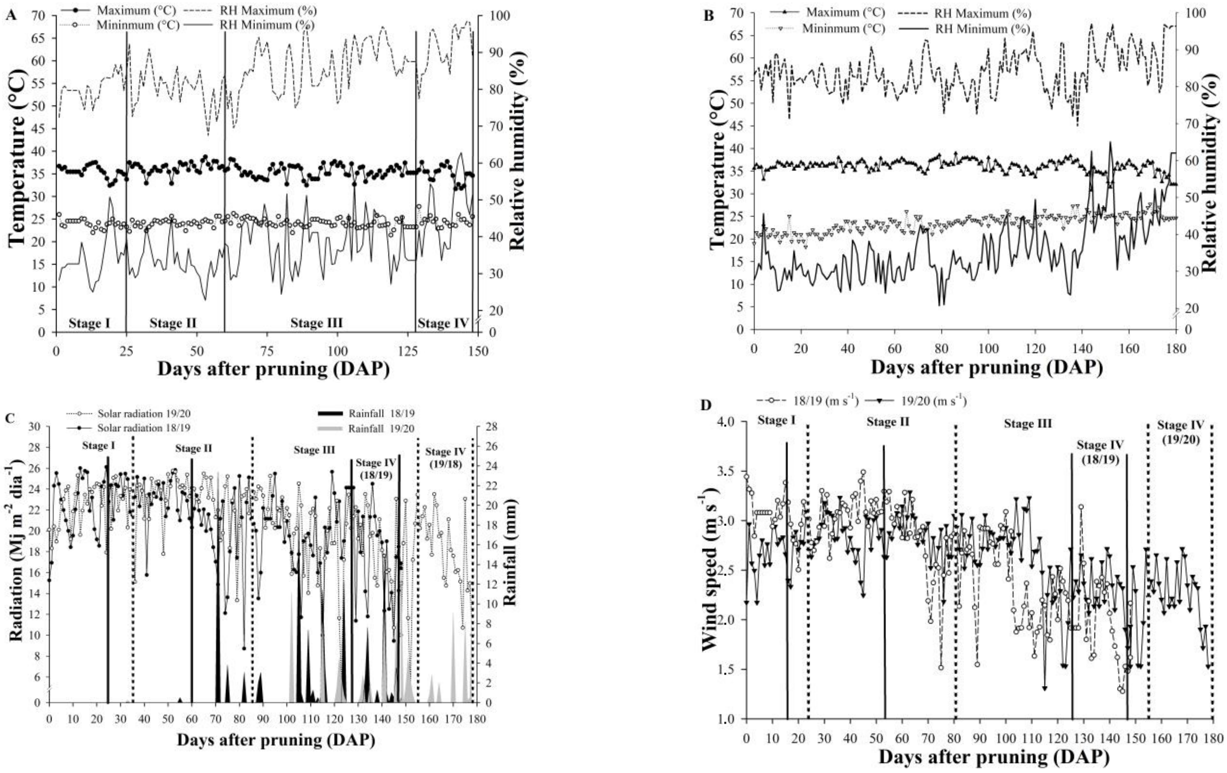

Figure 1. Climatic data collected during the experimental period (from 2018/2019 to 2019/2020). Temperature and relative humidity (18/19—(**A**); 19/20—(**B**)), global solar radiation and rainfall (**C**), and average wind speed (**D**) under semiarid conditions. Stage I—sprouting/initiation of new leaves; Stage II—start of effective full cover/inflorescence development; Stage III—effective full cover/beginning of fruit harvest; Stage IV—end of harvest.

Table 1. Analysis of the organic source used in fertilizing plants.

Samples	pH	EC	OM	P	K^+	Na^+	Ca^{2+}	Mg^{2+}	Al^{3+}	(H + Al)	SB	CTC	V	PET
	(Substrate)	dS m^{-1}	g kg^{-1}		Mg dm^3				cmolc dm^3				%	
Organic compost	7.24	3.26	38.17	522.275	433.61	3716.9	0	0	0	0	17.28	17.28	100	93.58

Electric conductivity (EC); organic matter (OM); phosphorus (P); potassium (K^+); sodium (Na^+) extractor mehlich-1; calcium (Ca^{2+}); magnesium (Mg^{2+}); aluminum (Al^{3+}) extraidos com KCl 1 mol L^{-1}; potential acidity (H + Al); sum of bases (SB); cationic exchange capacity (CTC); base saturation (V); percentage of exchangeable sodium (PET).

2.3. Experimental Design

The experimental design used was randomized blocks in a split-plot arrangement, with three blocks and two plants per experimental unit. The plots corresponded to the irrigation levels: 50, 75, 100, and 125% crop evapotranspiration (ETc). The potassium doses were applied in the subplots: 0, 60, 120, and 240 g plant^{-1}. At last, the sub-subplot corresponded to the crop years (2018/19 and 2019/20). Potassium chloride (60% K_2O) was used as the potassium source, being split into three applications every 20 days. The application and incorporation were performed according to [21].

The application of the irrigation levels was performed through an automatic microsprinkler irrigation system, using emitters with an average flow rate of 31 L h^{-1}, determined in the experiment, based on the estimation of the crop evapotranspiration (ETc). Due to low rainfall, irrigation was applied daily. The ETc and the reference evapotranspiration (ETo) were estimated by the standard FAO Penman–Monteith method [22]. The same irrigation blades were applied to the same plants in the two cultivation cycles. Due to the long drought period in the region, the crop management, such as pruning and soil water storage replacement, was performed again.

The estimation of the crop coefficients (Kc) by the FAO method (Allen et al., 1998) used the basal crop coefficients (Kcb) of each plant growth stage. Stage I—sprouting/initiation of new leaves; Stage II—start of effective full cover/inflorescence development; Stage III—effective full cover/beginning of fruit harvest; stage IV—end of harvest. The irrigation time was then calculated for the treatment with 100% ETc, using the 94.5% irrigation efficiency determined in the field and a 2% leaching fraction, with plants spaced 2 m × 1.5 m apart (Table 2). Irrigation efficiency was calculated according to [23], considering it equal to the average of the application uniformity coefficient (AUC), Christiansen's uniformity coefficient (CUC), and statistical uniformity coefficient (SUE), which were tested using some microsprinklers in each irrigation level. The leaching fraction was only considered for this experiment, considering other research carried out in the region.

Table 2. Irrigation level applied—Li (mm) and crop coefficient—Kc in each growth stage and for each crop year (2018/2019 and 2019/2020).

Years/	Li (ETc%)	Stage/Total Days *					
		Stage I 25/33	Stage II 35/59	Stage III 68/63	Stage IV 20/23	Total mm	Average mm Day^{-1}
18/19	50	23.96	71.55	224.03	52.58	372.12	2.51
19/20		33.37	101.34	188	67.72	390.43	2.19
18/19	75	35.95	107.32	336.05	78.87	558.19	3.77
19/20		50.06	152.01	282	101.58	585.65	3.29
18/19	100	47.93	143.09	448.06	105.16	744.24	5.02
19/20		66.74	202.68	376.01	135.44	780.87	4.39
18/19	125	59.91	178.86	560.08	131.45	930.298	6.28
19/20		83.43	253.34	470.01	169.31	976.09	5.48
Kc 18/19		0.73	0.89	1.00	0.67	----------------------------	
Kc 19/20		0.75	0.88	1.03	0.99		

* Total days at each stage (18–19/19–20).

2.4. Characteristics Evaluated

Fruits were harvested three times a week when they reached the physiological maturation stage (Stage III) suitable for in natura consumption [1]. Fruit weight was measured on a digital analytical scale (±0.01 g). The number of marketable fruits (MF) and yield of marketable fruits (MY) (t ha^{-1}) were quantified. When the production of fruits intended for commercialization drastically reduced, turning the harvest economically unfeasible, the remaining green fruits (destined for the industry) were harvested and counted to determine the number of green fruits (IF). In addition, the total number of fruits (TF) and total yield (green and ripe fruits) were determined as t ha^{-1}. Marketable fruits (mature stage) are destined for fresh consumption (mature stage), while green fruits are intended for industry, for instance, to produce figs in syrup (green and semimature stages).

Irrigation water-use efficiency—IWUE (t ha^{-1} mm) and water-use efficiency—WUE (t ha^{-1} mm) were calculated according to [24,25]:

$$\text{IWUE} = \left(\frac{E_y}{I_r}\right) * 100 \tag{1}$$

$$\text{WUE} = \left(\frac{E_y}{E_{Tc}}\right) * 100 \tag{2}$$

where E_y is the economical yield (t ha^{-1}), I_r is the amount of applied irrigation water (mm), and E_{Tc} is the evapotranspiration (mm). However, in our calculation, total yield was used for E_y.

2.5. Fruit Quality

To evaluate fruit quality, only the mature fruits intended for trade (in natura) were collected. Ten fruits were evaluated per plant to determine the average fruit length (FL), fruit diameter (FD), and fruit mass (FM), totaling twenty fruits per plot. The fruits were measured with a digital caliper (±0.01 mm). The average fruit mass was determined with an analytical balance, and the results were expressed in grams (±0.01 g).

Color space and fruit firmness were determined using ten fruits per plot. Peel color was determined with a Chroma Meter–400/410 colorimeter (Minolta Corp., Osaka, Japan), by performing one reading on each side of the fruit. The lightness (L*), saturation (C), and hue angle (°hue) were also evaluated. Fruit firmness was determined using a digital texture analyzer manufactured by Stable MicroSystems®, model TA.XTExpress/TA.XT2icon, equipped with a 5 mm diameter probe. Two readings were performed on each side of the fruit, and the results were expressed in newtons (N).

Twelve fruits were evaluated per plot to determine the fruit physicochemical characteristics. The soluble solids (SS) were determined directly in the homogenized pulp juice using a digital refractometer (model PR–100, Palette, Atago Co., Ltd., Tokyo, Japan), with the results expressed in °Brix [26].

The titratable acidity (TA) was determined by volumetric titration using 1 g of pulp transferred to a 125 mL Erlenmeyer flask with 50 mL of water. Subsequently, titration was performed with a previously standardized NaOH 0.1 M solution until pH reached 8.1, with the results expressed in g 100 g^{-1} pulp of citric acid [26]. The SS/TA ratio was determined by relating the values of soluble solids and titratable acidity.

The potential of hydrogen (pH) was estimated using a potentiometer with automatic temperature adjustment (Model mPA-210 Tecnal®, Ourinhos, Brazil), previously calibrated with buffer solutions at pH 7.0 and pH 4.0 [26]. The data were expressed in actual pH values.

Vitamin C was estimated by titration with Tilman's solution (DCPIP-2,6-dichlorophenol-indophenol at 0.02%), using 1 g of sample diluted in a 100 mL volumetric flask with 0.5% oxalic acid, according to the methodology proposed by [27], with the results expressed in mg of ascorbic acid 100 g^{-1} pulp.

2.6. Statistical Analysis

The data obtained were subjected to the Shapiro–Wilk normality test and the test of homogeneity of variances according to Bartlett, and, if within the standards for normality and homogeneity, they were subjected to analysis of variance by the F-test ($p = 0.05$). The quantitative data were subjected to regression analysis, while the qualitative data were subjected to the least-significant difference test (LSD) ($p = 0.05$). All analyses were performed using the statistical software R, version. 4.0.2 [28].

3. Results

3.1. Climatic Influence

The maximum and minimum temperatures and humidity showed small variations during the crop growth period. The greatest discrepancies between climatic data in the period close to the same developmental stages were observed at 121 and 122 DAP, with differences of 4.31 °C and 4.83 °C from 2018/19 to 2019/20 (Figure 1A,B).

The solar radiation values showed greater reductions in the winter months, given the increase in cloudiness during this period. The most significant reductions were recorded in the first cycle (18/19) (Figure 1B). The total monthly rainfall values were higher in the first cycle, with 35.31, 57.40, and 33.53 mm from December 2018 to February 2019 (Figure 1B). The average wind speed observed during the fruit production period did not damage the fruits. A reduction in the wind speed was observed precisely when the fruits were under development and maturation, with a more significant reduction in the first cycle (18/19) (Figure 1D).

During the production period, the first crop year (18/19) showed lower average and total values for crop evapotranspiration (ETc—Stages I and IV) and reference evapotranspiration (ETo—Stages III and IV) compared to the second crop season (19/20) (Figure 2A,B). The climatic effects influenced the irrigation levels (Li) applied, and although the second crop year (19/20) had higher Li values applied, the first crop year (18/19) showed higher average values, with stage III constituting the period with the highest water requirement by the plants (Table 2).

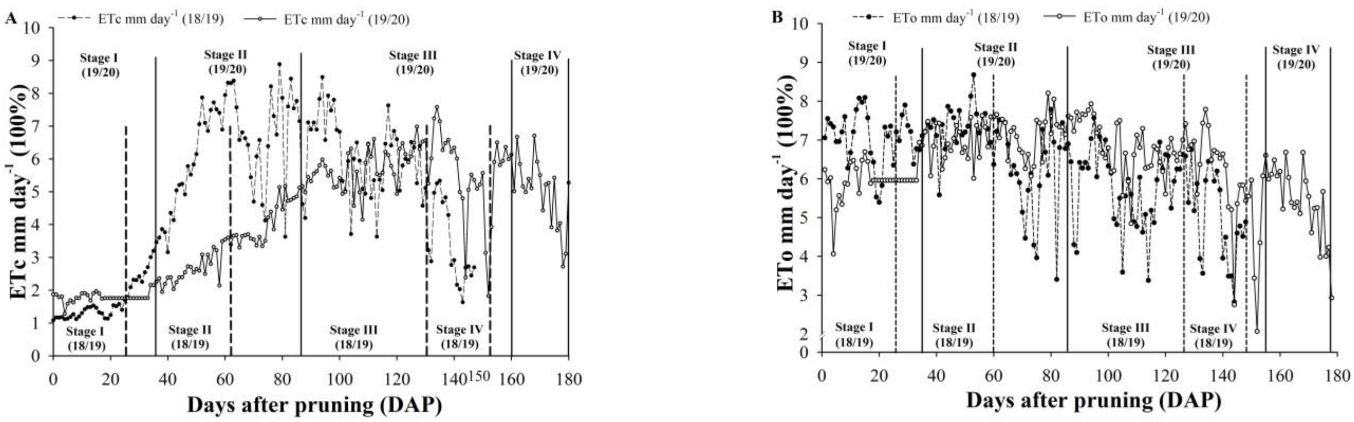

Figure 2. Standard crop evapotranspiration (**A**) (ETc 100% mm day^{-1}) and reference evapotranspiration (**B**) (ETo 100% mm day^{-1}) in the days after pruning, under semiarid climatic conditions, in the 2018/2019 and 2019/2020 crop years. Stage I—sprouting/initiation of new leaves; Stage II—start of effective full cover/inflorescence development; Stage III—effective full cover/beginning of fruit harvest; stage IV—end of harvest.

3.2. Production and Water Efficiency

The marketable yield (MY), the total yield (TY), the number of marketable fruits (MF), and the total number of fruits (TF) were influenced by the irrigation levels applied (Li) in the two crop years (18/19 and 19/20) ($p < 0.001$). As for the number of green fruits (GF) per plant, this variable was only influenced by the Li applied ($p < 0.01$). There was no significant effect for potassium doses ($p > 0.05$).

For the MY (Figure 3A) and TY (Figure 3B), the first crop year (18/19) showed linear increases with the increase in the Li, reaching yield values of 17.53 and 33.52 t ha^{-1} at 125% ETc, respectively. In the second year (19/20), the highest mean values for MY and TY (7.99 and 15.85 t ha^{-1}) were obtained at the Li of 95.16% and 102% ETc, respectively (Figure 3A,B). Among the Li values, there was a significant difference only at 125% ETc, for which the first year (18/19) resulted in an MY value 75.01% higher than the second year (19/20) ($p < 0.001$).

The first crop year (18/19) linearly influenced the MF, resulting, with the water deficit, in the lowest values. In the second year (19/20), for the same variable, the highest mean (61.60 fruits) was obtained at the Li of 94.89% ETc (Figure 3C). On the other hand, there was a greater number of green fruits (GF) (91.50 fruits) at the Li of 98.42% ETc (Figure 3D). For the TF, in the first and second years (18/19), the highest total numbers of fruits (169.69 and 162.69 fruits) were obtained at the Li of 125% and 95.13% ETc, respectively (Figure 3E).

The irrigation levels influenced the water-use efficiency (WUE) and the irrigation water-use efficiency (IWUE) in the two crop years ($p < 0.05$). In the first year (18/19), the highest values for WUE (2.14 t ha^{-1} mm) and IWUE (1.88 t ha^{-1} mm) were obtained at the Li of 125% ETc, resulting in the highest fig yields (Figure 4A,B).

There was a quadratic regression response in the second year (19/20), with means of 16 ton ha^{-1} mm for the WUE at the Li of 88.54% ETc and 0.99 ton ha^{-1} mm for the IWUE at the Li of 86.96% ETc. For the WUE, the first crop year obtained a 42.60% efficiency compared to the second year at the Li of 75% ETc ($p < 0.05$), and 78.04% at the Li of 125% ETc ($p < 0.001$).

Among the irrigation levels, there was a 21.02% yield reduction for the Li of 75% and 125% ETc, and only 2.75% for the Li of 75% and 100% ETc. The Li of 50% and 100% ETc were not influenced between crop years ($p > 0.05$) (Figure 4A). For the IWUE, there was a difference only for the Li of 125% ETc, with the first crop year (18/19) being 76.17% superior to the second (19/20) ($p < 0.001$) (Figure 4B).

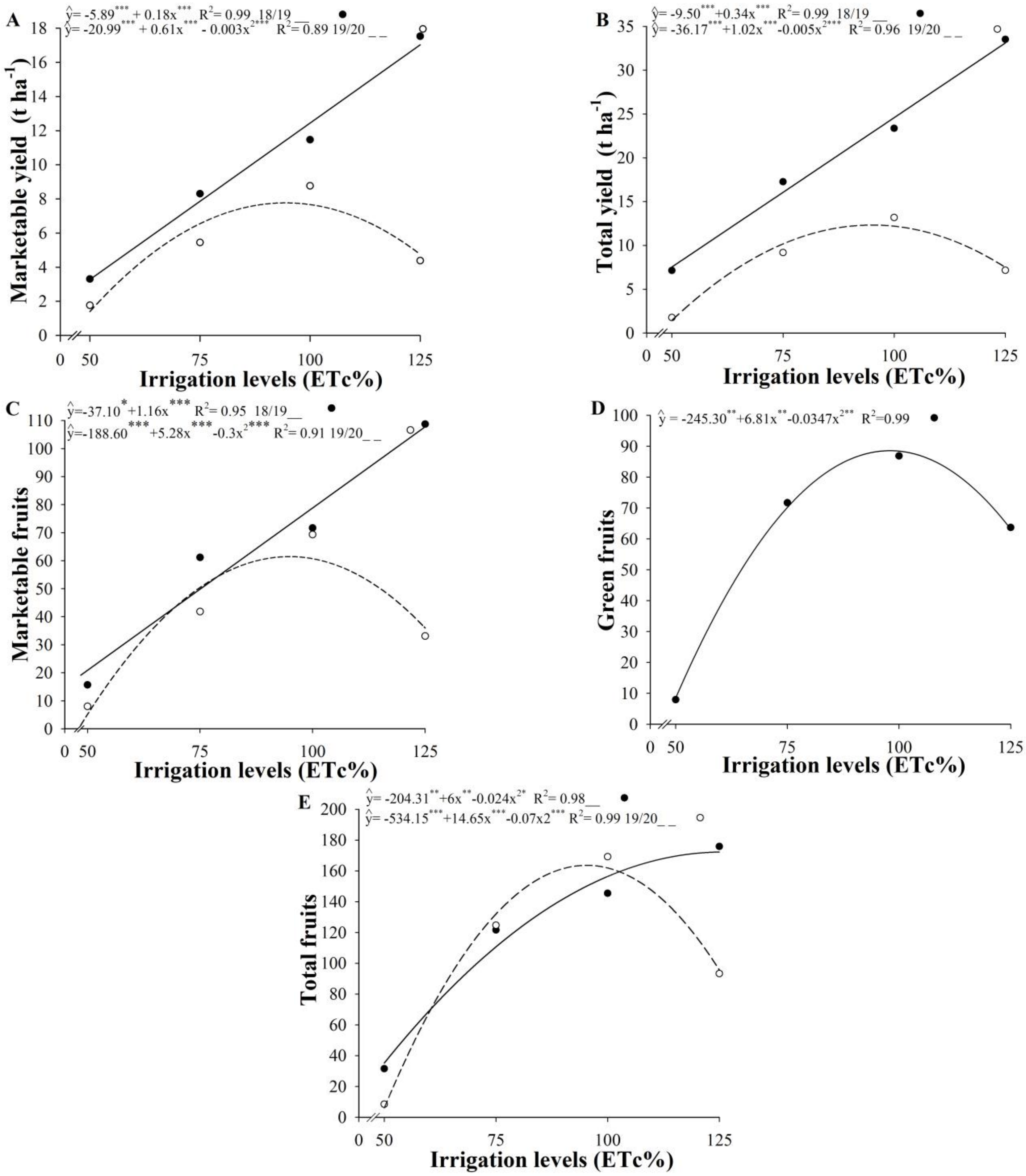

Figure 3. Marketable yield (**A**) and total yield (**B**)—ton ha^{-1}, and number of marketable fruits (**C**), green fruits (**D**), and total fruits (**E**) of fig plants grown under semiarid climatic conditions in the 2018/2019 and 2019/2020 crop years. * Significant ($p < 0.05$); ** ($p < 0.01$); *** ($p < 0.001$).

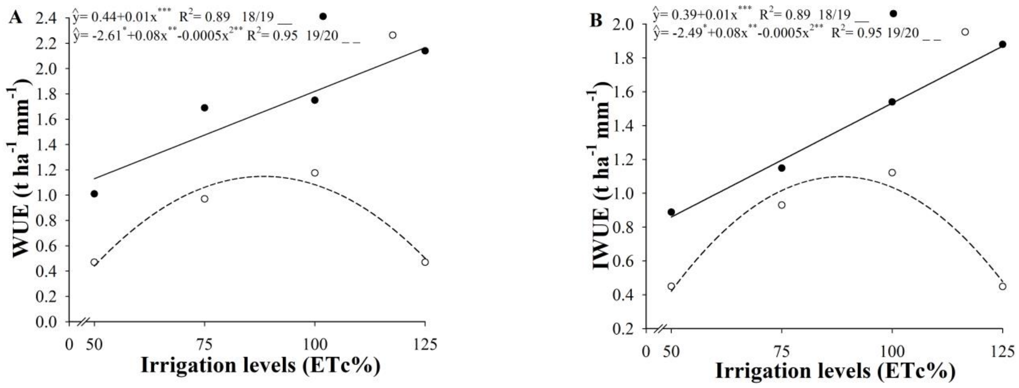

Figure 4. Water-use efficiency (WUE) (**A**) and irrigation water-use efficiency (IWUE) (**B**) of fig plants grown under semiarid climatic conditions in the 2018/2019 and 2019/2020 crop years. * Significant ($p < 0.05$); ** ($p < 0.01$); *** ($p < 0.001$).

3.3. Fruit Physical Characteristics

Fruit length (FL) was influenced by the Li and potassium doses in the two production years ($p < 0.001$). In the first year (18/19), the plants without potassium fertilization (0 g K plant^{-1}) and those fertilized with 60 and 120 g K plant^{-1} presented average fruit length (FL) values of 42.99, 42.19, and 41.70 mm at the Li of 104%, 104.55%, and 97.88% ETc, respectively (Figure 5A). In the second year (19/20), the plants fertilized with 60 and 120 g K plant^{-1} presented average FL values of 40.40 and 40.02 mm at the Li of 85.19% and 98.70% ETc, respectively. However, the regression response was negative in the plants without potassium (0 g K plant^{-1}), with a decrease occurring in the FL with the increase in the Li up to 92.07% ETc, with an average of 35.35 mm (Figure 5B).

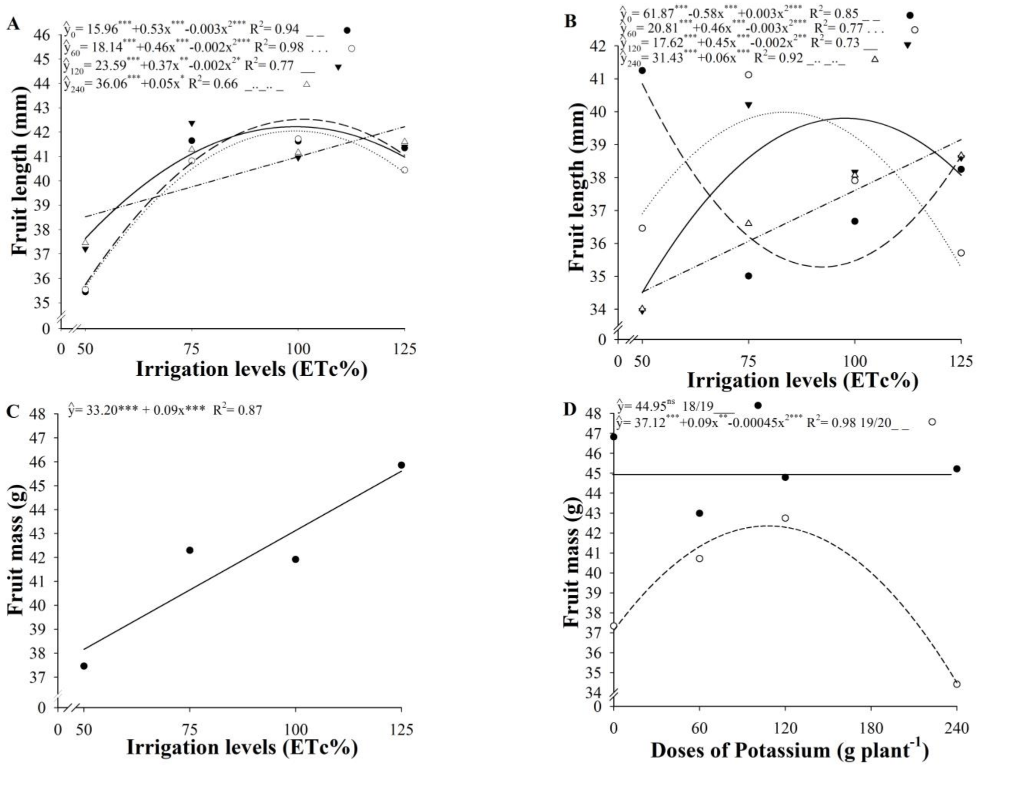

Figure 5. Fruit length ((**A**)—18/19 and (**B**)—19/20) and average fruit mass as a function of irrigation levels—Li (**C**) and potassium doses (**D**) in fig plants grown under semiarid climatic conditions in the 2018/2019 and 2019/2020 crop years. ns Not significant ($p > 0.05$); * Significant ($p < 0.05$); ** ($p < 0.01$); *** ($p < 0.001$).

There was an 18.51% reduction in the Li (19.36 mm) from the first to the second year with the application of 60 g K plant^{-1}, with a 6.02% loss in FL (1.78 mm). When 120 g K plant^{-1} was applied, there was only a 0.83% increase in the Li (0.81 mm) in the second year (19/20), with a 4.02% reduction in the FL (1.67 mm). For the plants fertilized with 240 g K plant^{-1}, there was a growing linear behavior with the increase in the irrigation levels applied in the first (18/19) and second crop years (19/20) (Figure 5A,B).

The irrigation levels influenced the fruit mass (FM) ($p > 0.01$) and the potassium doses in the two crop years ($p < 0.05$). There were linear increases in FM with the increase in the Li values up to 125% ETc (Figure 5C). For the potassium doses, the fruits from the first year (18/19) were larger than those produced in the second year ($p < 0.05$), but there was no significant reduction between them, thus being statistically equal. The second year, however (19/20), provided the highest average fruit mass (42.35 g) at the dose of 107.93 g K plant^{-1}, after which the FM was reduced at higher K doses (Figure 5D).

For the variables related to the color space of fruits, the irrigation levels influenced fruit lightness (L*) in the second year (19/20), presenting the lowest mean value for this variable (29.14 L*) at the Li of 82.87 ETc% (Figure 6A). The hue angle (°Hue) obtained the highest means in the fruits of the plants subjected to the highest water deficit, possibly characterizing fruits at an earlier maturation stage, closer to a green-yellowish color (Figure 6B).

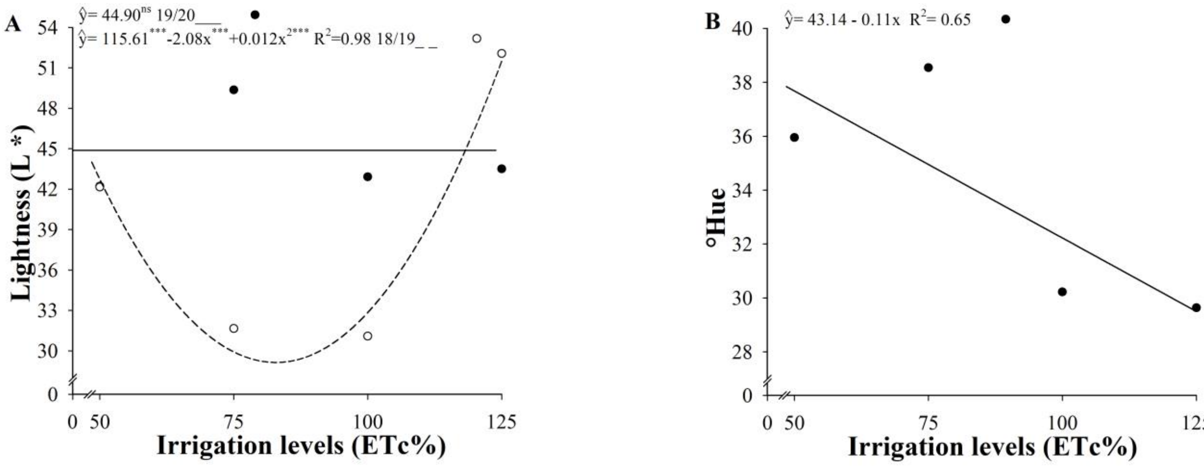

Figure 6. Lightness (L*) (**A**) and hue angle (°Hue) (**B**) of fruits as a function of the irrigation levels in fig plants grown under semiarid climatic conditions in the 2018/2019 and 2019/2020 crop years. ^{ns} Not significant ($p > 0.05$); *** ($p < 0.001$).

Fruit firmness (FF) was influenced by the irrigation levels and potassium doses in the two production years ($p < 0.01$). In the first year (18/19), the Li increase in the plants fertilized with 60 g K plant^{-1} caused a significant reduction in FF (2.08 N) up to the Li of 105% ETc, with further increases in FF occurring at higher Li values. In the plants without potassium (0 g K plant^{-1}), the firmest fruits (4.52 N) were obtained at the Li of 75.34% ETc, with reductions occurring in FF at lower Li values (water deficit), as well as at higher Li values up to 97.50% ETc, which resulted in the lowest result for FF (4.22 N). There were increases in FF at higher Li values (Figure 7A).

In the second year (19/20), the increase in the irrigation levels in the plants fertilized with 60 and 240 g K plant^{-1} caused reductions in FF up to the Li of 95.51% (2.82 N) and 92.50% (3.58 N), respectively, with further increases in FF occurring at higher Li values (Figure 7B). For the plants without potassium application (0 g plant^{-1}), there was a growing linear response of FF with the increase in the Li (ETc%). This response can be associated with the organic fertilization provided to the plants in both cycles (18/19 and 19/20). For the plants fertilized with 120 g K plant^{-1}, there were maximum increases in FF (4.36 N) by applying irrigation levels up to 103.75% ETc, with reductions in FF at higher Li values (Figure 7B).

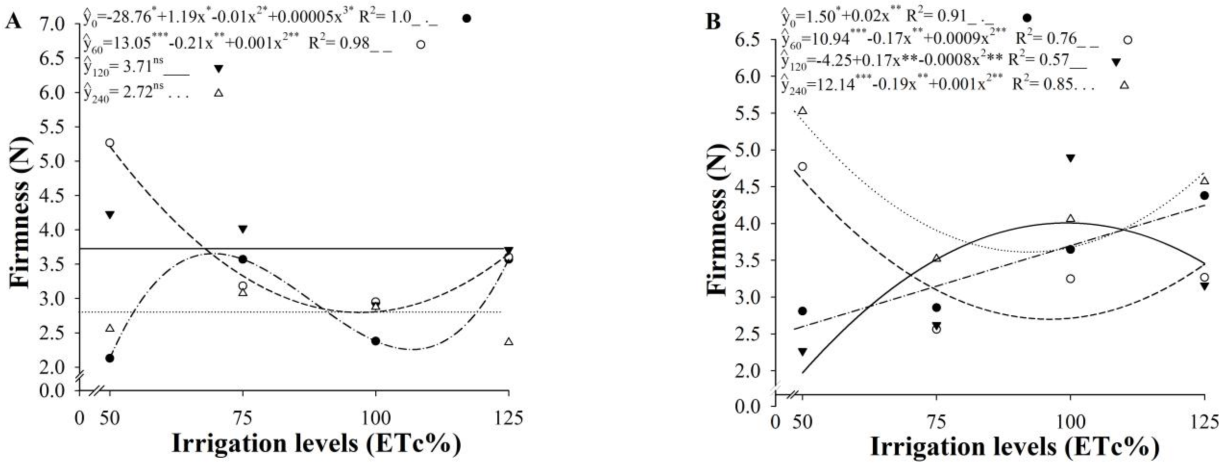

Figure 7. Firmness of fig fruits produced in the 2018/2019 (**A**) and 2019/2020 (**B**) crop years as a function of irrigation levels and potassium doses under semiarid conditions in the 2018/2019 and 2019/2020 crop years. * Significant ($p < 0.05$); ** Significant ($p < 0.01$); *** Significant ($p < 0.001$); ^{ns} Not significant ($p > 0.05$).

3.4. Fruit Physicochemical Characteristics

The contents of soluble solids (SS), titratable acidity (TA), potential of hydrogen (pH), and ratio (SS/TA) of the fig fruits were influenced by the irrigation levels (Li) and potassium doses in both production years ($p < 0.001$). The fruit vitamin C content, in turn, was only influenced by the Li.

In the first year (18/19), the plants without fertilization (0 g plant^{-1}) remained statistically equal, not being affected by water deficit or excess ($p > 0.05$). The SS content increased linearly with the increase in the Li (ETc%) in the plants fertilized with 60 g K plant^{-1}. For the plants fertilized with 120 and 240 g K plant^{-1}, the lowest SS contents were obtained with water deficit below the irrigation levels of 70.51% (10.69 °Brix) and 71.85% ETc (9.27 °Brix), while the highest SS contents were obtained with the increase in the Li up to 111.31% (14.42 °Brix) and 99.09% ETc (10.06 °Brix), respectively, with reductions in the SS contents at higher Li values (Figure 8A).

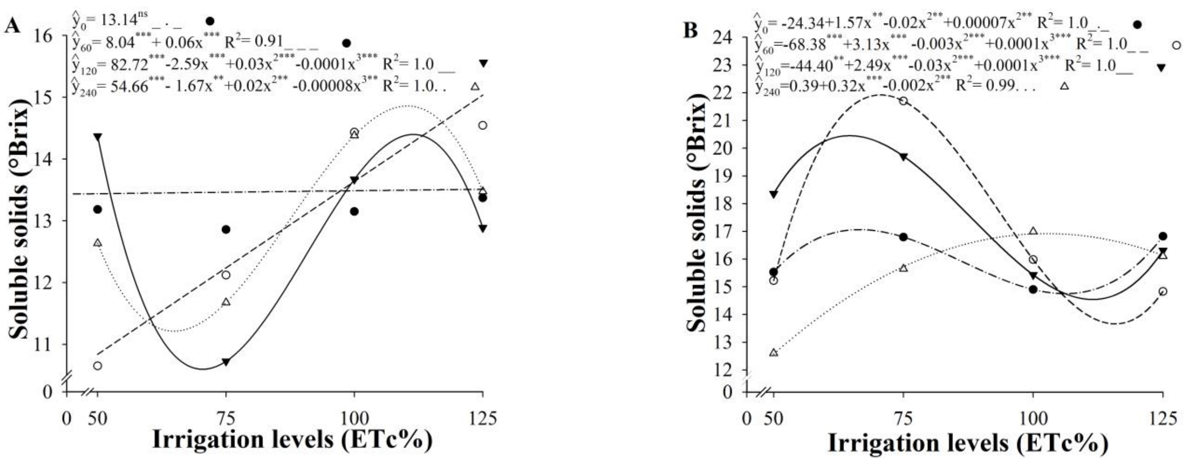

Figure 8. Soluble solids of fig fruits produced in the 2018/2019 (**A**) and 2019/2020 (**B**) production cycles as a function of irrigation levels and potassium doses under semiarid conditions in the 2018/2019 and 2019/2020 crop years. ** Significant ($p < 0.01$); *** Significant ($p < 0.001$); ^{ns} Not significant ($p > 0.05$).

In the second year (19/20), the highest SS contents were obtained at the Li of 63.84% (16.69 °Brix), 69.70% (20.38 °Brix), and 63.54% (20.28 °Brix) in the plants without fertilization (0 g K plant^{-1}) and in the plants fertilized with 60 and 120 g K plant^{-1}, respectively. There was a reduction in the SS contents at lower Li values (water deficit) and at Li values up to 117.1% (11.39 °Brix), 124.75% (10.37 °Brix), and 118.30% ETc (11.25 °Brix) for the doses of 0, 60, and 120 g K plant^{-1}, respectively. For the plants fertilized with 240 g K plant^{-1}, the highest SS content was obtained at the Li of 101.91% ETc, with 16.70 °Brix (Figure 8B).

In the first year (18/19), the TA at the Li values of 88.24%, 66.88%, and 89.29% ETc resulted in 0.19, 0.22, and 0.18 g of citric acid in the fruits grown with 0, 60, and 120 g K plant^{-1}, respectively. In the plants fertilized with 240 g K plant^{-1}, there was a growing linear increase in the TA of fruits with the increase in the Li values (Figure 9A). In the second year (19/20), the lowest TA value (0.16 g of citric acid) was obtained at the Li of 88.64% ETc for the plants without potassium fertilization (0 g K plant^{-1}) (Figure 9B). When applying 60 g K plant^{-1}, the lowest values appeared between the Li of 33.33% ETc, which resulted in 0.49 g of citric acid, and the Li of 100% ETc, with 0.64 g of citric acid.

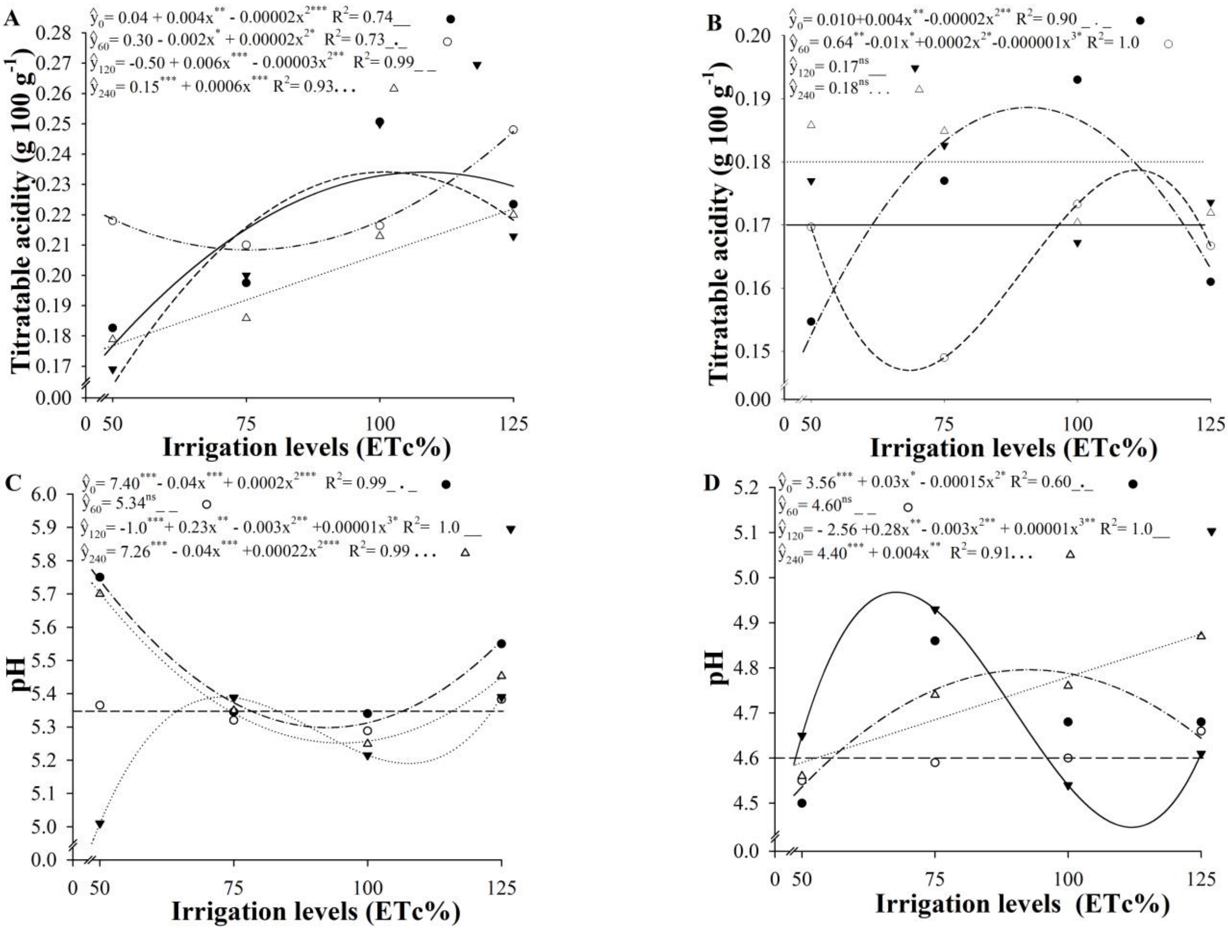

Figure 9. Titratable acidity of fig fruits in the 2018/2019 (**A**) and 2019/2020 (**B**) crop cycles, and pH of fig fruits in the 2018/2019 (**C**) and 2019/2020 (**D**) crop cycles as a function of irrigation levels and potassium doses under semiarid conditions in the 2018/2019 and 2019/2020 crop years. * Significant (p < 0.05); ** Significant (p < 0.01); *** Significant (p < 0.001); ^{ns} Not significant (p > 0.05).

Fruit pH showed no significant effect of the irrigation levels for the plants fertilized with 60 g K plant^{-1} in both years (18/20 and 19/20). In the absence or at the maximum K dose (0 and 240 g K plant^{-1}), the water deficit provided the highest fruit pH contents, with decreases in this variable (5.40 and 5.44) with the increase in the irrigation levels up to 100% and 90.91% ETc, respectively, further increasing at higher Li values (ETc%). The fruits of plants fertilized with 120 g K plant^{-1} obtained a pH 5.09 at the Li of 73.33% ETc. The reduction (water deficit) or increase in the irrigation levels up to 100% ETc decreased the fruit pH (5.00). There were, however, increases in the fruit pH at higher Li values (Figure 9C).

In the second year (19/20), the plants without fertilization (0 g K plant^{-1}) showed the highest fruit pH value (4.80) at the Li of 92.76% ETc. The plants fertilized with 120 g K plant^{-1} showed the highest fruit pH (4.92) at the Li of 66.01% ETc, with a decrease occurring in this variable with the increase in water deficit and with the increase in the Li up to 117.32% ETc, which resulted in the lowest pH value (4.10) (Figure 9D). Fruit pH increased linearly with the increase in the Li (ETc%) in the plants fertilized with 240 g K plant^{-1} (Figure 9D).

For SS/TA ratio in the first crop year (18/19), the water deficit resulted in higher SS/TA values for the fruits of the plants fertilized with 120 g K plant^{-1}, reducing when the irrigation levels were increased up to 103.93%, which resulted in the lowest SS/TA ratio value (40.33) (Figure 10A).

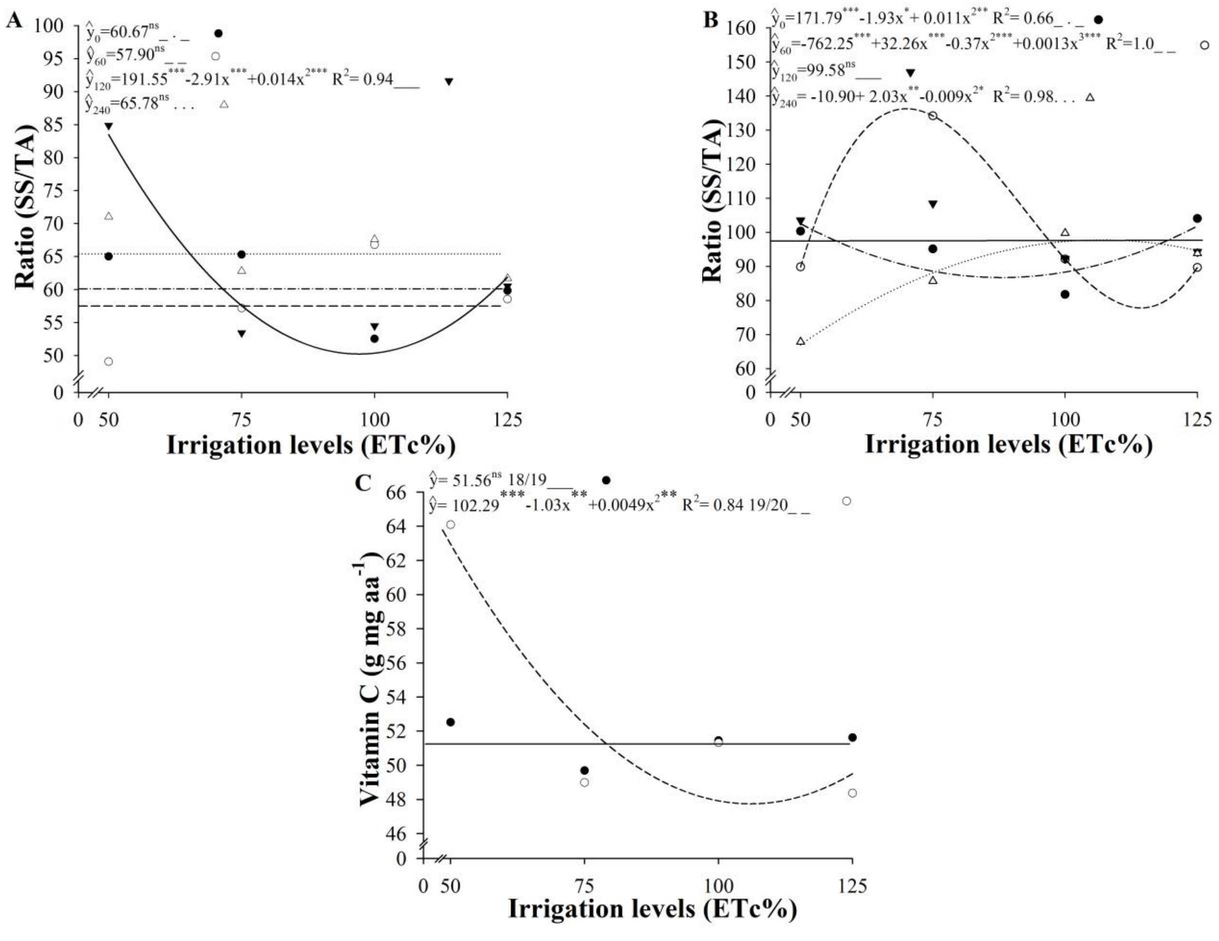

Figure 10. SS/TA ratio ((**A**)—2018/2019; (**B**)—2019/2020) and vitamin C (**C**) of fig fruits as a function of irrigation levels under semiarid conditions. * Significant ($p < 0.05$); ** Significant ($p < 0.01$); *** Significant ($p < 0.001$); ^{ns} Not significant ($p > 0.05$). Means of 2 crop years (2018/2019 and 2019/2020).

In the second year (19/20), the highest SS/TA values (87.13 and 103.57) were obtained at the Li of 87.93% and 112.78% ETc for the plants fertilized with 0 and 240 g K plant^{-1}, respectively (Figure 10B). The plants fertilized with 60 g K plant^{-1} showed the highest SS/TA values at the Li of 67.87% ETc (129.31), reducing the SS/TA values with increasing Li values up to 121.87% ETc, which resulted in the lowest value for the SS/TA ratio (26.99).

For the fruit vitamin C content, the first year (18/19) showed no statistical difference, with statistically equal means at the irrigation levels applied. For the second year (19/20), the highest vitamin C contents were obtained with plants subjected to a water deficit. The increase in the Li up to 105.93% ETc reduced the fruit vitamin C content (47.71 g mg of ascorbic acid 100 g^{-1} pulp), further increasing at higher Li values (Figure 10C).

4. Discussion

Solar radiation significantly influences plants during the production years, affecting the crop energy balance. The reflection of the incident solar radiation is associated with plant yield by photosynthesis, transpiration, flowering, and maturation. Daily observations regarding variations in soil moisture and water flow and climatic variation observations can provide essential elements to quantify the water balance components and estimate the actual crop evapotranspiration [29].

Under ideal management conditions, the plants did not show severe damages due to high temperatures for being a fruit species native to arid regions, featuring young leaves adapted to conditions of high radiation and temperature, and developing specific morpho-physiological characteristics to withstand the tensions mentioned above [30]. However, under water deficit conditions (50% ETc), the crop entered a rest period, maintaining only its physiological conditions for survival.

Water deficit reduces plant growth and productivity, although it improves some fruit quality attributes, such as increased antioxidant and sugar content [31], as we observed in our study. Such reductions caused by water stress were greater when low K was available to plants, causing drastic leaf dropping and decreasing MY and TY and increasing the content of soluble sugars and vitamin C. Similar results were observed by [32] in *Nicotiana rustica*.

Plants respond differently depending on the stress level: under mild water stress or water stress of limited duration, 'stress avoidance' mechanisms are induced, including stomatal closure and increased root/shoot ratio [4]. Under severe stress or after a long-term stress, in contrast, 'dehydration avoidance' mechanisms, such as osmolytes accumulation and cell wall stiffening, are induced [6].

The low yield is directly correlated with the number of fruits. The higher the water deficit imposed on the plants, the lower the fruit quality and yield. The more water provided to the plants, the higher the WUE and IWUE values in the first year, although reducing in the second year (19/20), which confirms the sensitivity of the plants subjected to water deficiency and water excess.

Lower WUE values possibly occur when soil evapotranspiration is high compared to the crop evapotranspiration, therefore not supplying the plant with the proper water requirement of the crop [33]. When faced with severe water stress, plants reduce the leaf area, close their stomata, and undergo leaf senescence, resulting in phenological responses that save water, possibly for survival in later periods [34].

The results showed that both water deficit and water excess, in a cumulative manner, caused fruit length reduction and that the irrigation level estimated by the FAO method [22] was highly precise in determining the water requirement of the plant. This limitation in the final fruit size may be related to the photosynthetic limitations of the plant faced with water deficit, which could cause reductions in the absorption and translocation of assimilates to the fruits. The effect of water deficit on fruit reduction has also been observed for the fig crop [7], for an extra early peach cultivar [35], and for highbush blueberries [36].

Likewise, water excess in the soil causes anaerobic stress to the roots, a condition that suppresses root activity, reduces root growth, and decreases nutrient and water absorption due to low transpiration. However, the plants fertilized with 240 g K $plant^{-1}$ showed a linear increase in fruit length at high irrigation levels. This linear behavior may be associated with the high K content in the soil solution, allowing absorption by mass flow, which may not have occurred at the lowest doses due to K depletion in the soil solution, with absorption occurring by diffusion instead [37]. The greater fruit mass obtained at the high K dose may be related to the effect of abiotic stress, considering that the climatic conditions of study are extreme, which may require an increased content of this nutrient.

The plants subjected to the highest water deficit condition (50% ETc) showed a considerable delay in fruit harvest: almost 30 days in the first crop year (18/19) and 20 days of difference in the second (19/20). Fruit harvest becomes a problem for the fig crop under water deficit (50% ETc): although all harvest aspects were analyzed, the fruits produced by plants subjected to water stress showed a dull green color (higher hue angle value), which was confirmed by the fruit color analysis (L* and h°), and may indicate a semimature maturation stage, considering that water stress strongly influences the fruit maturation process [38]. Moderate stress usually acts by providing improvements in fruit maturation, as noted in the results, while severe water stress (50% ETc) acts by delaying the process.

Although the plants fertilized with potassium presented reduced FF with the increase in the irrigation levels, satisfactory firmness values were still verified in the fruits, especially in the second year. Similar results with expressive responses only in the second year were reported by [39].

The reduction in the SS concentration in the fruits of plants under excessive irrigation levels (125% ETc) may be related to a dilution effect [36,40]. On the other hand, there was no effect of the irrigation levels on the SS, TA, SS/TA ratio, and firmness of fig fruits from cultivars subjected to irrigation deficit regulated at 50 and 100% ETc [41]. The increase in SS in the plants subjected to water deficit may be caused by an active osmotic adjustment in the fruits, which favors the increase in the content of solutes [39].

What may explain the high vitamin C content in the second cycle (19/20) is the effect of aerobic metabolism in plants on the generation of reactive oxygen species (ROS). The overproduction of ROS may be a response to water stress (drought), and plants regulate the expression of antioxidant enzymes to maintain ROS homeostasis, ensuring uninterrupted metabolism [5]. Antioxidants possess greater potential according to their ability to provide bioactive substances that neutralize ROS and remaining free radicals by oxidative stress [42–44]. When there is an excessive production of ROS under stress conditions, there is also membrane, DNA, and protein damage, in addition to lipid peroxidation [45], with the production of small hydrocarbon fragments, which may react with thiobarbituric acid to form colored products called TBARS [46].

5. Conclusions

Considering what was observed, water deficit significantly reduces the production characteristics of plants, as well as irrigation water levels equal to or greater than 100% ETc applied cumulatively throughout the years of cultivation. Thus, irrigation water levels between 85.19% and 95.16% ETc are the most recommended to obtain greater water efficiency for the crop and produce quality fruits. It was observed that a higher water deficit leads to increases in the SS and vitamin C contents in the fruits. Potassium influenced the reduction in water stress in the fig plants, providing reductions in the irrigation levels applied, especially in the second year, without compromising the fruit properties. The dose of 107.93 g K plant^{-1} provides fruits with a higher average mass.

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References

1. Silva, F.S.O.; Pereira, E.C.; Mendonça, V.; da Silva, R.M.; Alves, A.A. Phenology and Yield of the "Roxo de Valinhos" Fig Cultivar in Western Potiguar. *Rev. Caatinga* **2017**, *30*, 802–810. [CrossRef]
2. Moursi, H.; Kim, D.; Kaluarachchi, J.J. A Probabilistic Assessment of Agricultural Water Scarcity in a Semi-Arid and Snowmelt-Dominated River Basin under Climate Change. *Agric. Water Manag.* **2017**, *193*, 142–152. [CrossRef]
3. Bayer, A.; Ruter, J.; van Iersel, M.W. Elongation of Hibiscus Acetosella under Well-Watered and Drought-Stressed Conditions. *HortScience* **2016**, *51*, 1384–1388. [CrossRef]
4. Abdolahipour, M.; Kamgar-Haghighi, A.A.; Sepaskhah, A.R.; Zand-Parsa, S.; Honar, T.; Razzaghi, F. Time and Amount of Supplemental Irrigation at Different Distances from Tree Trunks Influence on Morphological Characteristics and Physiological Responses of Rainfed Fig Trees under Drought Conditions. *Sci. Hortic.* **2019**, *253*, 241–254. [CrossRef]
5. Wang, X.; Cai, X.; Xu, C.; Wang, Q.; Dai, S. Drought-Responsive Mechanisms in Plant Leaves Revealed by Proteomics. *Int. J. Mol. Sci.* **2016**, *17*, 1706. [CrossRef] [PubMed]
6. Darwish, A.D.; El-Berry, I.; Moursy, F.S.; Hagagg, L.F. Detecting Drought Tolerance of Fig (*Ficus carica*, L.) Cultivars Depending on Vegetative Growth and Peroxidase Activity. *Int. J. ChemTech Res.* **2015**, *8*, 1520–1532.
7. Trevisan, P.V.; Menegaes, J.F.; Fronza, D.; Nishijima, T. Produtividade Da Cultura Da Figueira (*Ficus carica* L.) Submetida a Diferentes Estratégias de Irrigação Por Gotejamento. *Acta Iguazu* **2016**, *5*, 49–60.
8. Gholami, M.; Rahemi, M.; Kholdebarin, B.; Rastegar, S. Biochemical Responses in Leaves of Four Fig Cultivars Subjected to Water Stress and Recovery. *Sci. Hortic.* **2012**, *148*, 109–117. [CrossRef]
9. Gholami, M.; Rahemi, M.; Rastegar, S. Use of Rapid Screening Methods for Detecting Drought Tolerant Cultivars of Fig (*Ficus carica* L.). *Sci. Hortic.* **2012**, *143*, 7–14. [CrossRef]
10. Abdolahipour, M.; Kamgar-Haghighi, A.A.; Sepaskhah, A.R. Time and Amount of Supplemental Irrigation at Different Distances from Tree Trunks Influence on Soil Water Distribution, Evaporation and Evapotranspiration in Rainfed Fig Orchards. *Agric. Water Manag.* **2018**, *203*, 322–332. [CrossRef]
11. Bagheri, E.; Sepaskhah, A.R. Rain-Fed Fig Yield as Affected by Rainfall Distribution. *Theor. Appl. Climatol.* **2013**, *117*, 433–439. [CrossRef]
12. Souza, A.P.; Silva, A.C.; Leonel, S.; Souza, M.E.; Tanaka, A.A. Evapotranspiração e Eficiência Do Uso Da Água No Primeiro Ciclo Produtivo Da Figueira "Roxo de Valinhos" Submetida a Cobertura Morta. Available online: http://www.seer.ufu.br/index.php/biosciencejournal/article/view/14076 (accessed on 4 July 2020).
13. Kanai, S.; Moghaieb, R.E.; El-Shemy, H.A.; Panigrahi, R.; Mohapatra, P.K.; Ito, J.; Nguyen, N.T.; Saneoka, H.; Fujita, K. Potassium Deficiency Affects Water Status and Photosynthetic Rate of the Vegetative Sink in Green House Tomato Prior to Its Effects on Source Activity. *Plant Sci.* **2011**, *180*, 368–374. [CrossRef]
14. Caretto, S.; Parente, A.; Serio, F.; Santamaria, P. Influence of Potassium and Genotype on Vitamin E Content and Reducing Sugar of Tomato Fruits. *HortScience* **2008**, *43*, 2048–2051. [CrossRef]
15. Daoud, B.; Pawelzik, E.; Naumann, M. Different Potassium Fertilization Levels Influence Water-Use Efficiency, Yield, and Fruit Quality Attributes of Cocktail Tomato—A Comparative Study of Deficient-to-Excessive Supply. *Sci. Hortic.* **2020**, *272*, 109562. [CrossRef]
16. Hawkesford, M.; Horst, W.; Kichey, T.; Lambers, H.; Schjoerring, J.; Møller, I.S.; White, P. Functions of Macronutrients. *Marschner's Miner. Nutr. High. Plants* **2012**, *1*, 135–189. [CrossRef]
17. White, P.J.; Karley, A.J. Potassium. *Plant Cell Monogr.* **2010**, *17*, 199–224. [CrossRef]
18. Cakmak, I. The Role of Potassium in Alleviating Detrimental Effects of Abiotic Stresses in Plants. *J. Plant Nutr. Soil Sci.* **2005**, *168*, 521–530. [CrossRef]
19. Rostami, A.A.; Rahemi, M. Screening Drought Tolerance in Caprifig Varieties in Accordance to Responses of Antioxidant Enzymes. *World Appl. Sci. J.* **2013**, *21*, 1213–1219. [CrossRef]
20. Peel, M.C.; Finlayson, B.L.; McMahon, T.A. Updated World Map of the Köppen-Geiger Climate Classification. *Hydrol. Earth Syst. Sci.* **2007**, *11*, 1633–1644. [CrossRef]
21. Leonel, S.; Reis, L.L. Potassium Fertilization on Fruits Orchards: A Study Case from Brazil. In *Soil Fertility*; InTech: London, UK, 2012.
22. Allen, R.G.; Pereira, L.S.; Raes, D.; Smith, M. *Crop Evapotranspiration-Guidelines for Computing Crop Water Requirements-FAO Irrigation and Drainage Paper 56*; FAO—Food and Agriculture Organization of the United Nations: Rome, Italy, 1998.
23. Merriam, J.L.; Keller, J. *Farm Irrigation System Evaluation: A Guide for Management*, 3rd ed.; Utah State University: Logan, UT, USA, 1978.
24. Howell, T.A.; Cuenca, R.H.; Solomon, K.H. Crop Yield Response. In *Management of Farm Irrigation Systems*; Hoffman, G.J., Howell, T.A., Solomon, K.H., Eds.; ASAE: St. Joseph, MI, USA, 1990; pp. 93–122.

25. Kanber, R.; Yazar, A.; Köksal, H.; Oguzer, V. Evapotranspiration of Grapefruit in the Eastern Mediterranean Region of Turkey. *Sci. Hortic.* **1992**, *52*, 53–62. [CrossRef]
26. AOAC. *Official Methods of Analysis of AOAC International*, 19th ed.; AOAC International: Gaithersburg, MD, USA, 2012; ISBN 0935584838 9780935584837.
27. Strohecker, R.; Henning, H.M. *Análises de vitaminas: Métodos comprovados*; Editora Paz Montalvo: Madrid, Spanish, 1967; 428p.
28. R Core Team. *R: A Language and Environment for Statistical Computing*; R Foundation for Statistical Computing: Vienna, Austria, 2020.
29. Souza, A.P.; Pereira, J.B.A.; da Silva, L.D.B.; Guerra, J.G.M.; de Carvalho, D.F. Evapotranspiração, Coeficientes de Cultivo e Eficiência Do Uso Da Água Da Cultura Do Pimentão Em Diferentes Sistemas de Cultivo. *Acta Sci. Agron.* **2011**, *33*, 15–22. [CrossRef]
30. González-Rodríguez, A.M.; Peters, J. Strategies of Leaf Expansion in *Ficus Carica* under Semiarid Conditions. *Plant Biol.* **2010**, *12*, 469–474. [CrossRef]
31. Ripoll, J.; Urban, L.; Brunel, B.; Bertin, N. Water Deficit Effects on Tomato Quality Depend on Fruit Developmental Stage and Genotype. *J. Plant Physiol.* **2016**, *190*, 26–35. [CrossRef]
32. Bahrami-Rad, S.; Hajiboland, R. Effect of Potassium Application in Drought-Stressed Tobacco (*Nicotiana rustica* L.) Plants: Comparison of Root with Foliar Application. *Ann. Agric. Sci.* **2017**, *62*, 121–130. [CrossRef]
33. Ertek, A.; Şensoy, S.; Gedik, İ.; Küçükyumuk, C. Irrigation Scheduling Based on Pan Evaporation Values for Cucumber (*Cucumis sativus* L.) Grown under Field Conditions. *Agric. Water Manag.* **2006**, *81*, 159–172. [CrossRef]
34. Chirinéa, C.F.; Pasqual, M.; de Araujo, A.G.; Pereira, A.R.; de Castro, E.M. Aclimatização e Anatomia Foliar de Plântulas de Figo Micropropagadas. *Rev. Bras. Frutic.* **2012**, *34*, 1180–1188. [CrossRef]
35. Alcobendas, R.; Mirás-Avalos, J.M.; Alarcón, J.J.; Pedrero, F.; Nicolás, E. Combined Effects of Irrigation, Crop Load and Fruit Position on Size, Color and Firmness of Fruits in an Extra-Early Cultivar of Peach. *Sci. Hortic.* **2012**, *142*, 128–135. [CrossRef]
36. Ehret, D.L.; Frey, B.; Forge, T.; Helmer, T.; Bryla, D.R. Effects of Drip Irrigation Configuration and Rate on Yield and Fruit Quality of Young Highbush Blueberry Plants. *HortScience* **2012**, *47*, 414–421. [CrossRef]
37. Oliveira, R.H.; Rosolem, C.A.; Trigueiro, R.M. Importance of Mass Flow and Diffusion on the Potassium Supply to Cotton Plants as Affected by Soil Water and Potassium. *Rev. Bras. Cienc. do Solo* **2004**, *28*, 439–445. [CrossRef]
38. Lopez, G.; Behboudian, M.H.; Vallverdu, X.; Mata, M.; Girona, J.; Marsal, J. Mitigation of Severe Water Stress by Fruit Thinning in "O'Henry" Peach: Implications for Fruit Quality. *Sci. Hortic.* **2010**, *125*, 294–300. [CrossRef]
39. Lobos, T.E.; Retamales, J.B.; Ortega-Farías, S.; Hanson, E.J.; López-Olivari, R.; Mora, M.L. Pre-Harvest Regulated Deficit Irrigation Management Effects on Post-Harvest Quality and Condition of V. Corymbosum Fruits Cv. Brigitta. *Sci. Hortic.* **2016**, *207*, 152–159. [CrossRef]
40. Lu, J.; Shao, G.; Cui, J.; Wang, X.; Keabetswe, L. Yield, Fruit Quality and Water Use Efficiency of Tomato for Processing under Regulated Deficit Irrigation: A Meta-Analysis. *Agric. Water Manag.* **2019**, *222*, 301–312. [CrossRef]
41. Kong, M.; Lampinen, B.; Shackel, K.; Crisosto, C.H. Fruit Skin Side Cracking and Ostiole-End Splitting Shorten Postharvest Life in Fresh Figs (*Ficus carica* L.), but Are Reduced by Deficit Irrigation. *Postharvest Biol. Technol.* **2013**, *85*, 154–161. [CrossRef]
42. Zhang, Y.J.; Gan, R.Y.; Li, S.; Zhou, Y.; Li, A.N.; Xu, D.P.; Li, H.B.; Kitts, D.D. Antioxidant Phytochemicals for the Prevention and Treatment of Chronic Diseases. *Molecules* **2015**, *20*, 21138–21156. [CrossRef] [PubMed]
43. Huan, C.; Jiang, L.; An, X.; Yu, M.; Xu, Y.; Ma, R.; Yu, Z. Potential Role of Reactive Oxygen Species and Antioxidant Genes in the Regulation of Peach Fruit Development and Ripening. *Plant Physiol. Biochem.* **2016**, *104*, 294–303. [CrossRef]
44. Oliveira, A.B.; Almeida Lopes, M.M.; Moura, C.F.H.; Siqueira Oliveira, L.; Souza, K.O.; Filho, E.G.; Urban, L.; de Miranda, M.R.A. Effects of Organic vs. Conventional Farming Systems on Quality and Antioxidant Metabolism of Passion Fruit during Maturation. *Sci. Hortic.* **2017**, *222*, 84–89. [CrossRef]
45. Johnson, H.E.; Broadhurst, D.; Goodacre, R.; Smith, A.R. Metabolic Fingerprinting of Salt-Stressed Tomatoes. *Phytochemistry* **2003**, *62*, 919–928. [CrossRef]
46. Larkindale, J.; Knight, M.R. Protection against Heat Stress-Induced Oxidative Damage in Arabidopsis Involves Calcium, Abscisic Acid, Ethylene, and Salicylic Acid. *Plant Physiol.* **2002**, *128*, 682–695. [CrossRef]