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Different Effects of Irrigation Water Salinity and Leaching Fractions on Pepper (*Capsicum annuum* L.) Cultivation in Soilless Culture †

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† This paper is a part of the PhD Thesis of Hatice Gurgulu presented at Ege University, Turkey.

Abstract: Pepper (*Capsicum annuum* L.) is one of the most important vegetables cultivated under greenhouse conditions in Turkey. Salinity problems are experienced in both the soil and irrigation water in agricultural areas. For this reason, soilless cultivation in greenhouses is increasing and important, meaning that salinity control must be conducted more effectively. The increase in soilless agriculture practices and salinity problems should be investigated and studies should be carried out to propose solutions to the problems experienced. In this study, the effects of different salinity levels and leaching fractions on the plant growth, yield, quality and water consumption of pepper grown in soilless cultures were determined. The experiment was carried out over four growing periods across two years. The adopted experimental design was a randomized split-plot design with three replications. Pepper plants were grown in a perlite and cocopeat mixture in 144 pots. The volume of the pots was 8 L and the pots were filled with a mixture of 4 L of perlite and 4 L of cocopeat. The plants were fed with a complete nutrient solution and their EC levels were used as the control treatment (S_1: the EC value of the control was 1.4–1.5 dS m^{-1}). The electrical conductivities of the solution in the other three treatments were increased to 2 (S_2), 4 (S_3) and 6 (S_4) dS m^{-1} above the control by adding NaCl. We attempted to achieve two different leaching fractions (LR: leaching ratio) by means of weekly measurements, with 15–20% (LR_1) or 35–40% (LR_2) being applied at each salinity level. According to our results, there was no significant difference between the leaching fractions with respect to yield in any of the four growing seasons, but the yield decreased with the increase in salinity. The difference between the salinity level treatments and their interactions between the subjects was generally significant for the production periods.

Keywords: pepper (*Capsicum annuum* L.), salinity; leaching fraction; water use efficiency; salt threshold value

Citation: Gürgülü, H.; Ul, M.A. Different Effects of Irrigation Water Salinity and Leaching Fractions on Pepper (*Capsicum annuum* L.) Cultivation in Soilless Culture. *Agriculture* **2024**, *14*, 827. https://doi.org/10.3390/agriculture14060827

Academic Editor: Aliasghar Montazar

Received: 12 March 2024
Revised: 21 May 2024
Accepted: 23 May 2024
Published: 25 May 2024

1. Introduction

Basic chemical fertilizers, applied with irrigation water to achieve plant growth and development, are composed of salts, which can sometimes limit plant growth. This causes significant salt accumulation in the plant's root zone environment, and the plant yield and quality may decrease [1–5].

The advantage of soilless cultivation is the improvement in labor conditions and the prevention of plant diseases [6]. In soilless cultivation, irrigation and fertilization are combined in the form of nutrient solutions and enable a more efficient use of water and fertilizers. The fact that the growing substrates that are used in soilless cultivation generally do not contain the necessary nutrients for plant growth means more effective and controlled fertilization is required in this type of cultivation. Salinity problems arise due to the accumulation of the salt that is contained in the nutrient solution used in soilless cultivation systems in the plant's root zone over time [3,7]. Due to the very small root volume of the medium used in soilless agriculture, a much faster salt accumulation is observed in the root zone environment and significant salinity problems are experienced because of this accumulation [6,8]. Generally, these salts are chlorides (NaCl, $CaCl_2$ and $MgCl_2$), sulfates (Na_2SO_4 and $MgSO_4$), nitrates (Na_2NO_3 and KNO_3), carbonates and bicarbonates (Na_2CO_3 and $NaHCO_3$) and borates [5,9–11].

In greenhouse cultivation, the accumulated salts negatively affect plant growth. Irrigation is necessary to ensure good growth, as the concentration of water-soluble salts limits the available water from the root zone. By applying more irrigation water than normal (leaching ratio), excess salt should be washed out of the pots where the root zone of the plant is located [12,13].

One of the most important elements in the development of modern agriculture is to act rationally in the use of production elements in the context of sustainable development [14–16]. The possibilities of using materials from various production branches to produce energy, fertilizers or soil enrichment agents have been emphasized [17,18]. In modern horticultural production, disposable substrates are used because it is easier to manage plant health [15,19,20]. In soilless substrate culture, the time and amount of nutrient solution applications are controlled through various programs. Under conditions where irrigation water is applied by means of the drip irrigation method, it is useful to drain 15–25% of the water applied under normal conditions, and 30–35%, when necessary, in each irrigation application to prevent the accumulation of salt in the substrate [21].

Turkey is surrounded by seas on three sides. Since the climatic conditions are milder and the transportation network is more commercially viable, soilless culture in greenhouse production is generally carried out in regions that are close to these seas. However, the irrigation water used in these regions is affected by salinity because there is an increase in salty water due to the intrusion of sea water and other chemicals [6,12,13]. For this reason, studies were carried out in our country to determine the responses of different vegetables grown under soilless conditions to saline conditions and the effects of saline irrigation water.

Five different irrigation water salinity levels (0.25, 1, 3, 6 and 9 dS m^{-1}) and three different irrigation water amounts (80%, 100% and 120%) were tested on broccoli plants. It was determined that the salinity and amounts of irrigation water had effects on the yield. However, only the salinity treatments had effects on the dry matter and total ash values. The decrease in yield was significant at the 6 dS m^{-1} level. An increase in the amount of irrigation water increased the yield. As the salinity increased, the plants' dry matter content decreased and the total ash content increased [22].

When saline irrigation water (5 dS m^{-1}) was applied to eggplants, a significant decrease was observed in the plants' water consumption, height and weight. However, the mineral matter content in the leaves and the salt level in the root zone of the plants increased. It was also stated that leaching is absolutely necessary in high-saline-water applications [23].

When saline water (0.1–4.5 dS m^{-1}) was used in cucumber cultivation, it was determined that there was a linear yield decrease in plants when the salt concentration of the irrigation water increased [3].

The salt tolerance of two pepper cultivars in soilless culture at 0, 10, 25, 50, 100 and 150 mM salt levels during germination, seedling and developmental stages increased, and the fruit yield increased by 95% from 10 mM to 150 mM [24].

In pepper cultivation, which has an economic potential both in terms of the production area and export values, it is important to determine the effects of salinity and leaching practices during irrigation on plant growth, yield and quality criteria, which are of great importance in terms of market presentation. The aim of this study was to determine the effects of different salinity levels and leaching ratios on the growth, yield, evapotranspiration (ET), water use efficiency (WUE) and selected quality criteria of pepper (*Capsicum annuum* L.) plants grown under greenhouse and soilless conditions. Although the studies conducted on this topic in our country are insufficient, it is thought that the data and information that were obtained as a result of this trial will contribute to overcoming the lack of information on the subject.

2. Materials and Methods

2.1. Experimental Area, Plant Material and Growing Substrate

This study was carried out in a polyethylene-covered greenhouse, established at Ege University Bergama Vocational High School Yusuf Perin Campus (39°6′4.77″ N, 27°8′52.84″ E) during two spring and two fall growing periods. The adopted experimental design was a randomized split-plot design with three replications. Irrigation in the greenhouse was provided by means of automation and misting heads were used to balance the humidity inside the greenhouse by lowering the ambient temperature when necessary. During the experiment, a climate station was used to measure the internal shading and selected meteorological data (temperature and humidity) in the greenhouse depending on the indoor climate. The indoor air temperature (measured in degrees Celsius) and relative humidity (RH; measured as a percentage) were measured and recorded using a HOBO-Onset data logger (HOBO H08–004-02) (Figure 1).

Figure 1. An overview of the irrigation system's automation unit and climate station which were used to measure meteorological data inside the greenhouse.

Pepper (*Capsicum annuum* L.) is an annual plant of the *Solanaceae* family. The "Super Amazon F1" pepper variety was used as the plant material. This is a hybrid pointed pepper variety that is suitable for greenhouse and early spring planting. It has early and vigorous plant growth. Its fruit weight is 26–27 g and its fruit length is 24–25 cm. The fruit color is glossy dark green and slightly gusseted. The fruit quality is very good and suitable for export. It is a variety with 30% more yield than other varieties in cold weather and it is resistant to diseases and root rot [25].

Pepper plants were grown in a perlite and cocopeat mixture in 144 pots. The volume of the pots was 8 L and the pots were filled with a mixture of 4 L perlite and 4 L cocopeat. The plants were fed with a nutrient solution and its first EC (electrical conductivity) level was used as the control treatment (S_1: the EC value of the control was 1.4–1.5 dS m^{-1}).

Agricultural perlite (with 60% of the particles' diameters being 2–5 mm) and coconut shell fiber (Cocopeat) were chosen as the growing medium substrate because they were available locally and were suitable for soilless culture. They are also widely used substrates in commercial greenhouses in the region.

2.2. Irrigation, Leaching Fractions (LR) and Salinity Rates (S)

The nutrient solution was applied to the plants using drip irrigation. A drip irrigation lateral consisting of 16 mm outer diameter PE (polyethylene) pipes was in each row of plants and drippers with a pressure regulator providing a flow rate of 2 L per hour (one for each pot) were connected to the pipe. For irrigation applications, four separate tanks were utilized for four different salt-level treatments. Four electromotopumps were used to take the nutrient solution from each tank and deliver it to the respective treatments.

When 15–20% of the given irrigation water amounts were obtained as drainage, LR_1 (the 1st leaching fraction or leaching ratio) was formed, and when 35–40% of the irrigation water amounts were obtained as drainage, LR_2 (the 2nd leaching fraction or leaching ratio) was formed.

The tanks in which the nutrient solution and salinity were created were filled with spring water (water from the mountain) with an EC (electrical conductivity) value of 0.35–0.40 dS m^{-1} and a pH between 5.5 and 6.5 or municipal water with similar properties. The nutrient solution was added to all four tanks, filled with equal amounts of water in accordance with the nutrient prescription specified in Table 1 (equal amounts to all tanks). The control treatment was formed with an EC of 1.4–1.5 dS m^{-1} and pH between 5.5 and 6.5 in the tank where only water and the nutrient solution were added, and the salinity level in this tank, which in all production periods was called the control treatment, was expressed as S_1. We tried to achieve the desired salinity levels in the other three tanks by adding NaCl at levels that were 2, 4 and 6 dS m^{-1} higher than the EC value in S_1. Thus, the salinity samples S_2 (3.4–3.5 dS m^{-1}), S_3 (5.4–5.5 dS m^{-1}) and S_4 (7.4–7.5 dS m^{-1}) were created. We tried to maintain their pH values between 5.5 and 6.5.

Table 1. The nutrient recipe used for pepper cultivation in this study.

STOCK-A (50 L)		**STOCK-B (50 L)**		**MICRO (50 L)**	
Nitric Acid	1000 mL	Nitric Acid	1000 mL	Boric Acid	45.8 g
Calcium Nitrate	2105.3 g	Potassium Nitrate	3928.0 g	Manganese Sulfate	46.2 g
Potassium Nitrate	3928.0 g	Magnesium Sulfate	5069.9 g	Copper Sulfate	15.7 g
Iron	230.8 g	Phosphoric Acid	948 mL	Zinc Sulfate	44.0 g
Ammonium Nitrate	2689.0 g			Ammonium Molybdate	1.10 g

Nutrient solutions with four different salt levels were measured volumetrically before being removed from the 24 separate drainage tanks in which they were collected after irrigation application and the samples were taken for analysis and then removed from the system.

Throughout the study, the amount of nutrient solution applied to the treatments and pH and EC values were checked three times a week. As a result, the plant water consumption of each treatment was determined weekly by utilizing the relationship between the applied and drained amounts. Throughout the experiment, the drippers' flow distributions and the accuracy of the meters were checked regularly. In determining the irrigation time, the solar radiation value of 2 MJ m^{-2} and its multiples were taken into consideration.

2.3. Measurements and Calculations

The fruit weight and number of fruits per unit of area: Ten of the harvested fruits were weighed on a scale with a precision of 0.01 g and the average fruit weight (g) was calculated. The number of fruits (pcs m^{-2}) was determined for each harvest. The yield values were considered to be the yield per unit of area (m^2).

Plant height and stem diameter: the plant height (cm) and stem diameter (mm), which are the vegetative growth characteristics of the plants, were measured during the study and the average values are given.

The fruit's dry matter content: for the analysis, 1/3 of the collected fruits were cut and weighed and their dry weights were measured until they were air-dried in the oven (when the change in dry weights was less than 0.05 g) and expressed as %.

The water-soluble dry matter content: after the juice obtained from the fruits that were harvested from each plot of the experiment was filtered through filter paper, 3–5 drops of juice samples were read in a refractometer (ATAGO, ATC-1) to determine the amount of water-soluble dry matter (%) [26].

The EC and pH of the juice: the EC (dS m^{-1}) and pH of the juice obtained from each replicate according to the treatments were determined with the help of a measuring device (Mettler Toledo MP220 model device).

The titratable acid content: a total of 5 mL of the juice in which the water-soluble dry matter was measured was titrated with 0.1 N NaOH using a pH meter and the values were calculated in mval per 100 mL [26].

Vitamin C: A total of 25 g of pepper fruit sample and 100 mL of oxalic acid were used for the analysis. The water-soluble dry matter was measured by adding 9 mL of 1% oxalic acid as a stabilizing agent to 1 mL of the fruit juice; then, 1 mL of this sample was colored by adding 9 mL of 0.0012% 2–6 dichlorophenyllindephenol dye and the absorbance values at a 518 nm wavelength were read in a spectrophotometer (VARIAN, CARY, 100 Bio). Standard curves were prepared by measuring the same readings from the standard ascorbic acid solutions and standard solutions prepared with a stabilized substance. The absorbance values read in the samples were converted to vitamin C amounts with the help of the standard curve and the results were given in mg per 100 g of the fruit sample.

In this study, the water budget method was used to determine the plants' actual water consumption [27–29]. Equation (1) was used for this:

$$I + R - (D + ET) = \pm \Delta S \quad (1)$$

In this equation, the following abbreviations are used:
I: the amount of irrigation water (mm);
R: effective rainfall (mm);
D: drainage (mm);
ET: evapotranspiration (mm);
ΔS: ambient humidity change (mm).

In greenhouse conditions, R = 0 (since there is no precipitation in the greenhouse) and the amount of evaporation from the top surface of the pot was ignored. In addition, since the volume of medium per plant was as small as 8 L, it was assumed that no nutrient solution was stored in the pot and the humidity change in the medium was assumed to be constant (zero), in which case, the following Equation can be used:

$$ET = I - D \quad (2)$$

In this equation, the following abbreviations are used:
ET: plant water consumption (liters $plant^{-1}$);
I: the amount of irrigation water (liter $plant^{-1}$);
D: drainage (liter $plant^{-1}$).

The amounts of nutrient solution applied to and drained from the experimental treatments were read from the relevant meters and the plants' actual water consumption for all treatments was calculated as liters $plant^{-1}$ per day with the help of Equation (2).

Water use efficiencies were determined using the amount of irrigation water that was applied and the plant water consumption for the total yield. Equations (3) and (4) were used in these calculations [6].

$$WUE_I = (\text{Total yield/amount of irrigation water})\ (kg\ m^{-3} = g\ L^{-1}) \quad (3)$$

$$WUE_{ET} = (\text{Total yield/plant water consumption})\ (kg\ m^{-3} = g\ L^{-1}) \quad (4)$$

The change in yield against the applied salt levels was determined with the help of Equation (5) [30,31].

$$Y = 100 - b\ (ECe - a) \quad (5)$$

In this equation, the following abbreviations are used:

Y: proportional yield reduction (%);

a: the salt threshold value (dS m^{-1}) or maximum salt content in the root zone at a 100% yield;

b: the slope of the line (yield reduction corresponding to a unit of salt increase);

ECe: average root zone's medium salinity (dS m^{-1}).

The measurement and analysis results for the fruit quality parameters in each production period were evaluated with the SPSS statistical analysis package program. Duncan's test was performed in the SPSS statistical program for the comparisons between salinity treatments and leaching ratios and fruit quality characteristics. The results obtained are presented in tables. The adopted experimental design was a randomized split-plot design with three replications. The data were evaluated using the SPSS statistical analysis program and Duncan's test was applied to determine significant differences ($p < 0.05$). SPSS is a useful statistical program for researchers and academics and is compatible with Windows, Mac and Linux. This program is used in many different fields such as survey and market research, academic research, quality improvement, planning and forecasting, human resources and resource utilization, report writing and decision making.

The effects of the salinity and leaching treatments on the ET and yield values obtained at the end of the four production periods were evaluated with Duncan's test in the SPSS statistical program and are presented in tables in the results section. A regression analysis was also performed to determine the relationship between yield and salinity. The results of the regression analysis are also presented in the form of graphs.

3. Results and Discussion

3.1. Meteorological Measurements inside the Greenhouse

During the experiment, a climate station was used to measure some of the meteorological data in the greenhouse, depending on the indoor climate.

In production period I, the highest temperatures were 44.90 and 40.30 °C in the 1st and 2nd weeks of the development period and the lowest temperature was 4.20 °C in the 14th week of the development period. In production period III, the highest temperatures were 38.30 and 40.10 °C in the 1st and 3rd weeks of the development period and the lowest temperature was 3.30 °C in the 14th week of the development period. In production period II, the highest temperatures were 46.10 and 50.00 °C in the 10th and 12th weeks of the growth period and the lowest temperature was 5.90 °C in the 2nd week after planting. In production period IV, the highest temperatures were 46.10 and 50.00 °C in the 10th and 12th weeks of the growth period and the lowest temperature was 11.08 °C in the 2nd week after planting.

In terms of the weekly average values in production period I, the highest relative humidity value was 96.00% in the 10th week of the development period and the lowest relative humidity value was 16.40% in the 1st week. In the 8th week of production period III, the highest relative humidity value was 92.70% and the lowest relative humidity value was 27.80% in the 2nd week. In terms of the weekly average values in production period II, the highest relative humidity value was 93.00% in the 8th week of the development period and the lowest relative humidity value was 19.10% in the 2nd week, while the highest relative humidity value was 93.20% in the 9th week of production period IV and the lowest relative humidity value was 22.20% in the 11th week.

When the weekly average solar radiations measured in the greenhouse during the first and third production periods were examined, it was observed that these production periods coincided with the fall and the following winter months and decreases were observed in the weeks constituting the second half of these periods. In terms of the weekly average values, the highest average solar radiation was measured in the 4th and 8th weeks and the lowest values were measured in the 14th week in production periods I and III.

In production periods II and IV, the weekly average solar radiations measured in the greenhouse reached their highest values in the 13th week after planting. Since these production periods coincided with spring and the following summer months, an increase was observed in the weeks after planting. The lowest values were measured in the 5th week in production period II and in the 2nd week in production period IV [13].

In some studies conducted with different plants in soilless greenhouse conditions, it was reported that the plant water consumption varied depending on the length of the growing period and climatic conditions in the greenhouse [32–35]. It was determined that the obtained plant water consumption results were similar to previous studies when accounting for the climatic characteristics in the greenhouse.

3.2. Plant–Water Relationships

3.2.1. Evapotranspiration (ET) and Yield Values

The measurements of the ET and yield parameters in each production period were evaluated using the SPSS statistical analysis package program. Duncan's test was performed in the SPSS statistical program for the comparisons between salinity treatments (S) and leaching ratios (LR) and ET and yield parameters. The obtained results are presented in tables (Tables 2 and 3). Duncan's test was applied to determine significant differences ($p < 0.05$).

Table 2. Production periods I, II, III and IV (a, b, ab are statistical groups).

Treatment		ET (Liters Per Plant)			
		Production Period I	**Production Period II**	**Production Period III**	**Production Period IV**
LR	LR_1	20.38	48.85	26.99	33.36
	LR_2	23.62	61.76	33.46	39.46
S	S_1	25.78 a	68.53 a	31.78 a	36.80 ab
	S_2	22.66 a	54.50 ab	27.80 a	34.54 b
	S_3	19.18 a	50.48 ab	31.44 a	35.50 b
	S_4	20.37 a	47.71 b	29.89 a	38.80 a
			*		*

* Statistically significant at $p < 0.05$ level.

Table 3. Production periods I, II, III and IV (a, b, ab, c are statistical groups).

Treatment		Yield (kg)			
		Production Period I	**Production Period II**	**Production Period III**	**Production Period IV**
LR	LR_1	8.75	12.11	6.70	6.38
	LR_2	9.50	11.75	7.48	8.11
S	S_1	12.11 a	14.56 a	8.26 a	8.22 a
	S_2	10.34 a	13.16 ab	7.21 b	7.98 a
	S_3	7.60 a	10.75 ab	7.08 b	6.52 b
	S_4	6.46 a	9.24 b	5.81 c	6.27 b
			*	*	*

* Statistically significant at $p < 0.05$ level.

When Table 2 was analyzed, the effect of LR and S treatments on the ET values in the first period were found to be statistically insignificant ($p > 0.05$). In the second period, the effect of LR treatments on the ET values were found to be statistically insignificant ($p > 0.05$). While the highest ET value was obtained following the S_1 treatment, the lowest ET value was obtained following the S_4 treatment. The S_2 and S_3 treatments were in the same group ($p < 0.05$). The effect of LR and S treatments on the ET values in the third period were found to be statistically insignificant ($p > 0.05$). In period IV, the effects of LR treatments on the ET values were found to be statistically insignificant ($p > 0.05$). The S_4 and S_1 treatments provided the best results and the S_2 and S_3 treatments provided the lowest values statistically ($p < 0.05$).

When Table 3 was analyzed, the effect of the LR treatments on the yield values in all periods were found to be statistically insignificant ($p > 0.05$). The effect of the S treatments on the yield values in the first period were found to be statistically insignificant ($p > 0.05$). In the second period, the highest yield value was obtained following the S_1 treatment, while the lowest value was achieved following the S_4 treatment. The S_2 and S_3 treatments were in the same group ($p < 0.05$). In the third period, the highest yield value was obtained following the S_1 treatment, while the lowest value was achieved following the S_4 treatment. The S_2 and S_3 treatments were in the same group ($p < 0.05$). In the fourth period, the highest yield values were obtained following the S_1 and S_2 treatments, while the lowest values were obtained following the S_3 and S_4 treatments ($p < 0.05$).

In general, the total ET was lower in subjects that were irrigated with nutrient solutions with higher electrical conductivities in all four production periods. In order to keep the leaching ratios within the desired limits due to the effect of salinity on ET, less nutrient solution was applied to the subjects that were irrigated with nutrient solutions with higher electrical conductivities. It has been reported that increasing the salinity decreases the ET [36], which is related to an increased osmotic pressure in the root zone [37,38]. The present study is consistent with other studies in terms of the decrease in ET with increasing salinity.

It was determined that the EC values varied depending on the meteorological factors in the greenhouse, the plant growth periods and the length of the production period in which the plants were grown. In a study conducted under soilless conditions, it was found that climatic conditions did not affect the pH of the nutrient solution, while the EC levels of the nutrient solution were related to the air temperature, relative humidity and solar radiation and that an increasing light intensity and air temperature tended to increase the ET, while an increasing relative humidity had a decreasing effect on the water and nutrient uptake [39]. Meric [40] reported that ET increased during periods when the solar radiation and vapor pressure deficit in the greenhouse were higher, while the ET decreased during periods when these values were lower.

It was determined that the yield decreased as the salinity of the irrigation water increased in all four production periods; the lowest yield values were obtained from the subjects with the highest salinity. In other similar studies, it was reported that the yield of pepper decreased at the end of the production period and the number of fruits and average fruit weight decreased with increasing irrigation water salinity [41].

A regression analysis was also performed to determine the relationship between the yield and salinity. The results of the regression analysis are also presented in the form of graphs.

According to the linear equation (Figures 2 and 3) obtained in order to estimate the yield decrease that was caused by the increase in salinity levels in the first production period, a 1 dS m^{-1} increase in the EC values of the nutrient solution applied to the treatments caused an average 12.21% decrease in yield, while a 1 dS m^{-1} increase in the EC values of the drainage solution caused an average 8.05% decrease in yield.

When the proportional decreases in yield in response to the increase in the EC levels of the nutrient and drainage solutions in the LR_1 application were examined, the salt threshold value at which the yield started to decrease compared to the nutrient solution applied to the leaching treatments was 2.98 dS m^{-1} and there was an average 8.12% decrease in yield for each unit of salt increase in the nutrient solution. At EC levels above 4.05 dS m^{-1} of the drainage solution, the yield started to decrease and it was determined that there was an average yield loss of 5.74% with each unit of salt increase.

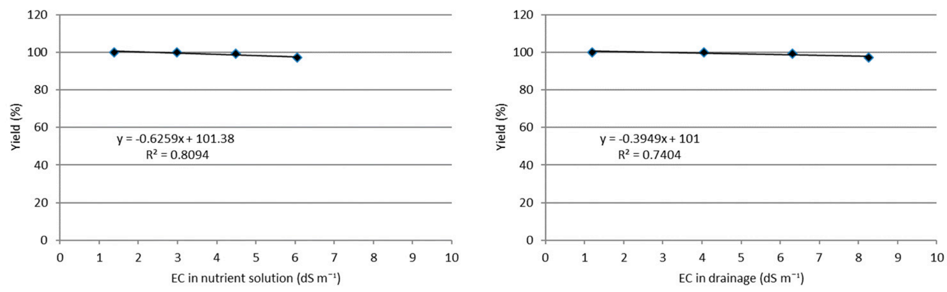

Figure 2. Proportional yield decrease against increase in EC of nutrient and drainage solutions in LR_1 treatment.

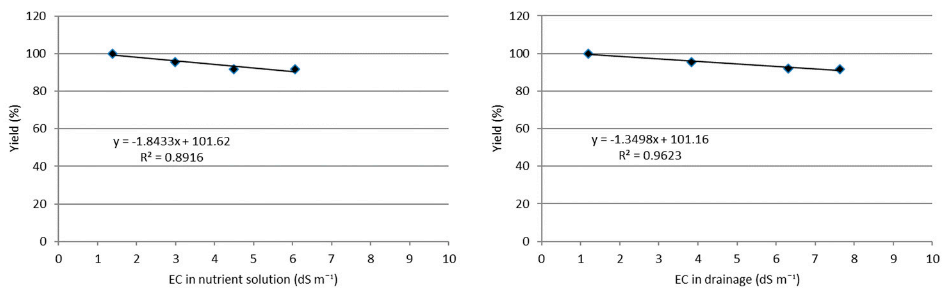

Figure 3. Proportional yield decrease against increase in EC of nutrient and drainage solutions in LR_2 treatment.

When the proportional decreases in yield that occurred in response to the increase in the EC levels of the nutrient and drainage solutions in the LR_2 application were examined, the salt threshold value at which the yield started to decrease compared to the nutrient solution applied to the leaching treatments was 1.38 dS m^{-1} and there was an on-average 16.31% decrease in yield for each unit of salt increase in the nutrient solution. At EC levels above 1.19 dS m^{-1} of the drainage solution, the yield started to decrease and it was determined that there was an average yield loss of 10.37% with each unit of salt increase.

According to the linear equation (Figures 4 and 5), which was developed to estimate the yield reduction in response to the increase in the salinity level in the second production period, it was determined that the yield reductions of the treatments were 10.29% for a unit increase in the nutrient solution's salinity and 6.92% for a unit increase in the drainage solution's electrical conductivity.

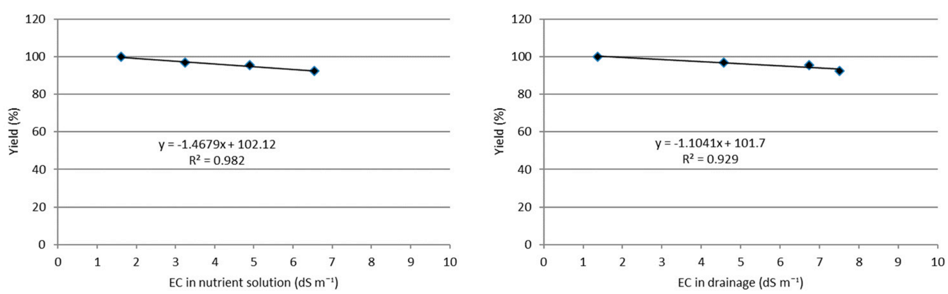

Figure 4. Proportional yield decrease against increase in EC of nutrient and drainage solutions in LR_1 treatment.

When the proportional decreases in yield that occurred in response to the increase in the EC levels of the nutrient and drainage solutions in the LR_1 application were examined, the salt threshold value at which the yield started to decrease compared to the nutrient solution that was applied to the washing subjects was 1.61 dS m^{-1} and there was an average 10.27% decrease in yield for each unit of salt increase in the nutrient solution. At

EC levels above 1.37 dS m^{-1} of the drainage solution, the yield started to decrease and it was determined that there was an average yield loss of 6.49% with each unit of salt increase.

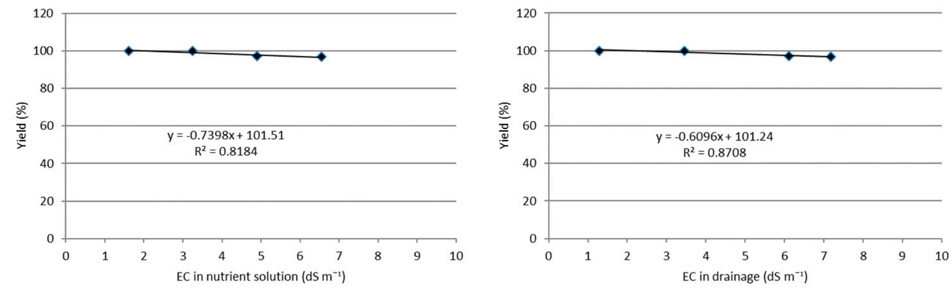

Figure 5. Proportional yield decrease against increase in EC of nutrient and drainage solutions in LR_2 treatment.

When the proportional decreases in yield that occurred in response to the increase in the EC levels of the nutrient and drainage solutions in the LR_2 application were examined, the salt threshold value at which the yield started to decrease compared to the nutrient solution that was applied to the leaching treatments was 3.25 dS m^{-1} and there was an average 10.32% decrease in yield for each unit of salt increase in the nutrient solution. At EC levels above 3.46 dS m^{-1} of the drainage solution, the yield started to decrease and it was determined that there was an average 7.35% loss in yield with each unit of salt increase.

According to the linear equation (Figures 6 and 7) obtained in order to predict the yield decrease in the third production period, a 1 dS m^{-1} increase in the EC values of the nutrient solution that was applied to the treatments caused an average 9.05% decrease in yield, while a 1 dS m^{-1} increase in the EC values of the drainage solution caused an average 6.32% decrease in yield.

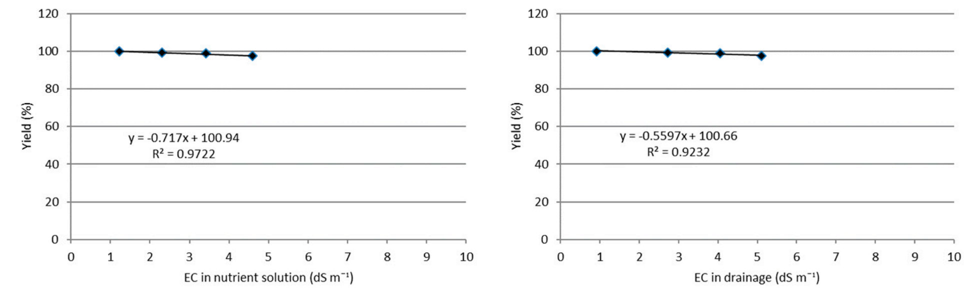

Figure 6. Proportional yield decrease against increase in EC of nutrient and drainage solutions in LR_1 treatment.

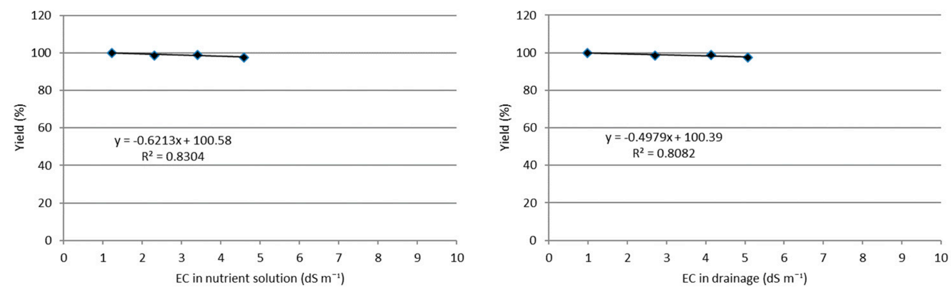

Figure 7. Proportional yield decrease against increase in EC of nutrient and drainage solutions in LR_2 treatment.

When the proportional decreases in yield that occurred in response to the increase in the EC levels of the nutrient and drainage solutions in the LR_1 application were examined, the salt threshold value at which the yield started to decrease compared to the nutrient solution that was applied to the leaching treatments was 1.23 dS m^{-1} and there was an average 8.59% decrease in yield for each unit of salt increase in the nutrient solution. At EC levels above 0.92 dS m^{-1} of the drainage solution, the yield started to decrease and it was determined that there was an average yield loss of 6.02% with each unit of salt increase.

When the proportional decreases in yield that occurred in response to the increase in the EC levels of the nutrient and drainage solutions in the LR_2 application were examined, the salt threshold value at which the yield started to decrease compared to the nutrient solution that was applied to the leaching treatments was 1.23 dS m^{-1} and there was an average decrease of 9.51% in yield for each unit of salt increase in the nutrient solution. At EC levels above 0.99 dS m^{-1} of the drainage solution, the yield started to decrease and it was determined that there was an average yield loss of 6.63% with each unit of salt increase.

According to the linear equation (Figures 8 and 9), developed to estimate the yield reduction in response to the increase in salinity levels in the fourth production period, it was determined that the yield reductions of the treatments were 7.72% for a unit increase in the nutrient solution's salinity and 4.37% for a unit increase in the drainage solution's electrical conductivity.

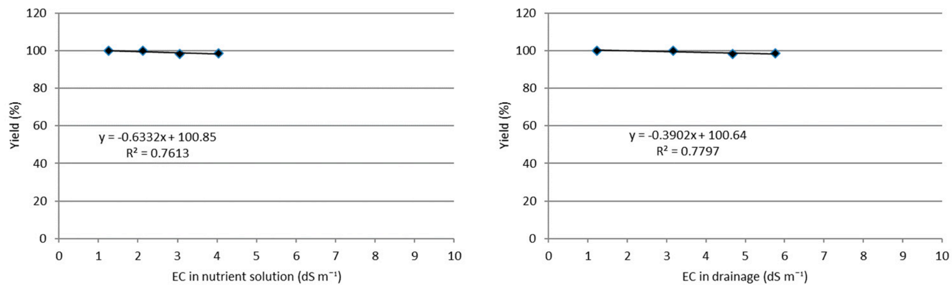

Figure 8. Proportional yield decrease against increase in EC of nutrient and drainage solutions in LR_1 treatment.

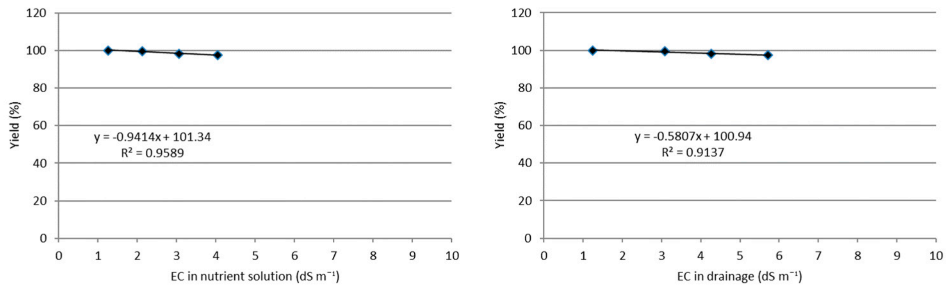

Figure 9. Proportional yield decrease against increase in EC of nutrient and drainage solutions in LR_2 treatment.

When the proportional decreases in yield that occurred in response to the increase in the EC levels of the nutrient and drainage solutions in the LR_1 application were examined, the salt threshold value at which the yield started to decrease compared to the nutrient solution that was applied to the leaching treatments was 1.26 dS m^{-1} and there was an average 7.33% decrease in yield for each unit of salt increase in the nutrient solution. At EC levels above 1.23 dS m^{-1} of the drainage solution, the yield started to decrease and it was determined that there was an average yield loss of 4.00% with each unit of salt increase.

When the proportional decreases in yield that occurred in response to the increase in the EC levels of the nutrient and drainage solutions in the LR_2 application were examined, the salt threshold value at which the yield started to decrease compared to the nutrient solution that was applied to the leaching treatments was 1.26 dS m^{-1} and there was an average 8.10% decrease in yield for each unit of salt increase in the nutrient solution. At EC levels above 1.24 dS m^{-1} of the drainage solution, the yield started to decrease and it was determined that there was an average yield loss of 4.73% with each unit of salt increase.

3.2.2. Water Use Efficiencies (WUEs)

The water use efficiencies were determined according to the amount of irrigation water applied (WUE_I) and nutrient solution consumed (WUE_{ET}) using the total weights of fruit (pepper) harvested in all four production periods. When the water use efficiencies were analyzed, it was determined that the WUE_I values ranged between 6.54 and 15.24 kg m^{-3} and the WUE_{ET} values ranged between 15.57 and 28.15 kg m^{-3} during the first production period. The WUE_I values ranged between 5.32 and 10.46 kg m^{-3} and the WUE_{ET} values ranged between 9.61 and 14.89 kg m^{-3} in production period II, 4.84–7.65 kg m^{-3} and 10.77–15.27 kg m^{-3} in production period III and 5.72–8.79 kg m^{-3} and 8.82–13.28 kg m^{-3} in production period IV. When the four production periods were compared, it was found that the highest WUE_I and WUE_{ET} values were achieved in production period I. The average WUE_I values for the S_1, S_2, S_3 and S_4 treatments were 13.38, 11.99, 9.16 and 7.55 kg m^{-3} in production period I; 8.62, 8.28, 7.37 and 5.82 kg m^{-3} in production period II; 7.36, 6.68, 6.36 and 4.97 kg m^{-3} in production period III; and 8.60, 8.57, 6.89 and 5.99 kg m^{-3} in production period IV. The average WUE_{ET} values obtained from the subjects in the four production periods were 25.79, 25.37, 21.97 and 17.92 kg m^{-3} (production period I); 12.06, 13.42, 12.27 and 11.08 kg m^{-3} (production period II); 14.52, 14.42, 12.83 and 10.81 kg m^{-3} (production period III); and 12.36, 12.80, 10.13 and 8.99 kg m^{-3} (production period IV) for the S_1, S_2, S_3 and S_4 subjects, respectively. Accordingly, the highest average water use efficiencies that were calculated for the amounts of irrigation water applied in all four production periods were those of the S_1 subjects, while the lowest values were those of the S_4 subjects. The highest average water use efficiency that was calculated according to the amount of nutrient solution consumed was that of the S_1 subjects in production periods I and III and of S_2 subjects in periods II and IV, and the lowest values were those of the S_4 subjects in all production periods. The highest WUE_I values for the leaching treatments were obtained from the LR_1 treatments in the first three production periods and from the LR_2 treatments in the last production period. In production periods I, II and III, the WUE_I values that were obtained following LR_1 treatment were 9.76%, 26.21% and 6.71% higher than the following LR_2 treatment, respectively, while in production period IV, the values obtained following LR_2 treatment were 2.37% higher than those following LR_1 treatment. Similarly, the WUE_{ET} in periods I, II and III was highest in LR_1 subjects, while in period IV, it was highest in LR_2 subjects. The highest WUE_{ET} values following LR_1 treatment in the first three production periods were 8.01%, 22.08% and 9.49% higher than those following LR_2 treatment, respectively, and the values obtained from the LR_2 treatment in the fourth period were 7.31% higher than those from the LR_1 treatment. Similarly, in other studies conducted on salinity, it was determined that the water use efficiency values calculated under saline irrigation water conditions were affected by the application subjects and the water use efficiency values decreased as the salinity increased [42].

3.3. Results on Yield, Vegetative Growth and Selected Fruit Quality Characteristics

The measurement and analysis results on the fruit quality parameters in each production period were evaluated using the SPSS statistical analysis package program. Duncan's test was performed in the SPSS statistical program for the comparisons between salinity treatments and leaching ratios and fruit quality characteristics. The results obtained are presented in tables. The data were evaluated using the SPSS statistical analysis program and Duncan's test was applied to determine significant differences ($p < 0.05$).

3.3.1. Yield

Fruit Weight

From Table 4, in which the statistical evaluation of the effect of the applied treatments on the fruit weight is presented, it can be seen that the effect of leaching treatments on the average fruit weight was not statistically significant in the first three production periods, while it was significant in production period IV. The difference between the salinity level treatments and their interactions with each other was significant for all four production periods with 95% confidence.

Table 4. Results for the effects of the applied treatments on the fruit weight in production periods I, II, III and IV (a, b, c, bc are statistical groups).

Treatment		Fruit Weight (g)			
		Production Period I	Production Period II	Production Period III	Production Period IV
LR	LR_1	22.90	17.48	20.18	11.11
	LR_2	23.93	20.10	18.79	12.76
					*
S	S_1	29.16 a	29.52 a	23.96 a	16.08 a
	S_2	22.98 b	18.86 b	21.60 a	12.11 b
	S_3	22.70 b	13.93 bc	19.09 a	10.55 bc
	S_4	18.80 c	12.82 c	13.27 b	8.99 c
		*	*	*	*

* Statistically significant at $p < 0.05$ level.

It was also determined that the fruit weights obtained in production period IV were lower than those in the other three periods. The reason for this may be the sudden changes in the meteorological values outside and inside the greenhouse (temperature and humidity changes) and the stress on the plant caused by the problems and irregularities in the irrigation scheduling.

In all production periods, fruit weights were generally higher following LR_2 treatment compared to LR_1 treatment. Accordingly, in the LR_2 leaching rate treatment, the fruit weights increased by 4.01% in production period I and 13.23% in production period II, decreased by 3.09% in production period III and increased by 14.10% in production period IV compared to the LR_1 leaching rate treatment.

In similar previous studies, it was reported that the yield would decrease with an increasing salinity and the effect of leaching rates on yield was statistically insignificant [43–45].

Number of Fruits per Unit of Area

When the statistical evaluation of the effect of treatments on the number of fruits per unit of area presented in Table 5 was analyzed, it was found that the effect of leaching treatments on the number of fruits per unit of area was not statistically significant in production periods I, II and IV, while it was significant in production period III. The difference between the salinity level treatments and their interactions with each other was significant with 95% confidence in production period I, while it was not statistically significant for the other three production periods.

In production periods I and IV, the highest numbers of fruits per unit of area were obtained from S_1, S_2 and S_3 subjects in the first three salinity treatments and in the same statistical group. The lowest numbers of fruits were found in production period I and production period IV in S_4, where the salt concentration had the highest value. In production periods II and III, the numbers of fruits were in the same statistical group in all of the salinity treatments.

In all production periods, fruit numbers were generally higher following LR_2 treatment compared to LR_1 treatment. Accordingly, following the LR_2 leaching rate treatment, the number of fruits increased by 7.05% in production period I, decreased by 0.33% in production period II, increased by 17.17% in production period III and increased by 29.95% in production period IV. The number of fruits obtained in production period I was lower than those in the other periods. The reason for this may be that the weather inside and outside the greenhouse was colder than in the other periods (this period coincided with the fall months) and, since it was the first production period, we were expected to wait for suitable yield sizes for fruit harvests. In addition, in the middle of this production period, a small accident occurred during the cleaning of the greenhouse cover, which caused damage to the plants in the S_1 and S_3 subjects in the third replicates and reduced the number of harvested fruits. According to the results obtained in other studies, similar to this study, it was reported that salinity significantly decreased the yield of pepper plants; with increasing irrigation water salinity, the pepper plant yield, fruit number and average fruit weight decreased [41].

Table 5. Results on the effects of the applied treatments on the number of fruits per unit of area in production periods I, II, III and IV (a, b are statistical groups).

Treatment		Number of Fruits (pcs m^{-2})			
		Production Period I	**Production Period II**	**Production Period III**	**Production Period IV**
LR	LR_1	35.07	88.33	64.72	82.64
	LR_2	37.29	84.86	75.56	107.64
				*	
S	S_1	42.36 a	94.72	74.44	72.77 a
	S_2	37.63 a	95.27	67.63	99.58 a
	S_3	36.39 a	85.27	71.38	97.22 a
	S_4	28.33 b	71.11	67.08	110.98 b
		*			

* Statistically significant at $p < 0.05$ level.

3.3.2. Vegetative Development

Plant Height

When Table 6, which presents the statistical evaluation of the effect of the treatments on the average plant height during the production periods, was analyzed, the effect of the leaching treatments on the average plant height was not found to be statistically significant in any production period. The differences between the salinity level treatments and their interactions were not statistically significant in any of the four production periods.

Table 6. Results on the effects of the applied treatments on plant height in production periods I, II, III and IV.

Treatment		Plant Height (cm)			
		Production Period I	**Production Period II**	**Production Period III**	**Production Period IV**
LR	LR_1	95.62	94.00	77.75	95.25
	LR_2	102.67	102.17	81.17	107.42
	n.s.				
S	S_1	82.68	57.81	63.64	56.12
	S_2	78.37	54.39	63.24	58.95
	S_3	79.37	55.50	57.07	57.83
	S_4	70.14	53.96	63.07	57.09
	n.s.				

n.s.: Not statistically significant.

Plant Stem Diameter

When Table 7, which presents the statistical evaluation of the effect of the applied treatments on the average plant stem diameters during the production periods, was analyzed, the effect of the leaching treatments on the average plant stem diameters was not found to be statistically significant in any of the production periods. The difference between the salinity level treatments and their interactions with each other was found to be significant with 95% confidence in production periods I and II, but it was not statistically significant in production periods III and IV.

Table 7. Results on the effects of the applied treatments on plant stem diameter in production periods I, II, III and IV (a, b, ab are statistical groups).

Treatment		Plant Stem Diameter (mm)			
		Production Period I	Production Period II	Production Period III	Production Period IV
LR	LR_1	12.30	12.12	10.39	9.95
	LR_2	12.76	12.30	10.24	10.31
	n.s.				
S	S_1	9.91 a	8.85 a	8.39	6.99
	S_2	9.44 a	8.52 a	8.23	7.15
	S_3	9.82 a	8.40 ab	7.89	7.09
	S_4	8.87 b	7.94 b	7.70	7.15
		*	*		

* Statistically significant at $p < 0.05$ level. n.s.: Not statistically significant.

It is reported that, for the normal development of plants, there should be a constant presence of water in the growing substrate at a level that does not prevent their development and with a decrease in water in the root zone, the water use of plants decreases. It has been reported that salinity is one of the conditions that prevent the plant from easily taking in water in the root zone environment and with an increase in the salt concentration in the root zone solution, the amount of energy that the plant has to spend to take in this water increases; as a result, the water use of the plant decreases with the increase in salinity. The difficulty in water utilization and the decrease in the water utilization of the plant has a decreasing effect on the plant yield and quality [36].

In plants under salt stress, there is a significant decrease in the ability of the roots to absorb water, resulting in a decline in activities such as root development and stem elongation. The stem diameters of stressed plants decrease and their heights remain smaller than the control. The leaf area, flowering and fruit yield during the transition to the generative stage are negatively affected. These consequences of salt stress are long-term problems. There is also a significant decrease in the dry matter and wet weight of the shoots and roots of stressed plants [46]. The results obtained in this study are similar to previous studies in this respect.

Chartzoulakis and Klapaki [24] examined the salt tolerance of two pepper cultivars in soilless culture and reported that the fruit yield decreased by 95% from 10 mM to 150 mM. Navarro et al. [47] reported in their study that there was a linear relationship between the pepper yield and salt concentration in peppers irrigated with irrigation water at 15 and 30 mM salt levels; thus, the total yield of peppers decreased. It was reported that the pepper yield, plant height, water consumption and fruit size decreased significantly with increasing the irrigation water's salinity [48]. In terms of these characteristics, this study is in accordance with the results of other studies.

3.3.3. Selected Fruit Quality Characteristics

Fruit's Dry Matter Content

When Table 8, which presents the statistical evaluation of the effect of the treatments on the fruit's dry matter content during the production periods, was analyzed, the effect of the leaching treatments on the fruit's dry matter content was found to be statistically significant in production periods I and IV, but not in production periods II and III. The difference between the salinity level treatments and their interactions with each other was found to be significant with 95% confidence in all production periods.

Table 8. Results on the effects of the applied treatments on the fruit's dry matter content in production periods I, II, III and IV (a, b, ab, c, d are statistical groups).

Treatment		Fruit's Dry Matter Content (%)			
		Production Period I	**Production Period II**	**Production Period III**	**Production Period IV**
LR	LR_1	6.83	9.81	7.14	9.68
	LR_2	5.97	8.70	7.10	8.58
		*			*
S	S_1	5.29 a	7.30 a	5.83 a	7.02 a
	S_2	5.84 a	9.08 ab	6.41 a	8.17 b
	S_3	6.73 b	10.38 b	7.62 b	9.84 c
	S_4	7.72 c	10.24 b	8.60 c	11.47 d
		*	*	*	*

* Statistically significant at $p < 0.05$ level.

Amount of Water-Soluble Dry Matter

When Table 9, which presents the statistical evaluation of the effect of the treatments on the amounts of water-soluble dry matter during the production periods, was analyzed, the effect of the leaching treatments on the amounts of water-soluble dry matter in all production periods was not found to be statistically significant. The difference between the salinity level treatments and their interactions with each other was found to be significant with 95% confidence in all four production periods. This is similar to other studies [42].

Table 9. Results on the effects of the applied treatments on the amount of water-soluble dry matter in production periods I, II, III and IV (a, b, c, d, ab are statistical groups).

Treatment		Amount of Water-Soluble Dry Matter (%)			
		Production Period I	**Production Period II**	**Production Period III**	**Production Period IV**
LR	LR_1	5.18	4.87	6.45	6.81
	LR_2	5.08	4.28	6.44	6.60
	n.s.				
S	S_1	4.50 a	4.60 ab	5.91 a	5.91 a
	S_2	4.83 a	4.26 a	6.21 b	6.23 a
	S_3	5.31 b	3.89 a	6.68 c	7.08 b
	S_4	5.86 c	5.55 b	6.96 d	7.56 b
		*	*	*	*

* Statistically significant at $p < 0.05$ level. n.s.: Not statistically significant.

EC Value of Fruit Juice

In Table 10, where the statistical evaluation of the effect of the applied treatments on the juice's EC values during the production periods is presented, the effect of the leaching treatments on the juice's EC values was not found to be statistically significant in any of the production periods. The difference between the salinity level treatments and their interactions with each other was found to be significant with 95% confidence in all production periods.

Table 10. Results for the effects of the applied treatments on the EC value of fruit juice in production periods I, II, III and IV (a, b, c, d are statistical groups).

Treatment		EC (dS m^{-1})			
		Production Period I	**Production Period II**	**Production Period III**	**Production Period IV**
LR	LR_1	5.63	6.23	5.90	6.52
	LR_2	5.47	6.22	5.91	6.48
	n.s.				
S	S_1	4.98 a	5.20 a	5.51 a	5.70 a
	S_2	5.42 b	5.98 b	5.68 a	6.21 a
	S_3	5.70 c	6.82 c	6.01 b	7.05 b
	S_4	6.08 d	6.87 c	6.39 c	7.02 b
		*	*	*	*

* Statistically significant at $p < 0.05$ level. n.s.: Not statistically significant.

The pH Value of the Juice

In Table 11, where the statistical evaluation of the effect of the treatments on the juice's pH values during the production periods is presented, the effect of the leaching treatments on the juice's pH values was not statistically significant in the first, third and fourth production periods, while it was significant in the second production period. The difference between the salinity level treatments and their interactions with each other was found to be significant with 95% confidence in the first three production periods and insignificant in the last production period.

Table 11. Results for the effects of the applied treatments on the pH value of the fruit juice in production periods I, II, III and IV (a, b are statistical groups).

Treatment		pH Value			
		Production Period I	**Production Period II**	**Production Period III**	**Production Period IV**
LR	LR_1	5.90	5.70	6.29	5.98
	LR_2	5.84	5.78	6.32	6.04
			*		
S	S_1	5.83	5.66	6.31	6.20 a
	S_2	5.83	5.72	6.31	5.94 b
	S_3	5.89	5.77	6.34	5.97 b
	S_4	5.89	5.78	6.25	5.90 b
					*

* Statistically significant at $p < 0.05$ level.

Amount of Titratable Acid

When Table 12, in which the statistical evaluation of the effect of the treatments on the titratable acid content during the production periods, is analyzed, it can be seen that the effect of the leaching treatments on the titratable acid content was statistically significant in production periods I and II, while it was insignificant in production periods III and IV. The difference between the salinity level treatments and their interactions with each other was found to be significant with 95% confidence in all production periods.

Table 12. Results on the effects of the applied treatments on the titratable acid content in production periods I, II, III and IV (a, b, ab, bc, c are statistical groups).

Treatment		Amount of Titratable Acid (Mval 100 mL^{-1})			
		Production Period I	**Production Period II**	**Production Period III**	**Production Period IV**
LR	LR_1	1.54	2.54	1.16	0.73
	LR_2	1.44	2.28	1.21	0.68
		*	*		
S	S_1	1.37 a	2.14 a	1.09 a	0.60 a
	S_2	1.39 a	2.30 ab	1.11 a	0.67 ab
	S_3	1.55 b	2.51 bc	1.18 ab	0.74 bc
	S_4	1.61 b	2.65 c	1.35 b	0.78 c
		*	*	*	*

* Statistically significant at $p < 0.05$ level.

Vitamin C

When Table 13, which presents the statistical evaluation of the effect of the applied treatments on the vitamin C values of the fruit juice samples taken at the end of the production periods, was analyzed, the effect of the leaching treatments on the vitamin C values in all production periods was not found to be statistically significant. The difference between the salinity level treatments and their interactions with each other was found to be significant with 95% confidence in production periods I, II and III, but it was not statistically significant in production period IV.

Table 13. Results for the effects of the applied treatments on the vitamin C value in production periods I, II, III and IV (a, b, ab are statistical groups).

Treatment		Vitamin C (mg 100 g^{-1})			
		Production Period I	**Production Period II**	**Production Period III**	**Production Period IV**
LR	LR_1	91.52	144.20	103.73	77.50
	LR_2	84.68	127.36	95.03	60.77
	n.s.				
S	S_1	78.56 a	112.92 a	92.94 a	67.46
	S_2	122.12 b	131.44 ab	83.78 a	69.93
	S_3	122.16 b	148.44 b	112.45 b	64.26
	S_4	86.92 a	150.12 b	108.35 b	74.86
		*	*	*	

* Statistically significant at $p < 0.05$ level. n.s.: Not statistically significant.

The effects of salinity on salt tolerance parameters such as the vitamin C content in the fruit or the total leaf chlorophyll content vary among plant species. In general, increasing salt levels decrease the total leaf chlorophyll content of pepper plants. In plants that have antioxidative defense systems against toxic oxygen derivatives formed under stress conditions, the amount of vitamin C, which is one of the leading antioxidants, is expected to increase. In the literature, the average vitamin C content of sweet pepper fruit is reported to be 120–128 mg 100 g^{-1} [49]. In this study, as stated in the literature, an increase in the vitamin C content, which is one of the most important antioxidants in the antioxidative defense system, was observed under salt stress conditions. This increase can be explained by the plant's attempt to resist salt stress at high EC levels [49].

In cultivated plants, as the salinity of the medium increases, the amount of product obtained decreases according to the resistance level of the plant [50]. When the effects of the salinity and amount of irrigation water on the yield and mineral matter content were investigated, both these factors had effects on the plant yield, while only salinity had an effect on the dry matter and total ash values. There was a significant decrease in yield starting from 6 dS m^{-1} and an increase in the amount of irrigation water decreased the yield. An increasing salinity caused a decrease in the plants' dry matter content and increased their total ash content [22]. Irrigation water salinity decreased the yield and quality of almost all of the studied plants. Considering that our water resources have become more saline due to different temporal factors, we are obliged to use lower-quality water in the future in order to provide the required yield increase and production value [13,36].

When the results obtained in the four production periods of this study were evaluated, it was found that the yield decreased with increasing salt applications in pepper cultivation under the conditions within the scope of the experiment. The highest yield values were obtained from the subjects with the lowest salt concentrations and the lowest yield values were obtained from the subjects with high salt concentrations. When the percentages of decreases in yield with increasing salinity levels and the threshold values at which the yield started to decrease were evaluated in terms of the salinity levels of the applied nutrient solution and the obtained salinity levels of the drainage solution, it can be said that pepper is a plant that is moderately sensitive to salinity [51,52]. In addition, the "Super Amazon F1" pepper variety was chosen as the plant material in this study because it is a hybrid pointed pepper variety that is suitable as a single greenhouse crop and for early spring planting; it also exhibits early and strong plant development and it produces a higher yield than other varieties in cold weather. It is also reported to be resistant to diseases and root rot [25].

There was no statistically significant difference between the yield values of the two different leaching rates that were applied in the four production periods. While the effect of the leaching treatments on the average fruit weight was not statistically significant in the first three production periods, it was significant in the fourth production period. The difference between the salinity level treatments and their interactions between the subjects was significant for all four production periods with 95% confidence.

4. Conclusions

This research presents findings related to the determination of the response of pepper (*Capsicum annuum* L.) plants grown in soilless cultivation under greenhouse conditions to different salinity levels of a nutrient solution that was applied with irrigation water. According to the results, there was no significant difference between the leaching fractions with respect to yield in all four growing seasons, but the yield generally decreased with an increase in salinity. With the effect of increasing the irrigation water salinity, the fruits' quality characteristics also showed significant changes between applications (Tables 8–13).

As a result of the evaluation of the data obtained regarding the amount of irrigation water, we aimed to contribute to the need for information on plants' water consumption and salinity in pepper cultivation. It is not possible for the findings from this study to answer all questions and problems. However, it is our thought that this study will set an example for future studies.

There is a need for further studies in which different growing media or substrates and different irrigation programs are used. It is also important to conduct other studies in which different nutrient solutions are prepared or applied together with irrigation water. These factors must be considered together under saline conditions, taking into account the climatic conditions in the greenhouse.

Author Contributions: Conceptualization, H.G.; methodology, H.G.; software, H.G.; validation, H.G. and M.A.U.; formal analysis, H.G.; investigation, H.G.; resources, H.G.; data curation, H.G.; writing—original draft preparation, H.G.; writing—review and editing, H.G.; visualization, H.G. and M.A.U.; supervision, H.G.; project administration, M.A.U. All authors have read and agreed to the published version of the manuscript.

Funding: This research was supported by Ege University Faculty of Agriculture Scientific Research Projects Support Committee (Project No: 2010-ZRF-023, PhD Thesis Project).

Institutional Review Board Statement: Not applicable.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Conflicts of Interest: The authors declare no conflicts of interest.

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