Influence of Irrigation Water Acidity, Chemical Fertilizer and Propagation Method on the Contents of Nutrient Elements of Strawberry (*Fragaria x ananassa* Duch.) cv. Festival

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Abstract

The experiment was conducted to study the effect of the reproduction method and acidity of irrigation water and chemical fertilization plus their interactions on the strawberry fruit of the cv. Festival indicators. The percentage of total soluble solids, total acidity, total sugars, ascorbic acid content, and nitrate content were estimated. Results showed the superiority of the method of propagation using the plant tissue culture technique. The ascorbic acid content was 32.73 mg.100 g^{-1} fresh mass for the method of propagation by runners. Also, the water treatment with pH 5.5 was superior for the total sugars content in fruits 6.72% and the content of ascorbic acid 32.71 to 73 mg.100 g^{-1} fresh mass compared to the control treatment. As for the triple interaction, the method of propagation with runners and pH water 5.5 and the fertilizer recommendation of macro-elements outperformed in the percentage of T.S.S and carbohydrate content in the strawberry fruits reached 11.70% and 10.41%, respectively, but the total acidity decreased to 2.37 mg.g^{-1} for the same combination. In contrast, the highest content of ascorbic acid in fruits 44.81 mg.100 g $^{-1}$ of fresh mass was recorded by using the propagation method of tissue culture technique. Moreover, the lowest nitrate content was 11.19 mg. 100g^{-1} dry mass when using the propagation method of runners and pH of irrigation water at 6.5 plus the fertilizer recommendation of macro-elements.

Keywords: Strawberry, irrigation water**,** fertilization, T.S.S., carbohydrate, ascorbic acid.

Introduction

Planted strawberry or garden strawberry *Fragaria* × *ananassa* Duch belongs to the order Rosales, Rosaceae family, and to the genus Fragaria, which includes multiple species of up to 45 species. Strawberry is a hybrid between strawberry Virginia and Chilean strawberry (14), and the cultivated strawberry is a small beautiful perennial herbaceous plant whose flowers are mostly hermaphrodite and sometimes only feminine (10). Strawberry fruits are important for their nutritional value and distinct flavor, and they are rich in mineral elements such as calcium, silicon, iron, copper, zinc, and phosphorous (19).

The acidity range of soil (6.5 - 5.3) is considered appropriate to obtain the highest production of strawberries (4: 1: 5) and consequently, the soil pH has a direct and indirect role in the availability of nutrients (7), which in turn affect the availability of ions in the soil solution. Therefore, pH is one of the most significant factors affecting the availability and absorption of elements from the soil solution or plant growth medium (20).

Citric acid is a weak organic acid that is highly soluble in water, easily soluble in alcohol, and has a very acidic taste. It is produced by animals and plants to generate energy through the oxidation of fats, proteins, and carbohydrates. Citric acid plays a crucial role in biochemistry due to its contribution to the chain of enzymatic reactions, including the Krebs cycle. Citrate ions are naturally found in the leaves and roots of plants, and it has a high ability to form chelating compounds with mineral elements (9).

Soil and rocks are one of the most important sources of major and minor nutrients. Usually, the microelements are found on clay surfaces, or they may be conjugated in composition with carbonate minerals, or they may be adsorbed or deposited on the surfaces of carbonate minerals (4). Soils differ in terms of their productive ability, due to the variation in their quality. Hence, soil productivity may be declined as a result of the excessive use or depletion of part of the soil nutrients. However, soil fertility can be restored and its production could be increased by adding fertilizers, then the best rate of plant growth and production can be obtained when the nutrients are available to the plant in the appropriate quantities (7, 23).

In this research, we attempt to connect three perspectives in terms of propagation method and acidity of irrigation water and chemical fertilization plus their interactions in order to enhance the dynamics of strawberry fruit indicators.

Materials and Methods

The experiment was conducted in the plastic house belonging to the Agricultural Research Department \ Najaf Research Department of the Ministry of Agriculture, Iraq for the period from June 2020 to June 2021, the soil of the plastic house was prepared by turning it and sterilizing it, then worked terraces by adding previously sterilized soil that was brought from the banks of a river The Euphrates, located in the Mashkhab area, was then mixed with decomposed animal fertilizers in an amount of 40 tons. ha^{-1}, six terraces were made along the length of the greenhouse with a width of 60 cm, and the distance between one terrace and another was 77 cm, leaving the same distance on both sides of the house, and they were sterilized by spraying the systemic fungicide and bacteria Kriptanol, according to the recommendation of the addition, at a

concentration of 3 ml. l^{-1}, then covered with plastic The blacks The experimental unit was determined with an area of 7500 cm^2 (125 x 60) cm^2, in which two planting lines pass, the distance between them is 25.98 cm, leaving a distance between the line and the edge of the terrace of 17 cm, and the distance between one seedling site and another is 30 cm (an equilateral triangle) with 6 seedlings for each experimental unit. The distance between the last plant in the experimental unit and the first plant of the next experimental unit was 50 cm in order not to overlap between the treatments.

Each terrace was divided into 30 experimental units, every 10 experimental units separated by 1 m to separate the sectors. A rubber tube was extended to each terrace in order to feed it with water of the reaction degree assigned to it, as the first terrace was irrigated with river water stored in a tank capacity of 1000 liters, and the second terrace was irrigated with water with a reaction degree pH = 6.5 stored in a plastic tank with a capacity of 1000 liters, and the third terrace was in the tube Connected to the 1000 liter plastic tank with reaction degree of 5.5. The degree of reaction of water stored in plastic tanks was reduced to the degree of reaction assigned to each terrace with citric acid, and the degree of reaction of stored water was measured before each irrigation process for seedlings and after filling the tank with water with a pH-meter.

The three water tanks were placed in the middle of the outer right side of the greenhouse, and the irrigation system was established for each tank separately.

The fertilizer was added using Iraqi urea CO $(NH_2)_2$ Urea (N 46%), diammonium phosphate $(NH_4)_2HPO_4$ (N 18%) and (23 P_2O_5%) and potassium sulfate (K_2SO_4) Potassium sulfate (50%). K_2O and (16% S), and micronutrient fertilizer containing Fe water soluble in water 7.5% Fe chelated by EDTA 7.6%, Manganese Mn water soluble in 3.5% Manganese Mn chelated by EDTA 3.5%, Boron B water soluble in 7.5%, water-soluble Zn, 0.7%, chelated Zn, 0.7%, EDTA, 0.7%, water-soluble copper, 0.28%, chelated copper, EDTA 0.28%, and molybdenum soluble 0.3%, produced by the Spanish company Tarazona.

Fertilization was carried out by adding the major elements with seven dates after planting the seedlings in the sites designated for them, starting from 9/23/2020 AD (three weeks after planting) and the next date was 10/23/20AD. Subsequent additions were given every month and from the same date until the last date. It was on 3/23/21, and the fertilizers were added separately, and the proportions of the elements in the addition varied according to the stage of growth and the plant's need for the elements (10).

stuied traits

1- Percentage of total soluble solids (T.S.S.) in fruits

Total soluble solids were measured according to the method used using the Abbe refractometer and the reading was taken after harvesting for a period not exceeding two hours to keep the percentage of total soluble substances unchanged due to the vital interactions of the fruits. Fifteen homogeneous ripe fruits from each experimental unit were cut into slices and placed in a blender Electricity for 2-3 minutes, then the juice was filtered with a cotton cloth, and the reading was taken to represent (T.S.S.) in the fruit juice

The following steps were taken when taking the readings

a. Clean the prism of the refractometer with ethanol and then water.

b. Adjust the reading before using the refractometer by measuring the refractive index of distilled water at a temperature of 20 ° C, as it should be 1.333.

c. The sample was placed between the prisms, taking into account that it does not contain suspended matter.

The eyepiece was used to mark the line between the bright and dark areas and then the grading was looked at and the reading was taken.

2 The percentage of total acidity in the fruits

The total acidity of the fruits was measured according to the method used before (18).

3 The percentage of total sugars in fruits

The percentage of sugars in the fruits was measured according to the method used before (15).

4 Ascorbic acid content in fruits

The ascorbic acid content of fruits was measured according to the method used by (1).

5 Determination of the nitrate content of fruits

The nitrate content of fruits was measured as stated by Cataldo et al. 1975).

Results

1- Percentage of total soluble solids in fruits (T.S.S.) %

The results of the statistical analysis presented in Table 1 indicate that there is no significant difference in the percentage of solid matter between the two methods in which the strawberry abound.

While the addition of citric acid to the irrigation water in order to reduce the degree of its reaction and reach the required value had a significant effect in increasing the percentage of total soluble solids in the fruits of the licorice, as the percentage of TSS was 8.87% and 8.72% in the irrigation water with a reaction degree of 6.5 C_1) and 5.5 C_2), respectively, superior to the comparison treatment, which recorded a percentage of 7.87%.

The chemical fertilization had a clear effect in increasing the percentage of total soluble solids in the fruits of the strawberry variety of Festival, so the chemical fertilization treatment with the fertilizer recommendation for macro-elements (F_1) was significantly superior to all fertilizer treatments when the percentage of total soluble solids was recorded at 10.71% compared to the lowest percentage of solids Total solubility 7.21% in comparison treatment; The treatment of half of the fertilizer recommendation for macro-elements (F_2) with a percentage of TSS, which scored 9.06%, outperformed the two treatments of fertilization with microelements in the fertilizer recommendation and half of the fertilizer recommendation, which gave the percentage of total soluble solids 7.68% and 7.62%, respectively.

Table 1. The effect of the method of reproduction and the degree of interaction of irrigation water and chemical fertilization and their interactions on the percentage of total dissolved substances (T.S.S.) %

Seedling Produce (T)	Irrigation Water (C)	Chemical fertilization (F)					Rate of C×T
		F_0	F_1	F_2	F_3	F_4	
T_1	Control	6.70	9.51	7.91	7.73	7.41	7.85
	pH = 6.5	7.30	10.90	10.03	7.82	7.61	8.73
	pH = 5.5	7.61	11.55	9.07	7.52	8.01	8.75
T_2	Control	6.91	9.61	8.01	7.60	7.33	7.90
	pH = 6.5	7.22	11.02	10.22	7.93	7.73	8.82
	pH = 5.5	7.53	11.70	9.09	7.50	7.61	8.69
LSD $_{(0.05)}$		0.834					
Seedling Produce (T)		F_0	F_1	F_2	F_3	F_4	Rate of (T)
T_1		7.20	10.65	9.01	7.69	7.67	8.44
T_2		7.22	10.78	9.11	7.68	7.56	8.47
LSD $_{(0.05)}$		0.482					N.S
Water Irrigation (C)		F_0	F_1	F_2	F_3	F_4	Rate of (C)
Control		6.81	9.56	7.96	7.67	7.37	7.87
pH = 6.5		7.26	10.96	10.13	7.87	7.67	8.87
pH = 5.5		7.57	11.62	9.08	7.51	7.81	8.72
LSD $_{(0.05)}$		0.590					0.264
Chemical fertilization (F)		F_0	F_1	F_2	F_3	F_4	LSD $_{(0.05)}$
Rate of (F)		7.21	10.71	9.06	7.68	7.62	0.341

It is noted that the percentage of total dissolved solids increases by adding citric acid to the irrigation water and interfering with the two methods in which the strawberry is abound. % when treating the interaction of the method of propagation by plant tissue culture and irrigation water without adding citric acid, as shown in the results of the statistical analysis presented in Table 1.The results of the binary interaction of the experimental workers with the method of propagation (plant tissue culture and runners) and the irrigation water presented in the same table show the superiority of the interaction of the fertilizer recommendation treatment for major and overlapping elements with the method of propagation by pruning (10.78%) and the method of propagation by plant tissue culture (10.65%) overall interactions of the workers for The percentage of total dissolved solids in comparison with the lowest percentage of TSS was 7.20% by overlapping the comparison treatment of chemical fertilization with the method of plant tissue culture.

It seems that the two-way interaction between the two factors, irrigation water, and chemical fertilization had an effect in the presence of significant differences in the

percentage of total soluble solids in the strawberry fruits. 5.5 with fertilization with the fertilizer recommendation of the macroelements that significantly outperformed all interactions and compared to the lowest percentage of TSS 6.81 when the comparison treatment for irrigation and fertilization water was overlapped. Significant in its analogs of fertilizer treatments overlapping with the comparison treatment of irrigation water (without adding citric acid).

The results of the tripartite interaction of the experimental factors show the method in which the strawberry is multiplied (tissue culture and runners), irrigation water (different interaction degrees), and chemical fertilization (macro and micro-elements) and there is a significant superiority of the fertilization treatments with major elements in the fertilizer recommendation interfering with irrigation water reduced the degree of its interaction with citric acid with the two methods of increasing It contains strawberry in the percentage of dissolved solids on most of the triple interventions, so percentages of TSS were recorded 11.70%, 11.02%, 11.55% and 10.90% in the triple interventions according to the sequence (T_2, C_2, F_1), (T_2, C_1, F_1) (T_1 and C_2). And F_1) and (T_1, C_1, and F_1) and in comparison with the lowest percentage of dissolved solids, it was recorded at 6.70% at the triple interaction of the method of propagation by plant tissue culture, the comparison for irrigation water and the comparison for chemical fertilization.

2. Total acidity percentage in fruits (mg. g^{-1})

It is clear from the results of the statistical analysis of the experimental data presented in Table No. 2, that there is no significant difference in the acidity percentage in the fruits of the strawberry variety, Festfal cultivar, between the two methods in which the strawberry is multiplied.

It appears from the same table that the decrease in the degree of reaction of the irrigation water has reduced the total acidity of the fruits; The highest acidity was 4.30 $mg.g^{-1}$ when the control treatment significantly outperformed the two treatments that reduced the degree of reaction of the irrigation water and compared with the lowest acidity of the irrigation water of 5.5 was 3.56 mg. g^{-1}.

The addition of chemical fertilizers has reduced the acidity in the strawberry fruits, especially the fertilization with major elements. The highest acidity rate in the comparison treatment was 4.51 mg. g^{-1}, which significantly outperformed all treatments, and the acidity of fruits was 4.07 mg. g^{-1} and 4.25 mg. g^{-1} in the two treatments of fertilization with microelements in the fertilizer recommendation and half of them, respectively, which were significantly superior to the two treatments of fertilization with major elements in half the fertilizer recommendation of 3.60 mg. g^{-1} and the fertilizer recommendation is 2.89 mg. g^{-1} which recorded the lowest acidity in the fruits of the strawberry.

Table 2 shows that the two-way interaction between the method of propagation and the degree of interaction of the irrigation water had an effect on the presence of significant differences in the total acidity of the strawberry fruits, so the highest percentage was 4.38 $mg.g^{-1}$ when the method of propagation using tissue culture technique was overlapped with the control treatment of irrigation water, which outperformed all the interactions for the two workers except for the treatment of overlapping the method of propagation by runners with the comparison treatment of irrigation water which recorded

an acidity of 4.22 mg. g $^{-1}$ in comparison with the lowest acidity ratio of 3.49 mg. g $^{-1}$ when the runner propagation method is overlapped with water with a reaction degree of 5.5.

Table 2. Effect of the method of reproduction and the degree of interaction of irrigation water and chemical fertilization and their interactions on the total acidity of fruits mg. g $^{-1}$

Seedling Produce (T)	Irrigation Water (C)	Chemical fertilization (F)					Rate of C×T
		F_0	F_1	F_2	F_3	F_4	
T_1	Control	4.56	3.71	4.17	4.80	4.67	4.38
	pH = 6.5	4.43	2.37	3.50	3.92	4.46	3.74
	pH = 5.5	4.57	2.60	2.90	3.57	4.47	3.62
T_2	Control	4.60	3.60	4.43	4.23	4.23	4.22
	pH = 6.5	4.57	2.40	3.13	4.40	4.17	3.73
	pH = 5.5	4.30	2.67	3.48	3.52	3.49	3.49
LSD $_{(0.05)}$		0.224					0.139
Seedling Produce (T)		F_0	F_1	F_2	F_3	F_4	Rate of (T)
T_1		4.52	2.89	3.52	4.10	4.53	3.91
T_2		4.49	2.89	3.68	4.05	3.96	3.82
LSD $_{(0.05)}$		0.138					N.S
Water Irrigation (C)		F_0	F_1	F_2	F_3	F_4	Rate of (C)
Control		4.58	3.65	4.30	4.52	4.45	4.30
pH = 6.5		4.50	2.38	3.32	4.16	4.31	3.73
pH = 5.5		4.43	2.63	3.19	3.55	3.98	3.56
LSD $_{(0.05)}$		0.174					0.109
Chemical fertilization (F)		F_0	F_1	F_2	F_3	F_4	LSD $_{(0.05)}$
Rate of (F)		4.51	2.89	3.60	4.07	4.25	0.128

The two-way interaction between the method of propagation and chemical fertilization had significant effect on the acidity percentage of the fruits of the licorice fruit of the Festival cultivar. It was noticed that the acidity decreased when the chemical fertilization with macroelements interfered with the two methods of propagation, and it increased when the chemical fertilization with microelements was overlapped with both methods of propagation; The highest value of acidity was recorded when the two interactions of the method of propagation by growing plant tissues with the fertilization treatment with half the fertilizer recommendation for microelements amounted to 4.53%, which outperformed all interactions of the two workers except for the two treatments of overlapping the comparison treatment of fertilization with the two methods of propagation using the tissue culture technique and runners, which gave an average acidity of 4.52 mg . g^{-1} and 4.49 mg. g $^{-1}$ compared to the lowest acidity ratio of 2.89 mg.g $^{-1}$ when overlapping the fertilization treatment with the fertilizer recommendation

of the macroelements with the two methods of propagation, as shown by the results presented in Table 2.

The same table indicates that the interaction coefficients between the two factors of the study represented by irrigation water and chemical fertilization were significant differences in the acidity of the strawberry fruits; The highest acidity rate was recorded when the comparison treatment for the two workers overlapped, which gave 4.58 mg. g $^{-1}$ it was significantly superior to the lowest acidity ratio of 2.38 mg. g $^{-1}$ when the reduced irrigation water interacts with citric acid to 6.5 with the fertilization treatment according to the fertilizer recommendation for macro-elements.

While the triple interaction between the method of reproduction, irrigation water and chemical fertilization had a significant effect on the acidity of the strawberry fruits, the highest percentage was when the triple interaction of the method of propagation using tissue culture technique with the comparison treatment of irrigation water and fertilization according to the fertilizer recommendation for microelements amounted to 4.67 mg. g $^{-1}$, which significantly outperformed the lowest acidity in strawberry fruits when the triple interaction of the method of propagation by plant tissue culture with irrigation water with reaction degree of 6.5 and fertilization with the fertilizer recommendation for major elements 2.37 mg.g $^{-1}$, and from observing the results of the triple interaction of the experimental factors, it is clear that the interactions of fertilization with macro-elements with other factors have reduced the acidity of fruits in both treatments with the fertilizer recommendation or half of it, as shown in the results presented in Table No. 2.

3- The percentage of total carbohydrates in fruits %

It is evident from the results of the statistical analysis of the percentage of total carbohydrates in the fruits of the strawberry of the Festival cultivar by the effect of the method in which the strawberry is multiplied (the technique of plant tissue culture and runners) presented in Table 3, that there is no significant difference for the studied trait due to the effect of the method of propagation.

Reducing the degree of reaction with citric acid for irrigation water increased the percentage of total carbohydrates in the fruits, so the highest percentage of total carbohydrates was recorded at 7.62% when treating irrigation water with a reaction degree of 5.5, which in turn was significantly superior to the comparison treatment, which recorded 6.49%.

It appears from the same table that chemical fertilization significantly affected the percentage of total carbohydrates in the strawberry fruits, giving the highest percentage of carbohydrates when fertilizing with the fertilizer recommendation of the macroelements 9.34%, which outperformed all fertilizer treatments that gave the ratios 7.86%, 6.44%, 6.35% and 6.03% at the treatments half of the fertilizer recommendation for the macroelements, the fertilizer recommendation for the minor elements, half of the fertilizer recommendation for the microelements and the comparison, respectively, that differed significantly from each other except for the two treatments of the microelements.

It is clear from Table 3 that the two-factor interaction between the two experimental factors, the method in which the strawberry was multiplied and the irrigation

water had an effect on the percentage of total carbohydrates, the highest percentage of 7.63% was recorded when the method of multiplication by growing plant tissues interacted with irrigation water with a reaction degree of 5.5, which significantly outperformed the lowest percentage of carbohydrates was 6.47% when the method of propagation by tissue culture overlaps with the control treatment of irrigation water.

Table 3. The effect of the method of reproduction and the degree of interaction of irrigation water and chemical fertilization and their interactions on the percentage of total carbohydrates %

Seedling Produce (T)	Irrigation Water (C)	Chemical fertilization (F)					Rate of C×T
		F_0	F_1	F_2	F_3	F_4	
T_1	Control	5.36	7.99	6.65	6.34	6.04	6.47
	pH = 6.5	6.06	9.59	8.73	6.57	6.39	7.47
	pH = 5.5	6.47	10.40	8.07	6.39	6.81	7.63
T_2	Control	5.53	8.08	6.73	6.23	5.99	6.51
	pH = 6.5	5.99	9.59	8.89	6.74	6.50	7.54
	pH = 5.5	6.78	10.41	8.09	6.38	6.39	7.61
LSD (0.05)		0.709					0.317
Seedling Produce (T)		F_0	F_1	F_2	F_3	F_4	Rate of (T)
T_1		5.96	9.32	7.82	6.43	6.41	7.19
T_2		6.10	9.36	7.90	6.45	6.29	7.22
LSD (0.05)		0.410					N.S
Water Irrigation (C)		F_0	F_1	F_2	F_3	F_4	Rate of (C)
Control		5.45	8.03	6.69	6.29	6.01	6.49
pH = 6.5		6.03	9.59	8.81	6.65	6.44	7.50
pH = 5.5		6.62	10.40	8.08	6.38	6.60	7.62
LSD (0.05)		0.502					0.224
Chemical fertilization (F)		F_0	F_1	F_2	F_3	F_4	LSD (0.05)
Rate of (F)		6.03	9.34	7.86	6.44	6.35	0.290

As for the effect of the binary interaction between the method of propagation and chemical fertilization, it appears that the fertilizer treatments had the same effect as the two methods of propagation in the percentage of total carbohydrates. Reproduction, the highest percentages were 9.36% and 9.32%, with the interaction of fertilization with the macro-elements of the fertilizer recommendation with the two methods of propagation with runners and planting plant tissues in order, which were significantly superior to all interactions of the two factors. The tissues and runners, in order, had percentages of total carbohydrates 7.82, 7.90, 6.43, and 6.45 on the sequence, which all outperformed the lowest percentage of total carbohydrates 5.96% by overlapping the

method of propagation by tissue culture with the comparison treatment of fertilization, as shown in Table 3.

The interaction of irrigation water with the chemical fertilization presented in the same table affected the percentage of total carbohydrates in the fruits of the leeks of the Festival class. The highest percentage of total carbohydrates was 10.40% when the irrigation water overlapped with a reaction degree of 5.5 with the treatment of the fertilizer recommendation for the major elements that significantly outperformed all interactions of workers and in comparison With the lowest percentage of total carbohydrates when the comparison treatment for the two workers overlapped, 5.45%.

The results of the statistical analysis of the triple interaction of the experimental factors (propagation method, irrigation water, and chemical fertilization) indicate that there are significant differences in the percentage of total carbohydrates for the strawberry fruits. And plant tissue culture 10.41 % and 10.40%, respectively, which were significantly superior to all triple interactions and compared with the lowest percentage of total carbohydrates 5.36% in the interaction of the method of propagation by plant tissue culture with the control treatment of irrigation water and the comparison treatment of chemical fertilization.

4 The content of ascorbic acid in strawberries (mg. (100 g soft mass) $^{-1}$)

All the studied experimental factors (the method of strawberry propagation, irrigation water, and chemical fertilization) had a significant effect on the content of strawberry fruits of ascorbic acid as shown by the results of the statistical analysis presented in Table 4; The method of propagation with plant tissue culture technique outperformed the method of propagation with the ascorbic acid content, recorded 32.73 mg. (100 g of soft mass) $^{-1}$ superior to the runner method, which recorded content of 31.52 mg ascorbic. (100 gm soft mass)$^{-1}$

While the addition of citric acid to the irrigation water had a role in increasing the content of ascorbic acid in the water, the highest content of 32.71 mg. (100 g of soft mass) $^{-1}$ was recorded of fresh mass compared to the lowest content when the control treatment of irrigation water was 30.98 mg. (100 g of soft mass) $^{-1.}$

While chemical fertilization had a role in the high content of ascorbic acid in strawberry fruits, the highest content of ascorbic acid was recorded at 43.05 mg. (100 gm soft mass) $^{-1}$ when fertilizing with the major elements of the fertilizer recommendation, it outperformed all fertilization treatments that differed significantly between them and compared to the lowest content of ascorbic acid in the control treatment 24.51 mg. (100 g of soft mass) $^{-1}$.

The results of the statistical analysis presented in Table 4 indicate the superiority of the two-interference treatment of the method of propagation by plant tissue culture and irrigation water with a reaction degree of 6.5, which recorded the content of ascorbic acid in strawberry fruits amounted to 34.05 mg. (100 gm soft mass) $^{-1}$ which was superior to most of the interactions of the two factors, the method of propagation and the degree of reaction of the irrigation water, and compared with the lowest content of ascorbic 31.35 mg. (100 g soft mass) $^{-1}$ when the method of propagation by runners is overlapped with irrigation water with a reaction degree of 6.5.

The same table shows the superiority of the overlapping treatment of fertilization with macroelements in the fertilizer recommendation overlap with the two propagation methods that recorded content of ascorbic acid 43.43 mg. (100gm soft mass) $^{-1}$ and 42.67 mg. (100gm soft mass) $^{-1}$ In strawberry fruits when they were interacted with the two methods of propagation by runers and the tissue culture technique respectively, which outperformed all the interactions of the method of chemical propagation and fertilization in comparison with the lowest content of acid 24. mg. (100gm soft mass) $^{-1}$ when the method of propagation by culturing plant tissues overlaps with the comparison treatment of fertilization.

Table 4. Effect of the method of reproduction and the degree of interaction of irrigation water and chemical fertilization and their interactions on the content of strawberry fruits of ascorbic acid (ascorbic acid mg. (100 g soft mass) $^{-1}$

Seedling Produce (T)	Irrigation Water (C)	Chemical fertilization (F)					Rate of C×T
		F_0	F_1	F_2	F_3	F_4	
T_1	control	21.77	39.99	34.92	29.26	25.80	30.35
	pH = 6.5	22.81	44.81	38.89	34.26	29.47	34.05
	pH = 5.5	28.65	43.23	37.80	30.77	28.56	33.80
T_2	control	21.79	42.89	37.03	29.13	27.21	31.61
	pH = 6.5	26.68	43.89	35.88	26.28	24.00	31.35
	pH = 5.5	25.38	43.50	39.23	27.14	22.81	31.61
LSD $_{(0.05)}$		1.630					0.729
Seedling Produce (T)		F_0	F_1	F_2	F_3	F_4	Rate of (T)
T_1		24.41	42.67	37.20	31.43	27.94	32.73
T_2		24.62	43.43	37.38	27.52	24.67	31.52
LSD $_{(0.05)}$		0.941					0.421
Water Irrigation (C)		F_0	F_1	F_2	F_3	F_4	Rate of (C)
control		21.78	41.44	35.97	29.19	26.50	30.98
pH = 6.5		24.75	44.35	37.39	30.27	26.73	32.70
pH = 5.5		27.01	43.36	38.52	28.96	25.69	32.71
LSD $_{(0.05)}$		1.152					0.515
Chemical fertilization (F)		F_0	F_1	F_2	F_3	F_4	LSD $_{(0.05)}$
Rate of (F)		24.51	43.05	37.29	29.47	26.31	0.665

The fertilizer recommendation for fertilizing with macroelements interfering with irrigation water had the highest percentages of ascorbic acid, which significantly outperformed all the interactions of irrigation water and chemical fertilization as shown in Table 4, giving content of 44. mg. (100gm soft mass) $^{-1}$ and 43.36 mg. (100gm soft mass) $^{-1}$ when it interacted with irrigation water with a reaction degree of 6.5 and 5.5, respectively, which outperformed all interactions of the two factors, and recorded

the lowest content of 21.78 mg. (100gm soft mass) $^{-1}$ for acid by overlapping the two comparison treatments of the two factors: irrigation water and chemical fertilization.

The results of the statistical analysis of the three overlapping experiment factors show that there are significant differences in the content of ascorbic acid in the fruits of the strawberry of the cv. Festival cultivar as presented in Table 4. The highest content was recorded at the triple interaction of the recommended treatment for macro-elements with irrigation water with a reaction degree of 6.5 and the method of propagation by plant tissue culture 44.81 mg. (100gm soft mass) $^{-1}$ compared to the lowest content of ascorbic acid 21.77 mg. (100gm soft mass) $^{-1}$ At the triple interaction of the method of propagation using the plant tissue culture technique with the comparative treatments of irrigation water and fertilization.

5- Nitrate content of fruits (mg. (100 g dry mass)$^{-1}$)

It appears from the results presented in Table 5 that there are no significant differences between the two methods of strawberry propagation (plant tissue culture technique and runners) in the nitrate content of the fruits. The decrease in the degree of interaction of the irrigation water led to a decrease in the nitrate content of the fruits. The highest nitrate content was when treating the irrigation water free of citric acid, which recorded content of 15.65 mg. (100 gm dry mass)$^{-1}$ when the control treatment, which was significantly superior to the irrigation water treatments 6.5 and 5.5, which recorded 14.15 mg. (100 g dry mass)$^{-1}$ and 13.04 mg. (100 g dry mass)$^{-1}$ respectively.

Chemical fertilization had a role in reducing the nitrate content of fruits and the variation in the effect of fertilization between macro and microelements, as the macro elements played the largest role in the fertilizer recommendation in reducing the nitrate content of fruits, which was at its highest levels when the comparison treatment of fertilization; The highest nitrate content was 17.18 mg. (100 gm dry mass)$^{-1}$ when the control treatment, which significantly outperformed all treatments and compared to the lowest content of 12.31 mg nitrate. (100 gm dry mass)$^{-1}$ when fertilizing with the fertilizer recommendation for macro-elements, as shown in Table 5.

The same table indicates a decrease in the nitrate content of acidic water overlapping with the two methods of reproduction, which was relatively high when the comparison treatment of irrigation water overlapped with the two methods of propagation 15.65 mg. (100 gm dry mass)$^{-1}$ and 15.61 mg. (100 gm dry mass)$^{-1}$respectively, which were significantly superior to all interactions of the two agents and compared with the lowest content of 13.04 mg nitrate. 100 (gm dry mass)$^{-1}$ when the two methods of propagation by the method of propagation by cultivating plant tissues and irrigation water with a reaction degree of 5.5.

Significant differences appeared in the strawberry fruit's nitrate content when the two methods of reproduction and chemical fertilization were intertwined, and the highest content of 17.45 mg nitrate was recorded. 100) gm of dry mass 1) by the interaction of the propagation method with purlins with the comparison treatment of fertilization, which was significantly superior to all interactions of the two agents and compared with the lowest nitrate content of 12.31 mg. (100 gm dry mass)$^{-1}$ when the method of propagation by runners overlaps with fertilization with the

fertilizer recommendation for macro-elements.

The binary interaction of the experimental workers with irrigation water and chemical fertilization, the results of which are presented in Table 5, indicate that there are significant differences in the nitrate content of strawberry fruits between the interactions of 18.52 mg. (100 g dry mass)$^{-1}$ which was significantly superior to all interactions of the two agents and compared with the lowest nitrate content of 11.26 mg. (100 gm dry mass)$^{-1}$ recorded by double interaction of irrigation water with reaction degree of 6.5 and fertilization according to the fertilizer recommendation for microelements.

Table 5. The effect of the method of reproduction and the degree of interaction of irrigation water and chemical fertilization and their interactions on the nitrate content of strawberry fruits

Seedling Produce (T)	Irrigation Water (C)	Chemical fertilization (F)					Rate of C×T
		F_0	F_1	F_2	F_3	F_4	
T_1	control	18.48	14.26	14.98	14.59	15.93	15.65
	pH = 6.5	17.31	11.32	13.60	13.81	14.70	14.15
	pH = 5.5	14.92	11.37	12.69	12.45	13.75	13.04
T_2	control	18.55	14.30	14.72	14.59	15.91	15.61
	pH = 6.5	17.43	11.19	13.53	13.95	14.73	14.17
	pH = 5.5	16.38	11.43	12.61	12.41	13.54	13.27
LSD $_{(0.05)}$		0.496					0.222
Seedling Produce (T)		F_0	F_1	F_2	F_3	F_4	Rate of (T)
T_1		16.91	12.32	13.76	13.62	14.79	14.28
T_2		17.45	12.31	13.62	13.65	14.73	14.35
LSD $_{(0.05)}$		0.286					N.S
Water Irrigation (C)		F_0	F_1	F_2	F_3	F_4	Rate of (C)
Control		18.52	14.28	14.85	14.59	15.92	15.65
pH = 6.5		17.37	11.26	13.57	13.88	14.72	14.15
pH = 5.5		15.65	11.40	12.65	12.43	13.65	13.04
LSD $_{(0.05)}$		0.531					
Chemical fertilization (F)		F_0	F_1	F_2	F_3	F_4	LSD $_{(0.05)}$
Rate of (F)		17.18	12.31	13.69	13.63	14.76	0.202

The results of the statistical analysis of the triple interaction of the experimental factors presented in Table 5 show that there are significant differences between the interactions, as reducing the interaction degree of irrigation water intertwined with the methods of reproduction and chemical fertilization contributed to reducing the content of fruits of nitrates, and the fertilization treatments with the major

elements of the fertilizer recommendation and overlapping with the two methods of propagation Irrigation water had a clear effect on reducing the nitrate content of fruits in the triple interactions compared to the interactions of other fertilizer treatments with the two workers, while the comparison treatment of the chemical fertilization overlapping with the two workers recorded the highest nitrate content in the fruits; It recorded the highest content of nitrate (18.55 and 18.48) mg. (100 g dry mass)$^{-1}$ when the triple interaction of the comparison treatment of fertilization and irrigation with the two methods of propagation by runers and the plant tissue culture technique in order, they were significantly superior to all the triple interactions of the factors and compared to the lowest content of nitrate in strawberry fruits 11.19 mg. (100g dry mass)$^{-1}$ when multiplication with runners overlaps with irrigation water with a reaction degree of 6.5 and fertilization with the fertilizer recommendation for macroelements.

Discussion

The tables that dealt with some qualitative characteristics of the fruits of the strawberry variety Festival, including the percentage of total soluble solids (T.S.S.) Table 1, the percentage of total carbohydrates Table 3 and the percentage of ascorbic acid Table 4, that to reduce the degree of interaction of irrigation water increased the percentage of T.S.S, the percentage of carbohydrates and Ascorbic acid and this may be due to the role of the low degree of interaction in providing the necessary nutrients to the plant at appropriate levels in the soil solution, entering them to the roots and then reaching the food factories in the plant (leaves), which leads to the plant carrying out vital processes with high efficiency, including photosynthesis processes that convert energy Light into chemical energy. This energy is stored in the plant by carbohydrate molecules such as carbohydrates and starches, and the plant can benefit from it in vital processes after releasing it during cellular respiration to nourish vital activities (11). Then, the natural compounds produced by the plant, which are divided into two parts, include compounds in the first part. that enter into primary reactions or primary metabolic compounds that result in carbohydrates Basic simple silica, amino acids, carbohydrates, lipids, proteins, and nucleic acids. Primary metabolic compounds are the starting materials for the Secondary Metabolic Compound (7), including ascorbic acid, which recorded a significant increase almost identical to the increase in carbohydrates in strawberry fruits.

When potassium is insufficient in plants, the level of starch and soluble carbohydrates decreases and they do not produce proteins despite the abundance of nitrogen available due to the enzyme nitrate reductase that catalyzes the formation of potassium-activated proteins as mentioned by(16: 4) indicates that phosphate fertilization reduced the acidity of the fruits. When carbohydrates enter the fruits in the form of carbohydrates, the sugar turns into starch when it reaches the fruits and is stored in the form of starch. Then the starch turns at maturity into sugar, which increased the percentage of carbohydrates when phosphate fertilization and reduced From the acidity of the fruits, and the researchers indicate that the concentration of the necessary elements for the plant improves the quality characteristics of the fruits, and the increase in the concentration of the elements added to the soil by fertilization leads to an increase in the metabolism process and the building of organic matter, which is included

in many compounds of the plant cell components, including amino acids and nucleic acids (12) In addition to its role in the manufacture of thousands of enzymes that participate in the processes of biological construction, cellular metabolism, respiration, making energy compounds and the conduct of vital processes, and that the lack of mineral elements will directly inhibit growth (6).

As for the percentage of total acidity in fruits (table 2) and the content of fruits from nitrates (table 5), the results clearly indicate their decrease when the nutritional status of the plant is good, which was positively reflected on the indicators of the qualitative characteristics of the aforementioned fruits, which contributed to reducing the total acidity and nitrate content in ripe fruits As pointed out by (17) and the fruits were in the highest content of nitrates when compared to irrigation water and chemical fertilization. This may be due to the absence of ammonium HN^{+}_{4} that is added to the soil in the form of urea fertilizer, which competes with nitrates NO_3^- and its absorption decreases by increasing ammonia in the soil solution, and because the representation of ammonia is very fast. In the plant, as it produces amino acids and compounds that contain nitrogen in a reduced form, as well as the reduction of the plant to nitrates NO_3^- after entering the root tissues to nitrite NO_2^- and then to ammonia NH_3 before it enters the synthesis of organic nitrogen compounds and these transformations into nitrates It needs the energy provided by the plant from its active compounds (6). In addition, the increase in the presence of citric acid in the soil reduces the rate of absorption of nitrate NO_3^- to ammonium NH_4^+ by the plant (10).

Conclusion

Reducing the degree of reaction of irrigation water with citric acid led to an increase in the total soluble solids, total carbohydrates, and ascorbic acid content, and reduced the total acidity and nitrate content in strawberry fruits.

Conflict of Interest

The authors have no conflict of interest.

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