Impact of Foliar Application with Calcium And Iron On Chemical Content Of Two Hybrids Of Cherry Tomato Planted In Plastic Houses

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Abstract

The experiment was conducted during the winter season 2023/2024 in one of the greenhouses affiliated with the research station of the College of Agriculture, University of Basra. It aimed to test the effect of hybrids and spraying with calcium and iron on the chemical content of the leaves of the cherry tomato plant Solanum Lycopersicum L. .The experiment included 24 factorial treatments, which are combinations between two hybrids of cherry tomato (POMODORO Principe Borghese V1) and (Principe EOR V2), four concentrations of chelated calcium (0, 1, 2, and 3 ml.L-1), and three concentrations of chelated iron, which are (0, 100, and 200 mg.L-1), the plants were sprayed with three times with an interval of 14 days between one spraying and another. The experiment was a two-time factorial split-split plot design according to Randomized Complete Block Design (R.C.B.D.) with three replicates, The arithmetic means of the reatments were compared using the least significant difference test at the probability level (0.05). The results showed that the plants of the first hybrid V1 were significantly excelled on second hybrid V2 in the chemical components of the leaves (chlorophyll and enzymatic activity), with an increase rate of (2.62 and 28.10%, respectively. Spraying with 3 ml L-1 chelated calcium gave a highest value in total chlorophyll with an increase rate of 17.96%, while 2 ml L-1 concentration Superior in carotene, carbohydrates and calcium percentage with rates of increase reaching 16.16, 15.94 and 57.77% compared to control treatment, respectively, also 1 ml.L-1 excelled on control and the rest of the concentrations by increasing the effectiveness of the catalase enzyme, with rates of increase reaching 179.79, 1.46 18.46)%, respectively. Spraying with 100 mg.L-1 chelated iron was excelled in increasing gave a highest value in total chlorophyll and calcium, with rates of increase reaching (5.27, 0.73)% and (10.52, 6.77)% and (18.91, 9.09), compared to the control, respectively, while 200 mg.L-1 was significantly excelled in increasing in carotene and carbohydrates reaching 10.52 , 5% and (4.36, 7.49)% compared to control treatment and the other concentration, respectively. While the 0 mg L-1 was excelled in increasing enzymatic activity. Most the twice and triple interactions between treatment showed a significant effect of the traits under experiment .

Introduction

Cherry tomato (Solanum Lycopersicum L. (Var.cerasiforme) belonging to the Solanaceae family is one of the important summer vegetable crops whose, the original homeland is South America (Peru and Mexico) and then moved from South America to Europe. [1]. It has great economic importance as it is the second vegetable crop in the world after potatoes [2]. Cherry tomatoes small fruits are rich in vitamin C, carotenoids, flavorioids and lycopene, these substances are essential for human health and protect it from cancer, bone growth, cell division and differentiation, It also helps in the absorption of iron [3].The

ISSN 2072-3857

cherry tomato is characterized by its ability to widely adapt to various agricultural climatic conditions, and it is desired by the poor and the rich because of its high nutritional value.Compared to global production, the Iraqi production of cherry tomatoes is low. In order to increase production, improve the quality of the fruits, and increase their quantity, attention must be paid to agricultural operations, including fertilization, especially macro nutritional elements, and the appropriate method for adding them, including foliar nutrition, which ensures the arrival of the mineral elements in a form that can be absorbed by the plant during the growth stage. Vegetative and flowering, which may be susceptible to sedimentation if added directly to the soil, especially in the basic soils prevailing in the country [4], as well as to avoid a deficiency of elements, including calcium (Ca), which is one of the macronutrients that has many physiological functions in the growth and development of the plant, it is involved in the formation of the pectin substances that bind the cell walls and in the formation of the middle lamina in the form of calcium pectate. It is involved in the formation of the cell walls and has a role in regulating the entry of non-toxic nutrients to the plant. It has a role in the meristematic activity of organic acids, and the spraying of calcium. On the leaves, it is highly effective compared to ground fertilization. It is also considered one of the stable elements. Calcium gives the cell wall flexibility and elasticity, and this in turn helps in cell division, growth, development, elongation, and increasing their size, and thus the growth and development of plants [5] Many studies have indicated a role. Calcium increases the content of total chlorophyll and carotenoids in plant leaves, as [6] obtained, when spraying the tomato plant (Tivi F1) with calcium chloride at a concentration of (15 mM), the highest value for chlorophyll compared to control treatment and other concentrations, and [7] found when spraying the plant Tomatoes are classified as Ark Samart with three sources of calcium: calcium chloride ($CaCl2$) and calcium nitrate (CaNo3 in addition to ammonium nitrate and calcium CAN) and with three concentrations of each of them (0.20, 0.50, 0.80)%, in addition to control treatment (distilled water), which led to an increase in Leaves content of nutrients, calcium and iron compared with control. [8] Metwaly and Nada (2020) found when spraying tomato plants with different concentrations of calcium(0, 400 and 800 mg L-1) under kaolin levels (0, 20, 40 and 60 g L-1) during both seasons (2018, 2019). The concentration 800 mg L -1 was significantly excelled on the rest of the concentrations, as it gave the highest values in chemical characteristics, as it gave the highest value for chlorophyll a, chlorophyll b and carotenoids compared to control treatment for the two seasons in a row, and between [9] Birgin et al.(2021) When spraying tomato plants (Aziz F1) with calcium in the form of (CaSO4 at a concentration of 1%, it led to an increase in the leaves' content of nitrogen and calcium and a decrease in the percentage of potassium compared to control treatment. [10] Ghahremani et al.(2021) obtained the highest value for chlorophyll and carotenoids in eggplant plants (IR3121) when spraying calcium lactate at a concentration of (4 g L -1) compared to control treatment. The use of micronutrients is also an important means of increasing yields and improving its quality, and it is one of the basic nutrients necessary for plant growth [11]. The plant needs iron in larger quantities than the rest of the

ISSN 2072-3857

micronutrients, and the average concentration of iron in plant tissues ranges from 50-150 ppm [12]. One of the most widely used forms of iron is chelated iron, as the chelated compounds preserve the element in a form that is easily absorbed and transported by the plant, and it does not decompose in the soil. The two substances, Fe_EDDHA and Fe_EDTA, are among the commonly used chelated iron compounds in many plants [13], and iron elements have many functions, including that it contributes to the process of forming nucleic acid (RNA) [14] and contributes to the construction of chlorophyll, in addition to its role in the synthesis and construction of many enzymes responsible for the processes of construction, catabolism, and oxidation and reduction reactions [15]. Many studies have indicated the role of iron in increasing the leaf content of chlorophyll, carbohydrates, and iron. [16] Ghazi (2018) showed that when spraying eggplant plants with chelated iron (Fe-EDTA) at a concentration of (300 mg L-1) the foliar spray was excelled to spraying with iron compared to the control treatment in An increase in the plant leaves' content of total chlorophyll and carbohydrates occurred when [17] Sakya and Sulan(2019) treated the tomato plant (Permata) with four concentrations of ferrous sulphate (FeSO4 (0.25, 0.50, 0.75, 1.0%) in addition to control treatment, where the results showed excelled The concentration (0.50%) was significantly excelled in total chlorophyll compared to control treatment and other concentrations. Many studies also indicated that spraying with iron increased the leaf content of nutrients such as nitrogen, potassium, and iron, and this was confirmed by Kumar et al. (2020) [18]. As noted by [19] El- Desouky et al. (2021) Spraying tomato plants (Solanum lycopersicum) grown in a heated environment with three sources of iron (FeCL3 chelated iron, and Fe-nano iron) at different concentrations (0, 50, 100 mg kg-1 soils) during both growing seasons (2015_ 016) and (2016_2017) The results showed that (Fe-nano) at a concentration of 100 mg kg-1 was significantly excelled on the rest of the treatments in the percentage of chlorophyll compared to control treatment. Based on the above and the lack of studies on the effect of hybrids and foliar nutrition with calcium and iron and their interactions on the chemical components in the leaves of the cherry tomato plant in Basra province, this study was proposed.

Materials and methods

The experiment was conducted in the winter season 2023-2024 in one of the unheated greenhouses affiliated with the Agricultural Research Station affiliated with the College of Agriculture, University of Basra, with dimensions (42 x 8.5 m) and an area of 357 m2. The soil of the greenhouse was analyzed before planting by taking random samples from different places at a depth of (0-30 cm). it also took samples of the irrigation water for the purpose of conducting some chemical analyzes on it. Table (1) shows some of the physical and chemical traits of the soil of the greenhouse and the irrigation water. Analyzed in the laboratories of the Marine Science Center/University of Basra. The soil of the greenhouse was prepared on August 15, 2023, by deep plowing it twice with a flip plow in a perpendicular manner, smoothing it, and adding decomposed animal manure (cow waste) to it at an average of 10 m3.dun-1, which is equivalent to 30 tons ha-1 [20]. with the addition of Superphosphate at a rate of 1.5 kg Convert to Hectare was leveled and sterilized by exposing it to direct sunlight. The land of the plastic house was divided into six lines (36 m long) and (50 cm wide) with a distance of 128 c between one line and another and a depth of 30 cm. A space was left on each side. The house, and the lines were buried in the field soil to a height of 15 cm. The house was sprayed with the fungicide (Beltanol), and the drip irrigation system was extended in the middle of the lines, and the lines were covered with black Mulching Soil, and 10 kg of dab with 10 kg of urea[20]were added before cultivation. The treatments were distributed randomly among the experimental units in each line, and each experimental unit contained 10 plants, 5 plants on each side of the line, at opposite sides, with a planting distance of 30 cm between one plant and another. The seeds of the cherry tomato hybrid (V1 POMODORO Principe Borghese) of Italian origin were used in this experiment, as this hybrid has a germination rate of 90% and purity of 99% and the second hybrid (V2 EOR Principe) is of Russian origin, and the germination rate of this hybrid is 90% and purity is 99%. The seeds were planted on 16/10/2023 in white cork dishes containing 198 holes. The corks were filled with peat moss after being moistened and sterilized, one seed was placed in each hole and covered with a light layer of peat moss. After planting, the seeds were irrigated with a light spray using a special sprinkler, and the corks were placed inside a shaded and cooled plastic house to reduce the effect of direct sunlight. All operations related to seedling production were carried out, as the seedlings were sprayed with a compound fertilizer high phosphorus, at a rate of 1 g L-1 and NPK fertilizer 20:20:20 at a rate of 1 g L-1 also sprayed a fungicide (Menatol) at an amount of 1 ml L-1, also the plants were hardened by up the corks from the soil and reducing the number of irrigations to reduce transplant shock.

Table (1) The physical and chemical properties of experimental soil and the Irrigation water

properties	**value**	**Traits**
. Physical1		
Sand (%)	**65**	[21]
Silt (%)	**25**	
Clay (%)	**10**	
Texture Soil	**Sandy loam**	
2. Chemical (available)		
N (mg g^{-1})	0.567	[22]
P (mg g^{-1})	0.014	
K (mg g^{-1})	0.02	
Fe (mg g^{-1})	**0.343**	
Ca (mg g^{-1})	**0.8**	
Organic matter (%)	**2.58**	
pH	**8.24**	
E.C (ds.m^{-1})	**4.14**	
3. Irrigation Water		
pH	**7.54**	
E.C (ds.m^{-1})	**4.70**	

ISSN 2072-3857

One line was divided into 12 experimental units, the length of the experimental unit (1.5 m). Each 24 experimental units is considered a sector, where every three experimental units take one of the four concentrations of calcium, which is distributed It contains the three iron concentrations. The area of one experimental unit was 1.92 m2, The seedlings were transferred to the greenhouse after 30 days. From planting seeds, they were transferred to the lines on 24/11/2023, and then the process of patching and replanting the failed Seedling was carried out. Then, on 12/21/2023, a foliar fertilizer high in phosphorus (20:50:20) was sprayed (1 g L-1 and a week later a neutral fertilizer was sprayed (20:20:20), at an amount of 1 g L-1 of water, and the spraying was repeated twice. The plants were also periodically sprayed with insecticides and fungicides to resist insects and diseases. All service operations were also carried out, including hoeing, weeding and regular watering, in addition to performing the carcinogenic process, removing side branches and raising the plant. On one stem only. In addition, the plants were hung with ropes to allow them to grow vertically. Chelated calcium was sprayed a month after the transplanting process, with three sprays two weeks apart.

The experiment was conducted as a factorial experiment that included two cherry tomato hybrids and four concentrations of chelated calcium (0, 1, 2, 3) mlL-1 and three concentrations of iron (0, 100, 200 mg L-1 split twice (Split Plot design) and according to Complete Block Design Randomized (R.C.B.D) and in three sectors where cultivar is Main Plot and the concentrations of spraying with calcium as Sup Plot and the concentrations of spraying with iron as Sup Sup Plot), at a rate of three sprays, where all treatments were sprayed on the Vegetative growth in the early morning, the first spraying thirty days after transplanting, and the second spraying 14 days after the first spraying. The third spraying was 14 days after the second spraying, so the number of experimental units became (2 x 4 x 3 x 3 = 72 experimental units). Every two adjacent lines are considered as a sector that distributes the two types randomly on one of the two lines. Then the results were analyzed using analysis of variance, and the least significant difference (L.S.D) Least Significant Differences Test was chosen to compare the means at a probability level of 0.05 [23]. There was a time difference, which was a day one between spraying plants with calcium and spraying plants with iron.The chemical components of the leaves were estimated by taking the fourth leaf below the growing apex of a number of plants from each experimental unit [24] after 65 days of transplantation, and the following was estimated: total chlorophyll and carotenoids (mg 100 g-1soft leaf tissue) according to the described method. by [25] leaf content of total soluble carbohydrates (mg 100 g-1 dry leaf tissue) described by [26] percentage of calcium and iron according to the method described by [21] enzymatic activity (catalase enzyme) (unit.kg-1 fresh weight) according to the method described by [27.[

Results and discussion

Table 2 shows that the study factors and the interactions between them had a significant effect on the chlorophyll character of the plant, where the plants of the first hybrid, V1, were significantly excelled on the plants of the second hybrid, V2, with an increase rate of 2.62%, while the hybrid plants did not differ significantly among themselves in the amount of carotenoids in the leaves.

ISSN 2072-3857

It appears from the same table that spraying with calcium had a significant effect on the quality of chlorophyll and carotenoids, as the plants that were sprayed with the concentration of 3 ml L-1 excelled significantly compared to control treatment and other concentrations, with an increase rate of 17.96, 10.76, and 3.12%, respectively, in the quality of chlorophyll, while in the quality of carotenoids, the two concentrations of 1 and 2 ml L-1 was significantly excelled, with an increase rate of 16.66, 5% compared to control treatment and the concentration of 3 ml L-1, Spraying with iron had a significant effect on both plant characteristics, as the plants that were sprayed with iron at a concentration of 100 mg L -1 excelled significantly compared to control treatment and the other concentration, with an increase rate of 5.27 and 0.73%, respectively, in the chlorophyll trait, while the plants that were sprayed with the other concentration excelled. 200 mg L-1 was significantly excelled compared to control treatment and the other concentration, with an increase rate of 15.78,10% espectively, in the characteristics of carotenoids.As for the interactions, the results of the table showed that the interaction between the hybrids and spraying with calcium did not significantly affect the total chlorophyll content of the leaves, while the first hybrid V1 plants sprayed with calcium at a concentration of 2 ml.l-1 were significantly excelled and gave the highest amount of carotenoids amounting to 0.022 mg 100 g-1. While the first hybrid V1 plants not sprayed with calcium recorded the lowest value, which was 0.017 mg 100 g-1.

The results of the table show that there are significant differences resulting from the interaction between hybrids and spraying with iron, as the first hybrid V1 plants sprayed with iron at a concentration of 100 mg L-1 were significantly excelled, achieving the highest amount of chlorophyll in the leaves, which reached 14.25 mg 100 g-1, while the lowest value was 12.805 mg 100 g-1 in the second hybrid V2 plants not treated with iron. The table also shows that there is a significant effect of the interaction between the hybrids and spraying with iron on the quality of carotenoids, as the first hybrid V1 plants sprayed with iron at a concentration of 200 mg L-1 gave the highest value of 0.023 mg 100 g.-1, while the lowest value was in the first hybrid V1 plants not treated with iron, which was 0.018 mg 100 g-1.

The results in the same table shows that the interaction between spraying with calcium and iron has a significant effect in increasing the total amount of chlorophyll in the leaves, as plants sprayed with calcium at a concentration of 3 ml L -1 and those sprayed with iron at a concentration of 100 mg.L-1 achieved the highest amount of total chlorophyll in the leaves, reaching 14.81 mg. 100 g-1, while the lowest value for chlorophyll was 10.85 mg.100 g-1 in plants not sprayed with calcium and iron (Control), while spraying wontrolith calcium at a concentration of 1 ml.l-1 and iron at a concentration of 200 mg.l-1 was significantly excelled and gave the highest value for carotenoids, it reached 0.023 mg.100 g-1, while the lowest value was 0.014 mg 100 g-1 in plants not sprayed with calcium and iron.The results of the table showed that the triple interaction had a significant effect on increasing the total chlorophyll content of the leaves, as the first hybrid plants sprayed with calcium at a concentration of 3 ml.L-1 and those sprayed with iron at a concentration of 100 mg.L-1 were significantly excelled and gave the highest value of 15.02 mg.100 g-1, while The plants of the second hybrid V2,

ISSN 2072-3857

which were not sprayed with calcium and iron, gave the lowest value, which was 10.64 mg.100 g-1, while the plants of the first hybrid, V1, which were sprayed with calcium at a concentration of 1 ml.L-1 and iron at a concentration of 200 mg.L-1, gave the highest amount of carotenoids, amounting to 0.026 mg. 100 g-1 compared to the lowest amount in the first hybrid V1 plants not sprayed with calcium and iron, which was 0.011 mg.100 g-1

.**Table 2. The effect of chelated calcium and iron on total chlorophyll and carotene in leaves (mg.100 g-1 FW) of two hybrids of cherry tomato**.

Hybrids	Ca ml L^{-1}	Chlorophyll (mg 100 g^{-1})				Carotene (mg 100 g^{-1})			
		Fe (mg L^{-1})			Hybrids X Ca	Fe (mg L^{-1})			Hybrids X Ca
		0	100	200		0	100	200	
V1	0	11.06	12.40	14.15	12.53	0.011	0.017	0.025	0.017
	1	12.85	14.89	11.94	13.22	0.018	0.021	0.026	0.022
	2	14.57	14.69	13.60	14.29	0.023	0.022	0.022	0.023
	3	14.88	15.02	14.03	14.64	0.022	0.021	0.017	0.020
V2	0	10.64	11.83	13.76	12.07	0.017	0.018	0.020	0.018
	1	12.48	12.80	13.67	12.98	0.024	0.021	0.020	0.021
	2	13.66	13.86	14.05	13.86	0.021	0.020	0.021	0.020
	3	14.43	14.60	14.13	14.60	0.019	0.021	0.019	0.019
LSD 0.05		**0.32**			**N.S**	**0.001**			**0.001**
					Hybrids				Hybrids
Hybrids X Fe	V1	13.34	14.25	13.43	13.67	0.018	0.020	0.023	0.020
	V2	12.80	13.27	13.90	13.32	0.020	0.020	0.020	0.020
LSD 0.05		**0.18**			**0.22**	**0.001**			**N.S**
					Ca				Ca
Ca X Fe	0	10.85	12.11	13.95	12.30	0.014	0.018	0.023	0.018
	1	12.66	13.85	12.80	13.10	0.021	0.021	0.023	0.021
	2	14.11	14.28	13.82	14.07	0.022	0.021	0.022	0.021
	3	14.66	14.81	14.08	14.51	0.020	0.021	0.018	0.020
LSD 0.05		**0.22**			**0.15**	**0.001**			**0.001**
Fe		13.07	13.76	13.66		0.019	0.020	0.021	
LSD 0.05		**0.10**				**0.001**			

ISSN 2072-3857

Data show in table 3 there are no a significant effect of the hybrids factors in the soluble carbohydrates in the leaves, while the first hybrid V1 were given a significant increase in the enzyme activity compared to the second hybrid, V2, with an increase rate of 28.15%. The sprying with 2 ml.L-1 chelated calcium was significantly excelled on the other concentrations in total carbohydrate with an increase rate of 15.94, 13.82, and 2.89%, respectively, ,It also appears from the table that spraying with iron concentrations had a significant effect on the carbohydrate quality as spraying with a concentration of 200 mg.L-1 was significantly excelled compared to the other concentrations, with an increase rate of 18.89 and 11.14%, respectively, while control treatment excelled on the rest of the concentrations in the enzyme activity trait with an increase rate of 45.12 and 17.87%, respectively.

As for the twice interaction between the factors, V2 hybrids treated with a concentration of 2 ml l-1 chelated calcium gave the highest amount of carbohydrates amounting to 142.30 mg 100 g-1, compare on the lowest amount of carbohydrates was 113.79 mg.100 g-1 in V2 hybrid not treated with calcium, also the enzymatic activity increase in chelated calcium at a concentration of 1 ml.l-1 gave the highest enzyme activity amounting to 50.36 mg.100 g-1 while the plants V1 hybrid not sprayed with calcium, recorded the lowest value which was 14.96 . units kg-1. The table also shows that V1 hybrid plants were sprayed with 200 mg L-1 iron gave the highest carbohydrates151.02 mg100 g-1 compared to the lowest value in the V2 hybrid not treated with iron 122.37 mg100 g-1, but in the enzymatic activity amounting to 47.62 units kg-1 in V1 not treated with iron, compared to the lowest value in the V2 hybrid plants sprayed at 100 mg l-1 which was 21.020 units kg-1.

Also plants sprayed with 3 ml L-1 calcium and 200 mg l-1 iron gave the highest amount of carbohydrates amounting to 167.37 mg 100 g-1, but the plants treated with 2 ml L-1 calcium and 0 mg l-1 iron gave a highest value of enzymatic activity amounting to 62.62 units kg-1, compared to the lowest amount was 107.99 mg 100 g-1 and 10.72 units.kg-1 in plants not sprayed with calcium and iron, respectively.

The triple interaction in the same table, shows that the V1 hybrid plants sprayed with 3 ml.L-1 chelated calcium and 200 mg.L-1 chelated iron gave the highest value of carbohydrates which was 167.37 mg.100 g-1 compared at lowest value on the V2 plants not sprayed with calcium and iron which was 112.02 mg.100 g-1, while the enzyme activity, that the first hybrid V1 plants sprayed with 2 ml L-1 calcium and 0 mg L-1 iron gave a highest value amounting to 72.46 units.kg-1 compared to the lowest value in the second hybrid V2 plants not sprayed with calcium and iron, which was 10.335 units.kg-1

ISSN 2072-3857

Table 3. The effect of chelated calcium and iron on total Carbohydrates (mg 100 g-1 FW) and Catalase enzyme activity in leaves of two hybrids of cherry tomato.

Hybrids	Ca ml L^{-1}	Carbohydrates (mg 100 g^{-1} DW)				Catalase enzyme activity (unit kg^{-1} FW)			
		Fe (mg L^{-1})			Hybrids X Ca	Fe (mg L^{-1})			Hybrids X Ca
		0	100	200		0	100	200	
V1	0	103.96	126.03	159.06	129.68	11.11	14.98	18.79	14.96
	1	114.38	126.07	133.67	124.71	51.21	59.50	40.36	50.36
	2	137.33	138.67	144.00	140.00	72.46	34.19	37.30	47.98
	3	119.79	130.48	167.37	139.21	55.71	30.16	35.25	40.37
V2	0	112.02	113.55	115.80	113.79	10.33	11.58	25.24	15.72
	1	113.78	119.59	136.59	123.32	23.44	30.56	52.44	35.48
	2	135.67	142.74	148.51	142.30	52.78	23.15	33.93	36.62
	3	128.00	135.08	142.33	135.14	46.41	18.79	31.08	32.09
LSD 0.05		**6.67**			**5.18**	**1.33**			**0.81**
					Hybrids				Hybrids
Hybrids X Fe	V1	118.87	130.31	151.02	133.40	47.62	34.71	32.93	38.42
	V2	122.37	127.74	135.81	128.64	33.24	21.02	35.67	29.98
LSD 0.05		**7.02**			**N.S**	**0.72**			**0.84**
					Ca				Ca
Ca X Fe	0	107.99	119.79	137.43	121.74	10.72	13.28	22.01	15.34
	1	114.08	122.83	135.13	124.01	37.32	45.03	46.40	42.92
	2	136.50	140.70	146.25	141.15	62.62	28.67	35.61	42.30
	3	123.90	132.78	154.85	137.18	51.06	24.47	33.17	36.23
LSD 0.05		**4.75**			**3.73**	**0.93**			**0.56**
Fe		120.62	129.03	143.41		40.43	27.86	34.30	
LSD 0.05		**1.98**				**1.52**			

Data show in table 4 that the hybrids did not differ significantly among themselves in the percentage of calcium and iron in the leaves, but that there was a significant effect of calcium in the calcium content of the leaves, as spraying with of 2 ml.l-1 was a significantly excelled, with an increase rate of 57.77, 36.53, and 1.42% compared to the first, second, and fourth concentrations, respectively, while spraying with calcium did not a significant effect in the iron percentage in the leaves.

It also appears that spraying with100 mg L-1 iron had a significant effect in calcium which 10.52, 6.77%, and iron percentage which 18.53, 9.05% compared with the other concentrations.

ISSN 2072-3857

The interaction between the of the first hybrid, V1 and 2 ml.l-1 calcium had gave the highest percentage of calcium in the leaves, amounting to 0.76%, while the plants of the second hybrid, V2, not sprayed with calcium, recorded the lowest percentage was 0.44%, but the interaction between V1 hybrids plants not treated with calcium gave a highest iron content of the leaves which 0.0530% compared to the same hybrid treated with 3 ml L-1 calcium gave lowest value which 0.0195%. also shows that hybrid V1 plants sprayed with 100 mg.l-1 iron gave the highest percentage of calcium and iron amounting to 0.65, 0.0315%, respectively, while the lowest percentage of calcium was in the first hybrid V1 plants not treated with iron, which was 0.57, 0.0199%, respectively. The table also shows that the plants sprayed with calcium at a concentration of 2 ml.L-1 and iron at a concentration of 100 mg.L-1 gave the highest value of 0.74%, while the lowest value was in unsprayed plants with calcium and iron, which was 0.42%, while the plant sprayed with 0 ml L-1 calcium and 200 mg L-1 iron have a significant effect in increasing the iron content amount 0.0328% compare to the plant not treatment with the twice factors of 0.0154%.

The triple interaction also had a significant effect in the calcium percentage in the leaves, V2 hybrid plants sprayed with 3 ml L-1 calcium and 200 mg L-1 iron gave highest calcium of 0.79% compared the lowest value in V2 not sprayed with calcium and iron which was 0.40%, but V1 hybrid treated with 2 ml L-1 calcium and 100 mg L-1 iron have a significant effect in the iron content of the leaves which 0.0431%.compared to the lowest value in V1 not sprayed with calcium and iron which was 0.0124%.

Table 4. The effect of chelated calcium and iron on percentage of calcium and iron (%) in leaves of two hybrids of cherry tomato.

Hybrids	Ca ml L^{-1}	Calcium (%)				iron (%)			
		Fe (mg L^{-1})			Hybrids X Ca	Fe (mg L^{-1})			Hybrids X Ca
		0	100	200		0	100	200	
V1	0	0.43	0.52	0.46	0.47	0.0124	0.0342	0.0285	0.0530
	1	0.48	0.55	0.52	0.52	0.0193	0.0321	0.0197	0.0237
	2	0.71	0.86	0.71	0.76	0.0234	0.0431	0.0201	0.0289
	3	0.65	0.66	0.67	0.66	0.0244	0.0166	0.0177	0.0195
V2	0	0.40	0.45	0.48	0.44	0.0183	0.0190	0.0371	0.0248
	1	0.54	0.57	0.47	0.52	0.0250	0.0237	0.0253	0.0247
	2	0.70	0.62	0.63	0.65	0.0270	0.0192	0.0209	0.0223
	3	0.67	0.78	0.79	0.75	0.0282	0.0239	0.0250	0.0257
LSD 0.05		**0.02**			**0.02**	**0.0077**			**0.0058**
					Hybrids				Hybrids

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Hybrids X Fe	V1	0.57	0.65	0.59	0.60	0.0199	0.0315	0.0215	0.0243
	V2	0.58	0.60	0.59	0.59	0.0246	0.0214	0.0271	0.0244
LSD 0.05		**0.01**			**N.S**	**0.0054**			**NS**
					Ca				Ca
Ca X Fe	0	0.42	0.48	0.47	0.45	0.0154	0.0266	0.0328	0.0223
	1	0.51	0.56	0.49	0.52	0.0222	0.0279	0.0225	0.0242
	2	0.70	0.74	0.67	0.71	0.0252	0.0312	0.0205	0.0256
	3	0.66	0.72	0.73	0.70	0.0263	0.0202	0.0213	0.0223
LSD 0.05		**0.02**			**0.01**	**0.0051**			**N.S**
Fe		0.57	0.63	0.59		0.0223	0.0265	0.0243	
LSD 0.05		**0.01**				**0.0034**			

Discussion

The excelled of the first hybrid V1 in the some chemical components of the leaves may be due to the influence of genetic factors between the varieties and the tolerance of this cultivar to the climatic conditions prevailing inside and outside the greenhouse. Also spraying with chelated calcium increased the content of chlorophyll and carotene due to the role of calcium in increasing cells, their expansion and division, and its role in reducing respiration [28]. or may be due to the role of calcium in the formation of chlorophyll and the activation and prevention of inhibition of some enzyme systems in the plant by preventing the accumulation of oxalates in the dissolved form in the leaves [29], and this result is consistent with [6]. The increase in calcium content in leaves may be due to the effects of foliar calcium feeding that stimulates the uptake of mineral nutrients by the roots [30]. These results are consistent with [31] found that the highest calcium content values were 0.62% at 0.6% calcium foliar spray and [7]. The increase in chlorophyll and carotene pigments may also be due to the role of iron in many vital processes of the plant, either through its direct participation as a structural component of building materials or its activation of enzymatic processes within the plant, as iron enters as a factor, assistant and activator for the reactions of forming green pigments through a series of compounds that end with the formation of the chlorophyll molecule, which is consistent with what was mentioned by [32], or through its important role in the process of RNA representation of chloroplasts in the leaves, which are bodies containing chlorophyll. Iron may also enter into the formation of cytochromes, which are of great importance in the processes of photosynthesis and respiration through its role in receiving and transporting electrons, and any defect that

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occurs in these enzymatic pigments as a result of iron deficiency leads to a defect in the process of photosynthesis and yellowing of young leaves and burning of their edges and the tops of plants (4). The increase is also attributed to the role of iron in its participation in the formation of the chlorophyll molecule [33], or its role in improving vital activities and increasing enzymatic activities that lead to stimulating the increase of chlorophyll by increasing the activity of enzymes that stimulate the cessation of ethylene production and inhibiting its work, which plays a role in the activity of the oxidative enzyme of the chlorophyll pigment and also works to destroy and decompose plastids in the plant [34]. This result is consistent with (19; 16). The increase in carbohydrates is due to the important role of calcium in photosynthesis, which is reflected in plant growth and the accumulation of nutrients [35]. Calcium enters into the composition of the cell wall of different cells and controls the permeability of cell membranes and makes them more flexible and elastic [36]., thus increasing the plant's ability to metabolize CO2 (4) and then increasing the manufactured carbohydrates. These results are consistent with [37]. on tomato plants and [38]. on pepper plants. The increase in carbohydrates may be due to the role of iron in encouraging vegetative growth and increasing the flow of nutrients and their transfer to the leaves, stimulating the manufacture of proteins and carbohydrates [39]. This result is consistent with (16 .(

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