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STUDY OF BEARING SOME CARNATION (*DIANTHUS CARYOPHYLLUS* L.) CULTIVARS FOR SALT STRESS UNDER IRAQ CONDITIONS

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Abstract

The study was conducted under unheated plastic houses of the Department of Horticulture and landscape gardening at the College of Agriculture, Al-Qasim Green University, during the growing season 2017-2018, to study the tolerance of some cultivars of *Dianthus caryophyllus* for salt stress under the conditions of Iraq. The addition of the bio vaccine resulted in a significant increase in plant height, number of leaves, Leaf content of total chlorophyll, flower diameter, petals and leaf nutrient content (N, P, K, Na, Cl), which recorded 59.81 cm, 121.32 Leaf .plant^{-1}, 60.12 mg. 100 gm^{-1} fresh weight, 4.04 cm, 30.61 petal.flower^{-1}, 3.92%, 0.36%, 3.70%, 0.34%, 1.42%, respectively. Salt stress reduced the average of vegetative traits and leaves the content of macroelements (N, P, K). Salt stress reduced the average of vegetative traits and the leaves content of macronutrients (N, P, K). The lowest values were recorded in plants growing below the salinity level S4 (9 dsm^{-1}), which caused non-flowering of plants. the triple- interaction treatment between the study factors achieved the best significant values of averages of all studied traits, namely plant height, number of leaves, Leaf content of total chlorophyll, flower diameter, number of petals and leaves the content of nutrients (N, P, K, Na,). Cl, which amounted to 80.90 cm, 193.94 Leaf .plant^{-1}, 95.92 mg.100 gm^{-1} fresh weight, 5.41 cm, 42.17 petals. flower^{-1}, 5.60%, 0.59%, 6.08%, 0.12%, 1.16%, respectively.

Key words: Carnation, salt stress, bio vaccine, cultivars

Introduction

Dianthus caryophyllus L. is one of the plants of the Caryophyllaceae family, whose plants grow in the temperate zone of the northern hemisphere.). This family includes 2,100 species and 89 genus, One is the Dianthus genus, which includes about 300 species, most of which are annual or perennial herbs, and a few are shrubs (Jurgens *et al.,* 2003). It is a perennial herbaceous plant with special education, it needs high technical expertise in order to produce flowers of good commercial quality. Despite the importance of Dianthus and the desire to produce flowers with high-quality specifications, However, we note that environmental factors often stand in the way of this desire, especially the problem of salinity of irrigation water, which limits its cultivation in areas subjective to lack of irrigation water suitable for agricultural irrigation., High salinity causes fatal effects of plants such as low water Potential for plant cells and ionic toxicity of sodium and chloride (Driver *et al.,* 2005). Many field applications have been adopted to reduce the severity of the adverse effects of salinity, such as the use of bacterial and fungal microorganisms that encourage plant growth and increase its And raise its ability to tolerate salt stress by processing some of the necessary elements for plant growth such as nitrogen, which is fixation by the bacterium *Azospirillum* and phosphorus, which are processed by mycorrhizal fungi and reduced by the number of soil reaction. pH) increases the readiness of the minor elements needed by the plant, In addition to its role in the secretion of some acids and hormones that act as growth regulators such as Auxins, Gibberllin, and Cytokinin, It also improves the physical, chemical and biological properties of the soil and increases preservation water (Al – Mashadani and Al– Obaidi, 2016). Many studies have shown that salinity, even at low concentrations, significantly affects in the different physiological processes of plants, which Negatively affect plant height, leaves the area, fresh and dry weight of the vegetative total (Tugwell and Moulds, 1999). When the electrical conductivity of the soil solution more than 4 dsm^{-1} causes a decrease in vegetative growth with the burning of the leaves of most plants (Grieve *et al.,* 1999). Al-Maamouri, (2015) observed when treating two

Table 1: Some chemical and physical traits of the study soil before cultivation.

Traits		Unit	value
PH		-----	7.4
E.C		ds.m^{-1}	1.7
Organic matter		%	0.83
Available ion	N	Mg.k^{-1}	16.8
	P	Mg.k^{-1}	10.5
	K	Mg.k^{-}	168.3
Soil separates (%)	sand	gm.k^{-1}	322
	silt	g.k^{-1}	345
	clay	g.k^{-1}	333
Soil texture		Sandy loam	

Table 2: Chemical trait of Peat moss used in the cultivation.

K_2O mg.L^{-1}	P_2O_5 mg.L^{-1}	N mg.L^{-1}	pH	Salt content g.L^{-1}
80-190	70-180	70-160	5.7-6.5	0.7-0.9

Table 3: shows the salinity levels used in irrigation of Carnation plants.

The salinity levels	Concen-tration (dsm^{-1})	The quality used for irrigation water
S1	1.12	Tap water
S2	3	Mixing the drainage water with the Tap water
S3	6	Mixing the drainage water with the Tap water
S4	9	Mixing the drainage water with the Tap water

Table 4: Shows the most important chemical traits of Tap and drainage water used in the study.

Traits	values	Units	
	Tap water	Drainage water	
pH	7.24	7.85	
EC	1.12	24.3	dsm^{-1}
Ca	5.22	91.55	Meq .L^{-1}
Mg	3.45	74.20	Meq .L^{-1}
Na	3.70	27.80	Meq .L^{-1}
K	0.25	3.00	Meq .L^{-1}
Cl	8.90	179.5	Meq .L^{-1}

Lisianthus cultivars Croma and Mdvantage with salinity levels of 3 dsm^{-1}, 6 dsm^{-1} and 9 dsm^{-1}. High salinity reduced the rates of all vegetative traits. Al-Maamouri (2016) showed that the levels salinity of irrigation water 4 dsm^{-1} and 6 dsm^{-1} had a negative effect on the growth traits of the petunia plant. The Recent studies have proven that inoculation of the interaction between Azospirillum and mycorrhizal fungi, It has an important effect on the growth of ornamental plants and increased nutrient absorption rate. Muzain *et al.*, (2004) were found in the inoculation of Gladiolus with mycorrhizal fungi, bacteria solvent of phosphorus and *Azospirillum* bacteria. Has achieved a significant increase in plant growth and the spike length and his appearance in the early, As well as increasing the number of flowers in the spike and prolong the flowering life of flowers. The lack of interest in cultivating it in order to the cut flowers in Iraq and The lack of studies on the introduction of technologies to increase the tolerance of carnation plant salt tolerance .The study aimed at introducing new cultivars of carnations suitable for commercial harvesting to Iraq and studying their vegetative and floral traits in the region's conditions. It evaluates the tolerance of these cultivars to saline stress resulting from the salinity of irrigation water with the help of some biofertilizers.

Materials and methods

The study was conducted under unheated plastic houses of the Department of Horticulture and landscape gardening at the College of Agriculture, Al-Qasim Green University, to study the tolerance of some cultivars of *Dianthus caryophyllus* for salt stress under the conditions of Iraq. Small seedlings of 8-10 cm length not exceeding four nods were used for five cultivars of carnations produced by Hilverda Kooij company and propagated by tissue culture method. These seedlings were planted in the autumn season on 1/11/2017 in plastic pots with a capacity of 3.500 kg, 25 cm in diameter and 24 cm high after being filled with an agricultural medium of river soil and peatmoss at a ratio of 2 : 1, respectively, with one plant per pot. Before starting the agricultural operations, a random sample of the study soil was taken before mixing it with peat moss. And conducted to chemical and physical analyzes in the laboratories of the Department of Soil Science and Water Resources the College of Agriculture, Al-Qasim Green University. Table 1 shows the results of this analysis, The peat moss traits were installed on the bags and table 2 shows the chemical properties of the German-peat moss produced by Sab-Germany company. All the Agricultural operations of plants breeding were conducted by the producers of commercial cut flowers for all plants in the experimental units and whenever needed. The experiment included three factors: First, five plant cultivars, *Dianthas caryophllus* Culti Orange (V1), *Dianthas caryophllus* Culti Viana(V2), *Dianthas caryophllus* Liberty Culti (V3), *Dianthas caryophllus* Culti Bizet (V4), *Dianthas caryophllus* Culti Mariposa (V5). The second factor is four salinity levels of irrigation water. The third factor is the Bio-vaccine, which is two-levels,without Bio-vaccine

Table 5: Effect of bio-vaccine, the salinity of irrigation water and plant cultivar on The Number of leaves (leaf.plant^{-1}).

Cultivars (V)	The bio-vaccine (M)	The salinity of irrigation water (dsm^{-1})				Interaction
		S_1	S_2	S_3	S_4	M × V
		1.12 Tap water	3	6	9	
V_1Orange	M_0	62.79	56.04	50.04	47.73	54.15
	M_1	78.76	74.54	56.89	48.91	64.77
V_2Viana	M_0	50.47	44.94	37.18	37.67	42.56
	M_1	65.77	61.27	46.27	38.77	53.02
V_3Liberty	M_0	54.34	49.99	42.18	40.94	46.86
	M_1	68.87	64.90	49.88	41.88	56.38
V_4Bizet	M_0	56.30	51.00	43.87	42.65	48.45
	M_1	71.21	67.64	51.57	43.19	58.40
V_5Mariposa	M_0	62.93	56.77	50.47	47.77	54.48
	M_1	80.90	76.90	57.70	50.44	66.48
L.S.D 0.05		11.76				5.88
						V
Interaction S × V	V_1	70.77	65.29	53.46	48.32	59.46
	V_2	58.12	53.10	41.72	38.22	47.79
	V_3	61.60	57.44	46.03	41.41	51.62
	V_4	63.75	59.32	47.72	42.92	53.43
	V_5	71.91	66.83	54.08	49.10	60.48
L.S.D 0.05		8.31				4.16
						M
Interaction M × S	M_0	57.36	51.74	44.75	43.35	49.30
	M_1	73.10	69.05	52.46	44.63	59.81
L.S.D 0.05		5.26				2.63
The salinity of irrigation water (S)		65.23	60.40	48.60	43.99	
L.S.D 0.05		3.72				

(M0), Producer at the office of agricultural research of the Ministry of Higher Education and Scientific Research. The mixture was placed in the pit for planting seedlings, and the bio- vaccine was in contact with the roots of the planted carnation seedlings. The four salinity levels were prepared by calculating the amount of drainage water mixed with tap water using the mixing equation proposed by the employees of the American Salinity Laboratory (Richards, 1954) For the purpose of reaching the concentrations shown in the table 3.

$$\text{Mixing equation } \frac{V_g}{V_p} = \frac{S_p - S_b}{S_p - S_g}$$

v_g : The volume of good water (Tap water), v_p : the volume of salinity (Drainage water).

s_p : Salinity salt water (Drainage water), s_p : salinity required, s_g : good salinity water (Tap water).

Irrigation was conducted to manually at the level of attrition 50% availability to absorption water.

The Randomized Complete Block Design (RCBD) was conducted with a Factorial Experiment (5 × 4 × 2). The number of study plants was 600 plants and the averages for all study indicators and were compared to according to the test of less significant difference (L.S.D) under 5% probability level.

Results and discussion

The Plant height (cm)

The results in Table 5 showed that the treatment of the bio- vaccine (M1)was significantly excelled in the plant height. The bio- vaccine treatment with *Glomus mosseae* and *Azospirillum brasilense* gave the highest value of the plant height amounted to 59.81 cm. This is an increase of 21.31% compared to without Bio- vaccine treatment (M0), which recorded the lowest average of plant height amounted to 49.30 cm. The results showed a significant negative effect on plant height as the salinity of irrigation water increased. The tap water treatment S1 was significantly excelled for all treatments which recorded the highest average of plant height amounted to 65.23 cm, while the irrigation treatment S4 (9dsm^{-1}) recorded the lowest average for this trait amounted to 43.99 cm. The results of the same table showed the significant effect of plant cultivars on plant height. The plant cultivar V5 (Mariposa) achieved the best results of this trait amounted to 60.48 cm without significant difference from the plant cultivar V1 (Orange), which recorded amounted to 59.46 cm, while the lowest average the plant height amounted to 47.79 cm recorded by plant cultivar V2 (Viana). In the triple- interaction treatment between the study factors, treatment V5S1M1 recorded the best results for plant height amounted to of 80.90 cm, without significant difference with treatments V1S1M1, V5S2M1, V1S2M1 and V4S1M1, which recorded amounted to 78.76, 76.90, 74.54 and 71.21 cm respectively, while V2S4M0 treatment recorded the lowest values for this traits amounted to 37.67 cm.

The Number of leaves (leaf.plant^{-1})

The bio- vaccine treatment contributed to a significant increase in the number of leaves as shown in Table 6 The treatment was recorded the highest average of this trait amounted to 121.32 leaf.plant^{-1} an increase of 25.43%, compared to without Bio-vaccine treatment which recorded to 96.72 leaf.plant^{-1}. All salinity treatments differed significantly. The salinity treatment level S1 (tap water) exceeded on all treatment by recording the highest number of leaves amounted to 132.57 leaf.plant^{-1} followed by The salinity treatment level S2 (3dsm^{-1}) which gave a value amounted to 123.37 leaf.plant^{-1}, The number of leaves decreased to 83.62 leaf.plant^{-1} in the salinity treatment level S4 (9dsm^{-1}). The results of the same table showed the significant effect of plant cultivars on the number of leaves Plant . The plant cultivar V5 (Mariposa) gave a height number of leaves amounted to 119.94 leaf.plant^{-1}, Compared with plant cultivars V2 (Viana), which gave the lowest average amounted to 101.34 leaf.plant^{-1}. The results of the triple-interaction between the study factors in the same table showed a significant effect in this trait as well, as the V5S1M1 treatment was significantly excelled by giving the highest average amounted to 193.94 leaf.plant^{-1} and without a statistical difference with treatment V5S2M1 which gave value amounted to 188.77 leaf.plant^{-1}, while treatment V1S4M0 gave the lowest average for this trait amounted to 60.01 leaf.plant^{-1}.

Leaf content of total chlorophyll (mg.100g^{-1} fresh weight)

The total content of chlorophyll in Carnation leaves was significantly affected by adding the bio-vaccine as shown in Table 7. The Bio-vaccine treatment was significantly excelled by giving the highest value of the total content of chlorophyll in the leaves of Carnation amounted to 60.12 mg.100g^{-1} fresh weight. Compared to without Bio- vaccine treatment which recorded to the lower value amounted to 44.34 mg.100g^{-1} fresh weight Similarly, the salinity of irrigation water decreased as the total content of chlorophyll decreased by increasing the levels of salinity irrigation water. and the treatment S4 (9 dsm^{-1}) recorded to the lowest total content of chlorophyll amount of 25.05 mg.100g^{-1} fresh weight while the treatment S1 (tap water) was significantly excelled by giving the highest value of the total content of chlorophyll in the leaves of Carnation amounted to 75.30 mg.100g^{-1} fresh weight. The results of the same table showed the significant effect of plant cultivars on Leaf content of total chlorophyll. The plant cultivar V5 (Mariposa) gave a height value of this trait amounted to58.85 mg.100g^{-1} fresh weight, Compared with plant cultivars V2 (Viana), which gave the lowest average amounted to 55.11 mg.100g^{-1} fresh weight. The results of the triple- interaction between the study factors in the same table showed a significant effect on this trait as well, as the V5S1M1 treatment was significantly excelled by giving the highest average amounted to 95.92 mg.100g^{-1} fresh weight,Not significantly different from treatments V5S2M1 and V1S1M1, which gave (92.07 and 87.73) mg.100g^{-1} fresh weight, respectively, while treatment V2S4M0 gave the lowest average for this trait amounted to 21.76 mg.100g^{-1} fresh weight.

Table 6: Effect of bio-vaccine, the salinity of irrigation water and plant cultivar on The Number of leaves (leaf.plant^{-1}).

Cultivars (V)	The bio-vaccine (M)	The salinity of irrigation water (dsm^{-1}) S_1 1.12 Tap water	S_2 3	S_3 6	S_4 9	Interaction M × V
V_1Orange	M_0	117.99	103.18	91.43	60.01	93.15
	M_1	160.24	155.31	100.88	92.10	127.13
V_2Viana	M_0	108.93	101.79	92.91	77.88	95.37
	M_1	122.18	117.08	99.54	90.43	107.30
V_3Liberty	M_0	111.62	101.81	92.99	82.04	97.11
	M_1	130.43	125.43	100.48	90.84	111.79
V_4Bizet	M_0	115.72	102.54	96.90	86.43	100.39
	M_1	142.94	137.91	100.49	90.86	118.05
V_5Mariposa	M_0	121.77	99.94	90.77	77.77	97.56
	M_1	193.94	188.77	98.69	87.86	142.31
L.S.D 0.05		13.13				6.56
						V
Interaction S × V	V_1	139.11	129.24	96.16	76.05	110.14
	V_2	115.55	109.43	96.22	84.15	101.34
	V_3	121.02	113.62	96.73	86.44	104.45
	V_4	129.33	120.22	98.69	88.64	109.22
	V_5	157.85	144.35	94.73	82.81	119.94
L.S.D 0.05		9.28				4.64
						M
Interaction M × S	M_0	115.20	101.85	93.00	76.82	96.72
	M_1	149.94	144.90	100.01	90.41	121.32
L.S.D 0.05		5.87				2.94
The salinity of irrigation water (S)		132.57	123.37	96.51	83.62	
L.S.D 0.05		4.15				

The Flower diameter (cm)

The results in Table 5 showed that the plants treated with bio- vaccine gave the largest flower diameter amounted to 4.04 cm, Morally significantly and an increase of amounted to 44.80% compared to without

Table 7: Effect of bio-vaccine, the salinity of irrigation water and plant cultivar on The Leaf content of total chlorophyll(mg.100g^{-1} fresh weight).

Cultivars (V)	The bio-vaccine (M)	The salinity of irrigation water (dsm^{-1})				Interaction
		S_1	S_2	S_3	S_4	M × V
		1.12 Tap water	3	6	9	
V_1Orange	M_0	70.56	56.05	38.60	22.61	46.95
	M_1	87.73	83.89	52.30	29.11	63.26
V_2Viana	M_0	62.67	46.25	23.17	21.76	38.46
	M_1	74.62	70.94	45.61	24.18	53.84
V_3Liberty	M_0	64.51	52.17	33.10	22.17	42.99
	M_1	78.35	74.35	48.70	24.41	56.45
V_4Bizet	M_0	66.35	53.08	37.78	22.35	44.89
	M_1	79.08	74.93	50.39	26.80	57.80
V_5Mariposa	M_0	73.20	56.14	40.83	23.50	48.42
	M_1	95.92	92.07	55.47	33.65	69.28
L.S.D 0.05		12.19				6.10
						V
Interaction S × V	V_1	79.14	69.97	45.45	25.86	55.11
	V_2	68.64	58.60	34.39	22.97	46.15
	V_3	71.43	63.26	40.90	23.29	49.70
	V_4	72.71	64.00	44.08	24.57	51.34
	V_5	84.56	74.10	48.15	28.57	58.85
L.S.D 0.05		8.62				4.31
						M
Interaction M × S	M_0	67.46	52.74	34.69	22.48	44.34
	M_1	83.14	79.23	50.49	27.63	60.12
L.S.D 0.05		5.45				2.73
The salinity of irrigation water (S)		75.30	65.99	42.59	25.05	
L.S.D 0.05		3.86				

Table 8: Effect of bio-vaccine, the salinity of irrigation water and plant cultivar on the Flower diameter (cm)

Cultivars (V)	The bio-vaccine (M)	The salinity of irrigation water (dsm^{-1})			Interaction
		S_1	S_2	S_3	M × V
		1.12 Tap water	3	6	
V_1Orange	M_0	3.57	2.93	2.43	2.98
	M_1	4.98	4.63	2.80	4.14
V_2Viana	M_0	2.71	2.36	1.98	2.35
	M_1	4.63	4.28	2.23	3.72
V_3Liberty	M_0	2.81	2.57	2.00	2.46
	M_1	4.63	4.28	2.33	3.75
V_4Bizet	M_0	3.53	2.90	2.33	2.92
	M_1	4.94	4.59	2.77	4.10
V_5Mariposa	M_0	3.79	3.17	2.65	3.21
	M_1	5.41	5.06	3.04	4.51
L.S.D 0.05		1.77			1.02
					V

Table 8 continued ......

Bio- vaccine treatment, which has a flower diameter amounted to 2.79 cm. The increase in the salinity of irrigation water led to a decrease in the average of the flower diameter. The treatment (S3) gave the smallest flower diameter amounted to 2.46 cm and a decreasing percentage of 40.0%. Compared to the treatment S1 which gave the largest flower diameter amounted to 4.10 cm. The results of the same table showed the significant effect of plant cultivars on flower diameter. The plant cultivar V5 (Mariposa) recorded the average of flower diameter amounted to 3.86 cm without significant difference from the plant cultivars V1 (Orange) and V4 (Bizet), which recorded amounted to(3.51, 3.56) cm, while the lowest average the plant height amounted to 3.04 cm recorded by plant cultivar V2 (Viana). From the results of the triple- interaction between the study factors, the V5S1M1 treatment was significantly excelled by giving the highest average of the flower diameter of 5.41 cm, while treatment V2S3M0 gave the Smaller flower diameter amounted to 1.98 cm.

The Number of petals (petals. flower $^{-1}$)

The results in Table 9 showed that Pollinated plants with biofertilizers were significantly excelled which Its flowers have the largest number of petals amounted to 30.61 petals. flower $^{-1}$. An increase amounted to 49.38%, compared to non-pollinated plants with Bio- vaccine whose flowers had the lowest number of petals of 20.49 petals. flower $^{-1}$. The results showed a significant negative effect on Number of petals when the salinity of irrigation water increased, which was accompanied by an increase in the salinity levels of irrigation water. the treatment S3 (6dsm^{-1}) had the lowest number of petals amounted to 17.30 petals. flower $^{-1}$, a decreasing percentage of 44.95 %, compared to S1 (tap water), which recorded the highest number of petals was 31.43 petals. flower $^{-1}$. The plant cultivar V5 (Mariposa) was recorded a height number of leaves amounted to 29.60 petals. flower^{-1}, without significant difference from the plant cultivar V1 (Orange) and V4 (Bizet), which recorded amounted to 26.82 and 26.34 petals. flower $^{-1}$ successively, while the class V2 (Viana)

Table 8 continued ......

Interaction S × V	V_1	4.28	3.78	2.62	3.56
	V_2	3.67	3.32	2.11	3.04
	V_3	3.72	3.43	2.17	3.11
	V_4	4.24	3.75	2.55	3.51
	V_5	4.60	4.12	2.85	3.86
L.S.D 0.05		1.25			0.72
					M
Interaction M × S	M_0	3.29	2.79	2.28	2.79
	M_1	4.92	4.57	2.64	4.04
L.S.D 0.05		0.79			0.46
The salinity of irrigation water (S)		4.10	3.68	2.46	
L.S.D 0.05		0.56			

Table 9: Effect of bio-vaccine, the salinity of irrigation water and plant cultivar on the Number of petals (petals. flower $^{-1}$).

Cultivars (V)	The bio-vaccine (M)	The salinity of irrigation water (dsm^{-1})			Interaction
		S_1	S_2	S_3	M × V
		1.12 Tap water	3	6	
V_1Orange	M_0	27.00	22.44	16.90	22.11
	M_1	38.93	35.00	20.66	31.53
V_2Viana	M_0	20.86	17.11	12.89	16.95
	M_1	35.00	32.44	15.33	27.59
V_3Liberty	M_0	21.77	18.64	12.96	17.79
	M_1	35.00	32.11	15.70	27.60
V_4Bizet	M_0	25.99	21.95	16.00	21.31
	M_1	38.37	35.11	20.64	31.37
V_5Mariposa	M_0	29.25	24.48	19.04	24.26
	M_1	42.17	39.78	22.90	34.95
L.S.D 0.05		9.87			5.70
					V
Interaction S × V	V_1	32.97	28.72	18.78	26.82
	V_2	27.93	24.78	14.11	22.27
	V_3	28.39	25.38	14.33	22.70
	V_4	32.18	28.53	18.32	26.34
	V_5	35.71	32.13	20.97	29.60
L.S.D 0.05		6.97			4.03
					M
Interaction M × S	M_0	24.97	20.92	15.56	20.49
	M_1	37.89	34.89	19.05	30.61
L.S.D 0.05		4.41			2.55
The salinity of irrigation water (S)		31.43	27.91	17.30	
L.S.D 0.05		3.12			

gave the lowest number of petals reached 22.27 petals. flower $^{-1}$. The results of the triple- the interaction between the study factors showed the largest number of petals was in the flowers of the treatment plants V5S1M1, which was amounted to 42.17 petals. flower $^{-1}$. The lowest number of this trait amounted to 12.89 petals. flower $^{-1}$. When treatment V2S3M0.

Percentage of nitrogen in leaves (%)

The results in table 10 showed That there was a significant response to adding Bio-vaccine in Percentage of nitrogen in leaves (%), The bio-vaccine treatment was significantly excelled and gave the highest rate of this trait amounted to 3.92%, an increase of 24.44% compared to without Bio-vaccine treatment which recorded 3.15%. The results of the same table showed that the increase in the levels of salinity of irrigation water led to a significant decrease in the percentage of nitrogen in the leaves. The salinity level S1 (Tap water) which recorded the highest average of the percentage of nitrogen in leaves amounted to 4.38% compared to the treatment of S4 ($9dsm^{-1}$) which recorded the lowest rate of 2.84%. Which gave percentage amounted to 3.02%. The results showed the significant effect of plant cultivars on the percentage of nitrogen in Carnation leaves. The plant cultivar V5 (Mariposa) gave a height percentage of nitrogen in leaves amounted to 3.83% and no statistical difference with V1 (Orange) which recorded 3.75%, while plant cultivars V2 was recorded the lowest nitrogen content in the leaves amounted to 3.17%. In the triple- interaction between the study factors, the V5S1M1 treatment was significantly excelled by giving the highest average of this trait amounted to 5.60%, without significant difference with treatments V1S1M1, V3S1M1, V4S1M1 and V5S2M1, which gave 5.23, 4.97, 4.97 and 4.95% respectively, while V2S4M0 treatment recorded the lowest values for this trait amounted to2.46%.

The percentage of phosphorus in leaves (%)

The use of bio-vaccine achieved a significant increase in the percentage of phosphorus in leaves, as the results in Table 11 shows an increase in the average percentage of phosphorus in the leaves from 0.26% without the use of bio-vaccine to 0.36% by treating the bio-vaccine, An increase of amounted to 38.46%. The salt stress was caused a significant reduction in the percentage of phosphorus in the leaves, decreased from 0.46% in The salinity level S1 (Tap water) to 0.17% in the treatment of the salinity level S4 ($9dsm^{-1}$) and it's a decreasing of 63.04% The plant cultivars V5 (Mariposa) gave the highest percentage of phosphorus in the leaves amounted to 0.35% and no statistical difference with the cultivar V1 (Orange) which gave 0.34% compared to the plant cultivar V2 (Viana) which

Table 10: Effect of bio-vaccine, the salinity of irrigation water and plant cultivar on the Percentage of nitrogen in leaves (%).

Cultivars (V)	The bio-vaccine (M)	The salinity of irrigation water (dsm^{-1})				Interaction
		S_1	S_2	S_3	S_4	M × V
		1.12 Tap water	3	6	9	
V_1Orange	M_0	3.97	3.60	3.18	3.01	3.38
	M_1	5.23	4.84	3.29	3.11	4.12
V_2Viana	M_0	3.30	2.81	2.60	2.46	2.79
	M_1	4.60	4.25	2.79	2.55	3.54
V_3Liberty	M_0	3.53	3.10	2.86	2.75	3.06
	M_1	4.97	4.50	2.99	2.78	3.81
V_4Bizet	M_0	3.62	3.10	2.92	2.75	3.10
	M_1	4.97	4.53	3.03	2.85	3.85
V_5Mariposa	M_0	3.99	3.80	3.20	3.03	3.40
	M_1	5.60	4.95	3.36	3.13	4.26
L.S.D 0.05			0.76			0.38
						V
Interaction S × V	V_1	4.60	4.10	3.24	3.06	3.75
	V_2	3.95	3.53	2.70	2.51	3.17
	V_3	4.25	3.80	2.93	2.77	3.44
	V_4	4.30	3.82	2.98	2.80	3.47
	V_5	4.80	4.17	3.28	3.08	3.83
L.S.D 0.05			0.54			0.27
						M
Interaction M × S	M_0	3.68	3.15	2.95	2.80	3.15
	M_1	5.07	4.61	3.09	2.88	3.92
L.S.D 0.05			0.34			0.17
The salinity of irrigation water (S)		4.38	3.88	3.02	2.84	
L.S.D 0.05			0.24			

Table 11: Effect of bio-vaccine, the salinity of irrigation water and plant cultivar on the percentage of phosphorus in leaves (%).

Cultivars (V)	The bio-vaccine (M)	The salinity of irrigation water (dsm^{-1})				Interaction
		S_1	S_2	S_3	S_4	M × V
		1.12 Tap water	3	6	9	
V_1Orange	M_0	0.43	0.32	0.22	0.16	0.28
	M_1	0.56	0.55	0.29	0.19	0.40
V_2Viana	M_0	0.35	0.23	0.19	0.12	0.22
	M_1	0.45	0.44	0.22	0.17	0.32
V_3Liberty	M_0	0.40	0.30	0.20	0.14	0.26
	M_1	0.46	0.45	0.23	0.18	0.33
V_4Bizet	M_0	0.40	0.31	0.22	0.15	0.27
	M_1	0.49	0.48	0.25	0.19	0.35
V_5Mariposa	M_0	0.45	0.32	0.22	0.16	0.29
	M_1	0.59	0.58	0.30	0.19	0.42
L.S.D 0.05			0.08			0.04
						V

Table 11 continued ......

recorded the lowest percentage of phosphorus in the leaves amounted to 0.27%. When the triple- interaction between the study factors, they showed the best results. the treatment (V5S1M1) gave the highest percentage of phosphorus in the leaves gave 0.59% and no statistical difference with V1S1M1 treatment which gave 0.56%.

Percentage of potassium in leaves (%)

The results in Table 12 shows that bio-vaccinated with mycorrhiza fungi and *Azospirillum* bacteria resulted in a significant increase in the percentage of potassium in the leaves. Percentage of potassium in leaves (%)The results in Table 12 shows that bio- vaccinated with mycorrhizal fungi and *Azospirillum* bacteria resulted in a significant increase in the percentage of potassium in the leaves. The Bio-vaccine treatment (M1) gave the highest average of amounted to 3.70% and an increase of 28.02% Compared to without Bio- vaccine treatment (M0) which recorded to the lower value amounted to 2.89%. The salinity treatment level S1 (Tap water) showed was significantly excelled in the percentage of potassium in the leaves, giving the highest percentage of this trait of 4.41% and without a statistical difference with the treatment of the salt level S2 ($3dsm^{-1}$), compared with the treatment of the salt level S4 (9dsm -1.) with the lowest rate of 2.12%.The plant cultivar achieved a significant increase in the percentage of potassium in the leaves, the Plant cultivar V5 (Mariposa) recorded the highest average of 4.02%, while the percentage of potassium decreased to the lowest level in plant cultivar V2 (Viana) to reach 2.88%. the triple-interaction between the study factors shown in the same table show that the treatment V5S1M1 gave the highest percentage of potassium in the leaves amounted to 6.08% compared to the treatment V2S4M0, which gave the lowest average this trait amounted to 1.76%.

Percentage of sodium in leaves (%)

The results in Table 13 indicate that The bio-vaccine was significantly reduced the adverse effects of irrigation at the salt levels,

Table 11 continued ......

Interaction S × V	V_1	0.50	0.44	0.26	0.18	0.34
	V_2	0.40	0.34	0.21	0.15	0.27
	V_3	0.43	0.38	0.22	0.16	0.30
	V_4	0.45	0.40	0.24	0.17	0.31
	V_5	0.52	0.45	0.26	0.18	0.35
L.S.D 0.05			0.05			0.03
						M
Interaction M × S	M_0	0.41	0.30	0.21	0.15	0.26
	M_1	0.51	0.50	0.26	0.18	0.36
L.S.D 0.05			0.03			0.02
The salinity of irrigation water (S)		0.46	0.40	0.23	0.17	
L.S.D 0.05			0.02			

Table 12: Effect of bio-vaccine, the salinity of irrigation water and plant cultivar on the Percentage of potassium in leaves (%).

Cultivars (V)	**The bio-vaccine (M)**	**The salinity of irrigation water (dsm^{-1})**				**Interaction M × V**
		S_1	**S_2**	**S_3**	**S_4**	
		1.12 Tap water	**3**	**6**	**9**	
V_1Orange	M_0	4.21	3.16	2.29	1.97	2.90
	M_1	4.85	4.82	3.10	2.10	3.71
V_2Viana	M_0	3.37	2.89	1.99	1.76	2.50
	M_1	4.23	4.20	2.70	1.96	3.27
V_3Liberty	M_0	3.60	3.11	2.28	1.90	2.72
	M_1	4.34	4.30	2.82	2.09	3.38
V_4Bizet	M_0	3.94	3.16	2.29	1.97	2.84
	M_1	4.77	4.53	2.99	2.09	3.60
V_5Mariposa	M_0	4.77	3.75	2.85	2.55	3.48
	M_1	6.08	5.69	3.66	2.82	4.56
L.S.D 0.05			1.73			0.86
						V
Interaction S × V	V_1	4.53	3.99	2.69	2.03	3.31
	V_2	3.80	3.54	2.34	1.86	2.88
	V_3	3.97	3.70	2.55	1.99	3.05
	V_4	4.35	3.84	2.64	2.03	3.22
	V_5	5.42	4.72	3.25	2.68	4.02
L.S.D 0.05			1.22			0.61
						M
Interaction M × S	M_0	3.96	3.21	2.34	2.03	2.89
	M_1	4.85	4.71	3.05	2.21	3.70
L.S.D 0.05			0.77			0.39
The salinity of irrigation water (S)		4.41	3.96	2.69	2.12	
L.S.D 0.05			0.55			

which was reflected in the decrease of sodium ion accumulation from 0.49% in the without bio- vaccine treatment to 0.34% in the vaccine treatment and a significant decrease of 30.61%. The levels of sodium ions decreased significantly with lower salinity levels of irrigation water, The levels of sodium ions decreased significantly with lower salinity levels of irrigation water. The salinity level S1 (Tap water) recorded the lowest accumulation of these ions amounted to 0.17% and a decrease of 75.71% compared to the treatment of The salinity level S4 ($9dsm^{-1}$) which gave the highest accumulation average amounted to 0.70%.The results of the same table indicated the significant effect of the plant cultivars on the percentage of sodium in the leaves, where the plant cultivar V5 (Mariposa) recorded the lowest percentage of this trait amounted to 0.38% and without a statistical difference with the plant cultivar V1 (Orange) which gave 0.39%, while the cultivar V2 (Viana) was recorded the highest percentage of sodium in the leaves amounted to 0.46%. From the results of the statistical analysis of the triple- interaction between the study factors shows the significant effect of the bio- vaccine and plant cultivars in reducing the Percentage of sodium ions in the leaves when they interact with the salinity of irrigation, the treatment V5S1M1 gave the lowest percentage of sodium ions in leaves amounted to 0.12%,Which did not significantly differ with triple-interaction treatment (V3S1M1, V5S2M1, V1S2M1, V4S2M1, V2S1M1, V3S2M1) while the treatment V2S4M1 which gave the highest average of this trait amounted to 0.87%.

Percentage of chlorine in leaves (%)

The results in Table 14 show the ability of the bio vaccine to significantly reduced the percentage of chlorine in the leaves. It amounted to 1.42%, Compared to without Bio- vaccine treatment which recorded 1.65% and with a significant decrease percentage of 13.93%. The results of the same table show that all irrigation water treatment were significantly different between them. The salinity treatment level S1 (Tap water) was excelled of all other treatments which recorded the lowest average of this trait amounted to 1.40%. followed by the treatment of S2 and S3, While the ratio increased to 1.68% in the treatment of the salinity level S4 ($9dsm^{-1}$). The results of the same table showed was significantly excelled of the plant cultivar in

Table 13: Effect of bio-vaccine, the salinity of irrigation water and plant cultivar on the Percentage of sodium in leaves (%)

Cultivars (V)	The bio-vaccine (M)	The salinity of irrigation water (dsm^{-1})				Interaction
		S_1	S_2	S_3	S_4	M × V
		1.12 Tap water	3	6	9	
V_1Orange	M_0	0.17	0.40	0.51	0.71	0.45
	M_1	0.13	0.15	0.45	0.61	0.34
V_2Viana	M_0	0.28	0.45	0.62	0.87	0.56
	M_1	0.16	0.18	0.48	0.66	0.37
V_3Liberty	M_0	0.22	0.42	0.57	0.85	0.52
	M_1	0.14	0.16	0.46	0.66	0.36
V_4Bizet	M_0	0.20	0.42	0.52	0.75	0.47
	M_1	0.13	0.15	0.45	0.61	0.34
V_5Mariposa	M_0	0.17	0.39	0.50	0.68	0.44
	M_1	0.12	0.14	0.44	0.61	0.33
L.S.D 0.05			0.06			0.03
V						
InteractionS × V	V_1	0.15	0.28	0.48	0.66	0.39
	V_2	0.22	0.32	0.55	0.77	0.46
	V_3	0.18	0.29	0.52	0.76	0.44
	V_4	0.17	0.29	0.49	0.68	0.40
	V_5	0.15	0.27	0.47	0.65	0.38
L.S.D 0.05			0.04			0.02
M						
InteractionM × S	M_0	0.21	0.42	0.54	0.77	0.49
	M_1	0.14	0.16	0.46	0.63	0.34
L.S.D 0.05			0.03			0.01
The salinity of irrigation water (S)		0.17	0.29	0.50	0.70	
L.S.D 0.05		0.02				

the percentage of chlorine in the leaves, Plant cultivar V5 (Mariposa) and V1 (Orange) recorded the lowest percentage of chlorine in leaves amounted to 1.36 and 1.36%, respectively. While the plant cultivar V2 (Viana) recorded the highest percentage of this trait amounted to 1.68%. The treatment V5S1M1 was significantly excelled which recorded the lowest percentage of 1.16%, compared to the treatment V2S4M0 which gave the highest percentage of chlorine in the leaves amounted to 2.08%.

The results of the tables (5-14) show that the use of the bio vaccine consisting of mycorrhizal fungi *Glomus mosseae* and bacteria *Azospirillum brasilense*, It led to promoted plant growth through strategies in which this biological system works, such as stimulating metabolic activities, Increase the plant's ability to nutrient absorption and produce different growth regulators and increase plant resistance to biotic and abiotic stresses (Al-Maamory, 2016; Bashan and de-Bashan, 2010; Mohammed and Abdul Hadi, 1982 ; Saharan and Nehra, 2011) It achieved a significant increase in vegetative growth indicators (plant height, number of leaves, and total chlorophyll content). This may be due to the role of the bio vaccine in the secretion of the enzyme Acc-deaminase, which works to change the path of senescence hormone synthesis (ethylene) Delay the destroy of chlorophyll and then continue the photosynthesis process and the transfer of its vital products to other plant parts causing increased plant growth. The physiological and metabolic activities of plants are greatly influenced by the activity of nitrogen-fixing organisms, Which reflected on plant growth, This effect may be due to Processing plant with vital nitrogen fixation, which increases the activity of plant hormones such as Auxins, Gibberellins and Cytokinines within the tissues of the plant, which plays a major role in the division and elongation of plant cells and thus increase the number of leaves and leaf area (Bolandnazar *et al.,* 2008). This leads to increased processing of food and carbohydrates that may achieve adequate and balanced nutrition of the plant, which improves the qualities of vegetative growth and development, Which is reflected positively on the flower diameter and the number of petals (Shaheen *et al.,* 2007; Shin *et al.,* 2001). In addition to its role in increasing the levels of potassium, which plays an important role in promoting cell division and expansion and growth of Meristematic tissues (Nazhat and Al-Mukhtar, 1987; Martinez-Medina *et al.,* 2001). *Azospirillum* leads to major alterations in the root system due to the secretion of large quantities of growth regulators such as IAA, which has the ability to control the formation of roots and provide Elasticity for cell walls and cytokinin, which has a role in increasing the rate of water absorption by the roots and increase transpiration. And thus improve the absorption and transport of mineral ions such as nitrates, phosphorus, potassium, etc., which are led by transpiration (Haroun *et al.,* 2003; Vessey, 2003). In addition, the ability of *mycorrhizae* to improve soil construction and its physical and chemical properties through the secretion of Glomalin, which binds soil particles, thereby improving its properties (AL maemuri, 2017). This is reflected in the formation of strong and active roots, which in turn is reflected in the increased

Table 14: Effect of bio-vaccine, the salinity of irrigation water and plant cultivar on the Percentage of chlorine in leaves (%).

Cultivars (V)	The bio-vaccine (M)	The salinity of irrigation water (dsm^{-1})				Interaction M × V
		S_1 1.12 Tap water	S_2 3	S_3 6	S_4 9	
V_1Orange	M_0	1.30	1.42	1.48	1.55	1.44
	M_1	1.17	1.22	1.36	1.40	1.29
V_2Viana	M_0	1.67	1.76	1.81	2.08	1.83
	M_1	1.42	1.49	1.57	1.63	1.53
V_3Liberty	M_0	1.62	1.74	1.80	2.07	1.81
	M_1	1.39	1.43	1.57	1.61	1.50
V_4Bizet	M_0	1.61	1.73	1.78	1.91	1.76
	M_1	1.38	1.43	1.56	1.61	1.49
V_5Mariposa	M_0	1.30	1.42	1.48	1.54	1.44
	M_1	1.16	1.21	1.36	1.40	1.28
L.S.D 0.05			0.21			0.11
						V
Interaction S × V	V_1	1.24	1.32	1.42	1.48	1.36
	V_2	1.55	1.63	1.69	1.85	1.68
	V_3	1.50	1.58	1.68	1.84	1.65
	V_4	1.50	1.58	1.67	1.76	1.62
	V_5	1.23	1.32	1.42	1.47	1.36
L.S.D 0.05			0.15			0.08
						M
Interaction M × S	M_0	1.50	1.62	1.67	1.83	1.65
	M_1	1.31	1.35	1.48	1.53	1.42
L.S.D 0.05			0.10			0.05
The salinity of irrigation water (S)		1.40	1.48	1.58	1.68	
L.S.D 0.05		0.07				

absorption of macronutrients (N, P, K) as well as the development of the mechanism of transfer of sodium ions to the vegetative total and prevent its accumulation inside the cell (AL-Samerria and Rahi, 2006) This is positively reflected in reducing the osmotic potential of plant cells and improving cell membrane construction and increasing its efficiency (Shekoofeh and Shahla. 2012; Smith and Read. 2008). As well as its ability to stimulate the roots of the plant to distinguish in the absorption of ions in soil solution and thus make the probability of concentration of sodium and chlorine within the levels tolerated by the plant (Al-Hadithi, and AlSharef, 2015). As for the effect of salt stress, the results of the same tables show that the values of the indicators under consideration are decreasing with increasing salinity levels of irrigation water This may be due to the effect of salt stress on plant growth, as the high salinity concentration in the medium of agriculture causes confusion in the ion balance in plants as well as unbalanced absorption of nutrients and then their impact on the effectiveness of enzymes, especially enzymes related to biological activities and plant metabolism and this is reflected negatively on the processes of division and elongation of plant cells and then inhibition of plant growth indicators (Hamdia and Shadad. 2010; Younis and Kazamel, 2010). The results of the same tables showed that plant cultivars differed in the indicators under consideration. This may be due to the effect of genetic factors among the cultivars as well as the different sensitivity of these cultivars to tolerate the salinity levels of irrigation water.

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