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Effect of Salinity Treatments on Vegetative Characteristics and Leaves Chemical Content of Transplants of Five Olive Cultivars

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Abstract: The present study was carried out during the period from 2009 to 2010 in greenhouse of the Pomology Department, Faculty of Agriculture, Cairo University on five olive (*Olea europaea* L.) cultivars (Picual, Koroneiki, Manzanillo, Coratina and Eggizi Shami, were grown under greenhouse condition. One-year-old uniformed transplants were transplanted in sand culture and were irrigated by saline water. Sodium chloride was used at 0 (control), 50, 100, 150 and 200 mM/L. Results could be summarized as follows: Increasing salinity concentration decreased the survival percentage, transplant length, leaves number / transplant, leaf area, leaves content of N, P, K, Ca and chlorophyll. But increased leaf content of Na, Cl and proline.

Key words: *Olea europaea* L. · Salinity · Vegetative characteristics · Chemical content

INTRODUCTION

Olive (*Olea europaea* L.) plays an important role in the agriculture products in many countries. Olive trees are considered oldest known cultivated trees in the world and it has been part of the Mediterranean civilization science before recorded history. Olive cultivation is concentrated in the Mediterranean basin and its surrounding [1, 2]. The olive tree was cultivated in Egypt thousands years ago. Nowadays olive is one of the favorable choice for cultivation in arid areas due to its high stress tolerance. Olive is suitable for cultivation in new reclaimed lands in Sinai, El Sadat, Eastern desert and Oases. In 2009, olive production was 500000 tons produced from 110000 ha [3]. Salinity stress is one of the main problems facing olive growers. Salinity of irrigation water can impair the performance of growth and production of olives.

The objective of this investigation was to evaluate salt tolerance of five olive studied cultivars (Picual, Koroneiki, Manzanillo, Coratina and Eggizi Shami); salinity effects on vegetative characteristics (survival percentage, transplant length, leaves number/ transplant and average leaf area) and leaves chemical content of studied olive cultivars.

MATERIALS AND METHODS

The present study was carried out during the period from 2009 to 2010 on five olive (*Olea europaea* L.) cultivars (Picual, Koroneiki, Manzanillo, Coratina and Eggizi Shami), uniform, 1-year-old own -rooted plant were transplanted in plastic pots 7 L, each pot filled with a constant weight (6 kg) of sand soil and plants were pruned to single shoot, plants were irrigated daily with water only for two weeks before salinization treatments begin.

Five treatments were done on five olive cultivars, five salinity levels were used NaCl solution was used at 0 (control), 50, 100, 150 and 200 mM/L. The plants received the recommended agricultural practices (fertilization and pest diseases control).

Vegetative Characteristics

Survival Percentage: Survival percentage was determined at the end of September during 2009 and 2010 seasons.

Transplant Length (cm): Plant height was estimated from the soil surface till the top of plant at the end of September during 2009 and 2010 seasons.

Leaves Number/ Transplant: The ultimate number of leaves / transplant was recorded.

Average Leaf Area (cm^2): Average leaf area of the basal 6^{th} and 7^{th} leaves (15 leaves) was determined by formula according to Ahmed and Morsy [4].

Leaf area = $0.53(L \times W) + 1.66$.
L = Length of leaf W= Width of leaf

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Leaves Chemical Content: Leaves samples were taken from the 6th and 7th leaves on the shoots which were picked at mid of August. After washing it several times with tap water then dried to constant weight at 70°C then the sample was digested in a mixture of sulphuric and perchloric acids according to Piper [5] and the following determinations were carried out as percent of dry weight:

Nitrogen Percentage: Total nitrogen percentage (%) was determined according to Novozamsky *et al.* [6].

Phosphorous Percentage: Phosphorous content was determined on the ground dry material of leaf by using Spectrophotometer according to Temminghoff and Houba [7].

Potassium Percentage: Potassium was determined by using the Flame photometer according to Brown and Lilleland [8].

Calcium Percentage: Calcium was determined by using Flame photometer according to Brown and Lilleland [8].

Sodium Percentage: Sodium content was determined by using Flame photometer according to Brown and Lilleland [8].

Chloride Percentage: Chloride was estimated by titration method with silver nitrate according to Jackson [9].

Proline Percentage: Free proline concentration was measured calorimetrically using nonhydrin reagent according to Batels *et al.* [10].

Total Leaf Chlorophyll Content (SPAD Value): Total chlorophyll content was determined in the basal 6th and 7th leaves from shoot (10 fresh leaves/ replicate) using MINOLTA SPAD-502- Japan -apparatus.

Statistical Design and Data Analysis: A randomized complete blocks design with two factors (cultivar and salinity level) was used for analysis, all data with three replications for each parameter, each treatment was replicated three times and each replicate was represented by nine transplants. The treatment means were compared by least significant difference (L.S.D.) test as given by Snedecor and Cochran [11] by Mstat-C program [12] to calculate least significant differences LSD (at 0.05) to compare among means according to Waller and Duncan [13].

RESULTS AND DISCUSSION

Vegetative Characteristics: Data presented the effect of salinity treatments on the morphological parameters or growth expressed as (survival percentage, transplant length, leaves number/ transplant and average leaf area) of Picual, Koroneiki, Manzanillo, Coratina and Eggizi Shami olive transplants during 2009 and 2010 seasons.

Survival Percentage (%): Survival percentage of Picual, Koroneiki, Manzanillo, Coratina and Eggizi Shami olive transplants was affected by salinity treatments in seasons 2009 and 2010 are presented in Tables 1 and 2.

Generally, the survival percentage of all transplants of the five olive cultivars significantly decreased with saline irrigation water compared with control treatment and this decrements were paralleled with increased of salt concentration.

Concerning the response of five olive cultivars under study to salinity, the obtained results cleared that Manzanillo cv. and Eggizi Shami cv. were the most sensitive, while Koroneiki and Coratina cultivars recorded the highest values (95%) in the first season, while Koroneiki cv. recorded the highest value (99%) followed by Coratina cv. (97%) in the second season.

Generally, it can be concluded that, there was a progressive decrease in the survival percentage of Manzanillo, Eggizi Shami, Picual, Coratina and Koroneiki transplants with increasing salinity concentration up to (50, 100, 150 and 200 mM/L NaCl), respectively.

These results are in harmony with Atia [14] and Karimi *et al.* [15] on different olive cultivars they recorded that, there was a reduction of survival percentage under saline conditions, concerning the role of Ca^{+2} and K^{+} in Na exclusion and retention mechanisms, Melgar *et al.* [16] and Tattini *et al.* [17] stated that, calcium play an important role in Na exclusion and retention mechanisms, mainly preventing Na^{+} transport to the shoot, which may be an important ability for survival under saline conditions. Also, Cimato *et al.* [18] suggested that survival, under unfavorable conditions, is a key determinant conferring salt-tolerance in olive.

Transplant Length (cm): It was clear from the results in Tables 3 and 4 that, transplant length reduction recorded gradually with increasing salt concentration in the irrigation water, the highest transplant length recorded with control treatment followed by 50 mM/L NaCl in both seasons of study. Meanwhile, the lowest significant value recorded for the 200mM/L NaCl treatment (62 and 57 cm), respectively in both seasons.

Table 1: Effect of salt treatments on survival percentage season 2009

	Treatments (mM/L NaCl)					
Cultivars	0	50	100	150	200	Mean
Picual	100	100	100	92	75	93
Koroneiki	100	100	100	92	83	95
Manzanillo	100	92	83	50	30	71
Coratina	100	100	100	92	83	95
Eggizi Shami	100	100	92	75	50	83
Mean	100	98	95	80	64	

LSD value at 0.05 Cultivars: 0.007 Treatments: 0.007

Table 2: Effect of salt treatments on survival percentage season 2010

	Treatments (mM/L NaCl)					
Cultivars	0	50	100	150	200	Mean
Picual	100	100	96	91	87	95
Koroneiki	100	100	100	100	96	99
Manzanillo	100	100	91	82	71	89
Coratina	100	100	96	96	91	97
Eggizi Shami	100	100	96	91	75	92
Mean	100	100	96	92	84	

LSD value at 0.05 Cultivars: 0.02 Treatments: 0.02

Table 3: Effect of salt treatments on transplant length (cm) season 2009

	Treatments (mM/L NaCl)					
Cultivars	0	50	100	150	200	Mean
Picual	101	89	72	54	53	74
Koroneiki	101	103	100	84	79	93
Manzanillo	108	92	85	73	51	82
Coratina	81	80	76	74	69	76
Eggizi Shami	83	77	73	65	59	71
Mean	95	88	81	70	62	

LSD value at 0.05 Cultivars: 4.13 Treatments: 4.13

Table 4: Effect of salt treatments on transplant length (cm) season 2010

	Treatments (mM/L NaCl)					
Cultivars	0	50	100	150	200	Mean
Picual	109	83	74	53	53	74
Koroneiki	131	130	121	121	115	124
Manzanillo	82	57	51	35	26	50
Coratina	92	64	56	50	48	62
Eggizi Shami	77	57	52	51	42	56
Mean	98	78	71	62	57	

LSD value at 0.05 Cultivars: 4.39 Treatments: 4.39

Regarding, the effect of cultivars, Koroneiki recorded the highest significant value (93 and 124 cm), respectively in both studied seasons, while Eggizi Shami and Picual recorded the lowest values (71 and 74 cm), respectively in the first season. In the second season, Manzanillo and Eggizi Shami recorded the lowest values (50 and 56 cm), respectively.

The obtained results are in agreement with those of Abo El- Khashab [19]; Chartzoulakis *et al.* [20]; Perica *et al.* [21] and Kchaou *et al.* [22] they found that, salinity led to decrease transplant length and this decrease was more by increasing salt concentration. In addition, Karimia *et al.* [15] mentioned that, increasing salt tolerance (0, 40 or 80 mM NaCl) in olive, *Olea europaea* L. plants by supplemental potassium nutrition was studied. Results indicated that, salinity caused a significant decrease in the growth of plants.

Leaves Number / Transplant: Data concerning the effect of saline stress on leaves number/ transplant are shown in Tables 5 and 6. It is clear that, irrigation with saline water resulted in significant reduction in the leaves number/ transplant of all investigated transplants than the control treatment. In addition, there was a progressive significant reduction in leaves number/ transplant with raising salts level in the irrigation water.

Regarding the cultivars, Koroneiki recorded the highest values (96 and 102), respectively in both studied seasons, while Eggizi Shami recorded the lowest values (77 and 58) respectively in both studied seasons.

These results are in line with El- Said *et al.* [23] who assessed the effect of using saline water (6000 ppm) NaCl, in pots plants of 11 olive cultivars; and found that saline water led to decrease leaves number. Similarly Abo El- Khashab [19] noticed that, olive plants Manzanillo cv. irrigated with saline water at (2000, 4000 and 6000 ppm) led to decrease number of leaves of seedlings and this decrease was more by increasing salt concentration. Abbas [24] reported that, using saline water (6000 ppm) on Manzanillo olive transplants decreased number of leaves. Also, Atia [14] treated "Rosciola, Koroneiki and Picual olive cultivars with saline water at (4000, 6000 and 8000 ppm) and found that, increasing salinity concentration led to decrease leaves number/transplants.

Leaf Area (cm^2): Tables 7 and 8 showed the effect of salinity on leaf area of Picual, Koroneiki, Manzanillo, Coratina and Eggizi Shami olive transplants in 2009 and 2010 seasons.

Irrigation with saline water resulted in significant reduction in the average leaf area of all investigated transplants than the control treatment. In addition, there was a progressive significant reduction in leaf area with raising salts level in the irrigation water, the highest leaf area recorded with control treatment, while, the lowest leaf area recorded with 200 mM/L NaCl.

Table 5: Effect of salt treatments on leaves number/ transplant season 2009

	Treatments (mM/L NaCl)					
Cultivars	0	50	100	150	200	Mean
Picual	105	98	83	79	61	85
Koroneiki	116	106	100	86	71	96
Manzanillo	119	105	88	76	57	89
Coratina	107	94	90	77	71	88
Eggizi Shami	94	89	85	66	52	77
Mean	108	99	89	77	62	

LSD value at 0.05 Cultivars: 5.68 Treatments: 5.68

Table 6: Effect of salt treatments on leaves number/ transplant season 2010

	Treatments (mM/L NaCl)					
Cultivars	0	50	100	150	200	Mean
Picual	88	81	88	41	33	66
Koroneiki	163	113	116	61	58	102
Manzanillo	91	69	50	37	21	54
Coratina	113	104	89	79	54	88
Eggizi Shami	88	59	39	58	44	58
Mean	108	85	76	55	42	

LSD value at 0.05 Cultivars: 12.67 Treatments: 12.67

Table 7: Effect of salt treatments on leaf area (cm^2) season 2009

	Treatments (mM/L NaCl)					
Cultivars	0	50	100	150	200	Mean
Picual	4.4	4.0	4.0	3.3	2.9	3.7
Koroneiki	4.0	3.6	3.2	3.0	2.9	3.3
Manzanillo	4.7	4.3	4.2	4.0	3.5	4.1
Coratina	4.3	4.3	3.9	3.7	3.1	3.9
Eggizi Shami	4.6	4.4	4.0	3.7	3.3	4.0
Mean	4.4	4.1	3.9	3.5	3.1	

LSD value at 0.05 Cultivars: 0.26 Treatments: 0.26

Table 8: Effect of salt treatments on leaf area (cm^2) season 2010

	Treatments (mM/L NaCl)					
Cultivars	0	50	100	150	200	Mean
Picual	5.1	4.5	4.0	3.5	3.2	4.1
Koroneiki	4.3	3.7	3.9	3.5	3.1	3.7
Manzanillo	5.6	5.0	4.3	3.7	3.0	4.3
Coratina	4.8	4.7	4.3	3.7	3.1	4.1
Eggizi Shami	5.8	4.5	4.1	3.5	3.0	4.2
Mean	5.1	4.5	4.1	3.6	3.1	

LSD value at 0.05 Cultivars: 0.34 Treatments: 0.25

Concerning the effect of cultivars, Manzanillo recorded the highest significant value (4.1 cm^2), while, Koroneiki recorded the lowest significant value (3.3 cm^2) in the first season. In the second season, Koroneiki recorded the lowest significant value (3.7 cm^2); while, there was no significant differences between the other cultivars.

These results are in line with those obtained by El- Said *et al.* [23]; Abo El- Khashab [19]; Abbas [24]; Atia [14] and Tabatabaei [25] they found that, saline water led to decrease leaf area. In addition, Chartzoulakis *et al.* [20] studied the effects of NaCl salinity (0, 25, 50, 100 and 200 mM NaCl) on growth of six olive cultivars (Koroneiki, Mastoidis, Kalamata, Amphissis, Kothreiki and Megaritiki), found that: total plant leaf area was reduced significantly above 25 mM NaCl, reaching 85% at 200 mM NaCl for the cvs. Mastoidis and Amphissis, due to defoliation. According to Kchaou *et al.* [22], assessment of tolerance to NaCl salinity (0.5, 50, 100 and 200 mM) of five olive cultivars (Chemlali, Chetoui, Koroneiki, Arbequina I18 and Arbosana I43), based on growth characteristics and Na^+ and Cl^- exclusion mechanisms reported that, total leaf area per plant were significantly affected by all salinity treatments in all studied cultivars, being 'Arbequina I18' the most sensitive cultivar. Tolerance to salinity stress was as follows: Chemlali > Chetoui > Arbosana I43 > Koroneiki > Arbequina I18 this order of salt tolerance was indicated by lower reduction in plant growth parameters such as total leaf area.

Furthermore, Hegazi [26] examined the effect of irrigation water salinity at two growing locations on chemical composition of leaves, of Eggizi Shami and Picual olive cultivars, the two locations were El Sadat and El Fayoum at which salinity in soil recorded (2.72 and 2.17 ds/m) and in water (1.33 and 0.30ds/m), respectively. Leaf area of Eggizi Shami at El Sadat location, was significantly the highest (3.8 cm^2). While, it was the lowest in Picual at El Sadat (2.63 cm^2) and in Picual at El Fayoum (2.68 cm^2).

Leaves Chemical Content

Leaves Nitrogen Percentage (N %): Data tabulated in Tables 9 and 10 showed the leaf (N) content decreased gradually with increasing salt concentration, the highest leaf (N) content recorded for control treatment followed by 50 mM/L NaCl, while the lowest content recorded with 200 mM/L NaCl (1.75 and 1.89 %) in the first and second seasons, respectively.

In the first season, Koroneiki and Coratina cultivars had the highest leaf (N) content compared with the other cultivars, while Manzanillo and Eggizi Shami recorded the lowest (N) content. Different trend was observed in the second season, Koroneiki recorded the highest leaf (N) content, while Manzanillo, Eggizi Shami and Coratina had the lowest leaf (N) content.

Table 9: Effect of salt treatments on leaf nitrogen percentage season 2009

	Treatments (mM/L NaCl)					
Cultivars	0	50	100	150	200	Mean
Picual	2.25	2.18	2.08	1.88	1.64	2.01
Koroneiki	2.49	2.48	2.32	2.18	1.98	2.29
Manzanillo	2.11	2.08	1.99	1.79	1.52	1.90
Coratina	2.36	2.33	2.19	2.09	2.00	2.19
Eggizi Shami	2.22	2.19	2.08	1.87	1.60	1.99
Mean	2.29	2.25	2.13	1.96	1.75	

LSD value at 0.05 Cultivars: 0.23 Treatments: 0.23

Table 10: Effect of salt treatments on leaf nitrogen percentage season 2010

	Treatments (mM/L NaCl)					
Cultivars	0	50	100	150	200	Mean
Picual	2.28	2.07	2.07	1.92	1.91	2.05
Koroneiki	2.14	2.17	2.09	2.05	2.09	2.11
Manzanillo	2.11	2.07	2.02	1.78	1.71	1.94
Coratina	2.05	2.04	2.04	1.88	1.82	1.97
Eggizi Shami	2.02	2.00	1.95	1.91	1.90	1.96
Mean	2.12	2.07	2.03	1.91	1.89	

LSD value at 0.05 Cultivars: 0.05 Treatments: 0.05

Table 11: Effect of salt treatments on leaf phosphorus percentage season 2009

	Treatments (mM/L NaCl)					
Cultivars	0	50	100	150	200	Mean
Picual	0.21	0.20	0.20	0.17	0.15	0.19
Koroneiki	0.28	0.27	0.27	0.25	0.23	0.26
Manzanillo	0.20	0.20	0.18	0.16	0.14	0.18
Coratina	0.24	0.23	0.24	0.21	0.19	0.22
Eggizi Shami	0.20	0.20	0.20	0.17	0.15	0.19
Mean	0.23	0.22	0.22	0.19	0.17	

LSD value at 0.05 Cultivars: 0.03 Treatments: 0.03

Table 12: Effect of salt treatments on leaf phosphorus percentage season 2010

	Treatments (mM/L NaCl)					
Cultivars	0	50	100	150	200	Mean
Picual	0.40	0.29	0.24	0.22	0.14	0.26
Koroneiki	0.35	0.32	0.30	0.27	0.23	0.29
Manzanillo	0.25	0.26	0.26	0.25	0.23	0.25
Coratina	0.39	0.28	0.25	0.25	0.21	0.27
Eggizi Shami	0.34	0.24	0.22	0.19	0.17	0.23
Mean	0.34	0.28	0.25	0.23	0.19	

LSD value at 0.05 Cultivars: 0.02 Treatments: 0.02

Table 13: Effect of salt treatments on leaf potassium percentage season 2009

	Treatments (mM/L NaCl)					
Cultivars	0	50	100	150	200	Mean
Picual	1.02	0.95	0.89	0.83	0.75	0.89
Koroneiki	1.06	0.95	0.90	0.83	0.72	0.89
Manzanillo	0.95	0.90	0.83	0.78	0.68	0.83
Coratina	1.02	0.92	0.91	0.84	0.71	0.88
Eggizi Shami	0.89	0.83	0.71	0.67	0.62	0.74
Mean	0.99	0.91	0.85	0.79	0.70	

LSD value at 0.05 Cultivars: 0.06 Treatments: 0.06

Table 14: Effect of salt treatments on leaf potassium percentage season 2010

	Treatments (mM/L NaCl)					
Cultivars	0	50	100	150	200	Mean
Picual	1.04	0.93	0.82	0.75	0.71	0.85
Koroneiki	1.12	1.02	0.93	0.85	0.72	0.92
Manzanillo	0.92	0.71	0.53	0.51	0.42	0.61
Coratina	1.13	0.82	0.81	0.75	0.73	0.84
Eggizi Shami	0.84	0.71	0.62	0.60	0.41	0.63
Mean	1.01	0.83	0.74	0.69	0.59	

LSD value at 0.05 Cultivars: 0.04 Treatments: 0.04

These results are in harmony with Abo El- Khashab [19]; Abbas [24] and Atia [14] who cleared that, increasing salinity concentration decreased leaf content of nitrogen. Furthermore, Hegazi [26] examined the effect of irrigation water salinity at two growing locations on chemical composition of leaves, of Eggizi Shami and Picual olive cultivars, the two locations were El Sadat and El Fayoum at which salinity in soil recorded (2.72 and 2.17 ds/m) and in water (1.33 and 0.30 ds/m), respectively. Nitrogen content decreased in leaves of plants grown in location of El Fayoum where salinity of water and soil was higher.

Leaf Phosphorous Percentage (P %): Phosphorous content in olive leaves was affected by salinity treatment where the highest value of leaf (P) content in control treatment, while the lowest values were observed in 200 mM/L NaCl in both studied seasons (Tables, 11 and 12).

Concerning the effect of cultivars, Koroneiki recorded the highest significant value (0.26 and 0.29 %) in the first and second seasons, respectively. However, Manzanillo, Eggizi Shami and Picual recorded the lowest values in the first season, while Manzanillo and Eggizi Shami cultivars recorded the lowest values in the second season.

The obtained results are in agreement with those of Abo El- Khashab [19]; Abbas [24]; Atia [14]; Hegazi [26] and Karimia *et al.* [15] cleared that, increasing salinity concentration decreased leaf content of phosphorous.

Leaf Potassium Percentage (K %): It's evident that, salinity treatment caused marked significant reduction in leaf (K) content in both seasons of study (Tables 13 and 14).

This reduction was more pronounced under the highest level of saline treatments (200 mM/L NaCl) which recorded (0.91 and 0.92 %) in the first and second seasons, respectively.

Concerning the effect of cultivars, Manzanillo recorded the lowest value (0.74 %) of leaf (K) content compared with the other cultivars in the first season, while in the second season Manzanillo and Eggizi Shami recorded the lowest values (0.61 and 0.63 %), respectively compared with the other cultivars.

These findings are, generally in line with those previously reported by Abbas [24]; Atia [14]; Demural [27]; Aragu *et al.* [28] and Hegazi [26] they found that, increasing salinity concentration decreased leaf content of potassium. Furthermore, the aim of this greenhouse study was to investigate the distribution of some ions in one-year old olive seedlings, (*Olea europaea* L., cultivars Zard, Conservolea, Manzanila and Mission) under saline conditions [0, 40, 80 and 120 mM sodium chloride (NaCl)] were used during 100 days. There was significant difference among cultivars in concentration, uptake and relative translocation of potassium (K) in different plant tissues. 'Conservolea' cultivar had the lowest K concentration in apical and basal leaves. In all cultivars, with increasing salinity, the tissue concentration of K was decreased. Results showed that under saline conditions, the distribution of mineral nutrients in olive depends on both plant cultivar and the ion of interest [29].

Leaf Sodium Percentage (Na %): Data in Tables 15 and 16 indicated that, leaf (Na) content increased gradually with increasing salinity concentration, the highest leaf (Na) content recorded with 200 mM/L NaCl followed by 150 mM/L NaCl, while the lowest content recorded for the control treatment.

Regarding the effect of cultivars, Picual and Koroneiki recorded the lowest values (0.53 and 0.54 %), respectively in the first season, while Koroneiki, Picual and Coratina recorded the lowest values (0.53, 0.53 and 0.54 %), respectively in the second season in comparison with the other cultivars.

These results go in parallel with those obtained by Ben-Ahmed *et al.* [30]; Melgar *et al.* [31] and Karimia *et al.* [15] observed that, increasing salt tolerance (0, 40 or 80 mM NaCl) in olive plants by supplemental potassium nutrition. The results showed that, concentration of Na^+ was very low in control plants, but increased significantly under salinity in all plant organs.

Leaf Chloride Percentage (Cl %): The results shown in Tables 17 and 18 indicated that, olive transplants under salinity stress have significant tendency to accumulate (Cl) content in their leaves than those grown under normal condition (control treatment) such increases of leaves (Cl) content were obviously recorded in highest values with the highest concentration of salts (200 mM/L NaCl) which recorded (1.24 and 1.26 %) in the first and second season, respectively.

Regarding the cultivars, there was no significant differences between the studied cultivars in the first season, while in the second season, Manzanillo recorded the highest significant value (0.92 %) compared with the other cultivars.

These results are in harmony with Abbas [24]; Atia [14]; Chartzoulakis *et al.* [20]; Demural [27], Ben-Ahmed *et al.* [30] and Melgar *et al.* [31] on different olive cultivars, as they recorded that, salinity increased of leaf content of Cl.

Leaf Calcium Percentage (Ca %): Leaf (Ca) content of olive transplants are presented in Tables 19 and 20 it's evident that, salt treatments decreased leaves (Ca) content significantly of the five olive cultivars in both studied seasons.

Concerning the effect of cultivars, there was no significant differences between the studied cultivars in the first season except Manzanillo which recorded the lowest value (1.54 %), while in the second season, Koroneiki recorded the highest value (2.37 %) of leaf (Ca) content, meanwhile Manzanillo, Coratina and Eggizi Shami recorded the lowest values (1.49, 1.57 and 1.49), respectively.

These findings are, in line with those previously reported by Loupassaki *et al.* [32] and Demural [27], as they reported that effect of salt stress on the concentrations of calcium (Ca) in the young and mature leaves, shoots and roots of six major Greek olive cvs (Koroneiki, Mastoidis, Kalamon, Amphissis, Kothreiki and Megaritiki) was investigated on self-rooted one-year-old plants. The treatments, consisting of 0, 25, 50, 100 and 200 mM NaCl in half-strength Hoagland nutrient solution; were applied for five months. After the end of the experiment, young leaves showed the drop in (Ca) was important and started at the first salinity level (25 mM NaCl) in all cultivars. On the contrary, long term responses of olive trees to salinity were investigated by Melgar *et al.* [33] they stated that, salt concentrations (0.5, 5 or 10 dS m^{-1}) were applied to mature olive trees in a long term field experiment (1998-2006). Eighteen-years-old olive trees (*Olea europaea* L.) Picual cv. were cultivated under drip irrigation with saline water composed of a mixture of NaCl and $CaCl_2$. (Ca^{2+}) concentrations in the leaves were not affected by salinity.

Table 15: Effect of salt treatments on leaf sodium percentage season 2009

	Treatments (mM/L NaCl)					
Cultivars	0	50	100	150	200	Mean
Picual	0.12	0.39	0.56	0.72	0.84	0.53
Koroneiki	0.14	0.38	0.57	0.76	0.86	0.54
Manzanillo	0.17	0.46	0.63	0.78	0.95	0.60
Coratina	0.23	0.40	0.63	0.77	0.93	0.59
Eggizi Shami	0.26	0.45	0.64	0.83	0.98	0.63
Mean	0.18	0.42	0.61	0.77	0.91	

LSD value at 0.05 Cultivars: 0.05 Treatments: 0.05

Table 16: Effect of salt treatments on leaf sodium percentage season 2010

	Treatments (mM/L NaCl)					
Cultivars	0	50	100	150	200	Mean
Picual	0.07	0.44	0.63	0.66	0.84	0.53
Koroneiki	0.20	0.26	0.47	0.77	0.94	0.53
Manzanillo	0.11	0.50	0.59	0.82	0.92	0.59
Coratina	0.03	0.42	0.63	0.73	0.88	0.54
Eggizi Shami	0.28	0.45	0.56	0.70	1.03	0.61
Mean	0.14	0.42	0.58	0.74	0.92	

LSD value at 0.05 Cultivars: 0.02 Treatments: 0.02

Table 17: Effect of salt treatments on leaf chloride percentage season 2009

	Treatments (mM/L NaCl)					
Cultivars	0	50	100	150	200	Mean
Picual	0.25	0.47	0.66	0.93	1.26	0.71
Koroneiki	0.26	0.44	0.64	0.97	1.27	0.72
Manzanillo	0.34	0.56	0.78	1.04	1.28	0.80
Coratina	0.24	0.49	0.75	0.93	1.09	0.70
Eggizi Shami	0.38	0.59	0.73	0.97	1.29	0.79
Mean	0.29	0.51	0.71	0.97	1.24	

LSD value at 0.05 Cultivars: 0.15 Treatments: 0.15

Table 18: Effect of salt treatments on leaf chloride percentage season 2010

	Treatments (mM/L NaCl)					
Cultivars	0	50	100	150	200	Mean
Picual	0.14	0.48	0.87	0.97	1.12	0.71
Koroneiki	0.11	0.30	0.46	1.30	1.30	0.70
Manzanillo	0.50	0.62	0.66	1.14	1.67	0.92
Coratina	0.17	0.42	0.84	1.11	1.18	0.75
Eggizi Shami	0.32	0.66	0.86	0.88	1.01	0.75
Mean	0.25	0.50	0.74	1.08	1.26	

LSD value at 0.05 Cultivars: 0.06 Treatments: 0.06

Table 19: Effect of salt treatments on leaf calcium percentage season 2009

	Treatments (mM/L NaCl)					
Cultivars	0	50	100	150	200	Mean
Picual	2.53	2.23	1.93	1.73	1.29	1.95
Koroneiki	2.33	2.07	1.77	1.63	1.30	1.82
Manzanillo	2.10	1.87	1.57	1.27	0.92	1.54
Coratina	2.37	2.13	1.90	1.70	1.26	1.87
Eggizi Shami	2.40	2.13	1.87	1.60	1.29	1.86
Mean	2.35	2.09	1.81	1.59	1.21	

LSD value at 0.05 Cultivars: 0.33 Treatments: 0.33

Table 20: Effect of salt treatments on leaf calcium percentage season 2010

	Treatments (mM/L NaCl)					
Cultivars	0	50	100	150	200	Mean
Picual	2.67	2.47	2.13	1.87	0.87	2.00
Koroneiki	2.83	2.57	2.30	2.27	1.87	2.37
Manzanillo	2.23	1.77	1.40	1.20	0.86	1.49
Coratina	2.30	1.73	1.43	1.37	1.03	1.57
Eggizi Shami	2.10	1.83	1.57	1.17	0.80	1.49
Mean	2.43	2.07	1.77	1.57	1.09	

LSD value at 0.05 Cultivars: 0.10 Treatments: 0.10

Leaf Proline Percentage (%): From data presented in Tables 21 and 22 it can be observed that in the second season, proline content increased with increasing salinity concentration (150 and 200 mM/L NaCl) recorded the highest value (0.028 %).

Regarding the effect of cultivars on leaf proline content, Eggizi Shami recorded the highest value in both seasons (0.094 and 0.093 %), respectively comparison with the other cultivars.

These data are in harmony with Abbas [24]; Roussos and Pontikis [34]; Ben-Rouina *et al.* [35]; Ben Ahmed *et al.* [36] and Rewald *et al.* [37] they found that, at the high salt level, proline content was increased.

Leaf Chlorophyll Content: The effect of different salt concentration of irrigation water on the leaf chlorophyll content of Picual, Koroneiki, Manzanillo, Coratina and Eggizi Shami are shown in Tables 23 and 24, it can be observed that, chlorophyll decreased significantly with increasing salinity levels in both seasons.

Concerning the effect of cultivars, Koroneiki and Picual recorded the highest significant values of chlorophyll (78.1 and 77.7 %) compared with the other cultivars in the first season, respectively, while Koroneiki recorded the highest significant values (81.4 %) followed by Picual (74.0 %) in the second season.

The obtained results are in agreement with those of Abo El- Khashab [19]; Atia [14] and Melgar *et al.* [30] as they stated that increasing salinity concentration decreased chlorophyll a, b and carotene.

From this Investigation it Could Be Concluded That:

- Increasing salinity concentration decreased vegetative characteristics (the survival percentage, transplant length, leaves number / transplant and leaf area) and also decreased leaves chemical content (leaves content of N, P, K, Ca and chlorophyll. But increased leaves content of Na, Cl and proline content).

Table 21: Effect of salt treatments on leaf proline percentage season 2009

	Treatments (mM/L NaCl)					
Cultivars	0	50	100	150	200	Mean
Picual	0.020	0.029	0.034	0.037	0.041	0.032
Koroneiki	0.021	0.022	0.025	0.027	0.031	0.025
Manzanillo	0.054	0.055	0.059	0.061	0.066	0.059
Coratina	0.020	0.022	0.027	0.029	0.035	0.026
Eggizi Shami	0.089	0.091	0.094	0.096	0.101	0.094
Mean	0.041	0.044	0.048	0.050	0.055	

LSD value at 0.05 Cultivars: 0.02 Treatments: 0.02

Table 22: Effect of salt treatments on leaf proline percentage season 2010

	Treatments (mM/L NaCl)					
Cultivars	0	50	100	150	200	Mean
Picual	0.024	0.025	0.023	0.023	0.031	0.025
Koroneiki	0.020	0.019	0.017	0.017	0.022	0.019
Manzanillo	0.022	0.025	0.026	0.022	0.029	0.025
Coratina	0.016	0.017	0.022	0.035	0.014	0.021
Eggizi Shami	0.015	0.043	0.049	0.041	0.045	0.039
Mean	0.019	0.026	0.027	0.028	0.028	

LSD value at 0.05 Cultivars: 0.007 Treatments: 0.007

Table 23: Effect of salt treatments on leaf chlorophyll percentage season 2009

	Treatments (mM/L NaCl)					
Cultivars	0	50	100	150	200	Mean
Picual	88.4	78.1	75.1	74.7	72.2	77.7
Koroneiki	87.9	85.2	76.4	71.5	69.4	78.1
Manzanillo	77.8	76.5	74.2	68.9	62.9	72.1
Coratina	78.2	75.3	70.8	70.5	61.9	71.4
Eggizi Shami	77.1	75.5	73.0	64.2	61.0	70.1
Mean	81.9	78.1	73.9	70.0	65.5	

LSD value at 0.05 Cultivars: 2.16 Treatments: 2.16

Table 24: Effect of salt treatments on leaf chlorophyll percentage season 2010

	Treatments (mM/L NaCl)					
Cultivars	0	50	100	150	200	Mean
Picual	77.6	74.7	74.7	73.0	70.1	74.0
Koroneiki	85.4	85.6	83.7	78.3	74.2	81.4
Manzanillo	80.0	78.8	72.6	68.5	60.8	72.2
Coratina	76.2	72.4	71.4	70.5	66.2	71.3
Eggizi Shami	78.5	73.8	72.8	68.5	62.3	71.2
Mean	79.5	77.1	75.0	71.8	66.7	

LSD value at 0.05 Cultivars: 1.42 Treatments: 1.42

- Koroneiki, Coratina and Picual olive cultivars were more tolerant to salt stress (salinity) compared to other studied cultivars.
- Eggizi Shami and Manzanillo cultivars were the lowest cultivars of salt stress (salinity) and vegetative characteristics of transplant were lower compared to other cultivars.
- Koroneiki cv. recorded the highest tolerance to salinity stress followed by Coratina and Picual cvs.

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