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Response of some olive cultivars to different salinity levels under shade house conditions

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ABSTRACT

This experiment was carried out during two succession seasons (2019&2020) on one year old olive seedling cultivars i.e., Koroneiki, Koratina and Maraki. The studied olive seedlings were similar as possible in shape, height and width. Effect of saline irrigation water levels 2000, 4000 and 6000 ppm and their impact on some seedling vegetative growth plant parameters i.e. [fresh weight (g), dry weight (g), shoot high (cm), Trunk diameter (mm), no. of shoots, root length (cm) and no. of roots] and leaf mineral content. Among the three studied cultivars in the present work Maraki and Koratina cultivars exited increasing adaptability and better counteracting the effects of salinity stress. Results: Significant increases in dry weight of olive plant seedling and root percentages while fresh weight and height of plant as well as root length significantly decreased. Mineral N, P, K, Na and Ca leaf content was significantly varied not only among studied olive cultivars but also levels of salinity used. A high level of salinity significantly reduces the concentration of K in the leaves. However, P leaf content was not affected. Conclusion: It could conclude that Maraki olive cv. proved to be a promising salt tolerant olive genotype recommended for cultivation in arid and saline lands.

Keywords: olives, salinity, vegetative growth, mineral content, cultivar.

1. Introduction

Olive is considered as a moderately salt tolerant plant; however, tolerance to salt appears to be cultivar-dependent. Increased salinization of arable land is expected to have devastating global effects, resulting in 30% land loss within next 25 years and up to 50% by the middle of 21st century (Wang *et al.* 2003). Hence, it should be found an effective way to use saline lands by the cultivation of tolerant cultivars or other agro-techniques. It is estimated that approximately a third of the world's irrigated lands and half the lands in semiarid and coastal regions are affected by Salinization (Epstin *et al*. 1980). All salts can affect plant growth, but not all inhibit growth. Among the most common effects of salinity is growth inhibition by NaCl. For there are studies that suggest that olive is moderately tolerant to salinity however, there is a considerable variation among salt tolerant cultivars so that several examples of successful use of saline water for irrigation can be found (Rhoades *et. al.* 1992). Salt tolerance in olives significantly depends on the cultivar and is most likely due to control of salt translocation to the shoots. Many studies show that the mechanism of salt tolerance is placed in the roots preventing the translocation of toxic ions, rather than absorption olive (is a cultivar-dependent characteristic. Understanding the mechanisms involved in salt-tolerance of olive trees is crucial to select salt tolerant genotype. Many studies show that the mechanism of salt tolerance is placed in the roots preventing the translocation of toxic ions, rather than absorption. Salt tolerance in olives significantly depends on the cultivar and is most likely due to control of salt translocation to the shoots Recent research indicates that certain olive cultivars are able to tolerate salinity of 5800 mg l-1 (EC ≈8 dS m^{-1}) producing new growth at a leaf Na concentration of 4-6 mg g-1 Dwt. Salt tolerance in olives significantly depends on the cultivar and is most likely due to control of salt translocation to the shoots. The present investigation

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aims to evaluate the response of Koroneiki, Koratina and Maraki. Grown under 2000, 4000 and 6000 ppm saline irrigation water levels on vegetative growth and national status.

It's important to select cultivars that may give good performance when cultivated in soil with salinity problems or irrigated with saline water (Proietti *et al.,* 2015). The aim of this work was study the behavior of three different olive cultivars: Koroneiki, Koratina and Maraki in term of vegetative growth parameters, and mineral status responses during different saline irrigation water stress.

2. Materials and Methods

A pot culture experiment was conducted under shade net house condition at the National Research Center at Dokki, Cairo governorate Egypt, during 2019 and 2020 seasons. The study aimed to evaluate the response of one year old olive seedlings, Koroneiki, Koratina and Meraki cultivars produced of nursery in Egypt. They grow under 2000, 4000 and 6000 ppm saline irrigation water. The tested seedlings were planted individually in plastic containers in the first week of February of each season. Each container contained 15 kg of a mixture of peat moss and sand (1:2 v/v). Water drainage was allowed through holes provided at the bottom of container. The seedlings were irrigated every 2-3 days with a compound fertilizer (19:19:19) at 2g/l (1/2/Liter for each container) before starting salinity treatments. Salt treatment started in the first week of May till the end August during both seasons of investigation. The salt mixture was prepared by mixing NaCl, $CaCl_2$ and $MgCl_2$ salts according to the obtained balance by Ibraheim and El-Kobbia (1986) as follows:3 [NaCl]: 1 [3 ($CaCl_2$) + 1 ($MgCl_2$)]. The chosen seedlings were irrigated with saline solutions twice a week; each container received one liter every time. Moreover, at each of third saline irrigation time, the volume of saline water was increased by about 25% as a leaching requirement to avoid salt accumulation in soil containers. The experimental treatments were arranged in a complete randomized blocks design. Each treatment was represented in three and each replicate contained 2 seedlings. The obtained data were statistically analyzed at 5% level according to Snedecor and Cochran (1982). At the end of October plants of each treatment were removed genteelly with their root system to estimate and record the following data:
Growth measurements:

- Plant fresh weight (gm).
- Plant dry weight (%).
- Plant height (cm).
- Trunk diameter (mm)
- Shoot numbers per seedling.
- Root fresh weight (gm).
- Root dry weight (%).
- Root length (cm).
- Root numbers per seedling.

2.1. Chemical determinations:

2.1.1. Mineral analysis:

For the determination of nutrient content, samples from 4-5th from seedling top. Oven dry leaves petiole, then appropriate weight of 0.5 g was digested using a mixture of perchloric acid and sulphoric as; 1:4 (v/v) until clear solution was obtained. The digested solution was quantitatively transferred to 100 ml volumetric flask and increased with deionized water to standard volume. Thereafter, contents of different elements for each sample were determined as follows:

- Nitrogen percentage (N %) (Pregl, 1945).
- Phosphor percentage (P %) (Jackson, 1958).
- Potassium (K %) and sodium percentage (Na %) (Brown and Lilleland, 1946).
- Calcium percentage (Ca %) (Barrows and Simpson, 1962).

2.2. Data Analysis:

The average data of the two seasons (2019 - 2020) were subjected to analysis of variance and the method of Duncan's was used to differentiate means (Duncan, 1955).

3. Results

Data in Table (1) show the effect of salinity levels (2000, 4000, 000 ppm) on some seedling parameters (fresh weight (gm), dry weight (%), stem height (cm), Trunk diameter (mm) and No. of shoot. of three olive cultivars). Results reveled that highest significant fresh weight of shoot was recorded in Maraki cv. (148.46 gm.), irrigated with 4000 ppm saline water, meanwhile the lowest one was recorded in koroneiki cv. (100.18 gm). Koratina cv. Fresh weight (gm.) ranked value in between, (102.22 gm).

Table 1: Effect of salinity levels of irrigation water on seedling growth parameters of some olive seedlings cultivars (average 2019-2020).

Treatments		Plant fresh weight (gm)	Plant dry weight (%)	Plant height (cm)	Trunk diameter (mm)	Shoot numbers per seedling
Koroneiki	2000 ppm	104.83 b	69.01 c	75.20 b	4.70 c	15 a
	4000 ppm	100.18 d	66.18 d	68.20 d	4.10 d	12 b
	6000 ppm	84.12 f	69.15 c	64.20 e	4.60 c	11 b
Koratina	2000 ppm	75.36 g	70.17 b	82.00 a	6.60 a	16 a
	4000 ppm	102.22 c	63.31 e	76.60 b	5.50 b	14 b
	6000 ppm	69.70 h	68.81 c	64.80 e	3.70 d	14 b
Meraki	2000 ppm	98.34 d	59.91 f	78.20 b	4.40 c	13 b
	4000 ppm	128.46 a	65.50 d	75.80 b	6.20 a	19 a
	6000 ppm	88.89 e	73.61 a	72.40 c	4.70 c	10 c
Means of cultivars	Koroneiki	96.38 B	68.11 A	69.2 B	4.47 A	13 B
	Koratina	82.43 C	67.43 A	74.47 A	5.28 A	15 A
	Meraki	105.23 A	66.34 A	75.47 A	5.10 A	14 B
Means of salinity	2000 ppm	92.84 B’	66.36 B’	78.47 A’	5.23 A’	15 A’
	4000 ppm	110.29 A’	65.00 B’	73.53 B’	5.27 A’	15 A’
	6000 ppm	80.90 C’	70.52 A’	67.13 C’	4.33 A’	12 B’

Means having the same letters within a column are not significantly different at 5% level.

Dry weight of shoot (%) was affected significantly among olive cultivars as well as salinity concentrations used. Under low salinity concentration (2000 ppm), medium (4000 ppm) and high (6000 ppm) Koroneiki olive cv., recorded 69.01 %, 66.18 % and 69 % respectively. As for, Koratina olive cv. Dry weight of shoot (%), determined values were (70.17%) under low salinity concentration, (63.31%) under medium salinity concentration and (68.50 %) under high salinity concentration.

Maraki olive cv. Dry weight (%), resulted (59.61 %), (65.50 %) and (73.61 %) under saline irrigation water at 2000 ppm, 4000 ppm and 6000 ppm concentrations, respectively.

Concerning the effect of saline water on fresh weight (gm) olive cultivars regardless of concentration, data revealed that Meraki olive seedling cultivar gave the highest fresh weight of shoot (gm) compared with the other two cultivars (Koroneiki and Koratina). On the other hand, the effect of saline water concentration on fresh weight (gm) regardless olive cultivar, data shows that 4000 ppm saline water recorded the highest value.

Data in Table (1) that dry weight (%) tended to decrease with increasing saline water concentration from 2000 up to 4000 ppm, this was true in Koroneiki and Koratina cultivars.

on the contrary, Maraki olive seedling cultivar resulted in a gradual increase in dry weight (%) with increasing salinity concentration irrigation water, reached the highest dry weight (%) at 6000 ppm. Plant height (cm) data in Table (1) showed that of olive seedlings decreased with increasing saline irrigation water concentration, the highest Plant height (cm) was obtained with Koratina olive cultivar received 2000 ppm saline irrigation water.

Trunk diameter (mm) data in Table (1) recorded that high Trunk diameter was obtained with Koratina olive seedling irrigated at 2000 ppm saline water, on the other hand Meraki olive seedling cultivar recorded the highest Trunk diameter (mm) with 4000 ppm saline irrigated water, such results was supported with number of shoots for Koratina and Meraki cultivars.

Table (2) show the effect of three different levels of salinity (2000, 4000, 6000 ppm) on root growth parameters of three olive seedling cultivars.

Fresh weight of root (gm.) tended to decrease with increasing concentration of salinity in irrigation water but this was true only with Koroneiki seedling cultivar while increasing concentration of salinity in irrigation water up to 4000 ppm increasing fresh weight of root significantly and recorded high fresh weight of root similar to values obtained in Koroneiki seedling cultivar irrigated with 2000 ppm saline water.

The lowest fresh weight of root (gm.) values in the three olive seedling cultivars was recorded when using saline irrigation water at 6000 ppm.

Also, in Table (2) dry weight of roots (%) data followed a similar trend resulted on fresh weight of root where increasing concentration of salinity in irrigation water increased dry weight of roots (%) in Koroneiki and Koratina olive cultivars. On the contrary, increasing concentration of salinity up to 4000 ppm significantly decreased dry weight of roots (%) in Meraki seedling cultivar. Generally high dry weight of roots (%) was obtained in all studied cultivars irrigated with 6000 ppm.

Root length (cm) decreased with increasing saline irrigation water concentration. On the other hand, low concentration of saline irrigation water (2000 ppm) achieved the highest root length (cm), while high concentration in saline irrigation water (6000 ppm) recorded less root length (cm) values.

Roots number per seedling followed the same trend obtained in root length parameter. Where increasing concentration of salinity in irrigation water decreasing roots number per seedling. Except Maraki olive cultivar, behaved a different manner where number of roots values under 4000 or 6000 ppm were similar from the statically stand point.

Table 2: Effect of salinity levels of irrigation water on root growth parameters of some olive seedlings cultivars (average 2019-2020).

Treatments		Root fresh weight (gm)	Root dry weight (%)	Root length (cm)	Root numbers per seedling
Koroneiki	**2000 ppm**	38.47 a	65.27 e	21.0 a	25 a
	4000 ppm	28.18 d	70.37 c	15.0 c	21 b
	6000 ppm	23.11 f	77.11 a	14.0 c	20 c
Koratina	**2000 ppm**	25.29 e	59.79 g	22.0 a	21 b
	4000 ppm	31.68 b	61.49 f	20.0 ab	19 d
	6000 ppm	22.97 f	64.87 e	18.0 b	16 f
Meraki	**2000 ppm**	27.89 d	68.38 d	16.5 bc	20 c
	4000 ppm	38.32 a	64.07 e	15.0 c	17 e
	6000 ppm	30.58 c	71.98 b	11.5 d	17 e
Means of cultivars	**Koroneiki**	29 92 B	70.92 A	16.7 B	22 A
	Koratina	26.65 C	62.05 C	20.0 A	19 B
	Meraki	32.26 A	68.14 B	14.3 C	18 C
Means of salinity	**2000 ppm**	30.55 B’	64.48 A’	19.8 A’	22 A’
	4000 ppm	32.73 A’	65.31 B’	16.7 B’	19 B’
	6000 ppm	25.55 C’	71.32 A’	14.5 C’	18 B’

Means having the same letters within a column are not significantly different at 5% level.

Data in table (3) show the effect of saline irrigation water on Koroneiki, Koratina and Maraki olive cultivars leaf mineral status (average 2019&2020 seasons)

Nitrogen (N) leaf content increased significantly as salinity irrigation water increase (Table 3) nitrogen leaf content in Koroneiki, Koratina and Maraki olive seedling cultivars ranged between: (1. 68-1.92%), (1. 65-1.90%) and (1. 75-1.95%) respectively. increase saline irrigation water concentration seemed to be accompanied with increase leaf N%. Leaf N content in olive cultivars regardless salinity concentrations, were similar from the statistical stand point, no significant differences were detected.
Phosphorus (p) leaf content in Koroneiki, Koratina and Maraki olive seedling cultivars ranged between: (0.22-0.20), (0.19-0.20) and (0.20-19%), respectively, however, no significance differences in

Phosphorus leaf content were recorded. Results in Table (3) revealed that, ether tested olive cultivars and/or saline irrigation water concentrations had no effaced leaf p %.

Table 3: Effect of salinity levels of irrigation water on leaves mineral content (nitrogen%, phosphorus%, potassium%, sodium%, potassium/ nitrogen ratio and calcium %) of some olive seedlings cultivars (average 2019-2020).

Treatments		N %	P %	K %	Na %	K/Na	Ca%
Koroneiki	2000 ppm	1.68 cd	0.127 a	1.35 d	0.61 c	2.21 de	1.50 a
	4000 ppm	1.85 b	0.130 a	1.32 d	0.55 cd	2.40 cd	1.45 a
	6000 ppm	1.92 a	0.103 a	1.15 g	0.87 a	1.32 g	2.35 a
Koratina	2000 ppm	1.65 d	0.093 a	1.44 b	0.49de	2.94 b	0.85 a
	4000 ppm	1.73 c	0.087 a	1.27 e	0.60 c	2.12 e	1.45 a
	6000 ppm	1.90 a	0.103 a	1.16 g	0.70 b	1.66 f	1.85 a
Meraki	2000 ppm	1.75 bc	0.100 a	1.50 a	0.43 e	3.49 a	2.10 a
	4000 ppm	1.81 b	0.110 a	1.39 c	0.54 cd	2.57 c	2.05 a
	6000 ppm	1.95 a	0.093 a	1.22 f	0.77 b	1.58 f	2.10 a
Means of cultivars	Koroneiki	1.82 A	0.120 A	1.27 B	0.68 A	1.98 A	1.77 B
	Koratina	1.76 A	0.094 A	1.29 B	0.60 B	2.24 B	1.38 C
	Meraki	1.84 A	0.101 A	1.37 A	0.58 B	2.55 C	2.08 A
Means of salinity	2000 ppm	1.69 C’	0.107 A’	1.43 A’	0.51 C’	2.88 A'	1.48 C’
	4000 ppm	1.80 B’	0.109 A’	1.33 A’	0.56 B’	2.36 B'	1.65 B’
	6000 ppm	1.92 A’	0.100 A’	1.18 A’	0.78 A’	1.52 C'	2.10 A’

Means having the same letters within a column are not significantly different at 5% level.

In Table (3) Potassium (K) leaf content in Koroneiki, Koratina and Maraki olive seedling cultivars ranged between: (1.35-1.15), (1.44-1.16) and (1.5-1.22%), respectively. A particular trend in leaf K content was observed, where a reduction potassium leaf content in all olive cultivars due to increasing salinity in irrigation water. This was true in all studied cultivars. However, Maraki cultivar showed higher significant increase in K leaf content compared with Koroneiki or Koratina cvs, which both recorded more or less similar K leaf content. In other words, results revealed that potassium was affected significantly by cultivar. Leaf potassium content decreased significantly as salinity irrigation water increase.

Data in Table (3) revealed that Na % in olive seedling leaves ranged between (0.55-0.87%), (0.49-0.70%) and (0.43-0.77%), in Koroneiki, Koratina and Maraki cvs, respectively. Na % means of cultivars leaves, regardless saline irrigation water concentration showed a particular trend that Na% in leaves in Koroneiki recorded (0.68%), in Koratina (0.60%) and Maraki (0.58%). In other words Na% in Maraki and Koratina showed lower Na% in leaves that those in Koroneiki.

Results in Table (3) showed that K/Na ratio in leaves ranged between (1.32-2.4), (1.66-2.94) and (1.58-3.49), the in Koroneiki, Koratina and Maraki olive seedling cultivars, respectively. Generally, K/Na ratio values decrease as concentration in irrigation water increase. This means that results exhipted a deverse relationship between K/Na ratio in leaves and salinity concentration, where data of related to K/Na ratio in olive seedling cultivars regardless salinity concentration, varied from olive cultivar to another, where highest K/N ratio value in leaves was estimated in Maraki cv., followed in a decreasing order by Koratina and Koroneiki cvs.

K/Na a ratio in leaves, results as affected by salinity concentration regardless, olive cultivar as shown in Table (3) showed a particular trued, where, the higher salinity in irrigation water, the lower K/N ratio in leaves.

Calcium (Ca) leaf cornet in Koroneiki, Koratina and Maraki olive seedling cultivars ranged between: (0.30-0.47), (0.17-0.37) and (0.40-41%), respectively, where no significant differences detected (Table 3).

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4. Discussion

The obtained results in plant growth, (i.e., shoot length, dry weight, and root length is inhibited by moderate and high salinity could be exculpated by the findings of (Therios and Misopolinos, 1988; Bartolini *et al.,* 1991; Tattini *et al.,* 1992; 1995; Chartzoulakis *et al.,* 2002) and, (Hernnandez *et al.* 1995) who mentioned that salt stress causes a considerable reduction in the fresh and dry weight of stem. Dry matter partitioning is also affected, since the above ground part of the plant is more affected than are roots at high salinity. In the three olive seedlings studied cultivars, the reduction of vegetative growth parameters in term of shoot fresh weight, trunk diameter and number of shoots under stress conditions was associated with increase salinity level. Growth parameters results are in agreement with (Greenway and Munns 1980). Chartzoulakis (2005), who reports that low and moderate salinity is associated with obvious stunting of plant as well as decreased growth rate, which varies significantly according to the duration of salt exposure as well as cultivar. which means that Maraki cv. could be regarded the most tolerant olive cultivar under the high salinity concentration 6000 ppm than the other two cultivars (Koroneiki and Koratina). In this regard, we noted that saline stressed plants clearly displayed, with time, a lower DW than controls. The DW reduction, mainly localized in leaves was observed also by Karimi and Hasanpour (2014), who found that if the amount of salt rises to a toxic level in the leaves, it causes premature leaf senescence and abscission.

However, the obtained results were also supported by the findings of (Therios and Misopolinos, 1988; Chartzoulakis *et al.,* 2002) who mentioned that, under saline conditions the K+ concentration in olive is severely reduced, although it varies little among cultivars for the same salinity treatment. (Marschner, 1995). Tattini (1994) in a detailed study reported that salt-tolerant ‘Frantoio’ exhibited higher K-Na selectivity than salt-sensitive ‘Leccino’. Furthermore, apical leavesof ‘Frantoio’ showed significantly higher K:Na ratios at all salinity levels than basals suggests that basal leaves play a protective role, accumulating the major part of incoming Na, and thus maintain an appropriate K:Na ratio in actively growing tissues. In this respect, Tatini (1994) reported that the resistance mechanism of salt tolerant olive cultivars is probably related to the ability to maintain an appropriate K/Na ratio in an actively growing tissue. The decline of K concentration under salinity conditions has been demonstrated (Greenway and Munns 1980; Devitt *et al.* 1981).

From the above reseals, it seem that K contenting leaves and K/Na ratio values showed a similar trend oppositely, Na% in olive seedling leaves increase as salinity in irrigation water increase. It could be concluded that increasing salinity in irrigation water in olive seedling studied cultivars significantly decrease K% and K/Na ratio but increased Na content in leaves.

The obtained are in agreement with those of (Ben Ahmed *et al.,* 2009; Anjum *et al.,* 2011; Singh and Reddy, 2011; Goltsev *et al.,* 2012; Abdallah *et al.,* 2018). Who reported a marked decrease in photosynthesis rate and transport of salt ions from roots to shoots, and decrease in K % and K/Na ratio and increase Na% in leaves. Moreover, Cramer (2002) founded reduction in plant growth due to the reduced leaf growth. Salt tolerance in olives significantly depends on the cultivar and is most likely due to control of salt translocation to the shoots In general; high salinity causes a depression K/Na ratio in salt-sensitive olive. Reduction in K concentration and K/Na ratio in saline conditions was reported by Rush and Epstein (1978), Devitt *et al.* (1981) and Jackson and Volk (1997).

4. Conclusions

Salinity tolerance in olive (*Olea europaea* L.) is a cultivar-ependent characteristic. Understanding the mechanisms involved in olive trees is crucial to select salt tolerant genotypes more research's on young and mature Maraki olive trees grown under salt-tolerance of different saline conditions in needed by understanding the physiology of tolerance to salinity and utilizing advanced agro-techniques and their impact on growth, nutritional status, and productivity.

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