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EFFECT OF IRRIGATION WITH SALINIZED WATER ON GROWTH AND CHEMICAL CONSTITUENTS OF "KALAMATA" OLIVE CULTIVAR GRAFTED ONTO DIFFERENT OLIVE ROOTSTOCKS

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ABSTRACT

The most important black table olive *(Olea europaea L.)* "Kalamata" cultivar, grafted onto three different vegetative olive rootstocks[Picual (Pic), Frantoio (Fra) and Koroneiki (Kor) cvs.] was evaluated with 2-year-old grafted plants grown in sand clay soil, and received concentrations of salt mixture (NaCl, Na_2So_4, $CaCl_2$, $MgSo_4$ and KCl) making 6000 and 8000 ppm with SAR 12 of salinity level, for two seasons. Morphological and chemical parameters were investigated to determine the relative salinity tolerance of these rootstocks and to define possible reasons for any observed differences in the salt tolerance. However, results indicated that differences in response to salinity among rootstocks were observed primarily in morphological traits. Increasing of salinity level in irrigation water decreased, all of scion height and its rate of increase, leaf area, number of leaves/plant and fresh & dry weight of leaves and roots. But different rootstocks can affect the degree to which these parameters is reduced under salinity, where Kalamata growth on Picual and Frantoio was considerably better than on Koroneiki at 6000 and 8000 ppm treatments. Inversely in untreated grafted plants Kalamata on Kornaki exhibited the best growth vigor, comparing with Kal/Pic or Kal/Fra plants, suggesting that a decrease of scion growth in untreated grafted plants is a salt tolerance quality transmitted by tolerant rootstocks. Salinity significantly decreased leaf chlorophyll (a) and (b) content of all grafted plants, but different content among rootstocks were noted. On the contrary, proline content increased in leaves of all treated plants, however, insignificant difference was noted between rootstocks, yet the interaction between the two factors show that Kalamata on Picual and on Frantoio rootstocks recorded higher values of leaf proline content than Kalamata on Koroneiki rootstock. Leaves and roots Na^+ and Cl^- content of treated grafted plants showed an increment but to a different degree, comparing with the untreated (control) plants. There were differences among the grafted plants where Kalamata grafted on Koroneiki (the least tolerant cv.) mostly affected by saline treatment and accumulated the highest content of Na^+ and Cl^- in leaves comparing with Kalamata on Picual (the most tolerant cv.) or on Frantoio (the

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moderate tolerant cv.). Tolerant rootstocks contained more Na^+ in roots than in leaves. This response become apparent as salinity increased. Leaf N, P and K contents decreased in Kalamata leaves as influenced by different rootstocks and increasing salinity in irrigation water comparing with the control. Kal/Pic and Kal/Fra plants had higher N% in leaves than Kal/Kor plants, whereas Kal/Pic accumulated K more than the other plants, while P content in leaves of all grafted plants were insignificant in the two seasons. Based on the overall growth parameters and chemical composition in response to salinity, Kalamata grafted on Picual exhibited the greatest salt tolerance followed by those grafted on Frantoio whereas, Kalamata on Koroneiki showed the poorest plants pertaining salt tolerance.

Key words: Grafting, Irrigation with salinized water, Olive cultuivars, Rootstocks, Salt stress

INTRODUCTION

Olive (*Olea europaea L.*) is a major crop in the countries of the Mediterranean Sea basin and in many semiarid areas of the world , in these areas large quantities of low quality water, mostly saline are available and could be used for olive irrigation **(Loupassaki *et al* 2002)**. Although it classified as a moderately salt tolerant **(Tattini *et al* 1992)**, olive is well known as a crop capable to grow successfully and giving substantial yields when irrigated with saline water unsuitable for other fruit tree crops **(Taha *et al* 1972; Tattini, *et al* 1994; El-Sayed *et al* 1996 and Tattini *et al* 1997).**

Salinity tolerance in olive is a cultivar depended characteristic **(Tattini *et al* 1997).** However, symptoms of toxicity and cultivar differences in susceptibility to high concentrations of salts have been described by **Bartolini *et al* (1991)** and **Laupassaki *et al* (2002).** They reported that, marked saline stress can produce accumulation of sodium (Na^+) and chloride (Cl^-) in olive leaves, decreased growth, alter photosynthesis, cause morphological changes in the leaves and decrease the concentration of nutrients affecting, the nutrition of the tree.

Recent data on physiological mechanisms involved in olive salt tolerance might help to interpret data concerning scion–rootstock combinations, **Therios and Misopolions (1988); Al-Absi *et al* (2003)** suggested that, the exclusion of Na^+ and Cl^- from leaves is the main mechanism of salt tolerance in olive, **Tattini *et al* (1994) and Loupassaki *et al* (2002),** concluded that, the mechanisms of salt tolerance in olives should be located within the roots preventing net salt export to the shoot , rather than salt absorption.

Plant adaptation to saline conditions can depend, also on an increase in specific organic solutes within the cell, which help in osmoregulation and in preventing salt accumulation within the cytoplasm **(Stewart and Lee 1974; Flower *et al* 1977).**

Rootstock can import stress tolerance to the scion and that the beneficial effect of the rootstock is often the exclusion of Na^+ and /or Cl^- from the scion, **(Michael and Mary, 2002).**This has been demonstrated clearly in citrus **(Banuls *et al***

1990), while there appears to be a correlation between leaf Na^+ or Cl^- concentrations and physiological responses to salinity in some citrus rootstock-Scion combinations **(Lloyd *et al* 1987).**

The objective of the present study was to:

1. Evaluate the performance of the most important black table olive “Kalamata” cultivar, when grafted on three different vegetative olive rootstocks and irrigated with different saline water solution.
2. Determine the uptake and accumulation of Na^+ and Cl^- ions in the leaves of grafted plants under salt stress.
3. Define the effect of salt stress on the leaf mineral status of grafted plants.

MATERIAL AND METHODS

The experiment was conducted in the greenhouse of the experimental orchard of the Horticulture Research Institute, Giza, Governorate, Egypt. during 2001, 2002 and 2003 seasons. Trial was done to evaluate the effect of irrigation with salinized water on growth and chemical constituents of Kalamata ″kal″ olive cultivars grafted onto three different vegetative olive rootstocks i.e. Picual ″Pic″ “the most tolerant cv.”, Frantoio ″Fra" “moderate tolerant cv.” and Koroneiki ″Kor″ “as sensitive one”, according to **Tattini *et al* (1994); El-Sayed *et al* (1996); Tattini *et al* (1997) and Loupassaki *et al* (2002).**

Scions of Kalamata olive cv. were grafted on each of the three different one-year-old vegetative rootstocks in February 2001 and 2002 seasons. Grafted plants were maintained under the experimental field conditions for one year in polyethylene containers. Beginning with Mach 2002 and 2003 seasons, the two-years- old chosen grafted plants were uniform in vigor and trimmed to a single main trunk, transplanted into plastic pots of 25 cm in diameter and 30 cm in depth, containing 6 Kgs/pot of sandy clay loam soil, free from salts taken in February from a depth of 30 cm from the surface soil layer of Ismaillia Governorate, Egypt. Some physical and chemical properties of the used soil in this study were done by Soil, Water and environment. Res. Inst .Agric .Res.center, according to the method as descried by **Jackson, (1973)** and were summarized in Table (1).

The grafted plants were irrigated twice weekly by tap water before application saline solutions up to early May for each season.

The experiment included 9 blocks {3 treatments x grafted plants on 3 different rootstocks (Kal/ Pic, Kal/ Fra and Kal/Kor)}, comprising 3 replicates, each one consisted of 9 plants, to receive one of salt treatment and arranged in a factorial complete randomized design. The grafted plants were irrigated with salinized water with dissolving amount of NaCl, Na So_4, $CaCl_2$, $MgSo_4$ and KCl salts making concentration of 6000 and 8000 ppm with SAR (Sodium adsorption ratio) 12 calculated on the basis of the following equation.

$$\boldsymbol{SAR = \frac{NA}{\sqrt{Ca + Mg/2}}}$$

The untreated (control) plants were irrigated with tap water (400 ppm). Irrigation with saline solutions carried out twice weekly using 750 ml./pot, started in the first week of May and ended at late November in the two successive seasons (2002 and 2003).

Table 1. Physical and Chemical properties of the experimented soil

(A) Physical properties

Saturation Percent	Partial size distribution			Textural class	F.C.*	W.P.**
	Total sand	Silt	Clay			
20%	69.7	25.3	5	Sand loam	16%	3%

(B) Chemical properties

E.C***	PH	Soluble cations (me/l)				Soluble anions (me/l)				$Caco_3$
		Na^+	K^+	Ca^+	Mg^{++}	Hco_3^-	$Co_3^{=}$	Cl^-	So_4^-	
1.35	8.26	26.75	2.20	43.90	12.60	9.00	-	43.60	32.85	2.17

F.C*= Field capacity. W.P**= Wilting Point. E.C*** = Electrical Conductivity (m.mhos/cm^3).

Leaching of accumulated salts was done every 21 days by irrigation with tap water to reach approximately EC(0.29–0.31m.moles), followed by re-watering with the corresponding saline solutions in the next day . Control treatment was irrigated by tap water at the same rate. Hoagland solution **(Hoagland and Arnon, 1950)** was added biweekly for all treatments through the growth period.

At the end of the growth in each season, nine plants (representing 3 replicates) were sampled for each treatment and carefully pulled from the pots, washed and air dried and were used for the following determinations:

I- Vegetative growth parameters

1. Average scion height (cm) and its rate of increase (cm/season).
2. Number of leaves / plant.
3. Leaf area (cm^2) was estimated from the equation of **(Leon & Bukovac, 1978 and Tattini *et al* 1997):** Leaf area = 0.717 X – 0.095) where X is the product of length by width.
4. Fresh and dry weight of leaves and roots in grams.

II- Chemical constituents

1. Foliar pigments

Representative leaf samples of the same physiological age and position were taken in both seasons. Photosynthetic pigments (chlorophyll a, and b) in response to salinity were quantitatively determined in samples of sufficient fresh leaves. The optical densities were measured colorimetrically at 660 and 640 µM. wave for chlorophyll a, and b content, respectively according to **Saric *et al* (1967).**

2. Leaf proline content

Proline content g/100g F.W. was colorimetrically estimated in fresh leaf samples according to the methods of **Bates *et al* (1973)**.

3. Minerals content

Leaves and root samples were dried at 70°c till a constant weight, then ground and used for subsequent determination of N, P, K, Na and Cl in each sample as follows:

a) Nitrogen was determined by the modified micro-Kjeldahl method as described by **Pregl, (1945)**.
b) Phosphorus was determined colorimetrically according to **A.O.A.C. (1970)**.
c) Potassium and Sodium were determined by atomic emission analysis **A.O.A.C. (2000).**
d) Chloride was extracted from ash samples with hot water and titrated with standard silver nitrate solution and then determined according to **A.O.A.C. (1970).**

Statistical analysis

All data of 2002 and 2003 experimental seasons were subjected to analysis of variance according to **Snedecor and Cochran (1980)** and means were differentiated using Duncan's multiple tests (**Duncan, 1955).**

RESULTS

I- Vegetative growth parameters

The vegetative growth parameters were tested and evaluated under the same experimental conditions in both 2002 and 2003 seasons.

1. Average scion height and its rate of increase

Data presented in Table (2) show that, increasing of salinity levels in irrigation water affected negatively in the scion height of grafted olive plants, regardless of the kind of rootstocks. The data concerning the rate of increase clearly indicate that kalamata scion on all rootstocks was reduced during growth flush by increasing the salinity level, resulting in a significant reduction in rate of scion height, such reduction was more drastic by raising the salinity level, where it was 14.72, 8.84 & 6.10 cm/in the first season and 14.08, 8.20 & 5.71 cm/ in the second season, for the grafted plants which irrigated with saline solution 400 (control), 6000 and 8000 ppm, respectively. These results are generally in line with those previously reported by **El-Sayed *et al* (1996); Tattini *et al* (1997) and Atia (2002)** on olive cultivars, as well as, **Bondok *et al* (1995)** on peach and **Michael and Mary (2002)** on avocado.

Regarding the kind of rootstocks and its effect on scion growth in grafted plants, data show that, there was conspicuous increase in Kalamata scion grafted on Picual rootstock where it recorded higher values of increasing rate (11.63 & 11.49) than that on the other two rootstocks, which recorded (10.06 & 9.32) and (7.98 & 7.18) in the two successive seasons, respectively.

Table 2. Average scion height (cm) and rate of increase (cm/season) of Kalamata olive cv. grafted on different rootstocks as influenced by salinity treatments in irrigation water, during 2002 and 2003 seasons

Parameters	Average scion height (cm)				Rate of height increase (cm/season)			
	2002							
Treatments	control	6000 ppm	8000 ppm	Mean	control	6000 ppm	8000 ppm	Mean
Kal/Pic	38.20 b	36.03 c	33.00 d	35.74 A	14.20 b	11.70 c	9.00 e	11.63 A
Kal/Fra	38.43 b	33.33 d	30.20 e	33.98 B	14.50 b	9.40 d	6.27 f	10.06 B
Kal/Kor	40.20 a	30.17 e	27.77 f	32.71 B	15.47 a	5.43 g	3.03 h	7.98 C
Mean	38.94 A	33.18 b	30.32 C		14.72 A	8.84 B	6.10 C	
Parameters	Average scion height (cm)				Rate of height increase (cm/season)			
	2003							
Treatments	control	6000 ppm	8000 ppm	Mean	control	6000 ppm	8000 ppm	Mean
Kal/Pic	36.27 b	33.53 c	31.17 d	33.79 A	13.97 a	11.63 b	8.87 c	11.49 A
Kal/Fra	36.33 b	30.77 e	27.67 g	31.59 B	14.07 a	8.50 d	5.40 e	9.32 B
Kal/Kor	38.00 a	28.27 f	26.67 h	30.98 B	14.20 a	4.47 f	2.87 g	7.18 C
Mean	36.87 A	30.99 B	28.50 C		14.08 A	8.20 B	5.71 C	
Parameters	No. of leaves/plant				Leaf area (cm2)			
	2002							
Treatments	control	6000 ppm	8000 ppm	Mean	control	6000 ppm	8000 ppm	Mean
Kal/Pic	184.3 b	159.0 c	115.3 f	152.9 A	3.45 a	3.26 b	3.08 d	3.27 A
Kal/Fra	185.3 b	154.0 d	92.67 g	144.0 B	3.44 a	3.17 c	3.03 d	3.21 A
Kal/Kor	195.3 a	126.3 e	57.00 h	126.2 C	3.43 a	3.07 d	2.82 e	3.11 B
Mean	188.3 A	146.4 B	88.33 C		3.44 A	3.17 B	2.98 C	
Parameters	No. of leaves/plant				Leaf area (cm2)			
	2003							
Treatments	control	6000 ppm	8000 ppm	Mean	control	6000 ppm	8000 ppm	Mean
Kal/Pic	177.7 b	157.0 c	102.0 f	145.6 A	3.46 a	3.11 b	2.93 c	3.16 A
Kal/Fra	183.0 a	145.7 d	91.33 g	140.0 B	3.38 a	3.07 b	2.65 d	3.03 B
Kal/Kor	181.3 a	110.0 e	43.00 h	111.4 C	3.41 a	2.98 c	2.60 d	3.00 B
Mean	180.7 A	137.6 B	78.78 C		3.42 A	3.05 B	2.72 C	

Concerning, the interaction between salinity levels and different olive rootstocks on the average scion height and its rate of increase data clearly show that both of the two factors affect significantly on such parameters.

From the obtained results, it could be also noticed that, although in the grafted plants Kal/Pic exhibited the highest values of average scion height and its rate of increase, comparing with Kal/Kor which appeared the lowest ones, contrariwise in untreated grafted plants Picual rootstock induced shorter scion height, in comparison with Koroneiki rootstock which exhibited the highest values of scion height in both seasons. These results suggesting that a reduction of scion growth in the untreated grafted plants is a sold tolerance quality transmitted by tolerant rootstocks, these data are agree with those of **Jose *et al* (2002) and Syvertsen *et al* (1989),** who indicated that there are significant negative relationships between vigour and salt tolerance.

Generally, it could be concluded that, different rootstocks can affect the degree to which olive scion growth is reduced under salinity.

2. Number of leaves/plant

The salinization response of grafted olive plants, presented in Table (2), indicate that, the maximum total leaves number per Kalamata scion were obtained when the grafted plants were irrigated with saline water 400 ppm (control) 188.31 & 180.70 in contrast to the plants irrigated with 8000 ppm (the highest salt stress) 88.33&78.78 in the two seasons, respectively.

Recorded data concerning the effect of different rootstocks, showed that, kal/ Pic plants had higher number of leaves than Kal/ Fra or Kal/ Kor plants when irrigated with saline water.

Results indicate that number of leaves in the grafted plants was in consequence of both salinity levels and kind of rootstock in grafted plants with the same scion. The same results were found by **Kaul, (1981)** on guava and **Bondok *et al* (1995)** on peach.

3. Leaf area (cm^2)

Results reported in Table (2) clearly show that, in both seasons, the leaf area was significantly decreased by increasing salinity levels in irrigation water. The reduction in leaf growth is probably due to increase in osmotic pressure of the growth medium, depress water absorption or excess of certain ions which seem to have specific toxic impact especially sodium **(Bernstein, 1965).**

The results, indicated that, the leaf growth was affected differently to salinity stress depending on the rootstocks, whereas Kalamata scion grafted on Picual rootstock gave the highest values of leaf area, while the reduction in leaf area in response to salinity was observed in Kalamata on Koroneiki which gave plants with narrow leaf area, thus low in building metabolism and low in tolerance to salinity stress. These results are in harmony with those mentioned by **Kaul (1981)** on guava**, Bondok *et al* (1995)** on peach and **Michael and Mary (2002)** on avocado.

4. Fresh and dry weight of leaves and roots

Data presented in Tables (3) indicates that, different salt concentrations in an irrigation water resulted in a significant

Table 3. Average fresh and dry weight of leaves and roots (gm) Kalamata olive cv. grafted on different rootstocks as influenced by salinity treatments in irrigation water, during 2002 and 2003 seasons

Parameters	Fresh weight of leaves (gm)				Dry weight of leaves (gm)			
	2002							
Treatments	Control	6000 ppm	8000 ppm	Mean	Control	6000 ppm	8000 ppm	Mean
Kal/Pic	25.87 a	22.11 c	17.31 e	21.76 A	12.79 b	9.96 c	8.36 e	10.37 A
Kal/Fra	25.33 b	20.48 d	12.60 g	19.47 B	12.39 b	8.84 d	5.78 g	9.19 B
Kal/Kor	25.97 a	16.11 f	7.11 h	16.39 C	13.33 a	7.00 f	2.55 h	7.63 C
Mean	25.72 A	19.57 B	12.34 C		13.02 A	8.60 B	5.56 C	
Parameters	Fresh weight of leaves (gm)				Dry weight of leaves (gm)			
	2003							
Treatments	Control	6000 ppm	8000 ppm	Mean	Control	6000 ppm	8000 ppm	Mean
Kal/Pic	25.77 a	21.45 c	17.50 e	21.38 A	12.38 a	8.28 b	6.98 c	9.21 A
Kal/Fra	25.03 b	18.40 d	12.29 g	18.58 B	12.49 a	8.17 b	5.14 e	8.60 A
Kal/Kor	24.74 b	14.10 f	5.75 h	14.86 C	12.68 a	5.92 d	2.48 f	7.03 B
Mean	25.18 A	17.98 B	11.84 C		12.51 A	7.45 B	4.87 C	
Parameters	Fresh weight of roots (gm)				Dry weight of roots (gm)			
	2002							
Treatments	Control	6000 ppm	8000 ppm	Mean	Control	6000 ppm	8000 ppm	Mean
Kal/Pic	53.92 b	48.25 c	39.86 d	47.34 A	23.67 b	20.53 d	16.48 f	20.22 A
Kal/Fra	53.65 b	39.08 e	31.36 g	41.36 B	23.24 c	17.48 e	13.93 g	18.22 B
Kal/Kor	55.03 a	35.36 f	26.50 h	38.96 C	24.14 a	14.13 g	11.33 h	16.53 C
Mean	54.20 A	40.90 B	32.57 C		23.68 A	17.38 B	13.91 C	
Parameters	Fresh weight of roots (gm)				Dry weight of roots (gm)			
	2003							
Treatments	Control	6000 ppm	8000 ppm	Mean	Control	6000 ppm	8000 ppm	Mean
Kal/Pic	48.92 b	46.13 c	37.05 d	44.03 A	21.00 b	18.98 c	15.46 d	18.48 A
Kal/Fra	48.65 b	36.96 b	29.81 f	38.47 B	21.77 a	15.71 d	12.09 f	16.52 B
Kal/Kor	49.86 a	33.59 e	24.94 g	36.13 C	22.12 a	13.84 e	10.09 g	15.35 C
Mean	49.14 A	38.89 B	30.60 C		21.63 A	16.18 B	12.55 c	

reduction with different degrees in fresh and dry weight of leaves and roots of olive grafted plants, when compared with those of control plants in 2002 and 2003 seasons. These results are coinciding with those of **Bartolini *et al* (1991); El-Sayed *et al* (1996); Micheal and Mary (2002).** Such reduction in plant growth might be due to low available water for tissue development rather than deficiency of inorganic nutrient supply **(Cooper *et al* 1952).**

Data in both seasons showed that, although the untreated grafted plants Kal/Kor exhibited the highest values of fresh and dry weight of roots comparing with Kal/Pic or Kal/Fra, they appear the lowest value in the grafted plants irrigated with saline water. The obtained results may confirm that previously discussed by **Tattini *et al* (1994)** that, root vigour was positively related to cultivar vigour and negatively related to salt tolerance.

Hartmann and Kester (1968), found that, there are three approaches that could be put into considerations to explain the scion-rootstock relationship affecting plant growth, these approaches are, nutritional uptake utilization, translocation of nutrient water and alterations in endogenous growth factor. These three factors generally affected growth of the scion expressed as dry weight.

In general, results clearly show that, salt tolerance response based on these growth parameters (average scion height and its rate of increase; number of leaves/plant, leaf area and fresh and dry weight of leaves and roots) for each rootstock–scion combination resulting in a reduction in scion growth.

Results also, indicated that, salt tolerance of grafted plants generally depended on the characteristics of the rootstocks in response to salinized irrigation water.

II. Chemical constituents

(1) Foliar pigments

The data obtained in the present study pertaining the chlorophyll (a) and (b) contents are shown in Table (4). These results reveal that, salinity significantly decreased the leaf foliar pigments content of all grafted plants. It has been noticed that the reduction in chlorophyll (a) and (b) content was correlated with the increase in salinity concentrations. Results also show that, different rootstocks exhibited significant variation in chlorophyll (a) & (b) in the two seasons.

Regarding to the interaction between salinity level and different olive rootstocks on foliar pigments content, results show that, significant variations were noted between grafted plants, where Kal/ Pic exhibited the highest values of chlorophyll (a) and (b), while, Kal/ Far recorded a moderate content, and Kal / Kor gave the lowest values.

The reduction in chlorophyll content as affected by saline irrigation water was previously reported by **El-Sayed *et al* (1996) and Atia (2002)** on olive. The results also similar to those reported by **Ferguson *et al* (2002)** on "Kerman" Pistachio on three rootstocks.

Reductions in chlorophyll content of plants treated with salinized water have been also studied by **Jacobson and Ortli (1956)** who suggested that the depressive effect of salinity on the absorption of ions such as iron was involved in chloroplast formation via protein synthesis. In addition, **Puritch and Barker (1967)** proved that ammonium accumulation in plant leaves was one of the main factors causing reduction in chlorophyll content through plastid breakdown.

(2) Proline content

Proline content indicates remarkable increase in the leaves of all treated grafted plants irrigated with saline water, (Table, 4).

Data concerning the effect of different rootstocks showed that, Kalamata olive cv. grafted on Picual, Frantoio or Koroneiki olive rootstocks contained nearly similar amount of proline in all cases and the difference were insignificant in the two studied seasons.

Regarding the interaction between salinity level and different olive rootstocks on proline content, it is clear that, both of the two factors affect significantly the proline content and significant variation were noted between the grafted plants. However, leaves of Kalamata cv. grafted on Picual rootstock has recorded the highest values of proline content compared to those grafted on Frantoio or Koroneiki rootstocks. These may confirm those reported by **Bates *et al* (1973); Stewart and Lee (1974)** who mentioned that proline was increased gradually as the level of salinity raised, they also suggested that, proline function as a source of solute for intra cellular osmotic adjustments under saline conditions.

(3) Ion concentration

(a) Sodium and chloride contents

In comparison with the control grafted plants, salinized water treatments increased significantly Na^+ and Cl^- concentration in leaves and roots (Tables 5 & 6).

There were differences among the grafted plants where Kal/Kor plants mostly affected by salinity treatment and accumulated the highest values of Na^+ in leaves(2.604 & 2.738) comparing with Kal/ Far (2.066 & 2.121) or Kal/Pic (1.621 & 1.653),when exposed the highest salinity level (8000 ppm)in the two studied seasons, respectively . All tolerant rootstocks retained more Na^+ in roots than that accumulated in leaves. In Picual cv. this response become apparent as salinity increased in Kal/Pic plants, root Na^+ / leaf Na^+ increased from (1.122 to 1.833) & (1.128 to 1.801) where in Kal / Kor plants this ratio decreased from (1.099 to 0.734) & (1.097 to 0.685) while there is a slight increase (1.142 to 1.237) & (1.097 to 1.205) in Kal/ Far plants, as salinity increased from 400 ppm (control) to 8000 ppm in 2002 and 2003 seasons, respectively. These results similar to that reported by **Ferguson *et al* (2002)** on pistachio budded plants.

Similar to Na^+, chloride increased with increasing salinity in leaves and roots of all grafted plants comparing with control. The results showed that Cl^- was lower in leaves and higher in roots than Na^+ in all grafted plants irrigated with saline water in different degrees.

Leaf analysis showed that plants of the sensitive rootstock (Koroneiki cv.) accumulated sizable amount of Na^+ and Cl^- in the leaves in contrast to plants of tolerant rootstock (Picual) which exclude both ions (Na & Cl) from the leaves.

These results are in line with those found by **Bondok *et al* (1995)** on Peach, who found that less tolerant rootstock in budded plants contained higher concentration of Na^+ and Cl^- in leaves than tolerant ones. Further more, Michael and Mary (2002) reported that, rootstock can

impart stress tolerance to the scion and that the beneficial effect of the rootstock is often the exclusion of Na^+ and / or Cl^- from the scion. Some evidence on the exclusion of toxic ions has been reported for olive cultivars by **Therios and Misopolinos (1988); Tattini *et al* (1992); Atia (2002) and Loepassaki *et al* (2002).**

(b) Nitrogen (N), Phosphorus (P) and Potassium (K) content

As for N, P and K content in Kalamata leaves as influenced by different rootstocks and increasing salinity level in irrigation water, results of both studied seasons in Table (7) clearly show that significant reduction in the N, P and K content in leaves of the studied grafted plants compared with the control ones. The results show a significant variable effect on N and K content in terms of the salinity response of the different grafted plants, For instance, the Kal/Pic and Kal/Fra plants had higher N % in leaves than Kal/Kor plants, whereas Kal/ Pic accumulated K more than the other grafted plants, while P content in leaves of all grafted plants showed insignificant difference in the two studied seasons. These results are generally in line with those reported by **Taha *et al* (1972); Bartolini *et al* (1991); El-Sayed *et al* (1996); Tattini *et al* (1997); Atia (2002); Loupassaki *et al* (2002) and Al-Absi *et al* (2003).**

The reduced concentrations of the nutrient combined with the stunting of growth caused by salinity **(Therios and Misoplinos, 1988; Loupassaki *et al* 2002)** leads to the conclusion that there is significant suppression of the nutrition of the olive.

Regarding to the interaction between salinity levels and different olive rootstocks on the N, P and K content in leaves, results show that, significant variations were found between grafted plants where Kal/Pic exhibited the highest values of N, P and K content, while Kal/Kor gave the lowest values in 2002 and 2003 seasons. The least contents of N, P and K were recorded with 8000 ppm salinity applied to Kal/Kor plants in both seasons.

However, the best markers for determining the relative salt tolerance among these rootstocks are Na^+ and Cl^- contents in leaves and roots as well as proline content in leaves.

In conclusion, salinity had increased Na^+ and Cl^- concentrations in leaves and roots, to different degrees and reduced growth of Kalamata olive cultivars grafted on the three rootstocks. The relative tolerance of the three studied rootstocks appears to be due to the characteristics of the rootstock in response to salinilized irrigation water and the ability of the root to exclude Na^+ and Cl^- from the leaves. Date show that Kal/Kor (sensitive rootstock) plants had the highest concentration of Na^+ and Cl^- in leaves and appeared to be the poorest plants, whereas Kal/Pic (the most tolerant rootstock) exhibited the greatest salt tolerance followed by Kal/Fra (the less tolerant one) this is clearly related to the different abilities of the rootstocks to exclude Na^+ and Cl^- ions from the leaves.

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تاثير الرى بالماء المملح على النمو والمحتوى الكيميائي لصنف الزيتون كلاماتا المطعوم على اصول زيتون مختلفة

[25]

سناء ابراهيم لاظ [1]

1- قسم بحوث الزيتون وفاكهة المناطق شبه الجافة - معهد بحوث البساتين - مركز البحوث الزراعية - الجيزة

أجريت هذة الدراسة لاختبار تأثير الرى بالماء المملح على النمو والمحتوى الكيميائي لصنف الزيتون كلاماتا المطعوم على ثلاثة اصول زيتون خضرية مختلفة (بيكوال- فرانتويو- كروناكى). حيث تم رى النباتات المطعومة بتركيزات 8000,6000 جزء فى المليون، عند مستوى صوديوم مدمص (12) من مخلوط المحلول الملحى (كلوريد الصويوم- كبريتات الصوديوم- كلوريد الكالسيوم- كبريتات الماغنسيوم- كلوريد البوتاسيوم) فى حين تم رى نباتات مطعومة اخرى بماء الصنبور للمقارنة وقد اظهرت النتائج التالى:

اختلاف فى مدى الاستجابة للرى بالماء المملح طبقا للأصول المختلفة وظهر هذا الاختلاف فى البداية على النمو الخضرى حيث وجد ان زيادة ملوحة مياه الرى ادت الى انخفاض فى طول الطعم ومعدل الزيادة فى طول الطعم وأيضا مساحة الورقة وعدد الاوراق/النبات وكذلك نقص فى الوزن الطازج والجاف للأوراق والمجموع الجذري. وكان لاختلاف الاصل تاثير على درجة هذا الانخفاض حيث وجد ان صنف الكلاماتا المطعوم على البيكوال أوالفرانتويو افضل نموا من الكلاماتا المطعوم على الكروناكى عند مستوى ملوحة 8000,6000 جزء فى المليون. بينما اظهرت النتائج فى النباتات الغير معاملة (الكنترول) ان الكلاماتا المطعوم على الكروناكى كان افضل فى النمو الخضرى من الكلاماتا المطعومة على البيكوال او الفرانتويو.

ادت المعاملة بالرى بالماء المملح الى انخفاض محتوى اوراق الكلاماتا من الكلورفيل أ، ب فى جميع النباتات المطعومة وكان للاصول المختلفة تاثير واضح حيث وجد ان محتوى اوراق الكلاماتا على البيكوال ثم على الفرانتيو بها اعلى قيمة من الكلورفيل مقارنة بمحتوى اوراق الكلاماتا على الكروناكى وعلى العكس ادت المعاملات بالماء المملح الى زيادة محتوى الاوراق من الحمض الامينى البرولين ولم يكن للاصول المختلفة تاثير على كمية البرولين فى اوراق الطعم.

أدت المعاملة بالرى بالماء المملح الى زيادة تركيز الصوديوم والكلوريد فى اوراق النباتات بالمقارنة بالكنترول وكان للاصول المختلفة تاثير على تركيز الصوديوم والكلورفى الاوراق حيث زاد التركيز فى النباتات المطعومة على الكروناكى (اصل حساس للملوحة) بالمقارنة بالنباتات المطعومة على البيكوال (اكثر مقاومة للملوحة) أو الفرانتيو (متوسط المقاومة) ولوحظ اختلاف فى نسبة الصوديوم فى الجذور: الصوديوم فى اوراق الطعم حيث وجد ان المعاملات بالماء المملح ادت الى زيادة هذة النسبة فى النباتات المطعومة على البيكوال وكانت الزيادة بدرجة اقل في النباتات المطعومة على الفرانتيو بينما انخفضت هذة النسبة فى النباتات المطعومة على الكروناكى بالمقارنة بالكنترول.ادت زيادة الملوحة الى انخفاض محتوى الاوراق من النتروجين والفوسفور والبوتاسيوم بالمقارنة بالنباتات الغير معاملة. وكان للاصل تاثير على نسبة النتروجين والبوتاسيوم حيث ظهرت زيادة فى نسبة النتروجين فى اوراق نباتات الكلاماتا المطعومة على البيكوال والفرانتيو بالمقارنة باوراق النباتات المطعومة على الكروناكى بينمالوحظ زيادة البوتاسيوم في اوراق الكلاماتا على البيكوال ولم يكن للاصول المختلفة اى تاثير على نسبة الفوسفور خلال موسمى النمو.

ويستنتج من هذة الدراسة

ان نباتات الكلاماتا المطعومة على اصل البيكوال اظهرت تحملا للملوحة بدرجة عالية تليها نباتات الكلاماتا المطعومة على الفرانتويو بينما اظهرت نباتات الكلاماتا المطعومة على اصل الكروناكى اكبر حساسية للملوحة كما اظهرت الدراسة ان درجة المقاومة للملوحة فى النباتات المطعومة ترجع الى طبيعة نمو الجذور ومدى استجابة الجذور للملوحة فى ماء الرى وان مقدرة النباتات على مقاومة الملوحة تعتمد على مقدرة جذور الاصول المختلفة على منع انتقال الصوديوم والكلوريد الى الاوراق. لذلك يوصى بزراعة صنف الكلاماتا مطعوما على الاصل الجذرى البيكوال او الفرانتويو فى الاراضى الجديدة التى تروى بماء مالح.

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