International Journal of ChemTech Research
CODEN (USA): IJCRGG ISSN: 0974-4290
Vol.8, No.10 pp 33-38, 2015

Vegetative growth of Manzanillo and Picual olive cultivars as Affected by irrigation with saline water

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Abstract: The present investigation was conducted during the period 1994-1995. The objective of this experiment is to determine the annual pattern of vegetative growth of young plants of Manzanillo and Picual cultivars under irrigation with saline water. Uniform 5 month - old plants (originally propagated by stem cutting) of two cultivars were grown in nursery of Faculty of Agriculture, Cairo University at Giza. Olive plants were planted in above-ground rhiziotrons. Plastic barrels rhizotrons were 50 cm in diameter and 90 cm depth were filled with sand and clay (8:1 by volume). Strogonov chloride mixture (1962) was used as the source of salinity. Linear extension of roots in each rhizotron was measured every 15 days. Samples were taken at the end of the experiment and the following properties were studied: Length of the fibrous root and wooden root per plant and dry weight of roots per plant. According to the obtained data it could be noticed that salinity exerted harmful effect on terminal shoot length (plant height), since the reduction in plant height was closely associated with increasing salt concentration for both Manzanillo and Picual cultivars. Salt treatment at 7000 ppm resulted in the lowest increment in growth rate (1.43 cm / month), while control treatment gave the highest value of growth rate (4.53 cm / month). Treatments of 3000 and 5000 ppm rated in between (1.91and 1.93cm/month respectively). Picual plants tended to had longer lateral shoot than Manzanillo plants, The lateral shoot length was more sensitive to salinity stress, since the length and growth rate lateral shoots of plants subjected to salinity treatments exhibited a marked and gradual decrease by raising the level of salt in the irrigation water.
Key words: Vegetative –growth – saline water – Manzanillo – Picual.

Introduction

Plants vary greatly in their tolerance to irrigation with saline water. Irrigating crops with water of salinity higher than the plant can tolerate will result in yield loss and may decrease crop quality. Salty irrigation water can affect plant growth in two ways - the osmotic effect and specific ion effect [1]. Taha [2] reported that shoot growth of olive plants decreased with increasing salt concentration and the maximum salt concentrations tolerated by olive plants was 6000 ppm. Soil salinity and irrigation with saline water had large effect on vegetative growth especially concerning the olive trees. El-Deen et al. [3] reported that increasing salinity resulted a significant reduction of plant height, number of leaves and total vegetative area of one-year-old seedlings of Chamlali olive cultivar. Rooted cuttings of the olive variety Chetoui showed no visible symptoms of salt toxicity expect of some rolled leaves but older leaves of plants treated with 8 gm/litre salt, considered to be the tolerance limit for olive trees [4]. Barakat et al. [5] reported that increasing the supply of NaCh decreased the growth of chamlali olive seedlings. El-Saidi et al. [6] studied effect of irrigation with saline water on the growth of Picual olive seedlings, found that length of the main shoot, secondary shoots; growth rate per day;

number and weight of leaves were not significantly affected by different salt concentration in irrigations water up to 6000 ppm, but concentration 8000 ppm negatively affected plant growth. Bartolini et al. [7] studied effect of salinity (at concentrations of 40, 60 or 90 meg/litre) of young olive plants. At the lowest concentration neither salt affected plant survival, whereas at the intermediate concentration the mortality rate averaged 23% and at the highest salt concentration it averaged 56%. Salt concentration also proportionately affected the growth of surviving plants. As the concentrations increased the liner growth, number of shoots, number of leaves and total leaf area decreased.

Shoot growth was less affected than root growth by salinity of citrus trees, so that the shoot; root ratio increased for all rootstocks but to different degrees. The more tolerant rootstock the lower was the ratio [8]. High salinity irrigation water reduced canopy growth of citrus trees [9].

Patil and patil [10,11] found that all indices that were studied on pomegranate plants such as plant height , number of leaves, stem diameter, plant spread, leaf area decreased with increasing salinity. Kassim [12] reported that the growth of the main, secondary shoots and the diameter of the main shoot of pomegranate plants were badly affected when irrigated with saline water. Anyhow, salinity reduced the growth of the plants and shoots. Yet, the reduction value in total growth per plant was about 42.4 % in plants irrigated with 4000 ppm chloride salt compared with plants irrigated with tap water. Meanwhile the lower concentration of salt (2000 ppm) reduced 6.8% of growth of the plants. In pot trails with three grape-vine cvs. [13] reported that sprouting of all cvs. was suppressed by the highest salt concentration. Shoot length, leaf number, leaf area and percentage of survival plants were also reduced especially the higher concentrations. Abou Rayya et al. [14] studied effect of irrigation with saline water on the growth of grape transplants. They found that total length, diameter of the main shoot and other characteristics of growth were not significantly affected by different salt concentrations in water irrigation up to 2000 ppm; but 3000 ppm negatively affected the plant growth characteristics. Number of leaves had the same criteria affected-negatively by salt concentrations up to 2000 ppm. Salinity significantly decreased the height of the main shoot, growth extension, total number of internodes and number of leaves of grapes; moreover, with the increase of salt concentration of the irrigation water the effect became more obvious [15].

Similarly to the above mentioned review, [16] on guava hybrids found that the salinity tended to restrict plant growth and decrease terminal growth increment, leaf formation and number of lateral shoots. Sweidan et al. [17] found that irrigation with saline water evidently reduced shoot length, the number of leaves /plant and raised the rate of leaf-abscission of apple trees. The effect was more obvious at high salt concentration. Sweidan et al. [18] noticed that high salinity of NaCl tended to restrict plant growth and decrease the rate of plant elongation and leaf formation of apricot seedlings. Plants failed to resist the highest concentration (240me/L) and they were wilted shortly after treatment. However, when the experiment came to an end, more than 50% of seedlings under 160 me/L were wilted and died. The concentration of 80 me/L, despite its deleterious effect than the control, did not cause the damage induced by higher level (160 me/ L).

The present investigation was conducted during the period 1994 - 1995. The objective of this experiment is to determine the annual pattern of shoot growth of young plants of Manzanillo and Picual cultivars under irrigation with different concentrations of saline water.

Materials and Methods

The present investigation was conducted during the period 1994 - 1995. The objective of this experiment is to determine the annual pattern of shoot growth of young plants of Manzanillo and Picual cultivars under irrigation with different concentrations of saline water.Uniform 5 month - old plants (orginally propagated by stem cutting) of the two cultivars were grown in nursery of Faculty of Agriculture, Cairo University at Giza . Olive plants were planted in above-ground rhiziotrons. Plastic barrels rhizotrons were 50 cm in diameter and 90 cm depth were filled with sand and clay (8:1 by volume). Three rhizotrons replicates were included in each treatment. Strogonov chloride mixture (1962) was used as the source of salinity. The mixture of salt was expressed as percentage of the total salt content.

Table 1. Contents of Strogonov chloride mixture.

$MgCl_2$	$CaCo_3$	$MgSo_4$	NaCI
2gm	10 gm	10 gm	78 gm

Salt concentrations in irrigation water were 3000, 5000, 7000 ppm in addition to tap water as control. The irrigation was carried out three times/ week during the summer and twice in the winter. The quantity of water in each irrigation time was 4 liters. The nutrition occurred by spraying plants with Greezed. Olive plants were in above ground rhiziotrons .Plastic barrels rhizotrons were 50 cm in diameter and 90 cmdepths were filled with sand and clay (8: 1 by volume).

Linear extension of shoots in each rhizotron was measured every 15 days. The number of shoots that were measured on a given plant varied during the experiment due to changes in plant size, shading of shoot terminals, root mortality, growth of roots out of the field of the rhizotrons face and other noncontrollable factors.

Randomly chosen shoot at each rhizotrons in the exterior protions of the canopy was monitored. Tagged nodes on each of the monitored shoots were used as a reference points and shoot extension was determined on each sampled date by measuring from the reference nodes to the ends of terminals.

Root growth was recorded by tracing root with an indelible marking pen on clear plastic sheets that were placed over the viewing face

Growth rate for shoots of a given plant was computed with the following formula:

Mean linear growth for shoots (mm/day) = $\frac{\text{total gro wth}}{no.days}$

Where total growth = the total growth of all measured shoots in mm. since the last measurement, and no. days = the number of days since the last measurements were taken. Standard horticultural management (Fertilization, irrigation) were applied.

Samples were taken at the end of the experiment and the following properties were studied:

- Length of the main shoot.
- Length of secondary shoot.
-Terminal and lateral shoot length were recorded before salt treatment and then measured again at monthly intervals all along the period of salt application. Net increase in plant height and longest of laterals as well as rate of growth / month were calculated.

Statistical analysis

All data were subjected to statistical analysis according to procedures reported by [19]. Treatments means were compared by the least Significant Difference test (L.S.D.) at the 5% level of probability of experimentation.

Results and Discussion

The data obtained regarding net increase in terminal shoot elongation (gained growth) as well as growth rate of the two studied cultivars are presented in Table (2 and 3) .

Generally the results indicated that the reduction in plant height was closely associated with increasing salt concentration. In this respect all salt treatments significantly decreased the increment in paint height for both cultivars as compared with the control; the matched values in this regard were 40.79, 17.46, 17.45 and 12.83 cm for control, 3000, 5000 and 7000 ppm respectively. Salt treatment at 7000 ppm showed the most depressive effect followed by 5000 ppm then 3000 ppm.

Table 2. Net increase in terminal shoots length (cm) of two olive cultivars as affected by salinity treatments.

Cultivars (A)	Salt concentrations ppm. (B)				Average (A)
	O (control)	3000	5000	7000	
Manzanillo	37.18	18.01	17.96	13.25	21.60
Picual	44.40	16.90	16.93	12.40	22.066
Average (B)	40.79	17.46	17.45	12.83	22.13

L.S.D. at 5% for:
Cultivars (A) NS
Salt concentration (B) 8.91
Interaction (A×B) 12.63

Regardless of salt treatments, the differences in the net increase in plant height (Table 2) as well as the rate of growth / month (Table 3) of the two studied cultivars did not attain the statistical level.

Concerning the main effect due to dates of the measurements, the data in Table (3) show a gradual and significant decrease in growth rate of the two studied cultivars from Sept.1994 till Nov.1994 then a gradual increase was detected in the period from Feb. 1995 up to May 1995. Any how a progressive inhibition in the rate of growth / month was obviously noticed. This reduction in the growth rate is mainly due to the presence of salts in the growth medium, whereas salt treatment at 7000 ppm resulted in the lowest increment in growth rate (1.043 cm / month), while control treatment gave the highest value of growth rate (4.53cm/ month).Treatments of 3000 and 5000 ppm rated in between (1.91 and 1.93 cm respectively).

Discussing the effect of interaction between salt concentration x cultivar on net increase in plant height (gained growth), the data (Table2) showed that there was significant interaction, that is the reduction in the gained growth of Manzanillo or Picual at a certain salt concentration was lower than that of the control. However insignificant differences were obtained when the effect of such interaction on growth rate (Table3) was detected, whereas at any salt concentration, Manzanillo and Picual seemed to exhibit similar response.

Table 3. Growth rate (cm/month) of lateral shoots of two olive cultivars as affected by salinity treatments.

Cultivars (A)	**Salt Concentrations Ppm (B)**	**Dates**										**Ave (A×B)**
		Sep. 1994	**Oct. 1994**	**Nov. 1994**	**Dec. 1994**	**Jan. 1995**	**Feb. 1995**	**Mar. 1995**	**Apr. 1995**	**May. 1995**		
Manzanillo	0 (control)	17.60	5.60	2.30	0.00	0.00	0.00	2.70	4.98	4.00		4.13
	3000	7.65	2.76	0.00	0.00	0.00	0.00	1.30	2.00	4.30		2.00
	5000	10.60	2.33	0.00	0.00	0.00	0.00	1.30	2.00	1.70		1.70
	7000	9.30	2.30	0.66	0.00	0.00	0.00	0.66	0.33	0.00		1.47
Ave. (A×C)		11.28	3.25	0.74	0.00	0.00	0.00	1.49	2.33	2.50	Ave.(A)	2.39
	0 (control)	14.30	5.70	4.70	0.00	0.00	1.70	3.00	8.00	7.00		4.93
	3000	9.00	2.20	0.00	0.00	0.00	0.70	1.70	2.10	1.20		1.20
	5000	8.30	3.90	0.33	0.00	0.00	0.70	1.70	1.00	1.00		1.00
	7000	8.70	1.00	0.00	0.00	0.00	0.00	2.00	0.70	0.00		1.38
Ave. (A×C)		10.08	3.20	1.26	0.00	0.00	0.77	2.10	2.95	2.30	Ave.(A)	2.52
	0 (control)	15.95	5.65	3.50	0.00	0.00	0.85	2.85	6.49	5.50	Ave. (B)	4.53
	3000	8.32	2.26	0.00	0.00	0.00	0.35	1.50	2.05	2.75		1.91
	5000	9.45	3.11	0.16	0.00	0.00	0.35	1.50	1.50	1.35		1.93
	7000	9.00	1.65	0.33	0.00	0.00	0.00	1.33	0.52	0.00		1.43
Ave.(C)		10.64	3.22	1.00	0.00	0.00	0.38	1.79	2.94	2.40		

L.S.D. at 5% for:
Cultivars (A) NS   Interaction (A×B) NS
Salt concentration (B) 1.25   Interaction (A×C) 1.77
Date (C) 1.25   Interaction (B×C) 2.50
Interaction (A×B ×C) 3.54

Moreover, there were significant interaction between cultivar x dates and salt concentrations x dates.

Lateral shoot length

Similarly to what was mentioned before with terminal shoot growth, the effect of salt treatments on the gained growth of lateral shoots (Table 4) as well as the monthly growth rate (Table 5) showed an obvious depression by increasing salinity level in the irrigation water, as salt concentration at 7000 ppm disclosed the most restrictive effect followed by 5000 ppm then 3000 ppm. As for the cultivar response, it was noticed from the data obtained that the differences between Manzanillo and Picaul cvs. in their averages of laterals length and the rate of elongatain did not attain the level of significance. However, Picual plants tended to had longer laterals than Manzanillo plants. Moreover, there was significant interaction between cultivar x salt concentration in this respect.

Table 4. Net increase in terminal shoots length (cm) of two olive cultivars as affected by salinity treatments.

	Salt concentrations ppm (B)				
Cultivars (A)	0 (control)	3000	5000	7000	Average (A)
Manzanillo	157.16	94.84	19.90	14.52	71.61
Picual	207.90	96.60	35.00	27.70	91.80
Average (B)	182.53	92.72	27.45	21.11	81.70

L.S.D. at 5% for:
Cultivars (A) NS
Salt concentration (B) 27.12
Interaction (A×B) 39.07

Table 5. Growth rate (cm / month) of lateral shoots of two olive cultivars as affected by Salinity treatments

Cultivars (A)	**Salt Concentretions ppm.(B)**	**Dates**										**Ave (A×B)**
		Sep. 1994	**Oct. 1994**	**Nov. 1994**	**Dec. 1994**	**Jan. 1995**	**Feb. 1995**	**Mar. 1995**	**Apr. 1995**	**May. 1995**		
Manzanillo	0 (control)	35.26	53.10	12.90	1.00	0.00	2.90	23.90	16.20	11.90		17.46
	3000	35.00	10.20	5.70	0.30	0.00	4.50	14.00	13.66	11.30		10.54
	5000	5.40	4.20	2.20	0.00	0.00	0.00	1.30	4.30	2.50		6.70
	7000	6.70	2.30	1.10	0.00	0.00	0.20	1.10	1.90	1.20		1.61
Ave. (A×C)		20.59	17.45	5.47	0.32	0.00	1.85	10.07	9.02	6.77	Ave.(A)	7.95
	0 (control)	20.30	26.20	15.60	0.00	0.00	12.90	37.80	54.80	40.30		23.10
	3000	19.90	15.00	5.00	0.00	0.00	10.14	16.90	14.40	15.00		10.73
	5000	15.00	0.70	0.00	0.00	0.00	1.30	6.70	4.30	7.00		3.89
	7000	11.90	2.30	0.30	0.00	0.00	1.00	4.90	2.90	4.40		3.08
Ave. (A×C)		16.77	11.05	5.22	0.00	0.00	6.40	14.57	19.10	16.66	Ave.(A)	3.08
	0 (control)	27.78	39.65	14.25	0.50	0.00	7.90	30.85	35.50	26.10	Ave. (B)	20.28
	3000	27.45	12.60	2.85	0.15	0.00	7.45	15.45	14.03	13.25		10.36
	5000	10.20	2.45	1.10	0.00	0.00	0.65	4.00	4.30	4.75		3.05
	7000	9.30	2.30	0.70	0.00	0.00	0.60	3.00	2.40	2.80		2.34
Ave. (C)		18.68	14.25	5.34	0.16	0.00	4.12	13.32	14.06	11.72	Ave.(A)	

L.S.D. at 5% for:

Cultivars (A)	NS	Interaction (A×B)	5.23
Salt concentration (B)	3.69	Interaction (A×C)	NS
Date (C)	2.76	Interaction (B×C)	5.51
		Interaction (A×B ×C)	7.97

Comparing the effect of salinity treatments on terminal and lateral growth, it is evident that laterals were sensitive to salinity stress, since the length and growth rate of laterals of plants subjected to salinity treatments showed a significant gradual decrease by raising the level of salt in the irrigation water, while such differences with respect the main shoot (terminal) did not attain the statistical level. Therefore from the above mentioned results, it appeared that salinity conditions had a harmful effect on plant growth that is the salt treated plants showed the lower growth rate than the untreated ones.

Moreover, the extension of salt effect on growth depression was almost parallel to the level of salinity in the irrigation water. Similar pattern of response to salt injurious effect was also noticed by [2,3,5,6] on olive, [16] on guava and [17] on some apple rootstocks .

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