RESPONSE OF SOME OLIVE CULTIVARS GROWN IN SIWA OASISTO WELL WATER QUALITY

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ABSTRACT

Ten olive (*Olea europea*, L) orchards at Siwa Oasis were selected to study the effect of well water quality on yield, oil content, fruit properties, leaf characteristics and soil chemical analysis during 1998 and 1999 growing seasons. Irrigation water for every orchard was taken from one well drilled in it. Two olive cultivars (Hamid and Wetteken) were used in this study. The data for both seasons, generally revealed that, increasing water salinity (EC_{iw}) markedly decreased yield, oil content and fruit weight, volume, length and diameter, for both cultivars. Moreover, seed weight, length and diameter significantly decreased with increasing EC_{iw}. With regard to flesh characteristics flesh weight, thickness and percent behaved similar trend. The data also revealed that the reduction of Wetteken cv. yield was more pronounced as compared with Hamid cv. Meanwhile oil content gave an adverse trend. Leaf area, leaf total chlorophyll and water contents significantly decreased as a result of increasing water salt content. Leaf, N, P, K, Fe, Mn, Zn, Cu and B contents decreased, while Ca, Mg, Na and Cl increased with increasing EC_{iw} for both cultivars. High salt content of irrigation water significantly increased pH, EC, soluble cations , anions and soil nutrient contents.

INTRODUCTION

Siwa Oasis is a closed basin located at western desert of Egypt. It lies within the extremely arid belt, in which the total annual average rainfall is 9.9 mm while the mean annul evaporation rate is 10.3 mm/day (El-Ramly, 1994). The principle crops in Siwa are olives and dates. The only source of water for cultivation is the ground water which flows from many springs and wells spreading all over the area. This ground water is of a limited quality by usual standards which characterized by electrical conductivity ranges between 2.3 and to more than 10 dS/m. The better quality water is estimated at 2.8 dS/m and is usually used for drinking, while the water available for irrigation attain the level of 3 to 6.5 dS/m (Harga *et al*., 1975). The quality of water is related to the effect on plant growth, yield and quality also soil properties. The saline water may have two harmful effects: the direct effect on plant growth and the indirect effect through the specific effects of some soluble salts (Szabolcs and Darab, 1979). Salinity decreases plant growth and yield to various degrees depending on plant species, salinity level and ionic composition of the soil solution. Salt stress may reduce plant growth by water deficit (Behboudian *et al.*, 1986; Lioyd *et al.*, 1987 and Walker *et al.*, 1983), ions toxicity (Cooper, 1961; Grieve and Walker, 1983 and Walker *et* *al.*, 1983), ionic imbalance (Walker, 1986 and Walker and Douglas, 1983) or by a combination of any of these factors.

The aim of the present study is to clarify the effects of irrigation water quality on two olive cultivars (Hamid and Wetteken) grown under Siwa Oasis conditions, that irrigated with saline well water.

MATERIALS AND METHODS

The present study was conducted through two successive seasons of 1998 and 1999 on 15 years old Hamid and Wetteken olive trees (*Olea europea*. L). The trees planted 8 x 10 m apart. Ten orchards in Siwa Oasis were selected according to the irrigation water quality and approximately similar in soil texture. In each orchard, both Hamid and Wetteken olive cultivars were grown together. Three locations were selected in each orchard. Three trees represented each location. (9 tree per orchard) for both cultivars. Under each tree, soil sample was taken down to 30-cm depth for initial soil physical and chemical analysis (Table, 1). Irrigation water for every orchard was taken from one well drilled in it. The chemical analysis from each well in both seasons is presented in Table (2). The orchards were ascending ranked according to the salinity of irrigation water, (from 1 to 10).

Quality of irrigation water was determined according to the following parameters (Wilcox, 1958 and FAO, 1973& 1976).

1. The salt concentration of water, which can be expressed in terms of electrical conductivity (EC_{iw}, dS/m).
2. The chemical composition of water, by determining the concentrations of Ca^{2+}, Mg^{2+} ,Na^{+}, K^{+}, $CO^{=}_{3}$, HCO^{-}_{3}, Cl^{-} and $SO^{=}_{4}$ ions, from the concentrations of ions, we can calculate:

a. Sodium Hazard:

Which can be expressed in terms of sodium adsorption ratio (SAR) or soluble sodium percentage (SSP) .

$$\mathrm{SAR} = \frac{\mathrm{Na}^{+}}{\sqrt{(\mathrm{Ca}^{2+} + \mathrm{Mg}^{2+})/2}}$$

$$\mathrm{SSP} = \frac{\mathrm{Na}^{+}}{\sum Cations} \times 100$$

(The concentration of cations was expressed in meq/L).

b. Magnesium hazard (SMgP):

It can be expressed by the value of soluble magnesium percentage (SMgP),

$$\mathrm{SMgP} = \frac{[\mathrm{Mg2+}]}{[\mathrm{Ca}^{2+} + \mathrm{Mg}^{+2}]} \times 100$$

Table (1). Some physical and chemical characteristics of orchards soil at the start of the experiment.

Orchard number	Particle size distribution %			Textural class	$CaCO_3$ (%)	Saturation water content (m^3/m^3)	pH	Ec (dS/m)
	Sand	Silt	Clay					
1	67.6	16.2	16.2	Sandy loam	8.7	0.44	7.81	0.92
2	65.7	19.7	14.6	Sandy loam	8.3	0.43	7.82	1.05
3	65.1	18.1	16.8	Sandy loam	10.7	0.44	7.70	1.21
4	62.1	18.9	19.0	Sandy loam	11.8	0.45	7.78	1.65
5	57.6	24.6	17.8	Sandy loam	10.6	0.45	7.82	1.90
6	79.4	13.2	7.4	Sandy loam	8.2	0.38	7.80	2.67
7	58.3	24.2	17.5	Sandy loam	11.2	0.45	7.70	2.31
8	65.1	18.1	16.8	Sandy loam	10.7	0.44	7.58	3.18
9	75.2	16.3	8.5	Sandy loam	14.1	0.40	7.58	5.60
10	81.4	9.4	9.2	Sandy loam	12.6	0.40	7.82	7.12

Table (2). Chemical analysis of irrigation water used in the present study during 1998 and 1999 growing seasons.

Orchard number	pH	EC as/m	Cations meq/L				Anions/meq/L	
			Ca	Mg	Na	K	CO_3	SO_4
1998								
1	7.6	2.47	4.99	6.13	13.17	0.46	2.45	8.48
2	7.5	2.86	5.66	7.35	15.00	0.60	3.21	9.95
3	7.5	3.07	6.06	7.45	16.59	0.60	3.31	10.96
4	7.6	3.17	6.34	7.53	17.14	0.69	3.42	10.77
5	7.6	3.31	6.54	8.72	17.14	0.59	3.82	11.17
6	7.6	3.54	7.00	9.16	18.52	0.72	4.10	11.98
7	7.6	3.84	7.74	9.91	19.92	0.83	4.50	12.84
8	7.7	4.86	8.50	13.20	26.00	0.90	4.02	16.46
9	7.8	5.44	10.08	14.77	28.45	1.10	4.08	18.03
10	7.9	7.23	14.80	18.90	37.10	1.50	6.73	23.12
1999								
1	7.5	2.62	4.95	4.73	15.99	0.53	1.87	8.67
2	7.5	3.01	5.79	7.12	16.52	0.66	2.25	10.18
3	7.6	3.31	6.36	7.87	18.16	0.71	3.76	10.96
4	7.7	3.48	6.61	8.75	10.72	0.71	4.06	11.42
5	7.6	3.64	7.12	9.66	18.91	0.71	4.07	11.67
6	7.7	3.93	7.50	10.25	20.60	0.95	4.34	12.39
7	7.7	4.12	7.92	11.13	21.08	1.07	4.35	13.44
8	7.8	5.22	9.32	16.16	25.48	1.24	5.42	16.14
9	7.9	5.91	14.90	16.83	26.12	1.26	4.89	20.55
10	8.0	7.51	15.50	19.60	38.70	1.30	7.95	18.88

c. Bicarbonate hazard:

It can be expressed by the value of residual sodium carbonate (RSC):

$$(RSC) = [CO_3^{2-} + HCO_3^-] - [Ca^{2+} + Mg^{2+}]$$

(The concentration of ions was expressed in meq/L.)

3. The concentration of toxic compounds, can be expressed by the values of:

   a. Potential salinity (PS): $PS\ (mg/L) = Cl^- + 0.5\ SO_4^{2-}$

   b. The boron concentration (B)

   c. The nitrate concentration (NO_3^-).

At mid of October of each season, samples of 100 leaves (one year old) from each tree were collected randomly at a constant height and at all directions of the trees for analysis. Leaf sample was divided into two portions. In the first portion, leaves were washed with tap water, distilled water, air-dried and oven dried at 65°C for 72 hr. The dried samples were ground and then digested with conc. Sulphuric acid + 30% hydrogen peroxide according to the method of Wolf (1982). Total N was determined by micro-Kjeldahl method (Jackson, 1973). Phosphorus was determined according the method of Murphy and Riely (1962). Potassium and Sodium were determined by Flame Photometery (Jackson, 1973). Calcium, Magnesium and micronutrients (Fe, Mn, Cu and Zn) leaf contents were determined by atomic absorption (Carter, 1993). Boron leaf content was clorimetrically determined according to Jackson (1973).

In the other portion (fresh leaf material) of each sample, total chlorophyll content was determined according to Moran and Porath (1980). Total water content (TWC) and relative water content (RWC) were determined by the method of Weatherly (1950). Free (FWC) and bound contents (BWC) were determined according to Abdel-Rasoul *et al.* (1987).

At harvest time (late of Oct.) of each season, yield of each tree was recorded, samples of 100 fruits were collected randomly from each tree. Physical and chemical fruit characteristics were determined; averages of fruit weight, volume, length and diameter, as well as seed weight, length and diameter were recorded. Also, flesh weight, thickness and percent were determined. Fruit oil content was determined by extracting the oil from the flesh by the method reported in A.O.A.C. (1980).

At the end of both seasons, three soil samples were collected from each orchard, one for each location, from the surface 30-cm layer for chemical analysis (Carter, 1993 and Jackson, 1973).

All locations for all orchards were supplied by the same horticultural practices according to the recommendation of Agricultural and Land Reclamation Ministry.

The randomized complete block design was applied on the data collected from each orchard with 3 replicates (3 trees for each replicate). The obtained results in both seasons for the two cultivars were subjected to analysis of variance according to Steel and Torrie (1980).

RESULTS AND DISCUSSION

I. Quality of irrigation water.

The water quality parameters for the all ground water sources taken from Siwa Oasis are presented in Table (3).

Table (3). Water quality parameters of Siwa wells used as irrigation water for the present study during 1998 and 1999 growing seasons.

Orchard No.	EC_W dS/m	SAR	SSP %	Mg Hazard%	RSC meq/L	Potential salinity meq/L	Cl^- meq/L	B mg/L	NO_3^- mg/L
1998									
1	2.47	5.60	53.32	55.37	-8.62	18.00	13.76	0.33	8
2	2.86	5.88	52.43	56.50	-9.80	20.41	15.44	0.42	12
3	3.07	6.38	54.04	55.14	-10.20	21.92	16.44	0.41	13
4	3.17	6.51	54.07	54.29	-10.45	22.90	17.51	0.54	15
5	3.31	6.21	51.80	57.14	-11.44	23.70	18.11	0.61	16
6	3.54	6.52	52.32	56.68	-12.06	25.32	19.33	0.62	18
7	3.84	6.71	51.87	56.15	-13.15	27.48	21.06	0.72	23
8	4.86	7.89	53.50	60.83	-17.68	36.35	28.12	0.83	25
9	5.44	8.07	52.30	59.44	-20.77	41.30	32.28	0.82	26
10	7.23	9.04	51.31	56.08	-26.97	54.01	42.45	1.21	31
1999									
1	2.62	7.27	61.03	48.86	-7.81	19.99	15.66	0.42	7
2	3.01	6.50	54.90	55.15	-10.66	22.76	17.67	0.48	11
3	3.31	6.81	54.86	55.31	-10.47	23.86	18.38	0.51	16
4	3.48	6.75	53.81	56.97	-11.30	25.03	19.32	0.61	17
5	3.64	6.53	51.95	57.57	-12.71	26.50	20.66	0.65	19
6	3.93	6.91	52.42	57.75	-13.41	28.76	22.56	0.72	21
7	4.12	6.83	51.17	58.43	-14.70	30.14	23.42	0.75	24
8	5.22	7.14	48.81	63.42	-20.06	38.71	30.64	0.81	25
9	5.91	6.56	44.19	53.04	-26.84	43.94	32.66	0.89	32
10	7.51	9.24	51.53	55.84	-27.15	57.71	48.27	0.97	36

From this data it appears that for all sources of ground water, the EC_{iw} ranged from 2.47 to 7.23 dS/m for the first season and from 2.62 to 7.51 dS/m for the second season. The critical level of EC_{iw} to cause severe salinity problems is 3 dS/m as reported by FAO (1976). There are some locations (1 and 2) where the values of EC_{iw} are less than the critical limit and no problems have arisen concerning the permeability of the soil irrigated by this water. The other locations have a EC_{iw} more than the critical level that can be affected by salinity. It could be considered relatively high and may cause severe salinity problems. Therefore, it is expected that continuous irrigation without good water management (leaching requirements) can led to severe problems from the salinity point of view.

The data presented in Table (3) also revealed that the SAR value of all ground water sources is relatively low in comparing with the critical level of sodium hazard (less than 10) as reported by Richards (1972).

With respect to the SSP as indicator for sodium hazard, the values of SSP for all sources of ground water were ranged from 51.80 to 54.07% in the first season and from 44.19 to 61.03% in the second season. The data revealed that all values of SSP were in the range of safety limit (< 60%) as reported by Wilcox (1958).

Magnesium hazard is one of the criteria of suitability of water for irrigation. In this respect, the values of SMgP tabulated in Table (3) indicated that all sources of ground water have a values ranged from 54.29 to 59.44% in the first season and from 48.86 to 63.42% in the second season.

The most values exceeded the harmful level (> 50%). The magnesium salts have toxic effects on the plant and the toxicity of Mg ions is higher than the toxicity of Na ions having the same concentrations.

The RSC value evaluates the tendency of irrigation water to form carbonates and to dissolve or to precipitate the calcium and to a less degree the magnesium carbonates. The precipitation of poorly soluble carbonates increases the sodium hazard of irrigation water and as a result increases the sodicity of irrigated soils, too. The present values of RSC are have a negative values, this means that Ca^2+ + Mg^2+ is more than the CO_3^{2-} + HCO^-_3 resulted in no problem of sodium hazard.

Potential salinity (PS) for all sources of groundwater used were ranged from 18.0 to 54.01 meq/L in the first season and from 19.99 to 57.71 meq/L in the second season. The high values of PS over the critical level (5 meq/L) as reported by Richards (1972) may be due to high chloride and sulphate content in the irrigation water.

Chloride ion (Cl^-) is extremely high and ranged from 13.76 to 42.45 meq/L in the first season and from 15.66 to 48.27 in the second season. According to the guidelines for interpreting water quality (FAO, 1976) this may also cause sever problems concerning Cl^- toxicity to plants.

The concentration of B for all the groundwater sources in the present study is < 1 mg/L, except for location No. 10 it is 1.2 mg/L. The olive trees are considered as semi-tolerant to Boron, which the limit of boron in irrigation water is from 1 to 2 mg/L (Wilcox, 1958). This would put these waters in the range of no problem of toxicity with respect to olive trees.

The nitrate contents (NO_3^-) in these groundwater varied from source to another, but it not exceed the critical limit (45 mg/L) that cause nitrate poisoning (Wilcox, 1958).

Generally, from the data previously presented, it appears that most of the groundwater resources used in the present study may cause one problem or another. By applying the criteria used for interpreting water quality for irrigation, the most domain problems are salinity hazard, potential salinity and magnesium hazard.

2. Yield, oil content and fruit characteristics.

Data presented in Tables (4 & 5) and Figures (1 & 2) show the effect of salinity of well water on yield, oil content fruit, seed and flesh characteristics of Hamid and Wetteken cvs. during 1998 and 1999 seasons.

2.1. Yield.

The data indicated that olive yield for both cultivars significantly decreased as increasing the salinity of well water sources increased. The olive yield of Hamid cv. was 182.37 kg/tree at salinity of 2.47 dS/m and

Fig (1)

Fig (2)

decreased to 125.43 kg/tree at salinity of 7.23 dS/m whereas, for Wetteken cv. the olive yield was decreased from 152.00 to 94.23 kg/tree as salinity of well water increased from 2.47 to 7.23 dS/m for the first season. In the second season, the olive yield was decreased from 162.23 to 102.7 kg/tree for Hamid cv. and from 130.8 to 74.87 kg/tree for Wetteken cv. as salinity increased from 2.62 to 7.51 dS/m. The reductions in olive yield due to the salinity of irrigation water (well water) were 31.22 and 36.69% for Hamid cv. and were 38.00 and 42.76% for Wetteken cv. for both season, respectively.

Moreover, the present data revealed that Wetteken cv. was more pronounced affected by salinity of irrigation water than Hamid cv.

The reduction in yield of olive trees grown under salinity conditions may be due to the reduction in tree growth. The reduction in growth may be attributed to the effect of salinity on inhibition of photosynthesis (Plaut and Grieve, 1988). The reduction of growth and yield as a result of salinity conditions may be also due to the increase in the osmotic potential of the soil solution that caused a marked depression in water absorbing power of the roots (Bernstein *et al.* 1956). Also, under salinity conditions there are an excess absorption and accumulation of sodium, chloride and sulphate in the tissue of trees, probably excrete some toxic effects on the plant growth and development (Bernstein *et al.*, 1956). In the same time, the salinity can decreased the activity of some key enzymes of the Calvin cycle (Plaut and Grieve, 1988). Singh *et al.* (1979) associated the yield decrease with increase the Na content in soil solution under salinity conditions due to the specific ion effect (Bernstein, 1975).

2.2. Oil content.

The data revealed that salinity of irrigation water has a pronounced effect on decreasing the oil content. (Tables 4 and 5) and Fig. 2). The oil contents were decreased from 20.28 to 16.47 % and from 23.53 to 21.17% for Hamid and Wetteken cultivars, respectively in the first season as salinity increase from 2.47 to 7.23 dS/m. In the second season, the values were from 20.77 to 17.33% and from 23.20 to 20.50% for Hamid and Wetteken cultivars, respectively as salinity of irrigation water increased from 2.62 to 7.51 dSm.

The reduction in oil content as a result salinity effect of irrigation water were 18.78 and 16.56% for Hamid cv. and were 10.0 and 11.64% for Wetteken cv. In the first and second, respectively. The reduction in flesh oil content as a result of salinity could be attributed to the effect of salinity in decreasing tree growth and nutrient uptake.

2.3. Fruit characteristics.

Tables (4 and 5) illustrated the fruit characteristics as influenced by the salinity of irrigation water, in both seasons. All fruit characteristics i.e. fruit weight, volume, length, diameter and shape index were found to be significantly influenced by the salinity of irrigation water.

Mean fruit weight ranged between 4.30 and 7.53 g for Hamid cv. and between 3.10 and 5.57 g for Wetteken cv. in the first season as salinity of irrigation water ranged between 7.23 and 2.47 dS/m. The corresponding values for the second season were 4.62 and 7.36 for Hamid cv. and between 2.85 and 6.06 for Wetteken cv. as salinity ranged between 7.51 and 2.62 dS/m.

The same trend was noticed with mean fruit volume, which ranged between 4.1 and 7.6 for Hamid cv. and 3.6 and 5.6 cm^3 for Wetteken cv. in the first season. The related values for the second season were 4.2 to 8.0 for Hamid and 3.1 to 6.0 cm^3 for Wetteken cv.

Mean fruit length, diameter and shape index was positively correlated with both fruit weight and volume. The data clearly indicated that salinity of irrigation water has a pronounced effect on fruit characteristics. The correlation coefficients (r) between the salinity of irrigation water (EC_{iw}) and the fruit characteristics were – 0.921** - 0.921**, -0.801** and – 0.848** for fruit weight, volume, length and diameter, respectively in the first season for Hamid cv. The corresponding values for the second season were –0.911**, -0.925**, -0.894** and –0.913**, respectively. The correlated values for wetteken cv. were -0.964**, -0.886**, -0.897** and –0.896**, for the first season and –0.880**, -0.875**, -0.887**and -0.838**, respectively for the second season.

The reduction in fruit weight as influenced by salinity of irrigation water were 42.89 and 44.34% for Hamid and Wetteken cultivars, respectively in the first season as salinity increased from 2.77 to 7.23 dS/m. In the second seasons, the values were 37.22 and 52.97%, respectively as salinity increased from 2.92 to 7.51 dS/m. The data revealed the fruit weight of Hamid cv. was more pronounced affected by salinity of irrigation water than Wetteken cv. The reduction of fruit weight has a clear effect on decreasing the olive yield.

2.4. Seed characteristics.

All seed characteristics seed weight, length, diameter and shape index were found to be significantly affected by the salinity of irrigation water (Tables 4 &5).

Mean seed weight ranged between 0.66 and 0.97 g for Hamid cv. and between 0.55 and 0.85 g for Wetteken cv. in the first season as the salinity of irrigation water ranged between 7.23 and 2.77 dS/m, the correlated values for the second season were between 0.69 and 1.15 g for Hamid cv. and between 0.55 and 1.08 g for Wetteken cv as water salinity ranged between 7.51 and 2.92 dS/m.

The other seed characteristics behaved the same trend in which increasing water salinity level decreased the seed characteristic values. The correlation coefficients between water salinity and the seed weight were – 0.929** and -0.868** in both seasons, respectively for Hamid cv. The corresponding values for Wetteken cv. were -0.915** and -0.830** for both seasons, respectively.

2.5. Flesh characteristics.

Flesh characteristics as shown in Table (4 and 5), indicated that salinity of irrigation water significantly decreased its values. Increasing salinity of irrigation water from 2.77 to 7.23 dS/m in the first season decreased the flesh weight and thickness by about 44.59 and 32.39% for Hamid cv., respectively. While for Wetteken cv. the values were 45.97 and 22.41%, respectively. Whereas in the second season, the corresponding values were 36.92 and 32.26% for Hamid cv. and 53.81 and 36.2% for Wetteken cv. respectively as salinity increased from 2.62 to 7.51 dS/m.

The flesh weight of wetteken cv. was more affected (49.89%) by salinity than Hamid cv. (40.76%), as a mean of both seasons. The flesh thickness has a contrast trend where it was 32.3% for Hamid cv. and 29.3% for Wetteken cv.

Generally, fruit, seed and flesh characteristics were found to be negatively responded to salinity of irrigation water.

Tthe reduction in olive yield, oil content and fruit, seed and flesh characteristics as a result of irrigation water salinity may be attributed to one of the following reasons: 1) reduction of water absorption by roots due to osmotic potential (Bernstein *et al*. 1972); 2) excessive levels of salinity my alter the hormone balance of plants (Bernstein, 1975); 3) the salinity may damage plant cells and cytoplasmic organelless (Meiri and Shalhevet, 1973); 4) poor physical conditions of soil due to exchangeable sodium percentage as a result of continuous irrigation with saline water that have an adverse effect on crop growth (Bernstein, 1975) and 5) Imbalance of nutrient absorption, in which increasing the Na and Cl ion in leaf tissue that may reduced the photosynthesis (Rawheya, 1994).

3. Leaf characteristics.

3.1. Leaf area and total chlorophyll.

Table (6) show the effects of water quality (EC_{iw}) on leaf area total, chlorophyll and water contents of Hamid and Wetteken cvs.

The data generally indicated that salinity of irrigation water decreased both leaf area and total chlorophyll content in both seasons.

Leaf area was decreased from 5.01 to 2.64 cm^2 for Hamid cv., whereas it decreased from 5.46 to 3.71 cm^2 for Wetteken cv. in first season as salinity increased from 2.77 to 7.23 dS/m. The corresponding values for the second season were 4.82 to 2.61 for Hamid cv and from 5.36 to 3.58 cm^2 for Wetteken cv. as salinity of irrigation water increased from 2.92 to 7.51 dS/m.

Table (6). Leaf area, total chlorophyll and water contents of Hamid and Wetteken olive cultivar as influenced by salinity of irrigation water during 1998 and 1999 growing seasons.

(Hamid)						
Orchard number	Leaf area $(cm)^2$	Total chlorophyll (mg/100g) f.w.	Leaf water contents, %			
			Free	Bound	TWC	RWC
1998						
1	5.01	170.67	18.33	48.33	66.67	78.67
2	4.92	158.40	17.80	45.57	63.37	76.83
3	4.66	153.83	17.37	43.80	61.17	75.90
4	4.31	146.00	16.73	42.27	59.00	74.93
5	4.96	138.27	16.43	42.20	58.63	74.37
6	3.55	136.27	15.90	42.33	58.23	73.57
7	3.38	132.70	15.67	41.53	57.20	72.90
8	3.14	127.27	15.37	41.23	56.60	72.43
9	2.98	121.43	14.73	41.67	56.40	71.33
10	2.64	117.93	14.53	41.13	55.67	72.33
$L.S.D_{0.05}$	0.07	3.40	0.29	0.41	0.41	0.49
1999						
1	4.82	183.10	17.93	49.47	67.40	79.23

2	4.82	162.73	17.53	46.90	64.43	77.47
3	4.56	164.37	17.07	45.23	62.30	76.67
4	4.23	157.83	16.47	42.77	59.23	75.30
5	3.83	143.23	16.20	43.47	59.67	74.47
6	3.46	145.27	15.70	42.93	58.63	74.27
7	3.28	140.40	15.43	42.10	57.53	73.43
8	3.06	132.13	15.40	42.17	57.57	72.77
9	2.91	132.00	14.53	42.00	56.53	72.13
10	2.61	125.80	14.23	41.67	55.90	71.73
L.S.D$_{0.05}$	0.05	3.87	0.23	0.50	0.51	0.51
(Wetteken)						
1998						
1	5.46	168.40	19.67	41.93	61.60	77.33
2	4.93	158.10	19.27	40.93	60.20	76.37
3	4.75	153.20	18.77	40.30	59.07	76.00
4	4.52	148.30	18.27	39.67	57.93	75.33
5	4.35	144.00	18.20	39.47	57.67	75.30
6	4.13	136.10	17.77	38.67	56.43	74.60
7	3.99	132.60	17.53	38.47	56.00	74.37
8	3.93	128.10	16.90	38.40	55.30	73.33
9	3.78	124.70	16.40	38.40	54.80	73.20
10	3.71	122.70	16.37	37.33	53.70	72.40
L.S.D$_{0.05}$	0.13	2.33	0.34	0.68	0.68	1.01
1999						
1	5.36	172.70	19.530	42.77	62.30	77.930
2	4.86	163.3	18.870	41.80	60.67	77.370
3	4.68	161.80	18.530	40.87	59.40	76.570
4	4.43	157.33	18.270	40.33	58.60	75.830
5	4.28	151.40	18.100	40.13	58.23	75.770
6	4.06	142.50	17.770	39.57	57.33	75.100
7	3.92	138.20	17.400	39.10	56.50	74.730
8	3.83	135.33	16.770	39.10	55.87	74.270
9	3.65	130.53	16.500	38.60	55.10	73.870
10	3.58	128.71	16.030	38.83	54.87	73.430
L.S.D$_{0.05}$	0.07	2.59	0.126	0.60	0.54	0.237

The leaf total chlorophyll content behaved the same trend as leaf area. The reductions in chlorophyll content were 30.90 and 27.14% in the first season for Hamid and Wetteken cultivars, respectively. The related values for the second season were 31.29 and 25.48, respectively.

Increasing salinity resulted in a significant reduction of plant growth, number of leaves and total vegetative area (Sary El-Deen *et al*., 1979). Also leaves became smaller (El-Saket and Aeshch (1987). The reduction in leaves size and number and tree growth as a result of salinity, may be a reasonable interpretative for leaf chlorophyll reduction

3.2. Leaf water contents.

The data presented in Table (6) revealed that all leaf water contents i.e. free, bound, total and relative water contents decreased in both seasons as salinity of irrigation water increased.

The reduction effect was more pronounced in the case of Hamid cv. than Wetteken cv. The low water contents of leaf tissue due to the salinity conditions as a result of irrigation with saline water may be due to the less water uptake under salinity conditions (Bernstien *et al.*, 1956). Under salinity conditions, Stewart and Nielsen (1990) reported an increasing of energy that must be expended by the plants to absorb water from soil. Thus, the water status of plant tissues was reduced and the tree leaves have less water content (Bingham, 1982; Grattan and Grieve, 1993 and Naidu and Rengasamy, 1993).

4. Leaf mineral composition

Table (7) shows the leaf mineral composition of Hamid and Wetteken cultivars as influenced by the salinity (EC_{iw}) of irrigation water.

The results revealed that N, P and K contents were significantly decreased as increasing the salinity of irrigation water. In contrast the leaf contents of Na, Ca, Mg and Cl were significantly increased. This behaviour was similar for both Hamid and Wetteken cultivars in both seasons. Moreover, the leaf micronutrient contents i.e., Fe, Mn, Cu, Zn and B were significantly decreased as increasing the salinity of irrigation water. Similar results were obtained by Taha *et al*. (1972), El-Azab and Minesey (1975) and Nawar and Ibrahim (1984).Moreover, Brenstein *et al*., (1956) reported that salinity conditions may induce nutritional deficiencies and imbalance in cation nutrition.

The reduction in leaf N content due to salinity may be attributed to the effects of salinity in severely inhibition of NO^{-}_{3} uptake, which could be a limiting factor for growth in a saline environment (Aslam *et al.* 1984). Decreasing Leaf P content may be explained by the competition between Cl^{-} and phosphate ions in soil solution or to the restricted root growth caused by salinity which may decrease the recovery of P by roots (Khalil *et al*., 1967). The decrease of leaf K content may be due to high Na content of soil soluition as illustrated by the antagonistic effect (Mengel and Kirkby, 1987) or may be due to K-Na selectivity (Ashraf and Naqvi, 1991). Increasing leaf Na and Cl contents due to increasing the salinity of irrigation water was also confirmed by the results of Sourout (1993).

Increasing the salinity of irrigation water increased soil salinity (Dahdoh and Hassan, 1997). In this respect, Ashraf and McNeilly, (1990) found a highly significant increase of Ca, Mg, Na and Cl leaf contents of *Brassica sp.* as soil salinity increased. Moreover, Hassan *et al.* (1970) reported that correlation coefficients indicated significant negative relationships between soil salinity and uptake of P, K, Fe, Cu, Mn and Zn.

5. Soil chemical analysis.

Data in Tables (8 and 9) illustrate the chemical analysis of orchard soil at the end of 1998 and 1999 growing seasons. The effect of irrigation water salinity on soil pH did not present a specific trend in both seasons. The results also showed an increase in soil EC_e (EC of soil paste) as increasing the salinity of irrigation water in both seasons. Dahdoh and Hassan (1997) confirmed this result. They mentioned the increasing in soil EC_e due to the accumulation of salts in soil as a result of application of saline water.

The soil salinity (EC_e) can be expected from the salinity of irrigation water EC_{iw} using the following regression equations (Fig. 3).

$$Y = 1.562\ x - 3.1503 \quad , \quad R^2 = 0.9664 \quad (1998)$$
$$Y = 1.7682\ x - 4.06 \quad , \quad R^2 = 0.9784 \quad (1999)$$

1998 **1999**

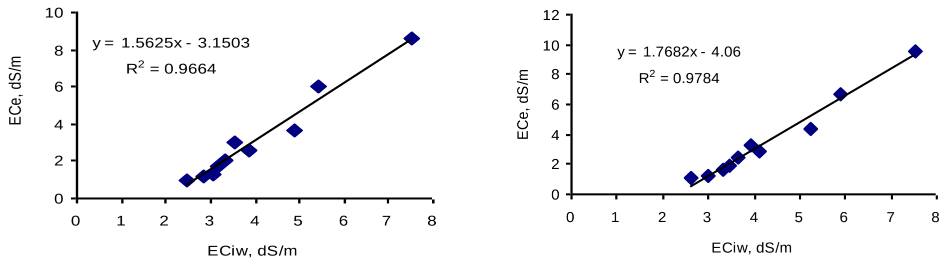

Fig. (3): The correlation between the electrical conductivity of soil paste EC_e, and the electrical conductivity of irrigation water, EC_{iw} during 1998 and 1999 growing seasons.

There are a significant correlation between the salinity of irrigation water (EC_{iw}) and soil salinity (EC_e), it reached a values of 0.985** and 0.99** for both seasons. In the same time, there are a good correlation between soil salinity and olive yield. The correlation coefficient were –0.869** and –0.884** for Hamid cv and were –0.885** and –0.872** for Wetteken cv. for the first and second seasons, respectively (Fig. 4). With regard to cation concentrations specially Na+, there are a high correlation coefficients between olive yield and Na concentration equal to –0.807** and -0.849** for Hamid cv. and -0.826** and –0.839** for Wetteken cv. for both seasons (Fig. 5).

The data also, indicated that all soluble cations and anions of soil solution were increased as the salinity of irrigation water increased.

Available soil macronutrient (N, P and K) and micronutrients (Fe, Mn, Cu, Zn and B) are presented in Table (9). The results revealed that soil nutrient contents were increased significantly as increasing the salinity of irrigation water. Such results might be due to the high nutrient content of well water.

From the present study, water quality evaluation of well water in Siwa Oasis is very important to insure a good plant growth, yield and fruit quality of olive cultivation.

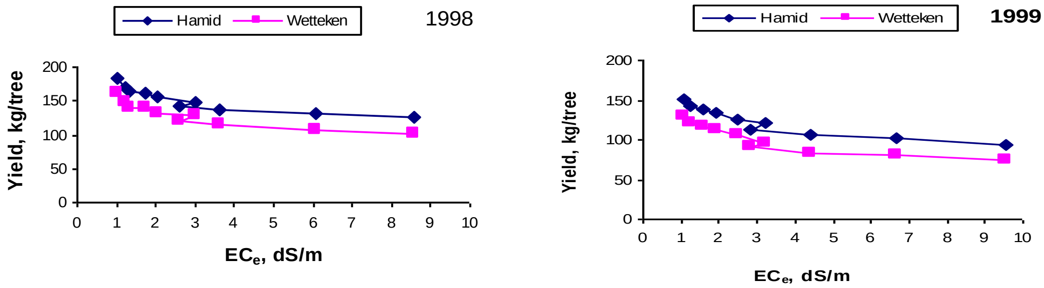

Fig. (4). Relationship between the yield of Hamid and Wetteken cvs. and soil solution salinity during 1998 and 1999 seasons.

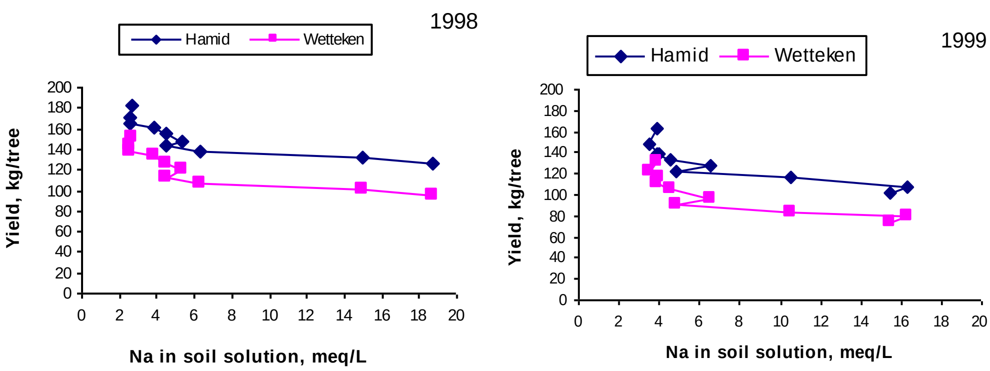

Fig. (5). Relationship between the yield of Hamid and Wetteken cvs, and Na content in soil solution during 1998 and 1999 seasons.

REFERENCES

Abdel-Resole, M., M.T. El-Saidi, A.I. Gabr and H.A. El-Zeiny (1987). Effect of CCC and B-9 at different water regimes on water regimes on water relations in Maize leaves. Annals Agric. Sci., Fac. Agric., Ain Shams Univ., Cairo, Egypt, 32 (2): 941-955.

A.O.A.C. (1980). Association of Official Methods of Analysis. Official Agricultural Chemists. Benjamin Franklin Station 11^{th} Ed. pp. 494-500, Washington D.C., U.S.A.

Ashraf, M. and M. Naqvi (1991). Growth and ion uptake of four *Brassica* species as affected by Na/Ca ratio in saline sand culture 2. Pflanzenernähr. Bodenkd., 155: 101-108.

Ashraf, M. and T. McNeily (1990). Responses of four *Brassica* species to sodium chloride. Environ. Exp. Bot. 30, 475-487.

Aslam, M.; R.C. Huffaker and D.W. Rains (1984). Early effects of salinity on nitrate assimilation in barley seedlings. Plant Physiol. 76: 321-325.

Behboudian, M.H.; E. Törökfalvy and R.R. Walker (1986). Effects of salinity on ionic content, water relations and gas exchange parameters in some citrus scion-rootstock combinations. Scientia Hortic. 28: 105-116.

Bernstein, L. (1975). Effect of salinity and sodicity on plant growth. Ann. Rev. Phytopath. 13: 295-312.

Bernstein, L.; J.W. Brown and H.E. Hayward. (1956). The influence of rootstock on growth and salt accumulation in stone-fruits trees and almonds. Proc. Amer. Soc. Hort. Sci. Hort. Sci., 68: 86-95.

Bernstein, L.; Francois, L.E. and Clark, R.A. (1972): Salt tolerance of ornamental shrubs and ground covers. J. Am. Soc. Hort. Sci 97: 550-556.

Bingham, F.T. (1982).Soil salinity and alkalinity Dept. of Soil and Environmental Sci., Univ. of California, Riverside.

Carter, M.R. (ed.) (1993). Soil Sampling and Methods of Analysis. Canadian society of Soil Science, Lewis Publishers. London, Tokyo.

Cooper, W.C. (1961). Toxicity and accumulation of salts in citrus trees on various rootstocks in Texas. Proc. Fla. State Hortic. Soc., 74: 95-104.

Dahdoh, M.S.; A. and F.A. Hassan (1997). Combined effect of sewage sludge and saline water irrigation on growth and elemental composition of Broad Bean. Egypt. J. Soil Sci. 37 (2): 189-204.

El-Azab, E.M. and F.A. Minessy (1975). Effect of salinity on Thompson seedless and Romi red grape vines in calcareous soils. Alex. Agric. Res. 23 (2): 265-274.

El-Ramly, I.M. (1994). Recent discoveries in the ground water resources of western desert of Egypt. Desert Inst., Cairo, Egypt.

El-Saket, I.A. and I.A. Aesheh. (1987). Effect of saline water on growth of young olive trees. Univ. of Jordan, Amman,14(2): 7-17.

FAO (1976). Water quality for Agriculture. Irrigation and Drainage paper 29, R.S. Ayers and D.W. Westcot.

FAO/Unesco (1973). Salinity, irrigation and drainage, p. 177-204.

Grattan, S.R. and C.M. Grieve (1993). Mineral nutrient acquisition and response by plants of plant and crop stress". Ed., M. Pessarak, pp. 203-226.

Grieve, A.M. and R.R. Walker (1983). Uptake and distribution of chloride, sodium and potassium ions in salt-treated citrus plants. Aust. J. Agric. Res. 34: 133-143.

Harga, A.A.; M.M. Hammad and M.A. Abd El-Salam (1975). The soils of Siwa Oasis, Egypt. Desert Int. Bull. A.R.E. 25 (1, 2): 173-186).

Hassan, N.K.; V. James; D. Knudsen and R.A. Olson (1970). Influence of soil salinity on production of dry matter and uptake and distribution of nutrients in barley and corn. I. Barley (*Hordeum vulgare* L.). Agron. J. 62: 43-45.

Jackson, M.L. (1973). Soil Chemical Analysis. Prentice-Hall, Inc. India.

Khalil, H.A.; F. Amer and H.M. El-Gabaly (1967). A salinity-fertility interaction study on corn and cotton. Soil Sci. Soc. Am. Proc. 31, 683.

Lioyd, A., P.E. Kriedmann and J.P. Syvertsen (1987). Gas exchange, water relations and ion concentrations of leaves on salt stressed " Valencia" orange *Citrus sinensis* L. Osbeck Aust. J. Plant Physiol. 14: 387-396.

Meiri, A. and J. Shalhevet (1973). Pepper plant response to irrigation water quality and timing of leaching Ecological studies, Vol. IV. Springer, Berlin Heidebrg, New York, pp. 421-429.

Mengel, K. and A. Kirkby. (1987). Principles of Plant Nutrition 4^{th} Ed., International potash Institute, Norblafen-Bern, Switzerland.

Moran, R. and D. Porath (1980). Chlorophyll determination in instact tissues using N-N-dimethyl formamide. Plant Physiol., 65: 478-479.

Murphy, J. and J.P. Riely (1962). A modified single solution method for the determination of phosphorus in natural water. Anal. Chem. Acta. 27: 31-36.

Nadiu, R. and P. Rengasamy (1993). Ion interaction and constraints to plant nutrition in Australian Sodic. Soils. Aust. J. Soil Sci. 31, 801-819.

Nasr, T.A.; E.M. El-Azab and E.M. Hassan (1974). Effect of salinity and soil types on vegetative growth and leaf and root mineral content in pecan. Alex. J. Agric. Res. 22 (3): 405-415.

Nawar, A. and A.M.F. Ibrahim (1984). Salinity of irrigation water in relation to growth and leaf composition of young le conte pear plants budded on three different rootstocks. J. Agric. Res. Tanta Univ. 10 (4): 1380-1392.

Plaut, Z. and C.M. Grieve (1988). Photosynthesis of salt-stressed maize as influenced by Ca : Na ratios in the nutrient solution. Plant and Soil. 105: 283-286.

Rawheya, B.M.A. (1994). Studies on the effect of salinity on some fruit plants (Apple and olive). Ph.D. Thesis, Fac. Of Agric., Ain Shams Univ.

Richards, L.A. (ed.) (1972). Diagnosis and Improvement of Saline and Alkaline Soils. U.S. Dept. of Agric., Agric. Handbook No. 60.

Sary El-Deen, S.A., M.M. Wassif and M.S. Fadl. (1979). Effect of salinity on olive seedling growth. Agric. Res. Rev., 57(2): 259-269.

Singh, S.B.; B. Chhabra and I.P. Abrol. (1979). Effect of exchangeable sodium on the yield and chemical composition of raya. Agron. J. 71: 767-770.

Sourour, M.S. (1993). Vegetative growth and Chemical constituents of Washington navel orange trees as influenced by salinity and water stress. M.Sc. Thesis. Fac. Agric. Alex. Univ.
Steel, R.G. and J.H. Torrie (1980). Principles and Procedures of Statistics. 2nd Ed., McGraw-Hill Book Company, New York, USA.
Stewart, B.A. and D.R. Nielsen (1990). Irrigation of Agricultural Crops. Am. Soc. Agron., Madison, Wisconsin, U.S.A. P. 1091-1136.
Szabolcs, I. and K. Darab (1979). Water quality for irrigation and salinization problems. In "Water and fertilizer use for food production in arid and semi-arid zones". 3. Symposium of C.I.E.C., E. Welte (ed.). Garyounis Univ., Benghazi, Libya, 26th Nov., 1979.
Taha, M.W.; El-Sewey, A. and Faliah, Z. (1972). Ionic leaf accumulation in grape, guava and olive plants as affected by the salinity of irrigation water. Alex. J. Agric. Res. 20: 299-309.
Walker, R.R. (1986). Sodium exclusion and potassium-sodium selectivity in salt-treated orange (*Poncirus trifoliata*) and Cleopatra mandarin (*Citrus reticulata*) plants. Aust. J. Plant Physiol. 13: 293-303.
Walker, R.R. and T.J. Douglas (1983). Effect of salinity level on uptake and distribution of chloride, sodium and potassium ions in citrus plants. Aust. J. Agric. Res. 34: 145-153.
Walker, R.R.; E. Törökfalvy; A.M. Grieve and L.D. Prior (1983). Water relations and ion concentration of leaves on salt stressed citrus plants. Aust. J. Plant Physiol. 10, 265-277.
Weatherly, P.E. (1950). Studies in the water relations of cotton plants. 1- Field measurements of water deficits leaves. New Phytology, 50: 36-51.
Wilcox, L.V. (1958). Determining quality of irrigation water. Agr. Inf. Bull. No. 147, USDA, Washington.
Wolf, B.(1982). A comprehensive system of leaf analysis and its use for diagnosing crop nutrient status. Commu. Soil Sci., Plant Anal. 13: 1035-1059.

استجابة بعض أصناف الزيتون النامية في واحة سيوه لجودة مياه الري

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أجري هذا البحث لدراسة تأثير جودة مياه الآبار علي صنفي الزيتون الحامض والوطيقن النامية في واحة سيوه خلال موسمي 1998 ، 1999 . تم اختيار عشرة بساتين منزرعة بالصنفين ويروي كل بستان من بئر خاص به . وتم دراسة تأثير جودة مياه الري علي المحصول ، محتوي الزيت ، خصائص الثمار ، المساحة الورقية ، محتويات الأوراق من الكلوروفيل – المحتوي المائي والتركيب المعدني للأوراق وصفات التربة الكيميائية . وبصفة عامة فقد أوضحت نتائج الموسمين أن زيادة ملوحة مياه الري سببت نقص مؤكد في المحصول ، محتوي الزيت ، وزن وحجم وطول وقطر الثمار في كلا الصنفين . وبالمثل فإن وزن وطول وقطر البذور انخفضت بصورة مؤكدة مع زيادة ملوحة ماء الري . وكذلك فإن صفات لب الثمار أوضحت نفس الاتجاه حيث قل وزن اللب وسمكه والنسبة المئوية لحجم اللب إلي البذور مع زيادة الملوحة . وأوضحت

النتائج أيضا أن النقص في محصول الصنف الوطيقن كان أكثر وضوحاً مع زيادة ملوحة مياه الري مقارنة بالصنف الحامض بينما لوحظ العكس بالنسبة لمحتوي الثمار من الزيت ، المساحة الورقية ، محتوي الأوراق من الكلوروفيل ، المحتويات المائية للأوراق (الماء الحر - الماء المرتبط — الماء النسبي — الماء الكلي) انخفضت بصورة مؤكدة مع زيادة تركيز الأملاح في مياه الري . وبالإضافة إلي ذلك فإن محتويات الأوراق من عناصر النيتروجين ، الفوسفور ، البوتاسيوم ، الحديد ، المنجنيز ، الزنك ، النحاس والبورون قلت بينما زادت محتويات الأوراق من الكالسيوم ، الماغنيسيوم ، الصوديوم والكلور مع زيادة ملوحة ماء التربة في كلا الصنفين . زيادة ملوحة مياه الري سببت زيادة مؤكدة في رقم حموضة التربة ، التوصيل الكهربي لمحلول التربة ، الكاتيونات والانيونات الذائبة وكذلك محتوي التربة من العناصر .

Table (8). Soil chemical characteristics of olive orchards as influenced by salinity of irrigation water during 1998 and 1999 seasons

Orchard number	PH	ECe (dS/m)	Soluble cations, meq/L				Soluble anions, meq/L		
			Ca	Mg	Na	K	HCO_3^-	CL	SO_4
1998									
1	7.74	1.00	3.44	3.63	2.70	0.22	4.62	3.00	2.38
2	7.87	1.21	3.38	5.88	2.62	0.20	4.02	4.42	3.65
3	7.63	1.31	4.18	6.10	2.56	0.20	4.24	4.93	3.85
4	7.71	1.73	6.36	6.86	3.84	0.27	6.22	6.03	5.08
5	7.85	2.02	7.53	7.57	4.53	0.60	6.32	8.97	4.93
6	7.83	3.00	8.41	11.85	5.40	0.66	7.18	13.32	5.82
7	7.72	2.60	7.55	13.46	4.47	0.53	6.96	13.52	5.52
8	7.63	3.64	11.73	17.73	6.32	0.58	9.69	18.93	7.74
9	7.51	6.05	18.35	25.24	14.95	1.96	17.71	28.94	13.86
10	7.73	8.58	32.07	27.09	18.71	5.80	22.07	43.20	18.39
$L.S.D_{0.05}$	0.16	0.11	1.52	1.11	0.87	0.06	1.60	2.16	1.66
1999									
1	7.90	1.10	3.11	3.73	3.84	0.23	2.23	6.30	2.37
2	7.77	1.26	4.09	4.64	3.52	0.31	2.47	7.27	2.82
3	7.60	1.61	4.73	6.99	3.94	0.44	4.49	8.21	3.39
4	7.87	1.93	5.18	9.77	3.92	0.46	7.32	8.54	3.46
5	7.83	2.51	7.75	12.31	4.55	0.51	9.01	11.18	4.92
6	7.67	3.21	9.53	15.07	6.54	0.97	12.50	12.73	6.88
7	7.81	2.80	10.81	11.50	4.84	0.85	11.33	12.20	4.48
8	7.67	4.39	16.03	16.09	10.48	1.26	14.61	19.12	10.13
9	7.61	6.65	27.10	21.66	16.31	1.43	18.88	31.79	15.83
10	7.77	9.53	54.24	21.68	15.45	1.56	19.56	50.87	22.49
$L.S.D_{0.05}$	0.18	0.15	2.11	0.86	0.69	0.03	2.11	1.88	1.73

Table (9). Available soil nutrients of olive orchards as influenced by salinity of irrigation water during 1998 and 1999 seasons.

Orchard number	Soil nutrients contents, mg/kg soil							
	N	P	K	Fe	Mn	Cu	Zn	B
1998								
1	129.97	16.57	172.97	2.82	3.53	0.82	1.14	0.37
2	135.03	17.37	178.40	3.37	4.03	0.95	1.22	0.42
3	142.17	18.73	185.57	3.68	4.55	1.05	1.26	0.45
4	148.23	19.17	191.87	3.81	5.72	1.15	1.54	0.53
5	148.23	19.27	196.87	4.32	7.98	1.14	1.16	0.55
6	153.60	19.97	204.87	5.54	11.47	1.15	1.91	0.61
7	155.20	20.90	213.13	5.48	13.17	1.18	2.09	0.76
8	156.53	21.33	221.73	5.69	15.07	1.32	2.53	0.80
9	155.90	23.27	227.27	5.80	16.37	1.28	2.60	0.00
10	166.37	28.07	236.70	8.93	16.92	2.29	2.98	0.97
$L.S.D_{0.05}$	4.56	0.36	5.33	0.06	0.17	0.08	0.03	0.02
1999								
1	144.77	18.10	100.10	2.93	3.87	0.98	1.36	0.43
2	146.43	19.47	194.93	3.32	4.48	1.08	1.60	0.52
3	154.03	20.63	206.13	3.83	4.95	1.16	1.59	0.56
4	155.87	21.80	214.87	4.09	5.52	1.32	2.01	0.63
5	161.70	21.67	223.37	4.33	8.33	1.22	1.78	0.57
6	163.93	19.77	227.20	5.50	12.40	1.40	2.09	0.75
7	172.07	23.60	238.83	5.73	13.22	1.31	2.30	0.81
8	171.87	23.10	246.00	5.71	15.05	1.70	2.65	0.80

9	173.23	27.43	254.33	5.98	17.15	1.53	2.72	0.73
10	182.23	30.17	260.10	8.42	16.48	2.40	3.31	0.87
$L.S.D_{0.05}$	7.11	0.33	4.62	0.08	0.25	0.06	0.02	0.02

Table (7): Leaf elemental composition of Hamid and Wetteken olive cvs. as influenced by salinity of irrigation water during 1998 and 1999 growing seasons.

(Hamid)												
Orchard number	% (DW)						Mg/kg (DW)					
	N	P	K	Na	Ca	Mg	Fe	Mn	Cu	Zn	B	CL
1998												
1	1.910	0.340	1.270	0.140	0.830	0.320	276.1	45.90	20.40	52.00	48.20	0.060
2	1.880	0.320	1.220	0.150	0.890	0.350	222.6	32.50	19.50	48.90	48.10	0.070
3	1.830	0.290	1.190	0.170	0.960	0.350	218.0	29.20	18.40	49.10	44.10	0.090
4	1.770	0.280	1.160	0.200	1.060	0.370	208.1	29.90	17.40	48.00	42.40	0.130
5	1.760	0.280	1.140	0.230	1.120	0.380	206.8	28.70	17.20	43.00	42.10	0.140
6	1.730	0260	1.110	0.250	1.210	0.420	201.8	27.60	16.50	43.40	41.60	0.170
7	1.740	0.240	1.090	0.280	1.230	0.420	195.1	24.20	14.60	42.60	41.50	0.190
8	1.660	0.240	1.050	0.300	1.250	0.430	185.1	29.40	13.60	42.30	39.60	0.220
9	1.620	0.230	0.920	0.330	1.260	0.440	179.1	20.00	12.80	38.90	39.30	0.240
10	1.540	0.210	0.810	0.370	1.320	0.450	175.9	11.80	10.40	37.60	37.20	0.270
L.S.D $_{0.05}$	0.024	0.021	0.029	0.013	0.029	0.024	2.7	3.60	0.99	1.030	1.88	0.022
1999												
1	2.21	0.320	1.480	0.120	0.950	0.230	265.3	39.6	19.10	47.90	45.50	0.060
2	2.16	0.280	1.420	0.140	1.010	0.240	212.0	36.7	18.30	45.30	42.80	0.070
3	2.12	0.240	1.350	0.170	1.140	0.270	208.3	35.3	17.30	44.40	40.20	0.090
4	1.99	0.230	1.330	0.190	1.150	0.270	199.1	33.6	16.70	43.90	38.30	0.120
5	2.03	0.240	1.300	0.220	1.250	0.280	195.5	33.1	16.10	40.20	36.30	0.150
6	2.05	0.220	1.280	0.206	1.310	0.310	191.7	31.2	15.50	39.40	37.20	0.190
7	2.04	0.220	1.250	0.290	1.310	0.330	186.7	28.0	13.40	37.70	36.50	0.210
8	1.95	0.200	1.200	0.320	1.340	0.350	172.9	33.3	12.30	38.10	33.40	0.250
9	1.84	0.180	1.120	0.350	1.370	0.350	167.2	23.7	11.40	33.60	35.20	0.280
10	1.78	0.170	1.050	0.390	1.360	0.370	163.8	15.5	9.20	33.20	32.20	0.320
L.S.D $_{0.05}$	0.03	0.007	0.049	0.015	0.054	0.033	1.8	1.8	0.68	1.23	0.20	0.008
(Wetteken)												
1998												
1	1.950	0.280	1.220	0.110	0.840	0.190	291.10	38.50	24.70	89.50	43.90	0.060
2	1.840	0.260	1.140	0.120	0.870	0.220	272.30	33.90	22.20	88.10	42.90	0.070
3	1.830	0.210	1.080	0.150	0.880	0.230	245.80	30.70	21.00	86.80	41.60	0.090
4	1.770	0.210	1.000	0.170	0.930	0.230	244.10	23.80	20.30	79.90	42.40	0.120
5	1.720	0.220	0.890	0.190	0.940	0.250	242.60	24.30	20.10	67.90	41.50	0.150
6	1.740	0.190	0.850	0.220	0.940	0.270	235.50	22.90	19.70	53.90	41.30	0.190
7	1.650	0.180	0.830	0.250	0.980	0.270	223.40	22.40	18.40	39.00	39.20	0.220
8	1.630	0.150	0.800	0.290	0.990	0.280	222.20	21.90	16.70	36.90	38.20	0.260
9	1.570	0.140	0.740	0.320	1.210	0.310	210.10	21.60	15.70	25.00	38.50	0.350
10	1.530	0.130	0.690	0.380	1.260	0.360	189.40	21.50	14.90	23.80	35.20	0.360
L.S.D $_{0.05}$	0.050	0.015	0.024	0.014	0.027	0.020	5.50	1.39	0.68	2.78	1.76	0.190
1999												
1	2.080	0.300	1.400	0.140	0.950	0.370	281.40	41.00	22.90	79.80	40.50	0.070
2	2.030	0.290	1.290	0.150	1.000	0.120	263.10	37.40	21.10	82.40	40.20	0.080
3	1.950	0.260	1.210	0.170	1.010	0.120	232.40	34.30	18.40	78.30	37.70	0.100
4	1.940	0.240	1.100	0.190	1.060	0.160	234.80	28.50	19.30	70.50	36.80	0.130
5	1.950	0.230	1.020	0.210	1.040	0.150	232.10	28.20	18.60	64.70	38.70	0.180
6	1.900	0.230	0.970	0.240	1.110	0.160	215.70	27.40	18.60	49.00	38.30	0.250
7	1.850	0.220	0.920	0.270	1.100	0.170	214.70	26.20	17.40	36.60	37.30	0.240
8	1.850	0.170	0.870	0.320	1.080	0.170	211.50	26.70	15.40	34.40	36.20	0.280

9	1.740	0.160	0.810	0.340	1.300	0.250	200.90	26.00	14.60	23.20	36.20	0.310
10	1.690	0.150	0.710	0.410	1.370	0.270	1780.40	26.50	13.60	23.40	32.40	0.350
$L.S.D_{0.05}$	0.025	0.022	0.062	0.011	0.059	0.025	2.36	1.21	0.81	4.17	0.23	0.512

Table (4): Olive yield, Oil percent and fruit characteristics of Hamid and Wetteken olive cultivar grown under Siwa conditions as influenced by the salinity of irrigation water during 1998 and 1999 seasons.

(Hamid)							
Orchard number	Yield (kg/tree)	Oil (%)	Fruit characteristics				
			Weight (g)	Volume (cm)^3	Length (cm)	Diameter (cm)	Shape index
1998							
1	182.37	20.28	7.530	7.600	2.720	2.100	1.300
2	171.13	19.92	6.920	7.500	2.580	1.950	1.320
3	165.00	19.52	6.510	7.100	2.510	2.950	1.290
4	161.70	19.14	6.320	6.000	2.500	1.930	1.290
5	155.20	18.69	6.180	6.100	2.490	1.860	1.340
6	148.53	18.42	6.080	6.200	2.490	1.760	1.420
7	142.83	17.76	5.870	6.400	2.460	1.710	1.440
8	137.40	17.43	5.160	5.300	2.490	1.710	1.400
9	132.33	16.65	5.060	4.600	2.360	1.670	1.420
10	125.43	16.47	4.300	4.100	2.340	1.530	1.530
L.S.D$_{0.05}$	2.74	0.25	0.113	0.137	0.030	0.032	0.026
1999							
1	162.23	20.77	7.600	8.000	2.730	2.060	1.320
2	148.03	20.33	7.350	7.300	2.640	2.040	1.290
3	138.90	19.73	7.240	7.100	2.550	2.010	1.270
4	139.43	19.43	6.450	6.400	2.560	2.020	1.270
5	132.77	19.13	6.450	6.200	2.570	1.950	1.320
6	127.60	18.60	6.170	6.400	2.550	1.920	1.330
7	121.37	18.20	5.780	6.200	2.530	1.850	1.370
8	116.33	17.87	5.340	5.300	2.460	1.850	1.330
9	106.77	17.43	4.940	5.100	2.360	1.760	1.340
10	102.70	17.33	4.620	4.200	2.360	1.700	1.390
L.S.D$_{0.05}$	3.52	0.13	0.105	0.078	0.058	0.031	0.040
(Wetteken)							
1998							
1	152.00	23.53	5.570	5.60	2.380	1.80	1.32
2	143.57	23.43	5.240	5.40	2.350	1.74	1.35
3	138.13	23.00	5.120	5.20	2.280	1.75	1.31
4	133.17	22.27	4.810	5.10	2.270	1.68	1.35
5	125.80	22.93	4.650	5.10	2.260	1.66	1.36
6	121.23	22.37	4.440	4.40	2.230	1.59	1.40
7	113.03	22.27	4.440	4.30	2.120	1.57	1.35
8	107.17	21.60	4.230	4.20	2.070	1.56	1.33
9	101.43	21.33	3.740	4.10	2.030	1.52	1.34
10	94.23	21.17	3.100	3.60	1.990	1.45	1.37
L.S.D$_{0.05}$	1.82	0.42	0.046	0.11	0.025	0.02	0.02
1999							
1	130.80	23.200	6.06	6.000	2.500	2.010	1.240
2	121.67	23.030	5.54	5.200	2.460	1.840	1.340
3	116.77	22.530	4.80	4.700	2.370	1.770	1.340
4	111.73	22.300	4.45	4.700	2.230	1.760	1.260
5	105.40	22.200	4.45	4.500	2.270	1.670	1.360
6	95.43	21.870	4.47	4.500	2.240	1.680	1.330
7	91.57	21.530	4.43	4.200	2.230	1.650	1.350
8	83.37	21.300	3.95	4.000	2.190	1.620	1.350

9	80.47	20.900	3.92	3.800	2.050	1.550	1.320
10	74.87	20.500	2.85	3.100	2.020	1.490	1.860
L.S.D$_{0.05}$	2.49	0.135	0.07	0.063	0.049	0.052	0.041

Table (5): Seed and flesh characteristics of Hamid and Wetteken olive cvs. as influenced by the salinity of irrigation water during 1998 and 1999 seasons.

Orchard number	Seed characteristics				Flesh characteristics		
	Weight (g)	Length (cm)	Diameter (cm)	Shape index	Weight (g)	Thickness (cm)	Percent (%)
(Hamid)							
1998							
1	0.970	1.690	0.930	1.820	6.570	0.710	87.17
2	0.960	1.680	0.870	1.920	5.960	0.670	86.17
3	0.890	1.660	0.820	2.010	5.620	0.650	86.28
4	0.880	1.650	0.630	2.610	5.450	0.650	86.15
5	0.860	1.640	0.830	1.970	5.620	0.640	86.66
6	0.860	1.610	0.820	1.970	5.220	0.620	85.91
7	0.820	1.590	0.810	11.970	5.050	0.610	85.98
8	0.790	1.580	0.780	2.020	4.370	0.580	84.77
9	0.780	1.530	0.780	1.970	4.280	0.560	84.57
10	0.660	1.490	0.720	2.070	3.640	0.480	84.60
$L.S.D_{0.05}$	0.040	0.020	0.028	0.085	0.290	0.040	0.87
1999							
1	1.150	1.770	0.950	1.850	6.230	0.620	84.39
2	1.110	1.750	0.920	1.910	6.210	0.570	84.84
3	1.060	1.720	0.910	1.900	6.180	0.560	85.41
4	0.960	1.750	0.860	2.030	5.490	0.550	85.13
5	0.970	1.780	0.860	2.070	5.480	0.550	84.97
6	0.950	1.760	0.830	2.130	5.220	0.550	84.60
7	0.830	1.720	0.830	2.080	4.960	0.520	85.72
8	0.820	1.700	0.810	2.100	4.520	0.480	84.59
9	0.800	1.640	0.790	2.080	4.140	0.440	83.87
10	0.690	1.570	0.780	2.000	3.930	0.420	85.15
$L.S.D_{0.05}$	0.027	0.048	0.028	0.098	0.123	0.023	0.67
(Wetteken)							
1998							
1	0.850	1.580	0.870	1.82	4.720	0.580	84.80
2	0.830	1.530	0.830	1.84	4.410	0.590	84.10
3	0.830	1.490	0.810	1.84	4.290	0.580	83.82
4	0.830	1.500	0.770	1.96	3.980	0.570	82.84
5	0.750	1.490	0.780	1.92	3.900	0.550	83.89
6	0.720	1.470	0.760	1.95	3.720	0.530	83.79
7	0.710	1.440	0.740	1.94	3.730	0.540	84.04
8	0.660	1.390	0.720	1.94	3.570	0.520	84.42
9	0.580	1.360	0.690	1.97	3.160	0.510	84.50
10	0.550	1.350	0.680	2.01	2.550	0.450	82.17
$L.S.D_{0.05}$	0.038	0.028	0.062	0.17	0.036	0.032	0.69
1999							
1	1.080	1.750	0.920	1.900	4.98	0.580	82.19
2	1.050	1.590	0.890	1.790	4.49	0.520	81.01
3	0.880	1.590	0.860	1.840	3.92	0.510	81.68
4	0.850	1.570	0.790	1.990	3.60	0.470	80.99
5	0.770	1.570	0.810	1.950	3.68	0.480	82.77
6	0.760	1.560	0.790	1.960	3.70	0.470	82.92
7	0.740	1.550	0.780	2.00	3.69	0.460	83.38
8	0.660	1.520	0.760	2.00	3.29	0.430	83.22
9	0.650	1.430	0.690	2.060	3.27	0.420	83.44
10	0.550	1.390	0.630	2.200	2.30	0.370	80.85

L.S.D$_{0.05}$	0.026	0.036	0.026	0.056	0.08	0.021	0.67