IV. RESULTS AND DISCUSSION

It is well known that salinity is considered one of the factors that affect plant growth through its depressive on both metabolic activities and water relations within the different plant tissues. Thus, the following presentation of results and discussion will be concerned with the effect of salinity concentration, sodium adsorption ratio (SAR) and chloride (Cl: SO_4) ratio of saline solutions used for irrigation on growth, physiological aspects, chemical composition of plant organs and anatonitical structure of three pomegranate cvs transplants.

IV.1. Effect of salt concentration; sodium adsorption ratio and chloride level (Cl: SO_4) in irrigation water on growth measurements of three pomegranate cultivars transplants:

In this regard, the vegetative growth measurements expressed as plant height; net increase in plant height; number of leaves/plant; net increase in number of leaves/ plant; number of shoots/ plant; net increase in number of shoots/ plant; leaf area, total assimilation leaves area; root length; number of roots; fresh and dry weights of plant organs (leaves, stem, roots and total plant) in response to specific effect of four factors i.e., salinity concentrations (2000, 4000 and 6000 ppm beside tap water as control), two sodium adsorption levels (3 & 6); two chloride: sulphate levels i.e. (low & high Cl: SO_4 ratio) in irrigation water used and three pomegranate cultivars transplants, as well as interaction effect of different combinations between four studied factors were investigated. Data obtained during 2000 and 2001 seasons are presented in **Tables (3); (4); (5); (6); (7); (8); (9); (10) and (11).**

IV.1.1. Effect on plant height (cm):

Data obtained during 2000 and 2001 seasons regarding the specific and interaction effects of the four investigated factors i.e; (pomegranate cultivars, salinity concentration, SAR and Cl: SO_4 ratio) on average plant height (cm.) of pomegranate cultivars transplants are presented in **Table (3)**.

A) Specific effect:

Regarding the specific effect of pomegranate cultivars on the average plant height (cm.), data obtained in **Table (3)** showed that Manfalouty transplants were the tallest ones followed in a descending order by Nab El-Gamel and Wardy transplants. These results are in harmony with the findings of **Youssif, (1989), Noaman** ***et al.*****, (1994), Ali (2000)** on pomegranate cvs and **Motosugi** ***et al.*****, (1987)** and **Schreiner and Ludders**, **(1992 a & b)** on apple rootstock.

Concerning the specific effect of salinity concentration, data in **Table (3)** clearly show that all three investigated concentrations (2000, 4000 and 6000 ppm) of saline solutions resulted in an obvious decrease in plant height of pomegranate transplants during 2000 and 2001 seasons. Such decrease was significant as compared to those of tap water irrigated ones. On the other hand, the most depressive effect was always in concomitant to the highest concentration i.e., 6000 ppm during both seasons of study. However, the 2000ppm saline solution exhibited the lowest decrease. Meanwhile, the 4000 ppm concentration was intermediate in this concern, whereas, differences between the three salinity concentrations were significant as each was compared to the two other ones during two seasons of study. The obtained results, regarding the specific effect of salt concentration, in irrigation water agree with that reported by **Wilcox, (1951)** who mentioned that salinity of soil solution may affect plant growth in two ways: 1- The osmotic pressure of the solution which may be much enough to limit the availability of water to the plant. or 2- the high concentration of salts may facilitate the uptake of one or more ions so that an accumulation may occur and cause a damage in the plant.

The effects of soil and irrigation water salinity on growth of pomegranate were intensively studied and recorded **Patil** ***et al.,*** **(1985); Doring** and **Ludders, (1986-a and b)** and **Doring, (1987); Mehata** ***et al.,*** **(1988); Mishra, (1990)** and **Luice,** ***et al.,*** **(1991).** Pomegranate has been described as a salinity tolerant fruit trees **Petrosyan, (1984)** and **Jain** and **Dass, (1988). Shashi** ***et al.,*** **(1995)** found that in pomegranate ***(Punica granatum, L.)*** highly significant and negative correlations were observed between growth parameters (plant height, stem girth and average spread) and electrical conductivity (EC) of soil at all depths.

Pokroveskay, (1957) found that in glycophages both cell division and cell elongation were inhibited with increasing salinity. Moreover, **Behairy** ***et al.,*** **(1984)** on the Thompson and American grape rooted cuttings; **Kabeel, (1985)** on some deciduous fruit seedlings; **Taylor** ***et al.*****, (1987); Al-Saidi** ***et al.*****, (1988)** and **Prior** ***et al.*****, (1992)** on grape vine plants, all reported that the plant height was decreased with increasing salinity concentrations.

Concerning the specific effect of sodium adsorption ratio (SAR) it was quite evident that raising it from 3 to 6 in irrigation water significantly decreased the plant height during 2000 and 2001 seasons. These results are inagreement with the findings of **Youssif, (1989), Noaman** ***et al.*****, (1994)** on pomegranate **Behariy** ***et al.*****, (1984)** on Thompson seedless and American grape, **Kabeel (1985)** on some deciduous fruit species, **AL-Khateeb, (1989)** on some fig varieties and **Omar, (1996)** on apricot and mango seedlings. They found that increasing sodium adsorption ratio (SAR) resulted in a significant reduction in plant height.

As for the specific effect of $Cl:SO_4$ ratio in saline solution used for irrigation on plant height, it could be noticed from data in Table (3) that the higher ratio (increasing the level of chloride in irrigation water) resulted in a significant decrease in stem length of apple rootstocks transplants during the two seasons of study. In this respect, **Kabeel, (1985)** on some deciduous fruits species, **Omar, (1996)** on apricot and mango seedlings and **Abd-El-Mageid, (1998)** on almond seedlings, found that increasing $Cl:SO_4$ ratio significantly decreased stem length.

B) Interaction effect:

Referring the interaction effect of possible combinations between four investigated factors i.e., pomegranate cultivars, salinity concentration, SAR and $Cl: SO_4$ ratio on average transplant height, data obtained in Table (3) show obviously a considerable response during two seasons. The most depressive effect was exhibited by the irrigated Wardy transplants with 6000 ppm saline solution of SAR 6 and higher $Cl:SO_4$ ratio, where the shortest transplants were resulted. Moreover, three other combinations of 6000ppm saline solutions ranked second in an increasing order.

On the other hand, the lowest decrease in stem length was detected by those of Manfalouty transplants irrigated with 2000 ppm saline solution of SAR 3 and lower $Cl:SO_4$ ratio as compared to those combinations of three pomegranate cultivars continuously irrigated with tap water (control) during 2000 and 2001 seasons. In addition, other combinations were in between the aforesaid two extents. These results are in agreement with the findings of **Noaman *et al.*, (1994)** on pomegranate **Osman, (2005)** on apple rootstocks and **Hassan, (2005)** on oliv.

IV.1.2. Effect on net increase in plant height (cm):

Data obtained during 2000 and 2001 seasons regarding the specific and interaction effects of the four investigated factors i.e; (pomegranate cultivars, salinity concentration, SAR and $Cl:SO_4$ ratio) and their combinations on net increase in plant height (cm.) of pomegranate transplants are presented in **Table (3).**

A) Specific effect:

Regarding the specific effect of pomegranate cultivars on net increase in plant height (cm.), data obtained in **Table (3)** showed that Manfalouty cultivar had the tallest transplants followed in a descending order by Nab El-Gamel and Wardy cultivars. These results are in harmony with the findings of **Youssif, (1989)** and **Ali, (2000)** on pomegranate cultivars, **Motosugi** ***et al.*****, (1987)** and **Schreiner** and **Ludders, (1992 a** and **b)** on apple rootstocks.

Concerning the specific effect of salinity concentration, data in **Table (3)** clearly show that all three investigated concentrations (2000, 4000 and 6000 ppm) of saline solutions obviously by decreased the net increase in plant height of pomegranate transplants during 2000 and 2001 seasons. Such decrease was significant as compared to those of tap water irrigated ones. On the other hand, the most depressive effect was always in concomitant to the highest concentration i.e., 6000 ppm during both seasons of study, however, the 2000ppm saline solution exhibited the lowest decrease. Meanwhile, the 4000 ppm concentration was intermediate in this concern, whereas, differences between the three salinity concentrations were significant as each was compared to the two other ones during two seasons of study. The obtained results, regarding the specific effect of salt concentration, in irrigation water agree with that reported by **Wilcox** ***et al.*****, (1951)** who mentioned that salinity of soil solution may affect plant growth in two ways: 1- The osmotic pressure of the solution which may be much enough to limit the availability of water to the plant. or 2- the high concentration of salts may facilitate the uptake of one or more ions so that an accumulation may occur and cause a derangement of the plant.

Pokroveskay, (1957) found that in glycophages both cell division and cell elongation were inhibited with increasing salinity. Moreover, **Youssif, (1989)** on pomegranate **Behairy** ***et al.*****, (1984)**

on the Thompson and American grape rooted cuttings; **Kabeel, (1985)** on some deciduous fruit seedlings; **Taylor *et al.*, (1987); Al-Saidi *et al.*, (1980)** and **Prior *et al.*, (1992)** on grape vine plants, all reported that the plant height was decreased with increasing salinity concentrations.

Concerning the specific effect of sodium adsorption ratio (SAR) it was quite evident that raising it from 3 to 6 in irrigation water significantly decreased the net increase in plant height during 2000 and 2001 seasons. These results are in agreement with the findings of **Youssif, (1989)** on pomegranate **Behariy *et al.*, (1984)** on Thompson seedless and American grape rooted cuttings, **Kabeel, (1985)** on some deciduous fruit species, **AL-Khateeb, (1989)** on some fig varieties and **Omar, (1996)** on apricot and mango seedlings. They found that increasing sodium adsorption ratio (SAR) resulted in a significant reduction in plant height.

As for the specific effect of $Cl:SO_4$ ratio in saline solution used for irrigation on net increase in plant height, it could be noticed from data in **Table (3)** that the higher ratio (increasing the level of chloride in irrigation water) significantly decreased stem length of pomegranate transplants during the two seasons of study. In this respect, **Kabeel, (1985)** on some deciduous fruits species, **Omar, (1996)** on apricot and mango seedlings and **Abd-El-Mageid, (1998)** on almond seedlings, found that increasing $Cl:SO_4$ ratio significantly decreased net increase in plant height.

Table (3): Plant height (cm) and net increase in plant height (cm) of pomegranate transplants (rooted cutting) in response to specific and interactior effects of Pomegranate cultivars; (salt concentrations, SAR and Cl:SO4 ratio in saline irrigation water) and their combinations during 2000 & 2001 seasons.

Treatments / Cultivars			Plant height (cm) Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****	net increase in plant height (cm) Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****
2000														
Tap water			79.33 a	72.83 b	72.83 b	75.00 A	SAR3	Low Cl	37.17 a	32.17 b	30.83 b	33.39 A	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	73.00 b	68.67 d	65.50 F	65.97 B	62.29 A	61.75 A	31.33 b	27.17 cd	23.83 fg	24.50 B	20.75 A	20.15 A
		High Cl	69.83 c	66.67 e	63.83 G				28.33 c	25.83 de	22.67 g			
	SAR 6	Low Cl	68.83 cd	65.17 f	60.33 J				26.33 de	25.00 ef	17.00 ij			
		High Cl	68.17 d	61.83 h	59.83 J				25.00 ef	20.67 h	17.33 kl			
4000 ppm	SAR 3	Low Cl	65.17 f	54.17 lm	55.33 K	56.49 C	SAR6	High Cl	22.83 g	17.17 l	13.00 n	14.67 C	SAR6	High Cl
		High Cl	64.67 fg	53.50 l-n	53.17M-O				21.00 h	16.50 l	11.33o-q			
	SAR 6	Low Cl	61.50 hi	52.83 no	52.50 N-P				20. 33 hi	16.17 lm	9.33 rs			
		High Cl	60.50 ij	52.17 op	52.33 N-P				18.67 jk	14.83 m	9.00 s			
6000 ppm	SAR 3	Low Cl	54.33 kl	47.33 q	45.67 RS	47.68 D	60.28 B	60.82 B	12.50 no	10.17 q-s	4.17 uv	6.33 D	18.69 B	19.29 B
		High Cl	53.50 l-n	46.17 r	44.50 T				12.17 no	9.00 s	2.83 vw			
	SAR 6	Low Cl	52.83 no	44.67 st	44.17 TU				11.67 n-p	7.33 t	2.33 w			
		High Cl	51.50 p	44.17 tu	43.33 U				10.67 p-r	5.00 u	1.83 w			
Mean *			63.32 A	56.17B	54.87C				21.38A	17.46B	12.73C			
2001														
Tap water			71.17 a	68.67 b	66.67 c	68.83A	SAR3	Low Cl	36.17 a	34.67 b	32.00 c	34.28A	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	65.67 d	64.67 e	55.83 l	58.93B	56.19A	55.67A	30.67 d	29.83 e	22.67 j	24.69B	21.79A	21.24A
		High Cl	63.50 f	62.50 g	54.50 n				28.50 f	28.83 f	21.50 k			
	SAR 6	Low Cl	61.17 h	59.83 i	52.50 p				26.50 g	25.17 h	18.67 o			
		High Cl	59.00 j	58.00 k	50.00 r				24.17 i	23.00 j	16.83 q			
4000 ppm	SAR 3	Low Cl	56.17 l	55.17 m	44.00 u	50.06C	SAR6	High Cl	21.33 kl	20.83 lm	10.33 u	15.50C	SAR6	High Cl
		High Cl	55.17 m	53.50 o	43.00 v				20.67 m	18.50 o	8.83 v			
	SAR 6	Low Cl	54.67 mn	52.67 p	41.83 w				19.33 n	17.83 p	8.50 v			
		High Cl	52.33 p	50.50 q	41.67 w				17.17 q	15.67 r	7.00 w			
6000 ppm	SAR 3	Low Cl	46.83 s	47.17 s	38.33 y	42.50D	53.97B	54.49B	12.17 st	12.50 s	3.67 x	8.03D	19.47B	20.08B
		High Cl	45.67 t	45.67 t	38.33 y				11.83 t	11.00 u	3.50 x			
	SAR 6	Low Cl	45.83 t	44.33 u	36.50 z				11.00 u	10.50 u	2.67 y			
		High Cl	44.00 u	40.50 x	36.83 z				8.50 v	06.83 w	2.17 y			
Mean *			55.48 A	54.09 B	46.15 C				20.62 A	19.63 B	12.18C			

*, **, *** and **** means refer to specific effect of pomegranate cvs; salinity concentration; SAR and Cl:SO4 ratio, respectively. Values within the same column or row for any of fou investigated factors and their combinations followed by the same letter/s were not significantly different at 5% level. Capital and small letters were used for distinguishing values of eithe specific effect for each investigated factor or interaction effect of their combinations, respectively.

B) Interaction effect:

Referring the interaction effect of possible combinations between four investigated factors i.e., pomegranate cultivars, salinity concentration, SAR and Cl: SO_4 ratio on net increase of plant height, data obtained in **Table (3)** show obviously a considerable response during two seasons. The most depressive effect was exhibited by the irrigated Wardy transplants with 6000 ppm saline solution of SAR 6 irrespective of Cl: SO_4 ratio, where the least increase in transplants height was significantly resulted. Moreover, two other combinations of 6000ppm irrigated transplants of the same cultivar ranked second in an increasing order.

On the other hand, the least decrease in net increase in plant height was detected by those combinations of Manfalouty transplants irrigated with 2000 ppm saline solution of SAR 3 and lower Cl: SO_4 ratio as compared to those irrigated with different saline solutions of three pomegranate cultivars during 2000 and 2001 seasons. In addition, other combinations were in between the aforesaid two extents.

IV.1.3. Effect on root length (cm):

A. Specific effect:

Concerning the specific and interaction effects of pomegranate cultivars; salt concentration; sodium adsorption ratio (SAR); chloride level (Cl: SO_4 ratio) and their combinations on root length, data are presented in **Table (4).** Referring the specific effect of pomegranate cultivar, it is clear that Manfalouty had the tallest roots followed in descending order by Nab El-Gamal and Wardy transplants.

Regarding the specific effect of salt concentration, data in **Table (4)** indicated that root length (cm.) was negatively correlated with salt concentration during the two seasons of study. In other words all three salt concentrations (2000, 4000 and 6000 ppm.) significantly depressed root length, however, such decrease was more remarkable with the highest concentration (6000 ppm). On the contrary 2000 ppm concentration exhibited the least depression. Meanwhile, the 4000ppm concentration was intermediate in this respect. Differences between the three salinity concentrations were significant as each was compared to two other ones during 2000 and 2001 seasons. In this connection, the findings of **Noaman *et al.*, (1994)** and **Ali (2000)** on pomegranate transplants gave support to the present results. Moreover, **Hayward and Long, (1942)** reported that the total concentration was a major factor in the general growth depression on peach. **Hayward** and **Spurr, (1943)** concluded that the increase in osmotic pressure of saline soil solution tended to restrict the water uptake by root of corn plants.

Omar, (1996) on apricot and mango seedlings and **Abd-El-Mageid, (1998)** on almond seedlings, reported that a significant decrease in root length was observed with increasing salt concentration in the irrigation water.

Concerning the specific effect of sodium adsorption ratio (SAR), it is quite clear that, increasing sodium adsorption ratio from 3 to 6 in irrigation water significantly decreased the root length of pomegranate cultivars transplants during 2000 and 2001 seasons. This result is similar to that reported by **Noaman *et al.*, (1994)** on pomegranate cultivars. **Omar, (1996)** on both apricot and mango seedlings and **Abd El-Mageid, (1998)** on almond seedlings.

With respect to the specific effect of chloride level (Cl: SO_4 ratio) of saline solution used for irrigation on root length, it is quite clear from the present data in **Table (4)** that the higher Cl: SO_4 ratio in irrigation water decreased root length. Such decrease was significant during the two seasons of study. The same trend was reported by **Omar, (1996)** on both apricot and mango seedlings and **Abd-El-Mageid, (1998)** on almond seedlings.

B) Interaction effect:

As for the interaction effect between pomegranate cultivars; salt concentration; sodium adsorption ratio (SAR) and chloride level (Cl: SO_4 ratio), data are presented in **Table (4).** Generally, data indicated that root length of pomegranate cultivars transplants irrigated with saline solutions were significantly depressed as compared with control during the study.

The most depressive on root length was always in conomitant to such combination of Wardy transplants irrigated with saline solutions of 6000ppm; SAR 6 and higher Cl: SO_4 ratio (highest decrease in root length was resulted). Moreover, other combinations of 6000ppm saline solution ranked second in an increasing order. On the other hand; the least decrease in root length was coupled with those combination of Manfalouty transplants irrigated with 2000 ppm saline solution of SAR3 and lower Cl: SO_4 ratio as compared with control during 2000 and 2001 sasons. In addition, other combinations were in between the abovementioned two extremes. The same trend was found by **Youssif, (1989)** on pomegranate, **Omar, (1996)** on apricot and mango seedlings, **Abd-El-Mageid, (1998)** on almond plants, **Osman (2005)** on apple rootstocks and **Hassan (2005)** on olive.

IV.1.4. Effect on number of roots per plant:

Data obtained during both 2000 and 2001 experimental seasons regarding the specific and interaction effects of four investigated factors and their combinations are presented in **Table (4).**

A) Specific effect:

Concerning the specific effect of the different factors involved in this study i.e., (pomegranate cultivars; salinity concentrations; SAR and Cl: SO_4 ratio) on the number of roots per plant, data as shown in **Table (4)** revealed that Manfalouty transplants had significantly the greatest number of roots/ plant in both seasons. Wardy took the other way around. In addition, total number of roots per plant decreased, in general, with increasing salt concentration in irrigation water during 2000 and 2001 seasons. Such decrease was significant as the three salts concentrations i.e. of 2000, 4000 and 6000ppm were compared to those of tap water. In addition, the most depressive effect was always in concomitant to the highest concentration i.e., 6000ppm during both seasons of study, however, the 2000 ppm saline solution exhibited significantly the lowest decrease. Meanwhile, the 4000 ppm concentration was intermediate in this conern.

These findings are in harmony with those obtained by **Ali, (2000)** and **Saeed, (2005)** on pomegranate cultivars **Fathi, (1994)** on apple rootstock seedlings, **Pandey** and **Divate, (1976)** on grapevine, **Kabeel, (1985)** on some decidious fruit species, **Bondok *et al.*, (1995)** on Florida prince peach, **Omar, (1996)** on some deciduous fruit species and **Abd-El-Mageid, (1998)** on almond plants. They found that number of roots per plant decreased considerably with increasing salt concentration in irrigation water.

Regarding the specific effect SAR, data as shown in **Table (4)** revealed that the higher ratio of SAR (6) resulted significantly in depressing the number of roots/ plant than the lower one i.e. SAR 3 during two seasons of study. These results are in agreement with that reported by **Behairy *et al.*, (1984)** on Thompson grape and American grape; **Omar, (1996)** on apricot and mango seedlings and **Abd El-Mageid, (1998)** on almond plants. They found that increasing SAR from 3 to 6 in irrigation water resulted in a significant reduction in the number of roots per plant.

As for the specific effect of the Cl: SO_4 ratio of saline solution used for irrigation on number of roots/plant, it could be observed from data in **Table (4)** that the higher ratio resulted in a significant decrease in number of roots/ plant than the lower one during the study. Similar results were also found by **Kabeel, (1985)** on some deciduous fruit species; **Omar, (1996)** on apricot and mango seedlings and **Abd-El-Mageid, (1998)** on almond seedlings.

B) Interaction effect:

Referring the interaction effect of different combinations between the four investigated factors i.e. pomegranate cultivars; salinity concentration; SAR and Cl: SO_4 ratio on number of roots. **Table (4)** shows a considerable and statistical effect in both seasons of study where, the most depressive effect on number of roots/plant was exhibited by Wardy transplants irrigated with (6000ppm) saline solution of SAR 6 regardless of Cl: SO_4 ratio, followed by the transplants of the same cultivar irrigated with 6000 ppm saline

Table (4): Average length and number of roots per plant of pomegranate transplant (rooted cutting) in response to specific and interaction effects o Pomegranate cultivars; (salt concentrations, SAR and Cl:SO4 of saline irrigation water) ratio and their combinations during 2000 & 200· seasons.

Treatments \ Cultivars			Average root Length (cm) Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****	Number of roots per plant Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****
2000														
Tap water			59.00 a	49.50 d	52.33 bc	53.61A	SAR3	Low Cl	9.500 a	8.67 b	8.33 c	8.83A	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	53.00 b	46.50 e	45.50 ef				8.667 b	8.33 c	7.33 ef			
		High Cl	52.00 bc	45.00 f	42.00 h				8.000 d	7.83 d	6.67 ij			
	SAR 6	Low Cl	51.50 c	42.50 gh	40.50 i	45.94B	43.56A	42.94A	8.500 bc	7.83 d	6.33 kl	7.54B	7.29A	7.24A
		High Cl	50.17 d	43.33 g	39.33 j				7.500 e	7.50 e	6.00 m			
4000 ppm	SAR 3	Low Cl	46.50 e	40.33 i	37.50 kl		SAR6	High Cl	7.200 fg	7.17 fg	6.00 m		SAR6	High Cl
		High Cl	44.50 f	38.33 k	35.33 no				7.333 ef	6.83 hi	5.67 n			
	SAR 6	Low Cl	43.00 gh	36.00 mn	33.50 p	38.46C			7.333 ef	6.50 jk	5.33 o	6.50C		
		High Cl	42.00 h	33.50 p	31.00 q				7.000 gh	6.67 ij	5.00 pq			
6000 ppm	SAR 3	Low Cl	37.50 kl	36.50 lm	30.33 q		40.83B	41.44B	6.667 ij	6.33 kl	4.83 qr		6.92B	6.97B
		High Cl	36.00 mn	28.33 r	28.50 r				6.333 kl	6.00 m	4.67 rs			
	SAR 6	Low Cl	35.33 no	26.00 t	27.00 s	30.75D			6.200 lm	5.67 n	4.50 st			
		High Cl	34.50 o	23.50 u	25.50 t				5.667 n	5.17 op	4.33 t	5.53D		
Mean *			45.00 A	37.64 B	36.02 C				7.38 A	6.96 B	5.77 C			
2001														
Tap water			68.33 a	57.83 f	56.17 g	60.78A	SAR3	Low Cl	9.67 a	9.167 b	7.833 fg	8.889A	SAR3	Low Cl
2000 ppm	SAR 3	Low cl	65.67 b	49.00 i	46.33 k				8.83 c	8.500 d	6.83 j			
		High cl	64.17 c	47.50 j	45.50 l				8.67 cd	8.167 e	6.00 no			
	SAR 6	Low cl	63.17 d	45.33 l	43.33 n	51.13B	48.92A	48.21A	8.50 d	8.000 ef	5.67 p	7.53B	7.20A	7.15A
		High cl	60.67 e	42.50 o	40.33 q				7.83 fg	7.500 gh	5.83 op			
4000 ppm	SAR 3	Low cl	58.00 f	41.33 p	39.33 rs		SAR6	High Cl	7.33 hi	7.167 i	5.33 q		SAR6	High Cl
		High cl	56.50 g	39.00 s	38.83 s				7.50 gh	6.667 jk	5.17 q			
	SAR 6	Low cl	56.00 g	37.50 t	36.50 u	43.97C			7.33 hi	6.500 kl	5.17 q	6.36C		
		High cl	54.50 h	35.00 v	35.17 v				7.17 i	6.333 lm	4.67 r			
6000 ppm	SAR 3	Low cl	48.67 i	31.33 x	32.33 w		46.10B	46.81B	6.83 j	5.667 p	4.50 rs			
		High cl	44.17 m	30.50 y	31.17 xy				6.50 kl	5.333 q	4.50 rs		6.87B	6.92B
	SAR 6	Low cl	40.00 qr	28.00 [	30.50 y	34.17D			6.50 kl	5.167 q	4.33 st	5.36D		
		High cl	38.00 t	26.00 \	29.33 z				6.18 mn	4.667 r	4.17 t			
Mean *			55.21 A	39.29 B	38.83 C				7.60 A	6.83 B	5.38 C			

*, **, *** and **** means refer to specific effect of pomegranate cvs; salinity concentration; SAR and Cl:SO4 ratio, respectively. Values within the same column or row for any of fou investigated factors and their combinations followed by the same letter/s were not significantly different at 5% level. Capital and small letters were used for distinguishing values of eithe specific effect for each investigated factor or interaction effect of their combinations, respectively.

solution of SAR3 (regardless of $Cl:SO_4$ ratio). In addition, the lightest decrease in number of roots/ plant was detected by Manfalouty seedlings irrigated with 2000ppm saline solution of SAR 3 and lower and $Cl: SO_4$ ratio, as compared with control during the two seasons of study. Other combinations were in between the aforementioned two extents. This result is in agreement with that reported by **Omar, (1996)** on apricot and mango seedlings and **Abd El-Mageid, (1998)** on almond plants.

IV.1.5. Effect on number of shoots per plant:

A) Specific effect:

Concerning the specific effect of the different factors involved in this study i.e., (pomegranate cultivars; salinity concentrations; SAR and $Cl: SO_4$ ratio) on the number of shoots per plant, data as shown in **Table (5)** revealed that Manfalouty transplants had significantly the greatest number of shoots/ plant in both seasons. Wardy took the other way around. In addition, total number of shoots per plant decreased, in general, with increasing salt concentration in irrigation water during 2000 and 2001 seasons. Such decrease was significant as the three salts concentrations i.e. of 2000, 4000 and 6000ppm were compared to those of tap water. In addition, the most depressive effect was always in concomitant to the highest concentration i.e., 6000ppm during both seasons of study, however, the 2000 ppm saline solution exhibited significantly the lowest decrease. Meanwhile, the 4000 ppm concentration was intermediate in this concern.

These findings are in harmony with those obtained by **Youssif, (1989), Noaman** ***et al.,*** **(1994), Ali (2000)** and **Saeed, (2005)** on pomegranate transplants. Besides, **Fathi, (1994)** on apple rootstock seedlings, **Pandey** and **Divate, (1976)** on grapevine, **Kabeel, (1985)** on some decidious fruit species, **Bondok** ***et al.,*** **(1995)** on Florida prince peach, **Omar, (1996)** on some decidious fruit species and **Abd El-Mageid, (1998)** on almond plants, all found that number of shoots per plant decreased considerably with increasing salt concentration in irrigation water.

Regarding the specific effect of SAR, data as shown in **Table (5)** revealed that the higher ratio of SAR (6) resulted significantly in depressing the number of shoots/ plant than the lower one i.e. SAR 3 during two seasons of study. These results are in agreement with that reported by **Behairy** ***et al.*****, (1984)** on Thompson seedless and American grapes; **Omar, (1996)** on apricot and mango seedlings and **Abd El-Mageid, (1998)** on almond plants. Who found that increasing SAR from 3 to 6 in irrigation water resulted in a significant reduction in the number of shoots per plant.

As for the specific effect of the Cl: SO_4 ratio of saline solution used for irrigation on number of shoots/plant, it could be observed from data in **Table (5)** that the higher ratio resulted in a significant decrease in number of shoots/ plant than the lower one during the study. Similar results was also found by **Kabeel,**

(1985) on some deciduous fruit species; **Omar, (1996)** on apricot and mango seedlings and **Abd-El-Mageid, (1998)** on almond seedlings.

B) Interaction effect:

Referring the interaction effect of different combinations between the four investigated factors i.e. pomegranate cultivars; salinity concentration; SAR and Cl: SO_4 ratio on number of roots, **Table (5)** shows a considerable and statistical effect in both seasons of study. The most depressive effect on number of roots/plant was exhibited by Wardy transplants irrigated with (6000ppm) saline solution of SAR 6 regardless of Cl: SO_4 ratio. In addition, the lighest decrease in number of shoots/ plant was dected by Manfalouty seedlings irrigated with 2000ppm saline solution of SAR 3 and lower and/or higher Cl: SO_4 ratio, as compared with control during 1^{st} and 2^{nd} seasons, respectively. Other combinations were in between the aforementioned two extents. This result is in agreement with that reported by **Omar, (1996)** on apricot and mango seedlings and **Abd El-Mageid, (1998)** on almond plants.

IV.1.6. Effect on net increase in number of shoots per plant:

A) Specific effect:

Concerning the specific effect of the different factors involved in this study i.e., pomegranate cultivars and (salinity concentrations; SAR and Cl: SO_4 ratio of saline water irrigation) on the net increase in number of shoots per plant, data obtained during two seasons are presented in **Table (5)**. With regard to specific effect of pomegranate cultivar tabulated data revealed that Manfalouty transplants had significantly the greatest number of shoots/ plant in both seasons. Wardy took the other way around. In addition, net increase in number of shoots per plant decreased, in general, with increasing salt concentration in irrigation water during 2000 and 2001 seasons. Such decrease was significant as the three salts concentrations i.e. of 2000, 4000 and 6000 ppm were compared either each other or to those of tap water. In addition, the most depressive effect was always in concomitant to the highest concentration i.e., 6000ppm during both seasons of study, however, the 2000 ppm saline solution exhibited significantly the lowest decrease. Meanwhile, the 4000 ppm concentration was intermediate in this conern.

These findings are in harmony with those obtained by **Youssif, (1989), Noaman *et al.,* (1994), Ali (2000)** and **Saeed, (2005)** on pomegranate transplants, **Fathi, (1994)** on apple rootstock seedlings, **Pandey and Divate, (1976)** on grapevine, **Kabeel, (1985)** on some deciduous fruit species, **Bondok *et al.,* (1995)** on Florida prince peach, **Omar, (1996)** on apricot and mango seedlings and **Abd El-Mageid, (1998)** on almond plants. They found that number of shoots per plant decreased considerably with increasing salt concentration in irrigation water.

Regarding the specific effect of SAR, data as shown in **Table (5)** revealed that the higher ratio of SAR (6) resulted significantly in depressing the net increase in number of shoots/ plant than the lower one i.e. SAR 3 during two seasons of study. These results are in agreement with that reported by **Behairy *et al.*, (1984)** on Thompson seedless grape and American grape; **Omar, (1996)** on apricot and mango seedlings and **Abd El-Mageid, (1998)** on almond plants. They found that increasing SAR from 3 to 6 in irrigation water resulted in a significant reduction in the number of shoots per plant.

As for the specific effect of the Cl:SO_4 ratio of saline solution used for irrigation on net increase in number of shoots/plant, it could be observed from data in **Table (5)** that the higher ratio resulted in a significant decrease in number of shoots/ plant than the lower one during the study. Similar result was also found by **Kabeel, (1985)** on some deciduous fruit species; **Omar, (1996)** on apricot and mango seedlings and **Abd El-Mageid, (1998)** on almond seedlings.

B) Interaction effect:

Referring the interaction effect of different combinations between the four investigated factors i.e. pomegranate cultivars; salinity concentration; SAR and Cl: SO_4 ratio on net increase in number of roots. **Table (5)** shows a considerable and statistical effect in both seasons of study. The most depressive effect on number of roots/plant was exhibited by Wardy transplants irrigated with (6000ppm) saline solution of SAR 6 regardless of Cl: SO_4 ratio. In addition, the lighest decrease in net increase in number of shoots/ plant was dected by Manfalouty seedlings irrigated with 2000ppm saline solution of SAR 3 either with lower or higher Cl: SO_4 ratio. Whereas differences between such two combinations from one hand and control from the other were not significant during two seasons of study. Other combinations were in between the aforementioned two extents. This result is in agreement with that reported by **Omar, (1996)** on apricot and mango seedlings and **Abd El-Mageid, (1998)** on almond plants.

Table (5): Total number and net increase in number of shoots per plant of pomegranate transplant (rooted cutting) in response to specific anc interaction effects of Pomegranate cultivars; (salt concentrations, SAR and Cl:SO4 ratio of saline irrigation water) and their combination: during 2000 & 2001 seasons.

Treatments / Cultivars			Total number of shoots per plant: Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****	Net increase in number of shoots per plant: Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****
2000														
Tap water			9.000 a	7.500 e	6.750 h	7.750A	SAR3	Low Cl	4.67 a	4.00 c	3.08 fg	3.92 A	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	8.500 b	7.500 e	6.500 i				4.25 b	3.92 cd	3.08 fg			
		High Cl	8.417 bc	7.500 e	6.500 i				4.17 b	4.00 c	3.00 fg			
	SAR 6	Low Cl	8.333 c	7.250 f	6.500 i	7.29 B	6.81 A	6.76 A	3.83 d	3.58 e	2.92 g	3.49 B	3.10 A	3.02 A
		High Cl	7.750 d	6.500 i	6.167 j				3.50 e	3.08 fg	2.58 h			
4000 ppm	SAR 3	Low Cl	7.000 g	6.500 i	5.750 l		SAR6	High Cl	3.00 fg	3.08 fg	2.58 h		SAR6	High Cl
		High Cl	7.000 g	6.500 i	5.750 l				3.00 fg	2.92 g	2.33 j			
	SAR 6	Low Cl	7.250 f	6.167 j	5.500 m	6.31 C			3.17 f	2.50 hi	2.17 k	2.69 C		
		High Cl	7.000 g	6.000 k	5.250 n				3.17 f	2.33 j	2.00 lm			
6000 ppm	SAR 3	Low Cl	6.583 i	5.583 m	5.167 n		6.52 B	6.58 B	2.42 ij	2.08 kl	1.75 n		2.79 B	2.87 B
		High Cl	6.083 jk	5.500 m	4.667 q				2.08 kl	1.67 n	1.67 n			
	SAR 6	Low Cl	6.000 k	5.000 o	4.583 qr	5.33D			1.92 m	1.50 o	1.25 qr	1.69 D		
		High Cl	5.500 m	4.833 p	4.500 r				1.42 op	1.33 pq	1.167 r			
Mean *			7.26 A	6.33 B	5.66 C				3.12 A	2.77 B	2.27 C			
2001														
Tap water			9.50 a	7.92 f	6.75 kl	8.04 A	SAR3	Low Cl	5.17 a	4.25 c	3.17 h	4.17A	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	9.00 b	7.75 fg	6.50 m				4.58 b	4.00 de	2.83 jk			
		High Cl	8.67 c	7.58 h	6.17 n				4.33 c	3.83 e	2.67 kl			
	SAR 6	Low Cl	8.50 d	7.17 i	6.00 o	7.33 B	7.00 A	6.92 A	4.25 c	3.58 f	2.58 lm	3.48 B	3.18 A	3.10 A
		High Cl	8.17 e	6.83 k	5.83 p				4.00 de	3.08 hi	2.17 op			
4000 ppm	SAR 3	Low Cl	7.92 f	6.67 kl	5.50 r		SAR6	High Cl	3.58 f	2.92 ij	2.33 no		SAR6	High Cl
		High Cl	7.58 h	6.50 m	5.50 r				3.33 g	2.92 ij	2.08 p			
	SAR 6	Low Cl	7.67 gh	6.17 n	5.17 s	6.42 C			3.00 h-j	2.42 mn	2.00 p	2.63 C		
		High Cl	7.25 i	6.00 o	5.00 t				2.83 jk	2.33 no	1.75 q			
6000 ppm	SAR 3	Low Cl	7.00 j	5.67 q	5.00 t		6.64 B	6.72 B	2.58 lm	2.00 p	1.67 q		2.82 B	2.9 B
		High Cl	6.83 k	5.25 s	4.50 v				2.33 no	1.67 q	1.33 r			
	SAR 6	Low Cl	6.58 lm	5.17 s	4.25 w	5.48 D			2.17 op	1.58 q	1.08 s	1.72 D		
		High Cl	6.50 m	4.83 u	4.17 w				2.00 p	1.08 s	1.00 s			
Mean *		-	7.78 A	6.42 B	5.41 C				3.40 A	2.74 B	2.04 C			

*, **, *** and **** means refer to specific effect of pomegranate cvs; salinity concentration; SAR and Cl:SO4 ratio, respectively. Values within the same column or row for any of fou investigated factors and their combinations followed by the same letter/s were not significantly different at 5% level. Capital and small letters were used for distinguishing values of eithe specific effect for each investigated factor or interaction effect of their combinations, respectively.

IV.1.7. Effect on number of leaves per plant:

A) Specific effect:

Concerning the specific effect of the different factors involved in this study i.e., pomegranate cultivars; (salinity concentrations; SAR and Cl: SO_4 ratio of water irrigation) on the number of leaves per plant, data as shown in **Table (6)** revealed that Manfalouty had significantly the greatest number of leaves/ plant in both seasons. Wardy took the other way around. In addition, total number of leaves per plant decreased, generally, with increasing salt concentration in irrigation water during 2000 and 2001 seasons. Such decrease was significant either the three salts concentrations i.e. of 2000, 4000 and 6000ppm were compared each other or to those of tap water. In addition, the most depressive effect was always in concomitant to the highest concentration i.e., 6000ppm during both seasons of study, however, the 2000 ppm saline solution exhibited significantly the lowest decrease. Meanwhile, the 4000 ppm concentration was intermediate in this conern.

These findings are in harmony with those obtained by **Patil** ***et al.*****, (1985), Youssif, (1989), Noaman** ***et al.*****, (1994)** and **Saeed, (2005)** on pomegranate transplants. **Fathi, (1994)** on apple rootstock seedlings, **Pandey and Divate, (1976)** on grapevine, **Kabeel, (1985)** on some deciduous fruit species, **Bondok** ***et al.*****, (1995)** on Florida prince peach, **Omar, (1996)** on apricot and mango seedlings and **Abd El-Mageid, (1998)** on almond plants. They found that number of leaves per plant decreased considerably with increasing salt concentration in irrigation water.

Regarding the specific effect of SAR, data as shown in **Table (6)** revealed that the higher ratio of SAR (6) resulted significantly in depressing the number of leaves/ plant than the lower one i.e. SAR 3 during two seasons of study. These results are in agreement with that reported by **Behairy *et al.*, (1984)** on Thompson seedless and American grape rooted cuttings; **Omar, (1996)** on apricot and mango seedlings and **Abd El-Mageid, (1998)** on almond plants. They found that increasing SAR from 3 to 6 in irrigation water resulted in a significant reduction in the number of leaves per plant.

As for the specific effect of the Cl: SO_4 ratio of saline solution used for irrigation on number of leaves/plant, it could be observed from data in **Table (6)** that the higher ratio resulted in a significant decrease in number of leaves/ plant than the lower one during the study. Similar results were also found by **Kabeel, (1985)** on some deciduous fruit species; **Omar, (1996)** on apricot and mango seedlings and **Abd-El-Mageid, (1998)** on almond seedlings.

B) Interaction effect:

Referring the interaction effect of different combinations between the four investigated factors i.e. pomegranate cultivars; salinity concentration; SAR and Cl: SO_4 ratio on number of leaves, **Table (6)** shows a considerable and statistical effect in both seasons of study. The most depressive effect on number of leaves/plant was exhibited by Wardy transplants irrigated with (6000ppm) saline solution of SAR 6 regardless of Cl: SO_4 ratio. In addition, the lightest decrease in number of leaves/ plant was detected by Manfalouty seedlings irrigated with 2000ppm saline solution of SAR 3 and lower Cl: SO_4 ratio especially during 1^{st} season which didn't significantly vary as compared with control. Other combinations were in between the aforementioned two extents. This result is in agreement with that reported by **Omar, (1996)** on apricot and mango seedlings and **Abd El-Mageid, (1998)** on almond plants.

IV.1.8. Effect on net increase in number of leaves per plant:

A) Specific effect:

Concerning the specific effect of pomegranate cultivars, salt concentration, SAR and Cl: SO_4 ratio on net increase in number of leaves per plant, **Table (6)** clearly shows that Manfalouty transplants had significantly the greatest net increase in number of leaves /plant followed in a desecending order by Nab El-Gamal and Wardy cultivars. Such trend was true and differences were significant during 2000 and 2001 seasons.

The obtained results as shown from **Table (6)** revealed that salinizing irrigation water with $CaCl_2$, $MgSO_4$, KCl, K_2SO_4, Na_2SO_4 and NaCl at different concentrations, had in general significant effect on net increase in number of leaves / pomegranate transplant. To clarify this, it was noticed that net increase in number of leaves / plant decreased with increasing salt concentration to reach its minimum value of net increase in number of leaves /plant at the highest salts concentration (6000 ppm) during 2000 and 2001 seasons. However, the 2000 ppm saline solution exhibited the lightest decrease. In addition, 4000 ppm concentration was intermediate in this concern. Moreover, differences between the three salinity concentrations were significant as they were compared either each other each was compared or to tap water irrigation (control) during two seasons of study. These results are confirmed by the earlier findings of several investigators **Youssif, (1989), Noaman *et al.*, (1994)** and **Saeed, (2005)** on pomegranate transplants, **Kabeel, (1985)** on some deciduous fruit species, **Prior *et al.*, (1992)** and **Walker, (1994)** on grapevines.

Concerning the specific effect of SAR level on net increase in number of leaves per transplant, it was quite clear as shown from tabulated data in **Table (6)** that raising SAR from 3 to 6 exhibited significant decrease in net increase in number of leaves per transplant during both seasons.

As for the specific effect of the Cl: SO_4 ratio of saline water used for irrigation on net increase in number of leaves /plant, data as shown from **Table (6)** revealed that the response significant as the net increase in number of leaves was negatively correlated with the Cl: SO_4 ratio of saline irrigation solution.

B) Interaction effect:

Table (6) indicates a significant variations between different combinations of pomegranate cultivars, salinity concentration, SAR and Cl: SO_4 ratio, in net increase in number of leaves / plant. Anyhow, Wardy transplants irrigated with 6000ppm saline water with SAR 6 and high level of Cl: SO_4 ratio had the lowest net increase in number of leaves / plant, during 2000 and 2001 seasons. Moreover, other combinations of 6000ppm saline solution specially of Nab El-Gamal and Manfalouty cultivars in an increasing order ranked next to the aforesaid inferior one. On the other hand, the lowest decrease in net increase in number of leaves /plant was

Table (6): Total number of leaves/plant and net increase in number of leaves per plant of pomegranate transplant (rooted cutting) in response t(specific and interaction effects of Pomegranate cultivars; (salt concentrations, SAR and Cl: SO4 ratio saline irrigation water) and thei combinations during 2000 & 2001 seasons.

Treatments		Cultivars	Total number of leaves/plant: Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****	net increase in number of leaves/plant: Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****
2000														
Tap water			126.00 a	125.10 a	112.10 i	121.07 A	SAR3	Low Cl	59.00 a	58.08 a	51.58 d-f	56.24 A	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	125.80 a	123.10 b	108.60 j	112.97 B	105.27 A	104.05 A	56.17 b	53.75 c	48.08 g	46.52 B	40.77 A	39.91 A
		High Cl	120.80 c	122.40 b	100.00 l				50.33 ef	51.92 d	40.33 j			
	SAR 6	Low Cl	119.80 d	118.00 e	95.08 o				50.67 d-f	50.17 f	33.58 l			
		High Cl	116.50 f	115.20 g	90.25 r				48.08 g	48.00 g	29.08 mn			
4000 ppm	SAR 3	Low Cl	116.30 f	102.70 k	85.00 t	97.06 C	SAR6	High Cl	46.17 h	43.17 i	22.17 p	34.25 C	SAR6	High Cl
		High Cl	115.90 fg	100.30 l	80.00 u		100.46 B	101.68 B	46.75 gh	39.83 j	17.67 q		36.70 B	37.57 B
	SAR 6	Low Cl	114.30 h	98.00 m	73.67 w				45.92 h	37.67 k	15.67 r			
		High Cl	112.60 i	95.00 o	71.00 y				46.58 gh	36.83 k	10.67 t			
6000 ppm	SAR 3	Low Cl	97.75 m	86.33 s	71.83 xy	80.36 D			30.25 m	26.00 o	12.33 s	17.94 D		
		High Cl	96.25 n	78.33 v	68.50 z				28.58 n	17.17 q	8.50 u			
	SAR 6	Low Cl	93.67 p	74.33 w	66.50 [				27.83 n	12.67 s	7.50 u			
		High Cl	92.33 q	72.67 x	65.83 [				26.17 o	12.50 s	5.83 v			
Mean *			111.38 A	100.88 B	83.72 C				43.27 A	37.52 B	23.31 C			
2001														
Tap water			130.50 a	129.50 b	121.30 e	127.11 A	SAR3	Low Cl	63.67 a	62.50 a	56.67 cd	60.94 A	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	125.30 d	126.70 c	115.70 h	114.61 B	104.99 A	103.41 A	57.67 c	59.33 b	50.17 f	48.23 B	40.07 A	38.98 A
		High Cl	121.30 e	121.30 e	108.30 k				52.83 e	55.75 d	43.67 h			
	SAR 6	Low Cl	119.00 f	117.00 g	100.70 m				50.83 f	54.00 e	34.17 j			
		High Cl	113.30 i	111.30 j	95.33 n				45.00 g	46.17 g	29.17 m			
4000 ppm	SAR 3	Low Cl	106.00 l	95.67 n	91.83 o	90.59 C	SAR6	High Cl	38.50 i	31.17 l	20.67 q	26.26 C	SAR6	High Cl
		High Cl	100.70 m	92.00 o	86.00 s		98.32 B	99.90 B	34.83 j	26.50 n	18.67 r		35.39 B	36.48 B
	SAR 6	Low Cl	95.73 n	89.67 q	79.33 y				32.50 k	25.75 n	17.17 s			
		High Cl	91.00 p	84.33 t	74.83 \				30.00 lm	24.17 o	15.17 t			
6000 ppm	SAR 3	Low Cl	86.50 r	80.67 w	70.83]	74.31 D			26.00 n	20.33 q	8.67 v	15.49 D		
		High Cl	83.00 u	78.00 z	67.33 -				24.33 o	19.00 r	8.00 vw			
	SAR 6	Low Cl	81.33 v	75.67 [	61.67				22.83 p	13.00 u	7.00 wx			
		High Cl	80.00 x	69.33 ^	57.33				22.00 p	8.917 v	5.75 x			
Mean *			102.36 A	97.78 B	86.96 C				38.54 A	34.35 B	24.23 C			

*, **, *** and **** means refer to specific effect of pomegranate cvs; salinity concentration; SAR and Cl:SO4 ratio, respectively. Values within the same column or row for any of fou investigated factors and their combinations followed by the same letter/s were not significantly different at 5% level. Capital and small letters were used for distinguishing values of eithe specific effect for each investigated factor or interaction effect of their combinations, respectively.

detected by those combinations of Manfalouty and/or Nab-El-Gamal transplants irrigated with 2000ppm saline solution of SAR3 and lower Cl: SO_4 ratio as compared to those irrigated with tap water during two seasons of study. In addition, other combinations were in between the aforesaid two extremes.

IV.1.9. Effect on average leaf area (cm^2) and total assimilation area (dec^2) per plant:

A) Specific effect:

Concerning the specific effect of the investigated factors i.e., pomegranate cultivars, salt concentration, sodium adsorption ratio (SAR) and Cl: SO_4 ratio on average leaf area and total assimilation area (dec^2) per plant, data obtained in **Table (7)** showed that Manfalouty cultivars had statistically the greatest values of both leaf / leaves measurements followed in a decreasing order by Nab El-Gamal and Wardy transplants during two seasons.

Referring the specific effect of salinity concentration on average leaf area (cm^2) and total assimilation area (dec^2)/plant, data obtained in **Table (7)** clearly show that both measurements were decreased significantly with increasing the salt concentration either compared each other or with tap water. On the other hand, the most depressive effect was always in concomitant to the highest concentration i.e. 6000 ppm during both seasons of study, however, the 2000 ppm saline solution exhibited the lowest decrease. Meanwhile, 4000 ppm concentration was intermediate in this concern, whereas differences between the three salinity concentrations (2000, 4000 and 6000 ppm) were significant as each was compared to two other ones during 2000 and 2001 seasons.

These findings are in harmony with those obtained by **Patil** and **Patil, (1982), Youssif, (1989), Noaman *et al.*, (1994)** and **Saeed, (2005)** on pomegranate who reported that the number of leaves and their surface area decreased with increasing soil salinity. **Turnsov, (1972), Pandy** and **Divate, (1976), Meligi *et al.*, (1983) and Hatem, (1984)** on grapevine; **Kaul, (1981)** In this connection, the findings of **Nieman, (1965)** concluded that the number of cells per leaf area unit **(*Phoseoulus vulgaris L.*)** tended to remain constant throughout most of the growth period in both the control and salt stunted leaves. In addition, similar results were pointed out by **Al-Khateeb, (1989)** on some Fig varieties.

Referring the specific effect of SAR, it was quite clear that the highest ratio i.e. S.A.R. 6 resulted significantly in an obvious decrease in both average leaf area (cm^2) and total assimilation area (dec^2)/ plant than the lower one i.e. SAR3 during two seasons of study. As for the specific effect of the Cl: SO_4 ratio of saline solution used for irrigation, it could be noticed from **Table (7)** that the higher ratio caused a significant decrease in both leaf area and total assimilation leaves area/ plant than lower one during 2000 and 2001 seasons. The obtained results are confirmed by the findings of **Al-Khateeb, (1989)** on some Fig varieties.

B) Interaction effect:

Regarding the interaction effect of the different combinations between four investigated factors i.e., pomegranate cultivars x salinity concentration x SAR x Cl: SO_4 ratio, on average leaf area (cm^2) and total assimilation area (dec^2) / plant, data in **Table (7)** showed obviously a variable response during two seasons. The

Table (7): Average leaf area (cm^2) and total assimilation area (dec^2) of pomegranate transplant (rooted cutting) in response to specific and interactioı effects of Pomegranate cultivars: (salt concentrations, SAR and Cl:SO4 ratio of saline irrigation water) and their combinations during 2000 & 2001 seasons.

Treatments		Cultivars	Average leaf area (cm^2) Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****	Total assimilation area (dec^2) Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****
2000														
Tap water			7.00 a	7.00 a	6.60 c-e	6.67 A	SAR3	Low Cl	88.21 a	87.56 a	73.98 fg	83.26 A	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	6.97 a	6.86 b	6.57 de	6.63 B	6.25 A	6.13 A	87.71 a	84.45 b	71.38 i	75.01 B	66.94 A	65.10 A
		High Cl	6.95 a	6.63 cd	6.54 d-f				84.06 b	81.20 c	65.44 k			
	SAR 6	Low Cl	6.68 c	6.50 ef	6.47 fg				80.13 d	76.74 e	61.52 m			
		High Cl	6.54 d-f	6.34 hi	6.45 fg				76.19 e	73.06 gh	58.18 n			
4000 ppm	SAR 3	Low Cl	6.40 gh	6.24 jk	6.30 ij	6.01 C	SAR6	High Cl	74.49 f	64.10 l	53.55 p	58.43 C	SAR6	High Cl
		High Cl	6.21 jk	6.15 k	6.28 ij				72.08 hi	61.75 m	50.25 q			
	SAR 6	Low Cl	5.82 l	5.82 l	5.81 l				66.54 j	57.01 o	42.80 t			
		High Cl	5.76 lm	5.68 m	5.59 n				64.86 kl	53.99 p	39.69 v			
6000 ppm	SAR 3	Low Cl	5.58 n	5.42 o	4.70 q	4.74 D	5.87 B	5.99 B	54.54 p	46.77 r	33.78 x	38.49 D	60.65 B	62.48 B
		High Cl	5.19 p	5.24 p	4.44 s				49.98 q	41.06 u	30.41 y			
	SAR 6	Low Cl	4.77 q	4.79 q	4.08 t				44.64 s	35.63 w	27.13 z			
		High Cl	4.46 s	4.56 r	3.58 u				41.21 u	33.16 x	23.56 [			
Mean *			6.03 A	5.94 B	5.65 C	-	-	-	68.05 A	61.27 B	48.59 C			
2001														
Tap water			6.96 a	6.78 b	6.53 cd	6.76 A	SAR3	Low Cl	90.83 a	87.85 b	79.27 f	85.98 A	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	6.77 b	6.55 c	6.45 d-f	6.40 B	6.22 A	6.15 A	84.89 c	82.96 d	74.65 h	73.46 B	66.27 A	64.75 A
		High Cl	6.58 c	6.51 c-e	6.38 f				79.88 e	78.95 f	69.15 k			
	SAR 6	Low Cl	6.52 cd	6.10 i	6.30 g				77.55 g	71.37 j	63.45 m			
		High Cl	6.44 ef	5.93 kl	6.26 gh				72.95 i	66.06 l	59.65 o			
4000 ppm	SAR 3	Low Cl	6.24 gh	5.85 mn	6.18 h	5.91 C	SAR6	High Cl	66.11 l	56.00 r	56.79 q	53.67 C	SAR6	High Cl
		High Cl	6.10 i	5.76 op	6.00 jk				61.41 n	52.99 s	51.60 t			
	SAR 6	Low Cl	6.07 ij	5.69 pq	5.91 lm				58.08 p	51.05 u	46.91 x			
		High Cl	5.81 no	5.64 qr	5.70 pq				52.90 s	47.54 w	42.66 \			
6000 ppm	SAR 3	Low Cl	5.67 q	5.58 r	5.58 r	5.33 D	5.98 B	6.05 B	49.08 v	45.04 z	39.50 -	39.80 D	60.19 B	61.71 B
		High Cl	5.59 r	5.43 s	5.45 s				46.40 y	42.38 \]	36.70 '			
	SAR 6	Low Cl	5.32 t	5.33 t	5.03 u				43.30 [	40.36 ^	31.04 b'			
		High Cl	5.27 t	5.07 u	4.63 v				42.13]	35.13 a'	26.57 c'			
Mean *			6.10 A	5.88 B	5.86 C				63.50 A	58.28 B	52.15 C			

*, **, *** and **** means refer to specific effect of pomegranate cvs; salinity concentration; SAR and Cl:SO4 ratio, respectively. Values within the same column or row for any of fou investigated factors and their combinations followed by the same letter/s were not significantly different at 5% level. Capital and small letters were used for distinguishing values of eithe specific effect for each investigated factor or interaction effect of their combinations, respectively.

most depressive effect on average leaf area and total assimilation area/ plant was exhibited by such combination reprsented irrigated Wardy transplants with saline solution of 6000ppm; SAR 6 and higher Cl: SO_4 ratio, whereas, the least values of both leaves measurements were resulted. On the contrary, the least depressive effect was generally found by the Manfalouty cultivars transplants irrigated with the 2000 ppm saline solution especially of the lower SAR and Cl : SO_4 ratios which did not significantly differ than tap water irrigated transplants of the same cultivar during both seasons. Other combinations were in between the aforesaid two extremes. The obtained results are confirmed by the findings of **Osman (2005)** on apple rootstocks and **Hassan (2005)** on olive.

IV.1.10. Effect on the fresh and dry weights of plant organs (leaves, stem, roots and total plants):

Data presented in **Tables (8, 9, 10 and 11)** show the specific and interaction effects of pomegranate cultivars; (salt concentration, sodium adsorption ratio and chloride level Cl: SO_4 of saline solutions) and their combinations on the fresh and dry weights of plant organs (leaves, stem, roots and total plant) during 2000 and 2001 seasons.

A) Specific effect:

Concerning the specific effect of different factors involved in this study i.e., pomegranate cultivars; salinity concentrations; SAR and Cl: SO_4 ratios of saline solutions on the fresh and dry weights of plant organs (leaves; stem; roots and total plant), data in **Tables (8; 9; 10 and 11)** showed that Manfalouty cultivars had significantly the heaviest fresh and dry plant organs followed in a decreasing order by Nab El-Gamal and Wardy transplants. These results are in harmony with the findings of **Noaman *et al.* (1994) and Ali (2000)** on pomegranate plants.

Referring the specific effect of salinity concentrations, data obtained in **Tables (8; 9; 10 and 11)** revealed that, the fresh and dry weights of plant organs were gradually decreased by increasing the level of salinity concentration in irrigation water. The decrease was significant as both fresh and dry weights for a given organ and consequently the total plant weights under an investigated saline solution were compared to the analogous ones of either transplants irrigated with any of two saline concentrations or those continuously irrigated with tap water (control) during both 2000 and 2001 experimental seasons.

These results are confirmed by the findings of **Aly, (1979), Youssif, (1989), Noaman *et al.*, (1994), Ali (2000)** and **Saeed, (2005)** on pomegranate plants, **Fathi, (1989)** on apple rootstocks; **Attia, (1994)** on apple and olive; **Taha *et al.*, (1972)** on some grapevine cvs., **El-Azab *et al.*, (1973)** and **Nasr *et al.*, (1974)** on pecan seedlings; **Sourial *et al.*, (1975); Aly, (1979); Al-Saidi, (1980)** and **Meligi *et al.*, (1983)** on grapevine, **Behairy *et al.*, (1984)** on two grape spp. (rooted cuttings); **Kabeel, (1985)** on some deciduous fruit species, **Bondok, *et al.*, (1995)** on some peach rootstock transplants, **Omar, (1996)** on apricot and mango seedlings and **Abd-El-Magied, (1998)** on almond seedlings. All reported that the fresh and dry weights of plant organs (leaves, stem, roots and total plant) were decreased gradually by increasing the level of salinity concentration in irrigation water.

Regarding the specific effect of sodium adsorption ratio (SAR), data in **Tables (8; 9;10 and 11)** pointed out that increasing it from 3 to 6 in irrigation water significantly decreased both fresh and dry weights of plant organs (leaves, stem, roots and total plant) during the two seasons of study. These results are in agreement with that reported by **Noaman *et al.*, (1994)** on pomegranate transplant **Behairy *et al.*, (1984)** on Thompson and American grape plants, **Kabeel, (1985)** on some deciduous fruit seedlings, **Al-Khateeb, (1989)** on fig plants, **Omar, (1996)** on apricot and mango seedlings and **Abd El-Mageid, (1998)** on almond seedlings. All found that increasing (SAR) resulted in a significant reduction in fresh and dry weights of different plant organs.

With respect to the specific effect of chloride levels (Cl: So_4 ratio) of saline solution used for irrigation **Tables (8; 9;10 and 11)** show that raising it significantly decreased both fresh and dry weights of various plant organs (leaves, stem, roots and total plant) during two seasons of study. These results agree those of **Kabeel, (1985)** on some deciduous fruit species; **Al-Khteeb, (1989)** on fig plants, **Omar, (1996)** on (apricot & mango seedlings) and **Abd El-Mageid, (1998)** on almond seedlings.

B) Interaction effect:

Concerning the interaction effect of various combinations between pomegranate cultivars; salt concentration; SAR and (Cl: SO_4 ratio) on fresh and dry weights of plant organs (leaves, stem, roots and total plant) data presented in **Tables (8; 9; 10 and 11)** declared that all saline solutions significantly decreased these parameters as compared with those of control regardless of pomegranate species during two seasons of study.

The most depressive effect on fresh and dry weights of plant organs was in closed relationship to such transplants of Wardy transplants irrigated with saline solution of the highest concentration (6000 ppm) especially of the higher SAR & Cl: SO_4 ratios); followed in an increasing order by those of Nab El-Gamal supplied with saline solution of 6000 ppm; SAR 6 and higher Cl: SO_4 ratios. Meanwhile, the least reduction in fresh and dry weights of various plant organs resulted by saline solutions was markedly related to Manfalouty cultivar transplants irrigated with 2000 ppm saline solution of lower SAR and Cl: SO_4 ratios. Such trend was true during both seasons, however, it was more pronounced with leaves; stem and total plant weights. This results are similar to those achieved by **Kabeel, (1985)** on some deciduous fruit species, **Al-Khateeb, (1989)** on fig plants, **Omar, (1996)** on apricot and mango seedlings and **Abd El-Mageid, (1998)** on almond seedlings.

The reduction in fresh and dry weight of pomegranate transplant organs (leaves, stem, roots and total plant) under three level of salinity (2000, 4000 and 6000 ppm) might be attributed to osmotic pressure of the substrate which may restrict the uptake of water by plant roots (**Hayward** and **Spurr, 1943**), or may be due to the absorption of particular ions from the saline medium to toxic accumulation or to decrease of essential nutrients **(Wadleigh** and **Gaush, 1944)**, in addition, **Greenway, (1963),** suggested that such growth reduction was due to drastic changes in the ion relationships of plants.

From the above results one may conclude that transplants growth of three pomegranate cultivars, as being indicated from the values of fresh and dry weights of plant organs (leaves, stem, roots and total plant), root and total plant length; number of leaves plant height, number of laterals (plant, leaf area and assimilation area have been adversely affected by the application of saline solution which may lead to earliness of plant senescence, as a result of the accumulation of some ions (Na^+ and/or Cl^-) to a toxic levels this may an adaptive mechanism in three pomegranate cultivars to retranslocate excess amount of Na^+ and or Cl^- out of younger leaves to the older leaves to put them away from the physiologically active tissue **Winter, (1982)**. On the other hand, the control plants (non-stressed plants) did not show such decline in fresh and dry weights of their plant organs, probably because of the balanced ion composition in their tissues. They were able to remain physiologically active to relatively longer period than the saline sensitive ones.

Moreover, the reduction of growth with increasing osmotic pressure (O.P.) of the external nutrient solution has been reported by **Bernstein** and **Hayward, (1958)** who have been indicated that the degree of reduction in growth caused by water stress is the same whether, the total soil moisture stress is composed mainly of tension or osmotic components. They suggested that salinity like drought, may reduce the water potential of plant cells to the point that one or both of its components osmotic potential and pressure (turgor pressure) became limiting to growth.

Slatyer, (1961) showed that when plants are exposed to osmotic substrates, a sufficient amount of the substrate is absorbed to increase the O.P. by an amount equal to the increase in solute O.P.

Table (8): Leaves fresh weight and Leaves dry weight (g.) of pomegranate transplant (rooted cutting) in response to specific and interaction effects o Pomegranate cultivars; (salt concentrations, SAR and Cl:SO4 ratio of saline irrigation water) and their combinations during 2000 & 200 seasons.

Treatments		Cultivars	Leaves fresh weight (g.) Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****	Leaves dry weight (g.) Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****
2000														
Tap water			11.12 a	9.25 c-e	7.68 gh	9.35 A	SAR3	Low Cl	2.05 a	2.01 ab	1.93 a-c	2.00 A	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	10.54 ab	8.38 e-g	7.13 h-k	7.95 B	7.01 A	6.84 A	2.01 ab	1.90 a-d	1.86 a-e	1.81 B	1.67 A	1.64 A
		High Cl	10.01 bc	7.96 f-h	6.55 i-m				1.95 a-c	1.86 a-e	1.72 a-g			
	SAR 6	Low Cl	9.42 cd	7.50 g-j	6.16 k-n				1.86 a-d	1.76 a-f	1.68 b-i			
		High Cl	8.87 d-f	7.11 h-k	5.80 m-o				1.77 a-f	1.72 a-g	1.64 c-j			
4000 ppm	SAR 3	Low Cl	8.04 f-h	6.07 l-n	5.35 n-p	5.72 C	SAR6	High Cl	1.71 a-h	1.47 f-n	1.50 f-m	1.45 C	SAR6	High Cl
		High Cl	7.52 g-i	5.46 n-p	4.80 o-r				1.65 c-j	1.42 g-o	1.38 h-o			
	SAR 6	Low Cl	7.00 h-l	5.06 o-q	4.17 q-s				1.58 d-k	1.36 i-o	1.27 k-p			
		High Cl	6.50 j-m	4.79 o-r	3.89 r-t				1.52 e-l	1.32 j-p	1.24 k-p			
6000 ppm	SAR 3	Low Cl	5.47 n-p	4.22 q-s	3.41 s-u	3.62 D	6.31 B	6.49 B	1.47 f-n	1.25 k-p	1.17m-q	1.21 D	1.57 B	1.59 B
		High Cl	4.68 p-r	3.80 r-t	2.76 uv				1.40 g-o	1.22 l-q	1.11 o-q			
	SAR 6	Low Cl	4.23 q-s	3.40 s-u	2.46 uv				1.33 j-p	1.18 m-q	1.02 pq			
		High Cl	3.93 r-t	3.00 t-v	2.14 v				1.31 j-p	1.14 n-q	0.90 q			
Mean *			7.49 A	5.85 B	4.79 C				1.66 A	1.51 B	1.42 C			
2001														
Tap water			10.07 a	9.40 c	8.45 g	9.31 A	SAR3	Low Cl	2.04 a	2.00 ab	1.80 c-f	1.95 A	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	9.43 b	8.82 e	7.69 j	7.88 B	7.09 A	6.93 A	1.96 a-c	1.91 a-c	1.71 e-h	1.78 B	1.64 A	1.62 A
		High Cl	8.87 d	8.38 h	7.17 m				1.90 a-c	1.86 b-e	1.67 f-i			
	SAR 6	Low Cl	8.52 f	7.66 k	6.63 o				1.88 a-d	1.81 c-f	1.60 g-j			
		High Cl	8.00 i	7.15 m	6.26 q				1.81 c-f	1.73 d-g	1.56 h-k			
4000 ppm	SAR 3	Low Cl	7.30 l	6.10 r	5.87 t	5.74 C	SAR6	High Cl	1.71 e-h	1.52 i-l	1.53 i-l	1.47 C	SAR6	High Cl
		High Cl	6.78 n	5.76 u	5.20 x				1.60 g-j	1.44 k-m	1.45 j-m			
	SAR 6	Low Cl	6.45 p	5.50 v	4.77 \				1.59 g-k	1.39 l-n	1.38 l-n			
		High Cl	5.90 s	4.92 z	4.35 -				1.49 j-l	1.30 m-p	1.28 n-p			
6000 ppm	SAR 3	Low Cl	5.47 w	4.54 ^	3.94 a'	4.08 D	6.42 B	6.58 B	1.38 l-n	1.23 n-q	1.19 o-r	1.16 D	1.54 B	1.57 B
		High Cl	5.17 y	4.18 `	3.57 c'				1.31 m-o	1.18 o-r	1.12 qr			
	SAR 6	Low Cl	4.80 [	3.87 b'	3.01 e'				1.23 o-q	1.14 p-r	0.97 st			
		High Cl	4.62]	3.27 d'	2.55 f'				1.22 o-r	1.07 rs	0.90 t			
Mean *			7.03 A	6.12 B	5.34 C				1.62 A	1.51 B	1.40 C			

*, **, *** and **** means refer to specific effect of pomegranate cvs; salinity concentration; SAR and Cl:SO4 ratio, respectively. Values within the same column or row for any of fou investigated factors and their combinations followed by the same letter/s were not significantly different at 5% level. Capital and small letters were used for distinguishing values of eithe specific effect for each investigated factor or interaction effect of their combinations, respectively.

Table (9): Stem fresh weight and Stem dry weight (g.) of pomegranate transplant (rooted cutting) in response to specific and interaction effects o Pomegranate cultivars; (salt concentrations, SAR and Cl:SO4 ratio of saline irrigation water) and their combinations during 2000 & 200 seasons.

Treatments / Cultivars			Stem fresh weight (g.) Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****	Stem dry weight (g.) Manfaslout	Nabel-Gamal	Wardy	Mean**	SAR3	Low Cl
2000														
Tap water			19.51 a	18.00 bc	18.00 bc	18.50 A	SAR3	Low Cl	6.60 a	6.03 c	6.00 cd	6.21 A	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	18.25 b	16.77 e	16.13 f	16.18 B	14.32 A	14.08 A	6.19 b	5.69 e	5.49 f	5.51 B	4.97 A	4.87 A
		High Cl	17.65 cd	16.76 e	15.47 g				5.98 cd	5.68 e	5.25 g			
	SAR 6	Low Cl	17.36 d	16.22 f	14.45 h				5.89 d	5.50 f	4.91 i			
		High Cl	16.47 ef	14.66 h	13.95 i		SAR6	High Cl	5.68 e	5.03 h	4.85 i		SAR6	High Cl
4000 ppm	SAR 3	Low Cl	14.66 h	12.20 k	11.87 kl	12.16 C	13.41 B	13.65 B	5.28 g	4.47 j	4.36 k	4.31 C	4.61 B	4.71 B
		High Cl	14.64 h	11.75 lm	11.48 m				5.18 g	4.12 l	4.03 lm			
	SAR 6	Low Cl	14.52 h	10.72 o	10.87 no				5.03 h	3.78 o	3.85 no			
		High Cl	13.16 j	9.91 q	10.14 pq				4.57 j	3.51 q	3.55 pq			
6000 ppm	SAR 3	Low Cl	11.11 n	8.53 r	8.21 rs	8.61 D			4.00 m	3.14 r	3.03 s	3.13 D		
		High Cl	10.64 o	8.53 r	7.98 s				3.92 mn	3.14 r	2.97 s			
	SAR 6	Low Cl	10.28 p	7.60 t	7.08 u				3.62 p	2.73 t	2.56 u			
		High Cl	9.97 pq	7.11 u	6.28 v				4.52 pq	2.57 u	2.29 v			
Mean *			14.46 A	12.21 B	11.69 C				5.11 A	4.26 B	4.09 C			
2001														
Tap water			19.29 a	18.66 b	18.69 b	18.88A	SAR3	Low Cl	6.52 a	6.59 a	6.59 a	6.57 A	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	18.04 c	17.99 c	17.56 d	17.02B	14.93 A	14.78 A	6.11 b	6.00 c	6.03 bc	5.67 B	5.08 A	5.02 A
		High Cl	17.87 c	17.82 c	16.60 fg				6.00 c	5.82 d	5.59 ef			
	SAR 6	Low Cl	17.42 d	17.04 e	16.49 g				5.85 d	5.62 e	5.15 g			
		High Cl	16.45 g	16.77 f	14.23 i		SAR6	High Cl	5.59 ef	5.50 f	4.73 i		SAR6	High Cl
4000 ppm	SAR 3	Low Cl	14.51 h	14.63 h	12.13 m	12.85C	14.08 B	14.24 B	4.95 h	4.62 j	4.23 l	4.33 C	4.79 B	4.85 B
		High Cl	13.77 j	13.87 j	11.91 m				4.62 j	4.50 k	3.98 n			
	SAR 6	Low Cl	13.39 k	13.20 k	11.62 n				4.61 j	4.28 l	3.87 o			
		High Cl	12.61 l	12.07 m	10.54 p				4.55 jk	4.09 m	3.71 p			
6000 ppm	SAR 3	Low Cl	10.79 o	10.13 q	8.83 s	9.28D			3.80 o	3.47 q	3.00 t	3.15 D		
		High Cl	10.13 q	9.94 qr	8.62 s				3.50 q	3.30 r	2.89 u			
	SAR 6	Low Cl	9.72 r	9.83 r	8.18 t				3.42 q	3.21 r	2.70 v			
		High Cl	8.06 t	9.67 r	7.44 u				2.89 u	3.11 s	2.56 w			
Mean *			14.00 A	13.97 B	12.53 C				4.80 A	4.62 B	4.18 C			

*, **, *** and **** means refer to specific effect of pomegranate cvs; salinity concentration; SAR and Cl:SO4 ratio, respectively. Values within the same column or row for any of fou investigated tactors and their combinations followed by the same letter/s were not significantly different at 5% level. Capital and small letters were used for distinguishing values of eithe specific effect for each investigated factor or interaction effect of their combinations, respectively.

Table (10): Root fresh weight and Root dry weight (g.) of pomegranate transplant (rooted cutting) in response to specific and interaction effects o Pomegranate cultivars; (salt concentrations, SAR and Cl:SO4 ratio of saline irrigation water) and their combinations during 2000 & 200' seasons.

Treatments / Cultivars			Root fresh weight (g.) Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****	Root dry weight (g.) Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****
2000														
Tap water			11.33 a	10.00 d	9.70 e	10.34 A	SAR3	Low Cl	5.17 a	4.40 d	4.37 d	4.65 A	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	10.57 b	9.19 g	8.73 i	8.79 B	8.27 A	8.11 A	4.97 b	4.06 e	3.80 f	3.89 B	3.59 A	3.52 A
		High Cl	10.10 c	8.57 j	8.57 j				4.60 c	3.77 fg	3.77 fg			
	SAR 6	Low Cl	9.60 f	7.85 n	8.00 m				4.40 d	3.39 i	3.45 i			
		High Cl	9.20 g	7.40 q	7.70 o				4.10 e	3.10 l	3.30 j			
4000 ppm	SAR 3	Low Cl	9.01 h	7.00 s	7.30 r	7.22 C	SAR6	High Cl	4.03 e	2.91 m	3.10 l	3.05 C	SAR6	High Cl
		High Cl	8.35 k	6.80 u	6.90 t				3.70 g	2.80 n	2.90 m			
	SAR 6	Low Cl	8.13 l	6.50 w	6.63 v				3.53 h	2.67 o	2.72 no			
		High Cl	7.50 p	6.27 x	6.20 y				3.21 k	2.52 p	2.50 p			
6000 ppm	SAR 3	Low Cl	6.64 v	6.00 z	5.44 ^	5.54 D	7.68 B	7.83 B	2.74 no	2.40 q	2.10 t	2.17 D	3.28 B	3.36 B
		High Cl	6.30 x	5.77 \	5.11 '				2.57 p	2.28 r	1.91 u			
	SAR 6	Low Cl	5.90 [	5.27 -	4.90 a'				2.32 r	2.30 r	1.79 v			
		High Cl	5.60]	5.10 '	4.47 b'				2.21 s	1.90 u	1.53 w			
Mean *			8.33 A	7.06 B	6.89 C				3.66 A	2.96 B	2.86 C			
2001														
Tap water			13.48 a	12.01 d	11.06 g	12.19 A	SAR3	Low Cl	6.27 a	5.61 d	4.90 i	5.59 A	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	12.74 b	11.13 fg	10.03 j	10.70 B	9.98 A	9.80 A	6.01b	5.14 g	4.50 l	4.91 B	4.51 A	4.40 A
		High Cl	12.32 c	10.75 h	9.72 k				5.83 c	4.97 h	4.38 mn			
	SAR 6	Low Cl	11.71 e	10.31 i	9.33 m				5.49 e	4.73 j	4.21 o			
		High Cl	11.25 f	09.90 j	9.17 n				5.28 f	4.51 l	3.92 q			
4000 ppm	SAR 3	Low Cl	10.75 h	9.50 l	8.46 p	8.79 C	SAR6	High Cl	4.99 h	4.21 n	3.71 s	3.95 C	SAR6	High Cl
		High Cl	10.02 j	9.02 o	7.91 q				4.61 k	4.03 p	3.50 t			
	SAR 6	Low Cl	9.66 k	8.55 p	7.67 r				4.43 lm	3.81 r	3.32 v			
		High Cl	9.09 no	7.62 r	7.24 s				4.14 o	3.47 tu	3.12 x			
6000 ppm	SAR 3	Low Cl	8.51 p	7.76 qr	6.70 u	6.70 D	9.21 B	9.39 B	3.79 r	3.22 w	2.82 z	2.77 D	4.10 B	4.21 B
		High Cl	7.82 q	6.96 t	6.22 w				3.40 u	2.97 y	2.57 [			
	SAR 6	Low Cl	7.01 t	6.43 v	5.71 x				2.99 y	2.33 \	2.31 \			
		High Cl	6.32 vw	5.74 x	5.20 y				2.60 [	2.27 \	1.99]			
Mean *			10.05 A	8.90 B	8.03 C				4.60 A	3.95 B	3.48 C			

*, **, *** and **** means refer to specific effect of pomegranate cvs; salinity concentration; SAR and Cl:SO4 ratio, respectively. Values within the same column or row for any of fou investigated factors and their combinations followed by the same letter/s were not significantly different at 5% level. Capital and small letters were used for distinguishing values of eithe specific effect for each investigated factor or interaction effect of their combinations, respectively.

Table (11): Total plant fresh and dry weight (g.) of pomegranate transplant (rooted cutting) in response to specific and interaction effects of Pomegranate cultivars; (salt concentrations, SAR and Cl:SO4 ratio of saline irrigation water) and their combinations during 2000 & 2001 seasons.

Treatments		Cultivars	Total plant fresh weight (g.) Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****	Total plant dry weight (g.) Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****
2000														
Tap water			41.96 a	37.25 d	35.39 f	38.20 A	SAR3	Low Cl	13.82 a	12.44 cd	12.30 de	12.85 A	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	39.36 b	34.34 g	32.00 i	32.92 B	29.60 A	29.03 A	13.17 b	11.65 f	11.15 h	11.21 B	10.23 A	10.03 A
		High Cl	37.76 c	33.29 h	30.58 k				12.53 c	11.31 g	10.73 l			
	SAR 6	Low Cl	36.38 e	31.57 j	28.61 n				12.15 e	10.65 ij	10.04 k			
		High Cl	34.54 g	29.17 m	27.45 o				11.55 f	9.85 l	9.79 l			
4000 ppm	SAR 3	Low Cl	31.71 ij	25.27 p	24.52 q	25.10 C	SAR6	High Cl	11.02 h	8.84 n	8.96 n	3.95 C	SAR6	High Cl
		High Cl	30.51 k	24.01 r	23.18 s		27.40 B	27.97 B	10.53 j	8.33 o	8.30 o		9.46 B	9.66 B
	SAR 6	Low Cl	29.65 l	22.29 t	21.67 u				10.14 k	7.81 p	7.84 p			
		High Cl	27.16 o	20.97 v	20.22 w				9.30 m	7.35 q	7.29 q			
6000 ppm	SAR 3	Low Cl	23.22 s	18.75 y	17.07 [	17.78 D			8.21 o	6.79 s	6.30 u	6.50 D		
		High Cl	21.62 u	18.10 z	15.85]				7.89 p	6.64 t	5.99 v			
	SAR 6	Low Cl	20.42 w	16.26 \	14.44 -				7.27 q	6.21 u	5.37 x			
		High Cl	19.50 x	15.21 ^	12.89 '				7.04 r	5.61 w	4.73 y			
Mean *			30.29 A	25.11 B	23.37 C				10.36 A	8.73 B	8.37 C			
2001														
Tap water			42.83 a	40.07 b	38.20 d	40.37 A	SAR3	Low Cl	14.84 a	14.20 b	13.29 e	14.11 A	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	40.21 b	37.94 de	35.28 h	35.61 B	32.00 A	31.50 A	14.08 c	13.04 f	12.24 h	12.36 B	11.23 A	11.04 A
		High Cl	39.06 c	36.95 f	33.49 j				13.73 d	12.65 g	11.64 i			
	SAR 6	Low Cl	37.65 e	35.01 h	32.45 k				13.23 e	12.16 h	10.96 j			
		High Cl	35.71 g	33.83 i	29.66 n				12.68 g	11.74 i	10.21 n			
4000 ppm	SAR 3	Low Cl	32.56 k	30.23 m	26.45 r	27.39 C	SAR6	High Cl	11.65 i	10.45 m	9.48 p	9.76 C	SAR6	High Cl
		High Cl	30.57 l	28.65 o	25.01 s		29.71 B	30.21 B	10.83 k	9.98 o	8.92 q		10.43 B	10.63 B
	SAR 6	Low Cl	29.50 n	27.25 q	24.06 u				10.64 l	9.48 p	8.57 r			
		High Cl	27.61 p	24.61 t	22.13 x				10.17 n	8.86 q	8.11 t			
6000 ppm	SAR 3	Low Cl	24.77 st	22.43 w	19.48 \	20.06 D			8.97 q	7.93 u	7.01 x	7.09 D		
		High Cl	23.12 v	21.07 z	18.41 ^				8.21 s	7.45 w	6.58 z			
	SAR 6	Low Cl	21.54 y	20.13 [	16.90 -				7.64 v	6.69 y	5.97 \			
		High Cl	19.01]	18.68 ^	15.19 -				6.71 y	6.46 [	5.45 ^			
Mean *			31.09 A	28.99 B	25.90 C				11.03 A	10.08 B	9.11 C			

*, **, *** and **** means refer to specific effect of pomegranate cvs; salinity concentration; SAR and Cl:SO4 ratio, respectively. Values within the same column or row for any of fou investigated factors and their combinations followed by the same letter/s were not significantly different at 5% level. Capital and small letters were used for distinguishing values of eithe specific effect for each investigated factor or interaction effect of their combinations, respectively.

Also, in this regard, **Strogonov, (1962)** attributed the depressive effect of salinity on growth to the disturbance in metabolic pathway of plants as a result of the adverse effect of salts on enzymatic activities. While, **Delane *et al.*, (1982)** indicated that reduction in plant height, fresh and dry weights of plants is located in the photo-synthetic or the growing tissues, and that in either cases, the inhibition could be arised from the adverse effect of Na^+ and Cl^- ions on metabolism or from disturbed water relations.

IV-II. Effect of salt concentrations, sodium adsorption ratio (SAR) and chloride level (Cl: SO_4 ratio) in irrigation water on some leaf physiological measurements of three pomegranate cultivars:

IV.II.1. Effect on leaf relative turgidity percent (L.R.T.):

A) Specific effect:

Concerning the specific effect of the different investigated factors involved in this study i.e., pomegranate cultivars; salinity concentration; SAR and chloride level (Cl: SO_4 ratio) on leaf relative turgidity percent, data as shown from **Table (12)** revealed that Manfalouty cultivars transplants exhibited statistically the greatest value of leaf relative turgidity while Wardy transplants was the inferior in both seasons. As for the specific effect of salinity concentration, it was quite evident that leaf relative turgidity % decreased significantly with raising salt concentration in the irrigation water during two seasons. These findings are in harmony with those obtained by **Bernstein, (1961)** on various plants; **Fenn *et al.*, (1970)** on avocado trees and **El-Hefnawy, (1986)** on guava seedlings.

Regarding the specific effect of SAR, data as shown from **Table (12)** revealed that the higher ratio of SAR 6 decreased significantly the leaf relative turgidity than the lower one i.e., SAR 3 during the two seasons of study.

As for the specific effect of the Cl: SO_4 ratio of saline solutions used for irrigation on the leaf relative turgidity, it could be observed from data in **Table (12)** that the higher ratio resulted in a significant decrease in leaf relative turgidity during the study.

B) Interaction effect:

Referring the interaction effect of the different combinations between four investigated factors i.e. pomegranate cultivars; salinity concentration; SAR and Cl: SO_4 ratio on the leaf relative turgidity, **Table (12)** shows a considerable and statistical effect in both seasons of study. Herein, the least leaf relative turgidity value was always in concomitant to the irrigated Wardy transplants with 6000 ppm saline solution of SAR 6 and higher Cl: SO_4 ratio. Moreover, other combinations of 6000 ppm saline solution followed in an increasing order the aforesaid combination. On the contrary, the lowest decrease in the value of leaf relative turgidity below control (tap water irrigation), was detected by Manfalouty rooted cuttings irrigated with 2000 ppm saline solution of SAR 3 and lower Cl: SO_4 ratio as compared with either control or other combinations during 2000 and 2001 seasons. In addition, other combinations were in between the aforesaid two extremes. The obtained results are confirmed by the findings of **Osman (2005)** on apple rootstocks and **Hassan (2005)** on olive.

IV.II.2. Effect on leaf osmotic pressure (L.O.P):

A) Specific effect:

Concerning the specific effect of different factors involved in this study i.e. (pomegranate cultivars; salinity concentration; SAR and Cl: SO_4 ratio) on the leaf osmotic pressure (atm), data obtained in **Table (12)** clearly show that Manfalouty cultivars has the highest value of leaf osmotic pressure significantly followed in a decreasing order by Nab El-Gamal and Wardy transplants which ranked second and last, respectively during two seasons of study.

Referring the specific effect of salt concentration on leaf osmotic pressure, it is quite clear from the present results in **Table (12)** that a significant positive relationship was detected between such character and salts concentration in irrigation water. Herein, the leaf osmotic pressure increased significantly with increasing salt concentration in the irrigation water from 0.0 (tap water) up to 6000 ppm during both seasons of study.

Analogous results were obtained by **Ayers, (1950); Bernstein, (1961)** in various plants; **Lioyd and Howie, (1989)** on Navel orange; **Abd El-Karim, (1997)** on three grapevine cultivars and **Abo El-Khashab, (1997)** on peach and olive. In this concern, **Hayward** and **Wadleigh, (1949)** reported that the tolerance of plant to salt depends on its ability to regulate the intake of ions so as to affect the increase in osmotic pressure without excessive accumulation of such absorbed ions. **Slatyer, (1961)** and **Bernstein, (1961 & 1975)** indicated that when plants are exposed to osmotic substances, a sufficient amount of the substrate is absorbed to increase the internal osmotic pressure by an amount equal to the increase in substrate O.P.

Table (12): Leaf relative turgidity (%) and Osmotic pressure of pomegranate transplants (rooted cuttings) in response to specific and interaction effects of Pomegranate cultivars; (salt concentrations, SAR and Cl: SO4 ratio of saline irrigation water) and their combinations during 2000 & 2001 seasons.

Treatments		Cultivars	L.R.T. (%) Manfalouty	L.R.T. (%) Nab El-Gamal	L.R.T. (%) Wardy	L.R.T. (%) Mean**	L.R.T. (%) Mean***	L.R.T. (%) Mean****	O.P. Manfalouty	O.P. Nab El-Gamal	O.P. Wardy	O.P. Mean**	O.P. Mean***	O.P. Mean****
2000														
Tap water			77.23 a	76.81 a	73.02 d	75.69A	SAR3	Low Cl	9.01 w	7.90 \	8.27 z	8.40 D	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	75.69 b	73.93 c	71.75 e				9.31 v	8.21 [	8.51 y			
		High Cl	73.66 c	71.83 e	69.34 g	70.68 B	67.34 A	66.75 A	9.95 s	8.70 x	9.26 v	9.58 C	10.06 B	10.21 B
	SAR 6	Low Cl	71.94 e	69.16 g	68.36 h				10.41 p	9.84 t	9.54 u			
		High Cl	70.38 f	67.81 i	64.33 l		SAR6	High Cl	11.03 n	10.32 q	9.92 s		SAR6	High Cl
4000 ppm	SAR 3	Low Cl	68.63 h	64.65 l	62.73 m				11.31 l	10.65 o	10.12 r			
		High Cl	67.20 j	61.54 n	60.32 p	62.60 C			11.56 j	11.09 m	10.33 q	11.18B		
	SAR 6	Low Cl	66.10 k	61.34 no	59.04 qr				11.88 h	11.43 k	10.61 o			
		High Cl	64.74 l	58.83 r	56.10 t		64.42 B	65.02 B	12.17 f	11.92 h	11.06 mn		10.67A	10.52 A
6000 ppm	SAR 3	Low Cl	62.54 m	56.71 s	54.36 u				12.39 e	12.07 g	11.26 l			
		High Cl	61.01 o	54.62 u	51.68 v	54.56 D			12.57 d	12.37 e	11.45 k	12.31A		
	SAR 6	Low Cl	59.41 q	52.06 v	49.33 x				12.72 c	12.78 b	11.72 i			
		High Cl	54.66 u	51.09 w	47.22 y				13.15 a	13.15 a	12.09 g			
Mean *			67.17 A	63.88 B	60.58 C				11.34 A	10.80 B	10.32 C			
2001														
Tap water			75.12 a	72.99 b	74.84 a	74.32A	SAR3	Low Cl	10.50 o	9.987 q	9.277 r	9.92D	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	74.67 a	70.69 c	72.95 b				10.53 o	10.07 q	9.970 q			
		High Cl	70.46 c	70.42 c	70.46 c	68.53B	65.72 A	64.76 A	10.86 n	10.81 n	10.31 p	10.82C	11.17 B	11.28 B
	SAR 6	Low Cl	63.37 g	67.76 d	67.63 d				11.23 l	11.00 m	10.61 o			
		High Cl	67.10 d	64.67 f	62.22 hi		SAR6	High Cl	11.99 i	11.51 k	10.93 mn		SAR6	High Cl
4000 ppm	SAR 3	Low Cl	65.37 e	62.88 gh	60.09 l				12.06 i	11.70 j	11.06 m			
		High Cl	64.32 f	60.82 k	58.52 m	60.23C			12.11 hi	12.03 i	11.49 k	11.94B		
	SAR 6	Low Cl	61.10 jk	61.74 ij	55.34 p				12.12 hi	12.21 h	11.73 j			
		High Cl	61.01 jk	57.28 no	54.30 q		62.39 B	63.35 B	12.20 h	12.43 fg	12.10 hi		11.63 A	11.52 A
6000 ppm	SAR 3	Low Cl	59.71 l	57.06 o	52.68 r				12.48 fg	12.66 e	12.23 h			
		High Cl	57.95 mn	52.01 r	50.32 t	53.14D			12.75 e	13.10 cd	12.36 g	12.92A		
	SAR 6	Low Cl	55.32 p	51.05 s	48.88 u				13.01 d	13.97 b	12.50 f			
		High Cl	54.55 q	50.05 t	48.12 v				13.15 c	14.17 a	12.68 e			
Mean *			63.85 A	61.49 B	59.72 C				11.97 A	11.92 B	11.33 C			

*, **, *** and **** means refer to specific effect of pomegranate cvs; salinity concentration; SAR and Cl:SO4 ratio, respectively. Values within the same column or row for any of fou investigated factors and their combinations followed by the same letter/s were not significantly different at 5% level. Capital and small letters were used for distinguishing values of eithe specific effect for each investigated factor or interaction effect of their combinations, respectively.

Abd El-Rahman *et al*., (1971) working on 8 orange cultivars reported that the increase in concentration of the external solution was accompanied by an increase in salt accumulation and total osmotic pressure of cell sap.

Referring the specific effect of SAR, it was quite clear that the higher ratio i.e., 6 resulted significantly increasing significantly the leaf osmotic pressure of pomegranate transplants, than the lower one i.e. SAR 3 during two seasons of study.

As for the specific of the chloride level (Cl: SO_4 ratio of saline solution used for irrigation on the leaf osmotic pressure, it could be noticed from data in **Table (12)** that the higher ratio caused a significant increase in leaf osmotic pressure value than the lower ratio during two seasons of study.

B) Interaction effect:

Regarding the interaction effect of the four investigated factors i.e., pomegranate cultivars; salinity concentration x SAR x Cl: SO_4 ratio on leaf osmotic pressure, data obtained in **Table (12)** showed obviously a variable response in leaf osmotic pressure of pomegranate rooted cuttings as related to the different combinations of four investigated factors during two seasons. The least increase in leaf osmotic pressure was found by such combinations representing transplants of 3 cultivars irrigated with the lowest saline solution (2000 ppm) of SAR 3 and lower Cl: SO_4 ratio as transplants of each cultivar were compared to the analogous ones continuously irrigated with tap water. Moreover, other combinations of 2000 ppm saline solution ranked second in an increasing order. On the other hand, the highest increase in leaf osmotic pressure was detected by Nab-El-Gamal transplants irrigated with 6000 ppm saline solution of SAR 6 and higher Cl: SO_4 ratio either compared to those continuously irrigated with tap water or supplied with other saline solutions during 2000 and 2001 seasons. In addition, other combinations were in between the aforesaid two extremes. The obtained results are confirmed by the findings of **Osman (2005)** on apple rootstocks and **Hassan (2005)** on olive.

IV.II.3. Effect on transpiration rate (T.R.):

A) Specific effect:

Regarding the specific effect of pomegranate cultivars; salinity concentration; SAR and Cl: SO_4 ratio on transpiration rate, **Table (13)** clearly shows that Wardy transplants had the greatest value of transpiration rate while the reverse was true with Manfalouty cultivar transplants.

The obtained results in **Table (13)** revealed that salinizing irrigation water with $CaCl_2$, $MgSO_4$, KCl, K_2SO_4 and NaCl at different concentrations significantly affected transpiration rate. To clarify this, it was noticed that transpiration rate decreased with increasing salts concentration to reach its minimum value at the high salts concentration i.e. 6000 ppm during 2000 and 2001 seasons. However, the 2000 ppm saline solution exhibited the lowest decrease. In addition, the 4000 ppm concentration was intermediate in this concern. Moreover, the differences were significant either three salinity concentrations were compared each other or to control (tap water) during two seasons of study.

These results are confirmed by the findings of **Ragab, (1979)** on citrus seedlings; **Walker *et al.*, (1979)** on guava trees; **Beshir, (1982)** on sultani fig transplants; **El-Hefnawy, (1986)** on guava seedlings; **El-Hawary, (1987); Gaser, (1992); Abd-El-Karim, (1997)** on grapevine rootstocks and **Valia** and **Patiel, (1997)** on Cashew seedlings, all pointed out that salt treatments strongly inhibited transpiration rate compared with untreated plants.

Concerning the specific effect of SAR, data as shown from **Table (13)** revealed that the higher ratio of SAR6 significantly decreased the transpiration rate than the lower one i.e., SAR3 during two seasons of study.

As for the specific effect of the chloride level (Cl: SO_4 ratio) of saline solution used for irrigation on transpiration rate value it could be noticed from data in **Table (13)** that the higher ratio resulted in a significant decrease in transpiration rate than the lower one during study.

B) Interaction effect:

Table (13) indicates a significant variances due to interaction effect of various combinations between pomegranate cultivars; salinity concentration; SAR and Cl: SO_4 ratios on leaf transpiration rate. Anyhow, three cultivars irrigated with 2000 ppm saline water of SAR 3 and low level of Cl: SO_4 ratio, which didn't significantly vary than the analogous ones irrigated with tap water as transplants of each cv. were compared separately. Moreover other combinations of the same cultivar from one hand and 2000 ppm saline solution (irrespective of SAR of Cl: SO_4 ratios) in an increasing order ranked statistically 2nd and /or 3rd during two seasons of study.

On the contrary, the greatest decrease in the leaf transpiration rate was detected by irrigated Manfalouty cultivars plants with 6000 ppm saline solutions of SAR 6 and higher Cl: SO_4 ratio as compared with either plants irrigated with tap water or those supplied with any other saline solution during two seasons of study. In addition, other combinations were in between the aforesaid two extremes. The obtained results are confirmed by the findings of **Osman (2005)** on apple rootstocks and **Hassan (2005)** on olive.

IV.II.4. Effect on leaf water potential (L.W.P):

A) Specific effect:

Concerning the specific effect of the different factors involved in this study i.e., pomegranate cultivars, salinity concentration, sodium adsorption ratio (SAR) and chloride level (Cl:SO_4 ratio) on the leaf water potential, **Table (13)** shows that Manfalouty cultivar plants had significantly the highest value followed in a descending order by Nab El-Gamal and Wardy transplants. Differences between 3 cultivars were significant as compared each other during 2000 and 2001 seasons.

Regarding the specific effect of salinity concentration, data obtained revealed that all investigated saline solutions (2000, 4000 and 6000 ppm) resulted significantly in an obvious decrease in leaf water potential during two seasons. The decrease in leaf water potential was gradually increased with raising salinity concentration. Differences were significant either 3 concentrations were compared each other or to those of tap water irrigated transplants. Consequently, the most depressive effect was always in concomitant to the highest concentration i.e. 6000 ppm, while 2000 ppm saline solution exhibited the lowest decrease during both seasons of study. These results are in coincidence with the findings of **Divate** and **Pandey, (1979)** on grapevine; **Beshir, (1982)** on fig transplants; **Hatem, (1984)** on grapevine; **El-Hefnawy, (1986)** on guava plants; **Stevens** and **Harvey, (1990)** on grapevine and **Nieves *et al.*, (1991)** on citrus. In this concern, **Stevens** and **Harvey, (1990)** proved that increasing salinity caused a decline in leaf water potential. However, **Kaul, (1981)** on guava plants found that salt stress reduced plant water status (especially with SO_4), and increased leaf diffusive resistance.

With respect to the specific effect of sodium adsorption ratio (SAR), it is quite clear that increasing SAR from 3 to 6 in saline irrigation water used resulted significantly in depressing the leaf water potential (L.W.P) during two seasons of study.

As for the specific effect of the Cl: SO_4 ratio of saline solution used for irrigation on leaf water potential, it could be noticed from data in **Table (13)** that the higher ratio decreased it significantly below those of lower Cl: SO_4 ratio during 2000 and 2001 seasons.

B) Interaction effect:

Referring the interaction effect of the four investigated factors i.e., pomegranate cultivars; salinity concentration; SAR and Cl: SO_4 ratio on leaf water potential, data obtained in **Table (13)** showed significantly an obvious response to the different investigated combinations during two seasons. The most depressive effect on leaf water potential was exhibited by such combination represented

Table (13): Transpiration rate (T.R) and leaf water potential (L.W.P.) of pomegranate transplants (rooted cuttings) in response to specific and interactio effects of Pomegranate cultivars; (salt concentrations, SAR and Cl:SO4 ratio of saline irrigation water) and their combinations during 2000 & 2001 seasons.

Treatments		Cultivars	Transpiration rate (T.R) Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****	Leaf water potential (L.W.P.) Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****
2000														
Tap water			0.201 a-c	0.204 ab	0.208 a	0.205A	SAR3	Low Cl	81.56 a	78.27 f	74.87 j	78.23 A	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	0.199 bc	0.199 bc	0.205 ab	0.175B	0.155A	0.149A	80.86 b	77.32 g	73.97 kl	76.68 B	74.56 A	74.15 A
		High Cl	0.181 d	0.166 e	0.201 a-c				80.51 c	76.67 h	73.78 l			
	SAR 6	Low Cl	0.156 fg	0.149 gh	0.193 c				80.23 d	76.53 h	72.73 n			
		High Cl	0.136 ij	0.140 i	0.175 d				80.00 d	75.82 i	71.72 p			
4000 ppm	SAR 3	Low Cl	0.121 lm	0.130 jk	0.163 ef	0.123C	SAR6	High Cl	78.70 e	75.82 i	71.96 p	73.93 C	SAR6	High Cl
		High Cl	0.111 n	0.121 lm	0.153 gh				78.07 f	74.07 k	71.32 q			
	SAR 6	Low Cl	0.092 p	0.114 mn	0.148 h		0.135B	0.140B	77.54 g	73.07 m	69.53 t		72.62 B	73.03 B
		High Cl	0.086 pq	0.102 o	0.133 ij				76.57 h	72.42 o	68.09 v			
6000 ppm	SAR 3	Low Cl	0.077 rs	0.085 p-r	0.123 kl	0.077D			73.15 m	70.38 r	65.79 x	65.52 D		
		High Cl	0.068 tu	0.072 st	0.111 n				70.04 s	67.98 v	59.64 [			
	SAR 6	Low Cl	0.045 w	0.062 uv	0.099 o				68.66 u	65.29 y	58.62 \			
		High Cl	0.035 x	0.06 v	0.082 qr				66.69 w	62.11 z	57.88]			
Mean *			0.116 C	0.123 B	0.153 A				76.35 A	72.75 B	68.45 C			
2001														
Tap water			0.210 c	0.213 bc	0.220 a	0.211A	SAR3	Low Cl	79.74 a	78.72 c	78.66 cd	79.04 A	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	0.200 d	0.200 d	0.217 ab	0.184B	0.164A	0.159A	79.23 b	78.37 d	77.76 e	77.25 B	76.00 A	75.69 A
		High Cl	0.190 e	0.177 f	0.210 c				78.57 cd	77.84 e	76.74 g			
	SAR 6	Low Cl	0.170 g	0.160 h	0.200 d				77.90 e	76.38 h	75.86 i			
		High Cl	0.147 i	0.150 i	0.190 e				77.38 f	75.77 i	75.13 jk			
4000 ppm	SAR 3	Low Cl	0.130 kl	0.140 j	0.170 g	0.132C	SAR6	High Cl	76.58 gh	75.08 kl	73.87 o	74.11 C	SAR6	High Cl
		High Cl	0.120 m	0.130 kl	0.167 g				76.36 h	75.01 kl	72.12 q			
	SAR 6	Low Cl	0.100 o	0.127 l	0.157 h		0.145B	0.150B	75.39 j	74.80 lm	71.02 s		74.64 B	74.95 B
		High Cl	0.097 o	0.110 n	0.140 j				74.87 k-m	73.64 o	70.52 t			
6000 ppm	SAR 3	Low Cl	0.090 p	0.097 o	0.133 k	0.086D			74.70 mn	72.82 p	69.74 u	70.88 D		
		High Cl	0.080 q	0.080 q	0.120 m				74.60 mn	71.75 r	68.57 v			
	SAR 6	Low Cl	0.057 s	0.073 r	0.100 o				74.44 n	70.52 t	67.85 w			
		High Cl	0.047 t	0.070 r	0.090 p				73.61 o	67.25 x	64.71 y			
Mean *			0.126 C	0.133 B	0.163 A				76.41 A	74.46 B	72.50 C			

*, **, *** and **** means refer to specific effect of pomegranate cvs; salinity concentration; SAR and Cl:SO4 ratio, respectively. Values within the same column or row for any of fou investigated factors and their combinations followed by the same letter/s were not significantly different at 5% level. Capital and small letters were used for distinguishing values of eithe specific effect for each investigated factor or interaction effect of their combinations, respectively.

the irrigated Wardy transplants with saline solution of the highest salinity concentration (6000 ppm); SAR 6 and higher Cl: SO_4 ratio, where the lowest value of leaf water potential was resulted. Moreover, other combinations of irrigated Wardy transplants with 6000 ppm saline solution ranked second in an increasing order. On the other hand, the lowest decrease in the leaf water potential % below control was detected by Manfalouty rooted cuttings irrigated with 2000 ppm saline solution of SAR 3 and lower Cl: SO_4 ratio as compared to the analogous ones of the same cultivar but continuously irrigated with tap water during 2000 and 2001 seasons. In addition, other combinations were in between the aforesaid two extremes. The obtained results are confirmed by the findings of **Osman (2005)** on apple rootstocks and **Hassan (2005)** on olive.

IV.II.5. Effect on leaf succulence grade (L.S.G.):

Data obtained during both seasons of 2000 and 2001 regarding the response of leaf succulence grade (H_2O in g/Dcm^2 leaf area) to specific and interaction effects of pomegranate cultivar; salt concentration; SAR; Cl: SO_4 ratio and their combinations are presented in **Table (14).**

A) Specific effect:

Concerning the specific effect of the different factors involved in this study i.e., pomegranate cultivars; salinity concentration; SAR and chloride level (Cl: SO_4 ratio) on leaf succulence grade, data obtained in **Table (14)** showed that Manfalouty cultivar transplants had significantly the highest value of leaf succulence grade. However, both Nab El-Gamal and Wardy cultivars slowed similar values and ranked statistically 2nd during two seasons.

Regarding the specific effect of salt concentration, **Table (14)** shows that leaf succulence grade in pomegranate rooted cuttings was significantly affected by salt concentration. In this regard leaf succulence grade decreased significantly with increasing salts concentration in the irrigation water during the two seasons of study. These results are in accordance with those obtained by **El-Hefnawy, (1986)** on guava seedlings and **Nomir, (1994)** on kaki plants

Referring the specific effect of sodium adsorption ratio (SAR), data obtained revealed that increasing it from 3 to 6 slightly decreased the leaf succulence grade during both 2000 and 2001 experimental seasons.

As for the specific effect of chloride level (Cl : SO_4 ratio) of saline solution used for irrigation on leaf succulence grade, it could be noticed from data in **Table (14)** that the higher Cl: SO_4 ratio decreased it slightly during both seasons.

B) Interaction effect:

Concerning the interaction effect of the different combinations between four investigated factors i.e., pomegranate cultivars; salinity concentration; sodium adsorption ratio (SAR) and chloride level (Cl: SO_4 ratio) on leaf succulence grade, data obtained in **Table (14)** showed obviously a considerable variances during 2000 and 2001 seasons. The combination of irrigated transplants of both Wardy and Nab-El-Gamal rooted cuttings with saline solution of 6000ppm; regardless of neither SAR nor Cl: SO_4 ratio showed in general the least values of leaf succulence grade. On the contrary the highest leaf succulence grade was always in concomitant to Manfalouty cultivar transplants coniniously irrigated with tap water, followed by the transplants representing the combinations between the same pomegranate cultivar irrigated with 2000 ppm saline solution; regardless of SAR or Cl: SO_4 ratios. Such trend was true during both 2000 and 2001 experimental seasons, however the combinations of the lower levels of Cl: SO_4 and SAR ratios tended to show higher values of L.S.G., especially during the second season. In addition, other combinations are in between the aforesaid two extremes. The obtained results are confirmed by the findings of **Osman (2005)** on pomegranate transplant and **Hassan (2005)** on olive.

IV.II.6. Effect on hard leaf character (H.L.C.):

A) Specific effect:

Referring the specific effect of the pomegranate cultivars; salt concentration, SAR and Cl: SO_4 ratio on hard leaf character (H. L. C), **Table (14)** clearly shows that Wardy transplants had statistically the greatest value of hard leaf character (H.L.C) especially during 1^{st} season as compared to two other cultivars. Meanwhile, both Manfalouty and Nab El-Gamal cultivars, didn't vary significantly by during two seasons of study.

With regard to the specific effect of salt concentration, data obtained during both seasons revealed that all three investigated (2000, 4000 and 6000ppm) saline solutions resulted in an obvious increase in values of hard leaf character (H.L.C). Such increase was gradually raised with increasing salt concentration in the irrigation water from 2000ppm to 6000ppm. Differences between 3 saline concentrations (2000; 4000 and 6000 ppm) were significant either compared each other or to non salinized water during two seasons of study, with unique except ion in 1st season when control was compared to the lowest concentration (2000 ppm).

With respect to the specific effect of sodium absorption ratio (SAR), data in **Table (14)** showed that increasing it from 3 to 6 in irrigation water increased relatively value of hard leaf character where differences was significant during 1st season only.

Regarding the specific effect of chloride levels (Cl : SO^4 ratio) of saline solution used for irrigation on the value of hard leaf character (H.L.C), in **Table (14)** shows that the hard leaf character (H.L.C) was slightly increased by increasing Cl: SO_4 ratio during the two experimental seasons.

B) Interaction effect:

Concerning the interaction effect of various combinations between; pomegranate cultivars; salt concentration; SAR and Cl: SO_4 ratio on the value of hard leaf character (H.L.C), data are presented in **Table (14).** It is quit clear that a variable response to the different combinations was detected during the two seasons. The highest hard leaf character (H.L.C) was detected by Wardy transplants irrigated with 6000 ppm saline solution regardless of SAR and Cl: SO_4 ratio, while the lowest value of hard leaf character (H.L.C.) was detected by irrigated transplants with saline solutions at 2000 ppm regardless of pomegranate cultivar or ratios of both SAR and Cl: SO_4, whereas all such combinations didn't significantly varied in most cases than those continuously supplied

Table (14): Leaf succulence grade (L.S.G.) and Hard leaf character (H.L.C.) of pomegranate transplants (rooted cuttings) in response to specific anc interaction effects of Pomegranate cultivars; (salt concentrations, SAR and Cl:SO4 ratio of saline irrigation water and their combination: during 2000 & 2001 seasons.

Treatments / Cultivars			Leaf succulence grade (L.S.G.) Mantalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****	Hard leaf character (H.L.C.) Mantalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****
2000														
Tap water			0.01027 a	0.00830b-c	0.007767 c-g	0.00876 A	SAR3	Low Cl	0.002333 hi	0.002300 i	0.002600 f-i	0.00241 B	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	0.00973 ab	0.00766c-g	0.007367 e-i				0.002300 i	0.002267 i	0.002600 f-i			
		High Cl	0.00960 a-c	0.00753d-h	0.007400 e-i	0.00812 B	0.00770 A	0.00768 A	0.002300 i	0.002300 i	0.002600 f-i	0.00243 B	0.00258 B	0.00263 A
	SAR 6	Low Cl	0.00943 a-d	0.00750d-h	0.007300 f-j				0.002300 i	0.002300 i	0.002700 e-i			
		High Cl	0.00933 a-e	0.00736e-i	0.007167 f-k				0.002300 i	0.002367 hi	0.002800 e-i			
4000 ppm	SAR 3	Low Cl	0.00846 a-f	0.00717f-k	0.007200 f-k		SAR6	High Cl	0.002300 i	0.002300 i	0.002800 e-i		SAR6	High Cl
		High Cl	0.00816 b-g	0.00657f-k	0.006833 f-k	0.00722 C			0.002267 i	0.002300 i	0.002733 e-i	0.00253 B		
	SAR 6	Low Cl	0.00820 b-g	0.00650f-k	0.006767 f-k				0.002367 hi	0.002400g-i	0.00300 d-g			
		High Cl	0.00770 c-g	0.00640g-k	0.006667 f-k				0.002367 hi	0.002433g-i	0.00313 c-f			
6000 ppm	SAR 3	Low Cl	0.00730 f-j	0.00637g-k	0.006667 f-k		0.00743 A	0.00745 A	0.002700 e-i	0.002700e-i	0.00346a-d		0.00273 A	0.00268 A
		High Cl	0.00653 f-k	0.00630g-k	0.005400 i-k	0.00616 D			0.002800 e-i	0.00297d-h	0.00367a-c			
	SAR 6	Low Cl	0.00553 f-k	0.00626g-k	0.005333 jk				0.002967 d-h	0.00330a-e	0.00377 ab	0.00323 A		
		High Cl	0.00633 g-k	0.00563h-k	0.005267 k				0.003200 b-f	0.00343a-d	0.003800 a			
Mean *			0.00827 A	0.006888 B	0.006702 B				0.002500 B	0.002566 B	0.039663 A			
2001														
Tap water			0.008867 a	0.008400 a-c	0.008367 a-c	0.00854 A	SAR3	Low Cl	0.002246 h	0.002277 gh	0.002275 gh	0.00227 D	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	0.008800 a	0.008333 a-c	0.008000 a-e				0.002309 f-h	0.002298 gh	0.002291 gh			
		High Cl	0.008700 ab	0.008267 a-d	0.007967 a-e	0.00828 AB	0.00809 A	0.00805 A	0.002379 e-h	0.002352f-h	0.002410 d-h	0.00244 C	0.00254 A	0.00257 A
	SAR 6	Low Cl	0.008600 a-c	0.008200 a-e	0.007900 a-e				0.002429 c-h	0.002536 b-h	0.002521 b-h			
		High Cl	0.008467 a-c	0.008200 a-e	0.007900 a-e				0.002481 b-h	0.002624 b-h	0.002609 b-h			
4000 ppm	SAR 3	Low Cl	0.008467 a-c	0.008167 a-e	0.007633 a-e		SAR6	High Cl	0.002586 b-h	0.002714 b-h	0.002700 b-h		SAR6	High Cl
		High Cl	0.008433 a-c	0.008167 a-e	0.007267 a-e	0.00792 B			0.002611 b-h	0.002717 b-h	0.002810 a-h	0.00276 B		
	SAR 6	Low Cl	0.008367 a-c	0.008067 a-e	0.007233 a-e				0.002732 b-h	0.002716 b-h	0.002949 a-f			
		High Cl	0.008367 a-c	0.007633 a-e	0.007233 a-e				0.002804 a-h	0.002726 b-h	0.003009 a-e			
6000 ppm	SAR 3	Low Cl	0.008300 a-c	0.007333 a-e	0.006957 a-e		0.00790 A	0.00794 A	0.002819 a-h	0.002738 b-h	0.003021 a-d		0.00266 A	0.00263 A
		High Cl	0.008300 a-c	0.007067 a-e	0.006667 b-e	0.00723 C			0.002831 a-h	0.002784 a-h	0.003061 a-c			
	SAR 6	Low Cl	0.008233 a-e	0.006733 b-e	0.006600 c-e				0.002833 a-h	0.002825 a-h	0.003114 ab	0.00295 A		
		High Cl	0.008067 a-e	0.006267 de	0.006233 e				0.002896 a-g	0.003046 a-d	0.003387 a			
Mean *			0.008459 A	0.007756 B	0.007382 B				0.002781 AB	0.002642 B	0.002881 A			

*, **, *** and **** means refer to specific effect of pomegranate cvs; salinity concentration; SAR and Cl:SO4 ratio, respectively. Values within the same column or row for any of fou investigated factors and their combinations followed by the same letter/s were not significantly different at 5% level. Capital and small letters were used for distinguishing values of eithe specific effect for each investigated factor or interaction effect of their combinations, respectively.

with tap water (control) during both 2000 and 2001 experimental seasons. In addition, other combinations showed intermediate values of H.L.C. as compared to the aforesaid two extremes. The obtained results are confirmed by the findings of **Osman (2005)** on apple rootstocks and **Hassan (2005)** on olive.

IV.III. Effect of pomegranate cultivars; salts concentration; sodium adsorption ratio (SAR) and chloride level (Cl: SO_4 ratio) in irrigation water on some chemical constituents:

IV.III.1. Effect on leaves photosynthetic pigments (chlorophyll a, b and carotein contents):

Data obtained during 2000 and 2001 seasons regarding the specific and interaction effects of the four investigated factors (pomegranate cultivars; salinity concentration; SAR and Cl: SO_4 ratio) in irrigation water on leaves chlorophyll a, b and carotein contents are presented in **Table (15)**.

A) Specific effect:

Concerning the specific effect of the different factors involved in this study i.e., pomegranate cultivars; salts concentration; SAR and chloride level (Cl: SO_4 ratio) on the leaf chlorophyll a, b and carotein contents, **Table (15)** shows that Manfalouty cultivar plants had the highest values of chlorophyll (a), (b) and carotein contents, followed in a decreasing order by Nab El-Gamal and Wardy transplants during two seasons of study. In this respect, **Noamen *et al.*, (1994)** on pomegranate transplants, **Gaser, (1992)** on some grapevine rootstock found that salinity greatly affected photosynthesis, via inhibiting chlorophyll pigment formation, where the most sensitive rootstocks i.e. St. George and Coudere 1202 accumulated the lowest amounts of chlorophyll A and B and carotenoids compounds.

Regarding the specific effect of salinity concentration on chlorophyll (a), (b) and carotein, data obtained revealed that all investigated three saline solutions (2000, 4000 and 6000 ppm) resulted in an obvious decrease in leaf chlorophyll A and B, as well as carotein contents of three pomegranate cultivars during the two seasons of study. Such decrease was significant as compared with those of tap water (control) irrigated rooted cuttings.

On other hand, the most depressive effect was always in concomitant to the highest concentration i.e., 6000 ppm during both 2000and 2001 seasons of study. However, the 2000 ppm saline solution exhibited the lowest decrease in both chlorophyll A, B and carotein contents. Meanwhile, the 4000 ppm concentration was intermediate in this concern, whereas. Differences between the three salinity concentrations were significant as each was compared to the two other ones regarding leaf chlorophyll A, B and carotein contents during 2000 and 2001 seasons. Thus, it could be stated that salinity reduced severely the photosynthetic pigments content in leaf. These results are coincided with the findings of **Noaman** ***et al.*****, (1994)** on pomegranate, **Pandey** and **Divate, (1976)** and **Salem, (1981)** on grape who mentioned that salinity decreased leaf chlorophyll content. **Hatem, (1984)** reported that, green pigments content (chlorophyll A and B) and caroteinoids in the salt treated Rome grape plants grown in calcareous soil, decreased with increasing salinity. **Attia, (1994)** found that leaf total chlorophyll content in both apple and olive transplants was significantly depressed by rising the salts concentrations.

Kabeel, (1985) stated that the salt concentrations in irrigation water decreased significantly total chlorophyll content as compared with those of the control (tap water irrigated seedlings of some fruit spp.).

Abo-El-Khashab, (1997) found that chlorophyll a, b and carotein were decreased in olive and peach seedlings irrigated with saline water. The same trend was found by **Mohamed, (1997)** on bitter almond and Nemaguard peach rootstock, **Abbas, (1999)** and **Attia, (2002)** on olive plants.

Concerning the specific effect of sodium adsorption ratio(SAR), it is quite clear that increasing SAR from 3 to 6 in irrigation water resulted significantly in decreasing chlorophyll a and b and carotein during two seasons of study. Similar observations were also found by **Noaman *et al.*, (1994)** on pomegranate transplants; **Kabeel, (1985)** on grape, peach and Plum, **Omar, (1996)** on peach and mango seedlings and **Abd El-Mageid, (1998)** on almond seedlings.

As for the specific effect of chloride level ($Cl:SO_4$) of saline solution used for irrigation water on pomegranate leaf chlorophyll a, b and carotein contents, **Table (15)** shows that the higher ratio (increasing the level of chloride in irrigation water) resulted in a significant decrease in leaves chlorophyll a, b and carotein contents during 2000 and 2001 seasons. The same findings was obtained by **Kabeel, (1985)** on three deciduous fruit species and **Abd El-Mageid, (1998)** on almond seedlings.

B) Interaction effect:

Regarding the interaction effect of different combinations between pomegranate cultivars; saline concentration; SAR and Cl: SO_4 ratio on leaf chlorophyll A, B and carotein contents, data obtained in **Table (15)** showed that chlorophyll A, B and carotein of all irrigated pomegranate cultivars transplants with saline solutions were significantly decreased as compared with control during the study.

The least level of leaf photosynthetic pigments i.e., chlorophyll (a & b) and carotein were always in closed relationship to such combination representing Wardy transplants irrigated with highest salinity concentration (6000 ppm) of SAR 6 and higher $Cl:SO_4$ ratio. Moreover, other combinations of 6000 ppm saline solution especially of Wardy transplants transplants ranked statistically second in an increasing order. On the other hand, the lowest decrease in leaves chlorophyll A, B and carotein contents below control (tap water irrigation) was exhibited by Manfalouty cultivar transplants irrigated with 2000 ppm saline solution of SAR 3 and lower $Cl:SO_4$ ratio during 2000 and 2001 seasons. These results are confirmed by those of **Kabeel, (1985)** on some deciduous fruit species, **Omar, (1996)** on both apricot and mango plants and **Abd El-Mageid, (1998)** on almond seedlings.

The decline in photosynthetic pigments content of salt-stressed plants might be due to the decrease in the a absorption of minerals needed for chlorophyll biosynthesis, i.e., iron and magnesium **Reddy, (1967)** or due to reduction of chloropyll moleculies **Polijakoff** and **Gale, (1975)** or due to inhibition of chlorophyll syntheses **Patil, *et al.*, (1984).**

Table (15): Leaf Chlorophyll (A), Chlorophyll (B) and Caroteins (mg/g f.w) of pomegranate transplant (rooted cuttings) in response to specific and interaction effects of Pomegranate cultivars; (salt concentrations, SAR and Cl: SO_4 ratio of saline irrigation water) and their combinations during 2000 & 2001 seasons.

Treatments \ Cultivars			Chlorophyll (A)				Chlorophyll (B)				Carotein			
			Manfalouty	Nab El-Gamal	Wardy	Mean**	Manfalouty	Nab El-Gamal	Wardy	Mean**	Manfalouty	Nab El-Gamal	Wardy	Mean**
2000														
Tap water			1.30 a	1.29 a	1.17 d	1.25 A	0.73 a	0.69 d	0.67 e	0.70 A	0.67 a	0.64 c	0.62 d	0.65A
2000ppm	SAR 3	Low Cl	1.28 a	1.26 b	1.16 d-f	1.16 B	0.71 b	0.67 e	0.64 g	0.65 B	0.66 b	0.63 c	0.60 e	0.59 B
		High Cl	1.21 c	1.20 c	1.14 e-g		0.70 c	0.66 f	0.62 h		0.64 c	0.60 e	0.57 f	
	SAR 6	Low Cl	1.13 f-h	1.16 de	1.09 j		0.68 d	0.64 g	0.59 j		0.63 c	0.56 g	0.54 h	
		High Cl	1.14 ef	1.12 g-i	1.06 k		0.65 g	0.61 i	0.58 j		0.56 g	0.52 j	0.51 k	
4000ppm	SAR 3	Low Cl	1.11 h-j	1.10 ij	1.03 l	1.03 C	0.60 i	0.58 j	0.57 k	0.54 C	0.53 i	0.50 l	0.49 l	0.47C
		High Cl	1.06 k	1.09 ij	0.99mn		0.58 j	0.54 m	0.55 l		0.51 k	0.47 m	0.46 n	
	SAR 6	Low Cl	1.05 k	1.05 k	0.96 o		0.54 m	0.50 o	0.52 n		0.47 m	0.45 n	0.44 o	
		High Cl	1.01 lm	0.98 n	0.88 p		0.50 o	0.49 pq	0.49 p		0.44 o	0.42 p	0.41 q	
6000 ppm	SAR 3	Low Cl	0.98 n	0.90 p	0.84 q	0.78 D	0.48 q	0.44 r	0.44 rs	0.42 D	0.42 p	0.40 rs	0.39 st	0.38D
		High Cl	0.90 p	0.78 s	0.77 s		0.43 s	0.42 tu	0.42 t		0.40 qr	0.39 st	0.37 u	
	SAR 6	Low Cl	0.80 r	0.73 t	0.67 v		0.41 uv	0.39 w	0.39 w		0.39 t	0.37 u	0.35 v	
		High Cl	0.71 u	0.69 u	0.58 w		0.40 v	0.38 x	0.37 x		0.37 u	0.35 v	0.33 w	
Mean *			1.05 A	1.03 B	0.95 C		0.57 A	0.54 B	0.53 C		0.51 A	0.49 B	0.47 C	
Mean ***			SAR 3 1.10 A		SAR 6 1.02 B		SAR 3 0.59A		SAR 6 0.56 B		SAR 3 0.54 A		SAR 6 0.50 B	
Mean ****			Low Cl: SO_4 1.08 A		High Cl: SO_4 1.04 B		Low Cl: SO_4 0.58 A		High Cl: SO_4 0.57 B		Low Cl: SO_4 0.53 A		High Cl: SO_4 0.51 B	
2001														
Tap water			1.35 a	1.33 b	1.21 g	1.30 A	0.78 a	0.71 c	0.70 c-e	0.73 A	0.69 a	0.67 b	0.67 b	0.677A
2000ppm	SAR 3	Low Cl	1.30 c	1.28 d	1.19 h	1.21 B	0.72 b	0.70 c-e	0.69 d-f	0.69 B	0.65 c	0.65 cd	0.63 e	0.61 B
		High Cl	1.24 e	1.25 e	1.18 i		0.71 cd	0.69 ef	0.68 fg		0.64 d	0.63 e	0.59 g	
	SAR 6	Low Cl	1.20 g	1.23 f	1.17 i		0.69 ef	0.69 ef	0.67 g		0.61 f	0.61 f	0.54 j	
		High Cl	1.78 i	1.15 j	1.14 kl		0.68 fg	0.66 h	0.64 i		0.60 g	0.58 i	0.52 l	
4000ppm	SAR 3	Low Cl	1.14 jk	1.13 l	1.12 m	1.07 C	0.61 jk	0.62 j	0.62 j	0.57 C	0.58 h	0.53 k	0.50 m	0.49 C
		High Cl	1.09 n	1.11 m	1.09 no		0.60 kl	0.56 m	0.59 l		0.58 i	0.52 l	0.48 p	
	SAR 6	Low Cl	1.08 o	1.09 n	0.99 q		0.56 m	0.51 op	0.56 m		0.49 n	0.48 o	0.44 s	
		High Cl	0.99 q	1.03 p	0.92 t		0.55 m	0.52 o	0.54 n		0.45 r	0.45 r	0.42 u	
6000 ppm	SAR 3	Low Cl	0.98 r	0.91 t	0.88 u	0.80 D	0.50 p	0.51 op	0.47 r	0.46 D	0.48 p	0.44 s	0.40 v	0.41 D
		High Cl	0.93 s	0.81 w	0.79 x		0.51 op	0.48 qr	0.44 s		0.46 q	0.42 u	0.39 w	
	SAR 6	Low Cl	0.84 v	0.77 y	0.70 [		0.48 q	0.42 t	0.42 t		0.43 t	0.40 vw	0.39 x	
		High Cl	0.72 z	0.70 [	0.61 \		0.44 s	0.40 u	0.39 u		0.35 z	0.39 x	0.38 y	
Mean *			1.13 A	1.06 B	1.00 C		0.60 A	0.58 B	0.57 C		0.54 A	0.52 B	0.49 C	
Mean ***			SAR 3 1.13 A		SAR 6 1.05 B		SAR 3 0.63 A		SAR 6 0.59 B		SAR 3 0.57 A		SAR 6 0.53 B	
Mean ****			Low Cl: SO_4 1.12 A		High Cl: SO_4 1.07 B		Low Cl: SO_4 0.62 A		High Cl: SO_4 0.60 B		Low Cl: SO_4 0.56 A		High Cl: SO_4 0.54 B	

*, **, *** and **** means refer to specific effect of pomegranate cvs; salinity concentration; SAR and Cl:SO4 ratio, respectively. Values within the same column or row for any of fou investigated factors and their combinations followed by the same letter/s were not significantly different at 5% level. Capital and small letters were used for distinguishing values of eithe specific effect for each investigated factor or interaction effect of their combinations, respectively.

IV.III.2. Effect on stem total carbohydrates content:

A) Specific effect:

Concerning the specific effect of the different factors involved in this study i.e., pomegranate cultivars; salt concentration; SAR and Cl: SO_4 ratio on stem total carbohydrates content, data as shown in **Table (16)** revealed that Manfalouty cultivar transplants exhibited the highest value of stem total carbohydrates in both seasons, while Wardy transplants was the poorest during two seasons of study.

Regarding the specific effect of different salts concentrations in the irrigation water on stem total carbohydrates content of pomegranate transplants, it is obvious from the results in **Table (16)** that stem total carbohydrates content decreased significantly with increasing salt concentration in the irrigation water during 2000 and 2001 seasons. Such decrease was significant within the three salts concentration of 2000, 4000 and 6000 ppm as compared to those of tap water (control) plants. These findings are in harmony with those obtained by **Nasr *et al.*, (1977)** on plum and Peach; **Aly, (1979)** on pomegranate and some fruit species; **Beshir, (1982)** on fig plants and **Lioyd** and **Howie, (1989**) on Washington Navel orange who proved that the actual amounts of carbohydrates in different plant organs were adversly affected with rising salinity level.

Regarding the specific of SAR, data as shown in **Table (16)** revealed that the higher ratio of SAR resulted significantly in decreasing the stem total carbohydrates content during two seasons of study.

As for the specific effect of the Cl: SO_4 ratio of saline solutions used for irrigation in stem total carbohydrates content, it could be observed from data in **Table (16)** that higher ratio slightly decreased stem total carbohydrates contents, during the study.

B) Interaction effect:

Referring the interaction effect of the different combinations between the investigated four factors i.e., pomegranate cultivars; salinity concentration; SAR and Cl: SO_4 ratio on stem total carbohydrates, **Table (16)** shows a considerable and statistical effect in both seasons of study. The most depressive effect on stem total carbohydrate was closely related to that combination represented Wardy transplants irrigated with the highest salinity concentration (6000 ppm) of SAR 6 and higher Cl: SO_4 ratio whereas the lowest value of stem total carbohydrates content was resulted. Moreover, other combinations of 6000 ppm saline solution ranked second in an increasing order. On the contrary, the lowest decrease in stem total carbohydrates was detected by Manfalouty cultivar transplants irrigated with 2000 ppm saline solution with SAR 3 and lower Cl: SO_4 ratio as compared with control during 2000 and 2001 seasons. In addition, other combinations were in between the aforementioned two extremes. The obtained results are confirmed by the findings of **Osman (2005)** on apple rootstocks and **Hassan (2005)** on olive.

IV.III.3. Effect on stem total soluble sugars content:

Data presented in **Table (16)** show the specific and interaction effects of pomegranate cultivars; salts concentration; sodium adsorption ratio (SAR); chloride level (Cl: SO_4 ratio) in irrigation water and their interaction on stem total soluble sugars.

A) Specific effect:

Concerning the specific effect of pomegranate cultivars; salts concentration; SAR and chloride level (Cl:SO_4 ratio) on stem total soluble sugars content, **Table (16)** clearly shows that Manfalouty cultivar transplants had the greatest value of stem total soluble sugars, while Wardy transplants was the poorest. It must be noticed that, Nab El-Gamal transplants was intermediate and differences between three pomegranate cultivars were significant during 2000 and 2001 seasons.

With respect to the specific effect of salinity concentration, data obtained revealed that, the stem total soluble sugars content was gradually increased by increasing salinity concentration during two seasons. Such increase was significant as compared to those of tap water irrigated transplants. On the other hand, the greatest level of stem total soluble sugars content was exhibited by the tap water irrigated transplants during both seasons of study. Differences between the three salinity concentrations were significant as each was compared to two other ones during the two seasons of study. Such results appeared to agree with those obtained by **Saeed, (2005)** on pomegranate **Nasr *et al.*, (1977)** on stone fruits; **Aly, (1979)** on grapevine and **El-Hefnawy, (1986)** on guava who found that high salinity levels increased total soluble sugars.

Regarding the specific effect of sodium adsorption ratio (SAR), it was quite clear that increasing SAR from 3 to 6 significantly increased stem total sugars content during two seasons of study.

With respect to the specific effect of Cl:SO_4 ratio on stem total soluble sugars content, data from **Table (16)** show clearly that the higher Cl level significantly increased total sugars in both 2000 and 2001 seasons.

B) Interaction effect:

As for the interaction effect of different combinations between the four investigated factors i.e., pomegranate cultivars, salinity concentration, SAR and Cl: SO_4 ratio on the stem total soluble sugars, data are presented in **Table (16)**. It is quite clear that the specific effect of each investigated factor was significantly reflected on interaction effect of their combinations during two seasons of study. Anyhow, the least stem total soluble sugars content was coupled with such combinations of Wardy transplants irrigated with the lowest salinity concentration (2000 ppm) of SAR 3 and lower Cl:SO_4 ratio as compared to any of other combinations of different saline solutions during two seasons of study. On the other hand, the highest stem total soluble sugars level was exhibited by Manfalouty transplants irrigated with 6000 ppm, saline solution of SAR 6 and higher Cl:SO_4 ratio during 2000 and 2001 seasons. In addition, other combinations ware in between the aforesaid two extremes. The obtained results are confirmed by the findings of **Osman (2005)** on apple rootstocks and **Hassan (2005)** on olive.

Table (16): Stem Total Carbohydrates and total sugars (%)of pomegranate transplant (rooted cuttings) in response to specific and interaction effects of Pomegranate cultivars., (salt concentrations, SAR and Cl:SO4 ratio of saline irrigation water) and their combinations during 2000 & 2001 seasons.

Treatments / Cultivars			Carbohydrates (%) Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****	Total sugars (%) Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****
2000														
Tap water			32.05 a	29.64 cd	27.92 h	29.87A	SAR3	Low Cl	1.91 xy	1.83 [	1.62]	1.79 D	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	30.86 b	28.72 fg	25.99 k	27.43B	26.20A	25.86A	2.03 v	1.89 yz	1.73 \	2.04C	2.25B	2.29B
		High Cl	30.06 c	27.47 hi	25.21 l				2.12 s	1.93 x	1.88 z			
	SAR 6	Low Cl	29.41 de	27.14 i	24.93 lm				2.24 r	2.07 u	1.96 w			
		High Cl	29.09 ef	26.54 j	23.69 o-q				2.37 p	2.15 s	2.10 t			
4000 ppm	SAR 3	Low Cl	28.52 g	25.84 k	22.70 s	24.30C	SAR6	High Cl	2.48 m	2.29 q	2.13 s	2.49B	SAR6	High Cl
		High Cl	27.63 hi	25.06 lm	21.73 t				2.62 k	2.37 p	2.29 q			
	SAR 6	Low Cl	26.13 jk	24.86 lm	20.36 uv				2.74 j	2.45 n	2.40 o			
		High Cl	24.99 lm	23.88 op	19.94 v				2.90 g	2.56 l	2.60 k			
6000 ppm	SAR 3	Low Cl	24.58 mn	22.96 rs	19.02 w	20.48D	24.84B	25.18A	3.04 e	2.79 i	2.73 j	3.03A	2.42A	2.38A
		High Cl	24.13 no	20.58 u	18.50 x				3.17 c	2.86 h	2.88 h			
	SAR 6	Low Cl	23.51 pq	18.94 wx	17.05 y				3.33 b	2.93 g	2.99 f			
		High Cl	23.25 qr	17.41 y	15.80 z				3.52 a	3.03 e	3.09 d			
Mean *			27.25 A	24.54 B	21.76 C				2.56 A	2.40 B	2.34 C			
2001														
Tap water			35.36 a	32.78 c	30.88 f	33.01A	SAR3	Low Cl	2.12 w	2.03 y	1.86 \	2.00 D	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	33.44 b	32.08 d	27.95 i	29.94B	28.61 A	28.14 A	2.20 v	2.05 y	1.92 [	2.22 C	2.47 B	2.53 B
		High Cl	33.18 bc	31.16 ef	26.86 j				2.33 s	2.09 x	2.00 z			
	SAR 6	Low Cl	32.05 d	29.98 g	26.28 k				2.48 q	2.23 u	2.11 w			
		High Cl	31.56 de	29.56 g	25.16 mn				2.53 p	2.37 r	2.30 t			
4000 ppm	SAR 3	Low Cl	31.18 ef	27.92 i	24.79 n	26.42C	SAR6	High Cl	2.68 n	2.46 q	2.39 r	2.74 B	SAR6	High Cl
		High Cl	31.02 ef	27.63 i	22.98 p				2.83 l	2.59 o	2.54 p			
	SAR 6	Low Cl	28.72 h	26.44 jk	22.11 q				2.94 k	2.73 m	2.81 l			
		High Cl	27.69 i	25.09 mn	21.43 r				3.11 i	2.82 l	2.92 k			
6000 ppm	SAR 3	Low Cl	26.38 jk	23.65 o	20.80 s	21.97D	27.06 B	27.52 A	3.41 d	3.00 j	2.99 j	3.37 A	2.69 A	2.63 A
		High Cl	25.71 l	21.91 qr	19.85 t				3.46 c	3.17 h	3.19 g			
	SAR 6	Low Cl	25.45 lm	20.09 t	18.61 u				3.73 b	3.31 f	3.35 e			
		High Cl	25.03 mn	19.14 u	16.98 v				3.93 a	3.43 d	3.48 c			
Mean *			29.75 A	26.73 B	23.44 C				2.90 A	2.64 B	2.60 C			

*, **, *** and **** means refer to specific effect of pomegranate cvs; salinity concentration; SAR and Cl:SO4 ratio, respectively. Values within the same column or row for any of four investigated factors and their combinations followed by the same letter/s were not significantly different at 5% level. Capital and small letters were used for distinguishing values of either specific effect for each investigated factor or interaction effect of their combinations, respectively.

IV.III.4. Effect on leaf proline content:

Data obtained during both 2000 and 2001 seasons regarding the specific and interaction effects of four investigated factors and their combinations are presented in **Table (17).**

A) Specific effect:

Concerning the specific effect of pomegranate cultivars, salinity concentration, SAR and chloride level (Cl: SO_4 ratio) on the leaf-proline content, data obtained in **Table (17)** clearly show that Wardy Pomegranate transplants had significantly the greatest value of leaf-proline content followed in a descending order by Nab El-Gamal transplants and Manfalouty cultivar during two seasons of study. In this respect, **Gaser, (1992)** reported on grapevines that the most sensitive rootstock (St. Georg, Gouderc 1202 and Couderc 1613) tended to accumulate higher amount of proline while the more tolerant stock (Cauderc 1616) Thompson seedless, Arabi and Dogridge contained the lowest amounts of proline in leaves.

Regarding the specific effect of salinity concentrations, data obtained in **Table (17)** revealed that a significant variances in leaf proline contents were obviously detected due to salt concentration of irrigation water during the study. Herein, the obtained results revealed that leaf proline content increased significantly by any of the three salt concentrations of the irrigation water as compared to that of tap water irrigation. Moreover, the most remarkable increase was resulted by the highest saline concentration (6000 ppm), however, 2000 ppm saline solution exhibited the lowest increase. Meanwhile, the 4000 ppm concentration was intermediate in this respect, whereas differences between the three salinity concentrations were significant as each was compared to two other ones during 2000 and 2001 seasons. Proline might act as an osmoregulator compound against salinity stress and its accumulation considered as an adaptive response to stress conditions **Saeed, (2005)** on pomegranate **Handa *et al.*, (1985)**.

Salt stress increased leaves proline content is in conformity with those obtained by **Saeed, (2005)** on pomegranate **Downton** and **Loveys, (1981)** on salinity stressed grapevines; **Kaul, (1981)** on guava plants; **Rajasekaran** and **Shanmugavelu, (1983)** on tomato plants and **El-Hefnawy, (1986)** on guava plants. However, **Nieves *et al.*, (1991)** found that free proline increased as salinity increased in the leaves of both Verna and fino lemon scions cultivars budded on sour orange rootstock but it was unaffected on Alemow (***Citrus macrophylla***). They also concluded that differences in both free total amino acids and proline contents parameters in response to salinity stress are attributable to the different capacity of each specific rootstock/scion combination to import chloride and sodium to leaves.

With respect to the specific effect of SAR, it was clear that, increasing sodium adsorption ratio (SAR) from 3 to 6 in irrigation water resulted significantly in increasing leaf proline content during two seasons of study.

Referring the specific effect of the Cl: SO_4 ratio of saline solution used for irrigation, **Table (17)** shows that leaf-proline content significantly increased with higher ratio than lower one during 2000 and 2001 seasons.

B) Interaction effect:

As for the interaction effect of various combinations between pomegranate cultivars; concentration level; SAR and $Cl:SO_4$ ratio on leaf proline content data presented in **Table (17)**, show generally, a noticeable variances during the study.

Anyhow, the greatest value of leaf proline content was always in concomitant to that combination between Wardy transplants x highest salinity concentration (6000 ppm) x SAR 6 x higher $Cl:SO_4$ ratio. Moreover, other combinations of 6000 ppm saline solution for the same pomegranate cultivar ranked statistically second; third and fourth in an decreasing order as SAR6 of lower Cl level and SAR3 of either higher or lower Cl: SO_4 ratio were concerned, respectively. On the other hand, the lowest increase in leaf proline content was found by Manfalouty cultivar transplants irrigated with 2000 ppm, saline solution of SAR3 x lower $Cl:SO_4$ ratio as compared with control during 2000 and 2001 seasons. In addition, other combination were in between with slight tendency of variance. The obtained results are confirmed by the findings of **Osman (2005)** on apple rootstocks and **Hassan (2005)** on olive.

IV.III.5. Effect on leaf total free amino acids content:

A) Specific effect:

Concerning the specific effect of the different factors involved i.e., pomegranate cultivars; salinity concentration; SAR and $Cl:SO_4$ ratio on leaves total free amino acids, data obtained in **Table (17)** showed that Wardy transplants had the highest value of leaf amino acids contents followed in a descending order by Nab El-Gamal transplants and Manfalouty cultivar during two seasons of study.

Referring the specific effect of different salts concentration in the irrigation water on leaf total amino acids content of pomegranate cultivars transplants, it is obvious from the results of **Table (17)** that total amino acids in leaves increased significantly with increasing salts concentration in the irrigation water comparing with those of the control (tap water) during 2000 and 2001 seasons. These results are in harmony with those reported by **Saeed, (2005)** on pomegranate **Petrosyan *et al.*, (1967)** on apple leaves; **Kessler** and **Snir, (1968)** on citrus seedlings; **Joham, (1971)** on cotton leaves and **El-Hefnawy, (1986)** on guava plants, who found that leaves of highly salinized treatments recorded higher value of free amino acids in comparison with the untreated treatments.

As for the specific effect of sodium adsorption ratio (SAR) in the irrigation water on leaf total free amino acids content (mg/100g D.W), data are presented in **Table (17)**. The results show that the total free amino acids content increased by increasing sodium adsorption ratio (SAR) from 3 to 6 during the study.

With respect to the specific effect of $Cl:SO_4$ ratio (chloride levels) on leaf-total free amino acids content, **Table (17)** shows clearly that leaf-free amino acid content in pomegranate cultivars seedlings increased slightly by increasing levels of chloride ($Cl:SO_4$ ratio) in irrigation water during two seasons of study.

B) Interaction effect:

Regarding the interaction effect of various combinations between the four investigated factors i.e., pomegranate cultivars;

Table (17): Leaf Proline and Total free aimino acids contents (mg/100g.f.w) of pomegranate transplants (rooted cuttings) in response to specific and interaction effects of Pomegranate cultivars., (salt concentrations, SAR and Cl:SO4 ratio of saline irrigation water) and their combinations during 2000 & 2001 seasons.

Treatments / Cultivars			Leaf Proline content (mg/100g.F.Wt.)						Total free aimino acids (mg/100g.F.Wt.)					
			Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****	Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****
2000														
Tap water			0.16 \	0.17 -	0.18 -	0.17 D	SAR3	Low Cl	2.01 \	2.05 ^	2.15 \	2.07 D	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	0.18 -	0.21]	0.22 [\	0.24 C	0.40 B	0.44 B	2.04 -	2.09]	2.24 x	2.21 C	2.34 B	2.37 A
		High Cl	0.19 ^	0.24 z	0.25 y				2.09]	2.17 [	2.28 w			
	SAR 6	Low Cl	0.21 \ ]	0.28 x	0.28 x				2.15 \	2.21 z	2.30 u			
		High Cl	0.22 [	0.30 w	0.32 v				2.22 y	2.29 vw	2.48 p			
4000 ppm	SAR 3	Low Cl	0.30 w	0.37 u	0.41 s	0.50 B	SAR6	High Cl	2.29 v	2.34 t	2.49 o	2.49 B	SAR6	High Cl
		High Cl	0.39 t	0.45 r	0.53 p				2.37 s	2.40 r	2.52 n			
	SAR 6	Low Cl	0.47 q	0.53 p	0.60 n				2.45 q	2.48 p	2.64 j			
		High Cl	0.59 o	0.64 m	0.66 l				2.53 m	2.55 l	2.77 h			
6000 ppm	SAR 3	Low Cl	0.71 k	0.77 i	0.75 j	0.99 A	0.55 A	0.51 A	2.62 k	2.63 j	2.81 f	2.82 A	2.46 A	2.43 A
		High Cl	0.84 h	0.92 g	0.91 g				2.71 i	2.71 i	2.92 c			
	SAR 6	Low Cl	1.06 f	1.09 e	1.14 d				2.80 f	2.78 g	2.98 b			
		High Cl	1.19 c	1.22 b	1.31 a				2.91 d	2.86 e	3.11 a			
Mean *			0.50 C	0.55 B	0.58 A				2.40 B	2.43 B	2.59 A			
2001														
Tap water			0.16 y	0.21 wx	0.20 wx	1.19 D	SAR3	Low Cl	2.09 y	2.11 y	2.19 w	2.13 D	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	0.19 x	0.21 wx	0.24 uv	0.29 C	0.45 B	0.48 B	2.10 y	2.20 w	2.23 v	2.27 C	2.41 B	2.44 A
		High Cl	0.22 vw	0.29 t	0.29 t				2.15 x	2.29 t	2.26 u			
	SAR 6	Low Cl	0.25 u	0.34 s	0.36 rs				2.22 v	2.35 r	2.32 s			
		High Cl	0.28 t	0.36 r	0.40 q				2.32 s	2.41 p	2.43 o			
4000 ppm	SAR 3	Low Cl	0.35 rs	0.42 q	0.48 o	0.55 B	SAR6	High Cl	2.39 q	2.49 n	2.49 n	2.56 B	SAR6	High Cl
		High Cl	0.44 p	0.48 o	0.59 m				2.42 op	2.50 n	2.57 m			
	SAR 6	Low Cl	0.54 n	0.54 n	0.68 k				2.50 n	2.61 l	2.67 k			
		High Cl	0.63 l	0.62 l	0.79 i				2.57 m	2.72 j	2.77 i			
6000 ppm	SAR 3	Low Cl	0.75 j	0.75 j	0.93 g	1.05 A	0.60 A	0.56 A	2.71 j	2.81 h	2.86 g	2.93 A	2.53 A	2.50 A
		High Cl	0.88 h	0.91 g	1.09 e				2.80 h	2.90 f	2.97 d			
	SAR 6	Low Cl	1.05 f	1.10 e	1.27 c				2.89 f	2.92 e	3.11 b			
		High Cl	1.20 d	1.31 b	1.40 a				2.91 e	3.01 c	3.26 a			
Mean *			0.53 C	0.58 B	0.67 A				2.47 C	2.56 B	2.63 A			

*, **, *** and **** means refer to specific effect of pomegranate cvs; salinity concentration; SAR and Cl:SO4 ratio, respectively. Values within the same column or row for any of four investigated factors and their combinations followed by the same letter/s were not significantly different at 5% level. Capital and small letters were used for distinguishing values of either specific effect for each investigated factor or interaction effect of their combinations, respectively.

salinity concentration; SAR and Cl: SO_4 ratio on leaf total free amino acids content, data obtained in **Table (17)** showed obviously the variable response to such combinations evaluated during two seasons. The highest leaf total free amino acids content was coupled with such combination representative of irrigated with saline solution of the Wardy transplants highest salinity concentration (6000 ppm); SAR 6 and higher Cl: SO_4 ratio as compared to either those of control or other salinity combinations during two seasons of study. However, the lowest leaf-total free amino acids was detected by those transplants of Manfalouty cultivar irrigated with 2000 ppm saline solution of SAR 3 and lower Cl:SO_4 ratio as compared to those of other salinity combinations which ranked 2nd just after those continuously irrigated with tap water during 2000 and 2001 seasons. Moreover, other combinations were in between in this concern. The obtained results are confirmed by the findings of **Osman (2005)** on apple rootstocks and **Hassan (2005)** on olive.

IV.III.6. Catalase and peroxidase enzymes activities:

Regarding activities of both catalase and peroxidase enzymes in leaves of pomegranate rooted cuttingsas affected by cultivars; salinity concentration; sodium adsorption ratio (SAR) and chloride level (Cl: SO_4 ratio) data obtained during 2001 seasons are presented in **Tables (18 and 19)**.

Concerning catalase activity, it is quite clear that an obvious decrease detected with advancement of estimation time till 60 recorded then it tended to be slightly increased. Such trend was true for three pomegranate cultivars during the study. Moreover, three pomegranate cultivars varied pertaining catalase activity in their leaves, whereas Manfalouty cultivar had the highest rate of activity, descendingly followed by Nab El-Gamal transplants and Wardy transplants which last was the inferior during the study.

In addition, catalase activity responded slightly to salinity concentration; sodium adsorption (SAR) and Cl: SO_4 ratios. Herein, the activity tended to be slightly decreased by rising salt concentration, especially with two higher ones (4000 & 6000 ppm) or SAR ratio in irrigation water. While with both SAR and Cl: SO_4 ratios the trend took the other way around where a positive relationship was detected.

With respect to the response of peroxidase activity to time of estimation, **Table (19)** shows that trend was entirely changed. Hence, activity was gradually increased as the time of estimation was advanced. Moreover, the response to pomegranate cultivars was typically the same where it followed the previously detected are trend of catalase, so leaves of Wardy had the lowest value of peroxidase activity but the contrary was found with Manfalouty.

Meanwhile, the trend of peroxidase activity in relation to salinity concentration and SAR both followed the same trend where an opposite relationship was obviously detected. Hence, rising the salt concentration and / or SAR resulted in increasing activity of peroxidase. Such increase exhibited by salt stress was more pronounced in transplants of both Nab El-Gamal and Manfalouty cultivars. Meanwhile, rising Cl: SO_4 ratio depressed peroxidase activity.

Generally, it could be safely concluded that activity of both catalase and peroxidase enzymes each followed its own trends regarding the response to pomegranate cultivars; salt concentration; SAR ratio and chloride level (Cl: SO_4 ratio), as well as advancement of estimation time. Hence, peroxidase enzyme activity recorded activity was the highest in Manfalouty cultivar, under salt stress and it continuously increased with advancement of estimation time. While the reverse was true for catalase enzyme regarding the response to either salt stress, or the advancement of duration of estimation.

Such results are in general agreement with **Lapina *et al.*, (1976)** on bean plants who found that sodium sulphate and chloride decreased the activity of cyclic and non cyclic phosphorylation in been plants noted for low salt resistance. From another point of view, **Kaur** and **Gupta, (1970)** on pea cvs., dehydrogenase activity in the shoots and roots of both varieties (Perfection as salt sensitive and T- 163 relatively salt tolerant) increased with salt concentration, being inversely related to salt toxicity. T- 163 polyphenol oxidase activity was greater in the roots than in the shoots and decreased with increasing salt concentration. Peroxidase activity was far greater in T- 163 than in perfection. On the contrary, **Bhardwaj, (1964)** on wheat; **Kaur** and **Gupta, (1970)** on pea cvs, **Morozovskiy** and **Kabanov, (1970)**, on peas **Kaul, (1981)** on guava and **Nomir, (1994)** on Kaki reported that a positive relationship between salinity level and the activity of both catalase and peroxidase enzymes in plant leaves. The leaves of salt treatments recorded higher values in comparison with the control (unsalinized). The obtained results are confirmed by the findings of **Osman (2005)** on apple rootstocks and **Hassan (2005)** on olive.

Table (18): Catalaze enzyme activity in leaves of some pomegranate cultivars (rooted cuttings) as influenced by saline solutions used for irrigation of various concentrations; sodium adsorption ratio SAR and chloride levels $Cl:SO_4$ ratio during 2001 season.

Time (sec.)			0			15			30			45			60			75			90			
Treatments / Pomegranate CVS.			Manfalouty	NabEl-Gamal	Wardy	Manfalouty	NabEl-Gamal	Wardy	Manfaluty	NabEl-Gamal	Wardy	Manfalouty	NabEl-Gamal	Wardy	Manfalouty	NabEl-Gamal	Wardy	Manfaluty	NabEl-Gamal	Wardy	Manfalouty	NabEl-Gamal	Wardy	Mean of salinity
Tap water			0.794	0.696	0.690	0.738	0.650	0.642	0.684	0.600	0.631	0.663	0.571	0.601	0.643	0.551	0.581	0.674	0.591	0.622	0.686	0.612	0.633	0.645
2000ppm	SAR3	Low	0.875	0.666	0.588	0.761	0.620	0.551	0.725	0.569	0.521	0.705	0.539	0.491	0.685	0.519	0.471	0.717	0.560	0.512	0.728	0.581	0.522	0.615
		High	0.812	0.681	0.602	0.752	0.632	0.565	0.700	0.577	0.537	0.680	0.659	0.500	0.660	0.529	0.480	0.692	0.570	0.521	0.703	0.581	0.532	
	SAR6	Low	0.767	0.710	0.582	0.720	0.661	0.522	0.672	0.610	0.502	0.639	0.581	0.462	0.619	0.561	0.442	0.650	0.602	0.490	0.660	0.623	0.503	
		High	0.784	0.670	0.588	0.787	0.640	0.569	0.740	0.592	0.542	0.720	0.569	0.512	0.701	0.549	0.492	0.738	0.590	0.532	0.749	0.609	0.543	
4000ppm	SAR3	Low	0.826	0.725	0.557	0.751	0.690	0.502	0.700	0.642	0.481	0.682	0.612	0.452	0.662	0.593	0.432	0.707	0.633	0.479	0.719	0.653	0.491	0.606
		High	0.765	0.742	0.558	0.705	0.723	0.491	0.651	0.661	0.473	0.631	0.631	0.449	0.612	0.611	0.429	0.645	0.652	0.470	0.655	0.667	0.493	
	SAR6	Low	0.772	0.720	0.572	0.727	0.672	0.522	0.666	0.602	0.509	0.647	0.582	0.479	0.627	0.562	0.459	0.659	0.603	0.500	0.670	0.626	0.521	
		High	0.821	0.671	0.572	0.752	0.624	0.538	0.697	0.580	0.521	0.679	0.552	0.492	0.660	0.533	0.472	0.690	0.573	0.516	0.680	0.385	0.520	
6000ppm	SAR3	Low	0.790	0.667	0.542	0.740	0.623	0.488	0.681	0.571	0.472	0.662	0.542	0.442	0.642	0.522	0.422	0.679	0.562	0.461	0.689	0.586	0.472	0.611
		High	0.788	0.666	0.588	0.731	0.631	0.522	0.672	0.571	0.504	0.652	0.542	0.474	0.632	0.523	0.455	0.668	0.563	0.499	0.679	0.585	0.510	
	SAR6	Low	0.860	0.692	0.601	0.800	0.640	0.563	0.741	0.582	0.544	0.721	0.559	0.514	0.707	0.539	0.494	0.741	0.579	0.536	0.753	0.600	0.549	
		High	0.840	0.720	0.583	0.783	0.663	0.551	0.716	0.602	0.537	0.690	0.571	0.484	0.688	0.551	0.497	0.719	0.595	0.537	0.729	0.600	0.550	
Mean of Time			0.807	0.694	0.586	0.750	0.651	0.540	0.696	0.597	0.521	0.675	0.578	0.489	0.657	0.549	0.471	0.691	0.590	0.513	0.700	0.593	0.526	
				0.696			0.647			0.605			0.581			0.559			0.598			0.606		

Mean of pomegranate cvs.	Manfalouty 0.711	NabEl-Gamal 0.607	Wardy 0.521
Mean of SAR	SAR3 0.606	SAR6 0.616	
Mean of $Cl:SO_4$ ratio	Low 0.609	High 0.612	

Table (19): Peroxides enzyme activity in leaves of some pomegranate cultivars (rooted cuttings) as influenced by saline solutions used for irrigation of various concentrations; sodium adsorption ratio SAR and chloride levels Cl:SO4 ratio during 2001 season.

Time (sec.)			0			60			120			180			240			300			
Treatment / Pomegranate CVS.			Manfalouty	NabEl-Gamal	Wardy	Manfalouty	NabEl-Gamal	Wardy	Manfalouty	NabEl-Gamal	Wardy	Manfalouty	NabEl-Gamal	Wardy	Manfalouty	NabEl-Gamal	Wardy	Manfalouty	NabEl-Gamal	Wardy	Mean of salinity
Tap water			0.661	0.551	0.424	0.694	0.591	0.484	0.715	0.605	0.502	0.778	0.652	0.551	0.822	0.691	0.530	0.888	0.739	0.632	0.639
2000ppm	SAR3	Low	0.631	0.549	0.478	0.622	0.602	0.539	0.674	0.591	0.564	0.712	0.692	0.628	0.772	0.711	0.602	0.838	0.772	0.708	0.688
		High	0.488	0.470	0.449	0.623	0.502	0.514	0.651	0.549	0.532	0.702	0.582	0.602	0.762	0.632	0.598	0.821	0.679	0.693	
	SAR6	Low	0.592	0.496	0.497	0.651	0.543	0.560	0.677	0.562	0.578	0.729	0.609	0.623	0.763	0.641	0.608	0.832	0.692	0.723	
		High	0.607	0.541	0.434	0.663	0.569	0.502	0.676	0.592	0.542	0.717	0.592	0.591	0.753	0.638	0.590	0.822	0.703	0.711	
4000ppm	SAR3	Low	0.602	0.523	0.531	0.652	0.597	0.621	0.679	0.612	0.653	0.738	0.583	0.698	0.778	0.740	0.713	0.832	0.783	0.829	0.637
		High	0.601	0.547	0.498	0.612	0.562	0.532	0.655	0.598	0.562	0.708	0.658	0.620	0.754	0.692	0.612	0.818	0.757	0.712	
	SAR6	Low	0.573	0.542	0.444	0.622	0.583	0.512	0.632	0.604	0.523	0.688	0.651	0.572	0.748	0.681	0.582	0.804	0.722	0.674	
		High	0.595	0.494	0.477	0.662	0.530	0.511	0.651	0.553	0.532	0.701	0.602	0.582	9.737	0.634	0.579	0.793	0.689	0.672	
6000ppm		Low	0.625	0.537	0.456	0.672	0.582	0.492	0.693	0.608	0.507	0.752	0.658	0.662	0.794	0.721	0.553	0.853	0.760	0.652	0.648
		High	0.661	0.527	0.411	0.641	0.601	0.499	0.702	0.632	0.514	0.768	0.679	0.558	0.722	0.747	0.543	0.888	0.782	0.648	
		Low	0.592	0.528	0.442	0.662	0.577	0.512	0.662	0.601	0.542	0.728	0.669	0.592	0.784	0.702	0.583	0.847	0.761	0.685	
		High	0.622	0.527	0.498	0.647	0.572	0.563	0.682	0.596	0.592	0.741	0.782	0.663	0.799	0.732	0.662	0.854	0.773	0.782	
Mean of Time			0.604	0.526	0.465	0.648	0.570	0.526	0.673	0.593	0.549	0.728	0.647	0.611	0.768	0.689	0.597	0.838	0.739	0.702	
			0.532			0.581			0.605			0.662			0.685			0.759			

Mean of pomegranate cvs.	Manfalouty 0.710	NabEl-Gamal 0.627	Wardy 0.575
Mean of SAR	SAR3 0.642	SAR6 0.673	
Mean of Cl: SO_4 ratio	Low 0.683	High 0.632	

IV.III.7. Effect on leaves mineral content:

The data concerning the effect of pomegranate cultivars; salt concentration; SAR and Cl: SO_4 ratio (chloride levels) on leaf Cl, Na, N, P, K, Ca, Mg, Fe, Mn and Zn contents are presented in **Tables (20, 21, 22, 23 & 24).**

IV.III.7.1. Effect on leaf chloride content :

A. Specific effect:

Concerning the specific effect of pomegranate cultivars, different salt concentration; SAR and Cl: SO_4 ratio in the irrigation water on leaf chloride content, **Table (20)** clearly shows that Wardy transplants had statistically the greatest value of leaf chloride content.

Regarding the specific effect of different salt concentrations in the irrigation water on leaf chloride content, it is quite clear that leaf chloride increased significantly with increasing salts concentration in the irrigation water as compared to those of control (tap water) during two seasons of study. Analogical results were reported by many investigators; **Youssif, (1989)** on pomegranate transplant **Pearson** *et al.*, **(1957)** on grapefruit; **Ayoub** and **Minessy, (1974)** on citrus; **El-Gazzar** ***et al.*, (1979)** on seedlings of some fruit species, **Khelil, (1979)** on citrus; **Salem, (1981)** on grapevines, **Gaser, (1986)** on avocado; **Garica** and **Charbaji, (1989)** on grapevine and **Bartolini** ***et al.*, (1991)** on olive plants.

As for the specific effect of sodium adsorption ratio (SAR) in the irrigation water on leaf chloride content, data presented in

Table (20) show an increase with increasing sodium adsorption ratio from 3 to 6 during two seasons of study.

With respect to the specific effect of Cl:SO_4 ratio (chloride levels) on leaf-Cl content, **Table (20)** shows clearly that the higher ratio increased it significantly during 2000 and 2001 seasons.

B. Interaction effect:

Referring the interaction effect of different combinations between the four investigated factors i.e., pomegranate cultivars; salinity concentration; SAR and Cl: SO_4 ratio on leaf-Cl content, data obtained in **Table (20)** showed obviously that the least leaf-chloride content in irrigated pomegranate transplants with saline solutions was exhibited by Manfalouty cultivar transplants irrigated with lowest salinity concentration (2000 ppm) of SAR 3 and lower Cl:SO_4 ratio as compared to other saline combinations during two seasons of study. Moreover, other combinations of (2000 ppm) saline solution ranked second in an increasing order. In addition the highest increase in leaf-Cl content value was detected by such combination represented Wardy transplants x 6000 ppm saline solution of SAR 6 and higher Cl: SO_4 ratio as compared with control during two seasons of study. In addition, other combinations were in between the aforesaid two extremes.

IV.III.7.2. Effect on leaf sodium content:
A. Specific effect:

Regarding the specific effect of the pomegranate cultivars on leaf-Na content, **Table (20)** clearly shows that Wardy transplants had statistically the highest leaf-Na content, while Manfalouty cultivar transplants showed the least level.

Concerning the specific effect of salinity concentration, data obtained revealed that three concentrations (2000, 4000 and 6000 ppm) of investigated saline solutions resulted in an obvious increase in leaf-Na content over control during two seasons. Such increase was significant as compared to those of tap water irrigated pomegranate transplants of three cultivars. Analogical results were reported by many investigators; **Patil** and **Patil, (1982)** and **Youssif, (1989), Wang *et al.*, (1995), Ali, (2000)** and **Saeed, Wafaa (2005)** on pomegranate. **Ivanova, (1971)** on apricot; **Salem, (1981)** on grapevines; **Sweidan *et al.*, (1982)** on apricot seedling; **Kabeel, (1985)** on some deciduous fruits; **Gaser, (1986)** on avocado; **El-Hefnawy, (1986)** on guava; **Garica** and **Charbaji, (1989)** on grapevines; **Bondok *et al.*, (1995)** on peach plants and **Omar, (1996)** on apricot and mango seedlings. They stated that as the salinity level of the irrigation water increased, a subsequent increase was observed in Na^+ accumulation in plant organs.

Regarding the specific effect of sodium adsorption ratio (SAR) on leaf Na^+ content, obtained results showed that higher SAR (6) significantly increased Na^+ content in leaves than lower SAR (3) during 2000and 2001 seasons. These result are in accordance with findings of **Sharaf *et al.*, (1985)** on Thompson seedless and American grape; **Al-Khateeb, (1989)** on some fig varieties; **Omar, (1996)** on apricot and mango seedlings, and **Abd El-Mageid, (1998)** on almond plants.

With respect to the specific effect of chloride level ($Cl:SO_4$ ratio) of saline solution used for irrigation on leaf - Na^+ content, it could be noticed that the higher $Cl:SO_4$ ratio increased it significantly during first and second seasons of study. In this respect, however, Table (20): Leaf Chloride (%) and Sodium (%) of pomegranate transplants (rooted cuttings) in response to specific and interaction effects of Pomegranate cultivars., (salt concentrations, SAR and Cl:SO4 ratio in saline irrigation water) and their combinations during 2000 & 2001 seasons.

Treatments \ Cultivars			Chlorid (%) Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****	Sodium (%) Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****
2000														
Tap water			0.59 s	0.71 p-s	0.74 o-s	0.68 D	SAR3	Low Cl	0.15 p	0.17 p	0.18 p	0.17 D	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	0.61 rs	0.73 o-s	0.83 n-p				0.21 p	0.21 p	0.22 p			
		High Cl	0.65 q-s	0.79 n-q	1.01 j-l	0.86 C	0.94 B	0.96 B	0.22 p	0.29 o	0.31 o			
	SAR 6	Low Cl	0.70 p-s	0.87m-o	1.10 h-k				0.29 o	0.34 no	0.39 mn	0.31 C	0.44 B	0.47 B
		High Cl	0.80 n-q	0.99 k-m	1.21 e-h				0.38 mn	0.41 lm	0.46 kl			
4000 ppm	SAR 3	Low Cl	0.82 n-p	1.04 i-l	1.23 e-h		SAR6	High Cl	0.42 lm	0.49 k	0.51 k		SAR6	High Cl
		High Cl	0.92 l-n	1.09 h-k	1.31 d-f	1.12 B			0.50 k	0.58 j	0.59 j			
	SAR 6	Low Cl	1.02 j-l	1.10 h-k	1.35 c-e				0.59 j	0.62 ij	0.68 hi	0.60 B		
		High Cl	1.08 h-k	1.13 h-k	1.38 cd				0.67 hi	0.69 h	0.79 g			
6000 ppm	SAR 3	Low Cl	1.10 h-k	1.16 g-j	1.41 b-d		1.04 A	1.02 A	0.76 g	0.75 g	0.87 ef		0.55 A	0.52 A
		High Cl	1.15 g-j	1.18 f-i	1.46 bc	1.29 A			0.80 g	0.82 gf	0.93 c-e			
	SAR 6	Low Cl	1.19 f-h	1.21 e-h	1.53 ab				0.90 e	0.92 de	1.04 b	0.90 A		
		High Cl	1.21 e-h	1.30 d-g	1.62 a				0.97 cd	0.98 bc	1.11 a			
Mean *			0.90 C	1.02 B	1.24 A				0.49 C	0.56 B	0.62 A			
2001														
Tap water			0.62 -	0.70 \	0.79 y	0.70D	SAR3	Low Cl	0.16 [	0.18 z	0.19 yz	0.18 D	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	0.65 ^	0.75 z	0.83 w				0.18 z	0.20 yz	0.28 w			
		High Cl	0.69]	0.81 x	0.89 t	0.82 C	0.91 B	0.93 B	0.21 y	0.29 w	0.29 w			
	SAR 6	Low Cl	0.73 [	0.85 v	0.94 r				0.23 x	0.31 v	0.33 u	0.28 C	0.44 B	0.46 B
		High Cl	0.79 y	0.90 s	0.99 p				0.29 w	0.38 t	0.43 r			
4000 ppm	SAR 3	Low Cl	0.82 w	0.94 r	1.06 mn		SAR6	High Cl	0.40 s	0.45 q	0.56 n		SAR6	High Cl
		High Cl	0.86 u	0.99 p	1.13 k	1.03 B			0.50 p	0.53 o	0.65 l			
	SAR 6	Low Cl	0.91 s	1.05 n	1.21 i				0.52 o	0.59 m	0.72 j	0.60 B		
		High Cl	0.97 q	1.13 k	1.22 h				0.66 l	0.68 k	0.89 e			
6000 ppm	SAR 3	Low Cl	1.02 o	1.19 j	1.29 f		0.99 A	0.97 A	0.69 k	0.74 i	0.90 e		0.54 A	0.52 A
		High Cl	1.06 m	1.25 g	1.34 d	1.26 A			0.79 h	0.81 g	0.98 c			
	SAR 6	Low Cl	1.12 l	1.30 e	1.42 b				0.86 f	0.89 e	1.04 b	0.89 A		
		High Cl	1.19 j	1.39 c	1.49 a				0.97 d	0.96 d	1.10 a			
Mean *			0.88 C	1.02 B	1.14 A				0.50 C	0.54 B	0.68 A			

*, **, *** and **** means refer to specific effect of pomegranate cvs; salinity concentration; SAR and Cl:SO4 ratio, respectively. Values within the same column or row for any of four investigated factors and their combinations followed by the same letter/s were not significantly different at 5% level. Capital and small letters were used for distinguishing values of either specific effect for each investigated factor or interaction effect of their combinations, respectively.

Kabeel, (1985) on grape, peach and plum reported that leaf Na^+ content was not affected by increasing chloride levels ($Cl:SO_4$ ratio) in irrigation water, but such results are in conformity with the findings of **Omar, (1996)** on apricot and mango seedlings and **Abd El-Mageid, (1998)** on almond seedlings, who stated that the higher $Cl:SO_4$ ratio significantly increased leaf -Na^+ content.

B. Interaction effect:

As for the interaction effect of different combination between the four investigated factors i.e., pomegranate cultivars; salinity concentration; SAR and Cl: SO_4 ratio on leaf-Na^+ content, **Table (20)** shows obviously the variable response to different combinations during 2000 and 2001 seasons. The highest leaf-Na^+ contents was detected by the combination representing Wardy transplants irrigated with saline solution of the highest salinity concentration (6000 ppm); SAR 6 and higher Cl: SO_4 ratios. While the lowest leaf-Na^+ content of saline stressed pomegranate transplants was detected by Manfalouty cultivar transplants irrigated with saline solution of 2000 ppm; SAR 3 and lower $Cl:SO_4$ ratio as compared to those continuously irrigated with tap water during two seasons of study.

IV.III.7.3. Effect on leaf nitrogen content:

A. Specific effect:

Regarding the specific effect of the four investigated factors involved in this study i.e., pomegranate cultivars; salts concentration; SAR and chloride level (Cl: SO_4 ratio) in irrigation water on leaf nitrogen content, data are presented in **Table (21)**. As for the specific effect of pomegranate cultivars it is so clear that Manfalouty cultivar had significantly the highest value of leaf-N content, followed in descending order by Nab El-Gamal and Wardy cultivars.

Concerning the specific effect of different salts concentrations in the irrigation water on leaf-N content, it is obvious from **Table (21)** that nitrogen level decreased significantly with increasing salts concentration with comparing to those of the control (tap water) during 2000 and 2001 seasons.

The data obtained considering the effect of salinity stress on total nitrogen agreed with those of other investigators i.e. **Salem, (1981)** on grape seedlings; **Abdalla *et al.*, (1981)** on El-Sultani fig; **Patil** and **Patil, (1982), Yamdagni *et al.*, (1988)** and **Ali (2000)** on pomegranate plants; **Kabeel, (1985)** on some deciduous fruits; **Sharaf *et al.*, (1985)** on Thompson seedless and American grapes and **Omar, (1996)** on apricot and mango seedlings. They stated that increasing the salt concentration in irrigation water decreased leaf nitrogen content. In this respect; **Shehata, (1989)** postulated that excess Cl^- in saline water used for irrigation, antagonized the uptake of nitrate by the affected plants. It might also be attributed to rapid protein decay under saline conditions **Prisco** and **O'leary, (1972)**, the reduce capacity for protein synthesis **Aliza *et al.*, (1967)** and/or reduced uptake and incorporation of protein amino acids into protein **El-Shourbagy, *et al.*, (1980)**.

Referring the specific effect of sodium adsorption ratio (SAR) on leaf nitrogen content, data presented in **Table (21)** show a significant decrease with increasing sodium adsorption ratio (SAR) from 3 to 6 during 2000 and 2001 seasons. In this respect, **Kabeel,**

(1985) on three deciduous fruit species seedlings, **Sharaf *et al.*, (1985)** on Thompson seedless and American grapes, **Al-Khateeb, (1989)** on some fig varieties, **Omar, (1996)** on apricot and mango seedlings and **Abd-El-Mageid, (1998)** on almond seedlings. They found that leaf nitrogen content was decreased by increasing sodium absorption ratio (SAR) in irrigation water.

With respect to the specific effect of $Cl:SO_4$ ratio (Chloride levels) on leaf-N content, **Table (21)** shows clearly that leaf nitrogen % significantly decreased with increasing levels of chloride ($Cl:SO_4$ ratio) in irrigation water during both 2000 and 2001 seasons.

This results are in harmony with those reported by **Kabeel, (1985)** on some deciduous fruit species, **Omar, (1996)** on apricot and mango seedlings and **Abd El-Mageid, (1998)** on almond seedlings.

B. Interaction effect:

Regarding the interaction effect of various combination between the four investigated factors i.e., pomegranate cultivars; salinity concentration; SAR and $Cl:SO_4$ ratio on leaf-nitrogen content, data obtained in **Table (21)** showed obviously that the most depressive effect on leaf nitrogen percent was always in concomitant to that combination between Wardy transplants x highest salinity concentration (6000 ppm) x SAR 6 x higher $Cl:SO_4$ ratio. On the contrary, the lowest decrease value in leaf-nitrogen content below control was detected by Manfalouty cultivar transplants irrigated with 2000 ppm saline solution of SAR 3 and lower Cl:SO_4 ratio during two seasons of study. Moreover, other combinations were in between in this concern.

IV.III.7.4. Effect on leaf phosphorus content:

A. Specific effect:

Concerning the specific effect of the different factors involved in this study i.e., pomegranate cultivars; salinity concentration; SAR and chloride level (Cl: SO_4 ratio) on leaf phosphorus content, data as shown in **Table (21)** revealed that Manfalouty cultivar had the highest value of leaf-P content, followed in a descending order by Nab El-Gamal and Wardy cultivars.

Regarding the specific effect of salinity concentration, **Table (21)** shows clearly that phosphorus level in pomegranate cultivars was significantly affected by salt concentration in the irrigation water. In this regard, phosphorus level decreased significantly in leaves with increasing salts concentration in the irrigation water during two seasons of study. These results are in accordance with those obtained by **Patil** and **Patil, (1982), Yamdagni *et al.*, (1988), Ali, (2000)** on pomegranate **El-Azab *et al.*, (1978)** on apricot and peach, **Al-Khateeb, (1989)** on some fig cultivars and **Omar, (1996)** on apricot and mango seedlings. They found that leaf phosphorus content decreased as salinity level increased.

The obtained results go also in line with those reported by **Abdalla *et al.*, (1981)** on fig plants **Salem, (1981)** on grapevine; **Kabeel, (1985)** on some deciduous fruit seedlings; **Gaser, (1986)** on avocado seedlings; **Garacia** and **Charbaji, (1989)** on grapevine plants, **Bondok *et al.*, (1995)** on peach plants and **Attia, (2002)** on olive seedlings. All stated that leaf-P content decreased with increasing salts concentration in irrigation water.

With respect to the specific effect of sodium adsorption ratio SAR it is quite clear that phosphorous level significantly decreased with increasing sodium adsorption ratio (SAR) from 3 to 6 during two seasons of study. In this respect, **Bernstein *et al.*, (1956)** on stone fruits, **El-Ashram *et al.*, (1985)** on some citrus stock seedlings, **Sharaf *et al.*, (1985)** on European and American grape plants and **Al-Khateeb, (1989)** on some fig cultivars did not show any definite differences

Referring the specific effect of Cl:SO_4 ratio of saline solution used for irrigations on leaf phosphorus content, it could be noticed that leaf-phosphorus content was significantly decreased with increasing chloride level in irrigation water during two seasons of study. In this respect **El-Ashram *et al.*, (1985)** on some citrus rootstocks seedlings; **Sharaf *et al.*, (1985)** on guava and olive seedlings; **Kabeel, (1985)** on some deciduous fruit species and **Abd El-Mageid, (1998)** on almond plants reported that no definite differences were detected in this concern.

B. Interaction effect:

Results in **Table (21)** showed obviously the response to the interaction effect of the different combinations between pomegranate cultivars; salts concentration; SAR and chloride levels (Cl: SO_4 ratio) in irrigation water on leaf-phosphorus content. These results revealed that the most depressive irrigation effect solution on leaf phosphorus was detected by that combination between Wardy transplants x highest salinity concentration (6000

Table (21): Leaf Nitrogen and Phosphorus (%) of pomegranate transplants (rooted cuttings) in response to specific and interaction effects of Pomegranate cultivars., (salt concentrations, SAR and Cl:SO4 ratio in saline irrigation water) and their combinations during 2000 & 2001 seasons.

Treatments / Cultivars			Nitrogen (%) Manfalouty	Nitrogen (%) Nab El-Gamal	Nitrogen (%) Wardy	Nitrogen (%) Mean**	Nitrogen (%) Mean***	Nitrogen (%) Mean****	Phosphorus (%) Manfalouty	Phosphorus (%) Nab El-Gamal	Phosphorus (%) Wardy	Phosphorus (%) Mean**	Phosphorus (%) Mean***	Phosphorus (%) Mean****
2000														
Tap water			2.92 a	2.61 e	2.44 f	2.65 A	SAR3	Low Cl	0.387 a	0.33 d	0.31 e	0.34 A	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	2.80 b	2.43 f	2.32 h	2.39 B	2.30 A	2.27 A	0.37 b	0.30 fg	0.30 ef	0.29 B	0.25 A	0.25 A
		High Cl	2.79 c	2.22 j	2.24 i				0.35 c	0.29 h	0.27 i			
	SAR 6	Low Cl	2.68 d	2.19 kl	2.18 l				0.33 d	0.27 i	0.25 j			
		High Cl	2.60 e	2.10 n	2.15 m				0.29 gh	0.24 j	0.23 k			
4000 ppm	SAR 3	Low Cl	2.44 f	2.05 o	2.06 o	2.12 C	SAR6	High Cl	0.27 i	0.21 m	0.22 l	0.20 C	SAR6	High Cl
		High Cl	2.41 g	1.99 pq	2.05 o				0.24 j	0.19 o	0.20 n			
	SAR 6	Low Cl	2.31 h	1.97 q	2.00 p				0.20 mn	0.18 p	0.18 p			
		High Cl	2.20 k	1.93 r	1.98 q				0.19 o	0.16 q	0.15 r			
6000 ppm	SAR 3	Low Cl	1.99 pq	1.89 t	1.91 s	1.81 D	2.19 B	2.22 B	0.16 q	0.13 s	0.13 s	0.12 D	0.23 B	0.23 B
		High Cl	1.97 q	1.88 t	1.83 u				0.14 s	0.12 t	0.12 tu			
	SAR 6	Low Cl	1.89 t	1.71 w	1.63 y				0.12 tu	0.11 uv	0.12 tu			
		High Cl	1.80 v	1.67 x	1.54 z				0.11 vw	0.10 w	0.11 vw			
Mean *			2.37 A	2.05 B	1.91 C				0.24 A	0.20 B	0.20 B			
2001														
Tap water			2.86 a	2.49 d	2.22 f	2.52 A	SAR3	Low Cl	0.37 a	0.31 d	0.29 e	0.32 A	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	2.62 b	2.38 e	2.20 fg	2.29 B	2.18 A	2.16 A	0.33 c	0.28 f	0.28 f	0.28 B	0.24A	0.24 A
		High Cl	2.58 bc	2.16 gh	2.11 hi				0.34 b	0.26 h	0.26 h			
	SAR 6	Low Cl	2.61 b	2.10 i	2.08 ij				0.31 d	0.25 i	0.24 j			
		High Cl	2.55 c	2.04 jk	2.04 jk				0.29 e	0.23 k	0.23 k			
4000 ppm	SAR 3	Low Cl	2.39 e	2.03 jk	2.01 k	2.06 C	SAR6	High Cl	0.27 g	0.20 n	0.21 m	0.19 C	SAR6	High Cl
		High Cl	2.37 e	1.90 mn	2.00 kl				0.22 l	0.17 p	0.20 n			
	SAR 6	Low Cl	2.20 fg	1.95 lm	2.00 kl				0.19 o	0.16 q	0.19 o			
		High Cl	2.17 fg	1.81 o-q	1.86 no				0.17 p	0.16 q	0.17 p			
6000 ppm	SAR 3	Low Cl	1.83 op	1.67 st	1.68 st	1.66 D	2.09 B	2.11 B	0.16 q	0.15 r	0.15 r	0.13 D	0.22 B	0.22 B
		High Cl	1.80 pq	1.64 t	1.71 rs				0.14 rs	0.15 r	0.14 s			
	SAR 6	Low Cl	1.76 qr	1.57 u	1.56 u				0.10 v	0.13 t	0.11 u			
		High Cl	1.69 st	1.54 u	1.47 v				0.10 v	0.10 v	0.10 v			
Mean *			2.26 A	1.95 B	1.92 C				0.23 A	0.20 B	0.19 C			

-*, **, *** and **** means refer to specific effect of pomegranate cvs; salinity concentration; SAR and Cl:SO4 ratio, respectively. Values within the same column or row for any of four investigated factors and their combinations followed by the same letter/s were not significantly different at 5% level. Capital and small letters were used for distinguishing values of either specific effect for each investigated factor or interaction effect of their combinations, respectively.

ppm) x SAR6 x higher Cl:SO_4 ratio as compared to either control or other saline combinations during two seasons of study. On the contrary, the least decrease in leaf-P content below the tap water irrigated transplants (control) was detected by Manfalouty cultivars x salts concentration (2000 ppm)x SAR 3 x low Cl:SO_4 ratio as compared with the control during study. Moreover, other combinations were in between in this concern.

IV.III.7.5. Effect on leaf potassium content :

Results of the two seasons as shown in **Table (22)** show the specific and interaction effects of salts concentration; SAR and Cl:SO_4 ratio in the irrigation water and their combinations on leaf potassium content of pomegranate transplants during 2000 and 2001 seasons.

A. Specific effect:

Concerning the specific effect of pomegranate cultivars on leaf-K content, **Table (22)** shows that Manfalouty cultivar had statistically the highest leaf-K content followed by both Wardy and Nab El-Gamal cultivars, where difference between later cvs. was not significant during two seasons of study.

With respect to, the specific effect of salts concentration, it is obvious from the results of **Table (22)** that pomegranate cultivars transplants irrigated with salinized water had significantly lower potassium % as compared to tap water irrigated ones (control).

From these results, it could be noticed that K concentration, decreased gradually and significantly with increasing salt concentration in the irrigation water from 2000 ppm to 6000 ppm.

during two seasons of study. The depressive effect of salinity on K level may explain the competitive effect of Na^+ ions existed in the prepared saline planting media on the absorption of K^+ ion.

This results is similar to that reported by **Patil** and **Patil, (1982)** on pomegranate **Rains, (1972)**, who confirmed the competition between Na^+ and K^+ ions in the growing media. In addition, **Cooper *et al.*, (1952)**, stated that increasing Ca content in irrigation water depressed K concentration of grapefruit leaves. **Pearson *et al.*, (1957)** found that increasing levels of salinity, as NaCl in irrigation water caused a decrease in leaf potassium content.

Similar findings were also reported by **Aly, (1979)**; **Khandija *et al.*, (1980)** on grapevine; **Kabeel, (1985)** on three deciduous fruit plants; **Al-Khateeb, (1989)** on some fig cultivars, **Omar, (1996)** on apricote and mango seedlings and **Abd El-Mageid, (1998)** on almond plants. They stated that potassium content in leaves decreased by rising salt concentration in irrigation water.

Regarding the specific effect of sodium adsorption ratio (SAR), it is quite clear that leaf-K % was decreased by increasing sodium adsorption ratio (SAR), the decrease was significant during 2000 and 2001 seasons. In this respect, **Bower** and **Wedleigh, (1949)** reported that increasing the exchangeable Na percentage of the growth substrate resulted in decreasing plant K content.

Similar findings were also reported by **Kabeel, (1985)** on three deciduous fruits seedlings; **Al-Khateeb, (1989)** on some fig cultivars; **Omar, (1996)** on apricot and mango seedlings and **Abd-El-Mageid, (1998)** on almond plants.

Referring the specific effect of chloride level ($Cl:SO_4$ ratio) of saline solution used for irrigation on leaf-K content, it could be noticed from **Table (22)** that, the higher $Cl:SO_4$ ratio in irrigation water significantly decreased leaf-K content of pomegranate transplants during 2000 and 2001 seasons. The same trend was found by **Kabeel, (1985)** on three deciduous fruit plants; **Omar, (1996)** on apricot and mango seedlings; **Abd El-Mageid, (1998)** on almond plants, all reported that increasing chloride level in irrigation water decreased leaf-K content in leaves but this decrease was not so pronounced.

B. Interaction effect:

As for the interaction effect of the various combinations between four investigated factors i.e., pomegranate cultivars; salinity concentration; SAR and chloride level ($Cl:SO_4$ ratio) on leaf-K content, data obtained in **Table (22)** showed obviously that the least leaf-K content of pomegranate transplants was always in concomitant to such combinations pomegranate transplants irrigated with saline solution of the highest salinity concentration (6000 ppm); SAR 6 and higher $Cl:SO_4$ ratio, especially Nab El-Gamal cv. In 2000 season and both Wardy and Manfalouty cvs. during 2^{nd} season, whereas the highest decrease was resulted. Moreover, the lowest decrease in leaf-K content exhibited by saline solution was detected by Manfalouty transplants irrigated with 2000 ppm saline solution of SAR 3 and lower $Cl:SO_4$ ratio as compared with these continuously irrigated with tap water during 2000 and 2001 seasons. In addition, other combinations were in between in this concern. The same findings were obtained by

Omar, (1996) on apricot and mango and **Abd El-Mageid, (1998)** on almond plants.

IV.III.7.6. Effect on leaf calcium content :

Data obtained during regarding two seasons the specific effect of pomegranate cultivars; salts concentration; SAR and chloride level (Cl:SO_4 ratio) in the irrigation water and interaction effect of their combinations on leaf Ca content are presented in **Table (22).**

A. Specific effect:

Regarding the specific effect of pomegranate cultivars on leaf calcium content, **Table (22)** clearly shows that, in seasons both Wardy transplants cultivar had statistically the highest value of leaf-Ca content, while Manfalouty leaves were the poorest in 2000 and 2001 seasons. In addition, Nab El-Gamal cv. Was significantly in between.

Concerning the specific effect of salinity concentration in irrigation water on leaf calcium %, data in **Table (22)** revealed that, Ca level increased gradually with increasing salts concentration in irrigation water from 2000 ppm to 6000 ppm. Differences between 3 salinity concentrations (2000, 4000 and 6000 ppm were significant either compared each other or to the non salinized transplants where the later one exhibited the least leaf Ca % during 2001and 2002 seasons. This might be explained according to the finding of **Wallace *et al.*, (1952)** who reported that low K content resulted by plants grown under salinity conditions, tended to compensate their low K content by either high calcium and/or magnesium contents in leaves.

These results confirmed post researches of **Yamdagni *et al.*, (1988)** and **Ali, (2000)** on pomegranate. **Kabeel, (1985)** on grape, peach and plum seedlings; **Gaser, (1986)** on avocado; **Abd El-Ghani, (1990)** on peach; **Omar, (1996)** on apricot and mango seedlings and **Abd El-Mageid, (1998)** on almond plants, whose results showed that Ca^{++} content in salt-treated plants was increased with increasing salinity levels.

Referring the specific effect of sodium adsorption ratio (SAR), it was quite clear that the higher ratio i.e., 6 significantly increased leaf calcium content than the lower one i.e., SAR 3 during 1st and 2nd seasons. These results are similar to that obtained by **Kabeel, (1985)** on grape, peach and plum seedlings; **Al-Khateeb, (1989)** on some fig cultivars; **Omar, (1996)** on apricot and mango seedlings and **Abd El-Mageid, (1998)** on almond plants. All found that leaf-Ca content increased by increasing salt concentration in irrigation water.

As for the specific effect of the $Cl:SO_4$ ratio, on leaf-Ca content, it could be noticed that the higher ratio resulted in a significant increase as compared to the lower one during two seasons of study. In this respect, **Kabeel, (1985)** on some deciduous fruit species; **Omar, (1996)** on apricot and mango seedlings and **Abd El-Mageid, (1998)** on almond plants, who found that leaf-Ca content increased by increasing $Cl:SO_4$ ratio.

B. Interaction effect:

Referring the interaction effect of the combinations between the four investigated factors, i.e., pomegranate cultivars, salinity concentration, SAR and chloride level ($Cl:SO_4$ ratio) on leaf-Ca

Table (22): Leaf Potassium and Calcium (%)of pomegranate transplants (rooted cuttings) in response to specific and interaction effects of Pomegranate cultivars., (salt concentrations, SAR and Cl:SO4 ratio in saline irrigation water) their combinations during 2000 & 2001 seasons.

Treatments / Cultivars			Potassium (%) Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****	Calcium (%) Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****
2000														
Tap water			1.99 a	1.85 b	1.84 b	1.89 A	SAR3	Low Cl	1.48 z	1.50 z	1.59 vw	1.52 D	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	1.79 c	1.63 f	1.71 d	1.58 B	1.45 A	1.41 A	1.53 y	1.54 y	1.69 s	1.66 C	1.75 B	1.78 B
		High Cl	1.71 d	1.52 h	1.67 e				1.55 xy	1.61 uv	1.76 q			
	SAR 6	Low Cl	1.61 g	1.44 j	1.63 f				1.57 wx	1.66 t	1.84 o			
		High Cl	1.52 h	1.34 lm	1.44 j				1.60 v	1.71 rs	1.89 m			
4000 ppm	SAR 3	Low Cl	1.48 i	1.32 m	1.35 l	1.25 C	SAR6	High Cl	1.63 u	1.72 r	1.98 jk	1.87 B	SAR6	High Cl
		High Cl	1.41 k	1.24 n	1.21 o		1.31 B	1.34 B	1.66 t	1.80 p	2.00 ij		1.84 A	1.82 A
	SAR 6	Low Cl	1.41 k	1.16 p	1.11 q				1.71 rs	1.90 m	2.12 g			
		High Cl	1.22 no	1.07 r	1.03 s				1.75 q	1.97 k	2.19 f			
6000 ppm	SAR 3	Low Cl	0.90 uv	0.92 u	0.96 t	0.78 D			1.81 p	2.04 h	2.29 d	2.13 A		
		High Cl	0.90 v	0.83 w	0.79 x				1.87 n	2.06 h	2.33 c			
	SAR 6	Low Cl	0.72 y	0.72 y	0.71 y				1.95 l	2.11 g	2.41 b			
		High Cl	0.66 z	0.63 [	0.67 z				2.02 i	2.23 e	2.48 a			
Mean *			1.33 A	1.21 B	1.24 B				1.70 C	1.83 B	2.04 A			
2001														
Tap water			1.78 a	1.70 ab	1.70 ab	1.73 A	SAR3	Low Cl	1.62 y	1.65 x	1.72 w	1.67 D	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	1.66 a-c	1.54 b-g	1.63 a-d	1.53 B	1.40 A	1.38 A	1.67 x	1.77 u	1.78 u	1.81 C	1.94 B	1.98 B
		High Cl	1.61 b-e	1.50 c-h	1.57 b-g				1.75 v	1.87 q	1.79 tu			
	SAR 6	Low Cl	1.57 b-f	1.42 f-i	1.52 c-h				1.81 st	1.94 p	1.82 s			
		High Cl	1.50 c-h	1.35 h-j	1.49 d-h				1.84 r	2.01 o	1.88 q			
4000 ppm	SAR 3	Low Cl	1.46 e-i	1.31 i-k	1.44 e-i	1.29 C	SAR6	High Cl	1.86 qr	2.06 n	1.94 p	2.10 B	SAR6	High Cl
		High Cl	1.40 g-i	1.29 i-k	1.32 i-k		1.28 B	1.31 B	1.95 o	2.11 l	2.00 o		2.08 A	2.04 A
	SAR 6	Low Cl	1.40 g-i	1.22 jk	1.16 kl				2.01 m	2.16 j	2.33 h			
		High Cl	1.30 i-k	1.16 kl	1.02 lm				2.09 jk	2.25 i	2.47 f			
6000 ppm	SAR 3	Low Cl	1.01 lm	1.02 lm	0.86 m-o	0.80 D			2.12 j	2.34 h	2.52 e	2.454 A		
		High Cl	0.92 mn	0.91 mn	0.70 oq				2.14 kl	2.43 g	2.66 c			
	SAR 6	Low Cl	0.73 o-q	0.84 n-p	0.65 q				2.15 j	2.48 f	2.87 b			
		High Cl	0.68 pq	0.70 o-q	0.62 q				2.24 i	2.57 d	2.93 a			
Mean *			1.31 A	1.23 B	1.20 B				1.94 C	2.13 B	2.21 A			

*, **, *** and **** means refer to specific effect of pomegranate cvs; salinity concentration; SAR and Cl:SO4 ratio, respectively. Values within the same column or row for any of four investigated factors and their combinations followed by the same letter/s were not significantly different at 5% level. Capital and small letters were used for distinguishing values of either specific effect for each investigated factor or interaction effect of their combinations, respectively.

content, data obtained in **Table (22)** showed obviously the variable response during the two seasons. The highest leaf-Ca content was related to such combination between Wardy transplants irrigated with saline solution of the highest salinity concentration (6000 ppm); SAR 6 and higher $Cl:SO_4$ ratio. However, the lowest leaf-Ca content was detected by Manfalouty transplants irrigated with 2000 ppm saline solution of SAR 3 and lower $Cl:SO_4$ ratio as compared to those continuously irrigated with tap water (control) during both 2000 and 2001 seasons.

These may mean that the four tested factors can act together in affecting Ca level in separable way. Moreover, other combinations were in between in this concern. The same trend was found by **Omar, (1996)** on apricot and mango seedlings and **Abd El-Mageid, (1998)** on almond plants.

IV.III.7.7. Effect on leaf magnesium content :

Regarding the specific and interaction effects of pomegranate cultivars; salts concentration; sodium adsorption ratio (SAR) and chloride level ($Cl: SO_4$ ratio) in irrigation water and their combinations on leaf magnesium level data obtained during both seasons are presented in **Table (23).**

A. Specific effect:

Concerning the specific effect of pomegranate cultivars; data obtained revealed that Manfalouty cultivar had the richest leaves in their Mg content, however difference was significant as compared to two other cvs during 1^{st} season and Wardy cv during 2^{nd} season.

On the contrary both Nab El-Gamal and Wardy cultivars had the poorest leaves during 2000 and 2001 seasons, respectively.

With respect to the specific effect of salinity concentration, data obtained revealed that three investigated concentrations i.e., 2000, 4000 and 6000 ppm saline solutions resulted significantly in decreasing leaf magnesium content as compared to those of tap water irrigation during two seasons. On the other hand, a gradual decrease in leaf-Mg content was significantly exhibited as salinity in irrigation water increased during two seasons of study.

These findings are supported by those of **Wallace *et al.*, (1952)** who reported that plant with low K-level obtained under salinity condition tended to compensate the low K level by either high calcium and/or magnesium contents in leaves. This results are in agreement with the findings by **Downton, (1978)** who reported that Mg^{++} content tended to increase somewhite in avacodo by salinity. On the other hand, **El-Azab** and **Minessy, (1975)** on grape; guava and olive and **Nasr *et al.*, (1977)** on plum showed that Mg^{++} content did not differ markedly with salinity condition. Moreover, **Al-Khateeb, (1989)** on some fig cultivars mentioned that leaf Mg^{++} content was decreased significantly by using different saline solutions for irrigation as compared with those irrigated with tap water.

Gaser, (1986) on avocado; **El-Hefnawy, (1986)** on guava; **Omar, (1996)** on apricot and mango seedlings and **Abd El-Mageid, (1998)** on almond plants all, concluded that using different saline solutions significantly decreased leaf Mg content.

Regarding the specific effect of SAR, it was quite clear that the higher ratio i.e. SAR 6 significantly decreased leaf. Mg content of pomegranate transplants as compared to the lower one (SAR 3) during 2000 and 2001 seasons. This result is confirmed by findings of **Al-Khateeb, (1989)** on some fig cultivars and **Kabeel, (1985)** on grape, peach and plum.

As for the specific effect of the Cl:SO_4 ratio, on leaf-Mg content **Table (23)** shows that the higher level decreased it slightly during the 1st and 2nd seasons. Such trend is in agreement with that reported by **Omar, (1996)** on apricot seedlings.

B. Interaction effect:

Referring the interaction effect of the different combinations between four investigated factors, i.e., pomegranate cultivars; salinity concentration; sodium adsorption ratio (SAR) and Cl:SO_4 ratio on leaf magnesium content, data obtained in **Table (23)** showed obviously the variable response during 2000 and 2001 seasons. The least leaf-Mg content was related to that combinations representative of Wardy and Nab El-Gamal transplants irrigated with saline solution of the highest salinity concentration (6000 ppm); SAR 6 and higher Cl:SO_4 ratio. On the contrary, the highest value of leaf-Mg content was detected by tap water irrigated Manfalouty transplants followed by those of the same cultivar irrigated with 2000 ppm saline solution of lower SAR3 and Cl: SO_4 ratio during 2000 and 2001 seasons. Moreover, other combinations were in between. These results indicated that the four factors can act together in affecting leaf-Mg content. Similar results were obtained by **Omar, (1996)** on apricot and mango seedlings and **Abd El-Mageid (1998)** on almond plants.

IV.III.7.8. Effect on leaf iron content:

Results presented in **Table (23)** show the specific and interaction effects of pomegranate cultivars; salts concentration, SAR; $Cl:SO_4$ ratio in irrigation water and their combinations on leaf- Fe content during 2000 and 2001 seasons.

A. Specific effect:

Concerning the specific effect of the different factors involved in this study i.e., pomegranate cultivars; salinity concentration; SAR and $Cl:SO_4$ ratio on leaf iron content, data obtained in **Table (23)** showed that Manfalouty cultivar plants had the greatest value of leaf- Fe content followed in descending order by Nab El-Gamal and Wardy cultivars in both seasons.

With respect to the specific effect of salinity concentration, the obtained results indicated that leaf iron content significantly decreased by raising salinity concentration in irrigation water during the two seasons of study. Differences between different salinity levels were significant.

These results are confirmed by the findings of **Patil** and **Patil, (1982)** on pomegranate, **Aly *et al.*, (1986a)** on some citrus rootstocks and **El-Hefinawy, (1986)** on guava, all found that leaf Fe content decreased with increasing levels of salinity. In this concern from another point of view, **Bartolini *el al.*, (1991)** working on olive plants, found that leaf- Fe content was not changed under different salinity levels. On the contrary **Ivanov, (1971)** working on apricot and **Gaser, (1986)** on avocado, who reported that leaf- Fe concentration increased by increasing salinity concentration.

Table (23): Leaf Magnesium and Iron contents (ppm) of pomegranate transplants (rooted cuttings) in response to specific and interaction effects of Pomegranate cultivars., (salt concentrations, SAR and Cl:SO4 ratio in saline irrigation water) and their combinations during 2000 & 2001 seasons.

Treatments		Cultivars	Magnesium (%) Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****	Iron (ppm) Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****
2000														
Tap water			0.84 a	0.67 g	0.75 c	0.75A	SAR3	Low Cl	232.6 a	228.0 c	211.1 j	223.9A	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	0.79 b	0.62 j	0.71 d	0.65 B	0.58A	0.57 A	230.3 b	224.3 d	208.4 k	217.0B	209.11 A	207.31 A
		High Cl	0.74 c	0.60 k	0.68 f				227.4 c	220.7 e	206.2 m			
	SAR 6	Low Cl	0.70 e	0.57 m	0.64 i				224.5 d	219.4 f	203.4 n			
		High Cl	0.65 h	0.51 o	0.58 l				220.5 e	217.8 g	201.3 o			
4000 ppm	SAR 3	Low Cl	0.60 k	0.49 p	0.54 n	0.48C	SAR6	High Cl	217.0 h	213.3 i	196.9 r	201.7C	SAR6	High Cl
		High Cl	0.55 n	0.46 q	0.49 p				213.9 i	209.0 k	192.2 s			
	SAR 6	Low Cl	0.50 o	0.42 s	0.45 r		0.53B	0.54 A	207.3 l	199.1 q	188.1 t		202.85 B	204.66 B
		High Cl	0.45 r	0.41 t	0.41 t				200.4 p	199.1 q	184.4 w			
6000 ppm	SAR 3	Low Cl	0.41 t	0.39 u	0.36 v	0.34 D			196.8 r	187.2 u	180.4 x	181.3D		
		High Cl	0.39 u	0.34 w	0.32 x				191.6 s	180.3 x	179.2 y			
	SAR 6	Low Cl	0.36 v	0.31 y	0.28 z				185.2 v	175.7 [	174.6 \			
		High Cl	0.34 w	0.28 z	0.31 xy				178.4 z	175.1 [\	170.6]			
Mean *			0.56 A	0.47 B	0.50 B				209.7 A	203.8 B	192.1 C			
2001														
Tap water			0.737 a	0.640 b	0.577 c	0.65 A	SAR3	Low Cl	218.3 a	214.3 c	198.4 l	210.4A	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	0.660 b	0.597 c	0.483 fg	0.53 B	0.49 A	0.48 A	215.4 b	209.7 de	195.4 n	203.6B	197.92 A	196.55 A
		High Cl	0.647 b	0.543 d	0.463 gh				213.6 c	210.3 d	192.4 o			
	SAR 6	Low Cl	0.583 c	0.513 e	0.423 ij				210.3 d	206.0 g	190.1 p			
		High Cl	0.513 e	0.507 ef	0.407 jk				209.1 e	203.3 i	187.3 q			
4000 ppm	SAR 3	Low Cl	0.490 e-g	0.480 fg	0.383 kl	0.40 C	SAR6	High Cl	207.4 f	204.1 hi	181.5 s	192.8C	SAR6	High Cl
		High Cl	0.443 hi	0.423 ij	0.367 lm				204.8 h	200.1 k	175.7 t			
	SAR 6	Low Cl	0.417 ij	0.407 jk	0.343 mn		0.45 B	0.46 A	201.7 j	197.2 m	172.7 w		192.75 B	194.12 B
		High Cl	0.343 mn	0.383 kl	0.330 n-p				199.0 l	195.3 n	173.5 v			
6000 ppm	SAR 3	Low Cl	0.327 n-q	0.340m-o	0.313 o-r	0.30 D			195.6 n	185.1 r	164.7 z	174.7D		
		High Cl	0.300 q-t	0.303 p-s	0.307 p-s				190.1 p	174.5 u	167.3 y			
	SAR 6	Low Cl	0.300 q-t	0.293 r-t	0.293 r-t				187.3 q	172.1 w	158.6 [			
		High Cl	0.293 r-t	0.280 st	0.270 t				181.3 s	168.3 x	150.8 \			
Mean *			0.46 A	0.44 A	0.38 B				202.6 A	181.2 B	177.6 C			

*, **, *** and **** means refer to specific effect of pomegranate cvs; salinity concentration; SAR and Cl:SO4 ratio, respectively. Values within the same column or row for any of four investigated factors and their combinations followed by the same letter/s were not significantly different at 5% level. Capital and small letters were used for distinguishing values of either specific effect for each investigated factor or interaction effect of their combinations, respectively.

Referring the specific effect of sodium adsorption ratio (SAR) on leaf Fe content, it was quite clear that increasing sodium adsorption ratio (SAR) significantly decreased leaf iron content during two seasons of study.

As for the specific effect of the $Cl:SO_4$ ratio of saline solution used for irrigation water on leaf iron content, it could be noticed that increasing the chloride level ($Cl:SO_4$ ratio) slightly decreased leaf- Fe content in both seasons of study.

B. Interaction effect:

Table (23) reveals that leaf iron level was greatly affected by various combinations between four investigated factors as they can act together in affecting Fe level in pomegranate leaves during two seasons of study. In addition, the pattern of Fe distribution showed that leaves of Wardy cultivar plants irrigated with the highest salt concentration (6000 ppm) of SAR 6 and high $Cl:SO_4$ ratio had the lowest value leaf Fe content while the reverse was true with Manfalouty plants irrigated with tap water during the two seasons of study. In addition, other investigated combinations were in between.

IV.III.7.9. Effect on leaf manganese content:

Data obtained regarding the specific and interaction effects of pomegranate cultivars; salts concentration; sodium adsorption ratio (SAR); chloride level ($Cl:SO_4$ ratio) and their combinations on leaf-Mn content of pomegranate transplants are presented in **Table (24).**

A. Specific effect:

Regarding the specific effect of the different factors involved in this study i.e., pomegranate cultivars; salinity concentration; SAR and $Cl:SO_4$ ratio on leaf-Mn content, data as shown in **Table (24)** revealed that Manfalouty cultivar had significantly the greatest value of leaf Mn content followed in a decreasing order by Nab El-Gamal transplants and Wardy transplants. Differences were significant with comparing Manfalouty to Wardy during two seasons, while both Manfalouty and Nab El-Gamal were equally the same from statistical point of view.

Concerning the specific effect of salts concentration, data obtained revealed that all three investigated concentrations (2000, 4000 nd 6000 ppm) of saline solutions resulted significantly in an obvious decrease in leaf-Mn content during 2000 and 2001 seasons. Such decrease in leaf-Mn content was significant as compared to those of tap water irrigated pomegranate transplants. On the other hand, leaf-manganese level significantly decreased with increasing salts concentration up to 6000 ppm, where differences between three tested levels were significant during two seasons of study.

In this respect, **Patil** and **Patil, (1982)** on pomegranate, found that, leaf-Mn content decreased with increasing salinity concentration in irrigation water.

Moreover, **Gaser, (1986)** found that leaves of some avocado rootstocks seemed to accumulate higher amounts of Mn in their organs, especially leaves than those of others under salinity levels. However, **Bartolini *et al.*, (1991)** on olive plants reported that leaf Mn concentration was unaffected by different salinity levels. From another point of view, **Dilley, (1958)** found that increasing Cl^- in the soil caused an increase in leaf-Mn content of apple, peach and cherry.

With respect to the specific effect of sodium adsorption ratio (SAR), it was quite clear that the higher ratio i.e., SAR 6 resulted in slight decrease in leaf-Mn content below SAR 3, where difference was too few to reach level of significance during two seasons of study. The present trend agrees with the finding of **Omar, (1996)** on apricot seedlings.

As for the specific effect of $Cl:SO_4$ ratio in saline solution used for irrigation on leaf manganese content, it could be noticed that increasing chloride level ($Cl:SO_4$ ratio) in irrigation water decreased slightly leaf-Mn content during 2000 and 2001 seasons. In this concern, the present trend goes partically with findings of **Omar, (1996)** on apricot and mango seedlings and **Abd El-Mageid, (1998)** on almond plants, who reported that increasing the level of chloride in irrigation water did not affect leaf-Mn content.

B. Interation effect:

Regarding the interaction effect of various combination between the four investigated factors i.e., pomegranate cultivars; salinity concentration; SAR and $Cl:SO_4$ ratio, on leaf-Mn content, data obtained in **Table (24)** showed obviously that, the most depressive effect on leaf-Mn was resulted by that combination representative of irrigated transplants of Wardy transplants with saline solution of the highest salinity concentration (6000 ppm) of SAR 6 and higher $Cl:SO_4$ ratio. However, the lowest decrease in leaf-Mn content was detected by those transplants of Manfalouty cultivar irrigated with 2000 ppm saline solution of SAR 3 and lower Cl:SO_4 ratio as compared to those continuously irrigated with tap water (control) during 2000 and 2001 seasons. Moreover, other combinations are in between the aforesaid two extremes in this concern. Similar findings were obtained by **Omar, (1996)** on apricot and mango seedlings and **Abd El-Mageid, (1998)** on almond plants.

IV.III.7.10. Effect on leaf zinc content:

Data obtained during both 2000 and 2001 seasons regarding the specific and interaction effects of pomegranate cultivars; salts concentration; SAR and Cl:SO_4 ratio in irrigation water and their combinations on leaf-Zn content are presented in **Table (24).**

A. Specific effect:

Concerning the specific effect of the different factors involved (pomegranate cultivars, salts concentration, SAR and Cl:SO_4 ratio) on leaf-Zn content, the results presented in **Table (24)** clearly show that, Manfalouty cultivar (in both seasons) showed significantly the highest value of leaf-Zn content than Nab El-Gamal and Wardy cultivars, where both were equally the same from statistical point of view during both experimental seasons.

Regarding the specific effect of salinity concentrations **Table (24)** shows that three saline solutions resulted in an obvious decrease in leaf-Zn content below control during two seasons of study. Differences in leaf-Zn content was significant either 3 solutions were compared each other or to those of tap water (control) during 2000 and 2001 seasons. Such trend is supported by those of **Patil** and **Patil, (1982)** on pomegranate, **Patil *et al.*, (1984)** on guava leaves, **Aly *et al.*, (1986-a)** on Cleopatra mamadrain and

Troyer citrange, **El-Hefinawy, (1986)** on guava leaves and **Gaser, (1986)** on Avocado plants regarding the influence of *salinity* concentration on Zn content.

With respect to the specific effect of sodium adsorption ratio (SAR), it was quite clear that the higher ratio i.e. SAR 6 significantly decreased leaf-Zn content below lower SAR 3 during the two seasons of study.

This trend goes with the findings of **Omar, (1996)** on apricot seedlings and **Abd El-Mageid, (1998)** on almond plants.

As for the specific effect of Cl:SO_4 ratio of saline solution used for irrigation on leaf zinc content, it could be noticed that, the higher chloride level (Cl:SO_4 ratio) slightly decreased leaf-Zn content during 2000 and 2001 seasons. The same trend was found by **Omar, (1996)** on mango seedlings.

B. Interaction effect:

Regarding the interaction effect of various combinations between four investigated factors i.e., pomegranate cultivars; salinity concentration, SAR and Cl:SO_4 ratio, on leaf-Zn content, data obtained in **Table (24)** showed obviously variable response during 2000 and 2001 seasons. Hence, the most depressive effect on Zn concentration was detected by Manfalouty transplants irrigated with the highest salinity concentration (6000 ppm) of SAR 6 and higher Cl:SO_4 ratio whereas, the lowest leaf-Zn content was resulted. On the other hand, the lowest decrease in leaf-Zn content below control was detected by Manfalouty transplants irrigated with 2000 ppm saline solution of SAR 3 and lower Cl:SO_4 ratio during both seasons of study. Moreover, other combinations were in between in this concern.

Table (24): Leaf Manganese and Zinc contents of pomegranate transplants (rooted cuttings) in response to specific and interaction effects of Pomegranate cultivars., (salt concentrations, SAR and Cl:SO4 ratio in saline irrigation water) and their combinations during 2000 & 2001 seasons.

Treatments		Cultivars	Manganese (ppm) Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****	Zinc (ppm) Manfalouty	Nab El-Gamal	Wardy	Mean**	Mean***	Mean****
2000														
Tap water			50.40 a	50.53 a	47.19 e	49.37A	SAR3	Low Cl	48.91 a	45.17 cd	45.53 c	46.54A	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	50.21 a	49.39 b	46.08 f				47.08 b	44.11 ef	43.70 fg			
		High Cl	49.08 b	49.60 b	45.16 hi	47.88B	47.05 A	46.86 A	46.70 b	41.84 h	42.25 h	43.08B	41.25 A	40.64 A
	SAR 6	Low Cl	49.56 b	49.17 b	45.38 gh				44.67 c-e	40.70 ij	41.43 hi			
		High Cl	48.34 c	47.98 cd	44.65 i-k				44.53 d-f	39.99 jk	39.93 jk			
4000 ppm	SAR 3	Low Cl	48.32 c	47.41 de	44.12 kl		SAR6	High Cl	43.09 g	38.51 l	39.63 k		SAR6	High Cl
		High Cl	47.53 de	47.51 de	43.62 lm	45.71C			40.44 jk	38.02 l	37.96 l	38.14C		
	SAR 6	Low Cl	46.94 e	46.00 fg	43.06 m				39.56 k	37.04 m	35.20 no			
		High Cl	46.03 fg	45.98 fg	42.04 n		46.21 A	46.401A	38.61 l	35.06 no	34.54 no		39.06 B	39.67 A
6000 ppm	SAR 3	Low Cl	45.53 f-h	46.03 fg	42.02 n				37.16 m	34.98 no	33.50 p			
		High Cl	44.97 h-j	45.48 f-h	40.95 o	43.55D			35.37 n	34.36 o	32.18 qr	32.87D		
	SAR 6	Low Cl	44.70 i-k	44.60 i-k	40.02 p				32.51 q	32.18 qr	31.12 st			
		High Cl	44.50 jk	44.40 jk	39.38 q				29.35 u	31.41 rs	30.38 t			
Mean *			47.39 A	47.24 A	43.36 B				40.61 A	38.95 B	37.49 B			
2001														
Tap water			49.30 a	48.36 b	45.34 ef	47.67A	SAR3	Low Cl	53.65 a	51.76 b	50.44 c	51.95A	SAR3	Low Cl
2000 ppm	SAR 3	Low Cl	48.57 b	46.20 d	44.72 g				51.70 b	51.20 b	48.64 e			
		High Cl	49.35 a	45.11 f	43.67 h	45.73B	44.60 A	44.57A	50.36 c	49.50 d	46.90 f	48.13 B	45.54 A	44.91 A
	SAR 6	Low Cl	48.63 b	45.65 e	43.35 i				49.65 d	46.80 f	45.70 gh			
		High Cl	47.04 c	43.92 h	42.52 j				48.72 e	44.70 i	43.75 jk			
4000 ppm	SAR 3	Low Cl	46.16 d	43.09 i	41.66 l		SAR6	High Cl	46.13 g	43.30 k	40.83 mn	41.75 C	SAR6	High Cl
		High Cl	46.77 c	42.07 k	41.09 mn	42.93C			45.34 h	42.13 l	40.11 op			
	SAR 6	Low Cl	45.36 ef	42.09 k	40.14 p				44.12 j	40.35 no	39.64 p			
		High Cl	44.54 g	42.15 k	40.09 p		43.88 A	43.91 A	42.33 l	38.57 q	38.12 qr		43.13 B	43.76 A
6000 ppm	SAR 3	Low Cl	43.83 h	41.36 lm	39.67 q				41.15 m	33.93 u	38.15 qr			
		High Cl	42.11 k	40.74 o	38.18 s	40.63D			38.56 q	35.72 t	37.70 rs	35.51 D		
	SAR 6	Low Cl	42.72 j	41.63 l	38.77 r				33.72 u	33.80 u	37.33 s			
		High Cl	40.14 p	40.82 no	37.53 t				31.64 w	31.73 w	32.75 v			
Mean *			45.73 A	43.32 AB	41.29 B				44.39 A	41.81 B	40.54 B			

*, **, *** and **** means refer to specific effect of pomegranate cvs; salinity concentration; SAR and Cl:SO4 ratio, respectively. Values within the same column or row for any of four investigated factors and their combinations followed by the same letter/s were not significantly different at 5% level. Capital and small letters were used for distinguishing values of either specific effect for each investigated factor or interaction effect of their combinations, respectively.

The present data of nutritional status i.e., leaf mineral composition of Manfalouty cultivar plants revealed an apparent increase in leaf dry weight accompanied by sharp decrease in leaf N, P and K content as a result of the increase in salt uptake which caused nutritional imbalance in the plant by depressing N, P and K uptake **Faruqe, (1968)** the increase in pH value in root medium, the matter that makes many nutrients becoming unavailable to the plants **Russell, (1982).**

Manfalouty cultivar was more tolerant to salinity treatments as it recorded more dry matter and mineral nutrient elements (N, P, K, content) while Wardy transplants showed less degree of salt tolerance.

Generally, it could be concluded that the reduction in growth of pomegranate cultivars seedlings associated with salinity stress noticed in the present investigation might be attributed to the process of building up the osmotic pressure of the developing cells by adjusting salts accumulation to meet the increasing osmotic pressure of the rooting medium **Bernstein, (1961** and **1975)** and **Munns *et al.*, (1982)**. It might also be due to the result of specific toxic effects of some ions excessively absorbed from saline soil solution.

The imbalance in nutritional cations in tissues of salt-stressed plants may be responsible for the depression of growth **Strogonov, (1962)** in connection with these views, **Greenway, (1963)** stated that salinity reduced plant height either by making osmotic cell enlargement dependent on solute accumulation or by the drastic changes in the ion relation, reduction of growth of pomegranate salt- stressed plants could also be attributed to the reduction in carbon fixation by photosynthesis and to increasing carbon release in respiration **Gale, (1975).**

The changes in many metabolic process including enzyme activity, protein synthesis and the activity of mitochondria and chloroplasts might also play role in growth reduction of salt-stressed plants **Poljackoff** and **Gale, (1975)**.

Balba, (1984) stated that the harmful effect of salts on plant growth is related to nutrient changing of their forms in the soil or to competition between the salt cations and anions with the nutrients.

Other causes are more related to the plant itself, which affect its ability to absorb water or directly affect the plant biochemical processes due to toxicity.

IV.IV. Anatomical structure:

The effect of irrigation with saline solution of the highest concentration (6000 ppm), sodium adsorption ratio (SAR 3 & 6) and chloride level (High and Low) beside tap water irrigated pomegranate transplants as control during 2nd 2001 growing season on the leaf and root anatomy of Manfalouty, Nab El-Gamal and Wardy pomegranate cvs. transplants have been studied in this work.

a. Leaf anatomy:

Data obtained regarding the response of investigated leaf structural features to the irrigation saline solution with 6000 ppm saline solution of two SAR and Cl: SO_4 levels (6 & 3 and lower & higher, respectively) are presented in **Table (25)** and illustrated by photos (1); (2) and (3).

1. Epiderms layer:

Concerning epiderms layer, as showen in **Table (25).** It is clear that, Manfalouty cv. 6000 ppm (SAR6) and high chloride treatment only, exhibited an increase in the lower epiderms, although there was no effect either for lower or upper epidermis as affected by the rest of salt concentrations compared to the transplants irrigated with tap water.

As for Nab El-Gamal cv. **Table (25)**, it is obvious that irrigation with saline solutions increased the upper and lower epidermis except 6000 ppm concentration with SAR 3 and high chloride treatment didn't show difference is compared to the control. On the other hand, the upper epiderms of Wardy cv. **Table (25)** was decreased as affected by salts in irrigation water, however the lower epiderms of the same cultivar was not influenced by salt concentrations in irrigation water (SAR, 3 & 6) or chloride (high & low). These results go in harmony with **Ahmed, (1982), EL-Hamady *et al.*, 1986)**, and **Laz, *et al.*, (2005).**

2- Palisade layer:

According to palisade layer of Manfalouty cv. **Table (25)**, it was decreased as salt concentrations in irrigation water reached 6000 ppm (SAR, 6 & high chloride) in comparison with the control. Reversly, other salt treatments increased palisade layer of the same cv. when compaerd to plants irrigated with tape water.

Nab El-Gamal cv. **Table (25)** leaf palisade layer was increased when irrigated with 6000 ppm saline solution of low Cl: SO_4 ratio and solutions regardless of SAR. However, the same concentrations of SAR 3 and high chloride reduced the palisade layer but at SAR 6 didn't influence it. Meantime, Wardy cv. **Table (25),** although as general palisade layer was generally reduced by most salt solutions as compared to the leaf of the control plants (irrigated with tap water). These data coincide with the data obtained by **Sourial et al., (1978),** and **Ahmed (1982).**

3-Spongy layer:

Data in **Table (25)** showed the effect of salt concentrations on the spongy cells layer of Manfalouty leaf. It is obvious that, the songy layer of the plants irrigated with saline solutions was increased compared with that of the plants irrigated with tape water. In the same time the increase exhibited by saline solution of lower SAR (3) was more pronounced than that of higher one.

Nab El-Gamal spongy layer **Table (25)** was increased with low SAR and high chloride treatment. The reverse was true for saline solutions with low chloride (SAR 3 or 6) treatments. Whereas, there was no effect of the extreme salt solution and chloride. However, Wardy cv. **(Table 25)** responded positively to salt solutions either with low or high SAR and low or high chloride. This mean salt treatments increased the spomgy layer and the extreme was with the highest SAR and chloride levels. The effect of the irrigation of saline solutions on the leaf spongy tissue were presented by **Salem et al, (1989)** and **Abd El-Karim (1991).**

4- Blade thickness:

Concerning the balde thickness of Manfalouty pomegranate cv. **(Table 25)**, data obtained revealed that, the blade thickness was increased by saline solutions, especially at lower (3) SAR. Meantime, blade thickness of Nab El-Gamal cv. **Table (25)** was increased by saline solutions (SAR 3 or 6) but the rate was more pronounced with the higher SAR (6) regardless of Cl: SO_4 ratio. Moreover, Wardy cv. blade thickness **Table (25)** was increased as SAR increased except that of low SAR (3) and high chloride was reduced in blade thickness. The effect of saline solutions on leaf blade thickness was reported by **Sourial *et al.*, (1978)** and **Mohsen *et al.*, (1987)**.

5- Midribe Thickness:

As for the leaf Midrib thickness in **Table (25)** reveals obviously that, salt treatments increased the leaf midrib thickness of Manfalouty cv., however the concentration of 6000 ppm with SAR (6) and low chloride reduced the leaf midrib thickness. Whereas, leaf midrib thickness of Nab El-Gamal cv. **Table (25)** exhibited also an increase in thickness especially at SAR 6, regardless of Cl: SO_4 ratio. On contrast, leaf midrib thickness of Wardy cv. **Table (25)** was reduced when irrigated with salt solutions and there was a direct relationship between the midrib thickness and the concentration of saline solution. The reduction of the main vein and vascular system of Mango seedlings leaf as affected by salt stress was discussed by **Maksoud, (1988)**. However, **Mohsen, *et al.*, (1987)** indicated that the leaf midrib increased in the leaf of guava seedlings irrigated with salt solutions.

6-Vascular bundle thickness:

Thickness of vascular bundle was increased in the leaf of Manfalouty pomegranate transplants **Table (25)** as affected by the irrigation of saline solution either with low or high chloride or SAR, 3 or 6.

Table (25): Some measurements of leaf anatomical examination in Manfalouty; Nab El-Gamal and Wardy Pomegranate cultivars as affected by 6000 ppm saline solution of two SAR (3 & 6) and Cl: SO4 (low & high) ratios during 2001growing season. X = 60

Treatments	SAR	Chloride	Upper epidermis (µ m)			Lower epidermis (µ m)			Palisade layer (µ m)			Spongy layer (µ m)			Blade thickness (µ m)			Thickness of the main vein (µ m)			Thickness of vascular bundle (µ m)		
			M	N	W	M	N	W	M	N	W	M	N	W	M	N	W	M	N	W	M	N	W
Tap water			2	2	3	1	1	2	5	5	8	2	6	3	11	14	16	47	40	60	53	65	75
Salt 6000 ppm	3	Low	2	3	2	1	2	2	6	6	5	6	5	8	15	16	17	50	40	٤٢	60	55	40
		High	2	3	2	1	1	2	6	3	6	6	7	5	15	14	15	50	43	42	60	48	60
	6	Low	2	3	2	1	2	2	6	6	٦	3	5	4	12	17	14	45	52	55	55	62	60
		high	2	3	2	2	2	2	4	5	7	3	6	9	11	17	20	50	65	55	55	68	75

M= Manfalouty cultivar   N= Nab El-Gamal   W= Wardy

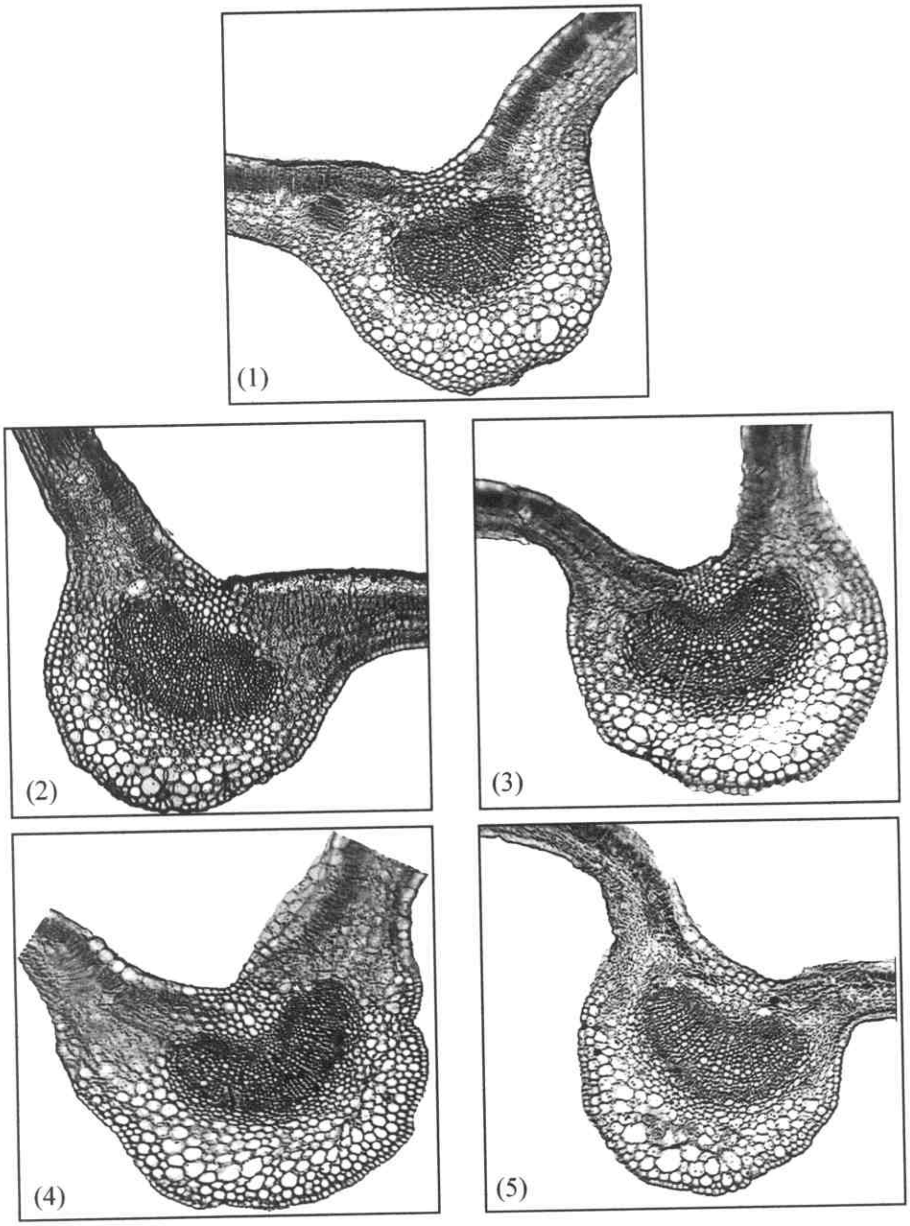

Photo (1): Leaf anatomical structure of Manfalouty Pomegranate transplants as influenced by salinity stress (X = 60).

(1) Tap water.
(2) 6000 ppm × SAR3 × Low Cl: SO_4.
(3) 6000 ppm × SAR3 × High Cl: SO_4.
(4) 6000 ppm × SAR6 × Low Cl: SO_4.
(5) 6000 ppm × SAR6 × High Cl: SO_4.

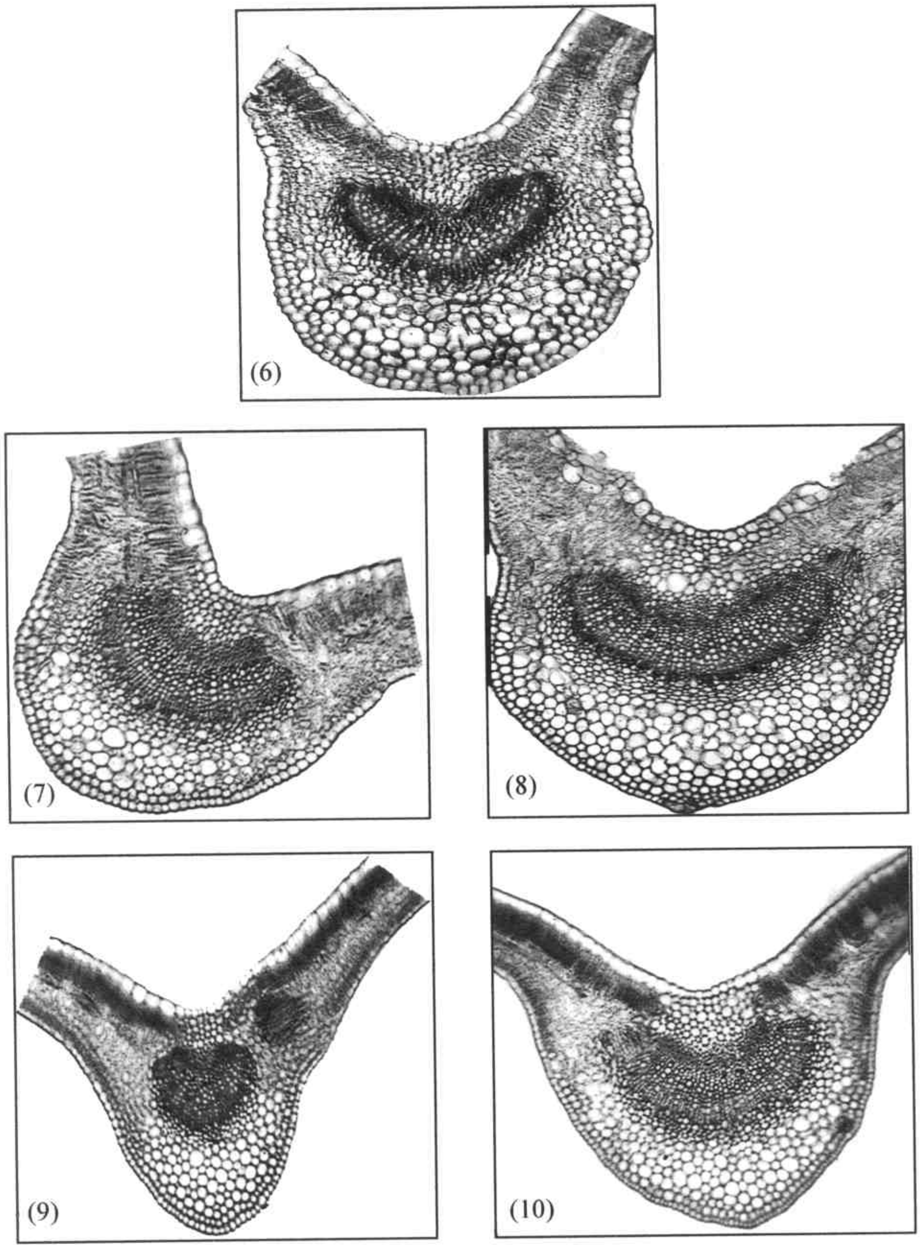

Photo (2): Leaf anatomical structure of Nab El Gamal Pomegranate transplants as influenced by salinity stress (X = 60).

(6) Tap water.
(7) 6000 ppm × SAR3 × Low Cl: SO_4.
(8) 6000 ppm × SAR3 × High Cl: SO_4.
(9) 6000 ppm × SAR6 × Low Cl: SO_4.
(10) 6000 ppm × SAR6 × High Cl: SO_4.

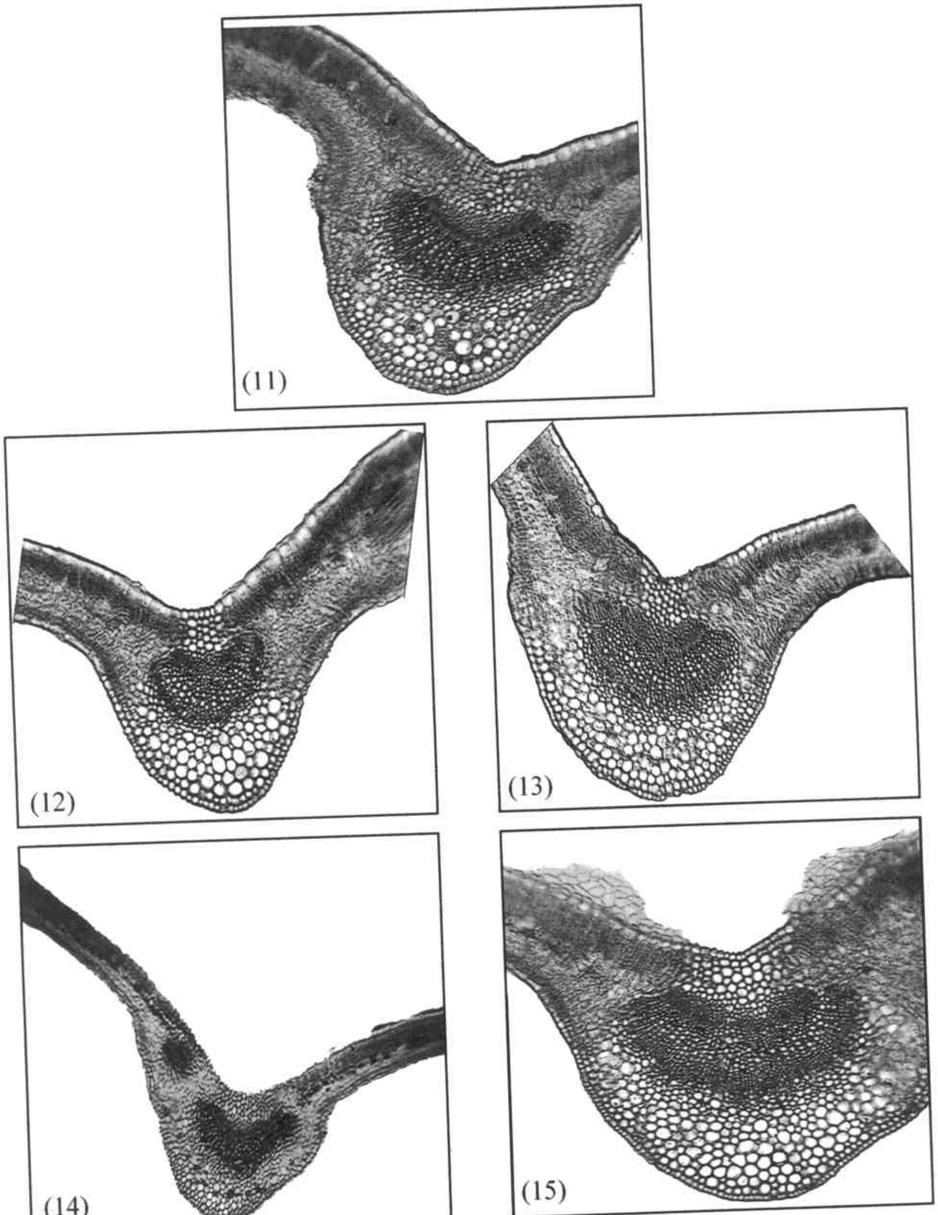

Photo (3): Leaf anatomical structure of Wardy Pomegranate transplants as influenced by salinity stress (X = 60).

(11) Tap water.
(12) 6000 ppm × SAR3 × Low Cl: SO_4.
(13) 6000 ppm × SAR3 × High Cl: SO_4.
(14) 6000 ppm × SAR 6 × Low Cl: SO_4.
(15) 6000 ppm × SAR6 × High Cl: SO_4.

Whereas, both Nab El-Gamal and Wardy cvs. **Table (25)** were exhibited less thickness of leaf vascular bundle when irrigated with saline solutions compard to the control irrigated with tap water. Meanwhile, the higher SAR and chloride increased the thickness of vascular bundle than the control in Nab El-Gamal. However, the same concentration of saline solution didn't affect the same character in Wardy cv. **Table (25)**. These results go on line with the findings of **Sourial** ***et al.*****, (1978)** and **Ahmed, (1982).**

b- Root anatomy:

Data obtained concerning the response of examined root structural features of 3 pomegranate cultivars (Manfalouty; Nab El-Gamal and Wardy) to 6000 ppm saline solution of SAR (3 & 6) Cl: SO_4 ratio (high & low) are presented in **Table (25)** and illustrated by photos (4); (5) and (6).

The root anatomy of three pomegranate cvs. under study (Manfalouty, Nab El-Gamal and Wardy) as affected by the irrigation with 6000 ppm of two SAR levels (3 & 6) at either low or high Cl: SO_4 ratio was investigated.

1- Periderm layer:

Periderm layer in the root of Manfalouty cv. **Table (26)** was reduced either with SAR or chloride level. It was decreased as SAR and chloride level was increased in irrigation water i.e we can say that, the least thickness of periderm layer was exhibited by Manfalouty transplants irrigated with the 6000 ppm saline solution of (SAR6) and high chloride. The same trend was found with transplants of Nab El-Gamal and Wardy cvs. where the periderm layer was decreased to reach minimum value with 6000 ppm (SAR 6) and high chloride, where the least thickness of periderm layer was detected. These results were consistent with those of **Walker *et al.*, (1984)** and **Abou Taleb, (2003)** who showed that the cortex of pecan root cross section was depressed by saline solution.

2- Phloem:

As for the phloem layer, of Manfalouty transplants **Table (26)** show that irrigation with 6000 ppm saline solution either SAR 3 or 6 and high or low chloride treatments decreased the thickness of the phloem compared to the control. On the other hand, the trend of response took the other onw around with Nab El-Gamal cv. increased the phloem of the root was increased in most cases when irrigated with saline solutions except with higher (SAR6) and high chloride treatment where the phloem was affected a compared to the control. However, transplants of Wardy cv. was not influenced by saline solutions as root phloem layer was concerned. These results go in line with, **Sourial, (1978) and Abd El-Karim, (1991)** who reported that saline conditions caused loss in vascular elements (xylem and phloem).

3- Cambium layer:

The root cambium layer of three pomegranate cultivars i.e., Manfalouty; Nab El-Gamal and Wardy did not respond to saline solutions; **Table (26)**. In this regard findings of **Pokrovskaya, (1954) and Salama, (1985),** confirmed partially the present result, as they mentioned that in glycophytes cell division and elongation was restricted by salinity.

4- Xylem thickness:

Root xylem layer as shown from **Table (26)** was obviously decreased in thickness by saline solution regardless as SAR and Cl: SO_4. Such trend was true with three cultivars with a noticeable slight variance better cultivars as the rate of change was concerned. These results were coincided to those of **Sourial, (1978), Abou Taleb, (2003).** Meantime, **Ahmed, (1982),** reported that xylem vessels within root were decreased by salinity, however average cross area per vessel was increased.

5- Root diameter:

As for the root diameter of the transverse section **Table (26)** shows that it followed nearly the same trend previously detected in xylem vessels diameter. These results are in harmony with those of **Ahmed, (1982)** and **Abou Taleb, (2003).**

Table, (26): Some measurements of root anatomical examination in Manfalouty; Nab El-Gamal and Wardy Pomegranate cultivars as affected by 6000 ppm saline solution of two SAR (3 & 6) and Cl: SO4 (low & high) ratios during 2001growing season. X = 60

Treatments	SAR	Chloride	Periderm layer (μ m)			Phloem (μ m)			Cambium (μ m)			Xylem vessels (μ m)			Transvese section diameter (μ m)		
			M	N	W	M	N	W	M	N	W	M	N	W	M	N	W
Tap water			13	16	16	4	4	4	3	3	3	150	191	178	225	278	244
Salt 6000 ppm	3	Low	10	13	10	3	6	4	3	3	3	140	169	135	205	245	205
		High	11	11	11	3	5	3	3	2	2	164	150	110	232	253	195
	6	Low	8	13	15	3	5	4	3	3	3	113	152	127	160	225	220
		high	7	7	8	3	4	4	2	3	3	113	62	143	167	122	228

M= Manfalouty cultivar N= Nab El-Gamal W= Wardy

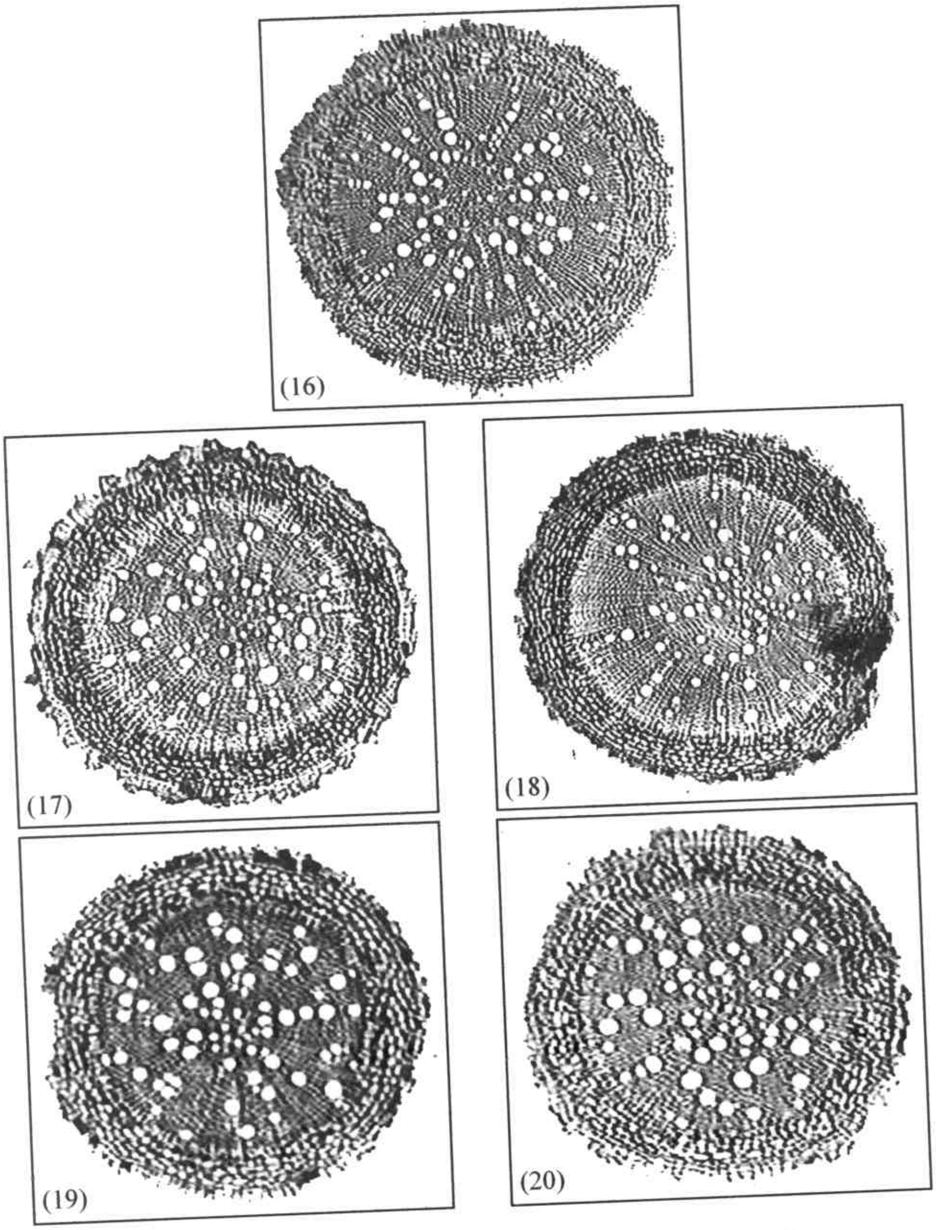

Photo (4): Root anatomical structure of Manfalouty Pomegranate transplants as influenced by salinity stress (X = 60).

(16) Tap water.
(17) 6000 ppm × SAR3 × Low Cl: SO_4.
(18) 6000 ppm × SAR3 × High Cl: SO_4.
(19) 6000 ppm × SAR6 × Low Cl: SO_4.
(20) 6000 ppm × SAR6 × High Cl: SO_4.

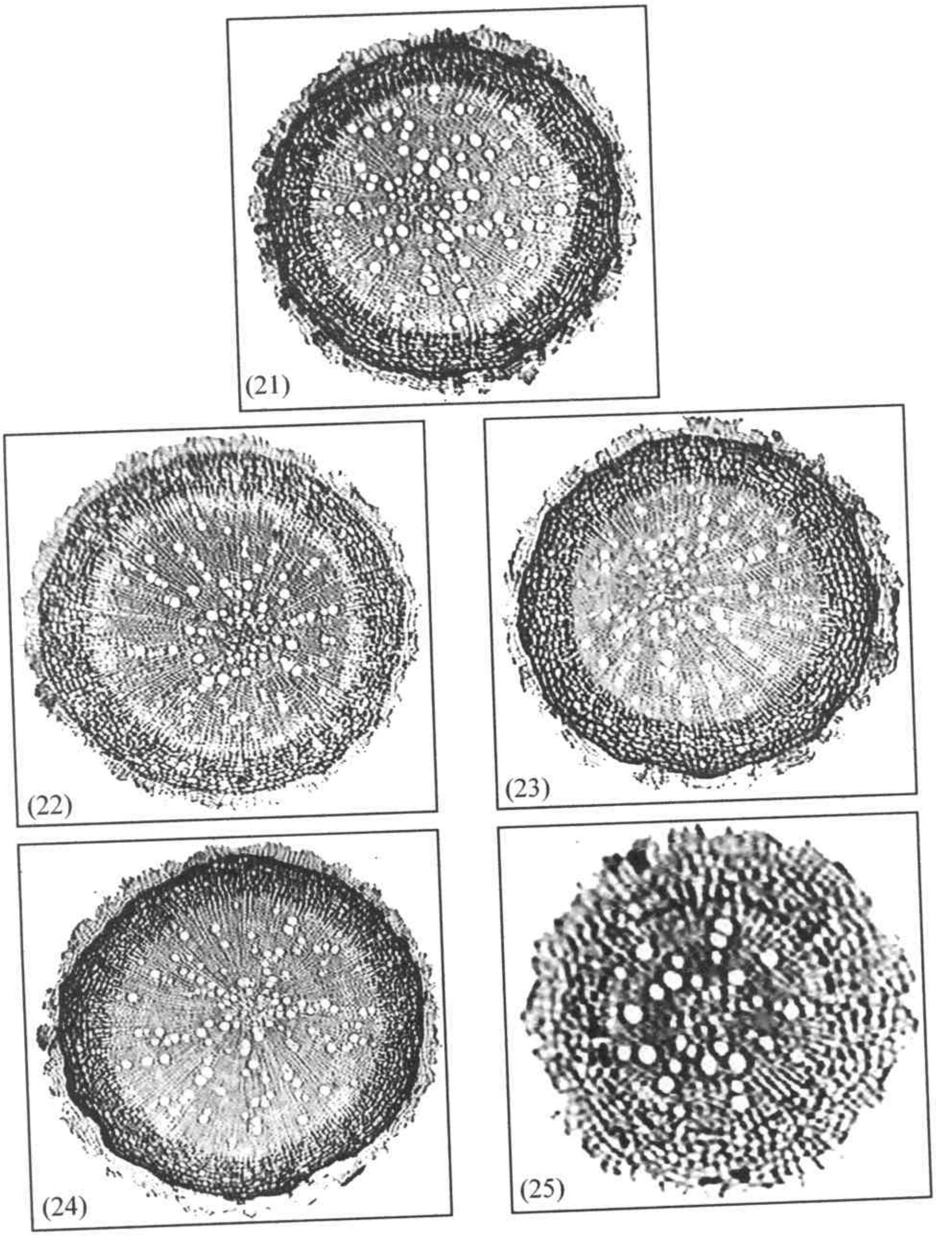

Photo (5) Root anatomical structure of Nab El Gamal Pomegranate transplants as influenced by salinity stress (X = 60).

(21) Tap water.
(22) 6000 ppm × SAR3 × Low Cl: SO_4.
(23) 6000 ppm × SAR3 × High Cl: SO_4.
(24) 6000 ppm × SAR6 × Low Cl: SO_4.
(25) 6000 ppm × SAR6 × High Cl: SO_4.

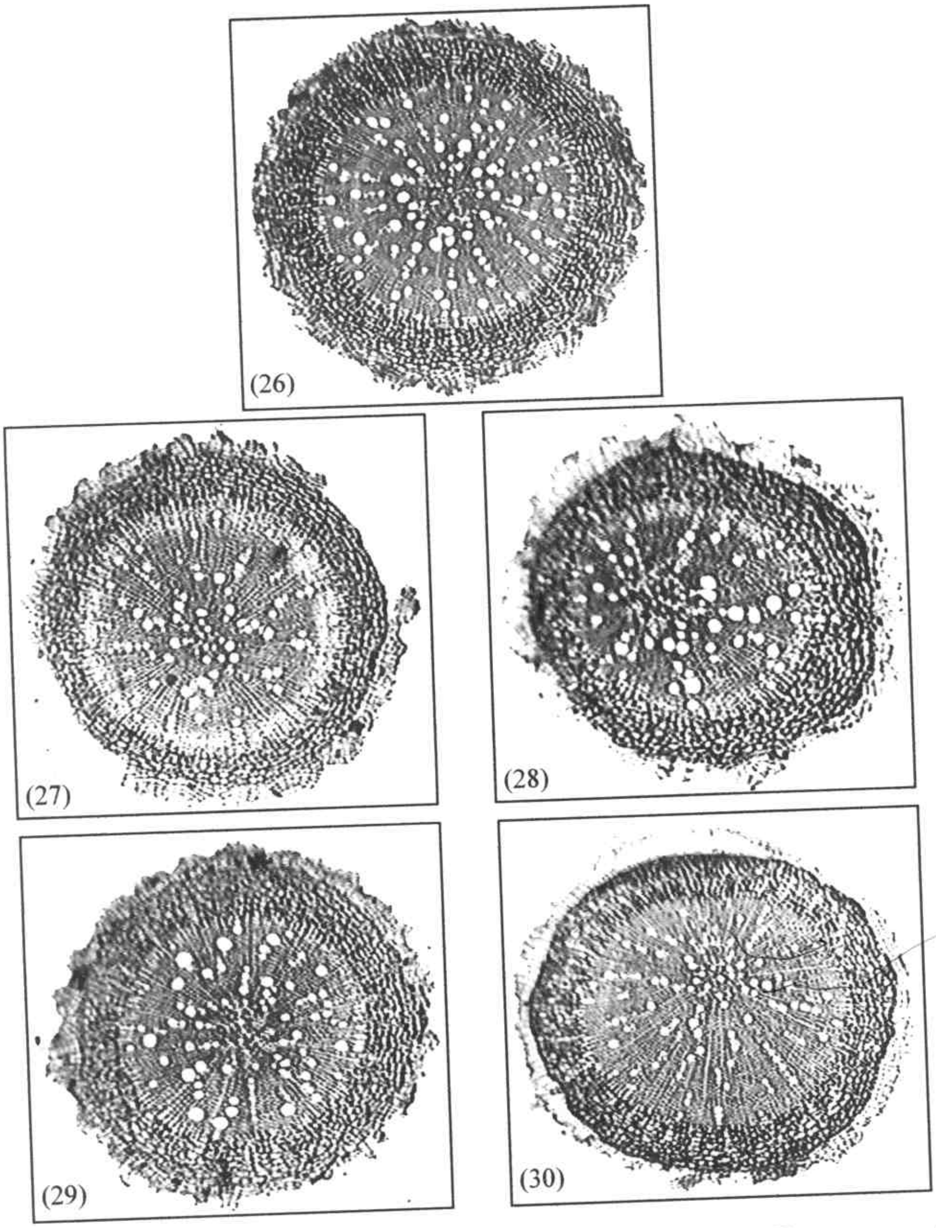

Photo (6): Root anatomical structure of Wardy Pomegranate transplants as influenced by salinity stress (X = 60).

(26) Tap water.
(27) 6000 ppm × SAR3 × Low Cl: SO_4.
(28) 6000 ppm × SAR3 × High Cl: SO_4.
(29) 6000 ppm × SAR6 × Low Cl: SO_4.
(30) 6000 ppm × SAR6 × High Cl: SO_4.