3- MATERIALS AND METHODS

The present study was conducted during the growing seasons of 1985 and 1986 in the greenhouse of El-Kanater Research Station Kaliobia Governorate , to investigate the effect of saline irrigation water and sodium adsorption ratio (SAR) treatments on growth , leaf and fibrous roots minerals , chlorophyll (A & B) , carotene , leaf soluble and nonsoluble carbohydrate , stem total carbohydrates and starch , bud indoles and phenols contents as well as leaf osmotic pressure of Washigton navel orange plants budded on four citrus rootstocks . Moreover , some histological studies were carried out on leaf and fibrous roots of the plants under study . Lastly , an evaluation of citrus rootstocks under salinity condition was conducted .

Preparation of the experimental units :-

Sour orange (Citrus aurantium L) , Rangpur lime (Citrus limonia . Osbeck) Cleopatra mandarin (Citrus reticulata . Blanco) and Poorman orange (Possibly of hybrid origin , Hodgson , 1967) seedlings , of one-year- old and nearly similar in their vigor were chosen for this study .

These seedlings were planted in March 1983 in clay pots of 30 cm. in diameter filled with clay loam soil and irrigated with tap water till they became suitable for budding with Washington navel orange scions in September , 1983 . In March , 1985 homogenous plants about 70 cm. height were irrigated with solution of various levels of salinity and SAR as treatments containing sodium sulphate , calcium chloride , calcium nitrate and magnesium sulphate at a rate of one liter per each clay pot three times weekly as shown in Table (1) :-

Table (1). Salinity treatments and there salt constituents

Salinity treatments		Salts (g. per 1 liter solution)			
p.p.m.	S A R	$Na_2 SO_4$	$Ca Cl_2$	$Ca (NO_3)_2$	$Mg SO_4$
Control		Tap water			
2000	6	1.154	0.406	-	0.440
2000	12	1.596	0.204	-	0.200
4000	6	1.787	0.555	0.548	1.110
4000	12	2.773	0.555	-	0.672
6000	6	2.267	0.555	1.438	1.740
6000	12	3.655	0.555	0.680	1.110

At monthly intervals , salinity was leached using the same saline solution for each treatment while they were applied continuously for two seasons . However , the budded treated rootstocks were grown under partial shade in both seasons .

Moreover , in 1986 season , another group of budded rootstocks were grown under full sun light and irrigated with the same previous treatments as presented in Table (1) .

Treatments were arranged in a complete randomized blocks design and each treatment was replicated three times with two pots per each replicate .

I - Growth measurements.

I . 1 - Dry weight :-

In october , 1986 plants of each treatment were gently removed from the pots then root system was completely excavated . Each plant top was further divided into leaves and stem . These parts of each plant were washed with tap water and rinsed in distilled water . Such severed leaves , shoots and roots were dried in an oven at 70° c till constant weight . The dry matter for each part was weighed in gms. and consequently top/root ratio was calculated .In addition, fibrous roots were weighed solely . Therefore , percentages of leaves to the top as well as fibrous roots to root system were also calculated .

I . 2- Leaf area :-

In season of 1986 , as leaves of spring flush reached full expanded stage (3 months old) , 10 leaves from the middle of shoots of each plant for each treatment were randomly picked for measuring leaf area by using a planimeter .

I . 3- Leaf specific weight :-

Leaf samples which were used for measuring leaf area were also used for the determination of leaf specific weight , via taking 100 cm^2 of leaf then washed with tap water , rinsed in distilled water and oven dried in a furance at 70°c till constant weight . Leaf specific weight was determined as g./100 cm^2 leaf area .

II- Chemical constituents.

II . 1- Leaf and root minerals content:

In both seasons of 1985 and 1986 as leaves of spring flush aged 3 months , 10 leaves from each plant of each treatment were randomly sampled from the middle of the spring shoot . These leaves were wiped free of dust with a damp cloth , washed , with 0.1 N Hcl to remove any residues then with distilled water . The leaves were oven dried at 70°c till constant weight . The dried leaves were weighed and recorded .

Samples of dried leaves and fibrous roots were finely ground for chemical determinations as follows :

0.2 g of each ground sample was digested using the procedure suggested by **Jackson (1958)** . The digested solution was used for the determination of N , P , K , Ca , Mg , Na , cl , Zn , Fe and Mn nutrients .

In this respect , total nitrogen was estimated according to microkjeldahl method , as described by **Pregl (1945)** .

Total phosphorus was determined using the mothed of **Chapman and Pratt , (1961)** method .

Potassium and sodium were determined by flame photo meter using the method recommended by **Brown and lilleland (1946)** .

Calcium and magnesium were estimated by titration against disodium dihydrogen ethylenediamine tetra acetate (versinate) according to A . o . A . c . (1970) method .

Chloride was determined in a hot water extract then titrated with silver nitrate as employed by **Higinbotham *et. al.* .(1967)** .

Moreover , Zn , Fe and Mn were determined directly in the diluted digested solution using the atomic absorption spectrophotometer . (PYE unicum SP 1900) .

Any how , N , P , K , Ca , Mg , Na and Cl elements were calculated as percentages in dry matter whilist Zn , Fe and Mn were estimated on the basis of ppm .

II . 2- Indoles and phenols in buds :

Samples of total buds were collected randomly in October , cleaned , cut into small pieces and extracted with 80% methanol at 0° c for 72 hours . The methanol being changed every 24 hours as described by **Daniel and George (1972)** .

The combined methanolic extraction was transferred into aqueous phase by evaporating methanol at 30 ± 2° c under vacum , then diluted to a known volume for the determination of soluble phenolic compounds and the indolic compounds .

Total soluble phenols were determined using the folin Dennis colourimetric methed (A.O. A.C., 1970) at 730 Mu wave length . The concentration was calculated as mg. per 100 g. dry weight .

Indolic compounds were determined by using the method of para dimethyl amins benzaldhyde test (Ehrlich reagent , **Larsen** **et. al.**, **1962**) as modified by **Selim** **et. al.** **(1978)** . They were , estimated colourimetrically at 530 Mu , the concentration was calculated as mg . IAA per 100 g . dry weight . Furthermore , indoles/phenols ratio was also calculated .

II . 3 - Leaf soluble and nonsoloble carbohydrates :

Soluble sugars were assayed in one hour boiling distilled water extract of 0.2 g. dry weight according to Mcilory (1948) .

The filtrate was clearified by charcoal then colourimetrically estimated . Non soluble sugars were determined in the residue left after extraction of soluble sugars . The residue was acid hydrolized (6NHCl) by boiling under reflex for 3 hours . The hydrolyzate was clearified by charcoal and sugars were determined as mentioned before . The value was multiplied by 0.9 to obtain the percentage of soluble sugars as mentioned by (A.O.A.C., 1970) .

II . 4 - stem starch and total carbohydrates :

After extracting the soluble sugars , starch was determined in the residue on left the filter paper according to (A.O.A.C. 1970) .

Total carohydrates were determined colourimetrically as g. glucose per 100 g. dry weight according to **Smith <u>et.</u> <u>al.</u> (1956)** .

II . 5 - Leaf chlorophyll A , B and carotene contents :

In both seasons , four leaf samples were taken at 30 days interval starting from April till July . Each sample composed of five leaves which were randomly picked from the middle of spring shoots . These leaves were wiped free of dust with a damp cloth , washed with distilled water to remove any residues for determining chlorophyll A , B and carotene contents . It was conducted using the method of **Wettstein (1957)** . However , chlorophyll A , chlorophyll B and carotenoids were calculated as mg./L. using the following equations .

chl. A = (9.784 x E 663) - (0.99 x E644) = mg./L.

chl. B = (21.426 x E644) - (4.650 x E663) = mg./L.

Carotenoids = (4.685 x E440) - (0.268 x chl. A+ Chl . B) = mg./L.

III - Salinity hazard coefficient (S.H.C.).

In order to study the relation between carbohydrates and pigments content in leaves of budded citrus plants grown under saline conditions, relative ratios of total soluble sugars and chl. A+B/carotene were carried out according to **Mostafa and Seif (1979)**. This was done in a trial ro establish a relative coefficient for salinity hazard. This coefficient is calculated using the following formula

$$: \frac{\text{Total soluble carbohydrate}}{\text{chl. A} + \text{chl. B}} \times \text{carotene}$$

IV - Osmotic pressure of citrus leaves.

In both seasons, four leaf samples were picked at 30 days interval starting from April up to July. Each sample was composed of three leaves per plant taken from the middle of spring shoots of each treatment. Leaves were wiped free of dust with a damp choth, washed with distilled water to remove any residues. Osmotic pressure of citrus leaves was carried out adopting the method of **Gosov (1960)**.

V - Histological studies.

Samples of leaves of the same physiological age and fibrous roots were taken in October, 1986 from each treatment and immediately preserved in the FAA (70) solution for killing , fixating and , dehydration with N. butyl , infiltration and embedding in pure paraffin wax (M.P. , 56 - 58° C) according to **(Johanson , 1940)** method . Longitudinal and cross sections of 10 microns in thickness were prepared using a rotary microtome . The prepared slides were stained with erethrosene and crystal violet **(Johanson , 1940)** and were examined microscopically and illustrated in photos .

VI - Evaluation of different citrus rootstocks.

The citrus rootstocks used in this study were subjected to an evaluation concerning the 6000 ppm. at SAR 12 treatment which is the highest salinity level in this study .

The various items for evaluation were : total plant dry weight , top/root ratio , salinity hazard coefficient , osmotic pressure and root sodium and chloride contents . Such evaluation was conducted according to the following :

1 - For evaluating the effect of salinity treatment 6000 ppm. at SAR 12 on osmotic pressure and salinity hazard coefficient for each rootstock , the values of 120 days from the initiation of treatments was put in consideration .

2 - A score of 50 points was assigened for total plant dry weight , 10 points for top/root ratio , 10 points for salinity hazard coefficient , 10 point for osmotic pressure , 10 points for root Na percentage , and 10 points for root chloride percentage .

3 - The best grade of each property had the maximum points, while the poorest grade equal to zero. The other grades had values depending upon the range between the two extremes.

4 - The highest values for total plant dry weight and osmotic pressure were considered the best properties. The opposite was true for values of top/root ratio, salinity hazard coefficient, and root Na and Cl contents.

5 - The final grade was calculated by the summation of various points of the different properties for each rootstock.

By all means, such evaluation was done under either full sun light or partial shade conditions.

VII - Statistical analysis.

All the obtained data were subjected to analysis of variance (Snedecor, 1956) and the L.S.D. was calculated to differentiate means.

4- RESULTS

4.1. Growth :

Growth of Washington navel orange plants budded on different citrus rootstocks grown under various levels of salinity and SAR and subjected to full sun light or partial shade conditions is shown in Tables 2 and 3 .

4 .1. a . Full sun light :

It is clear from Table(2) and Fig.(1) that salinity and SAR treatments for different rootstocks used decreased plant dry weight as compared to the control . Such decrease varied from 8.7 to 38.1 percent for sour orange , 2.6 to 34.1 percent for Rangpur lime , 1.4 to 34.2 percent for Cleopatra mandarin and 2.7 to 23.7 percent for Poorman orange . However , differences from the statistical point of view were more clear in case of sour orange values whilist Rangpur lime and Cleopatra mandarin showed less significant values . Poor man orange rootstock , on the other hand , failed to give signicant values in this respect .

Referring to different salinity levels at SAR 6 , it is quite evident that plant dry weight decreased with increasing level of salinity to 6000

Table(2) : **Growth of Washington navel orange plants budded on different rootstocks grown under full sun light as affected by different levels of salinity and S A R (season, 1986).**

Root stock	Salinity treatment p.p.m.	Salinity treatment SAR	Root D.w. (g.)	Top D.w. [1] (g.)	Plant D.w. (g.)	Top/Root ratio	Leaves [2] %	Fibrous roots [3] %	D.w.of 100 (cm²) leaves (g.)	Leaf area (cm²)
Sour orange	**Control**		**64.60**	**74.90**	**139.50**	**1.15**	**27**	**34**	**1.04**	**35.40**
	"2000"	"6"	46.40	80.90	127.30	1.49	13	31	1.00	16.40
	"2000"	"12"	45.50	58.20	103.70	1.44	27	41	0.92	19.20
	"4000"	"6"	38.10	58.40	96.50	1.60	15	24	0.86	14.30
	"4000"	"12"	36.80	58.10	94.90	1.57	24	31	0.99	18.50
	"6000"	"6"	34.60	51.80	86.40	1.65	28	27	0.94	18.80
	"6000"	"12"	39.20	59.00	98.20	1.52	16	24	1.09	22.50
Rangpur lime	**Control**		**59.00**	**66.00**	**125.00**	**1.15**	**29**	**33**	**0.99**	**25.20**
	"2000"	"6"	54.70	67.10	121.80	1.28	27	43	0.94	17.60
	"2000"	"12"	36.20	50.40	86.60	1.36	31	33	0.93	24.90
	"4000"	"6"	50.90	65.80	116.70	1.33	23	34	1.01	22.20
	"4000"	"12"	49.00	60.20	109.20	1.23	25	24	0.95	20.80
	"6000"	"6"	36.30	56.20	92.50	1.35	20	28	0.98	19.10
	"6000"	"12"	37.10	45.30	82.40	1.26	17	24	0.98	16.20
Cleopatra mandarin	**Control**		**61.10**	**71.30**	**132.40**	**1.32**	**24**	**29**	**1.02**	**26.40**
	"2000"	"6"	59.80	49.90	109.70	0.94	30	35	1.00	23.60
	"2000"	"12"	52.50	65.80	118.30	1.32	20	38	0.94	19.60
	"4000"	"6"	46.50	67.80	114.30	1.54	25	35	0.97	21.50
	"4000"	"12"	56.60	74.00	130.60	1.39	20	21	0.98	24.40
	"6000"	"6"	44.50	51.40	95.90	1.18	24	27	0.94	20.60
	"6000"	"12"	35.20	51.90	87.10	1.50	27	27	0.96	24.60
Poorman orange	**Control**		**48.60**	**52.90**	**101.50**	**1.09**	**35**	**36**	**0.91**	**25.80**
	"2000"	"6"	43.80	55.00	98.80	1.24	31	35	0.94	24.20
	"2000"	"12"	39.10	46.80	85.90	1.16	40	32	0.97	23.60
	"4000"	"6"	43.90	44.30	88.20	1.35	33	27	1.02	22.10
	"4000"	"12"	33.00	49.50	82.50	1.50	19	19	0.91	23.30
	"6000"	"6"	38.50	38.90	77.40	0.99	30	20	1.06	24.10
	"6000"	"12"	35.10	43.60	78.70	1.21	25	21	0.96	20.80
L . S . D . at 1%			**16.70**	**19.30**	**32.50**	**0.26**	-	-	**0.08**	**3.50**

[1] = Leaves + Stem
[2] = Leaves D.W. / Top D.W. x 100
[3] = Fibrous rootsD.W. / Root system D.W. x 100

D.W. = Dry Weight
S A R = Sodium adsorption ratio

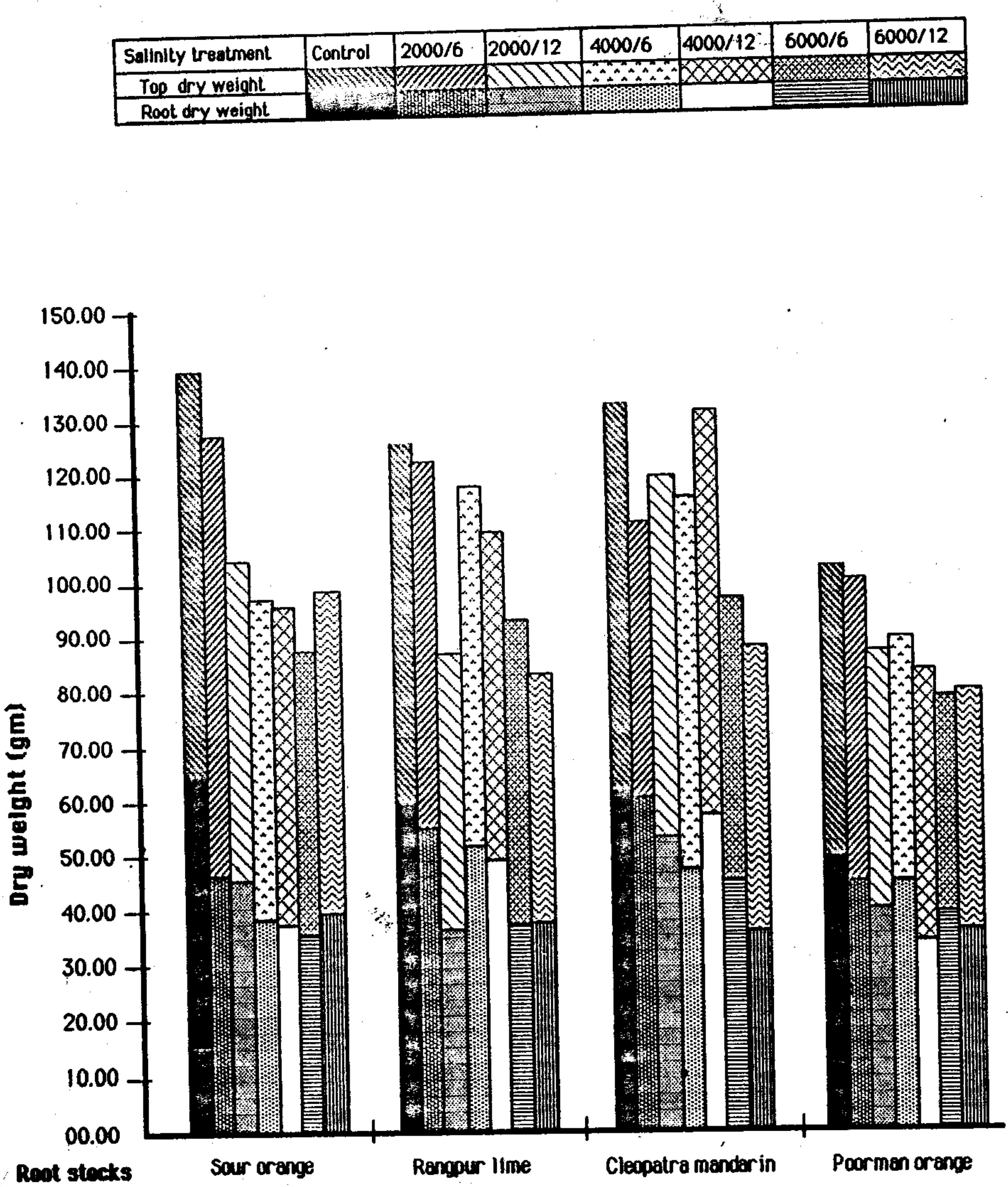

Fig. (1) : Dry weight of washington navel orange plants budded on different rootstocks grown under full sun light as affected by differat levels of salinity and S A R (season, 1986).

ppm. in all rootstocks. However , significant difference was only observed in the case of sour orange .

In the mean time , under SAR 12 such trend was noticed hence high level of salinity (6000 ppm) caused a reduction in plant dry weight as compared to those received low rate of salinity (2000) .

Comparing SAR 6 with SAR 12 under the same level of salinity , it is well noticed that plants of different rootstocks treated with 2000 ppm. level and SAR 12 decreased plant dry weight as compared to the analogous ones of those treated with SAR 6 . The same effect was observed for plants of either sour orange or Rangpur lime treated with salinity at the rate of 4000 ppm. However , the picture was changed to the reverse when Cleopatra mandarin and Poorman orange rootstocks were put in consideration . Under the rate of 6000 ppm at SAR 12 plant dry weight of Rangpur lime and Cleopatra mandarin decreased in respect of those of SAR 6 . However , in case of sour orange and Poorman orange such trend was generally changed to the opposite direction .

Generally , significant difference was observed only between plants treated with 6000 ppm at SAR 6 and those received 2000 ppm level at SAR 6 for sour orange , 6000 ppm at SAR 12 from one hand and either 2000 ppm at SAR 6 or 4000 p.p.m at SAR 6 for Rangpur lime and between 6000 ppm at SAR 12 treatment and 4000 ppm at SAR 12 treatment for Cleopatra mandarin .

No significant differences were noticed between different treatments of salinity for Poorman orange .

Regarding to top dry weight , it is interesting to notice that salinity treatment generally decreased top dry weight of all studied rootstocks , as compared to the analogous ones of the control . The percentage of decrease varied from 21.2 to 30.8 for sour orange , 0 - 31.4 for Rangpur lime , 1.4 - 34.2 for Cleopatra mandarin and 6.4 - 26.5 for Poorman orange . The statistical analyses indicated that sour orange and Cleopatra mandarin plants received saline irrigation water at the rate of 6000 ppm at SAR 6 gave significant values as compared to the control .

Meanwhile , Rangpur lime and Cleopatra mandarin plants treated with the same level of salinity but with SAR 12 rate had only significant values in this concern . Differences between Poorman orange values were significant .

IN the mean time , under SAR 6 top dry weight of all rootstocks except Cleopatra mandarin decreased with increasing levels of salinity mainly 6000 ppm . However , significant difference was noticed only in sour orange rootstock .

As for SAR levels , it is found that SAR 12 values decreased insignificantly top dry weight of Rangpur lime below those of SAR 6 . Such effect was not clear in the other rootstocks used .

Nevertheless , a significant difference was observed between SAR 6 and SAR 12 under low level of salinity (2000 ppm) when applied to sour orange

Referring to root dry weight , it is quite evident that salinity treatments dropped down root dry weight of different rootstocks as compared to the control. These decreases in percentages varied from (28.2 - 43.0) , (7.3 - 38.5) , (2.1 - 42.4) and (9.7 - 32.1) for sour orange , Rangpur lime , Cleopatra mandarin and Poorman orange , respectively .

Furthermore , differences between salinity treatments for sour orange plants and the control were so high to be statistically significant . On the other hand , 2000 ppm at SAR 12 as well as 6000 ppm combined with either SAR 6 or SAR 12 treatments gave significant differences for Rangpur lime rootstock . In the mean time , salinity treatments for Cleopatra mandarin plants indicated that 6000 ppm at SAR 12 was the unique treatment which induced significant effect . Moreover , values of Poorman orange were not significant .

As for salinity levels were concerned , it is obvious that root dry weight decreased as different rates of salinity increased . However, such effect was more clear under SAR 6 in all citrus rootstocks used . Significant difference was observed in case of Rangpur lime rootstock .

Comparing the two SAR levels used , it is found that plants received SAR 12 had generally low values of root dry weight than those of SAR 6 . That was true in all citrus rootstocks under study. Nevertheless , a significant difference was observed only when Rangpur lime plants treated with 2000 ppm.

Considering top/root ratio , it is quite evident from **Table (2)** and **Fig. (2)** that in all rootstocks , salinity and SAR increased this ratio than at of the control . Such increase varied between 25.2 % to 43.5 % for sour orange , 6.9 % - 18.3 % for Rangpur lime , 0 - 16.6 % for Cleopatra mandarin and 6.4 % - 37.6 % for Poorman orange .

Nevertheless , as for statistical analyses were concerned , salinity treatments had statistical effect in case of sour orange while they had no effect in both Rangpur lime and Cleopatra mandarin , hence values from the statistical point of view were more or less similar . In addition, Poorman orange plants treated with the rate of 4000 ppm beside either SAR 6 or SAR 12 levels had statistically the highest values.

Top/Root Ratio under full sun light season, 1986.

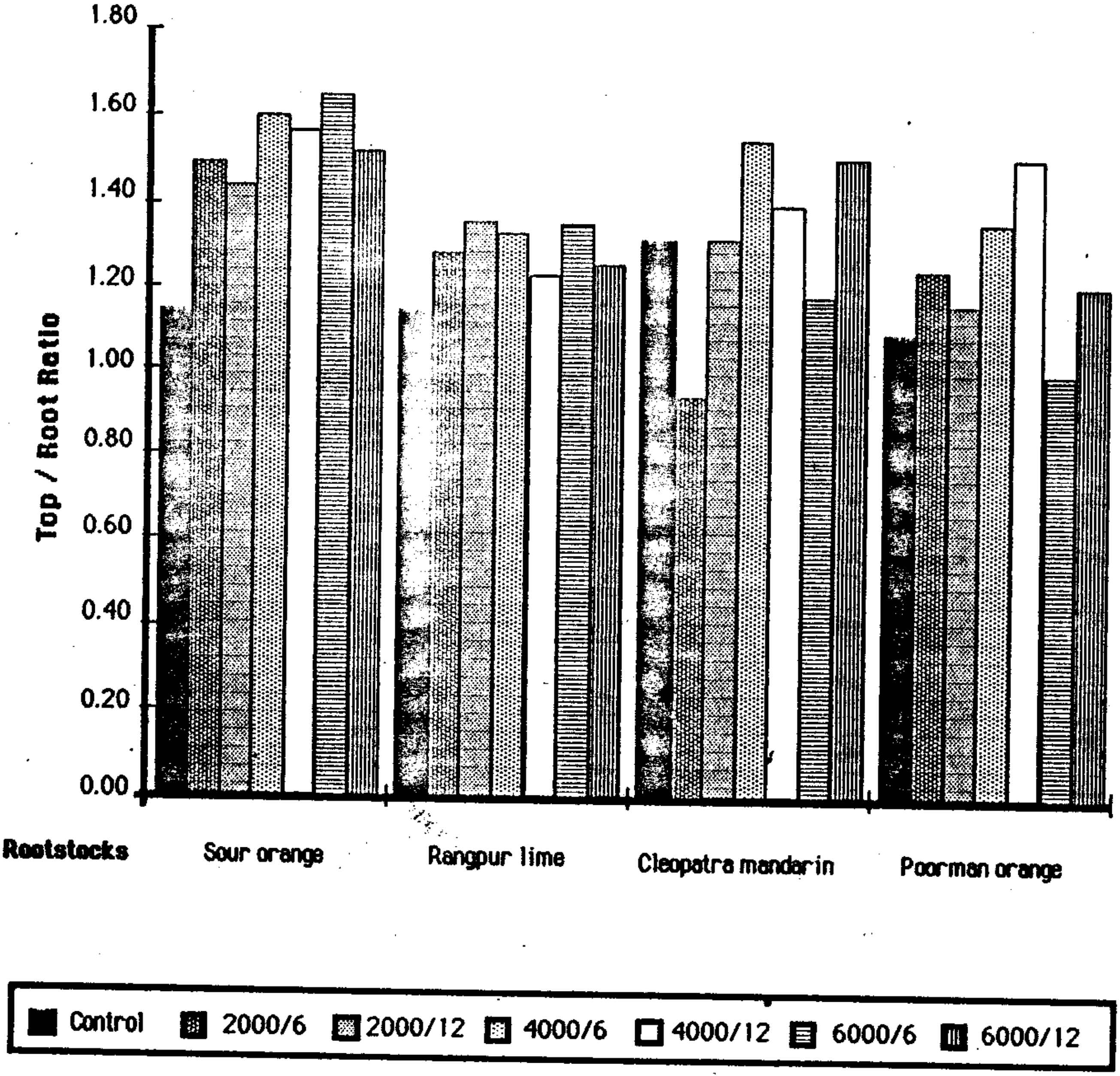

Fig. (2) : Top/root ratio of Washington navel orange plants budded on different rootstocks grown under full sun light as affected by different levels of salinity and S A R (season, 1986).

Regarding salinity levels under the same SAR 6 , it is found that top/root ratio increased under the level of 4000 ppm in all rootstocks and extended toward the hightest concentration of salinity in case of sour orange and Rangpur lime while it decreased in case of Cleopatra mandarin and Poorman orange .

With respect to SAR 12 , it is clear that top/root ratio increased with increasing salinity up to 4000 p.p.m then decreased under the rate of 6000 ppm .

Such result was true in case of sour orange and Poorman orange rootstocks . The picture was changed in case of Cleopatra mandarin where top/root ratio increased with increasing salinity . Considering the two levels of SAR under the same concentration of salinity , it is clear in both sour orange and Rangpur lime rootstocks that plants received SAR 12 decreased top/root ratio below those of SAR 6 .

Moreover , top/root ratio for Cleopatra mandarin and Poorman orange generally took the other way around . Any how , significant differences were only observed in case of Cleopatra mandarin and partially in case of Poorman orange . As for Cleopatra mandarin , significant difference was noticed between 2000 ppm at SAR 6 treatment and the other treatments of salinity except 6000 ppm at SAR 6 treatment . Concerning Poorman orange rootstock , 2000 ppm at SAR 12 treatment showed a significant decrease as compared with plants treated with 4000 ppm at either SAR 6 or SAR 12 treatments .

Concerning leaves percentage , it is interesting to notice that salinity treatments generally decreased leaves percentage as compared to the analogous ones of the control . Such decrease varied from (3-14 %) , (2-12 %) , (0-4 %), and (2-16 %) for sour orange , Rangpur lime , Cleopatra mandarin and Poorman orange , respectively .

Considering salinity treatments under the same SAR level it is well noticed that under SAR 6 , leaves percentage decreased with increasing salinity in case of Rangpur lime and Cleopatra mandarin .

On the contrary , leaves percentage increased towards the high level of salinity in case of sour orange . On the other side , such effect was not clear in case of Poorman orange rootstock .

Moreover , under SAR 12 , high rate of salinity caused a reduction in leaves percentage in respect with those of low level . That was true in all rootstocks studied , except Cleopatra mandarin .

Considering SAR rates , it is found that the effect of SAR varied according to the rootstock used . In other words , while SAR 12 generally decreased leaves percentage of Cleopatra mandarin and Poorman orange , it induced a general increase in case of sour orange and Rangpur lime as compared to the analogous ones of SAR 6 .

As for fibrous roots percentage , it is clear that regardless of Cleopatra mandarin , salinity treatments decreased fibrous roots as compared to the corresponding ones of the control . Such decrease ranged form (3 - 10 %) for sour orange , (0 - 9 %) for Rangpur lime and (1 - 17 %) for Poorman orange .

On the other hand , under SAR levels high level of salinity (6000 ppm) decreased remarkably fibrous roots percentage as compared with those of low concentration of salinity . The same trend could be observed when SAR 12 is put in consideration .

Concerning the two levels of SAR used , it is quite evident that under the same rate of salinity , SAR 12 decreased mostly fibrous roots percentage in respect to those of SAR 6 . This is nearly true in all rootstocks studied but with few exceptions .

As for dry weight of 100 (cm^2) of leaves , it is found that salinity treatments generally decreased these values below the control . The picture was changed to the reverse with Poorman orange was concerned . The percent of reduction ranged from (3.8 - 17.3) for sour orange, (1 - 6.1) for Rangpur lime , (1.9 - 7.8) for Cleopatra mandarin .

The statistical analysis indicated that sour orange treated with 4000 ppm salinity at SAR 6 was the unique treatment which induced a significant decrease below the control . Similary , in case of Cleopatra mandarin plants which treated with either 2000 ppm level at SAR 12 or 6000 ppm rate of salinity at SAR 6 caused significant reduction below the control .

Although salinity treatments decreased leaf specific weight of Rangpur lime below that of the control , but such decreases were so small to be significant . On the other hand , salinity treatments increased leaf specific weight of Poorman orange but such increases were not significant .

Referring to SAR 6 , it is found that applying high level of salinity to Washington navel orange plants budded on either sour orange or Cleopatra mandarin rootstocks caused a decrease in specific weight of leaves as compared with those treated with low level . Such trend was not clear in case of the other rootstocks under the study since the picture was changed to the reverse . As for SAR 12 , it is quite evident that dry weight of 100 (cm^2) of leaves increased with increasing levels of salinity .

As regard to SAR levels , data indicated that the results were fluctuated . Thus , while SAR 12 decreased specific weight of leaves in some cases than those treated with SAR 6 , it took slightly the other way around in other ones .

Furthermore , it is interesting to notice that salinity treatments decreased leaf area below the control . In this sphere , such decreases ranged from (36.4 - 59.6 %) for sour orange , (1.2 - 35.7 %) for Rangpur lime , (6.8 - 25.8 %) for Cleopatra mandarin and (6.2 - 19.4 %) for Poorman orange .

The differences between treatments and the control were significant as sour orange plants were concerned . Such significant differences were less with the other rootstocks used which could be arranged in descending order as follows , Rangpur lime , Cleopatra mandarin and Poorman orange .

In other words , two treatments for Rangpur lime i.e. 2000 ppm salinity at SAR 12 as well as 4000 ppm level at SAR 6 failed to give significant effect . The same was true with Cleopatra mandarin in treatments 2000 ppm beside SAR 6, 4000 ppm at SAR 12 and 6000 ppm combined with SAR 12 .

Referring to Poorman orange , significant differences were lacking in 2000 ppm either with SAR 6 or 12 , 4000 ppm at SAR 12 and 6000 ppm combined with SAR 6 treatments .

Meanwhile , under SAR 6 , high level of salinity caused an increase in leaf area over those of low level . Such result was true in case of sour orange and Rangpur lime rootstocks . The opposite was noticed when the remained rootstocks were concerned . As for SAR 12 , high rate of salinity (6000 ppm) induced an increase in leaf area of both sour orange and Cleopatra mandarin as compared with those of low level . In case of Rangpur lime and Poorman orange such trend took the other way around .

Comparing SAR 6 with SAR 12 under the same level of salinity , it is found that SAR 12 generally increased leaf area over those of SAR 6 with few exceptions .

4 .1. b . Partial shade :

Table (3) and Fig. (3) show that salinity treatments for different rootstocks used decreased plant dry weight as compared to the analogous ones of the control. Such decreases ranged from (27.3-44.7 %), (3.4 - 61.2 %) , (0 - 41.8 %) and (0 - 48.3 %) for sour orange , Rangpur lime , Cleopatra mandarin and Poorman orange rootstocks , respectively . However , significant differences were clear with sour orange rootstock whereas they were appreciable less with other rootstoks used.

Considering SAR 6 under various levels of salinity , it is clear that plant dry weight increased up to the level of 4000 ppm then decreased with increasing salinity (6000 ppm) . However , differences between treatments were insignificant .

In addition , the effect of SAR 12 on plant dry weight took the same trend of SAR 6 in all rootstocks studied except with Rangpur lime .

Any how , no significant difference was noticed except with Poorman orange plants that received 2000 ppm level as compared with those treated with 4000 ppm .

Table(3) : **Growth of Washington navel orange plants budded on different rootstocks grown under partial shade as affected by different levels of salinity and S A R (season, 1986).**

Root stock	Salinity treatment p.p.m.	Salinity treatment SAR	Root D.w. (g.)	Top D.w. [1] (g.)	Plant D.w. (g.)	Top/Root ratio	Leaves [2] %	Fibrous roots [3] %	D.w.of 100 (cm²) leaves (g.)	Leaf area (cm²)
Sour orange	**Control**		**68.80**	**114.50**	**183.30**	**1.66**	**29**	**28**	**0.71**	**29.90**
	"2000"	"6"	39.80	61.50	101.30	1.54	25	38	0.68	23.70
	"2000"	"12"	51.80	75.80	127.60	1.54	14	17	0.71	23.30
	"4000"	"6"	46.10	84.30	130.40	1.84	24	33	0.76	30.90
	"4000"	"12"	48.10	85.10	133.20	1.73	22	23	0.78	27.60
	"6000"	"6"	47.20	68.50	115.70	1.48	20	22	0.92	21.20
	"6000"	"12"	40.80	64.90	105.70	1.59	14	21	0.87	17.20
Rangpur lime	**Control**		**44.40**	**69.70**	**114.10**	**1.70**	**24**	**21**	**0.92**	**27.70**
	"2000"	"6"	40.50	59.40	99.90	1.49	25	22	0.82	21.40
	"2000"	"12"	26.60	46.10	72.70	1.63	17	16	0.75	18.50
	"4000"	"6"	45.10	65.10	110.20	1.45	23	21	0.87	24.30
	"4000"	"12"	27.20	30.40	57.60	1.09	14	13	0.68	17.20
	"6000"	"6"	36.80	48.20	85.00	1.32	10	17	0.93	21.90
	"6000"	"12"	20.60	23.70	44.30	1.14	7	10	0.80	14.70
Cleopatra mandarin	**Control**		**57.10**	**86.60**	**143.70**	**1.53**	**24**	**25**	**0.77**	**36.50**
	"2000"	"6"	54.00	83.50	137.50	1.52	25	21	0.83	25.30
	"2000"	"12"	31.40	52.30	83.70	1.64	33	25	0.76	31.30
	"4000"	"6"	54.00	89.60	143.60	1.53	11	22	0.84	20.40
	"4000"	"12"	46.90	66.60	113.50	1.43	10	20	0.83	23.90
	"6000"	"6"	52.40	78.30	130.70	1.46	16	17	0.86	18.50
	"6000"	"12"	57.50	54.80	112.30	0.94	13	18	0.85	25.50
Poorman orange	**Control**		**79.40**	**57.10**	**136.50**	**0.72**	**17**	**23**	**0.66**	**23.00**
	"2000"	"6"	41.80	61.40	103.20	1.47	30	22	0.79	25.10
	"2000"	"12"	27.80	42.50	70.30	1.69	34	16	0.76	24.40
	"4000"	"6"	42.80	72.90	115.70	1.55	30	23	0.78	24.10
	"4000"	"12"	52.90	83.40	136.30	1.65	31	16	0.82	29.40
	"6000"	"6"	32.20	38.20	70.40	1.23	26	18	0.86	25.10
	"6000"	"12"	54.40	57.20	111.60	1.08	18	19	0.81	21.00
L . S . D . at 1%			**N.S.**	**N.S.**	**53.00**	**0.24**	-	-	**0.09**	**3.40**

[1] = Leaves + Stem
[2] = Leaves D.W. / Top D.W. x 100
[3] = Fibrous roots D.W. / Root system D.W. x 100

D.W. = Dry Weight
S A R = Sodium adsorption ratio

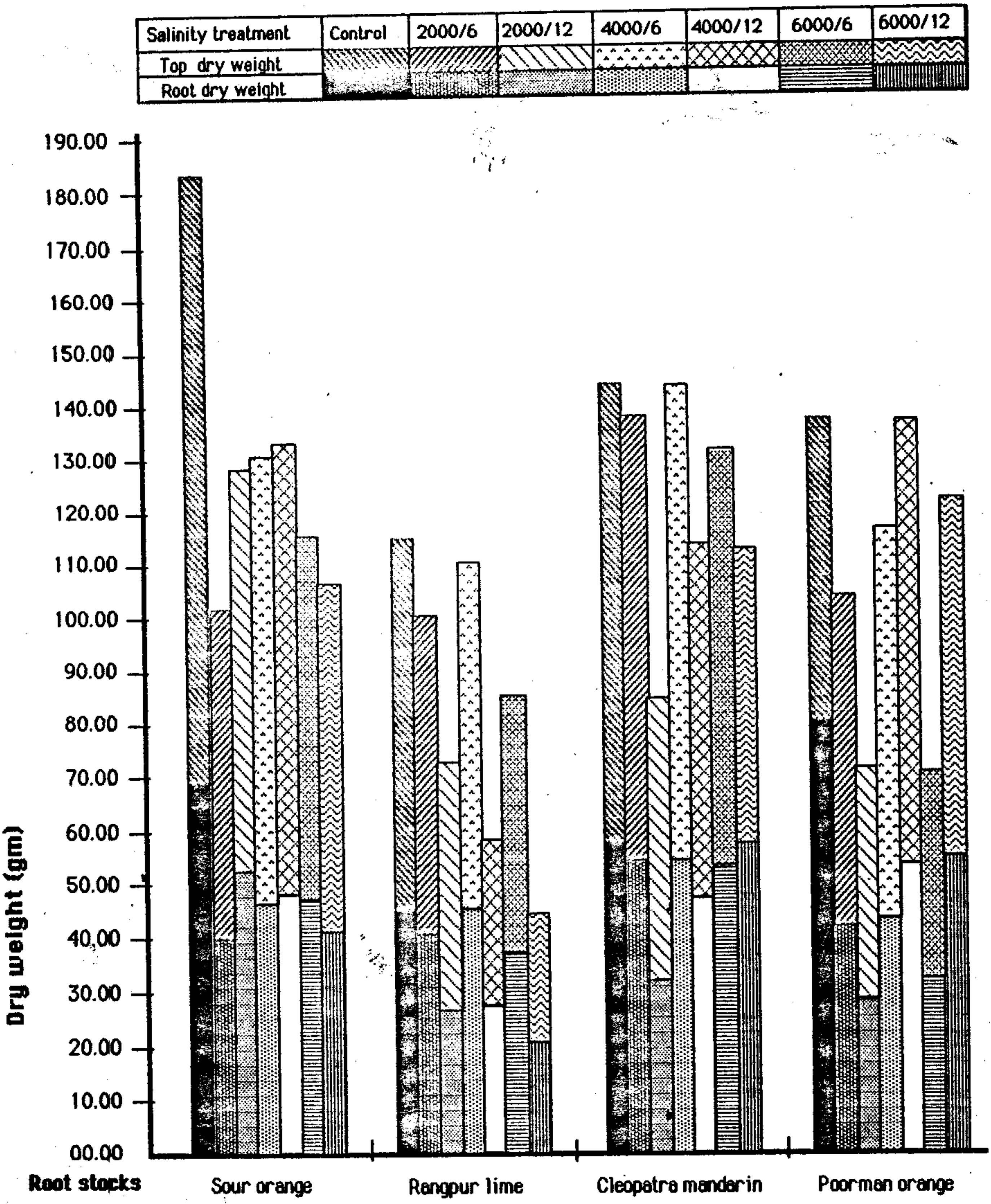

Fig. (3) : Dry weights of washington navel orange plants budded on different rootstocks grown under partial shade as affected by different levels of salinity and S A R (season, 1986).

Comparing the two levels of SAR used in this study under the same level of salinity it is quite evident that SAR 12 decreased plant dry weight below the analogous ones of SAR 6 . That was true in case of Rangpur lime and Cleopatra mandarin rootstocks . Nevertheless , no significant differences were observed between treatments except Cleopatra mandarin plants treated with 2000 ppm level .

Regarding top weight , it is found from Table (3) that salinity treatments , for various rootstocks induced a reduction in this respect below the control with few exceptions . Such decrease was insignificant. However , percentages of decrease varied between 25.7 - 46.3 for sour orange , 6.6 - 66.0 for Rangpur lime , 3.6 -39.6 for Cleopatra mandarin and 25.6 - 33.1 for Poorman orange .

Nevertheless , such effect of decrease was not clear in Poorman orange as in the other rootstocks . Furthermore , under SAR 6 while high level of salinity (6000 ppm) caused a decrease in top dry weight as compared to plants received low rate in case of both sour orange and Poorman orange , it had a reverse effect for Rangpur lime and Cleopatra mandarin . However , significant differences were lacking.

On the other hand , SAR 12 under the high concentration of salinity stimulated insignificantly top dry weight over those ones of low level . That was true in all rootstocks used discarding sour orange and Rangpur lime values .

Meanwhile , SAR 12 mostly gave lower values of top dry weight than those of SAR 6 . That was obvious in case of Rangpur lime and Cleopatra mandarin .

Generally , one can conclude that neither salinity treatments nor SAR levels from the statistical point of view , had any effect on top dry weight .

Aglance to values of root dry weight , it is well noticed that salinity treatments decreased root dry weight insignificantly as compared to the control . That was true in most cases . Such decreases differed from (24.7 - 42.2 %) , (8.8 - 53.6 %) , (5.4 - 45.0 %) and (47.4 - 64.9 %) for sour orange , Rangpur lime , Cleopatra mandarin and Poorman orange , respectively .

Comparing high level of salinity (6000 ppm) with low rate (2000 ppm) under SAR 6 , it is noticed that root dry weight decreased insignificantly with increasing salinity . However , such trend was not obvious for sour orange rootstock . The same trend was only noticed for sour orange and Rangpur lime when SAR 12 was put in consideration.

With respect to SAR levels , data declared that SAR 12 mostly decreased root dry weight as compared to the corresponding ones of SAR 6 . Nevertheless , such effect was not dominent in both sour orange and Poorman orange .

As for top/root ratio , disclosed data in Table (3) and Fig. (4) showed that salinity treatments dropped down top/root ratio below the control . Such decrease from the statistical point of view , was clear in case of Rangpur lime . On the other side , Poorman orange gave significantly the opposite trend .

Comparing various concentrations of salinity under SAR 6 , it is interesting to notice that plants treated with level (6000 ppm) gave lower and insignificant values than those of low level (2000 ppm).

Top/Root Ratio under partial shade season, 1986.

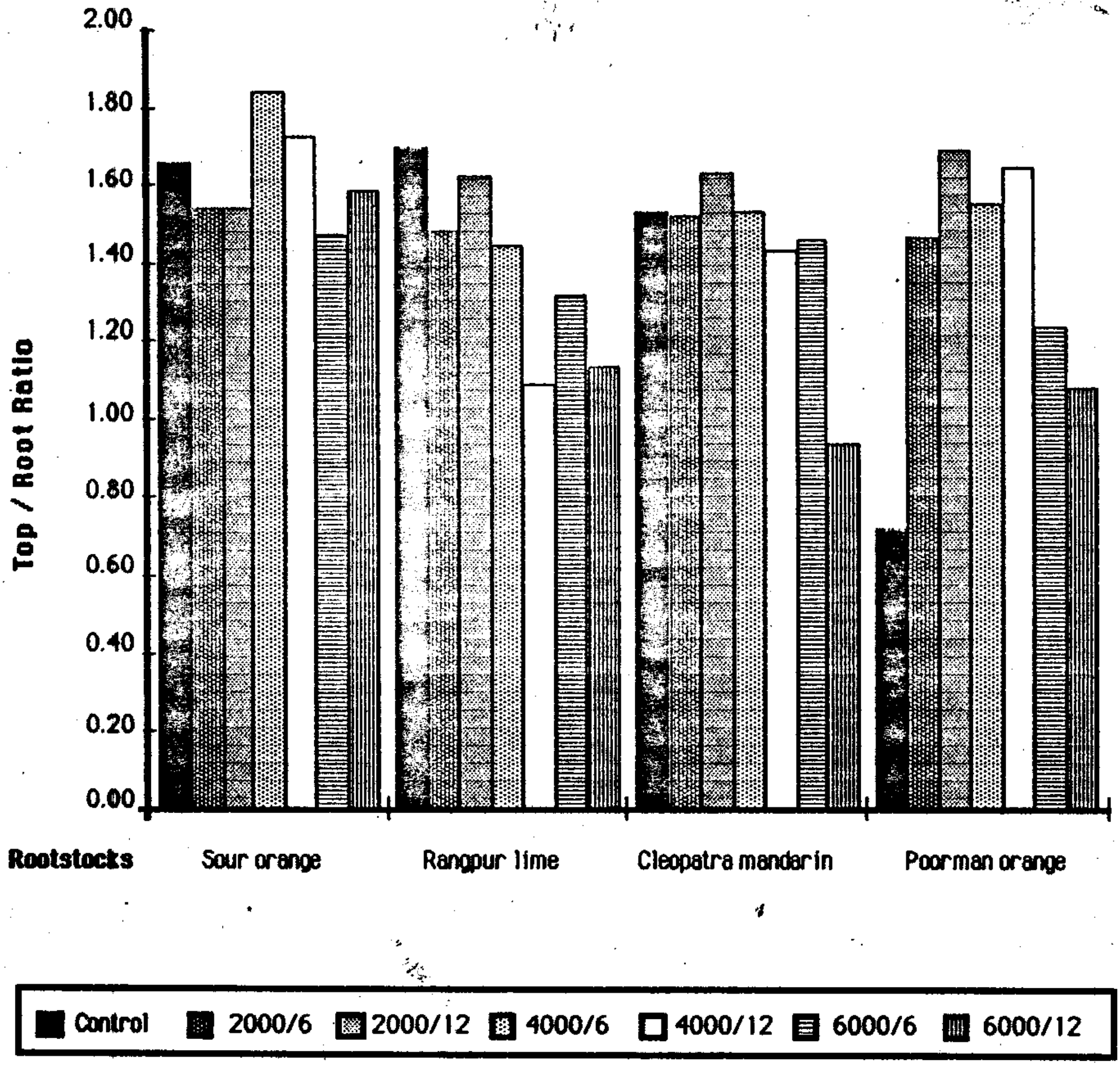

Fig. (4) : Top / root ratio of Washington navel orange plants budded on different rootstocks grown under partial shade as affected by different levels of salinity and S A R (season, 1986).

That was true in all rootstocks used . The same effect was obtained significantly when SAR 12 was noticed . However , such picture was not clear in case of sour orange .

As for SAR level , no clear trend was noticed . Thus , while SAR 12 caused a general decrease in top/root ratio of both Rangpur lime and Cleopatra mandarin below SAR 6 at the same treatment of salinity , it took the other way around in other rootstocks in this respect .

Regarding leaves percentage , it is obvious from Table (3) that salinity treatments generally decreased leaves percentage as compared to the control . That was true in all rootstocks studied except Poorman orange . Such decreases were (4 - 15 %) , (1 - 17 %) , and (8 - 14 %) for sour orange , Rangpur lime and Cleopatra mandarin , respectively.

Moreover , plants received SAR 6 beside different levels of salinity showed that plants treated with high concentration of salinity were inferior in leaves percentage than irrigated with low level of saline water. The same effect was noticed when SAR 12 was concerned.

Furthermore , under different levels of salinity SAR 12 treatment was generally lower in its value than those of SAR 6 in this respect. Such conclusion was not clear in case of Poorman orange .

Referring to fibrous roots percentage , data disclosed that salinity in general decreased fibrous roots percentage in respect to the analogous ones of the control . Moreover , under SAR 6 high level of salinity induced a reduction in this concern below the rate under the same level of SAR.

On the other hand , plants received SAR 12 showed that high level of salinity dropped down fibrous roots percentage below low concentrations . Such trend was clearly true with sour orange and Poorman orange rootstocks .

Comparing the two levels of SAR used under the same level of salinity it is obvious that SAR 12 generally decreased values of fibrous roots percentage as compared to the corresponding ones of SAR 6 . That was true in all rootstocks studied except Cleopatra mandarin which had no clear trend .

Considering specific weight of leaves (dry weight of 100 cm^2) , it is interesting to notice that salinity treatments generally increased values in respect of the analogous ones of the control . However, Rangpur lime gave a reverse picture in this sphere. Significant differences were clear with Poorman orange and Rangpur lime stocks. Anyhow , such increase ranged from 0 to 29.6 % for sour orange , 1.8 - 11.7 % for Cleopatra mandarin , and 5.2 - 30.3 % for Poorman orange. The reduction occurred with Rangpur lime varied from 5.4 - 26 % .

As far as salinity concentrations were concerned , it is found that under SAR 6 high level of salinity raised up values of leaf specific weight over those of low saline water . That was statistically clear in both sour orange and Rangpur lime . The same effect was noticed when SAR 12 level was concerned. Nevertheless , significant differences were noticed in case of sour orange and Cleopatra mandarin.

Meanwhile , SAR 12 under the same level of salinity , caused a general decrease in leaf specific weight as compared with the corresponding ones of SAR 6. However , significant difference was only observed in case of Rangpur lime .

Regarding leaf area , it is found that salinity treatments showed a general decrease in leaf area . However , differences were so high to be statistically significant . The picture was changed to the reverse as Poorman orange rootstock was put in consideration . Nevertheless , significant differences were generally lacking .

For all that , percentages of decrease were (7.7 - 42.5) , (12.3 - 46.9) , (14.7 - 49.3) for sour orange , Rangpur lime , and Cleopatra mandarin , respectively . On the contrary , percentage of increase for Poorman orange was 4.8 - 27.8 .

Regarding SAR 6 under different rates of salinity , data of both sour orange and Cleopatra mandarin rootstocks showed that high concentration of salinity decreased leaf area below the low level . Such effect was more or less similar in their values concerning Rangpur lime and Poorman orange plants . However , significant differences were only observed in case of Cleopatra mandarin . On the other hand , as SAR 12 level was concerned it is found that , in all citrus rootstocks used , high level of salinity caused significant decrement in leaf area as compared to plants irrigated with low level .

Concerning the two levels of SAR , it is clear that discarding the values of Cleopatra mandarin , SAR 12 mostly decreased leaf area as compared to the analogous ones of plants received SAR 6 under the same concentration of salinity . Such conclusion was more statistically clear in Rangpur lime .

4.2. Chemical constituents.

4.2.1- Leaf and fibrous roots nutrients content:

4.2.1.1- Effect of salinity treatments on leaf nutrients content of Washington navel orange plants budded on different citrus rootstocks grown under full sun light snd partial shade conditions.

4.2.1.1.a- Full sun light :-

Table (4) show the effect of different rates of salinity and SAR on leaf nutrients content of Washington navel orange plants budded on different citrus rootstocks grown under full sun light condition.

It is quite evident that leaf nitrogen content of saline plants increased as compared to those of the untreated ones. Such effect was more statistically observed in Rangpur lime stock. Moreover , citrus rootstocks irrigated with high level of salinity developed leaves of Washington navel orange with higher percentages of nitrogen in respect of the corresponding ones received low rate of salinity. That was true under both levels of SAR as well as in all rootstocks used. Such finding was more statistically clear in Rangpur lime.

Meanwhile , as far as SAR levels were concerned , it is obvious that in the majority of cases , plants treated with SAR 12 were less in leaf nitrogen content as compared to those ones received SAR 6 level. In spite of that , differences were mostly insignificant.

Respecting leaf phosphorus content , data presented in **Table (4)** showed that in all rootstocks , plants irrigated with saline irrigation water were lower significantly in their leaf phosphorus content than those of check plants.

Concerning different levels of salinity used , it is well noticed that plants irrigated with high level of salinity combined with SAR 6 rate had leaves with higher levels of phosphorus as compared with the analogous ones received low level of salinity and under the same rate of SAR 6 . However , the picture was not clear in case of Poorman orange. Reverse results were obtained when SAR 12 was used . Nevertheless, the average of the two levels of SAR under the same concentration of salinity indicated that in most citrus rootstocks used in this study, plants treated with high concentration of salinity slightly raised up leaf phosphorus values over those received low level of salinity.

Referring to SAR treatments , it is clear that under low level of salinity (2000 ppm) plants received SAR 12 developed leaves with higher percentages of phosphorus comparing with the corresponding ones but treated with SAR 6 level . Such finding was changed to the opposite when high concentration of salinity (6000 ppm) was used.

Concerning leaf potassium content , it is found that plants irrigated with saline water were mostly poor in leaf potassium content

Table(4) : **Leaf nutrient contents of Washington navel orange plants budded on different rootstocks grown under salinity, S A R and full sun light conditions (season 1986).**

Root stock	Salinity treatment		Elements concentration									
	p.p.m.	SAR	N	P	K	Ca	Mg	Na	CL	Zn	Fe	Mn
						(%)					(P.P.m)	
Sour orange	**Control**		**2.15**	**0.310**	**1.99**	**3.30**	**0.137**	**0.23**	**0.78**	**6.70**	**505.0**	**50.00**
	"2000"	"6"	2.58	0.260	1.75	3.00	0.270	0.29	0.90	12.00	429.7	37.30
	"2000"	"12"	2.45	0.280	2.05	2.53	0.350	0.18	0.76	12.00	420.0	39.00
	"4000"	"6"	2.67	0.290	2.18	1.77	0.220	0.33	0.59	15.30	337.0	66.70
	"4000"	"12"	2.23	0.270	1.89	2.60	0.280	0.34	0.85	10.00	344.0	33.00
	"6000"	"6"	3.06	0.290	1.61	2.20	0.287	0.50	0.73	6.00	564.3	105.70
	"6000"	"12"	2.58	0.260	1.64	2.53	0.100	0.55	1.14	3.00	534.7	80.30
Rangpur lime	**Control**		**2.06**	**0.360**	**1.74**	**2.33**	**0.093**	**0.17**	**0.48**	**3.00**	**434.0**	**83.00**
	"2000"	"6"	2.62	0.240	1.58	2.20	0.113	0.28	0.71	3.00	475.3	32.00
	"2000"	"12"	2.56	0.340	2.19	2.07	0.183	0.29	0.48	13.00	432.3	36.00
	"4000"	"6"	3.21	0.320	1.57	1.53	0.177	0.50	0.52	3.30	499.3	21.70
	"4000"	"12"	2.58	0.320	1.62	1.93	0.230	0.60	0.61	8.00	359.7	126.70
	"6000"	"6"	3.27	0.310	1.55	1.93	0.160	0.84	0.78	12.70	523.3	108.30
	"6000"	"12"	3.44	0.290	1.19	0.93	0.403	1.25	0.99	3.70	443.7	75.00
Cleopatra mandarin	**Control**		**2.15**	**0.360**	**1.84**	**3.00**	**0.050**	**0.17**	**1.02**	**2.70**	**346.3**	**40.00**
	"2000"	"6"	2.41	0.230	1.94	2.80	0.140	0.21	0.69	3.00	641.0	31.00
	"2000"	"12"	2.23	0.270	2.15	2.47	0.097	0.27	0.59	12.70	448.0	29.00
	"4000"	"6"	3.18	0.240	1.54	3.00	0.267	0.37	0.48	4.00	431.7	38.30
	"4000"	"12"	2.67	0.250	1.31	3.27	0.210	0.78	0.76	4.00	438.7	105.30
	"6000"	"6"	2.82	0.320	1.61	1.93	0.227	0.50	0.48	3.00	392.3	115.00
	"6000"	"12"	2.61	0.260	1.44	3.00	0.063	0.65	0.94	2.30	439.3	86.00
Poorman orange	**Control**		**2.32**	**0.350**	**1.60**	**2.67**	**0.240**	**0.20**	**0.92**	**3.00**	**498.7**	**53.70**
	"2000"	"6"	2.54	0.250	2.19	2.20	0.137	0.19	0.80	3.30	534.3	36.30
	"2000"	"12"	2.32	0.280	1.87	3.27	0.133	0.25	0.71	18.00	523.7	28.00
	"4000"	"6"	2.49	0.220	1.61	2.60	0.140	0.35	0.83	4.30	410.7	37.70
	"4000"	"12"	2.67	0.280	1.43	2.47	0.280	0.40	0.78	1.70	464.3	93.00
	"6000"	"6"	3.03	0.240	1.44	3.20	0.127	0.45	0.83	2.30	401.3	102.70
	"6000"	"12"	2.60	0.250	1.10	2.80	0.050	0.51	0.78	19.70	551.7	84.00
L.S.D. at 1%			**0.47**	**0.040**	**0.21**	**0.61**	**0.054**	**0.12**	**0.60**	**1.20**	**11.5**	**5.62**

as compared with those of untreated ones. However , significant differences were more clear in the case of Cleopatra mandarin stock. Moreover , high level of salinity induced a decrease in leaf potassium content in respect of those received low rate of salinity. Meanwhile , under high level of salinity , plants treated with SAR 12 rate were generally lower in their leaf potassium content as compared with the analogous ones received SAR 6 treatment. The picture was generally changed to the reverse when low concentration was concerned.

As for leaf Ca content , it is quite evident from **Table (4)** that treating citrus plants with different levels of salinity decreased obviously leaf Ca content in respect of those plants deprived of salinity (control). Such effect from the statistical point of view was mostly observed in case of sour orange stock. Moreover , plants received high concentration of salinity generally dropped down leaf Ca content as compared to the analogous ones of those treated with low rate of salinity.

As far as SAR treatments were concerned , it is clear that in both Rangpur lime and Poorman orange , plants treated with SAR 12 were less in their values than the corresponding ones received SAR 6 level. Such conclusion was mainly observed in case of high concentration of salinity. However , such result was less in case of both sour orange and Cleopatra mandarin.

Considering leaf Mg content , data in **Table (4)** declared that regardless the values of Poorman orange rootstock , salinity treatments increased leaf Mg content significantly over the control in most cases. Meanwhile , fluctuated results were obtained as salinity levels were concerned. Thus , while high level of salinity increased leaf Mg content over those received low level in case of Rangpur lime and Cleopatra mandarin , it took the other way around in case of sour orange and Poorman orange.

Concerning the SAR treatments used in this study , it is found that SAR 12 level generally raised up leaf Mg content over those treated with SAR 6 in case of sour orange and Rangpur lime rootstocks. The picture was completely changed to the other side as Cleopatra mandarin and Poorman orange stocks were concerned.

Referring to leaf Na content , it is quite evident from **Table (4)** that salinity treatments , as predicted , raised up remarkably leaf Na content in respect of the analogous ones of the control. Significant differences were observed in most rootstocks used.

Moreover , high level of salinity surpassed remarkably all other treatments of saline water in increasing leaf Na content. Furthermore , comparing the two levels of SAR used in this study , it is well noticed that in most cases , SAR 12 increased leaf Na content than those treated with SAR 6 level under the same concentration of salinity. That was statistically true in Cleopatra mandarin stock only.

Regarding leaf Cl content , tabulated data , indicated that salinity treatments varied in their effect on leaf Cl content according to the rootstock used. Thus , while salinity treatments generally increased leaf Cl content in respect of those deprived of salinity (control) in case of sour orange and Rangpur lime rootstocks , the opposite was noticed when both Cleopatra mandarin and Poorman orange plants were concerned. However , significant differences were noticed in the majority of treatments.

Moreover , high concentration of salinity for citrus plants raised up , in general , leaf Cl content as compared to the corresponding ones received low level of salinity.

Considering the two levels of SAR used in this study , it is noticed from **Table (4)** that neglecting values of Poorman orange , plants treated with SAR 12 combined with high concentrations of salinity gave significantly higher values of leaf Cl content than those treated with the same level of salinity but received SAR 6 level .

Concerning leaf Zn content , it is clear from **Table (4)** that control plants had generally leaves with low amounts of Zn as compared with those treated with saline irrigation water. Any how , significant differences were observed with large numbers in case of sour orange and less numbers in case of the remained rootstocks used. Moreover , plants received low level of salinity had generally leaves with higher amounts of Zn than those treated with high concentration of salinity. Furthermore , under high rate of salinity combined with SAR 12 level , citrus rootstocks , irrespective of Poorman orange developed scion leaves with lower amounts of Zn than those received SAR 6 and under the same level of salinity (high rate). However , the picture was changed to the reverse under low level of salinity.

Considering leaf Fe content , it is quite evident that citrus plants irrigated with different saline water treatments were mostly higher significantly in their leaf Fe content in respect of those of the control. That was true in all rootstocks studied except sour orange where salinity in general significantly decreased leaf Fe content.

Moreover , high level of salinity treatment for both sour orange and Rangpur lime rootstocks raised up leaf Fe content over the corresponding ones received low rate of salinity. Such effect was partially noticed in case of Poorman orange stocks. Also a reverse effect was observed for Cleopatra mandarin rootstock.

Referring to SAR rates it is clear that in general, SAR 12 treatment, under different concentrations of salinity, decreased leaf Fe content as compared to those ones received SAR 6 level under the same rate of salinity. That was true in case of sour orange and Rangpur lime plants, while the reverse was noticed when Cleopatra mandarin and Poorman orange stocks were taken in account.

Concerning leaf Mn content, **Table (4)** disclosed that salinity concentrations varied in their effect. Thus, while low level of salinity decreased leaf Mn content in respect of the corresponding ones of the control, the high rate of salinity values took the other way around. That was true in all citrus rootstocks used. Moreover, leaves of plants treated with high level of salinity were more rich in their values than the analogous ones received low level.

Furthermore, SAR 12 level generally decreased leaf Mn content as compared to those of SAR 6. Such conclusion was clear in all citrus rootstocks used in this study except ranpgur lime where it gave mostly opposite picture.

4.2.1.1.b- Partial shade:

Tables (5 and 6) showed that leaf nitrogen content fluctuated from one season to another. Thus, the average of two seasons was put in consideration (Table 7). It is clear that regardless of Poorman orange values, 4000 ppm treatment mostly decreased leaf nitrogen content below the control. Nevertheless, difference between this treatment and

Table(5) : **Leaf nutrient contents of Washington navel orange plants budded on different rootstocks grown under salinity, S A R and partial shade conditions (season 1985).**

Root stock	Salinity treatment		Elements concentration									
	p.p.m.	S A R	N	P	K	Ca	Mg	Na	CL	Zn	Fe	Mn
			(%)							(P.P.m)		
Sour orange	**Control**		**2.52**	**0.230**	**1.74**	**4.13**	**0.167**	**0.35**	**0.53**	**61.00**	**920.3**	**82.00**
	"2000"	"6"	2.43	0.190	1.00	4.13	0.163	0.28	0.67	48.00	495.7	78.30
	"2000"	"12"	1.96	0.140	1.10	3.07	0.123	0.23	0.60	53.00	520.3	63.30
	"4000"	"6"	2.43	0.210	1.29	4.13	0.160	0.28	0.67	48.30	479.3	41.00
	"4000"	"12"	2.26	0.200	1.55	4.13	0.163	0.34	0.82	58.00	651.7	58.00
	"6000"	"6"	2.69	0.160	1.50	3.80	0.153	0.29	0.57	45.00	645.7	78.00
	"6000"	"12"	2.58	0.220	1.57	3.73	0.150	0.30	0.53	34.70	977.7	64.00
Rangpur lime	**Control**		**2.52**	**0.240**	**1.63**	**3.53**	**0.140**	**0.20**	**0.52**	**55.00**	**725.3**	**64.70**
	"2000"	"6"	3.10	0.190	1.26	2.93	0.116	0.30	0.36	64.00	750.7	50.30
	"2000"	"12"	2.94	0.150	1.19	3.00	0.120	0.29	0.46	32.00	652.0	72.00
	"4000"	"6"	2.64	0.190	1.25	3.67	0.150	0.28	0.53	42.00	755.7	82.00
	"4000"	"12"	2.30	0.200	1.18	4.07	0.150	0.25	0.45	47.00	872.7	71.00
	"6000"	"6"	2.65	0.160	1.45	3.00	0.120	0.22	0.60	44.70	831.3	49.00
	"6000"	"12"	2.60	0.290	1.78	3.07	0.123	0.24	0.66	41.00	854.3	97.70
Cleopatra mandarin	**Control**		**2.13**	**0.220**	**1.19**	**4.00**	**0.160**	**0.20**	**0.54**	**37.70**	**575.7**	**64.70**
	"2000"	"6"	2.54	0.120	1.15	4.00	0.160	0.19	0.53	24.00	609.3	92.00
	"2000"	"12"	2.27	0.210	0.96	3.40	0.140	0.17	0.50	31.00	641.3	42.00
	"4000"	"6"	2.51	0.200	1.25	3.80	0.147	0.20	0.66	58.00	565.0	38.30
	"4000"	"12"	2.22	0.230	1.39	3.53	0.143	0.23	0.58	55.00	732.3	54.00
	"6000"	"6"	2.43	0.150	1.30	3.93	0.157	0.23	0.44	46.00	551.7	63.30
	"6000"	"12"	2.32	0.260	1.57	3.07	0.123	0.33	0.65	49.00	760.0	69.00
Poorman orange	**Control**		**2.17**	**0.310**	**1.78**	**3.13**	**0.127**	**0.15**	**0.36**	**57.00**	**702.3**	**67.30**
	"2000"	"6"	2.39	0.170	0.97	2.87	0.117	0.13	0.39	49.70	562.7	66.70
	"2000"	"12"	2.43	0.200	1.28	3.87	0.153	0.19	0.44	66.00	630.0	57.30
	"4000"	"6"	2.65	0.200	1.53	3.40	0.137	0.18	0.44	62.00	605.3	62.30
	"4000"	"12"	2.90	0.220	1.44	3.40	0.130	0.20	0.67	53.00	622.7	68.70
	"6000"	"6"	2.34	0.170	1.42	3.40	0.133	0.19	0.39	33.00	511.7	57.70
	"6000"	"12"	2.43	0.240	1.38	3.00	0.120	0.24	0.52	45.00	826.7	87.00
L . S . D . at 1%			**0.48**	**0.020**	**0.13**	**0.67**	**0.029**	**0.06**	**0.09**	**3.90**	**15.2**	**4.30**

Table(6) : **Leaf nutrient contents of Washington navel orange plants budded on different rootstocks grown under salinity, S A R and partial shade conditions (season 1986).**

Root stock	Salinity treatment p.p.m.	Salinity treatment SAR	N	P	K	Ca	Mg	Na	CL	Zn	Fe	Mn
			(%)							(P.P.m)		
Sour orange	**Control**		**2.64**	**0.290**	**1.49**	**3.07**	**0.123**	**0.19**	**0.43**	**25.00**	**498.7**	**55.00**
	"2000"	"6"	2.97	0.310	1.69	2.73	0.207	0.25	0.70	13.00	535.3	75.00
	"2000"	"12"	2.69	0.260	2.01	2.40	0.183	0.19	0.35	12.70	458.7	45.00
	"4000"	"6"	2.45	0.250	1.77	2.47	0.097	0.25	0.45	13.30	428.7	36.00
	"4000"	"12"	2.73	0.290	1.67	2.40	0.097	0.45	0.43	16.30	378.7	52.00
	"6000"	"6"	3.51	0.190	1.59	2.40	0.097	0.61	0.63	19.00	422.0	68.00
	"6000"	"12"	2.66	0.240	1.48	2.47	0.097	0.93	0.82	29.00	435.3	58.00
Rangpur lime	**Control**		**3.16**	**0.260**	**1.36**	**2.80**	**0.117**	**0.23**	**0.63**	**12.30**	**342.7**	**54.70**
	"2000"	"6"	2.73	0.230	1.29	2.40	0.097	0.31	0.75	17.00	449.7	73.00
	"2000"	"12"	2.34	0.270	1.40	2.67	0.143	0.54	0.50	17.00	311.7	43.00
	"4000"	"6"	2.45	0.230	1.19	3.40	0.137	0.49	0.87	11.30	343.7	43.00
	"4000"	"12"	2.72	0.230	1.46	2.47	0.097	0.41	0.74	10.00	549.0	49.00
	"6000"	"6"	3.12	0.210	1.40	1.67	0.067	1.10	0.39	17.00	458.7	38.00
	"6000"	"12"	2.82	0.240	1.61	1.73	0.067	1.19	0.60	12.30	447.3	46.00
Cleopatra mandarin	**Control**		**2.69**	**0.240**	**1.21**	**3.00**	**0.123**	**0.19**	**0.43**	**43.50**	**478.7**	**74.00**
	"2000"	"6"	2.17	0.230	0.94	3.40	0.137	0.41	0.68	32.00	634.7	94.30
	"2000"	"12"	2.00	0.220	1.29	3.40	0.137	0.33	0.74	32.00	424.3	62.00
	"4000"	"6"	2.13	0.170	1.17	3.53	0.143	0.50	0.44	27.00	486.3	64.00
	"4000"	"12"	2.69	0.190	1.46	2.53	0.097	0.77	0.42	32.00	471.7	62.00
	"6000"	"6"	2.99	0.180	1.48	2.47	0.097	0.69	0.49	35.00	603.7	54.70
	"6000"	"12"	2.90	0.220	1.39	2.47	0.100	0.80	0.60	31.70	482.3	50.00
Poorman orange	**Control**	.	**2.64**	**0.240**	**1.78**	**3.10**	**0.123**	**0.14**	**0.43**	**31.00**	**281.0**	**33.30**
	"2000"	"6"	2.52	0.200	1.04	3.27	0.140	0.45	0.96	45.00	330.7	41.70
	"2000"	"12"	2.17	0.210	1.46	3.27	0.133	0.34	0.31	49.00	502.7	46.00
	"4000"	"6"	2.53	0.270	1.18	3.40	0.143	0.55	0.55	45.00	318.0	66.00
	"4000"	"12"	2.56	0.180	1.33	3.40	0.140	0.59	0.60	62.00	430.0	61.70
	"6000"	"6"	3.25	0.200	1.60	2.47	0.097	0.72	0.72	46.00	395.0	66.00
	"6000"	"12"	3.05	0.300	1.63	1.87	0.077	0.91	0.82	44.70	427.3	54.70
L.S.D. at 1%			**0.49**	**0.020**	**0.13**	**0.58**	**0.024**	**0.06**	**0.08**	**5.43**	**14.43**	**3.64**

Elements concentration: N, P, K, Ca, Mg, Na, CL in (%); Zn, Fe, Mn in (P.P.m).

Table(7) : **Leaf nutrient contents of Washington navel orange plants budded on different rootstocks grown under salinity, S A R and partial shade conditions (Average of two seasons).**

Root stock	Salinity treatment		Elements concentration									
	p.p.m.	S A R	N	P	K	Ca	Mg	Na	CL	Zn	Fe	Mn
			(%)							(P.P.m)		
Sour orange	**Control**		**2.58**	**0.260**	**1.62**	**3.60**	**0.145**	**0.27**	**0.48**	**43.00**	**724.5**	**68.50**
	"2000"	"6"	2.70	0.250	1.35	3.43	0.185	0.27	0.69	30.50	515.5	76.70
	"2000"	"12"	2.33	0.200	1.56	2.74	0.153	0.21	0.48	32.90	489.5	54.00
	"4000"	"6"	2.44	0.230	1.53	3.30	0.129	0.27	0.56	30.80	454.0	38.50
	"4000"	"12"	2.50	0.250	1.61	3.27	0.130	0.40	0.63	37.20	515.2	55.00
	"6000"	"6"	3.10	0.180	1.55	3.10	0.125	0.45	0.60	32.00	533.9	73.00
	"6000"	"12"	2.62	0.230	1.55	3.10	0.124	0.62	0.68	31.90	706.5	61.00
Rangpur lime	**Control**		**2.84**	**0.250**	**1.50**	**3.17**	**0.129**	**0.22**	**0.58**	**33.70**	**534.0**	**59.70**
	"2000"	"6"	2.92	0.210	1.28	2.67	0.107	0.31	0.56	40.50	600.2	61.70
	"2000"	"12"	2.64	0.210	1.30	2.84	0.132	0.42	0.48	24.50	481.9	57.50
	"4000"	"6"	2.55	0.210	1.22	3.54	0.144	0.39	0.70	26.70	549.7	62.50
	"4000"	"12"	2.51	0.220	1.32	3.27	0.124	0.33	0.60	28.50	710.9	60.00
	"6000"	"6"	2.89	0.190	1.43	2.34	0.094	0.66	0.50	30.90	645.0	43.50
	"6000"	"12"	2.71	0.270	1.70	2.40	0.095	0.72	0.63	26.70	650.8	71.90
Cleopatra mandarin	**Control**		**2.41**	**0.230**	**1.20**	**3.50**	**0.142**	**0.20**	**0.49**	**40.60**	**527.2**	**69.40**
	"2000"	"6"	2.36	0.180	1.05	3.70	0.149	0.30	0.61	28.00	622.0	93.20
	"2000"	"12"	2.14	0.220	1.13	3.40	0.139	0.25	0.62	31.50	532.8	52.00
	"4000"	"6"	2.32	0.190	1.21	3.67	0.145	0.35	0.55	42.50	525.7	51.20
	"4000"	"12"	2.46	0.210	1.43	3.03	0.120	0.50	0.50	43.50	602.0	58.00
	"6000"	"6"	2.71	0.170	1.39	3.20	0.127	0.46	0.47	40.50	577.7	59.00
	"6000"	"12"	2.61	0.240	1.47	2.77	0.112	0.57	0.63	40.40	621.2	59.50
Poorman orange	**Control**		**2.41**	**0.280**	**1.78**	**3.12**	**0.125**	**0.15**	**0.40**	**44.00**	**491.7**	**50.30**
	"2000"	"6"	2.46	0.190	1.01	3.07	0.129	0.29	0.68	47.00	446.7	54.20
	"2000"	"12"	2.30	0.210	1.37	3.57	0.143	0.27	0.38	57.50	566.3	51.70
	"4000"	"6"	2.59	0.240	1.36	3.40	0.140	0.37	0.50	53.50	461.5	64.20
	"4000"	"12"	2.73	0.200	1.39	3.40	0.135	0.40	0.64	57.50	526.4	65.20
	"6000"	"6"	2.80	0.190	1.51	2.94	0.115	0.46	0.56	39.50	453.4	61.90
	"6000"	"12"	2.74	0.270	1.51	2.44	0.099	0.58	0.67	44.90	627.0	70.90
L . S . D . at 1%			**0.49**	**.02**	**0.13**	**0.63**	**0.027**	**0.06**	**0.09**	**4.80**	**15.5**	**4.10**

the control was insignificant. Moreover, high concentration of salinity for citrus plants increased insignificantly leaf nitrogen content over those ones received low level of saline irrigation water. In addition, under the same level of salinity, plants treated with SAR 12 level were mostly poorer in leaf nitrogen content than those received SAR6 rate. However, differences were so small to reach the significant level .

Concerning leaf phosphorus content, data of Tables (5,6 and 7) disclosed that in both seasons as well as the average of two seasons, salinity treatments dropped down leaf phosphorus content in respect of those ones of the control . Beside , differences between treatments and the control were mostly significant. However, the effect of salinity concentrations varied from one season to another. It is clear that under SAR 12 level , high concentration of salinity increased significantly leaf phosphorus content as compared to the corresponding ones of low concentration of salinity. Such conclusion was not obvious under SAR 6 treatment. Furthermore , comparing the two levels of SAR under the same level of salinity, data presented in Table (7) disclosed, that values of SAR 12 treatment were generally higher than those of SAR 6 in all studied citrus rootstocks. Beside, significant differences were mostly observed in this respect.

Considering leaf potassium content, the average of two seasons was concerned since the effect of salinity on leaf potassium content varied from one season to other. Consequently, it is interesting to notice from Table (7) that discarding values of Cleopatra mandarin, plants irrigated with different levels of saline water decreased leaf potassium content in respect of those ones of the control. However, significant differences were more clear in case of Rangpur lime and Poorman orange rootstocks. Meanwhile, high concentration of salinity as compared to low level significantly raised up potassium in leaves of all citrus rootstocks used in this study. Similarly, under the different levels of salinity, higher values of leaf potassium content was obtained when SAR 12 level was used. However , significant differences were not dominent in this concern.

Referring to data of leaf calcium content as presented in Table (7), it is found that the trend of the effect of salinity treatments in respect of untreated plants tended to decrease generally leaf calcium content in all citrus stocks used. In the mean time , high level of salinity caused a reduction in leaf calcium content as compared to those irrigated with low rate of salinity. Concerning SAR rates used in this study, data clearly showed that SAR 12 values were lowered insignificantly in leaf calcium content than those of SAR 6 in most cases .

Furthermore , values of leaf Mg content presented in Tables (5,6 and 7) indicated that in both seasons , salinity treatments caused a general decrease in leaf Mg content as compared to the control. Such conclusion was not clear in case of Poorman orange rootstock. The same trend was noticed when the average of two seasons was concerned. However , few significant differences were observed between treatments and the control . In addition , in 1985 no consistent effect of high salinity concentration on leaf Mg content was noticed. In this respect, while high level of salinity combined with SAR 12 increased leaf Mg content over those of low salinity level and the same level of SAR in case of both sour orange and Rangpur lime , the picture was changed to the reverse for Cleopatra mandarin and Poorman orange. In 1986 as well as the average of two seasons, the picture of effect was more clear, hence high level of salinity for all rootstocks used mostly decreased significantly values of leaf Mg content in respect of those received low concentration of salinity.

Referring to the two levels of SAR used in this study, data disclosed that plants treated with SAR 12 level generally decreased leaf Mg content as compared with those of SAR 6 under the same concentration of salinity. However, significant differences were lacking in most cases .

As far as leaf sodium content was concerned, it is well noticed that saline treated plants were higher in their leaf sodium values than those of the control (Table 7). In this respect, significant differences were mostly observed between salinity treatments and the control. Moreover, increasing level of salinity increased profoundly leaf sodium content. Furthermore , citrus plants received SAR 12 level increased significantly leaf sodium content in the majority of cases when compared with the corresponding ones of SAR 6 level under the same treatment of salinity.

Considering leaf chloride content, data presented in Table (7) showed that application of different concentrations of saline irrigation water generally increased leaf chloride-content over the control. However , significant differences were mostly observed in case of Poorman orange and sour orange rootstocks .

Moreover, citrus plants treated with the high concentration of salinity beside SAR 12 rate raised up leaf chloride content remarkably in respect of the corresponding ones received the same level of SAR and irrigated with low level of saline water. Meanwhile, under the high level of salinity, higher amounts of leaf chloride content was noticed as plants treated with SAR 12 level . Such conclusion was true when compared with the analogous ones of those treated with the same concentration of salinity but received SAR 6 level Table (7).

Concerning leaf micronutrients content, it is clear that the effect of salinity treatments on leaf Zn content fluctuated from one season to another. Thus, the average of two seasons was taken in account. It is found from Table (7) that salinity treatments generally decreased leaf Zn content in respect of those leaves of the control plants. That was true in all citrus rootstocks used except Poorman orange stock. Beside, such decrease was observed significantly in both sour orange and Rangpur lime rootstocks.

Comparing high level of salinity with low ones, it is clear that high concentration of salinity varied in its effect according to the rootstock used. Thus, while high rate of salinity decreased leaf Zn content of Rangpur lime and Poorman orange, it increased leaf Zn content of Cleopatra mandarin and in part in case of sour orange. Moreover, regardless values of Rangpur lime, data of SAR levels showed that SAR 12 level gnerally increased leaf Zn content over those of SAR 6 under the same level of salinity.

Regarding leaf Fe content, data presented in Table (7) indicated that salinity treatments increased significantly leaf Fe content of Rangpur lime and Cleopatra mandarin and partially in case of Poorman orange as compared with those of the control. The opposite was true in case of sour orange. Furthermore, citrus plants irrigated with high level of salinity generally surpassed significantly in their values the corresponding ones of those received low level of salinity. Meanwhile, under the high level of salinity, SAR 12 treatment was higher in leaf Fe content than those of SAR 6. On the contrary, under low level of salinity. SAR 12 treatment gave opposite effect where it decreased leaf Fe content more than those of SAR 6 rate. That conclusion was not true in case of Poorman orange.

As for leaf Mn content , it is remarkable from Tables (5,6 and 7) that salinity treatments as compared with the control, increased leaf Mn content of Rangpur lime and Poorman orange while gave opposite effect in case of sour orange and Cleopatra mandarin. Such effect from the statistical point of view was noticed significantly in all rootstocks used except Rangpur lime.

Comparing high level of salinity with those of low rate, data clearly showed that leaf Mn content under high concentration of salinity and SAR 12 increased significantly over those received the same level of SAR but under low rate of salinity. That was noticed in all rootstocks. The opposite was generally noticed when SAR 6 rate was concerned in this respect.

Moreover, the effect of SAR levels on leaf Mn content varied according to the rootstock used. In this sphere, while SAR 12 treatment generally caused an increase in leaf Mn content than those of SAR 6 rate of both Cleopatra mandarin and Poorman orange, it gave the other way around in case of sour orange and Rangpur lime.

4.2.1.2- Effect of salinity concentrations and SAR rates on fibrous roots nutrients content of Washington navel orange plants budded on different rootstocks grown under full sun light and partial shade conditions:

Fibrous roots nutrient contents of Washington navel orange plants budded on different citrus rootstocks grown under various levels of salinity and SAR as well as full sun light and partial shade conditions are presented in Tables (8 and 9).

4.2.1.2.a- Full sun light:

It is clear from Table (8) that fibrous roots nitrogen content of all studied rootstocks increased when salinity treatments were applied to the plants and in the mean time compared to the control. Anyhow, significant differences between treatments and the control were observed in most of citrus rootstocks. Moreover, high concentration of salinity gave higher values of root nitrogen content than those of plants received low level of salinity. Also, SAR 12 level for sour orange and Rangpur lime rootstocks raised up, in general, root nitrogen content. However, such finding was not clear in case of Cleopatra mandarin and Poorman orange.

Table(8) : **Fibrous roots nutrient contents of Washington navel orange plants budded on different rootstocks grown under salinity, SAR and full sun light conditions (season 1986).**

Root stock	Salinity treatment		Elements concentration									
	p.p.m.	SAR	N	P	K	Ca	Mg	Na	CL	Zn	Fe	Mn
			(%)							(P.P.m)		
Sour orange	**Control**		**0.80**	**0.047**	**0.52**	**2.04**	**0.187**	**0.32**	**0.36**	**230.00**	**425.0**	**243.70**
	"2000"	"6"	0.85	0.040	0.30	1.93	0.113	0.72	0.60	169.70	302.0	175.30
	"2000"	"12"	0.88	0.035	0.48	1.98	0.117	0.61	0.56	253.00	392.0	196.00
	"4000"	"6"	0.95	0.028	0.51	3.27	0.180	0.61	0.67	150.70	161.3	175.30
	"4000"	"12"	0.85	0.040	0.37	1.63	0.130	0.75	0.70	109.30	400.8	140.30
	"6000"	"6"	1.03	0.047	0.45	4.26	0.163	0.64	0.53	332.00	203.7	241.00
	"6000"	"12"	1.20	0.038	0.36	3.44	0.130	0.81	0.54	145.70	310.0	201.70
Rangpur lime	**Control**		**0.65**	**0.047**	**0.60**	**1.88**	**0.123**	**0.23**	**0.27**	**131.60**	**416.7**	**303.30**
	"2000"	"6"	0.82	0.023	0.36	1.52	0.137	0.49	0.46	214.30	375.0	225.30
	"2000"	"12"	0.82	0.035	0.61	1.52	0.133	0.62	0.46	233.00	366.7	164.00
	"4000"	"6"	1.05	0.030	0.48	2.92	0.147	0.57	0.50	128.70	276.7	224.30
	"4000"	"12"	0.92	0.043	0.45	2.98	0.163	0.73	0.53	200.30	407.5	264.70
	"6000"	"6"	1.02	0.030	0.32	4.57	0.127	0.56	0.53	171.70	187.1	260.30
	"6000"	"12"	1.05	0.037	0.31	4.42	0.163	0.60	0.45	142.30	362.5	272.70
Cleopatra mandarin	**Control**		**0.62**	**0.033**	**0.40**	**1.63**	**0.133**	**0.24**	**0.36**	**133.00**	**583.3**	**210.00**
	"2000"	"6"	0.83	0.038	0.22	1.52	0.137	0.53	0.55	141.70	437.2	230.70
	"2000"	"12"	1.02	0.038	0.46	1.40	0.140	0.53	0.56	100.00	145.4	125.70
	"4000"	"6"	0.98	0.028	0.44	3.27	0.130	0.58	0.75	146.30	324.2	161.00
	"4000"	"12"	0.97	0.038	0.42	2.12	0.153	0.69	0.67	126.00	340.8	233.70
	"6000"	"6"	0.97	0.048	0.33	2.47	0.133	0.56	0.54	90.30	358.3	233.70
	"6000"	"12"	0.98	0.047	0.56	3.85	0.230	0.61	0.51	99.00	208.3	173.30
Poorman orange	**Control**		**0.73**	**0.047**	**0.50**	**1.63**	**0.223**	**0.26**	**0.44**	**149.70**	**416.7**	**261.30**
	"2000"	"6"	0.85	0.028	0.40	2.10	0.200	0.52	0.52	340.30	654.2	263.00
	"2000"	"12"	0.83	0.035	0.72	1.57	0.127	0.64	0.65	195.30	212.5	136.70
	"4000"	"6"	0.95	0.033	0.37	2.68	0.137	0.70	0.78	169.70	303.3	120.30
	"4000"	"12"	0.93	0.030	0.70	3.65	0.340	0.61	0.70	206.00	291.7	190.70
	"6000"	"6"	0.98	0.050	0.43	2.16	0.123	0.73	0.82	123.30	316.7	188.30
	"6000"	"12"	1.00	0.043	0.37	3.50	0.243	0.97	0.60	146.00	445.8	182.30
L. S. D. at 1%			**0.19**	**0.010**	**0.09**	**0.42**	**0.031**	**0.08**	**0.07**	**12.20**	**10.5**	**9.90**

Concerning root phosphorus content, it is well noticed from Table (8) that regardless values of Cleopatra mandarin, irrigating citrus plants with different treatments of salinity induced a reduction in root phosphorus content as compared to those of the control. For all that, significant differences were commonly observed in case of Rangpur lime and Poorman orange stocks. However, high level of salinity increased root phosphorus content in respect of the corresponding ones of low level.

Moreover, root phosphorus content of both Rangpur lime and Cleopatra manadarin treated with SAR 12 level were more rich than those ones received SAR 6 under the same level of salinity. Such finding was not obvious in case of either sour orange or Poorman orange.

With respect to root potassium content, data remarkably indicated that discarding values of Cleopatra mandarin, salinity treatments generally decreased root potassium content comparing with those of the control. By all means, significant differences were observed in case of Rangpur lime and Poorman orange rootstocks. . Beside, high level of salinity decreased visually root potassium content of Rangpur lime and in part both sour orange and Poorman orange as compared with those of low level. On the other hand, opposite result was obtained in case of Cleopatra mandarin. Moreover, data pointed out that roots of either sour orange or Rangpur lime plants treated with SAR 12 level contained generally lower amounts of potassium as compared to the analogous ones of SAR 6 rate under the same concentration of salinity. Such finding in case of Cleopatra mandarin and Poorman orange was generally disappeared.

Regarding root calcium content, data clearly showed that salinity treatments generally increased root calcium content as compared with the control. In this respect, differences in case of Rangpur lime, Cleopatra mandarin and Poorman orange were so high to reach the significant level. Beside, citrus plants received high level of salinity developed significant roots with higher amounts of calcium as compared to the analogous ones treated with low level. Moreover, SAR levels varied in their effect on root calcium content. Thus, while SAR 12 level generally decreased root calcium content of both sour orange and Cleopatra mandarin stocks, it took the other way around in case of Rangpur lime and Poorman orange.

As for root Mg content, data clearly showed that salinity treatments differed in their effect on root Mg content according to the rootstock used. Any way, while salinity treatments abated root Mg content of both sour orange and Poorman orange plants, they gave reverse effect in case of Rangpur lime and Cleopatra mandarin stocks as compared to the untreated plants. At all events, significancy between treatments and the control was mostly observed in case of sour orange stock. Meanwhile, applying high concentration of salinity to plants of citrus rootstocks used in this study gave generally higher values of root Mg content than those treated with low level. Also, excluding values of sour orange, data disclosed that SAR 12 treatment generally developed plants with roots more rich in Mg content comparing with those ones received SAR 6 level.

In relation to root sodium content, it is found that salinity treatments increased profoundly root sodium content in respect of those of the control. In this concern, differences were statistically significant. In addition, high concentration of salinity generally raised up root sodium content over those received low level. Furthermore, SAR 12 level when applied to citrus plants induced an increment in root sodium content as compared to the corresponding ones treated with SAR 6 level under the same concentration of salinity. Such finding was true with the majority of cases.

Regarding root chloride content, data obviosly indicated that citrus plants, treated with different levels of salinity, gave roots with higher values of chloride as compared to the analogous plants deprived of salinity (control). In all studied rootstocks, differences were so high to reach the significant level. Nevertheless, in case of Rangpur lime and Poorman orange , high level of salinity combined with SAR 6 rate increased noticeably root chloride content in respect of those value of low level of salinity and the same rate of SAR .

Referring to SAR levels used in this study, it is remarkable that in case of Cleopatra mandarin and Poorman orange, plants irrigated with high concentrations of salinity as well as SAR 12 rate gave roots with lower amounts of chloride as compared with those received the same level of salinity and SAR 6 rate. In the other two rootstocks used i.e. sour orange and Cleopatra mandarin such effect was not clear.

Furthermore, data presented in Table (8) clearly showed that salinity treatments varied in their effect on Zn content as compared with the control according to the rootstock used. In this respect, while salinity treatments increased root Zn content of both Rangpur lime and Poorman orange over the control, they gave opposite results in case of sour orange and Cleopatra mandarin. In addition, most of treatments showed significant effect in this sphere. Moreover, citrus plants irrigated with high concentration of salinity gave roots with lower amounts of Zn in respect of those ones received low level of salinity. Beside, SAR rates varied in their effect according to the rootstock used. In this concern, while SAR 12 generally decreased root Zn content as compared with those of SAR 6 of sour orange and Cleopatra mandarin, the opposite was true in case of Rangpur lime and Poorman orange .

Considering root Fe content, data disclosed in Table (8) showed that in all citrus rootstocks, salinity treatments dropped down significantly root Fe content below the control. Moreover, applying high concentration of salinity to sour orange and Rangpur lime decreased root Fe content as compared with the analogous ones received low level. However, the high concentration of salinity for Cleopatra mandarin and Poorman orange partially decreased root Fe content below those of low level.

Regarding SAR levels, it is found that SAR 12 mostly increased root Fe content of sour orange and Rangpur lime and generally decreased values of root Fe content of Cleopatra mandarin and Poorman orange as compared to analogous ones of SAR 6 under the same level of salinity.

Considering root Mn content, it is clear from Table (8) that the majority of salinity treatments decreased significantly root Mn content as compared with the corresponding ones of the control. Moreover, high concentration of salinity generally increased root Mn content over those plants received low level.

Concerning SAR levels used in this study, data clearly showed that plants treated with SAR 12 gave lower values of root Mn content than those received SAR 6 level under the same concentration of salinity. Such conclusion was true in all citrus rootstocks used except Rangpur lime.

4.2.1.2.b- Partial shade :

Data presented in Table (9) clearly showed that neglecting values of Rangpur lime, salinity treatments increased root nitrogen content as compared with those of the control of different rootstocks used. However, significancy was few in this concern. Furthermore, high level of salinity decreased markedly root nitrogen content of Rangpur lime and in part for Cleopatra mandarin and Poorman orange plants as compared with the analogous ones received low level of salinity. Such effect was lacking in case of sour orange.

Comparing the two levels of SAR, it is clear that Rangpur lime and Cleopatra mandarin plants treated with SAR 12 were mostly inferior in root nitrogen content as compared with those ones received SAR 6 level under the same concentration of salinity. Such conclusion took the other way around in case of Poorman orange and in part for sour orange rootstocks.

Considering root phosphorus content, Table (9) pointed out that salinity treatments decreased root phosphorus content of different citrus rootstocks in the majority of cases as compared with plants of check ones. Anyhow, significant differences were dominant in case of Cleopatra mandarin and partially in Poorman orange. Moreover, high concentration of salinity for citrus plants generally decreased root phosphorus content in respect of those treated with low level. However , such finding was not clear in Poorman orange, hence values of both low and high levels were more or less similar. Nevertheless , significant difference was only observed for Rangpur lime.

In addition, the effect of SAR levels used in this study on root phosphorus content varied according to the rootstock used . Thus, in case of Rangpur lime and Poorman orange, SAR 12 level generally

Table(9) : **Fibrous roots nutrient contents of Washington navel orange plants budded on different rootstocks grown under salinity, S A R and partial shade conditions (season, 1986).**

Root stock	Salinity treatment p.p.m.	SAR	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Na (%)	CL (%)	Zn (P.P.m)	Fe (P.P.m)	Mn (P.P.m)
Sour orange	**Control**		**0.83**	**0.032**	**0.57**	**2.90**	**0.513**	**0.29**	**0.50**	**125.00**	**958.3**	**251.00**
	"2000"	"6"	0.85	0.028	0.70	2.55	0.250	0.62	0.96	59.00	291.6	208.60
	"2000"	"12"	0.88	0.025	0.44	1.93	0.240	0.57	0.78	79.00	400.0	115.00
	"4000"	"6"	1.05	0.035	0.54	4.01	0.187	0.52	0.89	143.00	316.6	173.30
	"4000"	"12"	1.00	0.030	0.43	2.10	0.243	0.85	0.95	135.00	316.6	149.60
	"6000"	"6"	0.90	0.025	0.44	4.20	0.570	0.60	0.96	93.00	308.3	184.30
	"6000"	"12"	0.90	0.032	0.36	2.57	0.360	0.68	0.85	62.00	641.6	276.00
Rangpur lime	**Control**		**1.02**	**0.035**	**0.58**	**2.92**	**0.437**	**0.17**	**0.45**	**166.00**	**1041.6**	**364.60**
	"2000"	"6"	1.03	0.042	0.62	4.74	0.680	0.40	0.71	148.00	616.6	253.60
	"2000"	"12"	0.93	0.045	0.62	2.35	0.263	0.42	0.65	143.00	450.0	190.30
	"4000"	"6"	0.82	0.027	0.39	5.95	0.170	0.52	0.75	110.00	416.6	196.30
	"4000"	"12"	0.80	0.032	0.64	5.02	0.150	0.59	1.06	203.00	291.6	113.60
	"6000"	"6"	0.78	0.025	0.44	7.82	0.260	0.33	0.50	139.00	458.3	144.30
	"6000"	"12"	0.88	0.025	0.30	5.98	0.237	0.53	0.61	142.00	591.6	171.00
Cleopatra mandarin	**Control**		**0.82**	**0.035**	**0.55**	**2.45**	**0.280**	**0.17**	**0.46**	**97.00**	**1291.6**	**429.30**
	"2000"	"6"	1.05	0.020	0.57	2.71	0.180	0.51	0.92	152.00	587.1	163.60
	"2000"	"12"	0.78	0.032	0.55	4.15	0.153	0.52	0.78	132.00	362.5	188.30
	"4000"	"6"	0.77	0.032	0.47	4.16	0.243	0.51	0.96	40.00	441.6	167.00
	"4000"	"12"	1.05	0.025	0.52	2.65	0.257	0.51	0.77	63.00	550.0	133.60
	"6000"	"6"	0.95	0.025	0.46	4.34	0.207	0.59	0.74	31.00	375.0	147.00
	"6000"	"12"	0.87	0.025	0.34	4.20	0.340	0.65	0.70	62.00	375.0	121.00
Paerman orange	**Control**		**0.83**	**0.040**	**0.58**	**2.53**	**0.427**	**0.13**	**0.52**	**186.00**	**1024.5**	**320.00**
	"2000"	"6"	0.78	0.025	0.70	4.90	0.350	0.45	0.85	223.00	300.0	133.60
	"2000"	"12"	1.02	0.032	0.52	2.55	0.123	0.29	0.82	123.00	433.3	136.00
	"4000"	"6"	0.82	0.035	0.57	4.24	0.280	0.50	0.96	251.00	616.6	285.00
	"4000"	"12"	0.92	0.025	0.67	4.01	0.480	0.63	0.91	267.00	541.0	199.30
	"6000"	"6"	0.92	0.025	0.52	3.03	0.300	0.51	0.84	187.00	800.0	261.30
	"6000"	"12"	0.88	0.032	0.35	5.25	0.300	0.57	0.75	146.00	550.0	167.60
L.S.D. at 1%			**0.17**	**0.009**	**0.07**	**0.67**	**0.058**	**0.07**	**0.06**	**15.80**	**11.5**	**15.00**

increased root phosphorus content as compared with the corresponding ones of SAR 6 under the same concentration of salinity. A reverse result was noticed when values of sour orange and Cleopatra mandarin were concerned. Though, it could be concluded that no consistent trend was noticed as SAR levels were concerned.

Respecting to root potassium content, it is obvious that roots of plants treated with high level of salinity contained significantly lower amounts of potassium as compared with values of either the control or plants treated with low level of salinity. Furthermore, as for SAR levels, it is quite evident that applying SAR 12 level for citrus plants mostly decreased root potassium content in respect of those received SAR 6 rate under the same level of salinity. Such difference was mostly significant in both sour orange and Poorman orange rootstocks.

Referring to root calcium content, it is well noticed that discarding values of sour orange, salinity treatments increased markedly root calcium content as compared with those of the control. By all means, significant differences were mostly observed in all rootstocks used. Moreover, high level of salinity caused an increase in root calcium content in respect of the corresponding ones of those treated with low level of salinity. Difference from the statistical point of view was mostly significant. Beside, data presented in Table (9) indicated that SAR 12 rate caused a general reduction in root calcium content as compared with plants treated with SAR 6 level. Significant differences, were more clear in sour orange and Rangpur lime in this concern.

In relation to root magnesium content, it is clear from Table (9) that salinity treatments generally decreased root magnesium content as compared to the analogous ones of the control. Any way, significant differences were generally observed in all citrus rootstocks used in this concern. Moreover, regardless of values of Rangpur lime plants, data disclosed that high level of salinity stimulated the accumulation of magnesium nutrient significantly in roots of the different rootstocks used in respect of those of low level. In addition, under low level of salinity, plants received SAR 12 treatment developed roots contained lower amounts of magnesium than those treated with SAR 6 level. However, the picture was not clear under the high level of salinity in this respect.

Concerning root sodium content, it is found that control plants had significantly roots with lower amounts of sodium as compared with those of plants treated with various treatments of salinity. That was true in all studied rootstocks. On the other hand, high level of saline water mostly caused an increase in root sodium content in respect of the corresponding ones of those received low level of salinity. For all that, in the majority of cases SAR 12 treatment surpassed SAR 6 rate under the same level of salinity, in their values of root sodium content.

In addition , date of root chloride content as presented in Table (9) showed that application of salinity treatments to various citrus rootstocks used in this study raised up root chloride content as compared to the values of the control of each rootstock. Such effect was almost statistically significant. However, high level of salinity for most citrus rootstocks used failed to increase chloride in roots than roots of plants treated with low level of saline water. Furthermore, excluding values of Rangpur lime, data indicated that citrus plants received SAR 12 level were generally lower in root chloride value in respect of those treated with SAR 6 rate under the same level of salinity.

Moreover, Table (9) also indicated that values of root Zn content of treated stocks with salinity concentrations , were in general lower than those of the control. That was true in all citrus rootstocks under study except Poorman orange stock . However, the majority of salinity treatments gave significancy as compared to the control. Beside , high concentration of salinity as compared with low level caused a reduction in root Zn content of Rangpur lime and Cleopatra manadarin and partially in roots of sour orange and Poorman orange.

Furthermore, comparing SAR 12 with SAR 6 under the same level of salinity it is clear that SAR 12 level mostly increased root Zn content in most rootstocks. However, Poorman orange and sour orange mostly gave reverse results in this respect.

Referring to root Fe content it is quite evident that in all citrus rootstocks used, plants irrigated with various treatments of salinity had roots with lower amounts of Fe in respect of the control. These treatments, however, were highly significant in all rootstocks under study. Moreover, high concentration of salinity as compared with low one increased root Fe content of both sour orange and Poorman orange and partialy of Rangpur lime and Cleopatra mandarin. As for SAR rates, it is clear that in case of Rangpur lime and Poorman orange values of SAR 12 level were generally lower than those of SAR6 under the same level of salinity. However, values of sour orange gave nearly reverse results.

As for root Mn content , it is remarkable noticed that salinity for citrus plants decreased significantly root Mn content as compared to the control. In addition, high concentration of salinity as compared with low level induced a significant reduction in root Mn content of Rangpur lime and Cleopatra mandarin. Such conclusion was noticed in part in case of sour orange in this respect. However, the opposite was true in case of Poorman orange. Considering SAR treatments, it is noticed that SAR 12 gave mostly a significant lower values of root Mn content in respect of the analogous ones of SAR 6 for all studied rootstocks .

4.2.2- Effect of salinity and SAR treatments on bud indoles and phenols contents of washington navel orange plants budded on different rootstocks grown under full sun light and partial shade conditions :

Bud indoles and phenols contents of Washington navel orange plants budded on different rootstocks grown under salinity and SAR treatments as well as full sun light and partial shade conditions are presented in Table (10) .

4.2.2.a- Full sun light :

Data of bud indoles indicated that salinity treatments generally decreased bud indoles as compared to the control. That was true in most studied rootstocks. Such decrease was more statistically observed in case of Cleopatra mandarin and Poorman orange rootstocks. Moreover, salinity treatments under the same level of SAR showed that high level of salinity (6000 ppm.) caused a significant reduction in bud indoles as compared to the corresponding ones of low level (2000 ppm). Comparing SAR 6 with SAR 12 under the same level of salinity, it is quite evident that under medium and high levels of salinity, SAR 12 treatment decreased generally bud indoles content in respect of plants treated with SAR 6. However, the picture was changed to the reverse when low level of salinity (2000 ppm.) was concerned. That was true in all rootstocks used .

Table (10) : **Effect of different rates of salinity and SAR on bud indoles, phenols and indoles / phenols contents of Washington navel orange plants budded on various rootstocks grown under full sun light and partial shade conditions (season, 1986).**

Root stock	Salinity treatment		Full sun light			Partial shade		
	p.p.m.	SAR	Indoles	Phenols	Indoles/ Phenols	Indoles	Phenols	Indoles/ Phenols
			mg./100 g. buds			mg./100 g. buds		
Sour orange	**Control**		**7.60**	**150.00**	**0.051**	**3.60**	**190.10**	**0.019**
	"2000"	"6"	4.30	72.70	0.059	6.80	178.80	0.038
	"2000"	"12"	15.80	192.30	0.082	7.70	143.40	0.054
	"4000"	"6"	13.80	77.40	0.178	8.90	213.50	0.042
	"4000"	"12"	4.40	163.00	0.027	6.60	316.70	0.021
	"6000"	"6"	8.00	190.20	0.042	5.90	231.30	0.026
	"6000"	"12"	4.40	172.10	0.026	4.20	228.60	0.018
Rangpur lime	**Control**		**8.90**	**141.90**	**0.063**	**12.90**	**207.90**	**0.062**
	"2000"	"6"	8.10	123.70	0.065	7.50	159.40	0.047
	"2000"	"12"	12.40	154.80	0.080	9.90	155.50	0.064
	"4000"	"6"	7.00	77.10	0.091	4.10	111.30	0.037
	"4000"	"12"	8.00	155.30	0.052	8.40	331.50	0.025
	"6000"	"6"	5.40	140.50	0.038	6.60	284.40	0.023
	"6000"	"12"	2.60	191.40	0.014	6.60	242.30	0.027
Cleopatra mandarin	**Control**		**11.40**	**143.70**	**0.079**	**7.30**	**131.20**	**0.056**
	"2000"	"6"	7.10	144.20	0.049	5.20	147.90	0.035
	"2000"	"12"	10.10	133.10	0.076	10.00	172.50	0.058
	"4000"	"6"	8.90	105.00	0.085	5.10	141.90	0.036
	"4000"	"12"	5.30	114.30	0.046	5.80	215.10	0.027
	"6000"	"6"	6.20	176.60	0.035	6.00	224.90	0.027
	"6000"	"12"	3.50	221.20	0.016	5.10	246.50	0.021
Poorman orange	**Control**		**11.80**	**177.30**	**0.067**	**9.70**	**146.20**	**0.066**
	"2000"	"6"	18.50	248.70	0.074	5.80	155.60	0.037
	"2000"	"12"	19.70	152.60	0.129	10.80	174.90	0.062
	"4000"	"6"	6.40	125.20	0.051	7.20	236.80	0.030
	"4000"	"12"	6.80	129.20	0.053	4.60	258.90	0.018
	"6000"	"6"	7.50	227.20	0.033	4.70	199.60	0.024
	"6000"	"12"	4.80	259.10	0.019	6.50	260.90	0.025
L.S.D. at 1%			**1.35**	**18.20**	**0.009**	**0.63**	**12.20**	**0.003**

Concerning bud phenols content, it is clear from Table (10) that salinity treatments for sour orange and Rangpur lime plants generally increased bud phenols as compared to their controls. Such effect was not clear in case of the other two rootstocks used i.e. Cleopatra mandarin and Poorman orange. However, significant differences were observed in the majority of treatments.

Comparing high level of salinity with low ones it is well noticed that in all rootstocks used, plants received high rate of salinity (6000 ppm.) gave higher values of bud phenols than those ones treated with low concentration of saline water. Moreover, under the same concentration of salinity, SAR 12 level generally increased bud phenols as compared with SAR 6 level. That was true in all rootstocks used.

Referring to indoles/phenols ratio it is found that salinity treatments for Cleopatra mandarin and Poorman orange plants mostly decreased indoles/phenols ratio below the control. Such effect was only noticed in case of sour orange and Rangpur lime rootstocks when plants were treated with high level of salinity. Meanwhile, disclosed data showed that high rate of salinity (6000 ppm) decreased remarkably bud indoles/phenols ratio than those received low concentration. In addition, citrus rootstocks either treated with medium or high concentration, showed that SAR 12 decreased the ratio of indoles to phenols in respect of values of SAR 6. The picture was changed to the reverse when 2000 ppm concentration was used.

4.2.2.b- Partial shade :

It is clear from Table (10) that excluding values of sour orange rootstock, data indicated that salinity treatments for the remained stocks used in this study decreased generally bud indoles content as compared with the control. Such decrease was mostly significant. Concerning levels of salinity used, it is quite evident that plants treated with high concentration of salinity had lower values of bud indoles than those received low level of saline water. Such result was not only true under SAR 6 level but also under SAR 12 rate. The effect of SAR levels under the same rate of salinity indicated that SAR 12 increased bud indoles under low level of salinity when compared with the corresponding ones of those of SAR 6. That was well noticed in all rootstocks under this study. Nevertheless, under the medium and high level of salinity such trend of effect was fluctuated.

Regarding bud phenols content it is obvious from Table (10) that salinity treatments generally increased bud phenols content over the control. Differences from the statistical point of view were significant. That effect was more true for both Cleopatra mandarn and Poorman orange rootstocks. Moreover, high concentration of saline water increased bud phenols content as compared to the corresponding ones of low level. That was obvious in both rates of SAR as well as all studied rootstocks. Furthermore, data of both Cleopatra mandarin and Poorman orange showed that SAR 12 level increased visually bud phenols content as compared with the analogous ones of SAR 6 level. Such effect was not clear in case of sour orange and Rangpur lime.

Referring to bud indoles/phenols ratio, data indicated that salinity treatments decreased indoles phenols ratio below the control in all studied rootstocks except sour orange. Differences were so high to reach the significant level.

Regarding salinity concentrations under the same level of SAR, it is interesting to notice that high level of salinity decreased visually bud indoles phenols ratio in respect of the corresponding values of low level. Such result was well noticed in all rootstocks under study .

Moreover, comparing the two levels of SAR under the medium and high level of salinity, it is obvious that SAR 12 generally decreased bud indoles phenols ratio below SAR 6 values. However, under low concentration of salinity the picture was changed to the reverse in this respect .

4.2.3- Effect of salinity on leaf soluble and nonsoluble carbohydrates contents :

4.2.3.a- Full sun light:

Leaf soluble and nonsoluble carbohydrates contents are shown in Table (11). It is clear that salinity treatments in most cases decreased leaf soluble carbohydrates content as compared to the analogous ones of the control .

Moreover , plants of both sour orange and Poorman orange rootstocks treated with high concentrations of salinity gave lower values of leaf soluble carbohydrates in respect of the corresponding ones of those received low level of salinity. However , significant differences between salinity treatments were remarkable in both sour orange and Cleopatra mandarin rootstocks more than in Rangpur lime and Poorman orange rootstocks . Such effect was noticed when plants were treated with high concentration of salinity combined with either SAR 12 or 6 for Cleopatra mandarin and Rangpur lime , respectively.

Comparing SAR 12 with SAR 6 under the same concentration of salinity it is clear that in both sour orange and Rangpur lime, SAR 12 level was the dominant in increasing leaf soluble carbohydrate as compared to those of SAR 6. Such effect was not noticed as Cleopatra mandarin and Poorman orange plants were concerend .

Referring to leaf nonsoluble carbohydrates, data presented in Table (11) indicated that salinity treatments fluctuated in their effect

Table (11) : **Effect of different rates of salinity and S A R on leaf soluble and non soluble carbohydrates contents of Washington navel orange plants budded on different rootstocks grown under full sun light and partial shade conditions.**

Root stock	Salinity treatment		Full sun light		Partial shade					
			"1986"		"1985"		"1986"		"1985 - 1986"	
	p.p.m.	SAR	S.C.	Non S.C.	S.C.	Non S.C.	S.C.	Non S.C.	S.C.	Non S.C.
			(%)		(%)		(%)		(%)	
Sour orange	**Control**		**3.78**	**6.70**	**2.00**	**3.72**	**3.95**	**5.60**	**2.98**	**4.66**
	"2000"	"6"	2.77	3.83	2.59	3.65	2.74	3.45	2.67	3.55
	"2000"	"12"	5.08	4.02	1.98	3.72	4.37	3.79	3.18	3.76
	"4000"	"6"	3.90	5.00	2.35	4.67	4.52	5.80	3.44	5.24
	"4000"	"12"	2.89	5.11	2.21	3.15	4.58	4.53	3.40	3.84
	"6000"	"6"	1.95	5.69	3.85	2.19	3.35	6.05	3.60	4.12
	"6000"	"12"	2.23	5.83	4.47	2.48	4.23	5.92	4.35	4.20
Rangpur lime	**Control**		**7.93**	**4.38**	**3.21**	**3.33**	**3.20**	**6.18**	**3.21**	**4.76**
	"2000"	"6"	5.26	6.73	2.48	2.93	2.82	5.88	2.65	4.41
	"2000"	"12"	5.83	6.80	3.82	3.48	3.11	3.78	3.47	3.63
	"4000"	"6"	5.50	6.83	3.45	3.11	4.40	6.08	3.93	4.60
	"4000"	"12"	5.54	5.17	3.78	3.24	4.23	5.60	4.01	4.42
	"6000"	"6"	4.28	3.90	1.63	3.02	3.62	4.20	2.63	3.61
	"6000"	"12"	7.58	4.65	2.28	3.83	4.08	5.83	3.18	4.83
Cleopatra mandarin	**Control**		**5.60**	**4.67**	**4.25**	**4.52**	**2.87**	**6.22**	**3.56**	**5.37**
	"2000"	"6"	4.82	5.25	3.93	3.33	2.38	5.78	3.16	4.56
	"2000"	"12"	5.95	3.82	3.55	3.23	2.68	6.42	3.12	4.83
	"4000"	"6"	5.80	5.00	3.58	4.28	2.59	6.95	3.09	5.62
	"4000"	"12"	3.97	4.45	3.73	5.73	2.84	6.57	3.29	6.15
	"6000"	"6"	6.18	4.45	3.62	5.07	2.43	5.97	3.03	5.52
	"6000"	"12"	5.15	4.62	3.97	4.55	2.82	6.58	3.40	5.57
Poorman orange	**Control**		**4.73**	**3.23**	**3.58**	**3.80**	**1.45**	**3.52**	**2.52**	**3.66**
	"2000"	"6"	4.37	6.05	3.08	3.11	2.55	6.92	2.82	5.02
	"2000"	"12"	5.77	4.00	3.19	3.48	2.71	6.50	2.95	4.99
	"4000"	"6"	4.07	3.98	4.30	4.97	2.90	5.85	3.60	5.41
	"4000"	"12"	4.08	4.35	3.47	3.90	2.68	6.92	3.08	5.41
	"6000"	"6"	4.45	4.45	3.85	3.40	3.13	6.83	3.49	5.12
	"6000"	"12"	4.42	3.27	3.38	3.45	2.38	3.52	2.88	3.49
L.S.D. at 1%			**0.41**	**0.61**	**0.27**	**0.25**	**0.27**	**0.41**	**0.27**	**0.33**

S.C. = Soluble carbohydrates.
Non S.C. = Non soluble carbohydrates.

according to the rootstock used . For instance, while salinity decreased leaf nonsoluble carbohydrates of sour orange and Cleopatra mandarin as compared to the control, it had a reverse effect in case of Rangpur lime and Poorman orange. Any how , differences between most treatments were statistically nil in all rootstocks used .

Moreover , comparing high level of salinity with the analogous ones of low concentration for each rootstock, it is well noticed that high concentration of salinity caused a significant reduction in nonsoluble carbohydrates of both Rangpur lime and Poorman orange . On the other hand , a general significant increase was observed for both sour orange and Cleopatra mandarin rootstocks .

Regarding SAR levels it is clear from Table (11) that SAR 12 surpassed SAR 6 in increasing leaf nonsoluble carbohydrates of sour orange and mostly in Rangpur lime. On the contrary , SAR 12 treatment mostly decreased leaf nonsoluble carbohydrates as compared to SAR 6 level for Cleopatra mandarin and Poorman orange .

4.2.3.b- Partial shade :

It is found from Table (11) that discarding values of Cleopatra mandarin , salinity treatments generally increased significantly leaf soluble carbohydrates over the control (as average of the two seasons) .

Moreover , high concentrations of saline water generally raised up leaf soluble sugars in respect of values of low level. That was true in all studied rootstocks except Rangpur lime plants where the reverse was noticed .

Comparing SAR levels it is clear that SAR 12 treatment surpassed in its value those of SAR 6 with some exceptions .

Regarding leaf nonsoluble carbohydrates, it is quite evident that salinity treatments as compared to the check (untreated) plants decreased significantly leaf nonsoluble carbohydrates content of sour orange and Rangpur lime rootstocks. On the contrary, a reverse effect was noticed in case of Cleopatra mandarin and Poorman orange .

In addition , plants received high concentrations of saline water developed leaves with higher amounts of nonsoluble carbohydrates than those treated with low level .

Furthermore , with respect to SAR levels it is clear that no consistent trend was observed.

4.2.4- Stem starch and total carbohydrates contents :

Stem starch and total carbohydrates percentages of Washington navel orange plants budded on different citrus rootstocks grown under salinity treatments and either full sun light or partial shade conditions are presented in Table (12) .

4.2.4.a- Full sun light :

It is clear from Table (12) that stem starch percentages of Washington navel orange plants budded on different citrus rootstocks and treated with different concentrations of salinity were generally lower than those of the control. Such finding was not clear when values of Cleopatra mandarin were considered. Nevertheless, such conclusion from the statistical point of view was not dominant in Poorman orange as in both sour orange and Rangpur lime . Moreover, high level of salinity applied to different rootstocks under the study increased stem starch content as compared to those of low level. Such increase was lacking when sour orange values were concerned .

On the other hand , data disclosed also that under the same salinity concentration , plants treated with SAR 12 were mostly lower in their values in respect of the corresponding ones of those received SAR 6 treatment . Nevertheless, this conclusion was not clearly noticed in case of Poorman orange rootstock .

As for stem total carbohydrates , it is well noticed that discarding values of Cleopatra mandarin, lower amounts of total carbohydrates were existed in stems of rootstocks treated with different levels of salinity as compared to those of the control. Such finding statistically was more clear in case of Rangpur lime stock . Furthermore, high rate of salinity caused mostly a decrease in stem total carbohydrates content of most rootstocks used than those received low level of salinity .

As far as SAR levels were concerned, it is found that plants received SAR 12 treatment had mostly lower values of stem total carbohydrates than the analogous ones of SAR 6 level .

Table (12) : **Stem starch and total carbohydrates contents of Washington navel orange plants budded on different rootstocks grown under full sun light, partial shade and various levels of salinity and SAR (season, 1986).**

Root stock	Salinity treatment		Full sun light		Partial shade	
	p.p.m.	SAR	Starch (%)	Total chrbohy drates (%)	Starch (%)	Total chrbohy drates (%)
Sour orange	**Control**		**16.74**	**21.70**	**13.86**	**19.33**
	"2000"	"6"	16.48	24.82	15.47	21.55
	"2000"	"12"	15.14	20.78	16.18	20.97
	"4000"	"6"	14.15	19.65	15.76	21.48
	"4000"	"12"	14.48	20.25	12.62	17.50
	"6000"	"6"	16.50	21.50	14.83	19.00
	"6000"	"12"	14.04	18.60	13.25	19.24
Rangpur lime	**Control**		**15.79**	**21.63**	**12.75**	**19.74**
	"2000"	"6"	16.93	24.24	16.14	21.00
	"2000"	"12"	14.50	19.48	16.96	21.55
	"4000"	"6"	14.50	20.18	14.93	21.04
	"4000"	"12"	12.97	19.27	13.97	18.93
	"6000"	"6"	17.46	22.01	14.44	18.88
	"6000"	"12"	15.21	19.68	12.63	17.96
Cleopatra mandarin	**Control**		**14.92**	**20.61**	**14.64**	**21.24**
	"2000"	"6"	15.77	23.32	15.88	21.12
	"2000"	"12"	14.49	20.37	16.72	21.89
	"4000"	"6"	14.60	19.22	14.44	20.61
	"4000"	"12"	15.99	21.90	13.57	19.09
	"6000"	"6"	17.96	22.76	14.22	19.36
	"6000"	"12"	16.58	21.04	11.43	18.35
Poorman orange	**Control**		**15.08**	**21.79**	**11.73**	**18.00**
	"2000"	"6"	14.27	20.48	15.83	20.93
	"2000"	"12"	14.64	20.09	17.21	22.77
	"4000"	"6"	12.87	18.42	13.21	19.33
	"4000"	"12"	15.04	21.36	9.87	17.04
	"6000"	"6"	16.42	20.71	14.21	19.85
	"6000"	"12"	14.54	18.75	15.75	19.75
L.S.D. at 1%			**0.96**	**1.47**	**0.58**	**0.64**

4.2.4.b- Partial shade :

Stem starch and total carbohydrates percentages of Washington navel orange plants buddded on different citrus rootstocks , treated with various levels of salinity and SAR and grown under partial shade condition are tabulated in Table (12).

Concerning stem starch percentages , it is quite evident that salinity treatments generally increased stem starch content significantly over the control . However, such finding was not clear in case of Cleopatra mandarin stock .

Meanwhile , high concentration of water salinity for budded rootstocks used decreased stem starch content as compared to those ones of low level . That was true under both SAR 6 and SAR 12 levels.

With respect to SAR levels , it is clear that under high level of salinity, plants received SAR 12 decreased stem starch content as compared to the corresponding ones of SAR 6 level . The picture was changed to the reverse when low level of salinity was concerned .

Referring to total carbohydrates percentages , it is obvious that high concentration of salinity treatments mostly dropped down stem total carbohydrates in respect of those of low level and the control .

Meanwhile , as far as SAR levels were concerned , it is found that in each rootstock used in this study, plants received SAR 12 level was generally the dominent treatment in decreasing stem total carbohydrates as compared to those ones treated with SAR 6 .

4.2.5- Effect of salinity and SAR treatments on leaf chlorophyll (A , B) and carotene contents :

Leaf chlorophyll (A , B) and carotene contents of Washington navel orange plants budded on different citrus rootstocks grown under full sun light and partial shade conditions and their relation to salinity and SAR treatments are shown in Tables (13 , 14 , 15 and 16) and illustrated graphically in Figs. (5,6,7,8,9 and 10) .

4.2.5.a- Full sun light :

It is clear from Table (13) and Fig. (5) that leaf chlorophyll A started with low value (after 30days from the initiation of treatments) followed with a sudden increase (after 60 days) in all studied rootstocks except Poorman orange where values were more or less similar. Such increase was extended till 120 days in case of Rangpur lime and Cleopatra mandarin and up to 90 days in case of Poorman orange rootstock then decreased suddenly at 120 days. However, leaf chlorophyll A of Washington navel orange plants budded on sour orange decreased slightly towards 120 days from starting of the treatments. On the other hand, leaf chlorophyll A of Poorman orange increased smoothly till 90 days then dropped down at 120 days .

Anyhow , the general trend of leaf chlorophyll A increased greatly at 60 days and resumed its increase till 90 days which followed with a decrease at 120 days .

By all means , for studying the effect of salinity treatments on leaf chlorophyll A , the sample of 120 days from the initiation of treatments was put in consideration .

It is clear that salinity treatments generally decreased leaf chlorophyll A as compared to the control. That was true in all rootstocks used . However , such decrease was generally observed statistically in Poorman orange. In the mean time, data disclosed that under SAR 6, increasing salinity level caused an increase in leaf chlorophyll A. On the other side, no consistent trend was observed when SAR 12 was concerned in this respect .

Comparing the two levels of SAR used, no clear trend was observed. In this sphere , while SAR 12 decreased sometimes leaf chlorophyll A in respect of values of SAR 6 , it increased values of leaf chlorophyll A specislly Poorman orange .

With respect to leaf chlorophyll B , it is clear from Table (13) and Fig. (6) that leaf chlorophyll B values were low at 30 days from the beginning of the treatments then increased strongly at 60 days followed with a very slight increase or a decrease toward the last leaf sample (120 days) .

Regarding the effect of salinity treatments on leaf chlorophyll B at 120 days , it is found that salinity generally increased leaf chlorophyll B as compared to the control . That was mostly obvious in all studied rootstocks.

Table (13) : **Effect of salinity and S A R levels on leaf chlorophyll A, B and carotene contents of Washington navel orange plants budded on different rootstocks grown under full sun light (season 86).**

Root stock	Salinity treatment		Chlorophyll A				Chlorophyll B				Carotene			
	p.p.m.	S A R	30 Days [1]	60 Days [1]	90 Days [1]	120 Days [1]	30 Days [1]	60 Days [1]	90 Days [1]	120 Days [1]	30 Days [1]	60 Days [1]	90 Days [1]	120 Days [1]
Sour orange	**Control**		**2.11**	**4.87**	**4.31**	**3.73**	**1.93**	**4.40**	**3.68**	**3.01**	**2.66**	**3.38**	**2.54**	**1.70**
	"2000"	"6"	2.11	2.57	2.69	2.84	1.26	2.31	2.64	2.96	2.29	2.50	1.70	0.88
	"2000"	"12"	2.55	2.76	3.17	3.58	2.38	2.36	2.98	3.64	2.34	2.62	2.27	1.86
	"4000"	"6"	4.04	4.91	4.26	3.61	3.08	3.83	3.63	3.37	2.89	3.51	2.40	1.28
	"4000"	"12"	2.60	2.94	3.27	3.62	2.54	2.04	2.78	3.50	2.64	2.42	2.17	1.87
	"6000"	"6"	2.39	4.22	3.90	3.87	2.29	3.47	3.42	3.40	2.77	3.60	2.24	0.88
	"6000"	"12"	2.03	3.42	2.80	2.47	1.79	3.41	2.96	2.50	2.67	2.61	2.28	1.85
Rangpur lime	**Control**		**1.09**	**4.29**	**4.26**	**4.31**	**0.60**	**4.38**	**3.37**	**2.36**	**1.85**	**2.98**	**1.80**	**0.60**
	"2000"	"6"	0.87	3.16	3.08	3.22	1.14	2.76	2.89	3.01	1.64	2.51	1.62	0.72
	"2000"	"12"	0.89	4.95	5.79	6.65	1.46	4.17	3.35	2.53	2.27	3.57	2.24	0.92
	"4000"	"6"	1.35	3.73	4.93	6.14	0.82	3.58	4.57	5.57	1.78	2.38	1.53	0.66
	"4000"	"12"	1.08	4.03	3.42	2.74	0.65	3.41	3.15	2.82	1.72	2.64	1.70	0.76
	"6000"	"6"	0.98	3.50	3.89	4.28	0.79	3.09	3.21	3.36	1.36	2.42	1.42	0.38
	"6000"	"12"	1.21	2.64	3.26	3.88	0.78	2.76	3.25	3.72	2.00	2.16	1.36	0.56
Cleopatra mandarin	**Control**		**2.60**	**3.45**	**3.48**	**3.47**	**3.76**	**3.98**	**3.62**	**3.27**	**2.22**	**2.50**	**1.64**	**0.78**
	"2000"	"6"	2.11	2.59	3.19	3.76	2.74	3.60	3.63	3.75	2.23	2.08	1.38	0.68
	"2000"	"12"	1.81	2.70	2.76	2.81	3.01	3.67	3.18	2.73	2.06	2.24	1.56	0.87
	"4000"	"6"	2.09	3.41	3.28	3.11	2.49	4.29	3.70	3.09	2.39	2.46	1.43	0.40
	"4000"	"12"	1.58	2.40	2.86	3.33	2.57	2.93	3.19	3.45	1.86	1.92	1.25	0.56
	"6000"	"6"	1.72	3.15	3.54	3.76	2.22	3.43	3.58	3.70	2.06	2.51	1.72	0.94
	"6000"	"12"	1.55	2.86	3.04	3.18	1.80	4.56	3.98	3.49	1.94	3.19	2.10	1.02
Poorman orange	**Control**		**3.04**	**3.39**	**3.28**	**3.17**	**2.87**	**3.73**	**2.69**	**1.69**	**3.16**	**1.97**	**1.69**	**1.43**
	"2000"	"6"	4.19	3.52	3.01	2.46	3.03	3.43	2.67	1.95	3.12	2.65	2.02	1.30
	"2000"	"12"	4.44	3.81	3.29	2.74	3.34	3.56	3.28	2.99	3.36	2.87	1.79	0.70
	"4000"	"6"	2.66	3.10	2.60	2.11	4.54	2.63	2.79	2.97	2.54	2.54	1.39	1.23
	"4000"	"12"	3.53	3.35	2.79	2.19	4.53	2.94	2.55	2.21	3.64	2.84	2.00	1.20
	"6000"	"6"	3.51	3.54	3.25	3.07	4.22	3.46	2.72	2.01	2.57	2.89	2.18	1.47
	"6000"	"12"	2.86	3.52	3.60	3.67	2.29	3.67	3.13	2.85	2.64	2.74	1.91	1.10
L . S . D . at 1%			**0.51**	**0.73**	**0.51**	**0.38**	**0.58**	**0.63**	**0.54**	**0.42**	**0.54**	**0.40**	**0.23**	**0.16**

N.B. = Chlorophyll A, B and carotene were calculated as mg/L.
[1] = Days from the initiation of treatments.

Chlorophyll 'A' under full sun light (season, 1986)

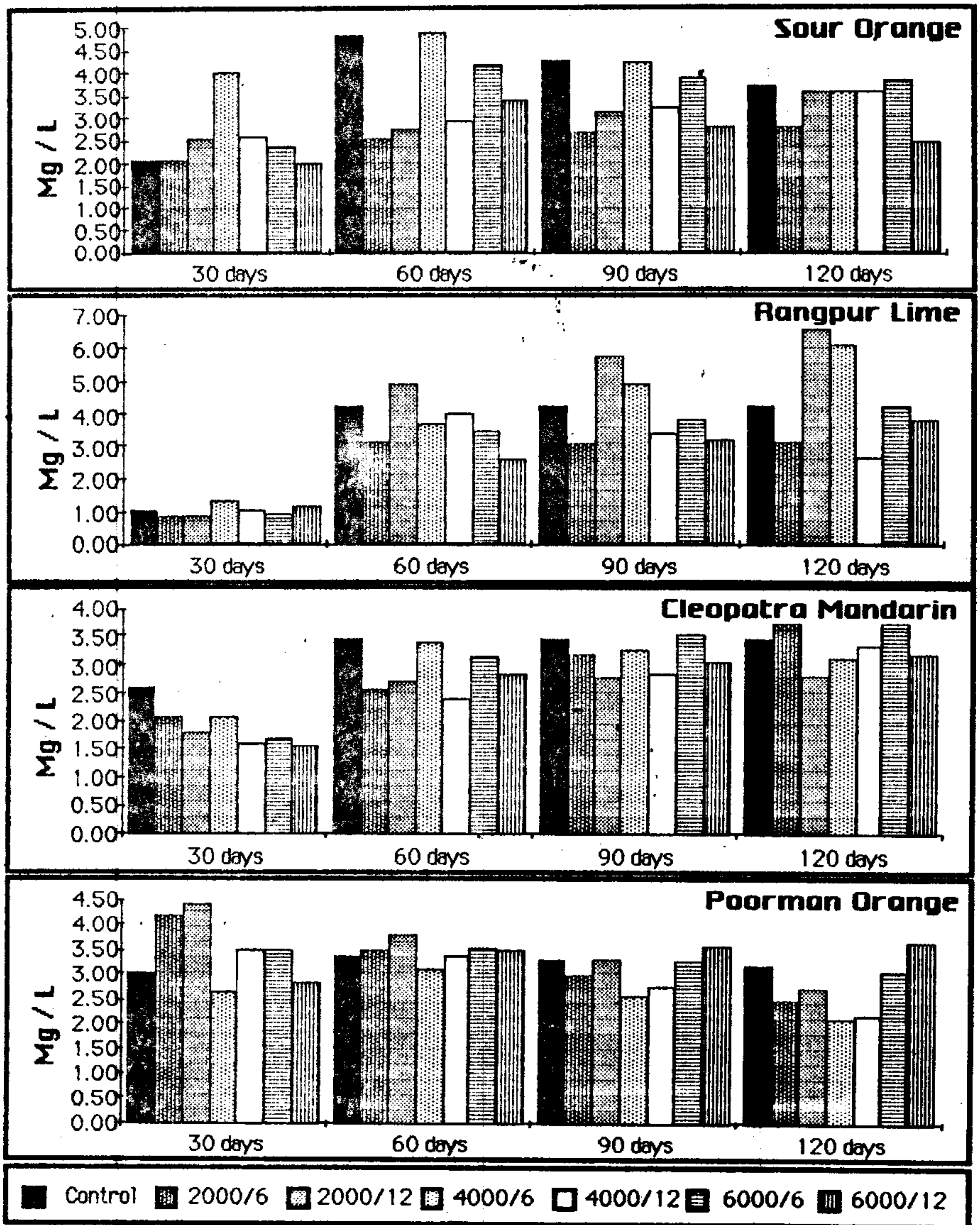

Fig. (5) : Effect of salinity and S A R levels on leaf chlorophyll A contents of Washington navel orange plants budded on different rootstocks grown ***under full sun light (season, 1986).***

However , such increase was statistically most observed in case of Rangpur lime and Poorman orange .

Referring to the effect of salinity levels on leaf chlorophyll B, it is well noticed that under SAR 6 , high level of salinity increased leaf chlorophyll B content as compared with those received low level. Under SAR 12 oscillation trend was noticed . In respect to SAR levels under the same concentration of salinity, no inevitable effect was noticed in this respect .

Regarding leaf carotene content , it is noticed that leaf carotene of Washington navel orange plants budded on both sour orange and Poorman orange started with higher values after 30 days from the starting of treatments then decreased toward the last leaf sample at 120 days . However , seasonal trend of leaf carotene content of plants budded on Rangpur lime and Cleopatra mandarin varied somewhat since they increased up to 60 days then decreased afterwards Fig. (7) .

Anyhow , the general seasonal trend (as average of the four rootstocks) showed that leaf carotene content increased slightly up to 60 days followed with a sudden decrease at 90 days and afterwards .

Referring to salinity treatments and their relation to leaf carotene content, it is clear that excluding values of Rangpur lime , salinity treatments in most cases decreased leaf carotene content at 120 days as compared to the control .

In regard to salinity concentrations under the same level of SAR , no clear effect was noticed . Thus , while high level of salinity caused an increase in leaf carotene content in case of Cleopatra mandarin and Poorman orange as compared to low concentration , it induced a decrease or none in case of Rangpur lime and sour orange, respectively.

Chlorophyll 'B' under full sun light (season, 1986)

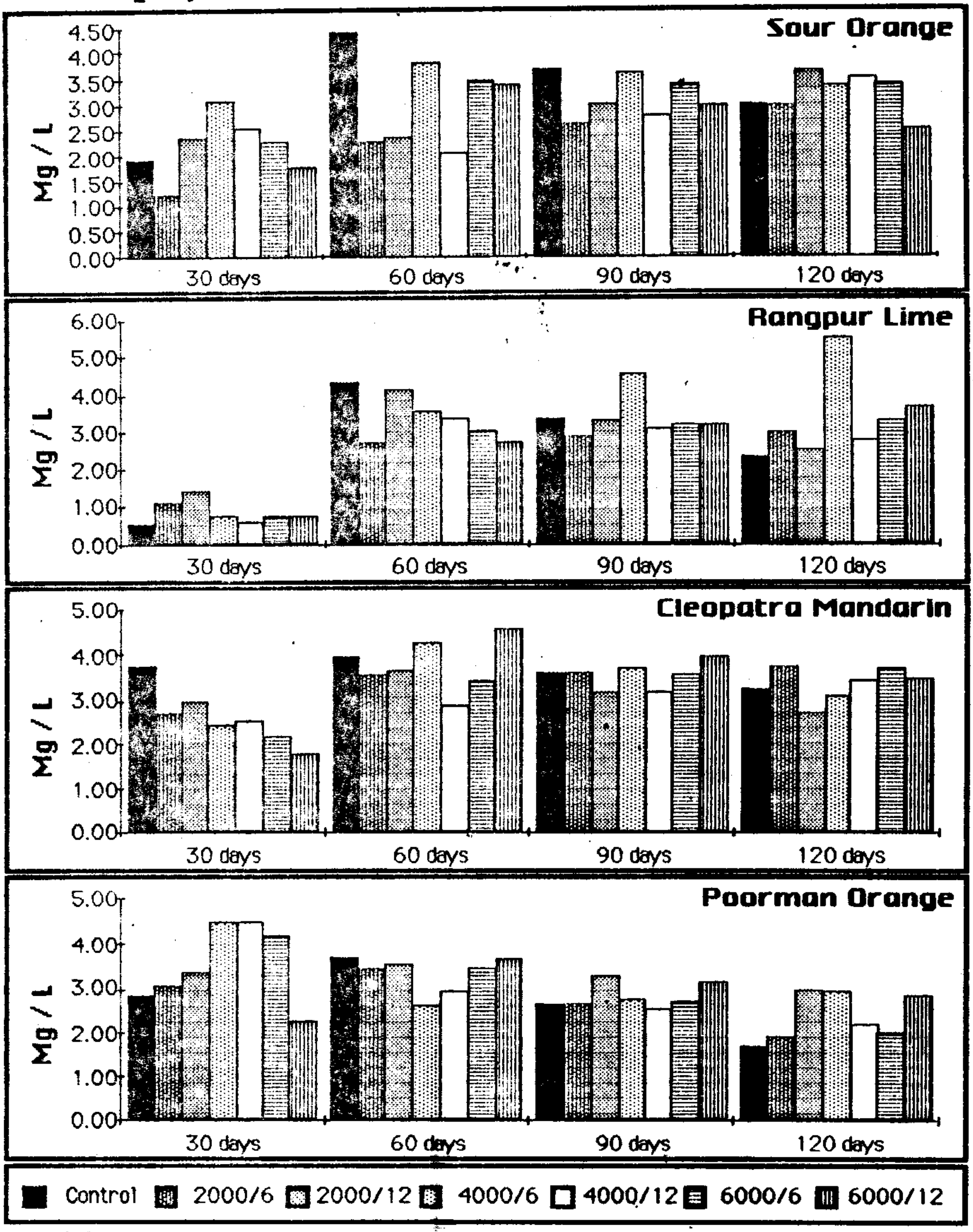

Fig. (6) : Effect of salinity and S A R levels on leaf chlorophyll B content of Washington navel orange plants budded on different rootstocks grown ***under full sun light (season, 1986).***

With respect to SAR levels under the same concentration of salinity, data indicated that regardless values of Poorman orange ; SAR 12 caused an increase in leaf carotene content as compared to the analogous ones of SAR 6 .

4.2.5.b- Partial shade :

Leaf chlorophyll A , B and carotene contents of Washington navel orange plants budded on different citrus rootstocks , grown under partial shade condition and affected by different levels of salinity and SAR are presented in Tables (14, 15 and 16) and illustrated graphically in Fig. (8). It is clear that chlorophyll A started with low values at 30 days from the initiation of salinity treatments and reached the maximum after 60 days from the beginning of treatments followed with a decrease till 90 days . At 120 days no consistent trend was observed.

Moreover , data tabulated in Tables (14 , 15 and 16) indicated that regardless of Poorman orange values , salinity treatments decreased leaf chlorophyll A below the control . Anyhow , significant differences were observed in Rangpur lime stock .

With respect to salinity rates, no consistent effect was noticed . In this respect , while high level of salinity caused a slight decrease as compared with low level of salinity for Rangpur lime and Cleopatra mandarin rootstocks, it gave a slight opposite effect in case of the remained citrus rootstocks under the study.

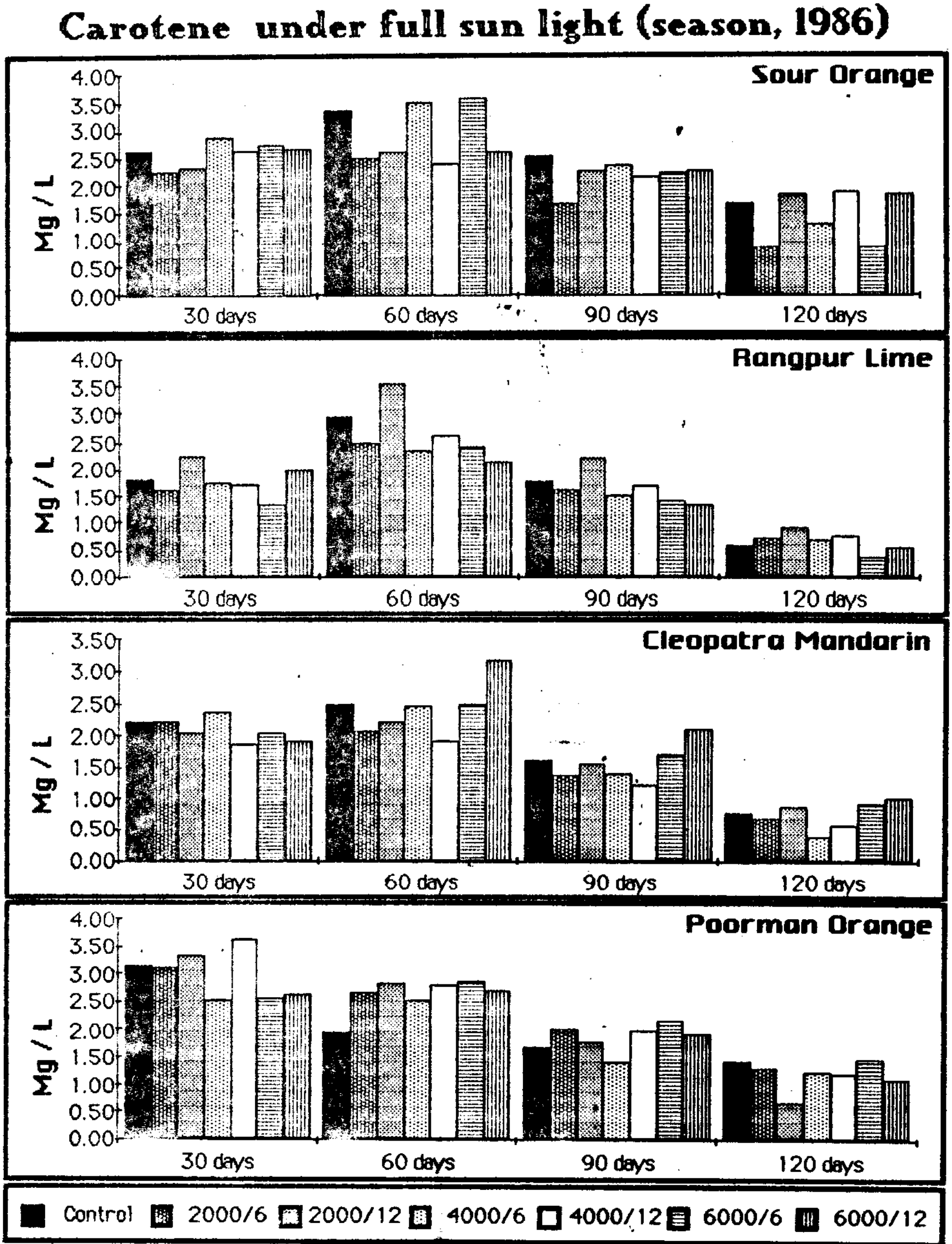

Fig. (7) : Effect of salinity and S A R levels on leaf carotene content of Washington navel orange plants budded on different rootstocks grown *under full sun light (season, 1986).*

Considering SAR levels under the same concentration of salinity, it is obvious that SAR 12 level generally decreased leaf chlorophyll A as compared to the analogous ones of SAR 6. However, differences were, so small to be significant in most cases.

Aglance to values of chlorophyll B as presented in Tables (14, 15 and 16) and Fig. (9) indicated that leaf chlorophyll B was highest at leaf sample picked after 60 days from the starting of salinity treatments followed with a decrease toward the last leaf sample in most citrus rootstocks used.

Meanwhile, plants treated with different treatments of salinity generally had leaves with low values of chlorophyll B in respect of the corresponding ones of the control. That trend was true in all studied rootstocks except Poorman orange. However, significant differences were more noticed in Rangpur lime stock.

Regarding salinity concentrations, it is clear that high rate of salinity caused mostly an increase in leaf chlorophyll B as compared with the analogous ones of low level.

Concerning sour orange, Rangpur lime and Cleopatra mandarin plants, SAR 12 level raised up leaf chlorophyll B content over SAR 6 level. The picture was completely changed to the reverse with Poorman orange values were concerned.

Considering leaf carotene content, it is clear from Tables (14, 15 and 16) and Fig. (10) that highest amounts of carotene were existed in leaves of Washington navel orange plants budded on different rootstocks up to 60 days from the initiation of salinity treatments then decreased profoundly towards the last leaf sample at 120 days from the starting of treatments.

Table (14) : **Leaf chlorophyll A, B and carotene contents of Washington navel orange plants budded on different rootstocks grown under partial shade as affected by various levels of salinity and S A R (season, 1985).**

Root stock	Salinity treatment p.p.m.	Salinity treatment SAR	Chlorophyll A 30 Days [1]	Chlorophyll A 60 Days [1]	Chlorophyll A 90 Days [1]	Chlorophyll A 120 Days [1]	Chlorophyll B 30 Days [1]	Chlorophyll B 60 Days [1]	Chlorophyll B 90 Days [1]	Chlorophyll B 120 Days [1]	Carotene 30 Days [1]	Carotene 60 Days [1]	Carotene 90 Days [1]	Carotene 120 Days [1]
Sour orange	**Control**		**5.27**	**5.08**	**3.48**	**3.67**	**5.47**	**6.13**	**3.30**	**3.34**	**3.96**	**4.61**	**1.05**	**0.92**
	"2000"	"6"	6.07	5.95	3.47	3.71	6.42	5.13	3.44	3.42	3.46	3.32	0.51	0.52
	"2000"	"12"	9.55	7.95	2.48	2.65	8.31	6.21	2.87	2.68	2.84	3.75	0.35	0.45
	"4000"	"6"	5.42	5.38	4.18	4.20	4.88	4.58	4.47	4.05	2.06	3.05	0.61	0.93
	"4000"	"12"	5.40	6.34	2.98	3.13	7.19	7.10	3.01	3.99	3.47	5.02	0.81	1.03
	"6000"	"6"	4.64	4.59	3.03	3.42	5.97	4.99	3.48	3.64	3.24	4.25	0.79	0.79
	"6000"	"12"	5.35	5.32	3.98	4.15	5.71	5.15	4.38	4.18	3.74	3.98	0.44	0.67
Rangpur lime	**Control**		**5.05**	**0.26**	**5.55**	**5.61**	**4.10**	**4.35**	**4.84**	**5.07**	**3.19**	**3.15**	**0.73**	**0.67**
	"2000"	"6"	5.74	5.82	3.47	3.76	5.70	5.38	2.96	3.51	3.35	3.17	0.88	0.95
	"2000"	"12"	5.51	5.19	3.83	4.14	4.33	4.50	3.17	3.66	3.03	2.82	0.72	0.54
	"4000"	"6"	5.14	5.56	4.17	4.26	4.04	3.92	4.14	3.83	2.92	3.10	0.52	0.39
	"4000"	"12"	5.50	5.55	4.53	4.54	4.80	4.49	4.36	4.41	3.03	3.11	0.60	0.72
	"6000"	"6"	5.52	5.54	4.21	4.43	4.98	4.56	4.07	4.11	3.57	3.04	0.74	1.09
	"6000"	"12"	5.35	5.41	4.41	4.43	5.00	4.55	4.82	5.50	3.16	2.77	0.69	0.70
Cleopatra mandarin	**Control**		**4.02**	**4.65**	**3.40**	**4.29**	**5.63**	**4.35**	**3.68**	**3.83**	**0.64**	**0.86**	**0.85**	**1.01**
	"2000"	"6"	4.88	4.57	2.08	2.34	6.81	4.74	2.22	1.77	1.76	3.58	0.65	1.13
	"2000"	"12"	4.79	4.88	2.83	3.14	4.79	4.91	2.06	2.75	2.48	3.07	1.00	0.55
	"4000"	"6"	5.09	5.19	4.14	4.19	5.51	5.61	4.04	4.09	2.65	2.57	0.66	0.38
	"4000"	"12"	4.13	4.14	3.88	4.09	3.83	4.95	3.31	3.40	2.65	3.67	0.71	0.73
	"6000"	"6"	5.70	4.64	4.15	3.80	4.70	5.74	3.89	3.47	2.65	3.67	0.79	0.93
	"6000"	"12"	5.79	5.47	4.02	3.94	5.42	6.22	3.47	3.44	0.23	0.38	0.83	0.85
Poorman orange	**Control**		**2.69**	**2.17**	**3.13**	**3.02**	**3.08**	**2.06**	**2.09**	**2.14**	**0.53**	**0.42**	**0.99**	**0.92**
	"2000"	"6"	4.54	4.68	3.13	3.09	4.15	4.47	1.98	2.24	0.74	0.76	0.71	0.42
	"2000"	"12"	4.73	4.65	2.96	3.13	3.40	4.35	2.26	2.07	0.70	0.28	0.58	0.66
	"4000"	"6"	5.18	4.56	3.97	3.93	4.55	4.47	3.31	3.29	0.41	0.70	0.71	0.60
	"4000"	"12"	5.75	5.69	3.36	3.57	5.57	4.48	2.65	2.97	0.82	1.60	0.69	0.65
	"6000"	"6"	4.90	3.66	3.78	3.76	3.59	3.77	2.61	2.89	1.26	1.44	0.82	0.69
	"6000"	"12"	5.06	3.18	3.87	3.95	3.05	3.60	3.23	2.79	1.38	1.76	0.66	0.90
L . S . D . at 1%			**1.02**	**1.06**	**0.89**	**0.72**	**1.66**	**1.19**	**0.95**	**0.71**	**0.69**	**0.65**	**0.22**	**0.11**

N.B. = Chlorophyll A, B and carotene were calculated as mg/L.
[1] = Days from the initiation of treatments.

Table (15) : **Leaf chlorophyll A, B and carotene contents of Washington navel orange plants budded on different rootstocks grown under partial shade as affected by various levels of salinity and S A R (season, 1986).**

Root stock	Salinity treatment		Chlorophyll A				Chlorophyll B				Carotene			
	p.p.m.	S A R	30 Days [1]	60 Days [1]	90 Days [1]	120 Days [1]	30 Days [1]	60 Days [1]	90 Days [1]	120 Days [1]	30 Days [1]	60 Days [1]	90 Days [1]	120 Days [1]
Sour orange	**Control**		**4.10**	**5.62**	**5.79**	**5.91**	**2.53**	**4.75**	**5.24**	**5.72**	**3.68**	**3.16**	**2.51**	**1.87**
	"2000"	"6"	3.82	5.66	5.82	6.01	2.38	5.41	5.09	4.83	3.93	3.24	1.91	0.59
	"2000"	"12"	2.36	4.71	4.79	4.90	1.84	4.66	5.26	5.93	3.49	2.95	1.82	0.66
	"4000"	"6"	2.13	4.57	5.29	6.01	1.63	4.42	4.60	4.70	3.38	2.72	1.67	0.59
	"4000"	"12"	2.59	4.43	4.66	4.90	1.86	4.12	4.83	5.62	3.60	2.53	1.82	1.11
	"6000"	"6"	1.61	4.24	4.97	5.66	1.12	4.27	4.94	5.07	3.27	2.70	1.84	0.97
	"6000"	"12"	1.78	2.84	3.69	4.55	1.06	2.74	3.35	3.99	3.21	2.33	2.07	1.78
Rangpur lime	**Control**		**2.60**	**5.82**	**6.14**	**6.40**	**3.98**	**5.50**	**5.76**	**6.12**	**1.69**	**3.60**	**2.22**	**0.84**
	"2000"	"6"	4.74	5.14	4.86	4.55	5.60	4.14	3.98	3.83	3.02	3.19	1.98	0.78
	"2000"	"12"	3.69	4.59	5.11	5.75	4.27	4.45	4.98	5.53	3.01	2.80	1.89	0.98
	"4000"	"6"	3.30	4.00	4.26	4.52	2.22	3.91	3.84	3.81	2.58	2.58	1.65	0.72
	"4000"	"12"	3.52	4.56	4.82	5.07	2.68	4.22	4.32	4.41	3.37	[illegible]	1.48	0.31
	"6000"	"6"	2.26	4.36	4.54	4.75	2.92	3.62	4.09	4.48	1.71	3.08	1.79	0.37
	"6000"	"12"	2.28	3.18	3.58	3.98	2.69	4.11	3.83	3.77	2.14	2.15	1.47	0.79
Cleopatra mandarin	**Control**		**4.09**	**6.23**	**5.41**	**4.54**	**4.01**	**6.17**	**4.91**	**3.64**	**2.79**	**3.20**	**1.89**	**0.75**
	"2000"	"6"	3.59	5.09	5.16	5.30	3.33	4.64	4.44	4.30	2.52	2.64	1.58	0.52
	"2000"	"12"	3.90	5.22	5.84	6.40	3.48	4.64	4.51	4.59	2.51	2.56	1.62	0.69
	"4000"	"6"	3.09	4.79	4.84	4.87	3.65	4.78	4.41	4.04	2.05	2.12	1.41	0.69
	"4000"	"12"	2.86	4.28	4.56	4.77	2.88	4.27	4.12	3.96	2.55	2.15	1.73	0.56
	"6000"	"6"	1.19	2.87	3.76	4.64	1.11	2.84	3.30	3.78	1.63	2.12	1.91	0.75
	"6000"	"12"	2.06	4.99	4.53	4.11	2.29	4.66	4.54	4.43	2.27	2.90	1.42	0.25
Poorman orange	**Control**		**4.60**	**6.23**	**4.74**	**3.30**	**5.40**	**4.70**	**3.40**	**2.10**	**2.83**	**3.11**	**1.88**	**0.65**
	"2000"	"6"	4.64	4.80	4.35	3.97	5.23	4.60	4.12	3.63	2.61	2.93	1.79	0.64
	"2000"	"12"	3.16	4.76	3.66	2.57	3.47	4.04	3.20	2.34	2.30	2.84	1.80	0.78
	"4000"	"6"	3.91	5.28	4.59	3.89	3.94	4.69	3.80	2.98	2.89	2.89	2.02	1.13
	"4000"	"12"	4.07	4.91	4.31	3.69	4.14	4.27	3.31	2.43	2.26	3.05	1.93	0.81
	"6000"	"6"	3.60	4.44	3.84	3.24	4.51	4.44	4.30	2.32	2.26	2.60	1.91	1.23
	"6000"	"12"	3.01	3.77	3.42	3.08	3.23	3.45	2.62	1.79	2.94	3.22	2.11	1.02
L . S . D . at 1%			**0.67**	**0.69**	**0.30**	**0.43**	**0.71**	**0.54**	**0.40**	**0.44**	**0.31**	**0.81**	**0.22**	**0.18**

N.B. = Chlorophyll A, B and carotene were calculated as mg/L.
[1] = Days from the initiation of treatments.

Table (16) : **Leaf chlorophyll A, B and carotene contents of Washington navel orange plants budded on different rootstocks grown under partial shade as affected by various levels of salinity and S A R (Average of seasons 1985, 1986).**

Root stock	Salinity treatment		Chlorophyll A				Chlorophyll B				Carotene			
	p.p.m.	SAR	30 Days [1]	60 Days [1]	90 Days [1]	120 Days [1]	30 Days [1]	60 Days [1]	90 Days [1]	120 Days [1]	30 Days [1]	60 Days [1]	90 Days [1]	120 Days [1]
Sour orange	**Control**		**4.69**	**5.35**	**4.64**	**4.79**	**4.00**	**5.44**	**4.27**	**4.53**	**3.82**	**3.89**	**1.78**	**1.40**
	"2000"	"6"	4.95	5.81	4.65	4.86	4.40	5.27	4.27	4.13	3.70	3.28	1.21	0.56
	"2000"	"12"	5.96	6.33	3.64	3.78	5.08	5.44	4.07	4.31	3.17	3.35	1.09	0.56
	"4000"	"6"	3.78	4.98	4.74	5.11	3.26	4.50	4.54	4.38	2.72	2.89	1.14	0.76
	"4000"	"12"	4.00	5.39	3.82	4.02	4.53	5.61	3.92	4.81	3.54	3.78	1.31	1.07
	"6000"	"6"	3.13	4.42	4.00	4.54	3.55	4.63	4.21	4.36	3.26	3.48	1.32	0.88
	"6000"	"12"	3.57	4.08	3.84	4.35	3.39	3.95	3.87	4.09	3.48	3.16	1.26	1.23
Rangpur lime	**Control**		**3.83**	**5.54**	**5.85**	**6.01**	**4.04**	**4.93**	**5.30**	**5.60**	**2.44**	**3.38**	**1.48**	**0.76**
	"2000"	"6"	5.24	5.48	4.17	4.16	5.65	4.76	3.47	3.67	3.19	3.18	1.43	0.87
	"2000"	"12"	4.60	4.89	4.47	4.95	4.30	4.48	4.08	4.60	3.02	2.81	1.31	0.76
	"4000"	"6"	4.22	4.78	4.22	4.39	3.13	3.92	3.99	3.82	2.75	2.84	1.09	0.56
	"4000"	"12"	4.51	5.06	4.68	4.81	3.74	4.36	4.34	4.41	3.20	2.88	1.04	0.52
	"6000"	"6"	3.89	4.95	4.38	4.59	3.95	4.09	4.08	4.30	2.64	3.06	1.22	0.73
	"6000"	"12"	3.82	4.30	3.99	4.21	3.85	4.33	4.33	4.65	2.65	2.46	1.08	0.75
Cleopatra mandarin	**Control**		**4.06**	**5.44**	**4.41**	**4.42**	**4.82**	**5.26**	**4.30**	**3.74**	**1.72**	**2.03**	**1.37**	**0.88**
	"2000"	"6"	4.24	4.83	3.62	3.82	5.07	4.69	3.33	3.04	2.14	3.11	1.12	0.83
	"2000"	"12"	4.35	5.05	4.34	4.77	4.14	4.78	3.29	3.67	2.50	2.82	1.31	0.62
	"4000"	"6"	4.09	4.99	4.49	4.53	4.58	5.20	4.23	4.07	2.35	2.35	1.04	0.54
	"4000"	"12"	3.50	4.21	4.22	4.43	3.36	4.61	3.72	3.68	2.60	2.91	1.22	0.65
	"6000"	"6"	3.45	3.76	3.96	4.22	2.91	4.29	3.60	3.63	2.14	2.90	1.35	0.84
	"6000"	"12"	3.93	5.23	4.26	4.03	3.86	5.44	4.01	3.94	1.25	1.54	1.13	0.55
Poorman orange	**Control**		**3.65**	**4.20**	**3.94**	**3.16**	**4.24**	**3.38**	**2.75**	**2.12**	**1.74**	**1.82**	**1.55**	**0.97**
	"2000"	"6"	4.59	4.74	3.74	3.53	4.69	4.54	3.05	2.94	1.79	1.94	1.30	0.54
	"2000"	"12"	3.95	4.71	3.31	2.85	3.44	4.20	2.73	2.21	1.66	1.61	1.19	0.65
	"4000"	"6"	4.55	4.92	4.28	3.91	4.25	4.58	3.56	3.14	1.36	1.77	1.26	0.69
	"4000"	"12"	4.91	5.30	3.84	3.63	4.84	4.38	2.98	2.70	1.86	2.25	1.36	0.89
	"6000"	"6"	4.25	4.05	3.81	3.50	4.05	4.11	3.01	2.61	1.76	2.25	1.38	0.75
	"6000"	"12"	4.04	3.48	3.65	3.52	3.14	3.53	2.93	2.29	1.82	2.18	1.29	1.07
L . S . D . at 1%			**0.85**	**0.88**	**0.60**	**0.58**	**1.19**	**0.78**	**0.68**	**0.58**	**0.50**	**0.73**	**0.22**	**0.15**

N.B. = Chlorophyll A, B and carotene were calculated as mg/L.
[1] = Days from the initiation of treatments.

Chlorophyll 'A' under partial shade (Avg., 85, 86)

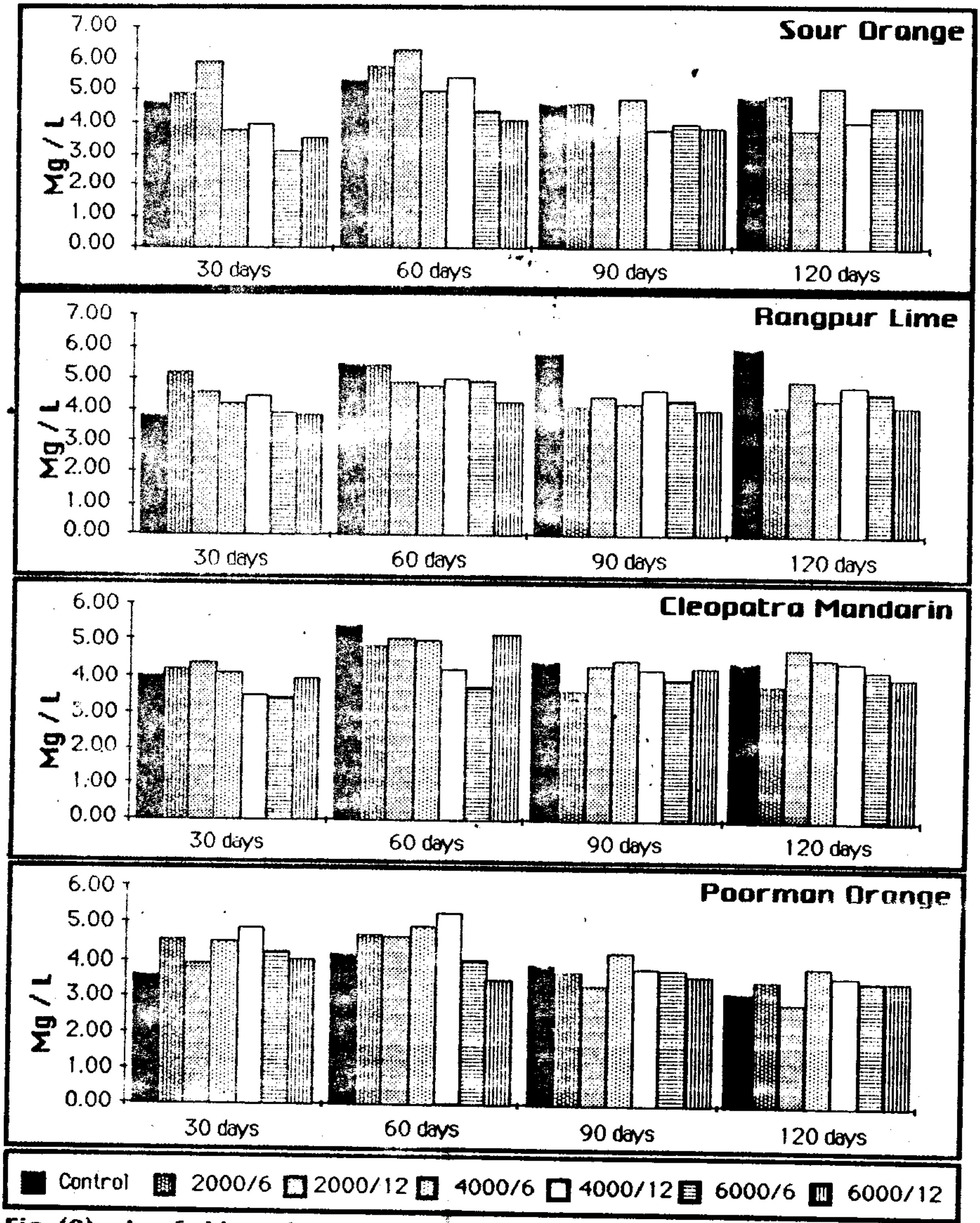

Fig. (8) : Leaf chlorophyll A content of Washington navel orange plants budded on different rootstocks grown under partial shade as affected by various levels of salinity and S A R (Average of seasons 1985, 1986).

Moreover , salinity treatments generally decreased leaf carotene content as compared to those of the control . Significant differences were observed in all rootstocks used except Rangpur lime where few treatments showed significancy. However, salinity concentrations showed no steady effect in this concern. Thus , while high level of salinity caused a reduction in leaf carotene content in some rootstocks used i.e. Rangpur lime and Cleopatra mandarin ; it increased leaf carotene content in case of sour orange and Poorman orange as compared with those of low concentration. Furthermore, it is found that SAR 12 increased leaf carotene content in respect of the analogous ones of SAR6 when sour orange and Poorman orange were used. The vice versa was generally noticed when Rangpur lime and Cleopatra mandarin stocks were concerned .

Chlorophyll 'B' under partial shade (Avg., 85, 86)

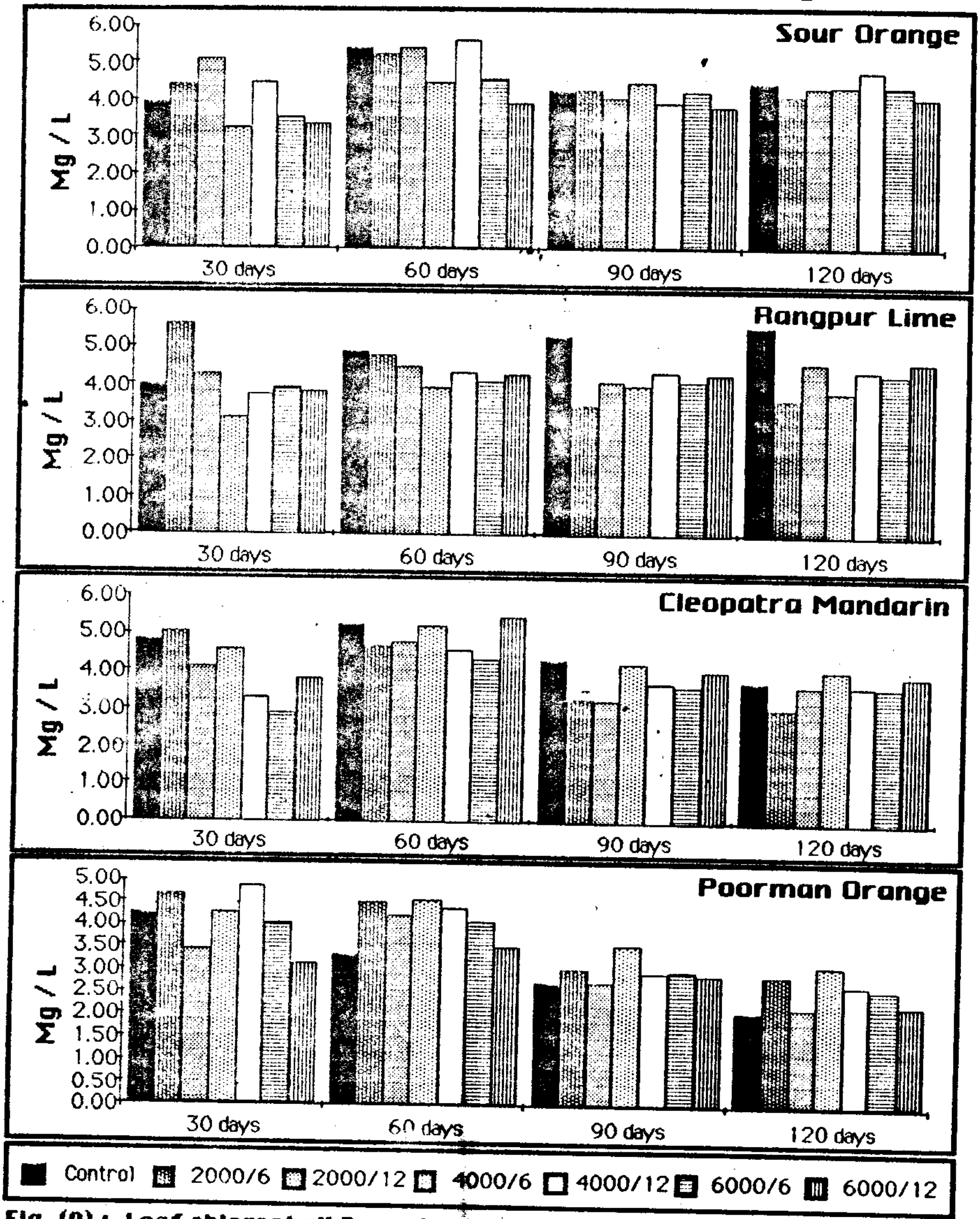

Fig. (9) : Leaf chlorophyll B content of Washington navel orange plants budded on different rootstocks grown under partial shade as affected by various levels of salinity and S A R (Average of seasons 1985, 1986).

Carotene under partial shade (Avg., 1985, 1986)

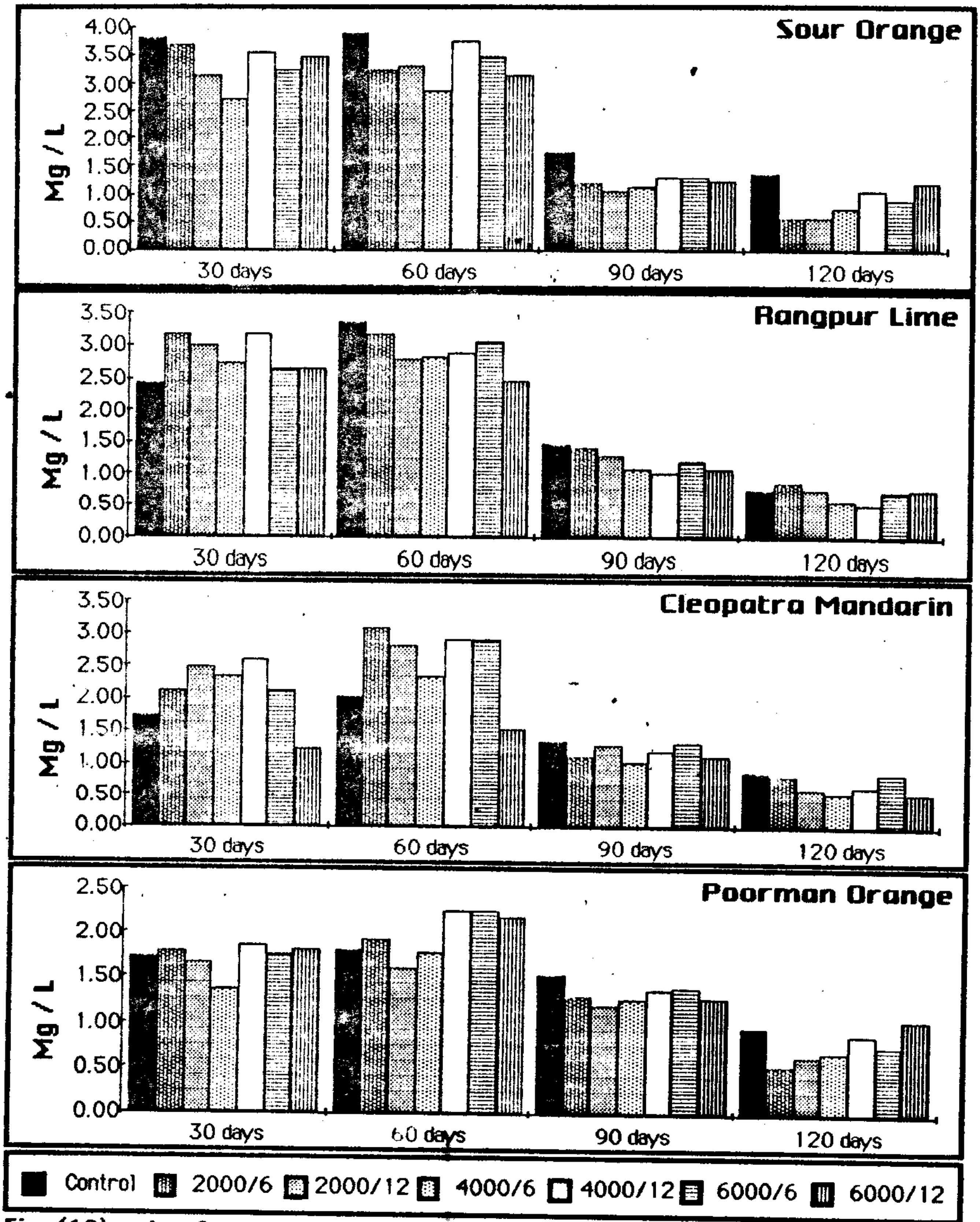

Fig. (10): Leaf carotene content of Washington navel orange plants budded on different rootstocks grown under partial shade as affected by various levels of salinity and S A R (Average of seasons 1985, 1986).

4.3- Effect of salinity and SAR rates on leaf salinity hazard coefficient of Washington navel orange plants budded on different citrus rootstocks, grown under full sun light and partial shade conditions :

4.3.a- Full sun light:

Leaf salinity hazard coefficient is presented in Table (17) and graphically illustrated in Fig. (11).

It is clear from Fig. (11) that salinity hazard coefficient of all citrus rootstocks used in this study started with highest values at 30 days from the initiation of treatments and decreased stoutly towards 90 days then resumed its decrease smoothly till 120 days . Such trend was observed in most salinity treatments used for different citrus rootstocks. Moreover, it is noticed that in sour orange, salinity hazard coefficient was the least when 6000 ppm at SAR 6 treatment was used, whilist 2000 ppm salinity beside SAR 12 treatment gave the other way around in this respect . Other treatments were in between . Regarding Rangpur lime it is clear that 6000 ppm at SAR 6 treatment caused the lowest effect on salinity hazard coefficient in all sampling dates. On the other hand , plants deprived of salinity (Control) gave the highest values in this concern as compared with other treatments .

Table (17) : **Effect of different levels of salinity and S A R on leaf salinity hazard coefficient of Washington navel orange plants budded on different rootstocks grown under full sun light and partial shade coditions (season, 1986).**

Root stock	Salinity treatment		Full sun light				Partial shade			
	p.p.m.	SAR	30 Days [1]	60 Days [1]	90 Days [1]	120 Days [1]	30 Days [1]	60 Days [1]	90 Days [1]	120 Days [1]
Sour orange	**Control**		**20.70**	**11.30**	**4.90**	**3.90**	**12.60**	**8.70**	**3.30**	**2.30**
	"2000"	"6"	14.50	13.40	4.20	2.00	11.30	5.20	1.60	0.50
	"2000"	"12"	18.30	19.80	7.20	5.00	26.70	10.10	2.90	1.00
	"4000"	"6"	12.30	12.20	4.60	2.80	26.90	9.10	2.50	0.90
	"4000"	"12"	9.30	8.90	3.30	2.40	25.30	9.20	3.00	1.70
	"6000"	"6"	10.00	7.80	2.60	1.00	25.30	6.70	2.00	1.00
	"6000"	"12"	14.00	7.60	4.00	3.70	32.30	11.90	4.20	3.00
Rangpur lime	**Control**		**71.80**	**22.10**	**7.60**	**2.90**	**5.60**	**6.90**	**2.00**	**0.70**
	"2000"	"6"	38.60	20.20	6.50	2.80	5.50	6.40	2.10	0.90
	"2000"	"12"	32.90	17.70	5.60	2.30	7.80	6.30	1.90	0.90
	"4000"	"6"	35.20	14.00	3.50	1.20	13.10	9.10	2.90	1.20
	"4000"	"12"	31.80	11.40	4.20	2.20	14.30	7.80	2.10	0.40
	"6000"	"6"	23.70	11.30	3.20	0.80	6.50	7.60	1.90	0.40
	"6000"	"12"	57.40	23.00	6.10	2.10	10.70	7.40	2.50	1.30
Cleopatra mandarin	**Control**		**14.70**	**14.20**	**3.70**	**2.40**	**7.40**	**5.50**	**1.30**	**1.00**
	"2000"	"6"	19.20	16.40	5.00	2.20	7.20	5.30	1.60	0.50
	"2000"	"12"	20.10	16.30	6.10	3.70	6.50	4.90	1.50	0.60
	"4000"	"6"	23.80	14.60	4.70	1.50	5.20	3.80	1.30	0.70
	"4000"	"12"	12.10	9.30	2.80	1.10	8.30	4.70	1.90	0.60
	"6000"	"6"	21.10	15.80	5.00	2.60	11.30	5.90	2.20	0.70
	"6000"	"12"	24.70	18.20	6.40	3.20	9.50	5.50	1.40	0.30
Poorman orange	**Control**		**19.70**	**11.00**	**5.60**	**6.20**	**3.50**	**3.50**	**1.60**	**1.10**
	"2000"	"6"	15.10	13.40	6.20	5.30	5.80	6.60	2.20	0.90
	"2000"	"12"	18.30	16.50	5.80	2.60	8.30	6.10	2.80	1.40
	"4000"	"6"	10.50	13.50	3.90	0.70	5.80	5.60	2.10	1.10
	"4000"	"12"	13.80	13.60	5.60	4.10	6.70	6.00	2.50	1.70
	"6000"	"6"	11.30	14.70	6.50	5.10	6.50	7.90	3.10	1.70
	"6000"	"12"	17.40	12.80	4.80	2.80	5.20	5.90	2.60	2.10

[1] = Days from the initiation of treatments.

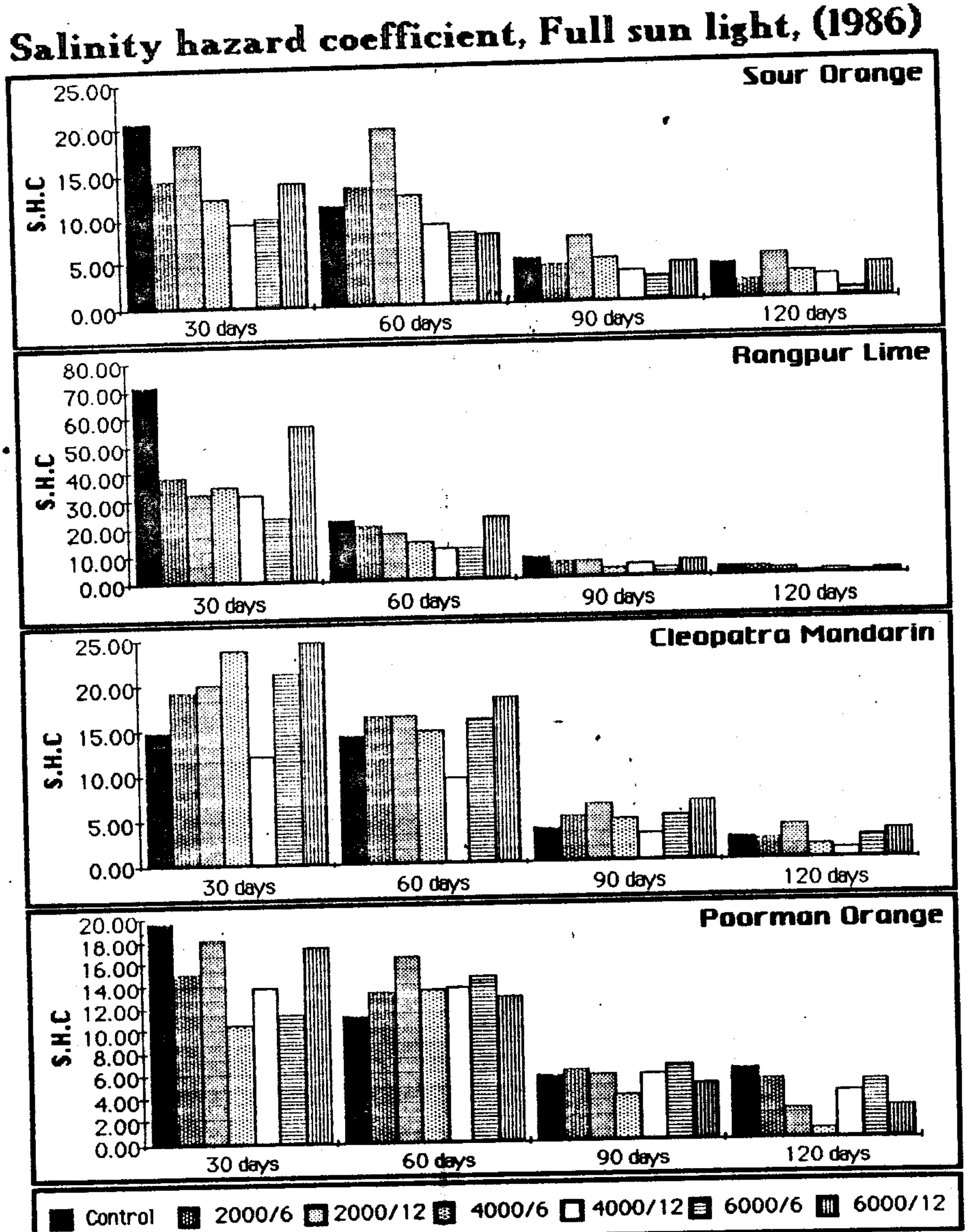

Fig. (11) : Effect of different levels of salinity and S A R on leaf salinity hazard coefficient of Washington navel orange plants budded on different rootstocks grown under full sun light condition (season, 1986).

Concerning Cleopatra mandarin rootstock it is obvious that plants treated with 4000 ppm together with SAR 12 treatment were poor in leaf salinity hazard coefficient value in all sampling dates. Adversely, plants received 2000 ppm combined with SAR 12 treatment attacked strongly with salinity hazard as compared with other treatments .

Respecting Poorman orange rootstock , it is clear that 4000 ppm at SAR 6 treatment had the lowest effect on leaf salinity hazard coefficient in all sampling dates . On the other side , 2000 ppm combined with SAR 12 treatment surpassed all other treatments in the deterioration effect on leaf salinity hazard coefficient till 90 days then failed afterwards .

Furthermore, during the period between 90 and 120 days , salinity treatments varied in their effect in this sphere. Such conclusion was true in all citrus rootstocks used except Rangpur lime where differences between treatments were little .

Concisely, it is easy to conclude that citrus plants suffered much from salinity early after 30 days from the initiation of treatments , then adapted to salinity afterwards till 120 days (last sampling date) .

Furthermore ., Fig. (11) also indicated that under different levels of salinity, plants treated with SAR 12 suffered much from salinity than those received SAR 6 rate . That finding was true in all concentrations of salinity except 4000 ppm level .

4.3.b- Partial shade :

Leaf salinity hazard coefficient of citrus plants treated with different treatments of salinity and grown under partial shade is presented in Table (17) and demonstrated in Fig. (12).

It is quite evident that citrus plants suffered much from salinity after 30 days from the starting of treatments with few exceptions in some treatments for Rangpur lime and Poorman orange where salinity hazard coefficient reached the peak after 60 days . For all that , salinity hazard coefficient values strongly decreased after 60 days in all citrus rootstocks and extended subsequently towards 120 days. Thus , it is safe to say that salinity hazard coefficient for citrus rootstocks was high after 30 days then declined towards the termination of leaf samples at 120 days . Moreover , data illustrated in Fig. (12) showed that salinity treatments varied in their effect on leaf salinity hazard coefficient at the beginning of leaf samples (30 days). However, such variance was decreased at the last leaf sample (120 days) . Such finding was more clear in all rootstocks except Poorman orange .

On the other hand , Fig. (12) also indicated that in both sour orange and Poorman orange , SAR 12 treatment of all sampling dates generally increased values of salinity hazard coefficient as compared to the corresponding ones of those of SAR 6 rate .

However, the picture was changed to the reverse as Cleopatra mandarin and Rangpur lime rootstocks were concerned, hence SAR 6 level mostly surpassed those of SAR 12 rate in increasing values of leaf salinity hazard coefficient .

Salinity hazard coefficient, partial shade, (1986)

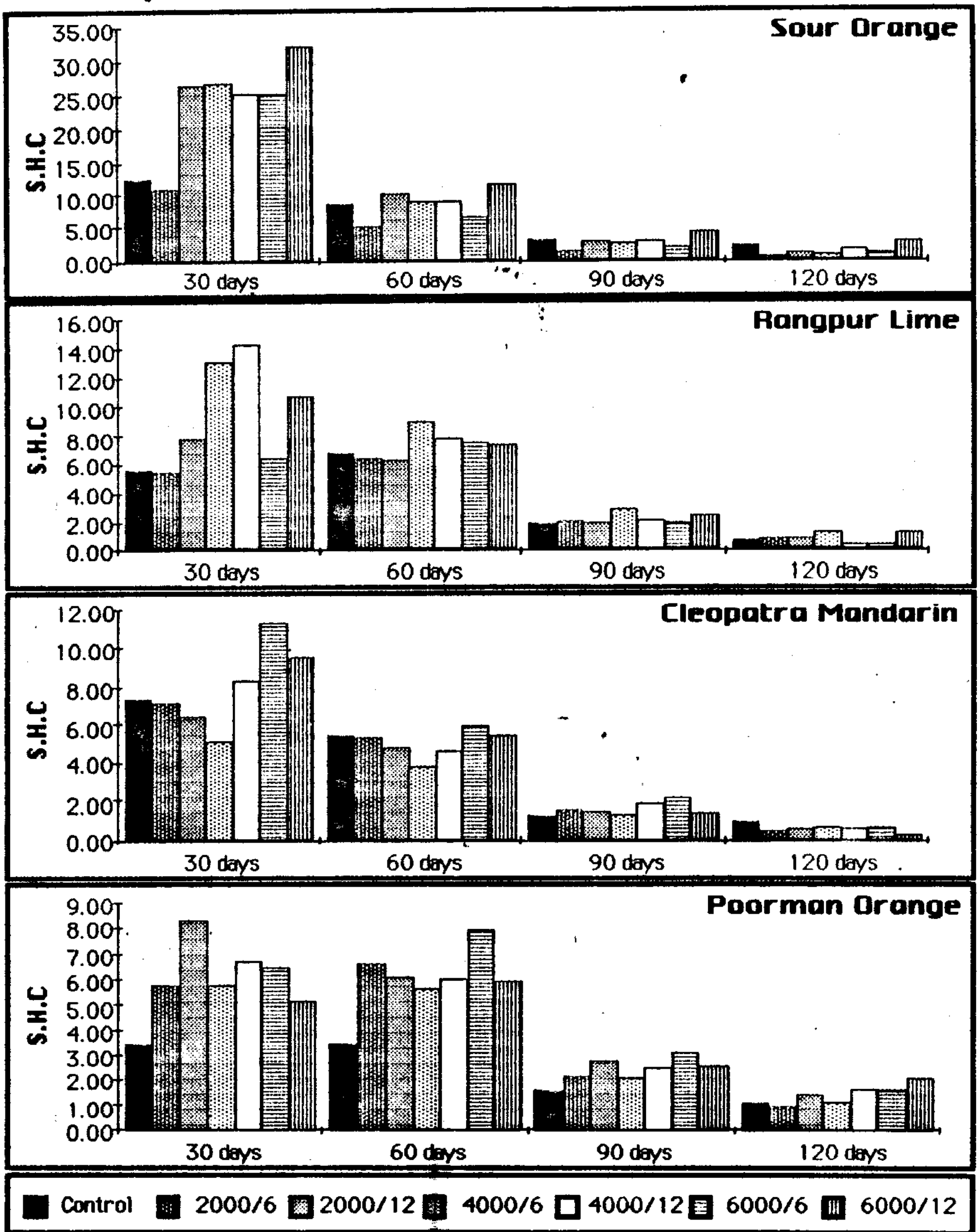

Fig. (12) : Effect of different levels of salinity and S A R on leaf salinity hazard coefficient of Washington navel orange plants budded on different rootstocks grown under partial shade condition (season, 1986).

4.4- Effect of various rates of salinity and SAR on leaf osmotic pressure of Washington navel orange plants budded on different rootstocks grown under full sun light and partial shade conditions :

4.4.a- Full sun light :

It is clear from Table (18) and Fig. (13) that in all studied rootstocks leaf osmotic pressure increased as leaves age go by. However , a drop was occurred in leaf osmotic pressure of both sour orange and Cleopatra mandarin after 60 days from starting of treatments.

For studying the effect of salinity treatments on leaf osmotic pressure , the last leaf sample was taken in account. Consequently , it is well noticed that salinity treatments fluctuated in their effect on leaf osmotic pressure . In other words , while they increased leaf osmotic pressure of both Rangpur lime and Cleopatra mandarin as compared with the control , they generally took the other way around in case of sour orange and Poorman orange stocks. However , differences from the statistical point of view were commonly noticed in sour orange, Cleopatra mandarin , and Poorman orange rootstocks .

Comparing the different levels of salinity, disclosed data showed that high concentration of salinity raised up leaf osmotic pressure of sour orange and Rangpur lime rootstocks and in part Poorman orange when compared to those of low level treatments . The picture was changed to the reverse when Cleopatra mandarin rootstock was concerned . In regard to SAR levels, it is interesting to notice that discarding Poorman orange values, SAR 12 treatment generally decreased leaf osmotic pressure as compared to those of SAR 6 .

Table (18) :**Effect of different rates of salinity and SAR on leaf osmotic pressure (At.p.) [2] of Washington navel orange plants budded on different rootstocks grown under full sun light (season, 1986).**

Root stock	Salinity treatment		30 Days [1]	60 Days [1]	90 Days [1]	120 Days [1]
	p.p.m.	SAR				
Sour orange	**Control**		**20.21**	**16.92**	**19.36**	**21.83**
	"2000"	"6"	12.18	14.67	16.46	18.33
	"2000"	"12"	16.82	16.35	18.02	19.62
	"4000"	"6"	15.70	18.25	18.85	20.01
	"4000"	"12"	21.49	17.70	18.53	19.35
	"6000"	"6"	19.95	19.17	22.55	26.16
	"6000"	"12"	20.74	18.33	21.82	25.59
Rangpur lime	**Control**		**13.96**	**17.17**	**17.21**	**17.54**
	"2000"	"6"	16.26	18.36	17.29	16.36
	"2000"	"12"	18.82	18.33	17.82	17.24
	"4000"	"6"	17.19	16.82	18.84	20.63
	"4000"	"12"	19.45	16.78	17.70	18.23
	"6000"	"6"	15.82	19.99	22.56	24.24
	"6000"	"12"	18.71	19.59	18.95	18.02
Cleopatra mandarin	**Control**		**15.80**	**16.33**	**16.57**	**17.11**
	"2000"	"6"	16.48	16.62	18.95	21.02
	"2000"	"12"	15.88	18.72	19.57	20.33
	"4000"	"6"	24.71	19.09	19.57	19.76
	"4000"	"12"	17.50	20.80	20.41	19.89
	"6000"	"6"	19.71	18.03	19.16	19.94
	"6000"	"12"	18.93	16.67	17.82	18.84
Poorman orange	**Control**		**18.31**	**19.57**	**21.85**	**24.09**
	"2000"	"6"	11.21	20.57	20.32	20.21
	"2000"	"12"	19.64	22.10	23.24	24.08
	"4000"	"6"	20.84	21.18	20.52	19.59
	"4000"	"12"	26.32	23.47	24.34	24.71
	"6000"	"6"	22.98	24.22	25.46	26.91
	"6000"	"12"	22.51	21.51	20.20	18.72
L.S.D. at 1%			**1.60**	**1.66**	**1.68**	**2.11**

[1] = Days from the initiation of treatments.
[2] = Atmospheric pressure (At.p.)

Leaf osmotic pressure, full sun light (season,1986)

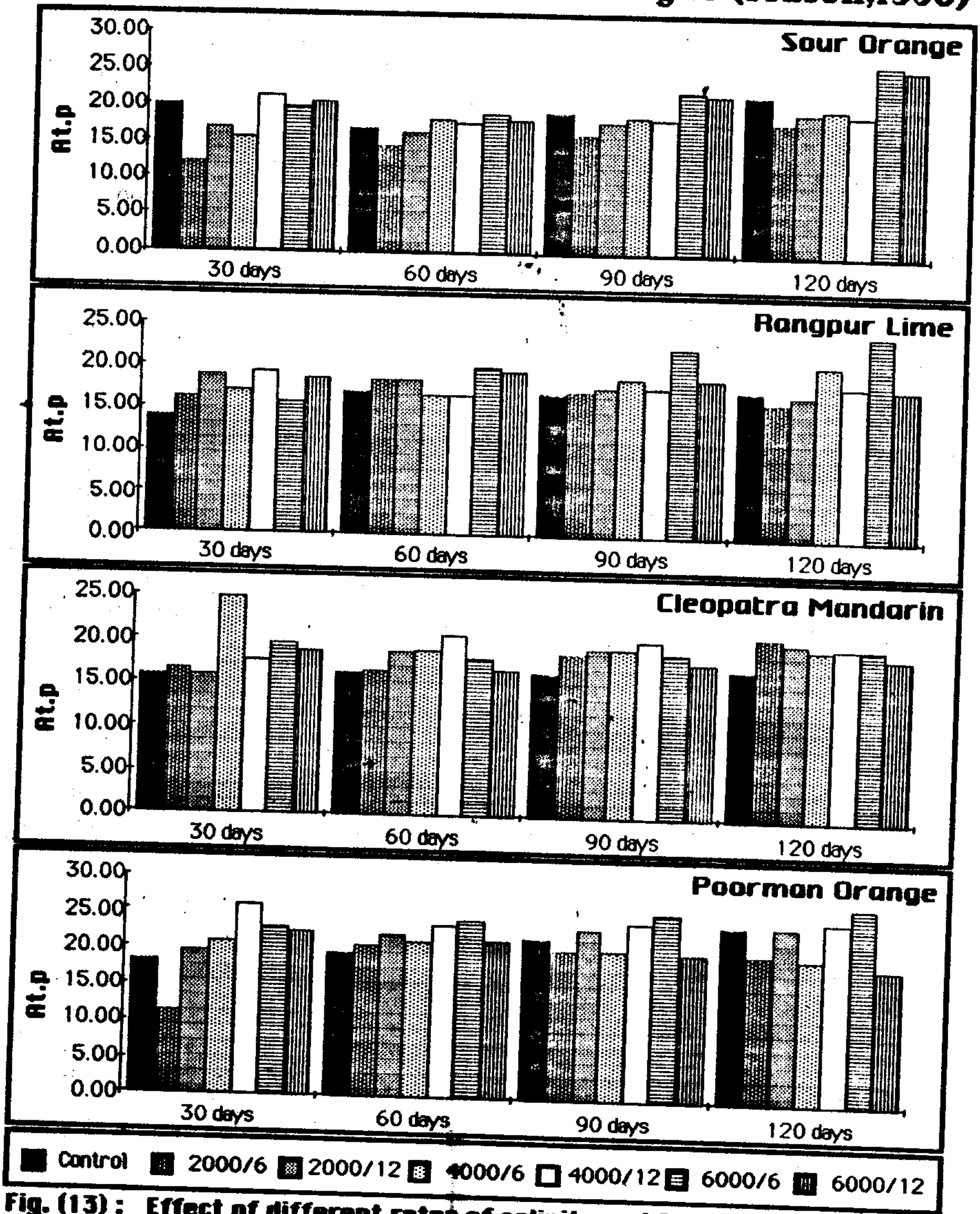

Fig. (13) : Effect of different rates of salinity and S A R on leaf osmotic pressure (At.p.) of Washington navel orange plants budded on different rootstocks grown under full sun light (season 1985).

4.4.b- Partial shade :

Data presented in Table (19) indicated that in 1985 leaf osmotic pressure of Washington navel orange plants budded on both sour orange and Rangpur lime rootstocks and treated with various salinity levels started with low values at 30 days from the beginning of treatments to reach the maximum at 90 days followed with a smooth decrease in the last leaf sample. Furthermore, seasonal changes in leaf osmotic pressure of either Cleopatra mandarin or Poorman orange gave similar trend with a drop in osmotic pressure at 90 days .

On the other hand , in 1986 seasonal changes in leaf osmotic pressure showed that values generally decreased at 60 days then increased towards the last leaf sample at 120 days .

Moreover, data of the average of two seasons clearly disclosed that seasonal changes in leaf osmotic pressure of sour orange and Rangpur lime plants started with low values and increased as leaves age go by (Fig. 14). On the contrary, values of both Cleopatra mandarin and Poorman orange showed opposite picture. However, general trend of leaf osmotic pressure (as mean of different rootstocks used) gave the same trend of both sour orange and Rangpur lime rootstocks.

Concerning the last leaf sample at 120 days, data disclosed that in both seasons, plants received different salinity treatments had mostly leaves with high values as compared to the control. Any way, Table (19) : **Effect of different rates of salinity and S A R on leaf osmotic pressure (At.p.) [2] of Washington navel orange plants budded on different rootstocks grown under partial shade (seasons 1985, 1986).**

Root stock	Salinity treatment		" 1985 "				" 1986 "				" 1985, 1986 "			
	p.p.m.	S A R	30 Days [1]	60 Days [1]	90 Days [1]	120 Days [1]	30 Days [1]	60 Days [1]	90 Days [1]	120 Days [1]	30 Days [1]	60 Days [1]	90 Days [1]	120 Days [1]
Sour orange	**Control**		**16.9**	**15.9**	**16.8**	**15.9**	**12.7**	**11.8**	**12.7**	**13.5**	**14.8**	**13.9**	**14.8**	**14.7**
	"2000"	"6"	15.67	17.55	20.25	20.29	11.77	9.18	10.86	12.31	13.72	13.37	15.56	16.30
	"2000"	"12"	10.67	13.93	19.15	19.06	11.67	10.38	12.02	13.52	11.17	12.16	15.59	16.29
	"4000"	"6"	17.18	18.82	22.13	21.94	9.90	10.46	11.34	11.88	13.54	14.64	16.74	16.91
	"4000"	"12"	18.02	17.52	20.46	20.61	11.59	[illegible]	13.15	13.68	14.81	15.03	16.81	17.15
	"6000"	"6"	18.74	19.06	22.64	22.89	12.97	[illegible]	15.67	16.57	15.86	16.78	19.16	19.73
	"6000"	"12"	15.00	16.56	21.27	20.64	11.68	11.87	13.25	13.52	13.34	14.22	17.26	17.08
Rangpur lime	**Control**		**13.0**	**13.0**	**13.9**	**14.7**	**12.4**	**13.4**	**13.5**	**14.0**	**12.7**	**13.2**	**13.7**	**14.3**
	"2000"	"6"	15.57	15.38	16.56	16.65	14.40	13.06	14.13	14.77	14.99	14.22	15.35	15.67
	"2000"	"12"	17.91	17.49	15.60	13.96	13.42	[illegible]	14.67	15.41	15.67	15.73	15.14	14.69
	"4000"	"6"	14.26	14.84	19.05	18.53	12.18	[illegible]	14.39	14.41	13.22	14.40	16.72	16.47
	"4000"	"12"	13.59	13.87	16.07	16.34	11.85	[illegible]	13.17	11.95	12.72	13.92	14.62	14.15
	"6000"	"6"	12.39	13.27	18.74	18.42	12.89	11.34	11.43	11.27	12.64	12.31	15.09	14.85
	"6000"	"12"	15.29	15.29	18.84	19.52	11.76	10.21	11.59	12.89	13.53	12.75	15.22	16.21
Cleopatra mandarin	**Control**		**17.1**	**17.5**	**13.2**	**12.7**	**13.1**	**11.1**	**11.2**	**11.4**	**15.1**	**14.3**	**12.2**	**12.0**
	"2000"	"6"	16.89	17.29	11.03	11.59	14.39	9.18	12.19	14.85	15.64	13.24	11.61	13.22
	"2000"	"12"	16.46	15.36	11.84	11.77	17.09	[illegible]	12.46	11.18	16.78	14.35	12.15	11.48
	"4000"	"6"	13.60	18.04	12.64	12.36	12.36	11.13	14.22	14.13	12.98	16.09	13.43	13.25
	"4000"	"12"	18.02	19.95	13.70	13.87	14.49	13.97	15.65	17.43	16.26	16.96	14.68	15.65
	"6000"	"6"	15.92	16.27	16.06	15.88	13.24	12.71	13.78	14.66	14.58	14.49	14.92	15.27
	"6000"	"12"	15.76	16.55	14.39	14.05	12.36	11.85	12.53	12.71	14.06	14.20	13.46	13.38
Poorman orange	**Control**		**13.3**	**13.5**	**14.0**	**11.6**	**10.9**	**11.6**	**11.4**	**10.8**	**12.1**	**12.6**	**12.7**	**11.2**
	"2000"	"6"	14.49	14.77	10.46	11.42	16.24	12.91	14.22	15.37	15.37	13.84	12.34	13.40
	"2000"	"12"	13.60	13.78	13.34	12.28	15.67	14.57	14.04	12.98	14.64	14.18	13.69	12.63
	"4000"	"6"	17.11	16.91	14.22	10.70	14.39	11.37	14.69	17.78	15.75	14.14	14.46	14.24
	"4000"	"12"	16.92	17.82	12.54	13.96	12.63	14.05	14.58	15.11	14.78	15.98	13.52	14.54
	"6000"	"6"	15.62	15.04	12.89	14.49	13.34	12.99	12.98	12.89	14.48	14.02	12.94	13.69
	"6000"	"12"	20.53	19.86	19.95	18.53	14.33	14.42	14.22	14.04	17.43	17.14	17.09	16.29
L . S . D . at 1%			**2.07**	**2.56**	**1.48**	**1.21**	**0.89**	**1.28**	**0.98**	**1.47**	**1.52**	**1.95**	**1.25**	**1.35**

[1] = Days from the initiation of treatments.
[2] = Atmospheric pressure (At.p.)

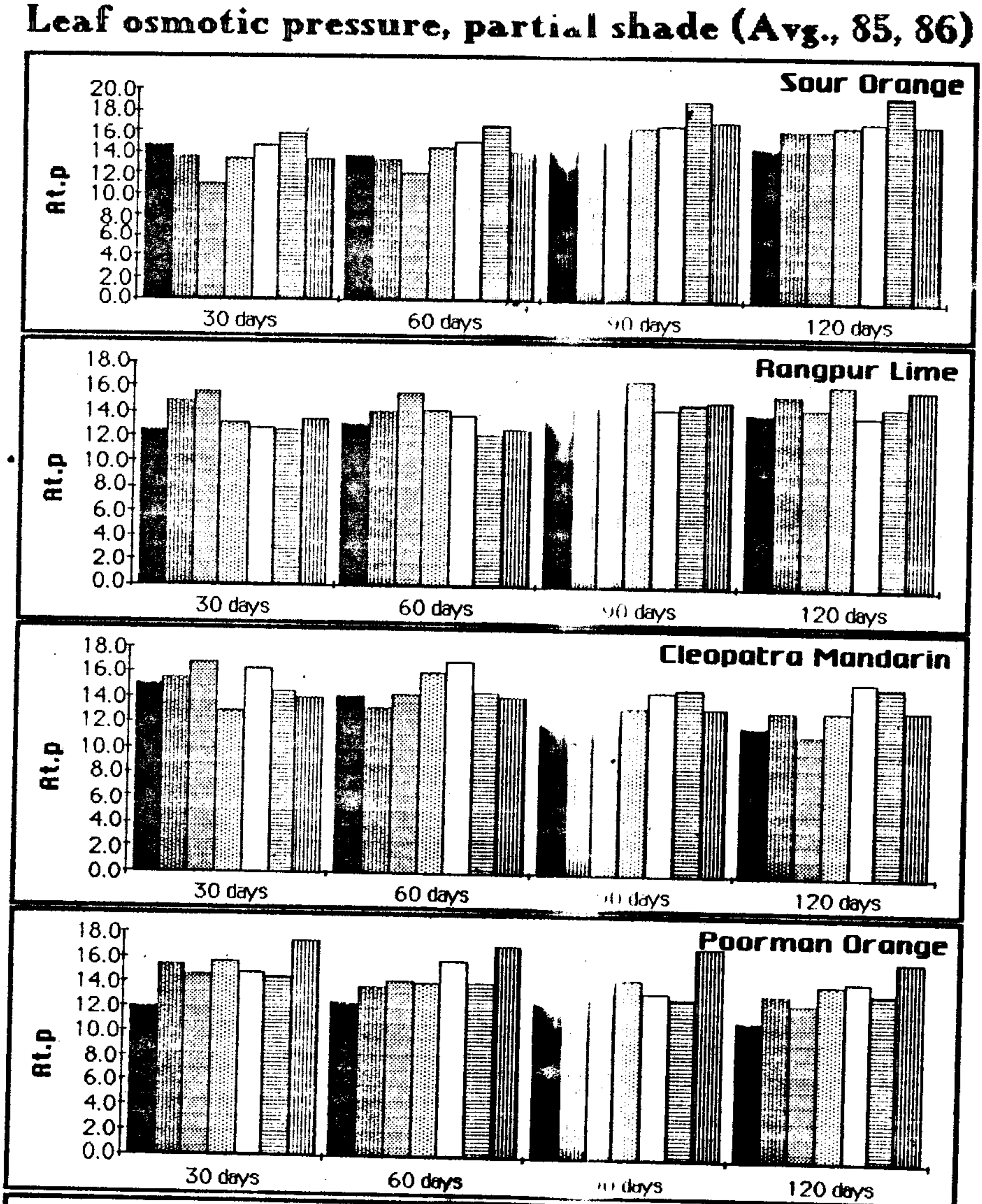

Fig. (14) : Effect of different rates of salinity and S A R on leaf osmotic pressure (At.p.) of Washington navel orange plants budded on different rootstocks grown under partial shade (Average of seasons 1985, 1986).

differences between treatments and the control showed that significancy was more noticed in sour orange and Poorman orange and partially in case of Rangpur lime and Cleopatra mandarin.

Anyhow , comparing control plants with those treated with different treatments of salinity (as average of two seasons) it is quite evident that salinized plants were generally higher in their values than those of the untreated ones (control).

Moreover, in 1985, leaf osmotic pressure of Washington navel orange plants budded on different citrus rootstocks and irrigated with high concentration of salinity increased values in this concern over those received low level . The picture was somewhat changed in the season of 1986 where such increment was only observed in case of sour orange and in part for Cleopatra mandarin and Poorman orange and failed for Rangpur lime. Meanwhile , the average of two seasons indicated that plants received high level of salinity had leaves with higher values of osmotic pressure than those treated with low rate of saline water (Fig. 14) .

Respecting SAR , levels used in this study, it is found that no steady results was observed in the two seasons. In 1985 , while SAR 12 treatment for sour orange and Rangpur lime mostly decreased leaf osmotic pressure as compared to those values of SAR 6 it took the other way around when both Cleopatra mandarin and Poorman orange rootstocks were used. However , the reverse was concerned in 1986 season. The average of two seasons indicated the same trend of season 1985 where no clear trend was noticed. In this respect , while SAR 12 rate increased leaf osmotic pressure over those ones of SAR 6 in some cases, the picture was changed to the reverse in others .

4.5 - Effect of salinity on the anatomical structure of citrus plants :

Some obbreviations were used to express the different parts of leaf and root tissues in the photos:

U.Ep - Upper epidermis	O.Gl - Oil Gland	En - Endodermis
L.Ep = Lower epidermis	Cu. - Cuticle	Hy - Hypodermis
P.t = Palisade tissue	Xy. = Xylem	Per = Pericycle
S.t = Spongy tissue	Ph. - Phloem	Ep = Epidermis
Id. = Idioplast	Cor. = Cortex	C.S. = Cross section

4.5.1- Anatomical features of leaves of Washington navel orange plants budded on different citrus rootstocks :

Leaf blade thickness of Washington navel orange plants budded on different citrus rootstocks and grown under normal conditions reached about 395-440 microns and consists of three differentiated tissues :

1- The epidermis :

In the transection, **Fig.(15)** the outer epidermal walls were covered by a smooth cuticle layer. The epidermal cells had nearly a quadrate shape. Their radial walls were arranged between 11 - 13 microns, while the tangential one reached 13 - 16 microns. These cells became narrow above both the oil glands and the idioplasts. The epidermal cells had large central vacuoles. No chloroplasts were observed. The stomata were sometimes found on the upper epidermis of the midvein.

The cells of the lower epidermis were similar in shape to those of the upper ones, although they were smaller. The chloroplast cells were observed only in the guard cells **Fig. (15)**.

2- The mesophyll :

The mesophyll was differentiated into palisade tissue, which was restricted to the adaxial side, beneath the upper epidermis. On the other hand, the spongy tissue was found on the adaxial side **Fig. (15)**.

The palisade parenchyma was arranged in two regular compact cell layers. The length of the palisade cells varied from 47 - 52 microns in the first layer and reached 42 microns in the second layer.

In the first palisade layer, large thin-walled cells containing different shape crystals or idioplasts had been observed. Usually one crystal occurred in each cell **Figs. (15 and 16)**.

The spongy tissue as mentioned earlier occurred on the lower epidermis. It took about 220 - 250 microns and consisted of 10 - 15

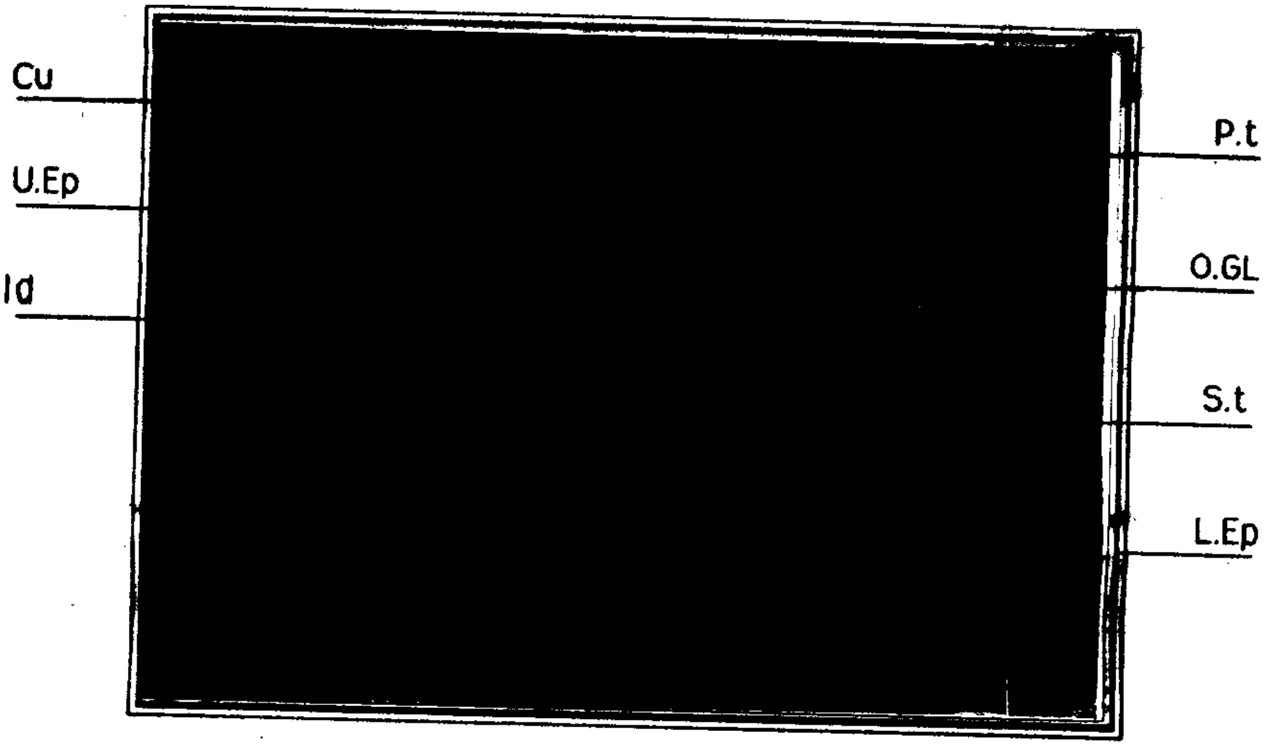

Fig. (15) : C.S. in navel orange leaf, blade control (x 63)

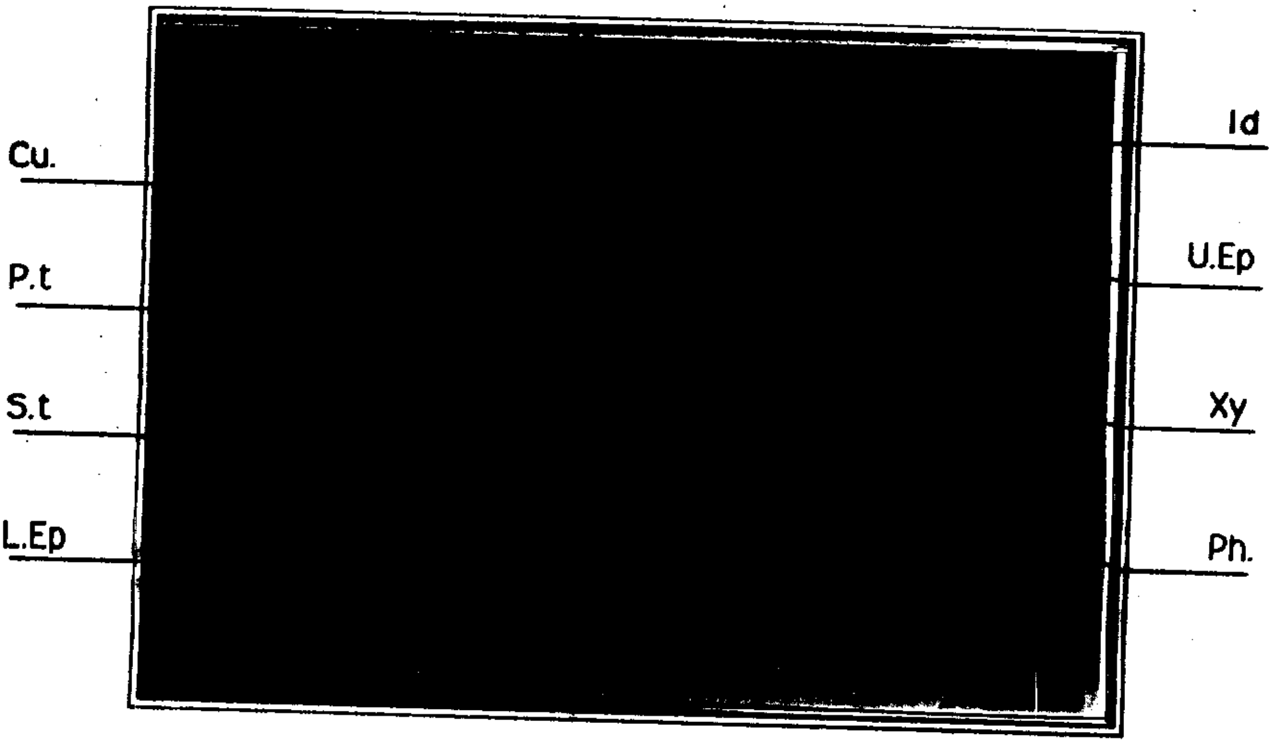

Fig. (16) : C.S. in navel orange leaf, midrib control (x 25) cell layers. The lower values of length and high values of cell layers were found near the midrib.

In the transection, the spongy paranchyma cells had nearly an isodiametric shape and loosely arranged with relatively wide intercellular spaces. The size of the spongy cells and the intercellular spaces decreased towards the lower epidermis, while the density of chloroplasts increased in the same direction. In contact with the lower epidermis, there were two compact raws of small cells **Figs.(15and16)**.

The mesophyll layers were interrupted by the oil glands. The majority of these glands were found in the leaf blade developed adaxially and acquired a spherical shape **Fig (15)**.

A slight depression in the epidermal surface was detected in front of the outer side of the gland. The cells surrounding the gland were arranged in two or three rows and had thicker walls **Fig. (15)**. The chloroplasts content and its size in these cells were less than those of the other mesophyll cells.

3- The vascular bundles :

The adaxial length of the midrib was 780 - 790 microns. It consisted of the vascular bundles beside the tissues mentioned above.

The vascular tissues were arranged in vascular bundles embeded in the ground tissue of the veins. The largest bundle was located in the midrib. The lateral viens protruded slightly on both lower and upper surfaces of the blade.

The vascular tissues were arranged in the form of two unequal bundles. The larger bundle was located downward and the smaller ones were located upward **Fig. (16).**

The larger bundle consisted of nearly 23 - 25 radial rows of tracheary elements, while the smaller bundle contained 12 - 14 rows.

Two rows of the primary phloem fibers were observed. One of these layers was towards the lower surface of the midrib, while the other layer occurred toward the upper surface.

4.5.1.1- Anatomical changes in leaves of Washington navel orange budded on sour orange rootstock as affected by salinity (6000 ppm. at SAR 6 and 12):

Some changes were observed in the leaf tissue of navel orange budded on sour orange rootstock and treated by salinity (6000 ppm at SAR 6 and 12) as compared to the normal leaves (control) can be mentioned as follows :

1- The leaf blade thickness:

It decreased under 6000 ppm at SAR 6 treatment than the control, hence it showed values from 247 - 265 microns, However, the observation showed no clear differences under this treatment and 6000 ppm at SAR 12 treatment where its values reached 257 - 278 microns. (Figs. 17 and 18).

2- The epidermis :

A marked reduction in the thickness of the cuticle could be observed in the leaves of the plants under the two treatments than the control plants. The size of the epidermis cells became smaller in both treatments of salinity as compared with the control. Thus, it could be observed that the cells were more turgid.

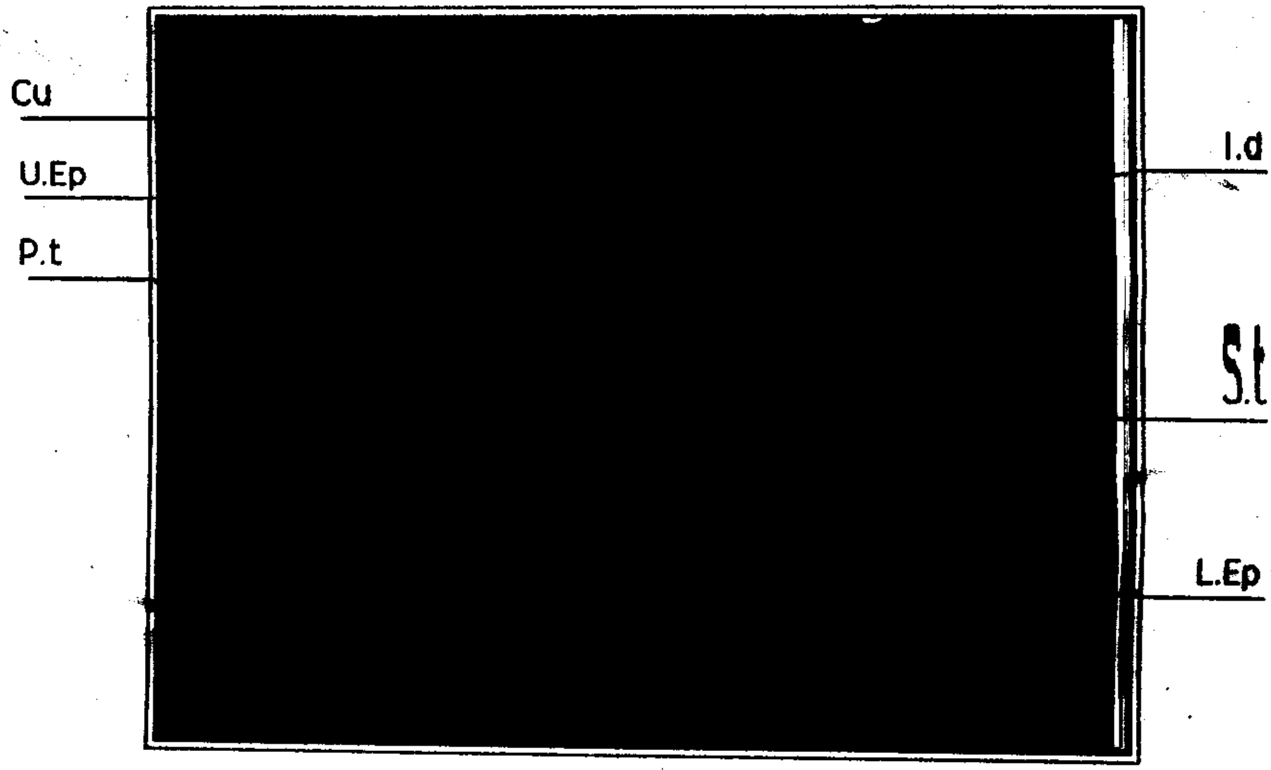

Fig. (17) : C.S. in navel orange leaf blade budded on sour orange rootstock and treated with saline solution containing 6000 ppm at SAR 6 (X 63).

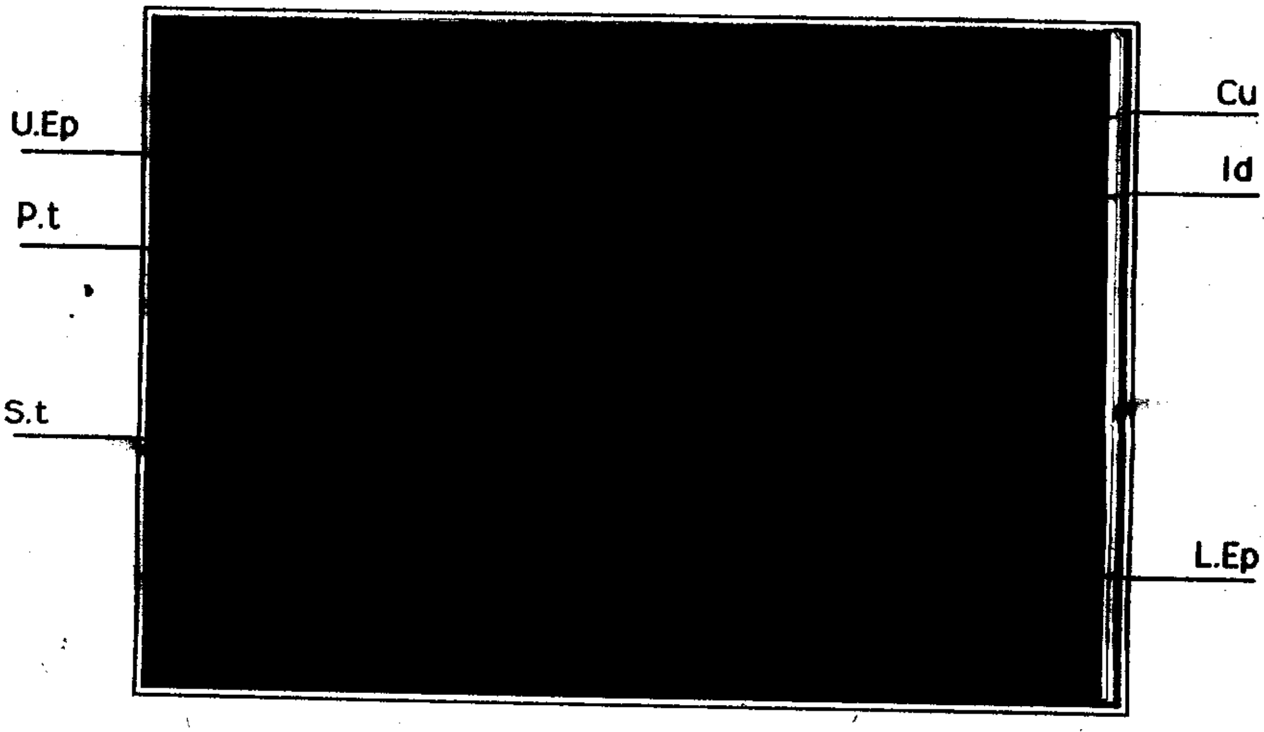

Fig. (18) : C.S. in navel orange leaf blade budded on sour orange rootstock and treated with saline solution containing 6000 ppm at SAR 12 (X 63).

6000 ppm at SAR 12 treatment it was nearly 950 microns **Figs.(19 and 20).**

Furthermore, the size of the vascular bundle increased in the number of archs. Thus, it reached 32 - 34 , 40 - 42 archs in the large bundle for 6000 ppm at SAR 6 and 6000 ppm at SAR 12 treatments, respectively (Figs. 19 and 20) instead of 23 - 25 for the control **Fig. (16)**. The number of archs increased also in the small bundles, where it reached about 22 - 24 archs in the two high salinity treatments while such value reached about 12 - 14 archs in the control. However, the number of vessels in the archs was not affected by neither total salinity nor SAR treatments.

In addition, the phloem fibers were clearly observed in the two high salinity trantments in respect of the control.

4.5.1.2- Anatomical changes in leaves of Washington navel orange budded on Rangpur lime rootstock as affected by salinity (6000 ppm at SAR 6 and 12) :

The following differences were observed between the control and salinity treatments i.e. (6000 ppm at SAR 6 and 12) in their anatomical features as follows :

1- The leaf blade thickness :

It decreased with increasing total salinity (6000 ppm treatment), also a marked decrease in leaf blade thickness can be observed under SAR 12 than SAR 6 treatments. Thus , the values of leaf blade thickness ranged from 395 - 440, 257 - 309 and 233 - 257 microns for the control , 6000 ppm at SAR 6 and SAR 12 treatments, successively.

2- The epidermis :

The cuticle of the leaves of the treated plants was reduced in its thickness as compared to the control **Figs. (21 and 22)**. Beside , the size of the epidermis cells became smaller in both two high salinity treatments (6000 ppm at SAR 6 and SAR 12) as compared with those of the control.

3- The mesophyll :

The length of the palisade cells was decreased than the control as the high salinity treatment (6000 ppm) was used. This decrease was more clear under SAR 12 than in SAR 6 treatment. Thus, the length of the tangential walls might reach 47 - 52, 38 - 42 and 33 - 38 microns in the first layer and 42, 33 and 28 microns in the second layer for the control, 6000 ppm at SAR 6 and SAR 12 treatments, respectively **Figs. (21 and 22).** Moreover, we can observe that the cell walls of mesophyll became rather thin and the number of green plastids in this tissue as well as the spongy tissue were noticeably reduced. The cells which contain the idioplasts increased and took different salt crystals shape. The idioplasts observed were also in the spongy tissue above the lower epidermis cells in both 6000 ppm at SAR 6 and 6000 ppm at SAR 12 treatments **Figs. (23 and 24).** The length of the spongy tissue cell layers decreased in both two high salinity treatments used, this decrease was more clear in 6000 ppm at SAR 12 treatment than in 6000 ppm at SAR 6, hence their values were about 133 - 142 microns for the first treatment while it was about 195 - 209 microns for the second one . Yet, the area occupied by this tissue was reduced by treating with high total salinity and SAR The intercellular spaces decreases noticeably in the spongy tissue which takes an isodiametric shape **Figs. (21 and 22).**

4- The vascular bundles :

No clear differences were detected between 6000 ppm at SAR 6 treatment and the control. Thus, the adaxial length of the midrib for the first treatment was 766 microns while it reached 780 microns for the second one (control). In this concern, 6000 ppm at SAR 12 treatment showed a high increase in the adaxial length of the midrib, hence it was about 986 microns **Figs. (23 and 24).** Furthermore, the phloem occupied more area in both 6000 ppm at SAR 6 and 6000 ppm at SAR 12 treatments as compared with the control. Moreover, the scond treatment showed a great phloem area than in the first one. **Figs. (23 and 24).**

In addition, the number of archs in the large bundle was increased to be around 32 - 34 archs for 6000 ppm at SAR 6 treatment while it reached 40 to 42 archs for 6000 ppm at SAR 12 treatment and 23 - 24 archs for the control. **Figs. (23 and 24).**

The number of archs in the small bundle was increased also to be 16 - 18 and 23 - 25 archs for 6000 ppm at SAR 6 and 6000 ppm at SAR 12 treatments, respectively, while it reached 12 - 14 archs in the control. Beside, it is quite evident that the number of vessels in each arch was not affected by the two high salinity treatments.

3- The mesophyll :

Cell walls of the mesophyll became rather thin and the palisade cells became smaller than the control in both high salinity treatments.

So , the length of the tangential walls might reach 31 - 33 microns in the first layer and 24 - 26 microns in the second layer for 6000 ppm at SAR 6 treatment while the decrease in the tangential length of the palisade cell walls became the highest for 6000 ppm at SAR 12 treatment so it rached 21 - 24 microns in the first layer and 16 - 19 microns in the second layer. The number of green plastide was noticeably reduced in the palisade and spongy parenchyma. The cells containing the different shapes of salt crystals or the idioplasts were increased in the first palisade layer. This idioplasts were also observed in a great number in the spongy tissue above the lower epidermis cells of 6000 ppm at SAR 12 treatment over than 6000 ppm at SAR 6 treatment. **Figs (25 and 27).** The intercellular spaces decreased noticeably in the spongy tissue which takes an isodiametric shape. The length of spongy tissue cell layers was decreased in both high salinity treatments. This decrease was more clear in 6000 ppm at SAR 12 treatment than in 6000 ppm at SAR 6 since their values were between 133 - 143 microns for the first treatment while it ranged from 180 - 190 microns for the second one. Yet the area occupied by this tissue was reduced. **Figs. (25 and 27).**

4- The vascular bundles :

The adaxial length of the midrib was 789 microns for 6000 ppm at SAR 6 treatment without any difference than the control. **Fig. (26).** However, an increase was observed in the adaxial length of the midrib of 6000 ppm at SAR 12 treatment, where it was 858 microns **Fig. (28).**

The phloem occupied more area in the above two salinity treatments than the control. The number of archs in the large bundle was increased to be 30 - 32 and 40 - 42 for 6000 ppm at SAR 6 and 6000 ppm at SAR 12 treatments, respectively instead of 23 - 25 for the control **Figs. (26 and 28).**

In addition, the number of archs in the small bundle was also increased to be 16 - 18 and 21 - 23 archs for 6000 ppm at SAR 6 and 6000 ppm at SAR 12 treatments, respectively instead of 12 - 14 archs for the control. Moreover, the number of vessels in each arch was not affected by neither total salinity nor SAR treatments.

4.5.1.4. Anatomical changes in leaves of Navel orange budded on Poorman orange rootstock as affected by total salinity 6000 ppm at SAR 6 and 12 :

The following anatomical changes have been observed as compared to the control plants:

1- Leaf blade thickness :

It decreased under 6000 ppm at SAR 6 treatment than the control, where it had values from 305 - 309 microns. The measurements showed a high decrease in leaf blade thickness under 6000 ppm at SAR 12, where it took values from 224 - 238 microns. In the same time, the control had values from 395 - 440 microns **Figs.(29 and 30).**

2- The epidermis :

In the transections **Figs. (29 and 30)** the observations showed that the thickness of the cuticle was reduced in both high salinity treatments. Under 6000 ppm at SAR 6 the size of the epidermis cells became smaller than the control, while it was the smallest under 6000 ppm at SAR 12 treatment. It could be also observed that the cells are more turgid and the nucleus in these cells was enlarged.

3- The mesophyll :

The palisade cells became smaller than the control in both high salinity treatments, so that the tangential walls might reach 33 - 42 microns in the first layer and 28 - 32 microns in the second layer for 6000 ppm at SAR 6 treatment, while it was highly decreased in the tangential length of the palisade cell walls under 6000 ppm at SAR 12 treatment so their values rached 28 - 33 microns in the first layer and 19 - 24 microns in the second layer. The cell walls of mesophyll became rather thin, also the number of green plastids are noticeably reduced in the palisade and spongy tissues. The idioplasts or the cells which containing different shape of salt crystals were observed in a great number in the first palisade layer **Figs. (29 and 30)**. The cells of the spongy tissue took the isodiametric shape and the intercellular spaces between it decreased than the control.

Also the area which occupied by the spongy tissue is reduced in both, high salinity treatments than the control. This reduction in spongy tissue area was higher under 6000 ppm at SAR 12 treatment than 6000 ppm at SAR 6 treatment.

In this concern, it is suitable to notice that the length of spongy tissue cell layers took values about 228 - 233 microns for 6000 ppm at SAR 6 and 152 - 161 microns for 6000 ppm at SAR 12 treatments.

4- The vascular bundles :

The adaxially length of the midrib was increased under 6000 ppm at SAR 6 than the control. Thus, their values took about 882 microns, while under the treatment which received 6000 ppm at SAR 12 the

4.5.2- Anatomical changes in the roots of sour orange, Rangpur lime, Cleopatra mandarin and Poorman orange rootstocks as affected by high level of salinity (6000 ppm at SAR 6 and 12):

4.5.2.1- Sour orange rootstock :

4.5.2.1.a- Sour orange root anatomical features (control):

The examination of the transver sesection in the root of sour orange revealed that it consists of the following layers:

1- The epidermis :

The epidermis consisted of one layer of cells. These cells had thick suberized walls and may contain dark meterials **Fig. (33)**.

2- The cortex :

The cortex consisted of 12 - 16 layers. The length of this layer was 210 - 215 microns. The first cortical cell layer which called the hypodermal layer had different characteristic feature. The hypodermal cells had large size and outer suberized thick walls. The suberization slightly extended on the radial walls to form a peglike structure between each two neighbouring cells Fig. (33).

The cortex consisted of parenchymatous cells which their size gradually decreased inwards. The cortical cells were interveind by intercellular spaces with different sizes and shapes.

The innermost cortical layer was differentiated into the endodermis with casparian strips. The tangential walls of the endodermis cells are longer than the radial wall Fig. (33).

3- Vascular cylinder :

The vascular cylinder radial length was about 570 - 600 microns. Its outermost layer was the pericycle which consists of two to three cell layers of different sizes. The stele had 8 - 10 xylem strands. Each xylem strand included 5 to 12 tracheary elements arranged in a triangular shape Fig. (33). Thick walled cells are presented beside the xylem archs. These cells resemble fibers.

The phloem differentiated into 8 strands alternating with those of xylem. The phloem consisted of sieve tubes, companion cells and parenchyma. The innermost tissue of the vascular cylinder was the pith. This tissue consists of thick walled parenchymatous cells without intercellular spaces Fig. (33).

4.5.2.1.b- Anatomical changes observed in sour orange root as affected by high salinity treatments (6000 ppm at SAR 6 and 12):

The following differences were observed as compared to the control. The root diameter was noticeably reduced with increasing either salinity or SAR. Thus, the root diameter of the different treatments took values about 1120 - 1170, 696 - 742 and 596 - 688 microns for the control, 6000 ppm at SAR 6 and 6000 ppm at SAR 12 treatments, respectively. The root shape, on the other hand, was irrigular **Figs. (34 and 35).**

Moreover, the epidermal layer disappeared only under 6000 ppm at SAR 12, and the hypodermal layer replaced it. The walls of these hypodermal cells became suberized. The number of cortex layers was not affected under 6000 ppm at SAR 6 treatment, but it reduced under 6000 ppm at SAR 12 than in either the control or 6000 ppm at SAR 6 treatments. Thus, it consists of 8 - 10 layer On the other hand, the length of the cortex radial walls reduced with increasing salinity and SAR levels. It tooks values from 232 - 278 and 199 - 241 microns for 6000 ppm at SAR 6 and 6000 ppm at SAR 12 treatments, respectively, while its values for the control reached to 270 - 315 microns. The endodermis is pressed in the tangential direction and the pericycle tissue became more disapparent. Moreover, the vascular cylinder, radial length reduced with increasing total salinity and SAR, thus it took values about 570 - 600, 276 - 290 and 262 - 277 for control, 6000 ppm at SAR 6 and 6000 ppm at SAR 12, respectively. It could also be observed that the vascular bundle having fewer vessels in both high salinity treatments than the control **Figs. (34 and 35).**

4.5.2.2- Rangpur lime rootstock :

4.5.2.2.a- Rangpur lime root anatomical features (control):

Root structure of this rootstock differs from that of sour orange in the following aspects:

The epidermal cell wall are thicker. The cortex consists of much layers and its length increased and took values from 291 - 333 microns. The hypodermal cells became regular and pressed, while its thick walls had less suberization **Fig. (36)**. It could observe a great cycle from the suberized cells which took its place in the middle of the cortex. Moreover, the intercellular spaces decreased. The endodermis is pressed. On the other hand, the radial length of the vascular cylindar increased and took values from 998 - 1040 microns and the pericycle layers were more than of sour orange root. The stele had 10 - 12 xylem strands. Also, the pith cells increased and became smaller without intercellular spaces **Fig. (36)**.

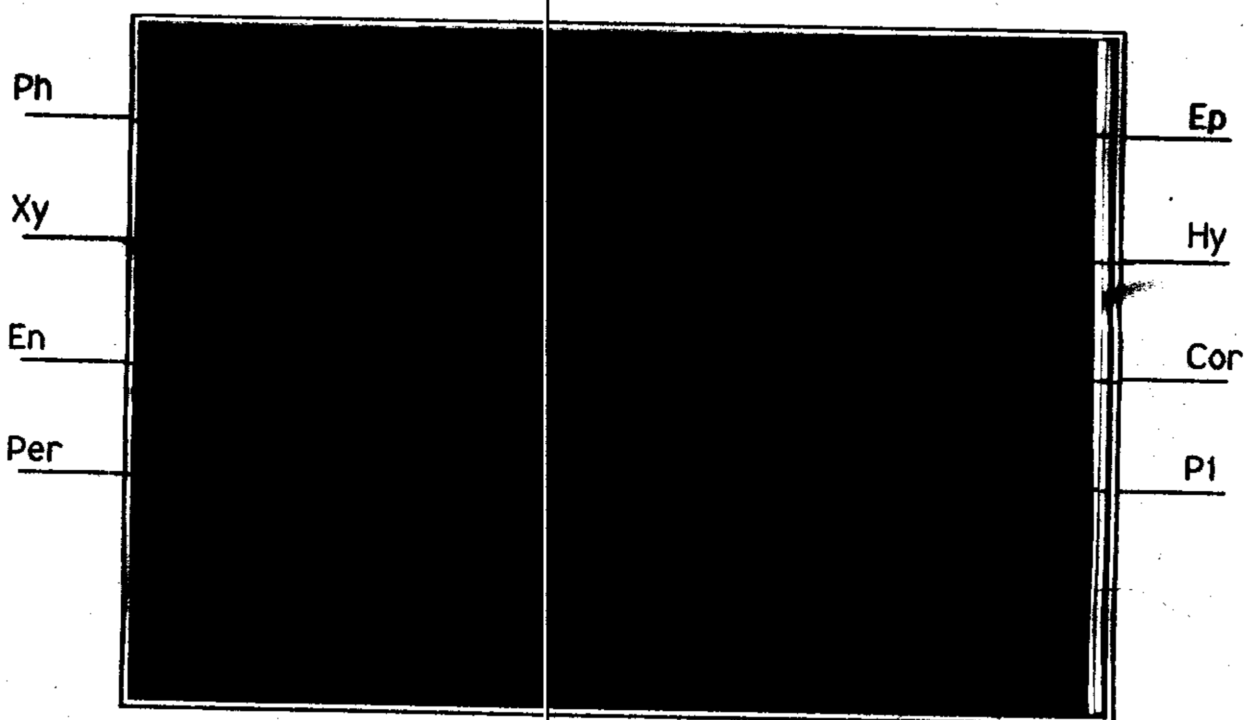

Fig. (36) : C.S. in Rangpur lime root, control (X 16).

4.5.2.b-Anatomical changes observed in Rangpur lime root as affected by high salinity treatments (6000 ppm at SAR 6 and 12):

The following changes were observed as compared to the control:

High salinity and SAR treatments caused a reduction in root diameter. Thus, it took values about 1789 - 1872, 730 - 974 and 676 - 770 microns for the control, 6000 ppm at SAR 6 and 6000 ppm at SAR 12 treatments, respectively. Beside, the roots had an irrigular outer surface. Moreover, the epidermal layer disappeared and the hypodermal layer replaced it under the two highy salinity treatments but the suberization on this layer became clear under 6000 ppm at SAR 6 than 6000 ppm at SAR 12 treatments **Figs (37 and 38)**. Also there was a clear decrease in the length of the cortex radial walls as a result of using either high salinity or SAR rates. Thus, their values reached about 291 - 333, 185 - 290 and 178 - 272 microns for the control, 6000 ppm at SAR 6 and 6000 ppm at SAR 12 treatments, respectively.

The endodermis and pericycle layers became pressed. Also the diameter of the vascular bundle is reduced with increasing both salinity and SAR since it took values about 267 - 315 and 215 - 264 microns for 6000 ppm at SAR 6 and 6000 ppm at SAR 12 treatments, respectively. On the other hand, this value for the control was about 998 - 1040 microns. The vascular bundle have fewer vessels and the lignification in this vessel walls was not normal, so that they were subjeted to be pressed in the radial direction. Pith area was reduced, and its cells became of very thin walls and very early ruptured **Figs. (37 and 38)**.

4.5.2.3- Cleopatra mandarin rootstock :

4.5.2.3.a- Cleopatra mandarin root anatomical features (control):

It differs from root of sour orange rootstock in the following as it appears in transverse sections :

The epidermal cell walls was thicker. The cortex consists of the same number of layers and its length took the same values as sour orange. The hypodermal cells were not pressed and had an isodiametric shape. Thick walls had much suberization Fig. (39). On the other side, we can observe a suberized cells on the cortex layers which took its place around the vascular bundle, and the intercellular spaces between cortex cells took different shapes. The endodermis was not pressed . However, the vascular cylinder racial length increased than that of sour orange root to reach a values of 1060 - 1102 microns. The number of strands in the xylem was small (8 - 10 strands). The pith had thick walled cells without intercellular spaces Fig. (39).

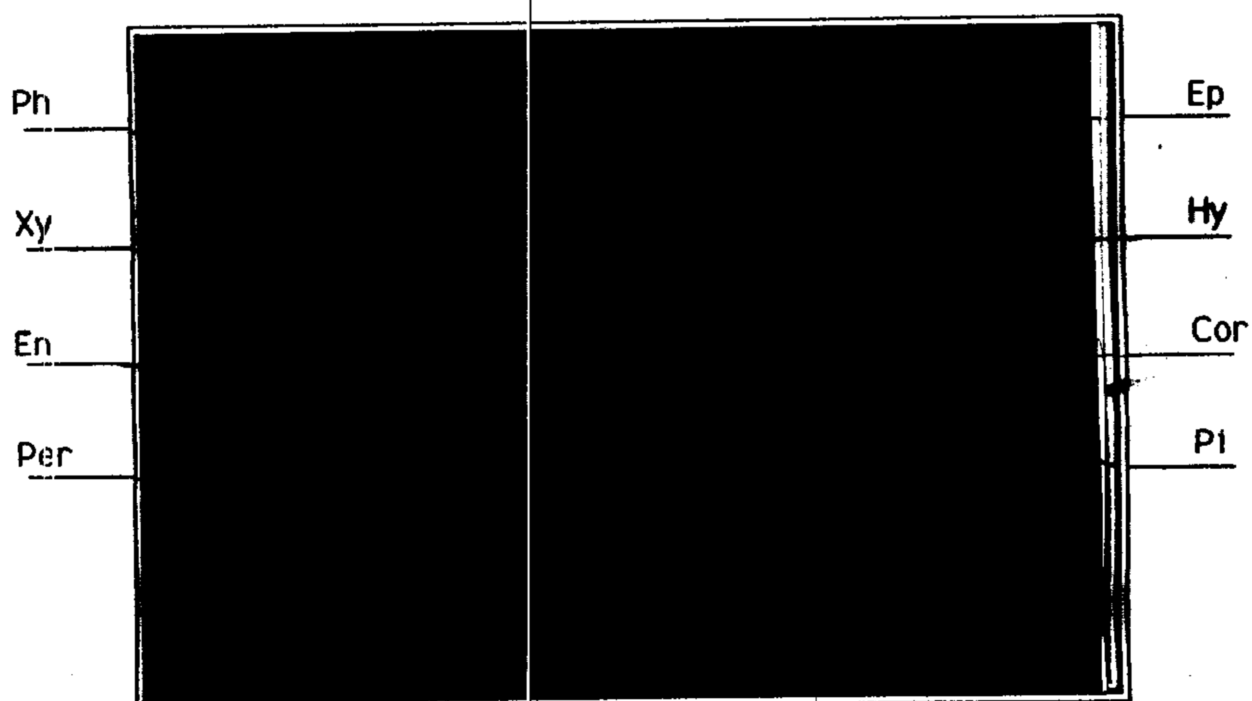

Fig. (39) : C.S. in Cleopatra mandarin root, control (X 16).

4.5.2.3.b- Anatomical changes observed in Cleopatra mandarin root as affected by high salinity treatments (6000 ppm at SAR 6 and 12):

The following differences were observed as compared to the control.

Irrigation with saline solution caused a reduction in root diameter, while increasing SAR values took the other way around in this respect. Thus, the root diameter of Cleopatra mandarin took values of about 1747 - 1934, 575 - 646 and 846 - 865 microns for the control, 6000 ppm at SAR 6 and 6000 ppm at SAR 12 treatments, respectively. On the other hand, the root took the isodiametric shape as the control.

Concerning 6000 ppm at SAR 6 treatment, it is observed that the epidermal layer disappeared and the hypodermal layer replaced it , while under 6000 ppm at SAR 12 the epidermal layer disappered in some places and the suberization was noticed in both the epidermal and hypodermal cells, **Figs. (40 and 41)**. Moreover, high decrease in cortex radial walls length under 6000 ppm at SAR 6 (156 - 206 microns) as compared with the control (312 - 353 microns). Such decrease under 6000 ppm at SAR 12 treatment was less than that of 6000 ppm at SAR 6 treatment , where it took values of about (235 - 273 microns). The cortex layers decreased under 6000 ppm at SAR 6 treatment (8 - 10 layers) than that of 6000 ppm at SAR 12 (12 - 14 layers). In addition, the endodermis and pericycle layers were pressed. Considering the diameter of the vascular bundle, the observations showed a decrease under 6000 ppm at SAR 12 (282 - 301 microns) than the control (1060 - 1102 microns). Furthermore, such decrease took the highest value under 6000 ppm at SAR 6 (178 - 227 microns). On the other hand, the vascular bundle have fewer vessels (5 xylem strands) and the tracheary elements reduced than the control. Beside, the lignification in these vessel walls became lesser than those of the control . Under the two high salinity treatments the pith area was reduced **Figs. (40 and 41)**.

4.5.2.4- Poorman orange rootstock :

4.5.2.4.a- Poorman orange root anatomical features (control) :

It differs from roots of sour orange rootstock in the following as appears in transverse sections :

The epidermal cell wall was thicker. The cortex consists the same number of layers but the cells became smaller and pressed . It had also the isodiametric shape and the intercellular spaces between cortex cells were depressed. In the same time , it took the same length. The hypodermal cells did not differ from roots of sour orange **Fig. (42).** The endodermis is pressed and the casparian strip is evident also . The vascular cylinder radial length increased than sour orange root and tooks values about 1040 - 1081 microns. While the number of strands in the xylem is smaller (8 - 10 strands) . An increase in the number of tracheary elements in each strand was opserved and it reached 16 - 20 elements . The pith had thick walled cells without intercellular spaces **Fig. (42).**

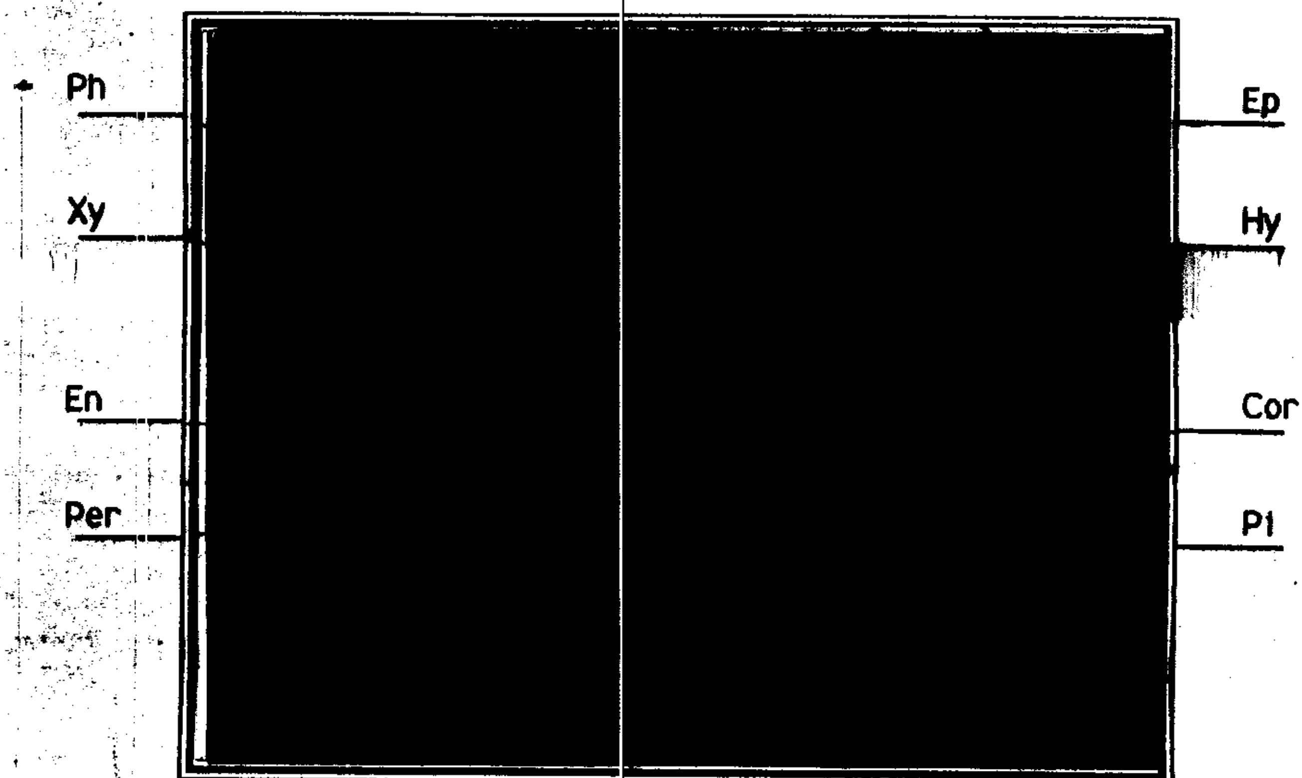

Fig. (42) ; C.S. in Poorman orange root, control (X 16).

4.5.2.4.b- Anatomical changes observed in Poorman orange root as affected by high salinity treatments (6000 ppm at SAR 6 and 12) :

The following changes were observed as compared to the control :

The high salinity treatment (6000 ppm) caused a reduction in root diameter , but the high SAR 12 level had no effect, but affected root shape , since it acquired the root an irregular outer surface **Figs. (43 and 44).** Both high salinity and SAR treatments led to disappear the epidermal layer and the hypodermal layer replace it with a suberization to the radial and tangential cell walls .

The reduction in cortex radial walls length was equal under salinity treatments, thus it tooks less values about 198 - 213 microns in comparison to 282 - 312 microns for the control . The endodermis and pericyle layers were pressed with a decreases in their numbers .

Moreover, it is evident to notice that the reduction in the vascullar bundle diameter was equal under both 6000 ppm at SAR 6 and 6000 ppm at SAR 12 treatments , since they took values of 156 - 170 microns. The vascular bundle had fewer vessels under 6000 ppm at SAR 12 treatment while the number of these vessels under 6000 ppm at SAR 6 treatment was not clear . On the other hand , in both treatments of salinity the lignification in this vessel walls was not normal , so that they were subjected to be pressed in the radial direction. Under salinity treatments , pith area was reduced with very thin cell walls and very early deteriorated **Figs. (43 and 44).**

4.6- Evaluation of some citrus rootstocks:

From Table (20) it is quit evident that sour orange rootstock was the most tolerant citrus rootstock to salinity under full sun light and other experimental conditions since it obtained the highest score (68.3) . It had the highest total plant dry weight and leaf osmotic pressure values . On the contrary , Poorman orange rootstock was inferior , hence it ranked the last in evaluation due it had the lowest score (16.5) . On the other hand , Rangpur lime and Cleopatra mandarin ranked the second and third since they had scores of 47.9 and 42.0 , respectively .

Under partial shade condition, Table (21) the picture was somewhat changed where Cleopatra mandarin surpassed all other rootstocks used in its salt tolerance as it obtained the highest score (78.3) because it had the highest total plant dry weight, top/root ratio and lowest salinity hazard coefficient . In contrast , Rangpurlime rootstock failed to tolerate salinity under this condition because it had the lowest score (40.8) . Moreover , Poorman orange and sour orange rootstocks took the second and third grade , since they had scores of 76.5 and 55.2 , respectively .

Anyhow , it is useful to notice that the tolerance of these rootstocks was evaluated under saline irrigation water containing not more than 10 millequivalent Cl^- /liter.

Table (20) : **Evaluation of the different citrus rootstocks under 6000 ppm at SAR 12 treatment and full sun light condition.**

Rootstock	Plant dry weight		Top/root ratio		Salinity hazard coefficient		Osmotic pressure		Root Na^{+}		Root cL^{-}		Total	Evaluation grade
Degree	gm	50		10		10	at.p	10	%	10	%	10	100	
Range *	19.5		0.31		1.6		7.57		0.37		0.15			
Sour orange	96.2	50.0	1.52	0.0	3.7	00.0	25.59	10.0	0.81	4.3	0.54	4.0	66.3	1
Rangpur lime	82.4	9.5	1.26	8.4	2.1	10.0	18.02	00.0	0.60	10.0	0.45	10.0	47.9	2
Cleopatra mandarin	87.1	21.5	1.50	0.6	3.2	3.1	18.84	1.1	0.61	9.7	0.51	6.0	42.0	3
Poorman orange	78.7	00.0	1.21	10.0	2.8	5.6	18.72	0.9	0.97	0.0	0.60	0.0	16.5	4

* Range is the difference between the maximum and the minimum values of each constituent.

Table (21) : **Evaluation of the different citrus rootstocks under 6000 ppm at SAR 12 treatment and partial shade condition.**

Rootstock	Plant dry weight		Top/root ratio		Salinity hazard coefficient		Osmotic pressure		Root Na $^{+}$		Root cL $^{-}$		Total	Evaluation grade
Degree	gm	50		10		10	at.p	10	%	10	%	10	100	
Range *	67.9		0.65		2.7		3.70		0.15		0.24			
Sour orange	105.7	45.2	1.59	0.0	3.0	00.0	17.08	10.0	0.68	0.0	0.85	0.0	55.2	3
Rangpur lime	44.3	0.0	1.14	6.9	1.3	6.3	16.21	7.6	0.53	10.0	0.61	10.0	40.8	4
Cleopatra mandarin	112.2	50.0	0.94	10.0	0.3	10.0	13.38	0.0	0.65	2.0	0.70	6.3	78.3	1
Poorman orange	111.6	49.5	1.08	7.9	2.1	3.3	16.29	7.9	0.57	7.3	0.75	4.2	76.5	2

* Range is the difference between the maximum and the minimum values of each constituent.