RESULTS & DISCUSSION

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The present study included two experiments: a laboratory experiment and a pot experiment.

I- The laboratory experiment:

Table (1) shows that different salinity levels (i.e. 0, 1000, 2000, 3000, 4000, 5000, 6000, 7000, 8000, 9000 and 10000 ppm) almost significantly affected seed germination even as percentages or rates of the wheat cultivars (Giza 163 & Sakha 92) and the tomato cultivars (Castle Rock & Edkawi).

1. Wheat cultivars (Giza 163 & Sakha 92):

For wheat cv. Giza 163, it was noticed that increasing the level of salinity from 0 to 7000 ppm progressively caused reduction in the germination percentages. This reduction was 10.0%, 12.5%, 17.5%, 22.5%, 30.0%, 32.5% and 42.5% at the salinity levels of 1000, 2000, 3000, 4000, 5000, 6000 and 7000 ppm, respectively. Meanwhile, the number of days required for germination was significantly increased as it was 3.30 for the control (zero ppm) and increased to 3.38, 3.58, 3.55, 3.74, 4.55, 4.47 and 4.21 with the salinity concentrations of 1000, 2000, 3000, 4000, 5000, 6000 and 7000 ppm, respectively. But, for wheat cv. Sakha 92, it was noticed that increasing salinity levels up to 6000 ppm did not show a clear effect on the germination percentages or rates. Meanwhile, salinity at 7000 ppm decreased the germination percentage and increased the number of days required for germination. Besides, Table (1) show that salinity at the concentrations more than 7000 ppm (8000, 9000 and 10000 ppm) completely inhibited seed germination in the assigned wheat cultivars.

Table (1): Effect of salinity on the germination of wheat and tomato seeds.

Salinity concentration (ppm)	Wheat cvs.				Tomato cvs.			
	Giza 163		Sakha 92		Castle Rock		Edkawi	
	Germinatiom		Germinatiom		Germinatiom		Germinatiom	
	Percentage	Rate	Percentage	Rate	Percentage	Rate	Percentage	Rate
0 (control)	100.00 ± 0.00	3.30 ± 0.06	100.00 ± 0.00	3.00 ± 0.00	91.20 ± 2.22	5.05 ± 0.09	92.50 ± 2.50	6.58 ± 0.23
1000	90.00 ± 4.08	3.38 ± 0.04	100.00 ± 0.00	3.00 ± 0.00	88.80 ± 2.22	5.50 ± 0.10	87.50 ± 2.50	6.51 ± 0.34
2000	87.50 ± 2.50	3.58 ± 0.16	100.00 ± 0.00	3.00 ± 0.00	86.00 ± 0.00	6.69 ± 0.10	85.00 ± 6.45	6.87 ± 0.16
3000	82.50 ± 4.79	3.55 ± 0.14	100.00 ± 0.00	3.00 ± 0.00	80.00 ± 3.85	6.85 ± 0.14	85.00 ± 5.00	7.25 ± 0.15
4000	72.50 ± 4.79	3.74 ± 0.14	100.00 ± 0.00	3.00 ± 0.00	69.60 ± 3.85	7.47 ± 0.19	85.00 ± 2.89	7.42 ± 0.21
5000	70.00 ± 0.00	4.55 ± 0.18	100.00 ± 0.00	3.00 ± 0.00	51.80 ± 4.60	8.02 ± 0.13	77.50 ± 2.50	7.72 ± 0.28
6000	67.50 ± 4.79	4.47 ± 0.15	100.00 ± 0.00	3.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	77.50 ± 6.45	8.06 ± 0.12
7000	57.50 ± 2.50	4.21 ± 0.11	97.50 ± 2.50	3.05 ± 0.05	0.00 ± 0.00	0.00 ± 0.00	72.50 ± 2.50	8.94 ± 0.28
*8000	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	25.00 ± 8.66	9.00 ± 0.00

* Concentrations of salinity more than 8000 ppm (i.e. 9000 & 10000 ppm) completely inhibited seed germination in both wheat and tomato cultivars.

2. Tomato cultivars (Castle Rock and Edkawi):

Table (1) shows that the dominant effect of salinilty on seed germination of the two tomato cultivars was the reduction in germination percentages and the increase in number of days required for germination. This effect was directly proportional to the applied concentration. Furthermore, the salinity concentrations more than 5000 ppm (6000, 7000, 8000, 9000 and 10000 ppm) completely inhibited seed germination in Castle Rock cv., although in Edkawi cv. all the seeds did not germinate at the high salinity concentrations (9000 and 10000 ppm).

Data in Table (1) clearly show that the maximum level of tolerable salinity (i.e. the salinity level after which the germination percentage was less than 50% of the control) was 7000 ppm for the two wheat cultivars and the tomato cv. Edkawi as well. While, the maximum level of tolerable salinity was 5000 ppm for the tomato cv. Castle Rock. Also, the results indicated that wheat cv. Sakha 92 and tomato cv. Edkawi were more tolerant than wheat cv. Giza 163 and tomato cv. Castle Rock.

In this respect, some other studies found also negative effect of salinity on seed germination of both wheat and tomato plants (**Francois** ***et al.*****, 1986; Mahmoud** ***et al.*****, 1986a; Osman** ***et al.*****, 1987; Prakash and Sastry, 1992; Ismaeil** ***et al.*****, 1993 and Rizk, 1993**).

The existed reduction or the complete inhibition in seed germination of wheat and tomato under the saline conditions could be attributed to the facts that salinity progressively diminish the endogenous gibberellins in both wheat and tomato plants grown under saline conditions (other results of the present study are mentioned afterwords) and gibberellins have been recommended to be the main factor that control seed germination of many plants especially cereals **(Devlin and Witham, 1983 and Weidner, 1984)**.

Explanations of the sequence of events related to germination of cereal grains could be summarized as follows:

The uptake of water causes the embryo to secrete gibberellin and this growth regulator then diffuses to the aleurone cells which are then induced to secrete ∝-amylase which hydrolyzes the starch grains in the underlying endosperm and the glucose produced is presumed to diffuse back to the embryo where it is used to fuel growth. So, GA3 could be generally stimulate (I) RNA synthesis (ii) the synthesis of ∝-amylase mRNA specifically or (iii) the synthesis of either rRNA or tRNA in a system in which the levels of these RNAs limit the rate of protein synthesis (including enzymatically protein).

Also, experiments in which mRNA extracted from cereal grains is translated in vitro suggest that gibberellin specifically affects the synthesis of ∝-amylase mRNA i.e. transcription of the ∝-amylase gene **(Ridge *et al.*, 1993)**.

II- The pot experiment:

a- Effect of the maximum tolerable salinity levels alone and the untolerable salinity levels preceded with paclobutrazol on the growth of wheat and tomato plants:

Tables (2, 3, 4 and 5) include different morphological characteristics that are considered in this study with regard to the two wheat cvs. (Giza 163 & Sakha 92) and the two tomato cvs. (Castle Rock & Edkawi). Besides, these Tables include the obtained data in the two successive seasons (1993/1994 and 1994/1995).

1. Wheat cvs. (Giza 163 and Sakha 92):

As for the size of the root system, Tables 2 & 3 clearly indicate that the treatment of salinity alone with 7000 ppm (i.e. the maximum tolerable level) significantly decreased the size of the root system of both wheat cultivars in the two seasons of study compared with that of the untreated plants. However, the higher salinity levels of 8000 and 9000 ppm (i.e. the untolerable levels) led to significant increase in the size of the root system but when preceded with paclobutrazol treatments at 10 and 50 ppm (Figs. 4, 5, 6 and 7). That was true for the two wheat cultivars at 70 days after sowing in the two assigned seasons. Also, Tables (2 & 3) clearly show that the roots of the cv. Giza 163 were more sensitive in their response to salinity than those of the cv. Sakha 92 .

In this respect, **Ismaeil *et al.* (1993)** and **Huang *et al.* (1994)** found the same effect of salinity on the root growth of wheat plants.

Furthermore, Tables (2 and 3) and Figs. (4, 5, 6 and 7) strictly confirmed the protective effect of paclobutrazol in relation to the harmful effect of salinity on the root growth of wheat plants. It was also noticed that paclobutrazol not only protected the roots growth of wheat plants from the harmful effect of salinity but also significantly stimulated their growth under the untolerable salinity levels (8000 and 9000 ppm) compared with those of the control (untreated plants). The previous mentioned findings could be interpreted on the basis of the physiological role of the nature of paclobutrazol action. Since (as will be mentioned later) paclobutrazol treatments alter the endogenous levels of different determined phytohormones i.e. auxins, gibberellins and cytokinins. Of this alteration was the high increase in the cytokinins level that tended to increase the size of root system of wheat plants. It is well established that cytokinins stimulate lateral

Table (2): Effect of the maximum tolerable salinity level (7000 ppm) alone and the untolerable salinity levels (8000 & 9000 ppm) preceded with paclobutrazol treatments on wheat growth (season 1993/ 94).

	Characters	Treatments					
		Tap water (control)	Salinity 7000 ppm	Paclobutrazol (ppm)			
				10		50	
				Salinity (ppm)		Salinity (ppm)	
				8000	9000	8000	9000
		Wheat cv. Giza 163					
70 days after sowing	Size of the root system (cm3)	7.95 ± 0.45	6.80 ±0.50	10.45 ± 0.85	9.40 ± 0.80	11.60 ± 0.90	10.70 ± 0.75
	Plant height (cm)	38.50 ± 1.12	33.25 ±0.95	30.50 ± 0.79	28.38 ± 0.79	18.28 ± 0.55	16.88 ± 0.65
	Stem length (cm)	14.60 ± 0.37	10.95 ±0.47	7.85 ± 0.33	6.80 ± 0.24	3.05 ± 0.27	2.65 ± 0.18
	No. of internodes	7.00 ± 0.00	6.50 ±0.29	6.50 ± 0.29	6.30 ± 0.24	5.00 ± 0.00	5.00 ± 0.00
	Mean length of the internode (cm)	2.09 ± 0.11	1.68 ±0.09	1.21 ± 0.08	1.08 ± 0.06	0.61 ± 0.06	0.53 ± 0.04
	No.of tillers/ plant	4.30 ± 0.63	3.50 ±0.29	5.50 ± 0.29	5.00 ± 0.50	9.20 ± 1.13	8.20 ± 0.63
	No. of leaves on the main stem	6.00 ± 0.00	5.50 ±0.29	5.50 ± 0.29	5.30 ± 0.24	4.00 ± 0.00	4.00 ± 0.00
	No. of leaves on the tillers	16.50 ± 1.85	13.50 ±1.29	22.50 ± 2.41	18.50 ± 1.96	29.50 ± 2.33	25.50 ± 1.25
	Total number of leaves/ plant	22.50 ± 1.85	19.00 ±1.22	28.00 ± 2.25	23.80 ± 1.71	33.50 + 2.33	29.50 ± 1.25
	Total leaf area (cm2)/ plant	443.08 ± 23.85	355.48 ±20.28	340.85 ± 18.55	338.39 ± 21.92	334.16 ± 12.89	256.00 ± 16.76
172 days after sowing	No. of fertile tillers/ plant	7.50 ± 0.42	5.50 ±0.33	7.00 ± 0.33	5.50 ± 0.38	9.00 ± 0.38	7.00 ± 0.33
	No. of unfertile tillers/ plant	3.50 ± 0.25	1.70 ±0.21	3.50 ± 0.25	2.50 ± 0.21	3.00 ± 0.38	3.20 ± 0.21
	Total number of tillers/ plant	11.00 ± 0.56	7.20 ±0.36	10.50 ± 0.63	8.00 ± 0.33	12.00 ± 0.58	10.20 ± 0.32
		Wheat cv. Sakha 92					
70 days after sowing	Size of the root system (cm3)	8.85 ± 0.40	7.95 ±0.35	12.15 ± 0.75	11.40 ± 0.85	14.50 ± 1.05	13.85 ± 0.95
	Plant height (cm)	44.00 ± 1.17	40.50 ±0.90	38.50 ± 1.01	32.13 ± 0.84	25.63 ± 0.72	22.25 ± 0.61
	Stem length (cm)	18.50 ± 0.45	14.75 ±0.41	10.25 ± 0.34	9.02 ± 0.27	4.77 ± 0.22	3.90 ± 0.16
	No. of internodes	7.00 ± 0.00	6.80 ±0.24	6.50 ± 0.29	6.50 ± 0.29	5.50 ± 0.29	5.30 ± 0.24
	Mean length of the internode (cm)	2.64 ± 0.12	2.17 ±0.13	1.58 ± 0.09	1.39 ± 0.06	0.87 ± 0.05	0.74 ± 0.03
	No.of tillers/ plant	4.80 ± 0.48	4.50 ±0.29	6.30 ± 0.24	5.50 ± 0.29	12.00 ± 0.88	10.00 ± 1.25
	No. of leaves on the main stem	6.00 ± 0.00	5.80 ±0.24	5.50 ± 0.29	5.50 ± 0.29	4.50 ± 0.29	4.30 ± 0.24
	No. of leaves on the tillers	18.50 ± 0.91	15.00 ±1.83	23.30 ± 1.44	20.30 ± 1.87	36.00 ± 2.08	30.80 ± 3.04
	Total number of leaves/ plant	24.50 ± 0.91	20.80 ±1.83	28.80 ± 1.35	25.80 ± 1.66	40.50 ± 1.89	35.10 ± 3.07
	Total leaf area (cm2)/ plant	515.66 ± 26.69	452.90 ±22.87	440.85 ± 24.82	415.91 ± 23.07	455.76 ± 17.03	412.68 ± 18.81
172 - after sowing	No. of fertile tillers/ plant	5.70 ± 0.33	4.70 ±0.21	8.50 ± 0.42	6.20 ± 0.40	9.20 ± 0.48	6.20 ± 0.32
	No. of unfertile tillers/ plant	1.80 ± 0.40	1.80 ±0.20	1.70 ± 0.33	2.80 ± 0.48	3.80 ± 0.48	3.80 ± 0.48
	Total number of tillers/ plant	7.50 ± 0.42	6.50 ±0.33	10.20 ± 0.58	9.00 ± 0.52	13.00 ± 0.75	10.00 ± 0.67

Table (3): Effect of the maximum tolerable salinity level (7000 ppm) alone and the untolerable salinity levels (8000 & 9000 ppm) preceded with paclobutrazol treatments on wheat growth (season 1994/ 95).

	Characters	Treatments					
		Tap water (control)	Salinity 7000 ppm	Paclobutrazol (ppm)			
				10		50	
				Salinity (ppm)		Salinity (ppm)	
				8000	9000	8000	9000
		Wheat cv. Giza 163					
70 days after sowing	Size of the root system (cm3)	8.50 ± 0.63	7.15 ±0.55	10.95 ± 0.73	10.05 ± 0.78	12.40 ± 0.85	11.60 ± 0.88
	Plant height (cm)	36.25 ± 1.01	31.55 ±0.88	29.00 ± 0.69	27.13 ± 0.63	17.50 ± 0.65	15.25 ± 0.48
	Stem length (cm)	13.05 ± 0.45	10.25 ±0.33	6.85 ± 0.24	6.05 ± 0.19	2.85 ± 0.12	2.35 ± 0.16
	No. of internodes	6.70 ± 0.16	6.20 ±0.26	6.00 ± 0.00	5.70 ± 0.25	5.00 ± 0.00	4.70 ± 0.25
	Mean length of the internode (cm)	1.95 ± 0.09	1.65 ±0.04	1.14 ± 0.06	1.05 ± 0.05	0.57 ± 0.03	0.49 ± 0.04
	No.of tillers/ plant	4.00 ± 0.00	3.50 ±0.29	5.00 ± 0.71	4.50 ± 0.48	8.80 ± 0.29	7.50 ± 0.63
	No. of leaves on the main stem	5.70 ± 0.25	5.20 ±0.26	5.00 ± 0.00	4.70 ± 0.25	4.00 ± 0.00	3.70 ± 0.25
	No. of leaves on the tillers	15.80 ± 0.41	13.30 ±1.60	19.50 ± 2.02	17.70 ± 1.17	27.80 ± 1.31	24.00 ± 1.15
	Total number of leaves/ plant	21.50 ± 0.56	18.50 ±1.47	24.50 ± 2.02	22.40 ± 1.45	31.80 ± 1.31	27.70 ± 0.91
	Total leaf area (cm2)/ plant	411.41 ± 19.29	327.87 ±12.31	325.58 ± 11.77	294.12 ± 10.81	299.02 ± 10.81	250.35 ± 8.70
172 days after sowing	No. of fertile tillers/ plant	6.20 ± 0.40	4.70 ±0.32	6.20 ± 0.31	5.00 ± 0.21	8.00 ± 0.37	6.50 ± 0.33
	No. of unfertile tillers/ plant	2.80 ± 0.28	2.00 ±0.21	3.30 ± 0.31	2.00 ± 0.33	2.50 ± 0.21	3.20 ± 0.36
	Total number of tillers/ plant	9.00 ± 0.42	6.70 ±0.38	9.50 ± 0.38	7.00 ± 0.42	10.50 ± 0.42	9.70 ± 0.58
		Wheat cv. Sakha 92					
70 days after sowing	Size of the root system (cm3)	9.25 ± 0.58	8.25 ±0.38	12.75 ± 0.95	12.00 ± 0.78	15.25 ± 1.15	14.70 ± 1.08
	Plant height (cm)	42.05 ± 1.29	39.50 ±1.08	35.10 ± 0.95	29.75 ± 1.05	24.00 ± 0.88	20.88 ± 0.94
	Stem length (cm)	16.25 ± 0.58	13.65 ±0.67	9.25 ± 0.33	8.10 ± 0.28	4.25 ± 0.16	3.75 ± 0.12
	No. of internodes	6.50 ± 0.29	6.50 ±0.29	6.00 ± 0.00	5.70 ± 0.26	5.00 ± 0.00	5.00 ± 0.00
	Mean length of the internode (cm)	2.50 ± 0.13	2.10 ±0.16	1.54 ± 0.08	1.42 ± 0.10	0.85 ± 0.05	0.75 ± 0.04
	No.of tillers/ plant	4.50 ± 0.29	4.30 ±0.24	6.00 ± 0.25	5.00 ± 0.29	10.50 ± 0.33	9.00 ± 0.63
	No. of leaves on the main stem	5.50 ± 0.29	5.50 ±0.29	5.00 ± 0.00	4.70 ± 0.26	4.00 ± 0.00	4.00 ± 0.00
	No. of leaves on the tillers	16.80 ± 0.91	14.30 ±0.69	21.50 ± 1.73	18.30 ± 0.95	31.70 ± 1.03	26.80 ± 1.73
	Total number of leaves/ plant	22.30 ± 1.11	19.80 ±0.82	26.50 ± 1.73	23.00 ± 1.15	35.70 ± 1.03	30.30 ± 1.73
	Total leaf area (cm2)/ plant	494.31 ±17.63	426.53 ±14.54	429.02 ± 15.65	401.25 ± 20.38	440.08 ± 10.04	390.19 ± 11.59
172 days after sowing	No. of fertile tillers/ plant	5.20 ± 0.17	4.70 ±0.41	8.00 ± 0.63	5.50 ± 0.33	8.20 ± 0.48	6.00 ± 0.36
	No. of unfertile tillers/ plant	1.30 ± 0.17	1.00 ±0.26	1.50 ± 0.21	2.50 ± 0.56	2.80 ± 0.48	3.20 ± 0.40
	Total number of tillers/ plant	6.50 ± 0.33	5.70 ±0.21	9.50 ± 0.42	8.00 ± 0.75	11.00 ± 0.40	9.20 ± 0.54

Figs: (4-7): Effect of the untolerable salinity levels (8000 and 9000 ppm) preceded with paclobutrazol treatments (10 and 50 ppm) on the growth of wheat roots (cvs. Giza 163 and Sakha 92).

Meaning of the abbreviations:

G = Wheat cv. Giza 163 (Figs. 4 & 5).

S = Wheat cv. Sakha 92 (Figs. 6 & 7).

(1) = Roots of an untreated plant.

(3) = Roots of a plant treated with salinity level of 8000 ppm preceded with paclobutrazol at 10 ppm.

(4) = Roots of a plant treated with salinity level of 9000 ppm preceded with paclobutrazol at 10 ppm.

(5) = Roots of a plant treated with salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm.

(6) = Roots of a plant treated with salinity level of 9000 ppm preceded with paclobutrazol at 50 ppm.

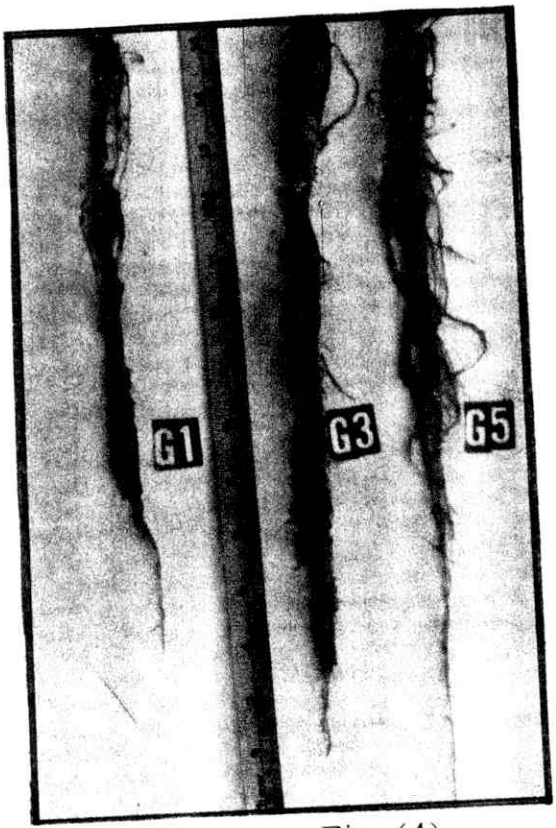
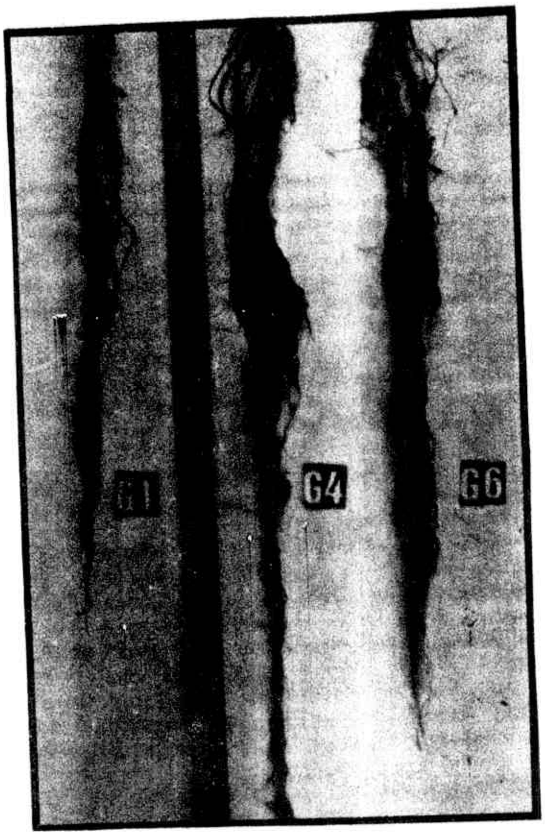


Fig. (4)



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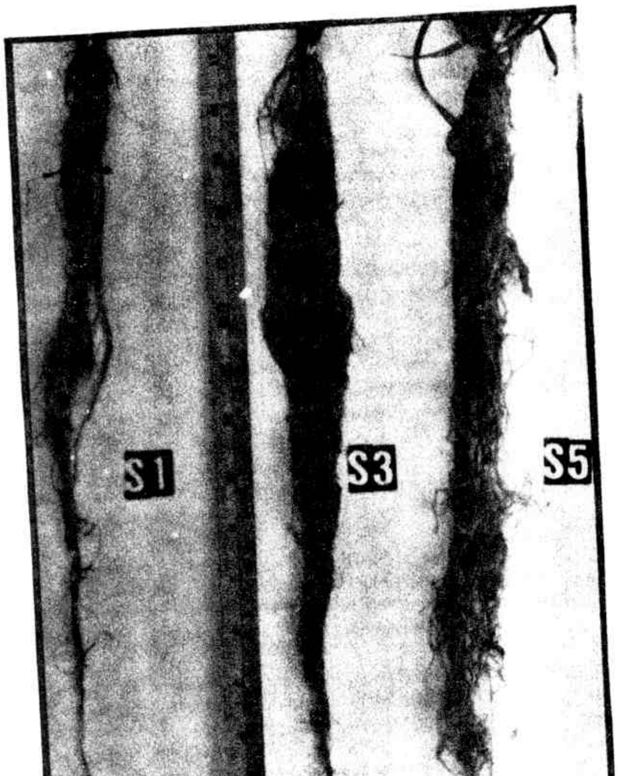

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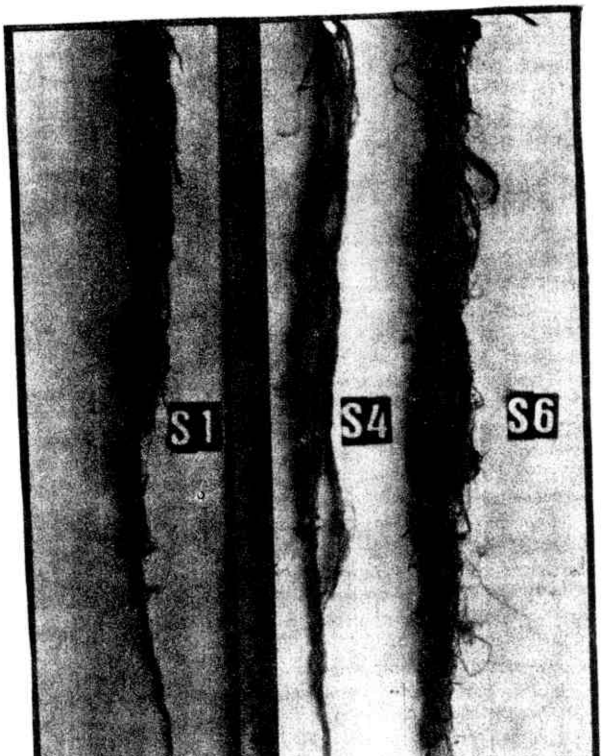


Fig. (7)

roots initiation and thus increasing the size of root system **(Devlin and Witham, 1983; El-Desouky and Abd El-Dayem, 1992 and Mohamed and El-Desouky, 1992)**.

With regard to the other vegetative growth aspects of the two wheat cultivars, also significant effect existed even with salinity alone or salinity preceded with paclobutrazol treatments (Tables 2 and 3). The data in these Tables, indicate that plant height, stem length, number of internodes, mean length of the internode, number of leaves on the main stem and total leaf area per plant of the two wheat cultivars that were estimated at 70 days after sowing in the two experimental seasons showed significant decrease under either the maximum tolerable salinity level alone (7000 ppm) or the untolerable salinity levels (8000 and 9000 ppm) preceded with paclobutrazol treatments (10 and 50 ppm) compared with those of the untreated plants. In other words it could be said that paclobutrazol treatments did not protect wheat plants from the harmful effect of salinity on these growth characteristics. However, the paclobutrazol treatments allowed wheat plants to survive under the untolerable salinity levels.

With respect to the number of tillers/plant, number of leaves on the tillers/plant and total number of leaves/plant of the two wheat cultivars at 70 days after sowing were significantly decreased with the treatment of salinity alone (7000 ppm). Meanwhile, paclobutrazol treatments at 10 and 50 ppm completely overcame the inhibitory effect of the untolerable salinity levels (8000 and 9000 ppm) on these characters. This positive effect of paclobutrazol treatments not only overcame the harmfull effect of salinity but also showed high significant increase in these characters compared with the untreated plants (Tables 2 & 3 and Figs. 8, 9, 10 & 11).

Figs. (8-11): Effect of the untolerable salinity levels (8000 & 9000 ppm) preceded with paclobutrazol treatments (10 & 50 ppm) on the growth of wheat shoots (cvs. Giza 163 and Sakha 92).

Meaning of the abbreviations:

G = Wheat cv. Giza 163 (Figs. 8 & 9).

S = Wheat cv. Sakha 92 (Figs. 10 & 11).

(1) = Shoots of an untreated plant.

(3) = Shoots of a plant treated with salinity level of 8000 ppm preceded with paclobutrazol at 10 ppm.

(4) = Shoots of a plant treated with salinity level of 9000 ppm preceded with paclobutrazol at 10 ppm.

(5) = Shoots of a plant treated with salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm.

(6) = Shoots of a plant treated with salinity level of 9000 ppm preceded with paclobutrazol at 50 ppm.

As regards, the number of fertile, unfertile tillers and total number of tillers per plant of the two wheat cultivars at 172 days after sowing in the two seasons of study were significantly decreased under the maximum tolerable salinity level alone (7000 ppm). Meanwhile, paclobutrazol treatments at 10 and 50 ppm successfully overcame the inhibitory effect of the untolerable salinity levels (8000 and 9000 ppm) on these characters resulting in significant increase in these characters compared with those of the untreated plants (Tables 2 & 3 and Figs. 12-17). The only exception was with paclobutrazol at 10 ppm applied to Giza 163 which did not show obvious effect on the number of fertile, unfertile tillers and the total number of tillers per plant under the untolerable salinity level of 8000 ppm, whereas significantly decreased these characters under the untolerable salinity level of 9000 ppm compared with those of the untreated plant (Fig. 13 and 14).

In this respect, other studies have been reported similar negative effect of salinity on some growth aspects of wheat and other plants. Of these studies on wheat plants were those mentioned by **Chhipa and Lal (1985), Sharama and Garg (1985), Maas and Poss (1989), Pessarakli *et al.* (1990), Ismaeil *et al.* (1993) and Huang *et al.* (1994)**.

The above mentioned results of the present or the other studies could be explained by the facts that salinity may show symptoms of drought on the growing plants but are actually subjected to the twin stresses of very negative soil water potentials and salt toxicity. Therefore, these negative effects of salt stress on plant growth could be attributed to (1) the toxicity of ions ecessively absorbed from saline soils, (2) to the process of building up the osmotic potential of the plant cells, (3) to the alteration of nutritional cations balance in tissues of salt-stressed

Figs. (12-14): Effect of the maximum tolerable salinity level alone (7000 ppm) and the untolerable salinity levels (8000 & 9000 ppm) preceded with paclobutrazol treatments (10 & 50) on the number of fertile and unfertile tillers per wheat plant of cv. Giza 163.

Meaning of the abbreviations:

G = Wheat cv. Giza 163.

(1) = An untreated plant.

(2) = A plant treated with salinity level of 7000 ppm.

(3) = A plant treated with salinity level of 8000 ppm preceded with paclobutrazol 10 ppm.

(4) = A plant treated with salinity level of 9000 ppm preceded with paclobutrazol at 10 ppm.

(5) = A plant treated with salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm.

(6) = A plant treated with salinity level of 9000 ppm preceded with paclobutrazol at 50 ppm.

Fig. (12)

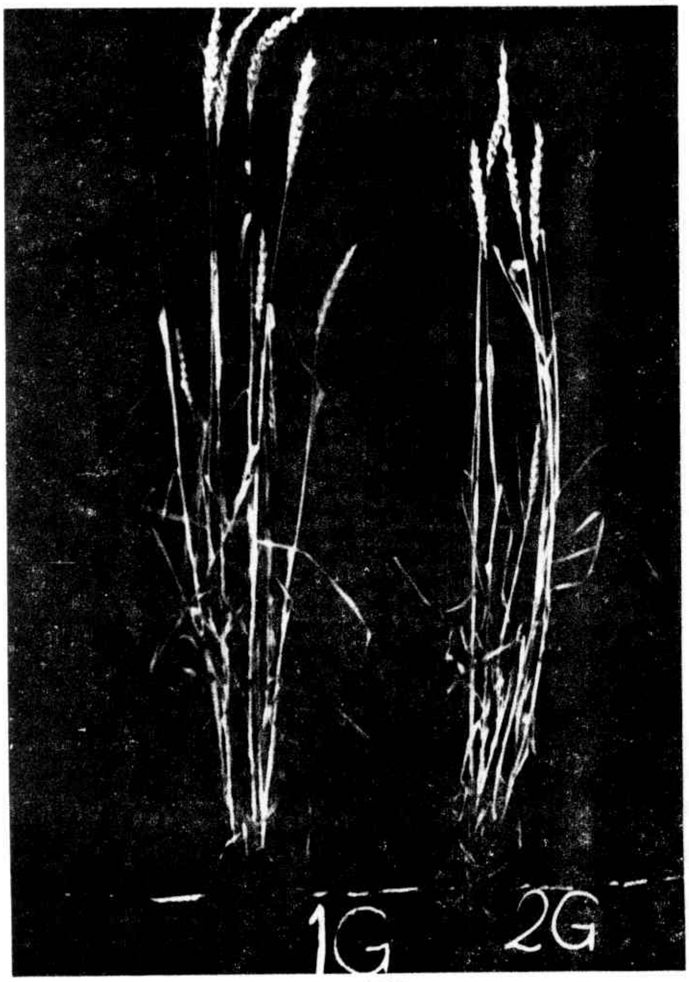


Fig. (13)

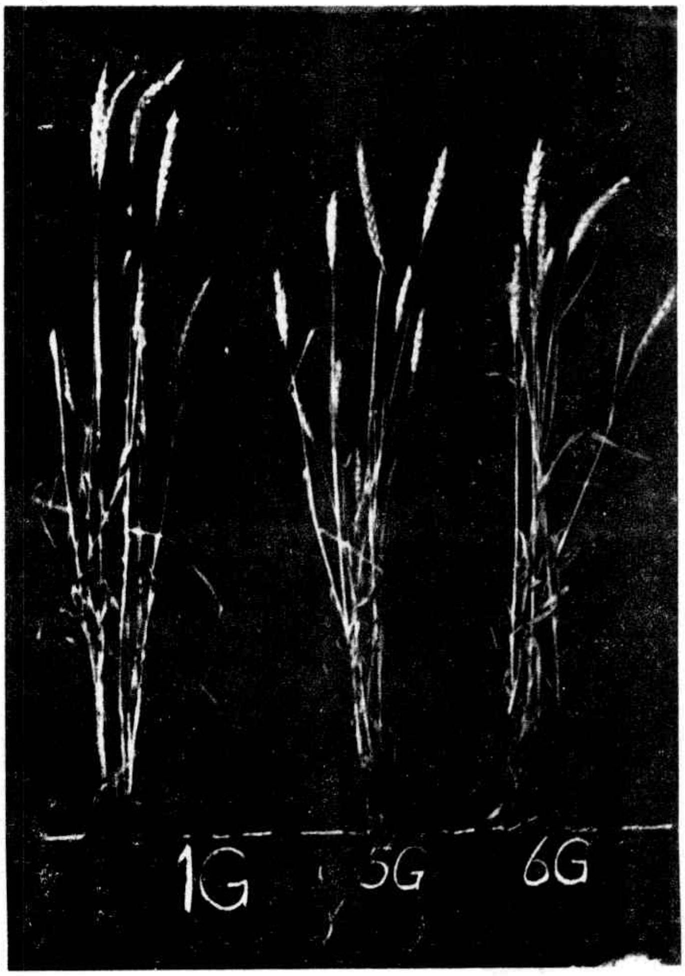


Fig. (14)

Figs. (15-17): Effect of the maximum tolerable salinity level alone (7000 ppm) and the untolerable salinity levels (8000 & 9000 ppm) preceded with paclobutrazol treatments (10 & 50) on the number of fertile and unfertile tillers per wheat plant of cv. Sakha 92.

Meaning of the abbreviations:

S =Wheat cv. Sakha 92.

(1) = An untreated plant.

(2) = A plant treated with salinity level of 7000 ppm.

(3) = A plant treated with salinity level of 8000 ppm preceded with paclobutrazol at 10 ppm.

(4) = A plant treated with salinity level of 9000 ppm preceded with paclobutrazol at 10 ppm.

(5) = A plant treated with salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm.

(6) = A plant treated with salinity level of 9000 ppm preceded with paclobutrazol at 50 ppm.

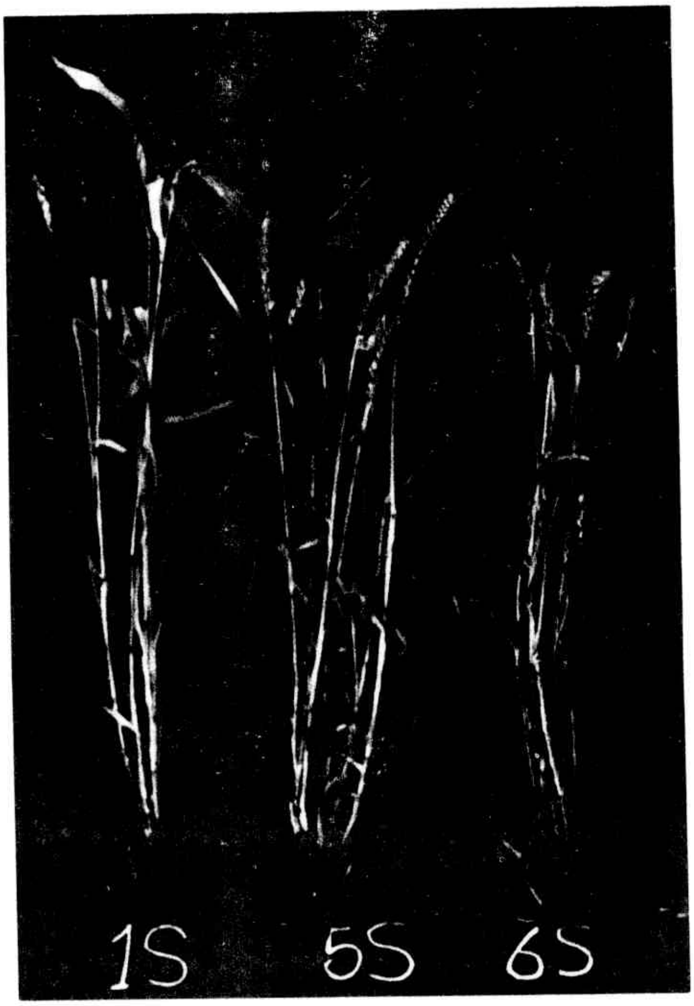
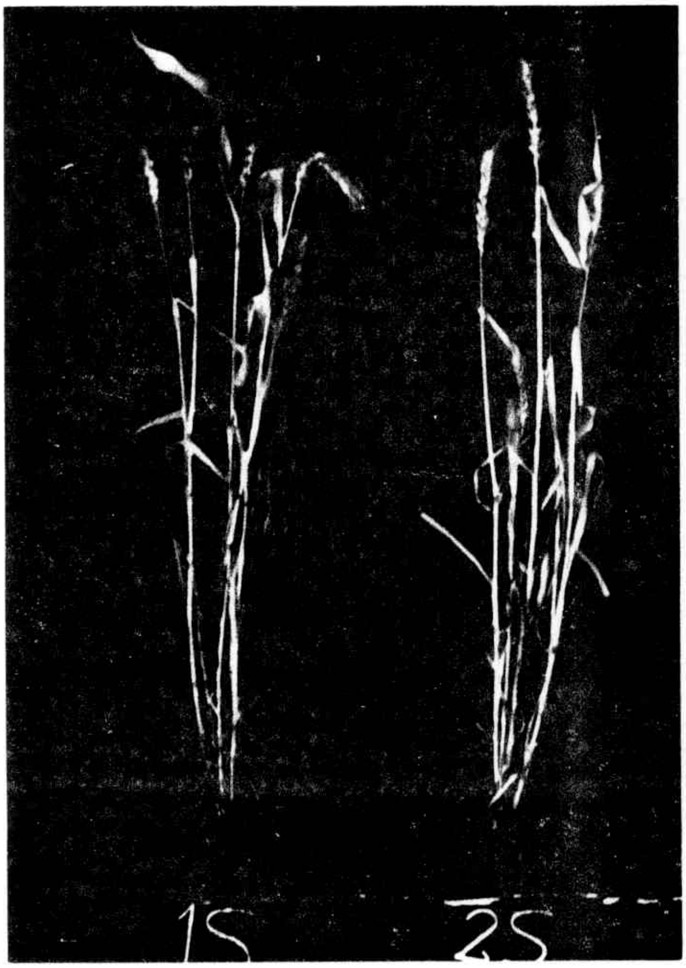


Fig. (15)



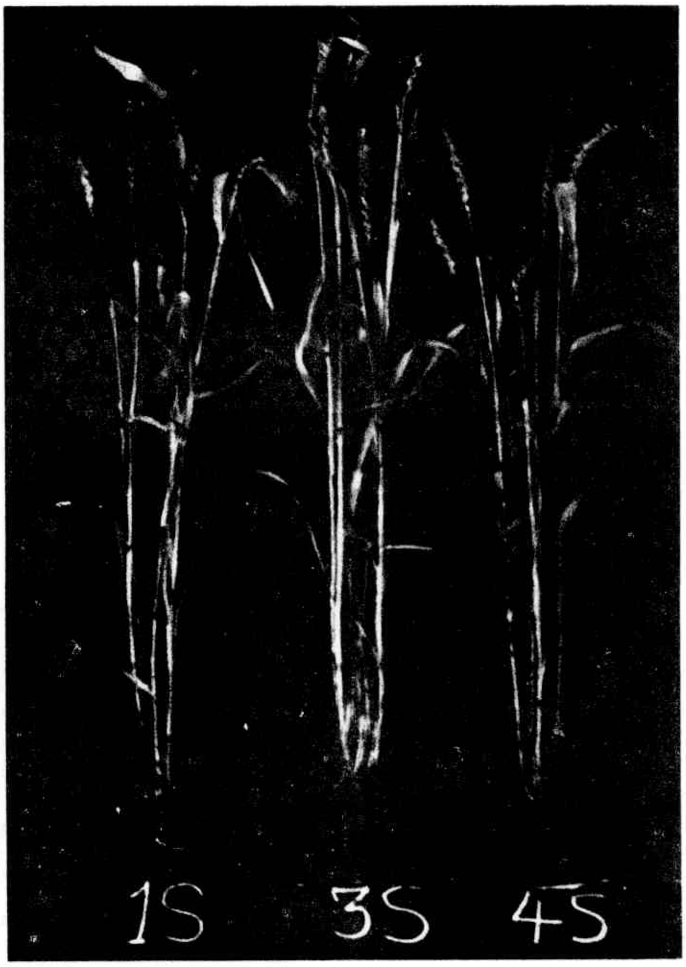


Fig. (16)

Fig. (17)

plants, (4) to the reduction in carbon fixtion in photosynthesis process and (5) to the increasing of carbon relase in respiration process **(Reid and Wample, 1985; El-Lawendy, 1990 and Ridge *et al.*, 1993)**. Also, among the effects of salinity on wheat or other plants growth are those alterations of the endogenous phytohormones under saline conditions. Of these alterations the reduction in auxins and gibberellins contents that reflected on cell division and cell elongation **(Sussex *et al.*, 1975; Walbot *et al.*, 1975; Khan, 1977 and Weidner, 1984)**. In addition, the reduction of cytokinins content as obtained in the prèsent study (as will be mentioned later) led to the reduction in the number of tillers. Since, cytokinin is known as the true shooting hormone and its role in the decrease of apical dominance and the increase of shoots growth is well established **(Devlin and Witham, 1983 and Mohamed and El-Desouky, 1992)**.

As regards, the effect of paclobutrazol on alteration of wheat tolerability to saline conditions, was noticed that paclobutrazol treatment not only overcame the negative effect of salinity on the number of tillers but also changed it to obvious stimulation. That is a new finding of the present study. Reversion of salinity effect and changed it to stimulation by paclobutrazol could be attributed to the new balance of endogenous hormones especially auxins and cytokinins existed under these treatments as will be mentioned later. So, cell division and elongation in dormant buds rise, thus number of tillers was increased. Also, the reduction in stem apical growth caused by paclobutrazol treatments may direct and channell the nutrients and other growth factors to the lateral buds where compensating growth subsequently takes place. The mechanism essentially conforming to the "nutrient theory" **(McIntyre, 1977)**.

2. Tomato cvs. (Castle Rock and Edkawi):

As for the size of the root system, Tables (4 and 5) clearly show that salinity at the maximum tolerable levels alone (5000 ppm for Castle Rock cv. and 7000 ppm for Edkawi cv.) significantly decreased the size of the root system of the two tomato cultivars at 70 days after sowing in the two seasons of this study. On the other hand, roots of the two tomato cultivars showed some differences in their response to the untolerable salinity levels preceded with paclobutrazol treatments (at 10 and 50 ppm). For instance, in Castle Rock cv. the size of the root system was significantly decreased with the untolerable salinity levels (6000 and 7000 ppm) preceded with paclobutrazol treatments (Figs. 18 and 19). In other words, it could be said that paclobutrazol did not reverse the deleterious effect of salinity on the root growth of this cultivar. Meanwhile, in Edkawi cv., paclobutrazol at 10 and 50 ppm successfully overcame the deleterious effect of the untolerable salinity levels (8000 and 9000 ppm) on the root growth and significantly increased the size of the root system compared with the untreated plants (Figs. 20 and 21). That it was true at 70 days after sowing in the two seasons of this study. Also, Tables (4 and 5) and Figures (18-21) clearly show that the roots of Castle Rock cv. were more sensitive in their response to salinity than those of Edkawi cv.

In this respect, the negative effect of salinity on the root growth of tomato plants was reviewed by **El-Lawendy (1990)** and **Rizk (1993)**.

For the other vegetative growth characters of the two tomato cultivars, they were also significantly affected even with salinity alone or salinity preceded with paclobutrazol treatments (Tables 4 and 5). Data represented in these Tables clearly show significant

Table (4): Effect of the maximum tolerable salinity levels alone and the untolerable salinity levels preceded with paclobutrazol treatments on tomato growth (season 1993/ 94).

	Characters	Treatments: Tap water (control)	Salinity 5000 ppm	Paclobutrazol (ppm) 10: Salinity (ppm) 6000	Paclobutrazol (ppm) 10: Salinity (ppm) 7000	Paclobutrazol (ppm) 50: Salinity (ppm) 6000	Paclobutrazol (ppm) 50: Salinity (ppm) 7000
		Tomato cv. Castle Rock					
70 days after sowing	Size of the root system (cm3)	0.65 ± 0.08	0.47 ±0.05	0.38 ± 0.03	0.28 ± 0.02	0.23 ± 0.04	0.20 ± 0.02
	*Stem length (cm)	22.85 ± 0.75	14.43 ±0.64	8.76 ± 0.46	7.55 ± 0.51	6.85 ± 0.27	6.25 ± 0.21
	Hypocotyl length (cm)	6.25 ± 0.35	5.43 ±0.20	3.98 ± 0.18	3.77 ± 0.18	3.68 ± 0.16	3.41 ± 0.11
	Internodes length (cm)	16.60 ± 0.67	9.00 ±0.73	4.78 ± 0.39	3.78 ± 0.34	2.99 ± 0.17	2.84 ± 0.10
	No. of internodes	9.50 ± 0.33	7.90 ±0.22	6.50 ± 0.50	6.20 ± 0.31	6.00 ± 0.27	6.00 ± 0.20
	Mean length of the internode (cm)	1.75 ± 0.07	1.14 ±0.04	0.74 ± 0.02	0.61 ± 0.04	0.50 ± 0.02	0.47 ± 0.02
	No. of leaves/ plant	8.50 ± 0.33	6.90 ±0.22	5.50 ± 0.50	5.20 ± 0.31	5.00 ± 0.27	5.00 ± 0.20
	Total leaf area (cm2)/ plant	242.06 ± 10.63	194.69 ±6.86	130.91 ±7.57	98.11 ±4.66	68.03 ±2.03	63.76 ±2.10
185 days after sowing	No. of reproductive branches/ plant	2.70 ± 0.32	0.80 ±0.24	3.70 ± 0.28	2.70 ± 0.32	2.20 ± 0.40	1.70 ± 0.32
	No. of vegetative branches/ plant	3.00 ± 0.36	3.00 ±0.24	4.00 ±0.27	4.00 ±0.24	5.50 ± 0.42	4.50 ± 0.34
	Total No. of branches/ plant	5.70 ± 0.33	3.80 ±0.20	7.70 ± 0.32	6.70 ± 0.28	7.70 ± 0.42	6.20 ± 0.40

	Characters	Treatments: Tap water (control)	Salinity 7000 ppm	Paclobutrazol (ppm) 10: Salinity (ppm) 8000	Paclobutrazol (ppm) 10: Salinity (ppm) 9000	Paclobutrazol (ppm) 50: Salinity (ppm) 8000	Paclobutrazol (ppm) 50: Salinity (ppm) 9000
		Tomato cv. Edkawi					
70 days after sowing	Size of the root system (cm3)	0.80 ± 0.07	0.68 ±0.80	1.07 ± 0.11	0.98 ± 0.08	1.28 ± 0.16	1.20 ± 0.13
	*Stem length (cm)	32.05 ± 1.02	27.35 ±0.89	19.00 ± 0.67	16.00 ± 0.67	12.70 ± 0.63	12.00 ± 0.50
	Hypocotyl length (cm)	7.55 ± 0.31	6.85 ±0.33	5.25 ± 0.26	4.75 ± 0.20	3.70 ± 0.16	3.63 ± 0.13
	Internodes length (cm)	24.50 ± 1.45	20.50 ±1.22	13.75 ± 0.60	11.25 ± 0.58	9.00 ± 0.57	8.37 ± 0.69
	No. of internodes	10.50 ± 0.33	10.00 ±0.27	9.50 ± 0.27	9.00 ± 0.27	8.00 ± 0.20	8.00 ± 0.27
	Mean length of the internode	2.33 ± 0.12	2.05 ±0.07	1.45 ± 0.06	1.25 ± 0.05	1.13 ± 0.05	1.05 ± 0.06
	No. of leaves/ plant	9.50 ± 0.33	9.00 ±0.27	8.50 ± 0.27	8.00 ± 0.27	7.00 ± 0.20	7.00 ± 0.27
	Total leaf area (cm2)/ plant	319.29 ± 18.55	289.68 ±14.42	199.99 ±8.03	153.55 ±11.16	96.32 ±5.24	93.17 ±5.03
185 days after sowing	No. of reproductive branches/ plant	2.50 ± 0.21	1.70 ±0.32	4.00 ± 0.24	3.00 ± 0.36	4.30 ±0.30	2.30 ±0.30
	No. of vegetative branches/ plant	5.00 ±0.36	3.50 ±0.24	5.20 ± 0.34	5.00 ± 0.30	4.20 ± 0.42	4.70 ±0.42
	Total No. of branches/ plant	7.50 ± 0.34	5.20 ±0.40	9.20 ± 0.40	8.00 ± 0.20	8.50 ± 0.21	7.00 ± 0.37

* Stem length includes also the hypocotyl.

Table (5): Effect of the maximum tolerable salinity levels alone and the untolerable salinity levels preceded with paclobutrazol treatments on tomato growth (season 1994/ 95).

Characters		Treatments: Tap water (control)	Salinity 5000 ppm	Paclobutrazol (ppm) 10, Salinity (ppm) 6000	Paclobutrazol (ppm) 10, Salinity (ppm) 7000	Paclobutrazol (ppm) 50, Salinity (ppm) 6000	Paclobutrazol (ppm) 50, Salinity (ppm) 7000
		Tomato cv. Castle Rock					
70 days after sowing	Size of the root system (cm3)	0.76 ± 0.06	0.60 ±0.05	0.45 ± 0.03	0.36 ± 0.03	0.31 ± 0.06	0.26 ± 0.03
	*Stem length (cm)	21.00 ± 0.63	13.38 ±0.55	8.00 ± 0.26	7.23 ± 0.54	6.50 ± 0.15	6.00 ± 0.26
	Hypocotyl length (cm)	5.63 ± 0.27	5.05 ±0.23	3.93 ± 0.17	3.85 ± 0.17	3.80 ± 0.12	3.44 ± 0.12
	Internodes length (cm)	15.37 ± 0.82	8.33 ±0.47	4.07 ± 0.22	3.38 ± 0.42	2.70 ± 0.15	2.56 ± 0.16
	No. of internodes	9.90 ± 0.58	7.50 ±0.27	6.00 ± 0.33	6.00 ± 0.20	5.70 ± 0.25	5.50 ± 0.21
	Mean length of the internode (cm)	1.55 ± 0.04	1.11 ±0.06	0.68 ± 0.02	0.56 ± 0.04	0.47 ± 0.02	0.47 ± 0.03
	No. of leaves/ plant	8.90 ± 0.58	6.50 ±0.27	5.00 ± 0.33	5.00 ± 0.20	4.70 ± 0.25	4.50 ± 0.21
	Total leaf area (cm2)/ plant	224.87 ± 16.87	183.96 ±9.16	111.50 ±17.57	93.88 ±2.25	66.81 ±3.10	59.63 ±7.29
185 days after sowing	No. of reproductive branches/ plant	2.50 ± 0.21	0.70 ±0.19	3.30 ± 0.42	2.30 ± 0.21	2.00 ± 0.24	1.00 ± 0.20
	No. of vegetative branches/ plant	3.00 ± 0.27	2.90 ±0.30	5.00 ±0.36	3.70 ±0.42	4.50 ± 0.21	4.50 ± 0.34
	Total No. of branches/ plant	5.50 ± 0.34	3.60 ±0.20	8.30 ± 0.33	6.00 ± 0.36	6.50 ± 0.42	5.50 ± 0.24

Characters		Treatments: Tap water (control)	Salinity 7000 ppm	Paclobutrazol (ppm) 10, Salinity (ppm) 8000	Paclobutrazol (ppm) 10, Salinity (ppm) 9000	Paclobutrazol (ppm) 50, Salinity (ppm) 8000	Paclobutrazol (ppm) 50, Salinity (ppm) 9000
		Tomato cv. Wdkawi					
70 days after sowing	Size of the root system (cm3)	0.95 ± 0.08	0.78 ±0.06	1.20 ± 0.13	1.05 ± 0.08	1.42 ± 0.20	1.30 ± 0.16
	*Stem length (cm)	29.75 ± 0.90	26.30 ±0.81	17.29 ± 0.79	14.80 ± 0.72	12.30 ± 0.47	11.15 ± 0.71
	Hypocotyl length (cm)	7.05 ± 0.28	6.50 ±0.33	4.85 ± 0.39	4.30 ± 0.27	3.90 ± 0.13	3.65 ± 0.12
	Internodes length (cm)	22.65 ± 1.13	19.80 ±1.17	12.44 ± 0.70	10.50 ± 0.64	8.40 ± 0.38	7.50 ± 0.63
	No. of internodes	10.20 ± 0.32	10.00 ±0.24	9.80 ± 0.24	9.00 ± 0.20	8.00 ± 0.20	7.50 ± 0.34
	Mean length of the internode	2.22 ± 0.05	1.98 ±0.09	1.27 ± 0.06	1.17 ± 0.07	1.05 ± 0.02	1.00 ± 0.05
	No. of leaves/ plant	9.20 ± 0.32	9.00 ±0.24	8.80 ± 0.25	8.00 ± 0.20	7.00 ± 0.20	6.50 ± 0.34
	Total leaf area (cm2)/ plant	287.31 ± 15.25	273.14 ±12.23	170.22 ±28.75	133.61 ±28.90	93.29 ±16.87	87.09 ±2.60
185 days after sowing	No. of reproductive branches/ plant	2.00 ± 0.24	1.50 ±0.42	3.50 ± 0.30	2.70 ± 0.32	3.50 ±0.38	2.00 ±0.20
	No. of vegetative branches/ plant	4.50 ±0.42	2.80 ±0.20	4.50 ± 0.38	4.50 ± 0.42	4.00 ± 0.24	4.50 ±0.34
	Total No. of branches/ plant	6.50 ± 0.34	4.30 ±0.30	8.00 ± 0.33	7.20 ± 0.48	7.50 ± 0.42	6.50 ± 0.28

* Stem length includes also the hypocotyl.

Figs. (18-21): Effect of the untolerable salinity levels preceded with paclobutrazol treatments on the growth of tomato roots (cvs. Castle Rock and Edkawi).

Meaning of the abbreviations:

C = Tomato cv. Castle Rock (Figs. 18 & 19).

(1) = Roots of an untreated plant.

(3) = Roots of a plant treated with salinity level of 6000 ppm preceded with paclobutrazol at 10 ppm.

(4) = Roots of a plant treated with salinity level of 7000 ppm preceded with paclobutrazol at 10 ppm.

(5) = Roots of a plant treated with salinity level of 6000 ppm preceded with paclobutrazol at 50 ppm.

(6) = Roots of a plant treated with salinity level of 7000 ppm preceded with paclobutrazol at 50 ppm.

E = Tomato cv. Edkawi (Figs. 20 & 21).

(1) = Roots of an untreated plant.

(3) = Roots of a plant treated with salinity level of 8000 ppm preceded with paclobutrazol at 10 ppm.

(4) = Roots of a plant treated with salinity level of 9000 ppm preceded with paclobutrazol at 10 ppm.

(5) = Roots of a plant treated with salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm.

(6) = Roots of a plant treated with salinity level of 9000 ppm preceded with paclobutrazol at 50 ppm.

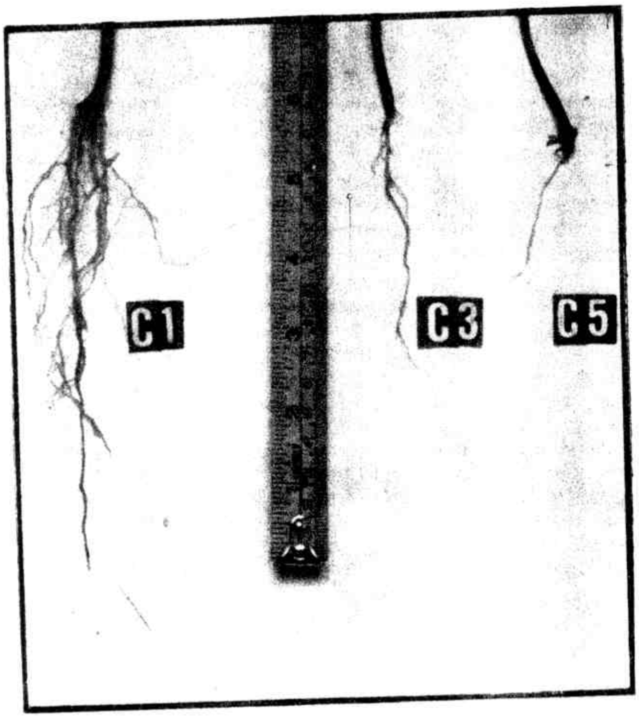


Fig. (18)

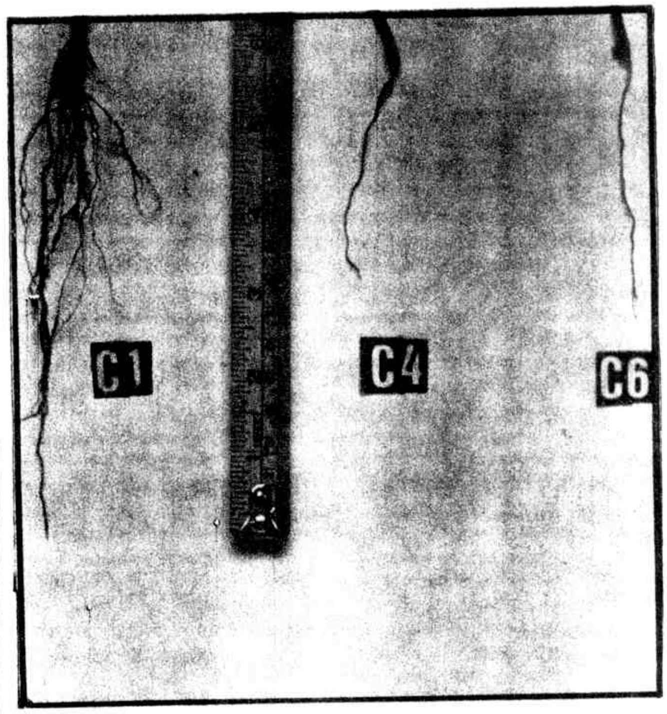


Fig. (19)

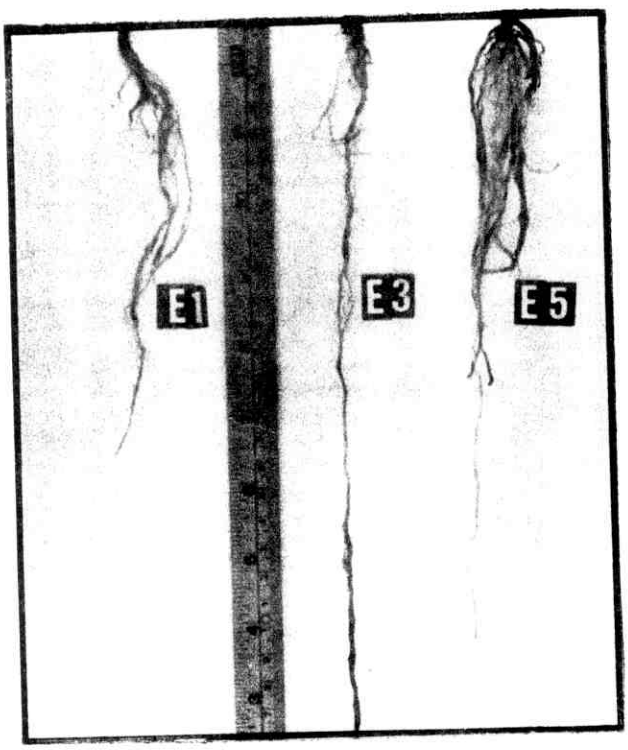


Fig. (20)

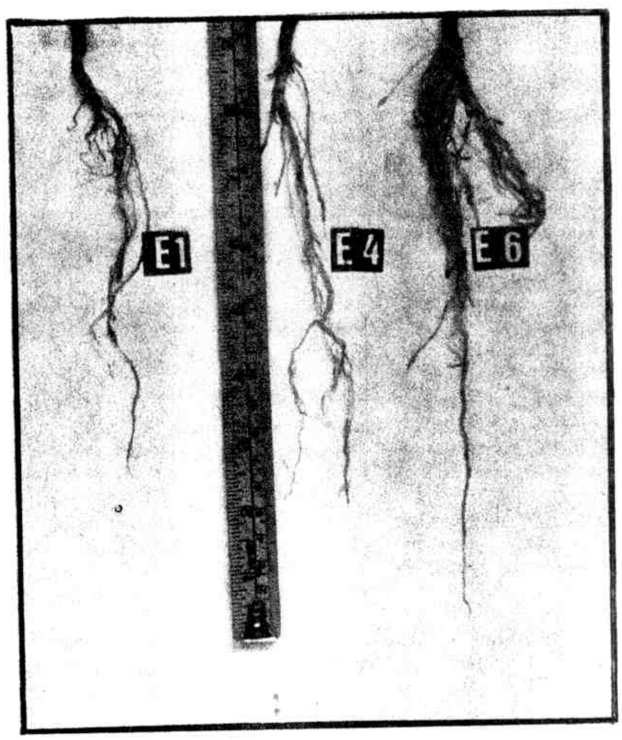


Fig. (21)

reduction in many growth characters (the length of the stem, hypocotyl and internodes, number of internodes, mean length of the internode, number of leaves/plant and total leaf area/plant) of the tomato cultivars at 70 days after sowing in the two seasons of this study under the maximum tolerable salinity levels (5000 ppm for Castle Rock cv. or 7000 ppm for Edkawi cv.) compared with the untreated plants. The interesting phenomenon was that the application of paclobutrazol at 10 and 50 ppm before subjection of the tomato plants to the untolerable salt-stresses (i.e. 6000 and 7000 ppm for Castle Rock or 8000 and 9000 ppm for Edkawi cv.) led to the duration of the plants under these adverse conditions. Since, the different growth aspects - measured under the untolerable salinity levels preceded with paclobutrazol treatments - as previously mentioned were negatively affected (Tables 4 and 5).

With respect to the number of reproductive, vegetative branches and their total number per plant of the two tomato cultivars at 185 days after sowing were significantly decreased with the maximum tolerable levels alone (5000 ppm for Castle Rock cv. or 7000 ppm for Edkawi cv.) in the two experimental seasons. However, the application of paclobutrazol at 10 and 50 ppm successfully overcame the inhibitory effect of the untolerable salinity levels (6000 and 7000 ppm for Castle Rock cv. or 8000 and 9000 ppm for Edkawi cv.) on these characters and significantly increased them compared with the untreated plants in the two seasons of this study. The only exception was that paclobutrazol at 50 ppm with Castle Rock cv. significantly decreased the number of reproductive branches, whereas significant increase existed with the number of vegetative branches and the total number of branches/plant compared with the untreated plants especially in the second season.

In this respect, **Mahmoud *et al.* (1986a), El-Lawendy (1990)** and **Rizk (1993)** found similar negative effects of salinity on some growth features of tomato plants.

Generally, data of the present study (Tables 2-5 and Figs. 4-21) clearly show that all the growth aspects under study of wheat or tomato cultivars were negatively affected by salinity alone (the maximum tolerable levels i.e. 7000 ppm for wheat cvs. Giza 163 and Sakha 92 as well as tomato cv. Edkawi and 5000 ppm for the tomato cv. Castle Rock). This negative effect of salinity on growth aspects was more pronounced in the wheat cv. Giza 163 and the tomato cv. Castle Rock (the less salt-tolerant cultivars) than in the wheat cv. Sakha 92 and the tomato cv. Edkawi (the more salt-tolerant cultivars). On the other hand, paclobutrazol treatments (10 and 50 ppm) exhibited positive effect that increased the tolerability of both wheat and tomato cultivars to the high saline conditions (i.e. 8000 & 9000 ppm for wheat cvs. Giza 163 and Sakha 92 as well as tomato cv. Edkawi, and 6000 & 7000 ppm for tomato cv. Castle Rock.

In addition, the application of paclobutrazol before the untolerable salinity treatments significantly increased some growth aspects and made them to prevail those obtained in the plants grown under the maximum tolerable salinity levels and also those grown under tap water conditions. Also, this striking effect of paclobutrazol on some growth aspects was more obvious in the wheat cv. Sakha 92 and the tomato cv. Edkawi (the more salt-tolerant cvs.) than in the wheat cv. Giza 163 and the tomato cv. Castle Rock (the less salt-tolerant cvs.)

b- Effect of the maximum tolerable salinity levels alone and the untolerable salinity levels preceded with paclobutrazol on photosynthetic pigments in wheat and tomato leaves:

Data in Tables (6, 7, 8 and 9) clearly indicate that the photosynthetic pigments (i.e. chlorophyll a, b and carotenoids) and their ratios nearly behaved the same trend with both wheat and tomato cultivars in the two seasons of this study. Salinity at the maximum tolerable level of each cultivar (i.e. 7000 ppm for wheat cv. Giza 163, cv. Sakha 92 and tomato cv. Edkawi, but it was 5000 ppm for tomato cv. Castle Rock) clearly reduced chlorophyll a, b and carotenoids content as well as the ratio of chlorophyll (a + b) to carotenoids and only increased the ratio of chlorophyll a/b. These results were true for both wheat and tomato cultivars during the two seasons of the present study. The inhibitory effect of salinity on chloroplast pigments synthesis was more pronounced in the wheat cv. Giza 163 and the tomato cv. Castle Rock (the less salt-tolerant cultivars) than in the wheat cv. Sakha 92 and the tomato cv. Edkawi (the more salt-tolerant cultivars).

It could be concluded from the previous mentioned data that the negative effect of salinity was more obvious on chlorophyll (a + b) content than on the content of carotenoids.

On the other hand, the application of paclobutrazol at 10 and 50 ppm before the untolerable salinity levels (8000 and 9000 ppm for wheat cv. Giza 163, cv. Sakha 92 and tomato cv. Edkawi but they were 6000 and 7000 ppm for the tomato cv. Castle Rock) not only led to overcome the inhibitory effect of salinity on photosynthetic pigments synthesis, but also converted this effect to stimulation. Since, paclobutrazol treatments clearly increased chlorophyll a, b and carotenoids content as well as the ratio of chlorophyll (a + b) to carotenoids even though it decreased the ratio of chlorophyll a/b under the untolerable salinity levels. In

Table (6): Effect of the maximum tolerable salinity level alone and the untolerable salinity levels preceded with paclobutrazol treatments on chloroplast pigments (chlorophyll a, b and carotenoids) of wheat plants - 70 days after sowing in 1993/ 94 season-.

	Chloroplast pigments	Treatments					
		Tap water (control)	Salinity 7000 ppm	Paclobutrazol (ppm)			
				10		50	
				Salinity (ppm)		Salinity (ppm)	
				8000	9000	8000	9000
		Wheat cv. Giza 163					
Mg/ g dry weight	Chl. a	10.05	8.45	11.32	10.67	11.84	11.24
	Chl. b	5.45	4.47	7.05	6.46	9.19	8.08
	Chl. (a + b)	15.50	12.85	18.37	17.13	21.03	19.32
	Carot.	5.15	4.60	5.66	5.58	6.03	5.78
	Chl.(a + b) + Carot.	20.65	17.45	24.03	22.71	27.06	25.01
Ratio	chl. a/ Chl. b	1.84	1.89	1.61	1.65	1.29	1.39
	Chl. (a + b)/ Carot.	3.01	2.79	3.25	3.07	3.49	3.34
		Wheat cv. Sakha 92					
Mg/ g dry weight	Chl. a	6.49	5.97	7.64	7.36	9.04	7.85
	Chl. b	2.98	2.70	3.73	3.67	4.63	4.34
	Chl. (a + b)	9.47	8.67	11.37	11.03	13.67	12.19
	Carot.	3.84	3.64	4.47	4.30	4.95	4.57
	Chl.(a + b) + Carot.	13.31	12.31	15.84	15.33	18.62	16.76
Ratio	chl. a/ Chl. b	2.18	2.21	2.05	2.01	1.95	1.81
	Chl. (a + b)/ Carot.	2.47	2.38	2.54	2.57	2.76	2.67

Chl. = Chlorophyll   Carot. = Carotenoids

Table (7): Effect of the maximum tolerable salinity level alone and the untolerable salinity levels preceded with paclobutrazol treatments on chloroplast pigments (chlorophyll a, b and carotenoids) of wheat plants - 70 days after sowing in 1994/ 95 season-.

Chloroplast pigments		Tap water (control)	Salinity 7000 ppm	Paclobutrazol (ppm) 10, Salinity (ppm) 8000	Paclobutrazol (ppm) 10, Salinity (ppm) 9000	Paclobutrazol (ppm) 50, Salinity (ppm) 8000	Paclobutrazol (ppm) 50, Salinity (ppm) 9000
		Wheat cv. Giza 163					
Mg/ g dry weight	Chl. a	9.65	8.25	10.77	10.34	11.58	10.90
	Chl. b	5.15	4.20	6.76	6.34	8.48	7.23
	Chl. (a + b)	14.80	12.45	17.53	16.68	20.06	18.13
	Carot.	5.00	4.52	5.46	5.36	5.71	5.54
	Chl.(a + b) + Carot.	19.80	16.97	23.16	22.04	25.77	23.67
Ratio	chl. a/ Chl. b	1.87	1.96	1.59	1.63	1.37	1.51
	Chl. (a + b)/ Carot.	2.96	2.75	3.21	3.11	3.51	3.27
		Wheat cv. Sakha 92					
Mg/ g dry weight	Chl. a	6.32	8.85	7.62	7.32	8.66	8.03
	Chl. b	2.87	2.59	3.75	3.56	4.48	4.09
	Chl. (a + b)	9.19	8.44	11.37	10.88	13.14	12.12
	Carot.	3.86	3.66	4.36	4.30	4.69	4.56
	Chl.(a + b) + Carot.	13.05	12.00	15.73	15.18	17.83	16.68
Ratio	chl. a/ Chl. b	2.20	2.26	2.03	2.06	1.93	1.96
	Chl. (a + b)/ Carot.	2.38	2.31	2.61	2.53	2.80	2.66

Chl. = Chlorophyll   Carot. = Carotenoids

Table (8): Effect of the maximum tolerable salinity levels alone and the untolerable salinity levels preceded with paclobutrazol treatments on chloroplast pigments (chlorophyll a, b and carotenoids) of tomato plants - 70 days after sowing in 1993/ 94 season-.

Chloroplast pigments		Treatments					
		Tap water (control)	Salinity 5000 ppm	Paclobutrazol (ppm)			
				10		50	
				Salinity (ppm)		Salinity (ppm)	
				6000	7000	6000	7000
		Tomato cv. Castle Rock					
Mg/ g dry weight	Chl. a	9.24	7.85	9.93	9.80	10.83	10.51
	Chl. b	4.13	3.34	4.84	4.54	6.15	5.18
	Chl. (a + b)	13.37	11.19	14.77	14.34	16.98	15.69
	Carot.	5.29	4.74	5.72	5.62	6.29	6.01
	Chl.(a + b) + Carot.	18.66	15.93	20.49	19.96	23.27	21.70
Ratio	chl. a/ Chl. b	2.24	2.35	2.05	2.16	1.76	2.03
	Chl. (a + b)/ Carot.	2.53	2.36	2.58	2.55	2.70	2.61

Chloroplast pigments		Treatments					
		Tap water (control)	Salinity 7000 ppm	Paclobutrazol (ppm)			
				10		50	
				Salinity (ppm)		Salinity (ppm)	
				8000	9000	8000	9000
		Tomato cv. Edkawi					
Mg/ g dry weight	Chl. a	15.67	15.00	18.19	17.40	20.66	19.41
	Chl. b	10.29	9.19	12.81	12.00	16.27	14.38
	Chl. (a + b)	25.96	24.19	31.00	29.40	36.93	33.79
	Carot.	8.26	7.84	9.42	9.10	10.79	9.97
	Chl.(a + b) + Carot.	34.22	32.03	40.42	38.50	47.72	43.76
Ratio	chl. a/ Chl. b	1.52	1.63	1.42	1.45	1.27	1.35
	Chl. (a + b)/ Carot.	3.14	3.09	3.29	3.23	3.42	3.39

Chl. = Chlorophyll   Carot. = Carotenoids

addition, this stimulatory effect of paclobutrazol on chloroplast pigments synthesis was directly proportional to the used concentration. Furthermore, the stimulatory effect of paclobutrazol on chloroplast pigments synthesis was more higher in the wheat cv. Sakha 92 and the tomato cv. Edkawi (the more salt-tolerant cvs.) than in the wheat cv. Giza 163 and the tomato cv. Castle Rock (the less salt-tolerant cvs.).

Other studies have been reported and got also negative effects of salinity on chloroplast pigments synthesis in the same or other economic plants. Of these studies were those mentioned by **Taha (1971), Salama *et al.* (1981), El-Lawendy (1990) and Rizk (1993)** on tomato and **Sharaky *et al.* (1987)** on rice.

The negative effect of salinity that existed in this respect could be attributed to: (I) the suppress of the specific enzyme, which is responsible for the synthesis of photosynthetic pigments **(Strognova *et al.*, 1970)**, (ii) the destruction of chlorophyll **(Mayber and Gale, 1975)** or (iii) the decrease in the absorption of minerals needed for chlorophyll biosynthesis, i.e. iorn and manganese **(El-Lawendy, 1990)**.

On the other hand, for the explanation of the incremental effect of paclobutrazol on chloroplast pigments, it could be illustrated here on the basis that paclobutrazol treatments stimulated the endogenous cytokinins synthesis as will be mentioned afterwords and there is an intimate relationship between cytokinins and chlorophyll metabolism in both excided or detached leaf discks and intact plants i.e. cytokinins retard chlorophyll degradation, preserve it and increase its synthesis **(Devlin and Witham, 1983)**. Besides, cytokinins activate a number of enzymes participating in a wide range of metabolic reactions in the leaves. These reactions included the maturation of proplastid into chloroplasts. These enzymes could be divided into two groups according to their response to cytokinins. The first group of enzymes could be said to relate to chloroplast differentiation, while the second group could be realted to cytokinin-stimulated group **(Kulaeva, 1979)**.

Accordingly, as the formation of chloroplast pigments was affected by the maximum tolerable salinity levels and the untolerable salinity levels preceded with paclobutrazol treatments, thus a great change in photosynthesis activity could be resulted and played a considerable role in the plant growth behaviour.

c- Effect of the maximum tolerable salinity levels alone and the untolerable salinity levels preceded with paclobutrazol on the dry weight of wheat and tomato plants:

Dry weights of the different organs of the two wheat cultivars and the two tomato cultivars treated with the maximum tolerable salinity levels and the untolerable salinity levels preceded with paclobutrazol treatments in the two seasons of study (i.e. 1993/1994 and 1994/1995) are shown in Tables (10, 11, 12 and 13).

1. Wheat cvs. (Giza 163 and Sakha 92):

Table (10 and 11) show that the application of maximum tolerable salinity level alone (7000 ppm) obviously decreased the dry weights of roots, stems and leaves of both wheat cultivars in the two seasons of this study. This reduction in the dry weights of the different plant organs as well as the total dry weight per plant was more pronounced in Giza 163 (the less salt-tolerant cultivar) than in Sakha 92 (the more salt-tolerant cultivar).

On the other hand, the application of paclobutrazol at 10 and 50 ppm before subjection of the plants to the untolerable salt-

Table (10): Effect of the maximum tolerable salinity level alone and the untolerable salinity levels preceded with paclobutrazol treatments on the dry weight of different organs and the assimilation rate of wheat plants (season 1993/ 94).

Characters		Tap water (control)	Salinity 7000 ppm	Paclobutrazol 10 Salinity (ppm) 8000	Paclobutrazol 10 Salinity (ppm) 9000	Paclobutrazol 50 Salinity (ppm) 8000	Paclobutrazol 50 Salinity (ppm) 9000
		Wheat cv. Giza 163					
Dry weight (g)/ plant	Roots	0.65	0.59	0.89	0.81	1.00	0.92
	Stems	0.18	0.14	0.17	0.13	0.13	0.11
	Leaves	1.43	1.07	1.21	1.12	1.34	0.96
Total dry weight (g)/ plant		2.26	1.80	2.27	2.06	2.47	1.99
Dry weight % related to the control		100.00	79.65	100.44	91.15	109.29	88.05
% distribution in different plant organs	Roots	28.76	32.78	39.21	39.32	40.49	46.23
	Stems	7.96	7.78	7.49	6.31	5.26	5.53
	Leaves	63.28	59.44	53.30	54.37	54.25	48.24
Root/ shoot ratio		0.40	0.49	0.64	0.65	0.68	0.86
Assimilation rate (g/cm2)		3.23	3.01	3.55	3.31	4.01	3.75
		Wheat cv. Sakha 92					
Dry weight (g)/ plant	Roots	0.76	0.71	1.07	1.01	1.31	1.21
	Stems	0.20	0.16	0.16	0.14	0.17	0.13
	Leaves	1.50	1.25	1.40	1.28	1.65	1.38
Total dry weight (g)/ plant		2.46	2..12	2.63	2.43	3.13	2.72
Dry weight % related to the control		100.00	86.17	106.91	98.78	127.24	111.48
% distribution in different plant organs	Roots	30.89	33.49	40.68	41.56	41.85	44.49
	Stems	8.13	7.55	6.09	5.76	5.43	4.78
	Leaves	60.98	58.96	53.23	52.68	52.42	50.73
Root/ shoot ratio		0.45	0.50	0.69	0.71	0.72	0.80
Assimilation rate (g/cm2)		2.91	2.76	3.18	3.08	3.62	3.34

Table (11): Effect of the maximum tolerable salinity level alone and the untolerable salinity levels preceded with paclobutrazol treatments on the dry weight of different organs and the assimilation rate of wheat plants (season 1994/ 95).

Characters		Treatments					
		Tap water (control)	Salinity 7000 ppm	Paclobutrazol			
				10		50	
				Salinity (ppm)		Salinity (ppm)	
				8000	9000	8000	9000
		Wheat cv. Giza 163					
Dry weight (g)/ plant	Roots	0.72	0.64	0.97	0.91	1.09	1.03
	Stems	0.15	0.12	0.14	0.13	0.10	0.08
	Leaves	1.37	1.00	1.12	1.04	1.22	0.93
Total dry weight (g)/ plant		2.24	1.76	2.23	2.08	2.41	2.04
Dry weight % related to the control		100.00	78.57	99.55	92.86	107.59	91.07
% distribution in different plant organs	Roots	32.14	36.36	43.50	43.75	45.23	50.49
	Stems	6.70	6.82	6.28	6.25	4.15	3.92
	Leaves	61.16	56.82	50.22	50.00	50.62	45.59
Root/ shoot ratio		0.47	57.14	0.77	77.78	0.83	1.02
Assimilation rate (g/cm2)		3.33	3.05	3.44	3.54	4.08	3.71
		Wheat cv. Sakha 92					
Dry weight (g)/ plant	Roots	0.81	0.73	1.13	1.08	1.35	1.30
	Stems	0.22	0.17	0.16	0.13	0.15	0.14
	Leaves	1.40	1.13	1.37	1.21	1.50	1.27
Total dry weight (g)/ plant		2.43	2.03	2.66	2.42	3.00	2.71
Dry weight % related to the control		100.00	83.54	109.47	99.59	123.46	111.52
% distribution in different plant organs	Roots	33.33	35.96	42.48	44.63	45.00	47.97
	Stems	9.05	8.37	6.02	5.37	5.00	5.17
	Leaves	57.62	55.67	51.50	50.00	50.00	46.86
Root/ shoot ratio		0.50	0.56	0.74	0.81	0.82	92.20
Assimilation rate (g/cm2)		2.83	2.65	3.19	3.02	3.41	3.25

stresses (8000 and 9000 ppm) clearly increased the dry weight of roots of the two wheat cultivars. This stimulative effect of paclobutrazol on the accumulation of dry matter in the roots was parallel to the applied concentration. On contrary, the dry weights of both stems and leaves of these two wheat cultivars were decreased with the application of the untolerable salinity levels preceded with paclobutrazol treatments in both seasons of study. The only exception was that increase existed in these characters in Sakha 92 cv. with the treatment of salinity at 8000 ppm preceded with paclobutrazol at 50 ppm. Also, it was noticed that the increment in the dry weight of roots led to increase of the total dry weight per plant, in spite of the reduction that existed in the dry weights of both stems and leaves.

Also, the stimulation or inhibition of dry matter accumulation in the different wheat organs led to disturb the distribution of dry matter in these organs. Since, the distribution percentage of dry matter was greatly increased in the roots, meanwhile decreased in both stems and leaves of the two wheat cultivars under the maximum tolerable salinity level alone and the untolerable salinity levels preceded with paclobutrazol treatments. In addition, this was also extended to the character of root/shoot ratio. Since, the maximum tolerable salinity level alone and the untolerable salinity levels preceded with paclobutrazol treatments led to increase in this ratio in the two wheat cultivars. This increase in root/shoot ratio indicate that there was an increase in the assimilate supply from shoots to roots resulting in the increase in this character.

With regard to the assimilation rate (i.e. the proporion of leaves dry weight to their area), Table (10 and 11) show that the application of salinity alone at the maximum tolerable level (7000 ppm) decreased this character in both wheat cultivars in the two seasons of study. Meanwhile, the application of paclobutrazol at 10 and 50 ppm before subjection of the wheat plants to the untolerable salt-stresses (8000 and 9000 ppm) led to obvious increase in the assimilation rate of the two wheat cultivars in the two seasons of this study.

2. Tomato cvs. (Castle Rock and Edkawi):

Data in Tables (12 and 13) indicate that the maximum tolerable salinity levels (5000 ppm for Castle Rock cv. and 7000 ppm for Edkawi cv.) diminished the accumulation of dry matter in the different tomato organs as well as the total dry weight per plant. Also, the distribution percentage of dry matter was reduced in both stems and leaves, while increased in the roots of the two tomato cultivars under the maxmium tolerable salinity levels.

As for the dry weights and the distribution percentages of dry matter in the different tomato organs under the untolerable salinity levels (6000 and 7000 ppm for Castle Rock cv. and 8000 and 9000 ppm for Edkawi cv.) preceded with paclobutrazol treatments (10 and 50 ppm), the same effect of the maximum tolerable salinity levels alone also existed. The only exception was that increase existed in the dry weight of the roots in Edkawi cv.

As regards, the root shoot/ratio, as shown in Tables (12 and 13) both the maximum tolerable salinity levels alone and the untolerable salinity levels preceded with paclobutrazol treatments increased this character in the two tomato cultivars. Meanwhile, the assimilation rate was decreased only under the maximum tolerable salinity levels alone but increased under the untolerable salinity levels when preceded with paclobutrazol treatments. Also, the above mentioned results were true for both tomato cultivars in the two seasons of this study.

Table (12): Effect of the maximum tolerable salinity levels alone and the untolerable salinity levels preceded with paclobutrazol treatments on the dry weight of different organs and the assimilation rate of tomato plants (season 1993/ 94).

Characters		Tap water (control)	Salinity 5000 ppm	Paclobutrazol 10, Salinity (ppm) 6000	Paclobutrazol 10, Salinity (ppm) 7000	Paclobutrazol 50, Salinity (ppm) 6000	Paclobutrazol 50, Salinity (ppm) 7000
		Tomato cv. Castle Rock					
Dry weight (g)/ plant	Roots	0.06	0.05	0.04	0.03	0.02	0.02
	Stems	0.28	0.20	0.11	0.10	0.09	0.07
	Leaves	0.61	0.44	0.36	0.26	0.20	0.18
Total dry weight (g)/ plant		0.95	0.69	0.51	0.39	0.31	0.27
Dry weight % related to the control		100.00	72.63	53.68	41.05	32.63	28.42
% distribution in different plant organs	Roots	6.32	7.25	7.84	7.69	6.45	7.41
	Stems	29.47	28.99	21.57	25.64	29.03	25.93
	Leaves	64.21	63.76	70.59	66.67	64.52	66.67
Root/ shoot ratio		0.07	0.08	0.09	0.08	0.07	0.08
Assimilation rate (g/cm2)		2.52	2.26	2.75	2.65	2.94	2.82

Characters		Tap water (control)	Salinity 7000 ppm	Paclobutrazol 10, Salinity (ppm) 8000	Paclobutrazol 10, Salinity (ppm) 9000	Paclobutrazol 50, Salinity (ppm) 8000	Paclobutrazol 50, Salinity (ppm) 9000
		Tomato cv. Edkawi					
Dry weight (g)/ plant	Roots	0.09	0.08	0.12	0.11	0.14	0.13
	Stems	0.38	0.31	0.21	0.19	0.16	0.14
	Leaves	0.90	0.74	0.64	0.47	0.34	0.30
Total dry weight (g)/ plant		1.37	1.13	0.97	0.77	0.64	0.57
Dry weight % related to the control		100.00	82.48	70.80	56.20	46.72	41.61
% distribution in different plant organs	Roots	6.57	7.08	12.37	14.29	21.88	2.81
	Stems	27.74	27.43	21.65	24.68	25.00	24.56
	Leaves	65.69	65.49	65.98	61.03	53.12	52.63
Root/ shoot ratio		0.07	0.08	0.14	0.17	0.28	0.30
Assimilation rate (g/cm2)		2.82	2.55	3.20	3.06	3.53	3.22

Table (13): Effect of the maximum tolerable salinity levels alone and the untolerable salinity levels preceded with paclobutrazol treatments on the dry weight of different organs and the assimilation rate of tomato plants (season 1994/95).

Characters		Tap water (control)	Salinity 5000 ppm	Paclobutrazol 10, Salinity (ppm) 6000	Paclobutrazol 10, Salinity (ppm) 7000	Paclobutrazol 50, Salinity (ppm) 6000	Paclobutrazol 50, Salinity (ppm) 7000
		Tomato cv. Castle Rock					
Dry weight (g)/ plant	Roots	0.07	0.06	0.05	0.04	0.03	0.03
	Stems	0.24	0.18	0.12	0.10	0.08	0.07
	Leaves	0.52	0.39	0.30	0.23	0.19	0.16
Total dry weight (g)/ plant		0.83	0.63	0.47	0.37	0.30	0.26
Dry weight % related to the control		100.00	75.90	56.63	44.58	36.14	31.33
% distribution in different plant organs	Roots	8.43	9.52	10.64	10.81	10.00	11.54
	Stems	28.92	28.57	25.53	27.03	26.66	26.92
	Leaves	62.65	61.90	63.83	62.16	63.34	61.54
Root/ shoot ratio		0.09	0.11	0.12	0.12	0.11	0.12
Assimilation rate (g/cm2)		2.31	2.12	2.69	2.45	2.87	2.68

Characters		Tap water (control)	Salinity 7000 ppm	Paclobutrazol 10, Salinity (ppm) 8000	Paclobutrazol 10, Salinity (ppm) 9000	Paclobutrazol 50, Salinity (ppm) 8000	Paclobutrazol 50, Salinity (ppm) 9000
		Tomato cv. Edkawi					
Dry weight (g)/ plant	Roots	0.11	0.09	0.13	0.12	0.16	0.14
	Stems	0.31	0.26	0.19	0.17	0.15	0.14
	Leaves	0.76	0.65	0.59	0.38	0.32	0.27
Total dry weight (g)/ plant		1.18	1.00	0.91	0.67	0.63	0.55
Dry weight % related to the control		100.00	84.75	77.12	56.78	53.39	46.61
% distribution in different plant organs	Roots	9.32	9.00	14.29	17.91	25.40	25.45
	Stems	26.27	26.00	20.88	25.37	23.81	25.45
	Leaves	64.41	65.00	64.83	56.72	50.79	49.10
Root/ shoot ratio		0.10	0.10	0.17	0.22	0.34	0.34
Assimilation rate (g/cm2)		2.65	2.37	3.27	2.84	3.43	3.10

In this respect, many research workers reported similar negative effect of salinity on the dry weights of some plants, e.g. **Sharam and Garg (1985)** on wheat, **Sharaky *et al.* (1987)** on rice, **Ahmed (1993)** on barley, **Martinez and Cerda (1987), Al-Rawahy *et al.* (1992) and Rizk (1993)** on tomato.

For the lower values that obtained in the dry weight of wheat and tomato plants due to salinity could be resulted from the reduction in the growth of different plant organs, deficiency of water absorption, suppressing cell division and cell enlargement, enhancement of photorespiration, inhibition of apical growth, alteration of hormonal balance and decline of net photosynthesis **(Starck and Karwowsk, 1980)**.

Hence, all these effects could be reflected on lowering of assimilates accumulation, transport and partitioning in different plant organs thus reversing on the reduction of dry weight.

On the other hand, according to that alteration of the hormonal balance obtained in the present study with paclobutrazol treatments under the untolerable salinity levels especially the increase of endogenous cytokinins, there have been suggestions that cytokinins are involved in regulating photosynthesis. Application of this growth regulator tends to oppose the action of ABA on stomatal closure **(Aharoni *et al.*, 1977)** and in some situations enhances transpiration. In addition, plants with water-stressed roots produce less cytokinin **(Itai and Vaadia, 1971)** - similar result of the present study - and thus one could be expected that with lowered cytokinin levels photosynthesis might be reduced as a result of stomatal closure **(Sivakumaran and Hall, 1979)**. Thus the effects of salinity on roots might in part influences photosynthetic rate by alteration in cytokinin production and its export to shoots. So, for the explanation of the role of the growth

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d- Effect of the maximum tolerable salinity levels alone and the untolerable salinity levels preceded with paclobutrazol on heading of wheat plants:

Table (14) shows that the maximum tolerable salinity level (7000 ppm) when applied alone hastened the date of the first spike appearance and the date of heading as well in the two wheat cultivars (Giza 163 and Sakha 92) in the two seasons of this study. This hastening effect of salinity on heading of wheat pants was more pronounced in Giza 163 (the less salt-tolerant cv.) than in Sakha 92 (the more salt-tolerant cv.). On the other hand, the application of paclobutrazol at 10 and 50 ppm before the treatments of the untolerable salinity levels (8000 and 9000 ppm) delayed the date of the first spike appearance and also the date of heading in both wheat cultivars in the two seasons. Retardation of the first spike appearance and heading as well was directly proportional to the applied concentration of paclobutrazol. This was also more obvious in Sakha 92 than in Giza 163 .

Table (14: Effect of the maximum tolerable salinity level alone and the untolerable salinity levels preceded with paclobutrazol treatments on heading of wheat cultivars in 1993/ 94 and 1994/ 95 seasons.

Heading characters			Tap water (control)	Salinity 7000 ppm	Paclobutrazol 10 Salinity (ppm) 8000	Paclobutrazol 10 Salinity (ppm) 9000	Paclobutrazol 50 Salinity (ppm) 8000	Paclobutrazol 50 Salinity (ppm) 9000
			Wheat cv. Giza 163					
Seasons	1993/ 1994	Days from sowing till first spike emergence	89	87	94	93	101	97
		Days from sowing till heading	95	92	98	96	109	101
	1994/ 1995	Days from sowing till first spike emergence	93	89	101	96	106	104
		Days from sowing till heading	99	94	105	101	113	110
			Wheat cv. sakha 92					
Seasons	1993/ 1994	Days from sowing till first spike emergence	70	70	79	77	95	89
		Days from sowing till heading	84	81	88	87	101	99
	1994/1995	Days from sowing till first spike emergence	79	77	92	89	99	95
		Days from sowing till heading	91	87	103	99	108	106

In this respect, other studies indicated similar hastening effect of salinity on heading of wheat plants. Of these studies were those mentioned by **Bastianpillai** ***et al.*** **(1982)** and **Maas and Grieve (1990)**.

Early existance of the first spike and early heading with the maximum tolerable salinity level alone could be partially attributed to the noticed modifications in the plants grown under saline conditions. Of these are different growth forms that leading to maturity and inducing senescence of the plants grown under saline conditions **(Maas and Poss, 1989 and Maas and Grieve, 1990)**. In addition to that the alterations in the endogenous levels of phytohormones under saline conditions could be severely affected the plant growth. Of these alterations are the reduction of the gibberellin synthesis and the increase of the natural inhibitors of growth promoters (other results of the present study).

On the other hand, retardation in heading that existed with paclobutrazol treatments under the untolerable salinity levels could be attributed to the obtained stimulation of cytokinins synthesis. So, the vegetative and reproductive growth periods were prolonged as cytokinin is Known as a true shooting hormone **(Devlin and Witham, 1983 and Mohamed and El-Desouky, 1992)**.

e- Effect of the maximum tolerable salinity levels alone and untolerable salinity levels preceded with paclobutrazol on flowering of tomato plants:

Data in Table (15) clearly indicate that the number of days required for the first flower appearance and flowering, as well as the mean number of flowers/plant in the tomato cultivars (Castle Rock and Edkawi) were significantly decreased with the maximum tolerable salinity levels alone (5000 ppm for Castle Rock cv. and 7000 ppm for Edkawi cv.) in the two experimental seasons.

Table (15) Effect of the maximum tolerable salinity levels alone and the untolerable salinity levels preceded with paclobutrazol treatments on flowring of tomato cultivars in 1993/ 94 and 1994/ 95 seasons.

Flowering characters			Treatments					
			Tap water (control)	Salinity 5000 ppm	Paclobutrazol			
					10		50	
					Salinity (ppm)		Salinity (ppm)	
					6000	7000	6000	7000
			Tomato cv. Castle Rock					
Seasons	1993/1994	Days from sowing till first flower appearance	97	96	114	109	114	110
		Days from sowing till flowering	117	115	121	119	120	115
		Mean no. of flowers/ plant	18.70 ±0.83	13.20 ±0.68	24.20 ±1.05	19.00 ±1.05	19.00 ±0.93	16.50 ±0.73
	1994/1995	Days from sowing till first flower appearance	103	101	111	110	115	108
		Days from sowing till flowering	118	115	120	119	122	114
		Mean no. of flowers/ plant	16.50 ±0.65	11.70 ±0.58	21.50 ±0.93	17.00 ±0.63	16.50 ±0.73	12.50 ±0.58

Flowering characters			Treatments					
			Tap water (control)	Salinity 7000 ppm	Paclobutrazol			
					10		50	
					Salinity (ppm)		Salinity (ppm)	
					8000	9000	8000	9000
			Tomato cv. Edkawi					
Seasons	1993/ 1994	Days from sowing till first flower appearance	88	85	78	76	83	78
		Days from sowing till flowering	106	102	93	91	95	94
		Mean no. of flowers/ plant	24.00 ±1.08	20.00 ±0.93	29.00 ±1.34	26.00 ±0.89	31.70 ±1.65	23.00 ±0.93
	1994/ 1995	Days from sowing till first flower appearance	93	91	83	80	85	82
		Days from sowing till flowering	110	105	95	85	96	92
		Mean no. of flowers/ plant	21.00 ±0.73	18.00 ±0.78	25.70 ±1.05	23.00 ±0.83	29.00 ±1.35	22.30 ±0.70

However, in Castle Rock the date of the first flower appearance and also the date of flowering were singificantly delayed with the untolerable salinity levels (6000 and 7000 ppm) when preceded with paclobutrazol treatments (10 and 50 ppm) in the two seasons of this study. Meanwhile, the reverse was true with the cv. Edkawi. grown under the untolerable salinity levels (8000 and 9000 ppm) preceded with paclobutrazol treatments. But the mean number of flowers/plant was significantly stimulated under the untolerable salinity levels preceded with paclobutrazol treatments in the two tomato cultivars in the experimental seasons.

In this respect, **Saleh and Al-Maghrabi (1991)** got similar results with tmato plants.

Supporting for our discussion the previously mentioned note of the nature of paclobutrazol effect on the prolongation of the vegetative and reproductive growth of wheat plants grown under the untolerable salinity levels, could be also expressed with the tomato plants. Since, increasing the endogenous level of cytokinins led to increasing the branching capacity of tomato plants as well as the tillering of wheat plants. This effect was reflected on the increase in the formation of tomato flowers and spikes in wheat plants.

f- Anatomical studies:

This study included microscopical mean counts and measurements of certain histological features in transverse and longitudinal sections. For the roots T.S. through the control and the treated plants as well of wheat cvs. (Giza 163 & Sakha 92) and also tomato cvs. (Castle Rock and Edkawi) were carried out. But for the stem T.S. and L.S. through a standard internode of the main stem and T.S. through the leaf blade were considered (Tables, 16-27 and Figs., 22-69).

Microscopical examinations clearly showed the differences - of interest - in the antatomical features of wheat and tomato plants treated with salinity alone and salinity preceded with paclobutrazol compared with their controls.

1- Effect of the maximum tolerable salinity levels alone and the untolerable salinity levels preceded with paclobutrazol on the histological features of the root:

Tables (16-19) and Figs. (22-33) show the effect of maximum tolerable salinity levels when applied alone and the untolerable salinity levels preceded with paclobutrazol on the mean counts and measurements of certain histological features of the primary root of wheat cvs. Giza 163 and Sakha 92 and of the tap root of tomato cvs. Castle Rock and Edkawi. These counts or measurements were then related - in percent - to the control.

In wheat plants the primary root was considered in this respect as a representative unite of all other adventitious roots.

1.1. Wheat cv. Giza 163:

Table (16) and Figs (22-24) clearly show that application of the maximum tolerable salinity level alone (7000 ppm) decreased the root diameter by about 17% than the control. Meanwhile, the usage of paclobutrazol at 10 and 50 ppm before the treatment with the untolerable salinity levels (8000 and 9000 ppm) diminished this deleterious effect of salinity on the root diameter. Since, the low concentration of paclobutrazol (10 ppm) decreased this parameter by about 7 and 14% than the control under the untolerable salinity levels of 8000 and 9000 ppm, respectively. While, the high concentration of pacloutrazol (50 ppm) decreased it by about 7 and 8% under the above mentioned untolerable salinity levels. Hence, it could be concluded that the compensating

Table (16): Mean counts and measurements related to the control in percent of certain histological features in transverse sections through the primary root of wheat cv. Giza 163.

Measurements (μ) & counts	Treatments											
	Tap water (control)		Salinity 7000 ppm		Paclobutrazol (ppm)							
					10				50			
					Salinity (ppm)				Salinity (ppm)			
					8000		9000		8000		9000	
	x	%	x	%	x	%	x	%	x	%	x	%
Root diameter	1075.50	100.00	895.50	83.26	1003.50	93.31	920.70	85.61	1003.50	93.31	990.00	92.05
Epidermis thickness	25.20	100.00	22.95	91.07	22.50	89.29	20.70	82.14	22.50	89.29	22.05	87.50
Cortex thickness	307.35	100.00	242.55	78.92	282.50	91.91	264.15	85.94	288.00	93.70	282.60	91.95
Exodermis thickness	78.30	100.00	81.00	103.45	106.20	135.63	98.10	125.29	108.00	137.93	104.40	133.33
No. of exodermal layers	3.50	100.00	4.00	114.29	4.00	114.29	4.00	114.29	4.00	114.29	5.00	142.86
Mean thickness of the exodermal layer	22.37	100.00	20.25	90.52	26.55	118.69	24.53	109.66	27.00	120.70	20.88	93.34
Thickness of cortical parenchyma layers	203.85	100.00	140.40	68.87	155.70	76.38	146.25	71.74	157.95	77.48	156.82	76.93
No. of cortical parenchyma layers	5.00	100.00	5.00	100.00	5.00	100.00	5.00	100.00	5.00	100.00	5.00	100.00
Mean thickness of the cortical parenchyma layer	40.77	100.00	28.08	68.87	31.14	76.38	29.25	71.74	31.59	77.48	31.36	76.93
Endodermis thickness	25.20	100.00	21.15	83.93	20.70	82.14	19.80	78.57	22.05	87.50	21.38	84.84
Vascular cylinder diameter	410.40	100.00	364.50	88.82	393.30	95.83	351.00	85.53	382.50	93.20	380.70	92.76
No. of vascular bundles (xylem or phloem)	12.50	100.00	13.75	110.00	13.00	104.00	12.50	100.00	13.00	104.00	13.00	104.00
Phloem bundle thickness	22.50	100.00	20.70	90.00	19.35	86.00	17.55	78.00	21.15	94.00	19.35	86.00
No. of protoxylem vessels in xylem bundle	3.00	100.00	4.00	133.33	4.00	133.33	3.50	116.67	4.00	133.33	4.00	133.33
No. of metaxylem vessels in the vascular cylinder	6.50	100.00	7.75	119.23	7.00	107.29	6.75	103.85	7.50	115.38	8.50	130.77
Widest metaxylem vessel diameter	63.00	100.00	49.50	78.57	59.40	94.29	45.00	71.43	70.65	112.14	49.50	78.57
Wall thickness of metaxylem vessel	2.43	100.00	3.12	128.40	3.92	161.32	4.14	170.37	3.92	161.32	3.69	151.85
Parenchymatous pith thickness	168.30	100.00	154.80	91.98	142.20	84.49	118.80	70.59	154.80	91.98	163.80	97.33
No. of parenchymatous pith layers	8.50	100.00	9.00	105.88	8.00	94.12	7.00	82.35	7.50	88.24	9.50	111.76
Mean thickness of the pith layer	19.80	100.00	17.20	86.87	17.78	89.80	16.97	85.71	20.64	104.24	17.24	87.08

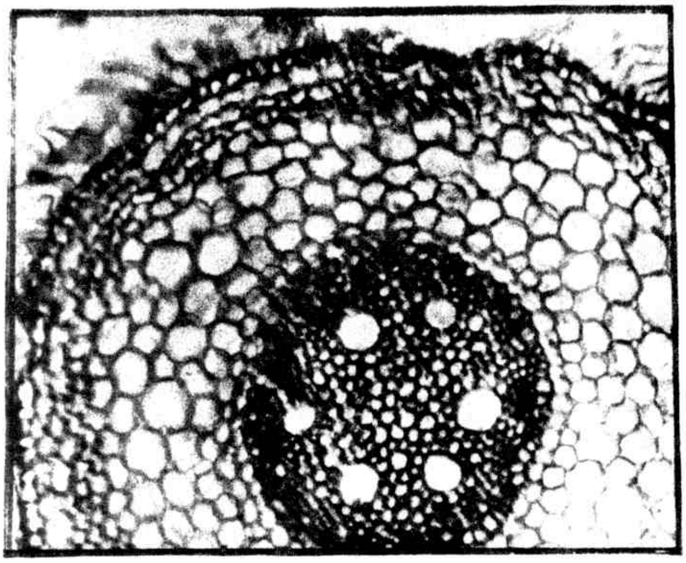


Fig. (22)

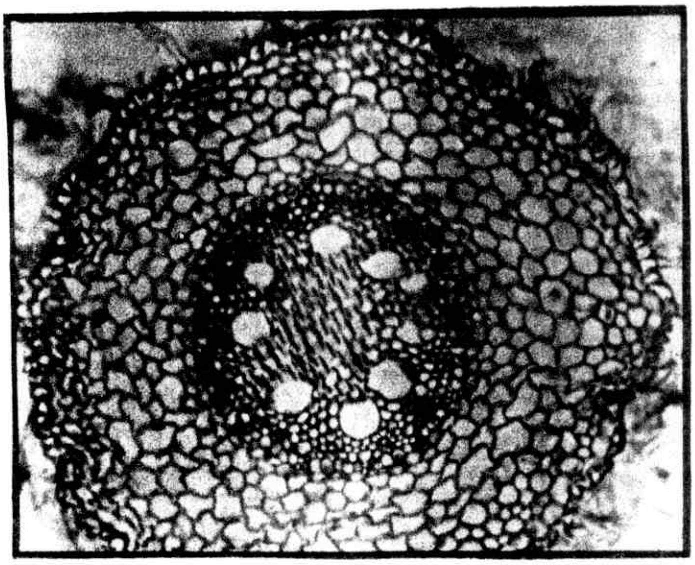


Fig. (23)

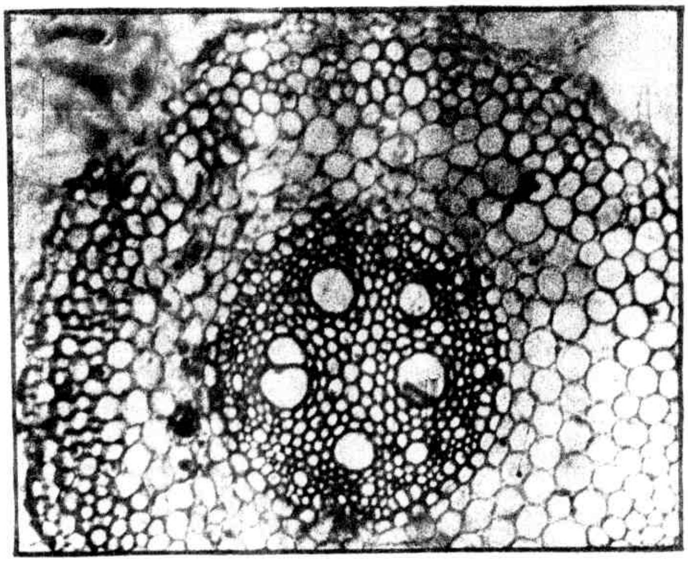


Fig. (24)

Figs. (22-24): Transverse sections through the primary root of wheat cv. Giza 163 as affected with the maximum tolerable salinity level of 7000 ppm alone and the untolerable salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm (X 100).

Fig. (22): Of an untreated plant.

Fig. (23): Of a plant treated with salinity level of 7000 ppm.

Fig. (24): Of a plant treated with salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm.

effect that existed with paclobutrazol was nearly proportional to the applied concentration.

The reduction that existed in the root diameter with the maximum tolerable level alone and also the untolerable salinity levels preceded with paclobutrazol treatments could be attributed to the reduction in the thickness of many tissues such as the epidermis, the cortical parenchyma layers, the endodermis, the vascular cylinder, the phloem tissue, thickness and number of the parenchymatous pith layers and also diameter of the metaxylem vessels while, the number of cortical parenchyma layers was not affected. This reduction was mostly more prononunced with the maximum tolerable salinity level alone (7000 ppm) than with the untolerable salinity levels (8000 and 9000 ppm) preceded with paclobutrazol (10 and 50 ppm).

On the other hand, both maximum tolerable salinity level alone and untolerable levels preceded with paclobutrazol treatments increased some anatomical features which could be related to the salt tolerance in this cultivar e.g. thickness and number of the exodermal layers, number of the vascular bundles, number of the protoxylem vessels in the vascular bundles, number of the metaxylem vessels in the vascular cylinder and wall thickness of the metaxylem vessels as well.

1.2. Wheat cv. Sakha 92:

Table (17) and Figs. (25-27) show that the application of salinity alone at the maximum tolerable salinity level (7000 ppm) led to reduction in the root diameter. This reduction was about 8% less than the control. On the other hand, the application of paclobutrazol (10 and 50 ppm) preceded the treatment with the untolerable salinity levels (8000 and 9000 ppm) exhibited different effects in this respect. For instance, the low concentration

Table (17): Mean counts and measurements related to the control in percent of certain histological features in transverse sections through the primary root of wheat cv. Sakha 92.

Measurements (μ) & counts	Treatments											
	Tap water (control)		Salinity 7000 ppm		Paclobutrazol (ppm)							
					10				50			
					Salinity (ppm)				Salinity (ppm)			
					8000		9000		8000		9000	
	x	%	x	%	x	%	x	%	x	%	x	%
Root diameter	1037.40	100.00	955.35	92.09	1017.00	98.03	979.20	94.39	1176.30	113.39	1126.00	108.54
Epidermis thickness	23.40	100.00	22.50	96.15	19.80	84.62	20.25	86.54	21.15	90.38	20.70	88.46
Cortex thickness	279.05	100.00	271.95	97.46	286.65	102.72	294.98	105.71	319.50	114.50	302.18	108.29
Exodermis thickness	74.60	100.00	91.80	123.06	108.00	144.77	102.60	137.53	99.00	132.71	94.50	126.68
No. of exodermal layers	3.50	100.00	4.00	114.29	4.00	114.29	4.00	114.29	4.00	114.29	4.00	114.29
Mean thickness of the exodermal layer	21.30	100.00	22.95	107.70	27.00	126.70	25.65	120.37	24.75	116.14	23.63	110.89
Thickness of cortical parenchyma layers	178.80	100.00	156.60	87.58	157.50	88.09	172.13	96.27	198.45	110.99	187.43	104.83
No. of cortical parenchyma layers	4.50	100.00	5.00	111.11	5.00	111.11	5.00	111.11	5.50	122.22	5.50	122.22
Mean thickness of the cortical parenchyma layer	39.73	100.00	31.32	78.83	31.50	79.29	34.43	86.66	36.08	90.82	34.08	85.78
Endodermis thickness	25.65	100.00	23.40	91.23	21.15	82.46	20.25	78.95	22.05	85.96	20.25	78.95
Vascular cylinder diameter	432.50	100.00	362.60	83.84	404.10	93.43	348.75	80.64	495.00	114.45	480.24	111.04
No. of vascular bundles (xylem or phloem)	13.50	100.00	13.50	100.00	13.50	100.00	13.50	100.00	15.00	111.11	14.00	103.70
Phloem bundle thickness	26.00	100.00	21.50	82.69	20.70	79.62	19.80	76.15	22.05	84.81	20.70	79.62
No. of protoxylem vessels in xylem bundle	3.00	100.00	3.50	116.67	3.50	116.67	4.00	133.33	4.00	133.33	4.00	133.33
No. of metaxylem vessels in the vascular cylinder	8.00	100.00	8.00	100.00	8.00	100.00	8.00	100.00	9.00	112.50	9.00	112.50
Widest metaxylem vessel diameter	67.32	100.00	60.60	90.02	49.50	73.53	47.70	70.86	57.60	85.56	54.00	80.21
Wall thickness of metaxylem vessel	2.61	100.00	3.15	120.69	3.60	137.93	3.87	148.28	3.78	144.83	3.69	141.38
Parenchymatous pith thickness	180.90	100.00	174.15	96.27	176.40	97.51	156.60	86.57	222.30	122.89	169.20	93.53
No. of parenchymatous pith layers	8.50	100.00	9.00	105.88	9.00	105.88	9.00	105.88	10.00	117.65	10.25	120.59
Mean thickness of the pith layer	21.28	100.00	19.35	90.93	19.60	92.11	19.80	93.05	22.23	104.46	16.51	77.58

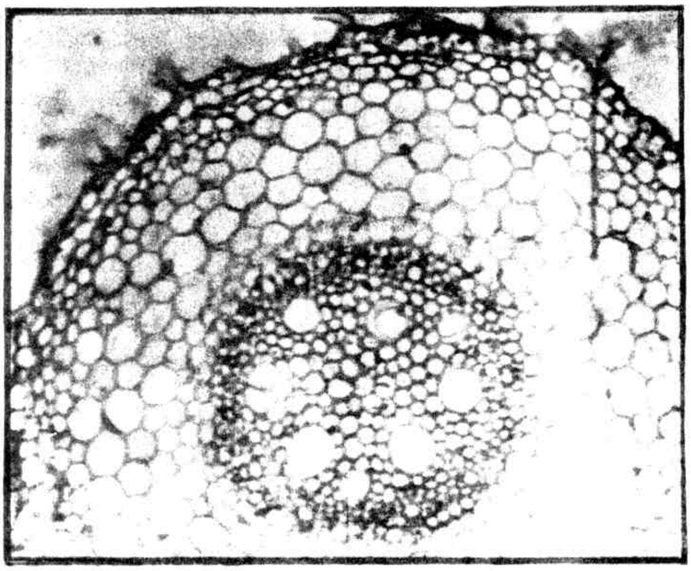


Fig. (25)

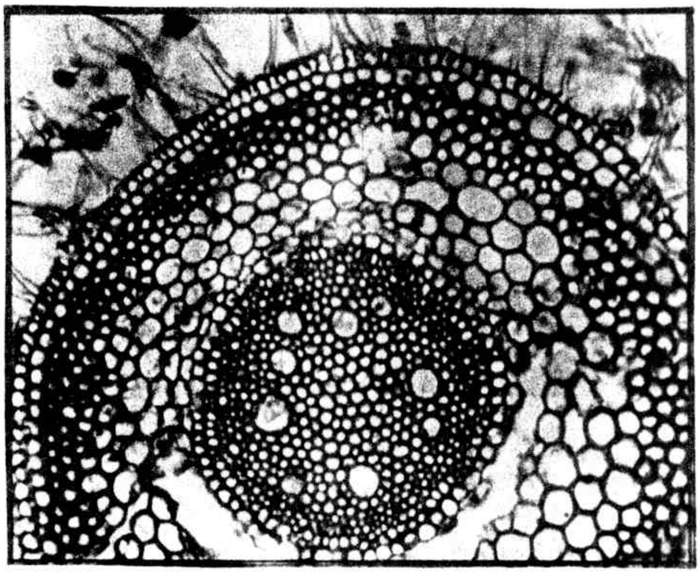


Fig. (26)

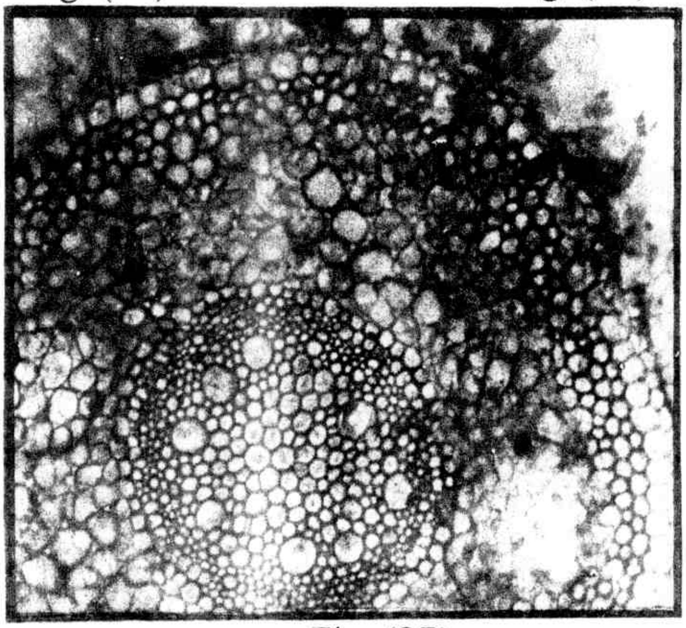


Fig. (27)

Figs. (25-27): Transverse sections through the primary root of wheat cv. Sakha 92 as affected with the maximum tolerable salinity level of 7000 ppm alone and the untolerable salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm (X 100).

Fig. (25): Of an untreated plant.

Fig. (26): Of a plant treated with salinity level of 7000 ppm.

Fig. (27): Of a plant treated with salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm.

of paclobutrazol (10 ppm) diminished the inhibitory effect of salinity existed in the diameter. Since, it decreased this parameter by about 2 and 6% than the control with the untolerable salinity of 8000 and 9000 ppm, respectively. While, the high concentration of paclobutrazol (50 ppm) not only led to complete recover of the retarding effect of salinity on the root diameter but also increased this diameter by about 13 and 8%, respectively more than the control.

The reduction that existed in the root diameter even with the maximum tolerable salinity level when applied alone or the untolerable salinity levels preceded with the low concentration of paclobutrazol (10 ppm) was mainly resulted from the reduction in the thickness of many tissues such as the epidermis, the cortical parenchyma layers, the endodermis, the vascular cylinder, the parenchymatous pith layers, the phloem tissue and also diameter of the metaxylem vessels. Although it was noticed some increases in the thickness and number of exodermal layers, number of the protoxylem vessels in the vascular bundle, number of both cortical parenchyma and parenchymatous pith layers and wall thickness of the metaxylem vessels. While, the number of both vascular bundles and metaxylem vessels was not affected.

For the increase in the root diameter caused by the untolerable salinity levels when preceded with the high concentration of paclobutrazol (50 ppm) could be attributed to the increase in many anatomical features of the root such as thickness and number of the exodermal layers, thickness and number of the cortical parenchyma layers, diameter of the vascular cylinder, thickness and number of the parenchymatous pith layers, number of the protoxlem vessels in the vascular bundle, number of the metaxylem vessels in the vascular cylinder and wall thickness of metaxylem vessels. In spite of that, decrease existed in the thickness of the epidermis, the endodermis, the phloem tissue and diameter of the metaxylem vessels.

In general, the comparison of the internal structure of the primary root of the two assigned wheat cultivars i.e. Giza 163 (the less salt-tolerant) and Sakha 92 (the more salt-tolerant) grown under the normal conditions and irrigated with tap water showed many anatomical differences. These differences distinguish the primary root of Sakha 92 as the more salt-tolerant cv. Of these features were the increase in the number of vascular bundles, number of the metaxylem vessels in the vascular cylinder and also the diameter and wall thickness of the metaxylem vessels. These characteristics were less in the primary root of Giza 163 as it is the less salt-tolerant cv. The previously mentioned characteristics could be related to the high ability of Sakha 92 cv. to act with salt tolerance phenomenon. However, other internal structures of the primary root were - to a great extend - similar (Tables 16 & 17 and Figs. 22 & 23).

On the other hand, the obtained results clearly show that the effect of maximum tolerable salinity level (7000 ppm) when applied alone and also the untolerable salinity levels (8000 and 9000 ppm) preceded with paclobutrazol (10 and 50 ppm) on the histological features of the primary root was nearly identical in the two wheat cultivars.

The maximum tolerable salinity level alone (7000 ppm) reduced the root diameter in the two wheat cultivars. This reduction could be due to reduction of some histological traits e.g. thickness of the epidermis, the parencymatous layers of both cortex and pith and also the vascular cylinder. Even though, increase existed in some important anatomical features which could be related to the salt tolerance phenomenon. This increase was in the number of exodermal layers, vascular bundles, protoxylem vessels in the vascular bundle, metaxylem vessels in the vascular cylinder and also the wall thickness of metaxylem vessels. These salinity effects even negative or positive were more obvious in Giza 163 than in Sakha 92 (Tables, 16 & 17 and Figs., 22, 23, 25 & 26).

In case of the application of paclobutrazol before the treatments with untorlerable salinity levels (8000 and 9000 ppm), the deleterious effects of salinity on the most histological features under study were diminished or completely overcame. These features were the thickness of the epidermis, the parenchymatous layers of both cortex and pith and the vascular cylinder. This positive and benificial effect of paclobutrazol was proprtional to its applied concentration and this was more pronounced in Sakha 92 than in Giza 163. Moreover, paclobutrazol caused high increase in some important anatomical features that could play a role in the enhancement of the ability of the two wheat cultivars to tolerate the high salinity levels. These features were the number of the exodermal layers, the vascular bundles, the protoxylem vessels in the vascular bundle, the metaxylem vessels in the vascular cylinder and also wall thickness of the metaxylem vessels. Meanwhile, the diameter of these vessels was decreased. This important and benificial effect of paclobutrazol was proportional to its applied concentration and also was more pronounced in Giza 163 - the less salt - tolerant cv. - than in Sakha 92 - the more salt-tolerant cv. - (Tables, 16 & 17 and Figs. 22, 24, 25 & 26).

1.3. Tomato cv. Castle Rock:

Table (18) and Figs. (28-30) clearly show that the application of the maximum tolerable salinity level alone (5000 ppm) led to the increase in the root diameter of this cultivar by about 28% more than the control. While, the untolerable salinity levels (6000

Table (18): Mean counts and measurements related to the control in percent of certain histological features in transverse sections through the tap root of tomato cv. Castle Rock.

Measurements (μ) & counts	Treatments											
	Tap water (control)		Salinity 5000 ppm		Paclobutrazol (ppm)							
					10				50			
					Salinity (ppm)				Salinity (ppm)			
					6000		7000		6000		7000	
	x	%	x	%	x	%	x	%	x	%	x	%
Root diameter	1260.00	100.00	1618.00	128.41	1230.00	97.62	1228.00	97.46	1104.00	87.62	1010.00	80.16
Cortex thickness	225.00	100.00	235.00	104.44	245.00	108.89	397.00	176.44	323.00	143.56	248.00	110.22
Exodermis thickness	61.00	100.00	81.00	132.79	88.00	144.26	82.00	134.43	63.00	103.28	54.00	88.52
No. of exodermal layers	2.00	100.00	3.00	150.00	3.00	150.00	2.00	100.00	2.00	100.00	2.00	100.00
Mean thickness of the exodermal layer	30.50	100.00	27.00	88.52	29.33	96.17	41.00	134.43	31.50	103.28	27.00	88.52
Thickness of cortical parenchyma layers	164.00	100.00	154.00	93.90	157.00	95.73	315.00	192.07	260.00	158.54	194.00	118.29
No. of cortical parenchyma layers	4.00	100.00	4.00	100.00	4.00	100.00	6.00	150.00	4.00	100.00	4.00	100.00
Mean thickness of the cortical parenchyma layer	41.00	100.00	38.50	93.90	39.25	95.73	52.50	128.50	65.00	158.54	48.50	118.29
Vascular cylinder diameter	810.00	100.00	1148.00	141.73	740.00	91.36	434.00	53.58	458.00	56.54	514.00	63.46
Phloem region thickness (primary & secondary)	60.00	100.00	88.00	146.67	60.00	100.00	29.00	48.33	32.00	53.33	39.50	65.83
Cambium region thickness	37.00	100.00	62.50	168.92	35.00	94.59	14.00	37.84	14.00	37.84	21.50	58.11
Xylem region diameter (primary & secondary)	616.00	100.00	847.00	137.50	550.00	89.29	348.00	56.49	366.00	59.42	392.00	63.64
No. of vessels in xylem region	50.00	100.00	70.00	140.00	50.00	100.00	51.00	102.00	58.00	116.00	61.00	122.00
Widest vessel diameter	71.70	100.00	69.00	96.23	61.50	85.77	36.50	50.91	51.70	72.11	50.00	69.74
Wall thickness of widest vessel	2.75	100.00	3.25	118.18	3.30	120.00	3.75	136.36	3.55	129.09	3.65	132.73

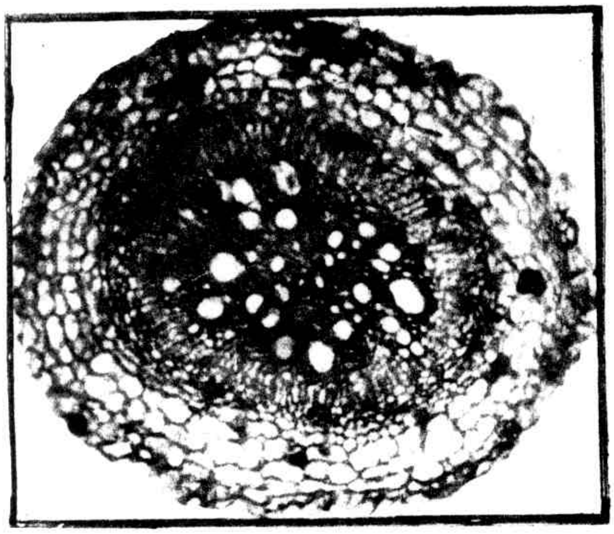


Fig. (28)

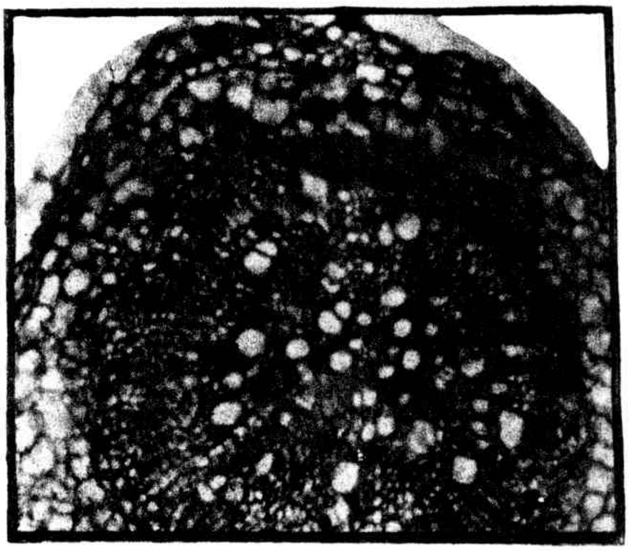


Fig. (29)

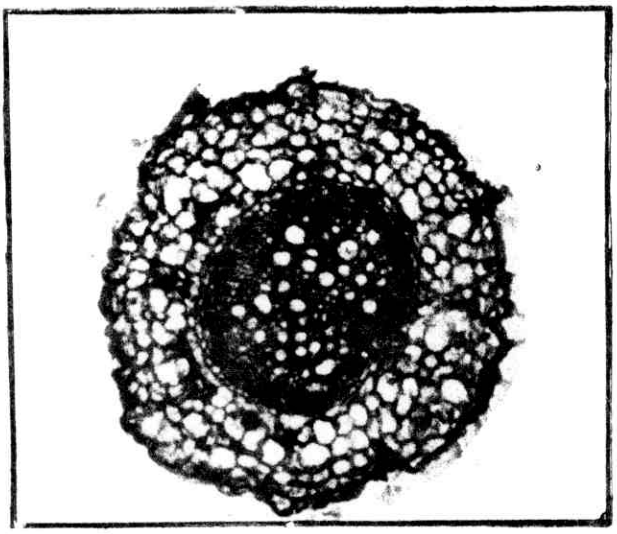


Fig. (30)

Figs. (28-30): Transverse sections through the primary root of tomato cv. Castle Rock as affected with the maximum tolerable salinity level of 5000 ppm alone and the untolerable salinity level of 6000 ppm preceded with paclobutrazol at 50 ppm (X 60).

Fig. (28): Of an untreated plant.

Fig. (29): Of a plant treated with salinity level of 5000 ppm.

Fig. (30): Of a plant treated with salinity level of 6000 ppm preceded with paclobutrazol at 50 ppm.

& 7000 ppm) preceded with paclobutrazol (10 and 50 ppm) caused reduction in this parameter. This reduction was nearly proportional to the applied concentration of paclobutrazol. Since, the reduction was about 2 and 3% with the untolerable salinity levels of 6000 and 7000 ppm, respectively when preceded with the low concentration of paclobutrazol (10 ppm), however it reached 12 and 13% with the same untolerable salinity levels when preceded with the high concentration of paclobutrazol (50 ppm).

For the application of the maximum tolerable salinity level alone, the noticable increase in the root diameter could be attributed to the excess in many histological features e.g. thickness and number of the exodermal layers, diameter of the vascular cylinder, thickness of the phloem region - primary and secondary phloem - , thickness of the cambial region, diameter of the xylem region - primary and secondary xylem - and number of the xylem vessels. Also the increase appeared in the wall thickness of xylem vessels. Even though, reduction existed in the thickness of cortical parenchyma layers and diameter of the xylem vessels. While the number of cortical parenchyma was not affected.

The reduction in the root diameter caused by the untolerable salinity levels preceded with paclobutrazol could be due to reduction in the thickness of vascular cylinder, phloem region, cambial region and xylem region, and also diameter of the vessels. However, increase existed in the thickness of the cortex (exodermal and parenchyma layers), number of the xylem vessels and wall thickness of these vessels as well.

1.4. Tomato cv. Edkawi:

Table (19) and Figs. (31-33) show that both maximum tolerable salinity level (7000 ppm) when applied alone and the untolerable salinity levels (8000 and 9000 ppm) preceded with

Table (19): Mean counts and measurements related to the control in percent of certain histological features in transverse sections through the tap root of tomato cv. Edkawi.

Measurements (µ) & counts	Treatments											
	Tap water (control)		Salinity 7000 ppm		Paclobutrazol (ppm)							
					10				50			
					Salinity (ppm)				Salinity (ppm)			
					8000		9000		8000		9000	
	X	%	X	%	X	%	X	%	X	%	X	%
Root diameter	1300.00	100.00	1660.00	127.69	1895.00	145.77	1660.00	127.69	1980.00	152.31	1860.00	143.08
Cortex thickness	255.00	100.00	244.00	95.96	320.00	145.49	300.00	117.65	320.00	125.49	300.00	117.65
Exodermis thickness	87.00	100.00	100.00	114.94	112.00	128.74	108.00	124.14	96.00	110.34	98.00	112.64
No. of exodermal layers	3.00	100.00	4.00	133.33	4.00	133.33	4.00	133.33	3.00	100.00	3.50	116.67
Mean thickness of the exodermal layer	29.00	100.00	25.00	86.21	28.00	96.55	27.00	93.10	32.00	110.34	28.00	96.55
Thickness of cortical parenchyma layers	168.00	100.00	144.00	85.71	208.00	123.81	192.00	114.29	224.00	133.33	202.00	120.24
No. of cortical parenchyma layers	4.00	100.00	4.00	100.00	5.00	125.00	5.00	125.00	5.00	125.00	5.00	125.00
Mean thickness of the cortical parenchyma layer	42.00	100.00	36.00	85.71	41.60	99.05	38.40	91.43	44.80	106.67	40.40	96.19
Vascular cylinder diameter	790.00	100.00	1172.00	148.35	1255.00	158.86	1060.00	134.18	1340.00	169.62	1260.00	159.49
Phloem region thickness (primary & secondary)	79.00	100.00	73.00	92.41	98.00	124.05	70.00	88.61	104.40	132.15	88.00	111.39
Cambium region thickness	48.00	100.00	72.00	150.00	83.00	172.92	70.00	145.83	71.00	147.92	62.00	129.17
Xylem region diameter (primary & secondary)	536.00	100.00	882.00	164.55	893.00	166.60	780.00	145.52	989.20	184.55	960.00	179.10
No. of vessels in xylem region	52.00	100.00	62.00	119.23	93.00	178.85	90.00	173.08	80.00	153.85	73.00	140.38
Widest vessel diameter	66.00	100.00	61.00	92.42	76.50	115.91	71.00	107.58	87.00	131.82	92.00	139.39
Wall thickness of widest vessel	3.00	100.00	3.60	120.00	4.10	136.67	4.05	135.00	5.40	180.00	4.65	155.00

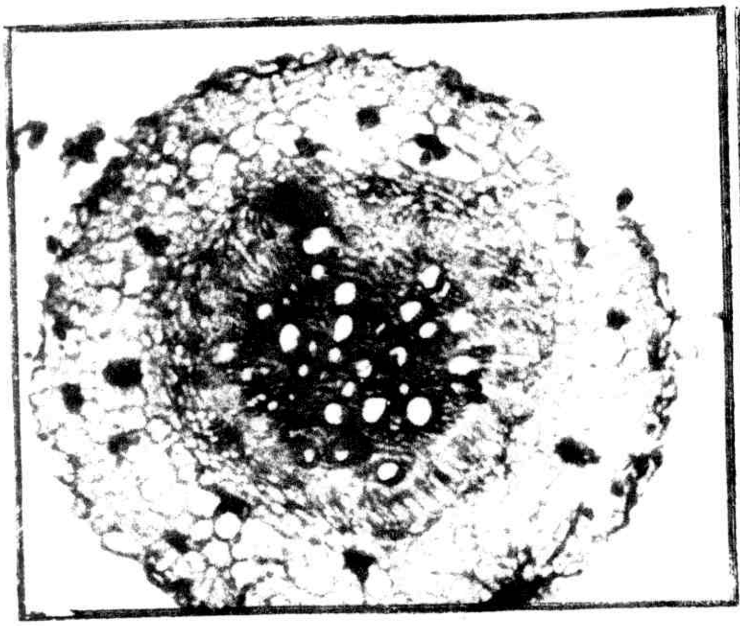


Fig. (31)

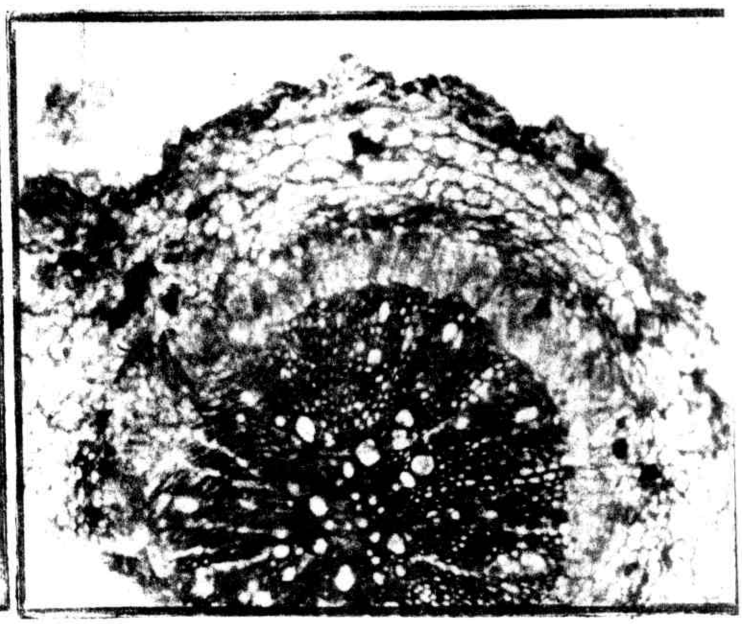


Fig. (32)

Fig. (33)

Figs. (31-33): Transverse sections through the primary root of tomato cv. Edkawi as affected with the maximum tolerable salinity level of 7000 ppm alone and the untolerable salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm (X 60).

Fig. (31): Of an untreated plant.

Fig. (32): Of a plant treated with salinity level of 7000 ppm.

Fig. (33): Of a plant treated with salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm.

paclobutrazol at 10 and 50 ppm led to increase in the root diameter of this tomato cultivar. This increase was about 28% with the maximum tolerable salinity level alone. While, it was about 46 and 28%, respectively with the two applied untolerable salinity levels preceded with the low concentration of paclobutrazol (10 ppm), but reached 52 and 43% when preceded with the high concentration of paclobutrazol (50 ppm).

The increase in the root diameter that existed with the application of the maximum tolerable salinity level alone could be due to the noticed increase in the thickness and number of exodermal layers, diameter of the vascular cylinder and thickness of both cambial and xylem regions. Also, the increase existed in the wall thickness of xylem vessels. Even though, reduction existed in the thickness of cortical parenchyma layers, phloem region and also diameter of the xylem vessels.

The increase that existed in the root diameter with the untolerable salinity levels when preceded with paclobutrazol could mainly due to the increase of all internal characteristics (Table, 19 and Figs. 34-37). Also, it was noticed that these increases were directly proportional to the applied concentration of paclobutrazol.

Generally, it could be concluded from the data presented in Tables (18 and 19) and Figs. (28 and 31) that the most important anatomical features that distinguish the tap root of the tomato cv. Edkawi (the more salt-tolerant) compared with that of the tomato cv. Castle Rock (the less salt-tolerant) grown under the normal conditions and irrigated with tap water are the increase in the thickness and number of exodermal layers, thickness of the phloem region (primary and secondary), thickness of the cambial region, number of the xylem vessels and also wall thickness of the vessels as well as the decrease in the xylem region thickness (primary and secondary) and the diameter of the vessels. These differences could be attributed to the high ability of Edkawi cv. to endure higher levels of salinity than Castle Rock cv.

Besides, it could be concluded from the previously mentioned results that the effect of the maximum tolerable salinity levels alone (5000 ppm for Castle Rock cv. or 7000 ppm for Edkawi cv.) on the anatomical features of the tap root was nearly the same in the two tomato cultivars. Since, application of the maximum tolerable salinity level alone led to increase in the root diameter. This increase was attributed to the increase in the thickness and number of exodermal layers, diameter of the vascular cylinder (included the increase existed in the thickness of the phloem, cambial and xylem regions, number of the xylem vessels and also wall thickness of the vessels). Even though, reduction existed in thikness and number of cortical parenchyma layers and the diameter of xylem vessels. These negative and positive effects of salinity were mostly more pronounced in Castle Rock "the less salt-tolerant cv." than in Edkawi "the more salt-tolerant cv." (Tables, 18 & 19 and Figs. 28, 29, 31 & 32).

The growth regulator (paclobutrazol) when applied before the treatments of untolerable salinity levels, different effects were inspected in these two assigned tomato cultivars. For instance, in Castle Rock cv.,the application of paclobutrazol (10 and 50 ppm) preceded the untolerable salinity levels (6000 and 7000 ppm) led to reduction in the root diamter. This reduction was mainly due to reduction in most of the histological features under study. However, increase existed in the thikness of the cortex (exodermal and parenchyma layers), number of the xylem vessels and also wall thickness of the vessels. This decrease or increase was directly proportional to the applied concentration of paclobutrazol (Table, 18 and Figs., 28 & 30). While, in Edkawi cv., the application of paclobutrazol (10 and 50 ppm) before the untolerable salinity levels (8000 and 9000 ppm) led to increase in the root diameter. This increase was mainly due to increase in all studied histological characters (Table, 29 and Figs. 31 & 33).

2- Effect of the maximum tolerable salinity levels alone and the untolerable salinity levels preceded with paclobutrazol on the histological features of the stem:

Tables (20-23) and Figs. (34-57) show the effect of the maximum tolerable salinity when applied alone and the untolerable salinity levels preceded with paclobutrazol treatments on the mean counts and measurements of certain histological features of the main stem of the two wheat cvs. (Giza 163 and Sakha 92) and also the two tomato cvs. (Castle Rock and Edkawi). These counts or measurements were then related - in percent - to the control in order to exhibit the increase or decrease with respect to the control.

2.1. Wheat cv. Giza 163:

Table (20) and Figs. (34-36) clearly show that the application of salinity alone at the maximum tolerable salinity level (7000 ppm) led to reduction in the stem diameter by about 16% less than the control. Meanwhile, the application of paclobutrazol especially its low concentration (10 ppm) before the treatments with the untolerable salinity levels (8000 and 9000 ppm) nearly diminished the deleterious effect of salinity on the stem diameter. Since, this parameter was decreased by about 9 and 14% with the untolerable salinity levels of 8000 and 9000 ppm, respectively when preceded with the low concentration of paclobutrazol (10 ppm), while the decrease reached 15 and 21% when preceded with the high concentration of paclobutrazol (50 ppm).

Table (20): Mean counts and measurements related to the control in percent of certain histological features in transverse and longitudinal sections through the middle part of the fourth internode of the main stem of wheat cv. Giza 163.

Measurements (μ) & counts	Treatments											
	Tap water (control)		Salinity 7000 ppm		Paclobutrazol (ppm)							
					10				50			
					Salinity (ppm)				Salinity (ppm)			
					8000		9000		8000		9000	
	X	%	X	%	X	%	X	%	X	%	X	%
Stem diameter	3688.20	100.00	3087.00	83.70	3366.00	91.26	3168.00	85.90	3123.00	84.68	2898.00	78.58
Hollow pith daimeter	925.20	100.00	630.00	68.09	333.00	35.99	384.30	41.54	0.00	0.00	0.00	0.00
Stem wall thickness	1381.50	100.00	1228.50	88.93	1516.50	109.77	1391.85	100.75	1561.50	113.03	1449.00	104.89
Epidermis thickness	18.00	100.00	15.75	87.50	16.65	92.50	15.75	87.50	21.60	120.00	19.80	110.00
Cutical thickness	1.85	100.00	2.12	114.59	2.34	126.49	2.61	141.08	2.61	141.08	2.74	148.11
Thickness of peripheral sclerenchyma layers	76.65	100.00	77.40	100.98	65.70	85.71	60.30	78.67	101.25	132.09	97.80	127.59
No. of sclerenchyma layers	5.50	100.00	7.00	127.27	6.50	118.18	6.50	118.18	8.50	154.55	9.00	163.64
Mean thickness of the sclerenchyma layer	13.94	100.00	11.06	79.34	10.11	72.53	9.28	66.57	11.90	85.44	10.87	77.98
Thickness of parenchymatous ground tissue in stem wall	1286.85	100.00	1135.35	88.23	1434.15	111.45	1315.80	102.25	1438.65	111.80	1331.40	103.46
No. of parenchymatous ground tissue layers in stem wall	17.00	100.00	20.00	117.65	21.50	126.47	21.50	126.47	25.25	148.53	26.00	152.94
Mean thickness of the ground tissue layer	75.70	100.00	56.77	74.99	66.70	88.11	61.20	80.85	56.98	75.27	51.21	67.65
No. of vascular bundles	47.00	100.00	50.50	107.45	52.00	110.64	54.00	114.89	62.00	131.91	57.00	121.28
Length of the largest v. bundle	218.00	100.00	190.80	87.52	183.60	84.22	162.90	74.72	194.50	89.22	186.50	85.55
Width of the largest v. bundle	189.90	100.00	166.50	87.68	164.25	86.49	151.95	80.02	123.30	64.93	131.70	69.35
Mean thickness of the bundle sheath	29.65	100.00	26.73	90.15	31.95	107.76	24.75	83.47	31.73	107.02	35.10	118.38
Phloem tissue thickness	59.40	100.00	45.90	77.27	43.65	73.48	39.15	65.91	38.75	65.24	36.45	61.36
No. of metaxylem vessels in the largest v. bundle	2.00	100.00	2.00	100.00	2.00	100.00	2.00	100.00	2.00	100.00	2.00	100.00
Widest metaxylem vessel diameter	60.30	100.00	48.60	80.60	43.65	72.39	41.40	68.66	36.90	61.19	35.10	58.21
Wall thickness of metaxylem vessel	3.26	100.00	3.49	107.06	3.67	115.34	3.45	105.83	3.08	94.48	2.76	84.66
No. of protoxylem vessels in the largest v. bundle	1.00	100.00	1.50	150.00	1.50	150.00	1.75	175.00	2.25	225.00	2.25	225.00
Protoxylem vessel diameter	36.90	100.00	31.50	85.37	31.95	86.59	28.35	76.83	27.90	75.61	27.00	73.17
Wall thickness of protoxylem vessel	2.56	100.00	3.14	122.66	3.14	122.66	2.97	116.02	3.33	130.08	3.24	126.56
Xylem cavity diameter	31.50	100.00	21.60	68.57	21.42	68.00	17.10	54.29	13.73	43.59	9.75	30.95
Mean length of the parenchymatous cell in the ground tissue	221.95	100.00	149.40	67.31	133.50	60.15	117.90	53.12	73.80	33.25	61.20	27.57

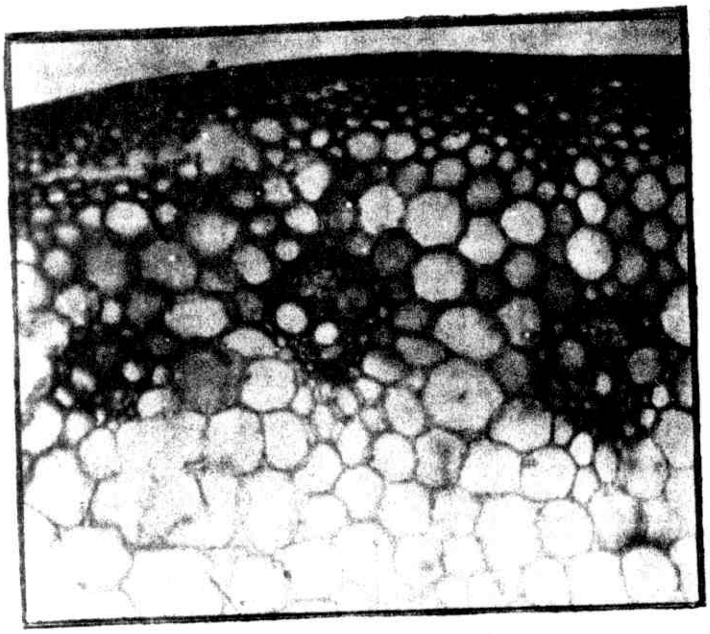


Fig. (34)

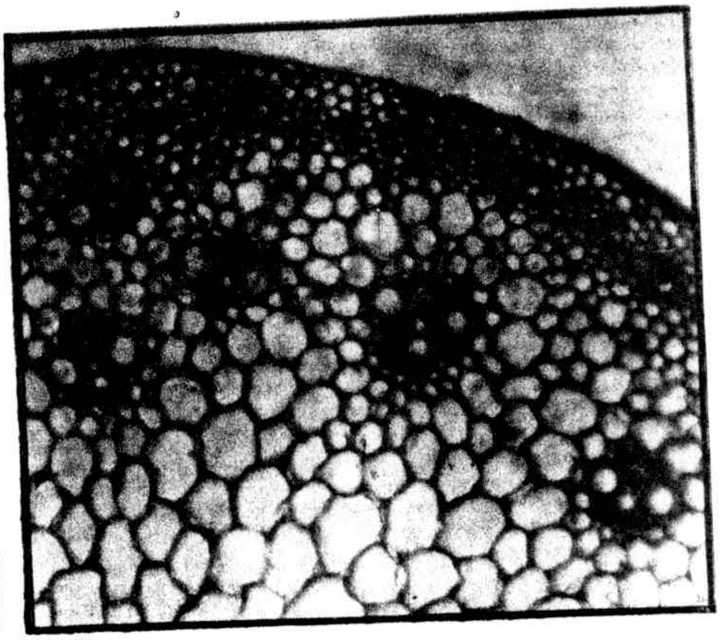


Fig. (35)

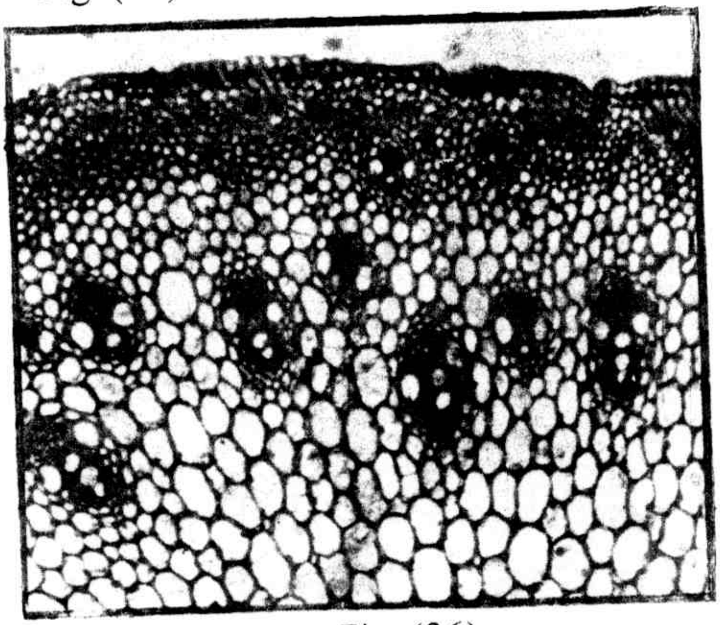


Fig. (36)

Figs. (34-36): Transverse sections through the main stem of wheat cv. Giza 163 as affected with the maximum tolerable salinity level of 7000 ppm alone and the untolerable salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm (X 100).

Fig. (34): Of an untreated plant.

Fig. (35): Of a plant treated with salinity level of 7000 ppm.

Fig. (36): Of a plant treated with salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm.

The reduction that existed in the stem diameter resulted from the application of the maximum tolerable salinity level alone could be attributed to the decrease in the thickness of stem wall and the diameter of hollow pith as well by about 32 and 11%, respectively. Besides, this reduction that existed in the stem wall was mainly due to the decrease in the thickness of the epidermis, the ground parenchyma tissue, length and width of the vascular bundles, thickness of the bundle sheath, phloem tissue thickness, diameter of both protoxylem and metaxylem vessels and also the xylem cavity. However, increase existed in some anatomical features such as the cuticle thickness, thickness and number of the peripheral sclerenchyma layers, number of the ground parenchyma layers, number of the vascular bundles, number of the protoxylem vessels in the vascular bundle and also wall thickness of the protoxylem and metaxylem vessels. While, the number of metaxylem vessels in the vascular bundle was not affected.

On the other hand, the reduction in the stem diameter that existed with the application of the untolerable salinity levels preceded with paclobutrazol (at 10 and 50 ppm) was a result of the complete absence or great reduction in the hollow pith. Since, the diameter of hollow pith was decreased by about 64 and 58% with the two untolerable salinity levels of 8000 and 9000 ppm, respectively when preceded with the low concentration of paclobutrazol (10 ppm). While, the hollow pith was completely disappeared with the high concentration of paclobutrazol (50 ppm). Although, increase existed in the thickness of the stem wall under these treatments. This increase was parallel to the applied concentration of paclobutrazol under the same untolerable salinity level. Since, the increase was about 10 and 1% with the two untolerable salinity levels of 8000 and 9000 ppm, respectively, when preceded with the low concentration of paclobutrazol (10 ppm), but it reached 13 and 5% with the high concentration of paclobutrazol (50 ppm). This increase that existed in the thickness of the stem wall was mainly due to the increase in many histological features e.g. thickness of the epidermis, thickness and number of the peripheral sclerenchyma (fibers) layers, thickness and number of the ground parenchyma layers, number of the vascular bundles and number of the protoxylem vessels as well. Also, increase existed in the cuticle thickness and wall thickness of the protoxylem and metaxylem vessels, although they did not clearly add to the thickness of the stem wall. The only exception was the reduction that existed in the wall thickness of metaxylem vessels with the two untolerable salinity levels (8000 and 9000 ppm) when preceded with the high concentration of paclobutrazol (50 ppm). Even though, reduction existed in the thickness of bundle sheath, dimensions of the vascular bundles, phloem tissue thickness, diameter of both protoxylem and metaxylem vessels and also the xylem cavity. Meanwhile, the number of metaxylem vessels in the vascular bundle was not affected.

With regard to the mean length of the parenchymatous cells in the ground tissue, the treatments of maximum tolerable salinity level alone (7000 ppm) and the untolerable salinity levels (8000 and 9000 ppm) preceded with paclobutrazol (10 and 50 ppm) led to its reduction. This could explain the shortness of the internodes. The reduction was directly proportional to the applied concentration of paclobutrazol and the salinity level as well (Table, 20 and Figs., 37-39).

2.2. Wheat cv. Sakha 92:

Table (21) and Figs. (40-42) show that the application of the maximum tolerable salinity level alone (7000 ppm) reduced the stem diameter by about 10% than the control. While, the application of paclobutrazol at 10 and 50 ppm before the treatment with the untolerable salinity levels (8000 and 9000 ppm)

Fig. (37)

Fig. (38)

Fig. (39)

Figs. (37-39): Longitudinal sections through the main stem of wheat cv. Giza 163 as affected with the maximum tolerable salinity level of 7000 ppm alone and the untolerable salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm (X 100).

Fig. (37): Of an untreated plant.

Fig. (38): Of a plant treated with salinity level of 7000 ppm.

Fig. (39): Of a plant treated with salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm.

diminished the adverse effect of salinity on the stem diameter. This positive effect of paclobutrazol was inversely proportional to the applied concentration. Since, the stem diameter was decreased by about 1 and 4% with the two untolerable salinity levels of 8000 and 9000 ppm, respectively when preceded with the low concentration of paclobutrazol (10 ppm), while the decrease reached 5 and 10% with the high concentration of paclobutrazal (50 ppm).

The reduction that existed in the stem diameter with the maximum tolerable salinity level when applied alone could be attributed to the decrease in the thickness, of the stem wall and diameter of the hollow pith as well by about 1 and 33%, respectively. Besides, this reduction that occurred in the stem wall was mainly due to the decrease in the thickness of the epidermis, the peripheral sclerenchyma layers, dimensions of the vascular bundles, thicknessof the bundle sheath, diameter of the protoxylem and metaxylem vessels and also the xylem cavity. Meanwhile, increase existed in some other anatomical features such as the cuticle thickness, thickness and number of ground parenchyma layers, number of the vascular bundles, phloem tissue thickness, number of the protoxylem in the vascular bundle and also wall thickness of both protoxylem and metaxylem vessels. Even though, the number of metaxylem vessels in the vascular bundle was not affected.

As for the reduction in the stem diameter that existed with the application of the untolerable salinity levels preceded with paclobutrazol was mainly resulted from the complete abscence or great reduction in the hollow pith. Since, the diameter of the hollow pith was decreased by about 38 and 33% with the two untolerable salinity levels of 8000 and 9000 ppm, respectively preceded with the low concentration of paclobutrazol (10 ppm).

Table (21): Mean counts and measurements related to the control in percent of certain histological features in transverse and longitudinal sections through the middle part of the fourth internode of the main stem of wheat cv. Sakha 92.

Measurements (μ) & counts	Treatments											
	Tap water (control)		Salinity 7000 ppm		Paclobutrazol (ppm)							
					10				50			
					Salinity (ppm)				Salinity (ppm)			
					8000		9000		8000		9000	
	X	%	X	%	X	%	X	%	X	%	X	%
Stem diameter	3501.00	100.00	3137.60	89.62	3465.00	98.97	3375.00	96.40	3330.00	95.12	3159.00	90.23
Hollow pith daimeter	1043.20	100.00	703.40	67.43	642.50	61.59	697.50	66.86	0.00	0.00	0.00	0.00
Stem wall thickness	1228.90	100.00	1217.10	99.04	1411.25	114.84	1338.50	108.92	1665.00	135.49	1579.50	128.53
Epidermis thickness	17.10	100.00	16.30	95.32	18.00	105.26	16.20	94.74	22.05	128.95	18.90	110.53
Cuticale thickness	2.01	100.00	2.03	101.00	2.25	111.94	2.30	114.43	2.79	138.81	2.34	116.42
Thickness of peripheral sclerenchyma layers	72.80	100.00	63.05	86.61	77.40	106.32	71.10	97.66	103.50	142.17	64.80	89.01
No. of sclerenchyma layers	6.00	100.00	6.00	100.00	6.75	112.50	6.75	112.50	10.25	170.83	6.00	100.00
Mean thickness of the sclerenchyma layer	12.13	100.00	10.51	86.61	11.47	94.56	10.53	86.81	10.10	83.26	10.80	89.04
Thickness of parenchymatous ground tissue in stem wall	1139.00	100.00	1147.75	100.77	1315.85	115.53	1251.20	109.85	1539.45	135.16	1495.80	131.33
No. of parenchymatous ground tissue layers in stem wall	16.00	100.00	18.50	115.63	20.25	126.56	20.25	115.63	24.00	150.00	24.50	153.13
Mean thickness of the ground tissue layer	71.19	100.00	62.04	87.15	64.98	91.28	61.79	86.80	64.14	90.10	61.05	85.76
No. of vascular bundles	49.00	100.00	51.00	104.08	56.00	114.29	56.00	114.29	57.00	116.33	53.50	109.18
Length of the largest v. bundle	184.45	100.00	194.85	105.64	207.90	112.71	184.50	100.03	225.30	122.15	198.00	107.35
Width of the largest v. bundle	170.20	100.00	149.40	87.78	155.70	91.48	153.00	89.89	135.00	79.32	140.40	82.49
Mean thickness of the bundle sheath	27.00	100.00	25.20	93.33	31.50	116.67	28.98	107.33	34.20	126.67	31.50	116.67
Phloem tissue thickness	46.60	100.00	49.40	106.01	42.30	90.77	40.50	86.91	39.40	84.55	37.80	81.12
No. of metaxylem vessels in the largest v. bundle	2.00	100.00	2.00	100.00	2.00	100.00	2.00	100.00	2.00	100.00	2.00	100.00
Widest metaxylem vessel diameter	47.70	100.00	43.65	91.51	43.10	90.36	40.05	83.96	39.60	83.02	36.90	77.36
Wall thickness of metaxylem vessel	3.16	100.00	3.23	102.22	3.68	116.46	3.07	95.05	3.05	96.52	2.88	89.16
No. of protoxylem vessels in the largest v. bundle	1.00	100.00	1.25	125.00	1.25	125.00	1.75	175.00	2.25	225.00	2.00	200.00
Protoxylem vessel diameter	34.20	100.00	32.85	96.05	31.30	91.52	30.85	90.20	29.05	84.94	32.40	94.74
Wall thickness of protoxylem vessel	2.43	100.00	2.79	114.82	2.75	113.17	3.02	124.28	3.11	127.98	3.20	131.69
Xylem cavity diameter	22.05	100.00	19.89	90.20	21.60	97.96	16.02	72.65	13.05	59.18	14.85	67.35
Mean length of the parenchymatous cell in the ground tissue	198.10	100.00	162.90	82.23	140.40	70.87	128.70	64.97	117.45	59.29	96.75	48.84

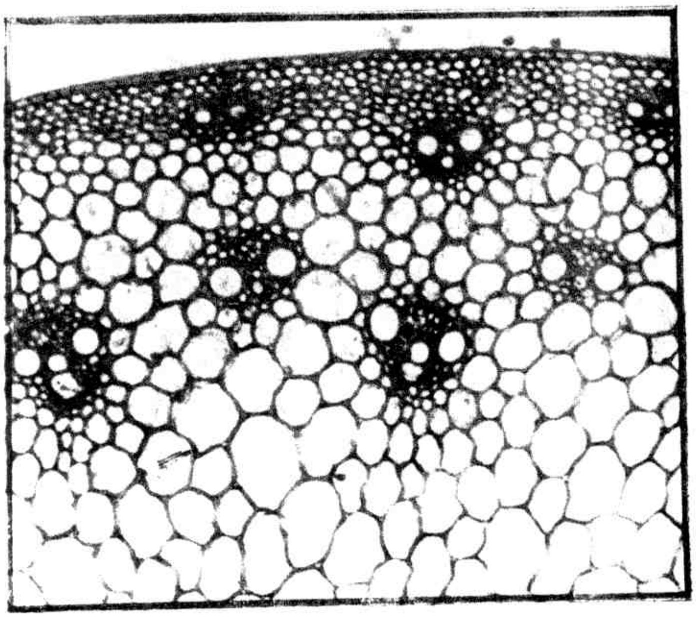


Fig. (40)

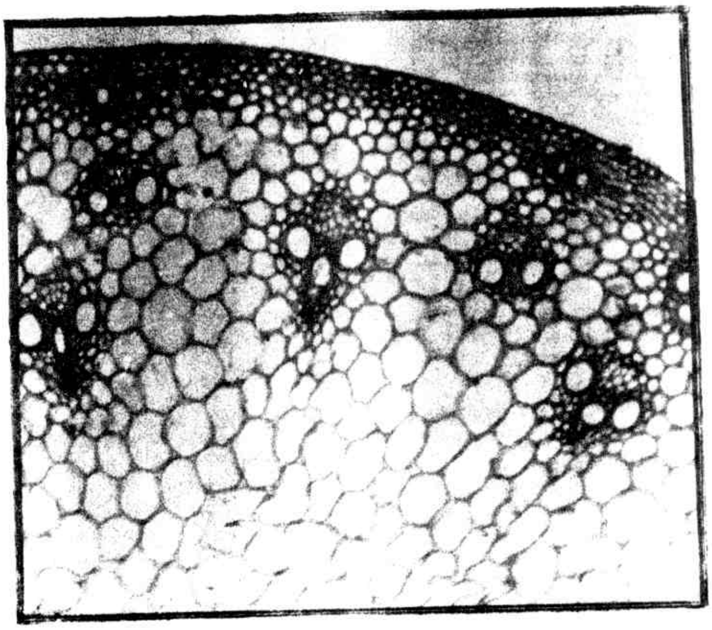


Fig. (41)

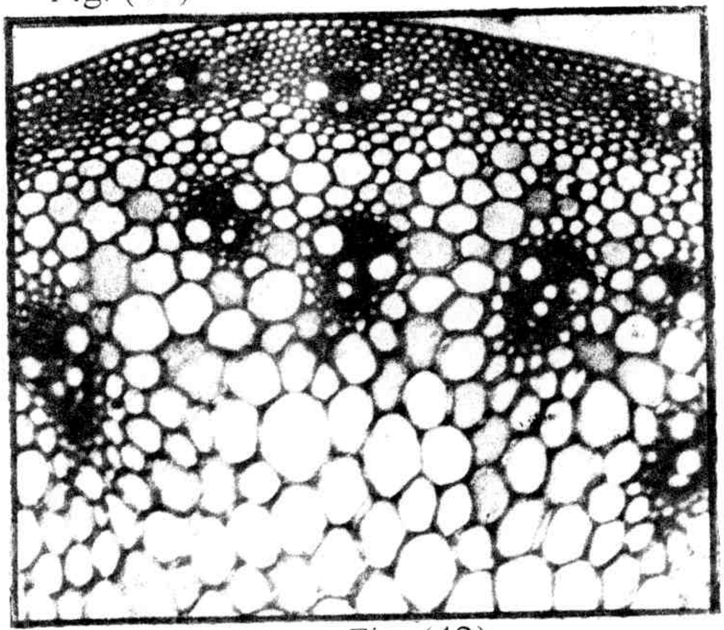


Fig. (42)

Figs. (40-42): Transverse sections through the main stem of wheat cv. Sakha 92 as affected with the maximum tolerable salinity level of 7000 ppm alone and the untolerable salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm (X 100).

Fig. (40): Of an untreated plant.

Fig. (41): Of a plant treated with salinity level of 7000 ppm.

Fig. (42): Of a plant treated with salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm.

While, the hollow pith was completely disappeared with the high concentration of paclobutrazol (50 ppm). Meanwhile, increase existed in the thickness of the stem wall with these treatments. This increase was directly proportional to the applied concentration of paclobutrazol under the same untolerable salinity level. As the increase was about 15 and ,19% under the two untolerable salinity levels when preceded with the low concentration of paclobutrazol (10 ppm), but it reached 35 and 26% with the high concentration of paclobutrazol (50 ppm). The increase that existed in the thickness of the stem wall was accompanied with increase in many histological features such as thickness of the epidermis, the cuticle thickness, thickness and number of the peripheral sclerenchyma layers, thickness and number of the ground parenchyma layers, number and length of the vascular bundles, thickness of the bundle sheath, number of the protoxylem vessels in the vascular bundle and also wall thickness of both protoxylem and metaxylem vessels. The only exception was the reduction that occurred in the wall thickness of metaxylem vessels with the two untolerable salinity levels preceded with paclobutrazol at 50 ppm. Even though, reduction existed in the width of vascular bundles, the phloem tissue thickness, the diameter of the protoxylem and metaxylem vessels and also the xylem cavity.

With respect to, the mean length of the parenchymatous cells in the ground tissue was decreased even with the application of maximum tolerable salinity level alone (7000 ppm) or the untolerable salinity levels (8000 and 9000 ppm) preceded with paclobutrazol (10 and 50 ppm). This could be explained the shortness of the internodes. The reduction was directly proportional to the used concentration of paclobutrazol and also applied salinity level (Table, 21 and Figs., 43-45).

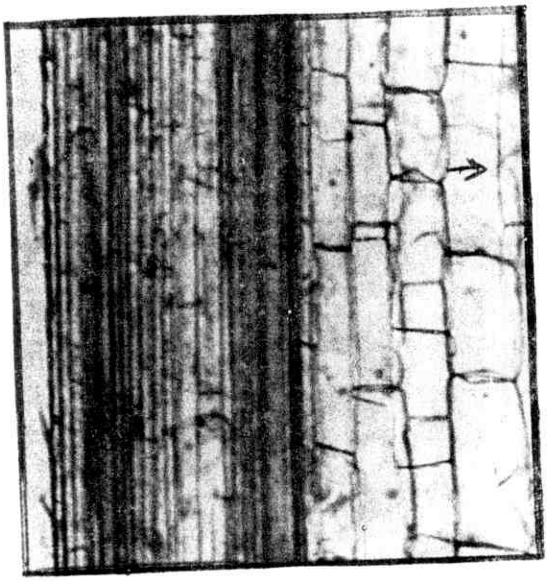


Fig. (43)

Fig. (44)

Fig. (45)

Figs. (43-45): Longitudinal sections through the main stem of wheat cv. Sakha 92 as affected with the maximum tolerable salinity level of 7000 ppm alone and the untolerable salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm (X 100).

Fig. (43): Of an untreated plant.

Fig. (44): Of a plant treated with salinity level of 7000 ppm.

Fig. (45): Of a plant treated with salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm.

Generally, when comparing the internal structure of the stem of the two wheat cultivars i.e. Giza 163 (the less salt-tolerant) and Sakha 92 (the more salt-tolerant) grown under the normal conditions and irrigated with tap water, many anatomical differences could be noticed. The differences that could represent the most important anatomical features are:

- decrease in thickness of many histological items such as the epidermis, the ground parenchymatous tissue, the peripheral sclerenchyma layers and the bundle sheath, the diminsions of vascular bundles, the diameter of xylem vessels and also the mean length of the parenchymatous cells in the ground tissue.
- increase in the cuticle thickness, the number of peripheral sclerenchyma layers, the number of vascular bundles and also the wall thickness of xylem vessels (Tables 20 & 21 and Figs., 34, 37, 40 & 43).

On the other hand, the obtained results dealing with main stem anatomy clearly show that the two assigned wheat cultivars were similarly responded to the treatment with the maximum tolerable salinity level alone and also the untolerable salinity levels preceded with paclobutrazol.

The application of maximum tolerable salinity level alone (7000 ppm) led to reduction in many histological features under study. However, increase existed in some important anatomical features which could accompany the salt tolerance phenomenon in these cultivars such as thickness of the cuticle, thickness and number of the peripheral sclerenchyma layers, number of the vascular bundles, number of the protoxylem vessels in the vascular bundle and also wall thickness of both protoxylem and metaxylem vessels. These contradicory effects of salinity were more pronounced in Giza 163 than in Sakha 92.

As for the application of paclobutrazol (10 & 50 ppm) before the treatment with the untolerable salinity levels (8000 and 9000 ppm) showed a clear compensating effect with regard to salinity. These was expressed in many important trends for instance:

- increase in the cuticle thickness.
- increase in the number of vascular bundles.
- decrease in the dimensions of these bundles.
- increase in the number of protoxylem vessels in the vascular bundle.
- decrease in the diameter of xylem vessels.
- increase in the wall thickness of xylem vessels.
- increase in the number of peripheral sclerenchyma (fibers) layers.
- decrease in the width of fiber cells in the ground tissue or arround the bundles.
- increase in the number of ground parenchyma layers that somtimes led to the disappearance of the hollow pith.
- decrease in the mean length of the parenchymatous cells in the ground tissue.

Hence, paclobutraczol seemed to be a very effective agent for increasing the tolerability of wheat plants to endure the high salinity levels. In addition to that paclobutrazol stimulated the transverse growth on the account of the longitudinal one. This made the wheat plants more resistant not only to salinity but also to loding.

2.3. Tomato cv. Castle Rock:

Table (22) and Figs. (46-48) show that the application of the maximum tolerable salinity level alone (5000 ppm) decreased the stem diameter by about 19% than the control. Also, the untolerable salinity levels (6000 and 7000 ppm) when preceded with paclobutrazol (at 10 and 50 ppm) led to reduction in the stem diameter than the control. This reduction was directly proportional to the concentration of paclobutrazol. The reduction was about 23 and 25% with the untolerable salinity levels of 6000 and 7000 ppm, respectively preceded with the low concentration of paclobutrazol (10 ppm). While, the reduction reached 47 and 45% with the same untolerable salinity levels when preceded with the high concentration of paclobutrazol (50 ppm). Therefore, it could be said that here paclobutrazol did not compensate the effect of salinity on the stem diameter. This could be due to the high inhibitory effect of the untolerable salinity levels on the stem growth of this cultivar.

The reduction that occured in the stem diameter even with the maximum tolerable salinity level alone or the untolerable salinity levels preceded with paclobutrazol could be attributed to the reduction in nearly all the histological features under study. This reduction existed in the thickness of the epidermis, thickness and number of the cortical collenchyma layers, thickness of the cortical parenchyma layers, thickness and number of the parenchymatous pith layers, dimensions of the vascular bundles, thickness of both outer and inner phloem, thickness of the cambial region, xylem tissue thickness and also diameter of the xylem vessels. Exceptions were with the untolerable salinity level of 6000 ppm preceded with paclobutrazol at 50 ppm as increase in the thickness of the epidermis existed, while the number of parenchymatous pith layers was not affected. However, increase existed in the cuticle thickness, the number of xylem vessels and the wall thickness of these vessels. Even though, the number of both large and small vascular bundles and also the number of cortical parenchyma layers were not affected.

For the mean length of the collenchymatous and parenchymatous cells of the cortex, Table, 22 and Figs., 49-51

Table (22): Mean counts and measurements related to the control in percent of certain histological features in transverse and longitudinal sections through the middle part of the fivth internode of the main stem of tomato cv. Castle Rock.

Measurements (µ) & counts	Treatments											
	Tap water (control)		Salinity 5000 ppm		Paclobutrazol (ppm)							
					10				50			
					Salinity (ppm)				Salinity (ppm)			
					6000		7000		6000		7000	
	X	%	X	%	X	%	X	%	X	%	X	%
Stem diameter	3330.00	100.00	2686.50	80.68	2565.00	77.03	2160.00	64.86	1773.00	53.24	1845.00	55.41
Epidermis thickness	32.40	100.00	26.55	81.94	27.00	83.33	29.25	90.28	35.10	108.33	26.55	81.94
Cutical thickness	2.20	100.00	2.66	120.91	2.88	130.91	2.70	122.73	2.97	135.00	3.24	147.27
Cortex thickness	351.00	100.00	279.00	79.49	280.80	80.00	256.50	73.08	369.00	105.13	241.20	68.72
Cortical collenchyma thickness	143.10	100.00	105.30	73.58	108.80	76.30	90.00	62.89	148.50	103.77	99.00	69.18
Thickness of cortical collenchyma layers	3.00	100.00	2.50	83.33	3.00	100.00	2.50	83.33	2.50	83.33	2.25	75.00
Mean thickness of the collenchyma layer	47.70	100.00	42.12	88.30	36.27	76.30	36.00	75.47	59.40	124.53	44.00	92.22
Thickness of cortical parenchyma layers	207.90	100.00	173.70	83.54	172.00	82.73	166.50	80.09	220.50	106.06	142.20	68.40
No. of cortical parenchyma layers	4.00	100.00	4.00	100.00	4.00	100.00	4.00	100.00	4.00	100.00	4.00	100.00
Mean thickness of the parenchyma layer	51.98	100.00	43.43	83.54	43.00	82.73	41.63	80.09	55.13	106.06	35.55	68.40
Parenchymatous pith diameter	1751.80	100.00	1434.60	81.89	1332.00	76.04	1041.30	59.44	466.20	26.61	859.50	49.06
No. of parenchmatous pith layer	14.00	100.00	14.00	100.00	14.00	100.00	12.00	85.71	8.00	57.14	11.00	78.57
Mean thickness of the pith layer	125.13	100.00	102.46	81.89	95.14	76.04	86.78	89.35	58.28	46.58	78.14	62.45
No. of large vascular bundles	4.00	100.00	4.00	100.00	4.00	100.00	4.00	100.00	4.00	100.00	4.00	100.00
No. of small vascular bundles	3.00	100.00	3.00	100.00	3.00	100.00	3.00	100.00	3.00	100.00	3.00	100.00
Total No. of vascular bundles	7.00	100.00	7.00	100.00	7.00	100.00	7.00	100.00	7.00	100.00	7.00	10.00
Length of the large v. bundle	405.90	100.00	320.40	78.94	308.70	76.05	273.60	67.41	249.30	61.42	225.00	55.43
Width of the large v. bundle	495.00	100.00	378.00	76.36	360.00	72.73	270.00	54.55	201.60	40.73	360.00	72.73
Thickness of the outer phloem tissue in the large v. bundle	29.70	100.00	20.70	69.70	21.60	72.73	18.00	60.61	23.40	78.79	19.80	66.67
Thickness of the inner phloem tissue in the large v. bundle	36.90	100.00	27.00	73.17	32.40	87.80	26.10	70.73	36.00	97.56	32.40	87.80
Thickness of the cambium region in the large v. bundle	33.30	100.00	23.40	80.17	25.20	75.68	20.70	62.16	27.00	81.08	24.30	72.97
Thickness of the xylem tissue in the large v. bundle	306.00	100.00	249.30	81.47	229.50	75.00	208.80	68.24	162.90	53.24	148.50	48.53
No. of the xylem vessels in the large v. bundle	20.50	100.00	27.00	131.71	21.50	104.88	21.00	102.44	18.50	90.24	23.00	112.20
Diameter of the widest xylem vessel	69.30	100.00	54.00	77.92	50.40	72.73	37.80	54.55	30.60	44.16	31.50	45.45
Wall thickness of widest xylem vessel	2.34	100.00	2.88	123.08	3.20	136.75	2.79	119.23	3.02	129.06	3.25	138.89
Mean length of the cortical collenchyma cell	216.10	100.00	180.45	83.50	184.50	85.38	175.50	81.21	153.50	71.03	161.10	74.55
Mean length of the cortical parenchyma cell	135.00	100.00	95.40	70.67	98.10	72.67	81.00	60.00	76.50	56.67	77.40	57.33

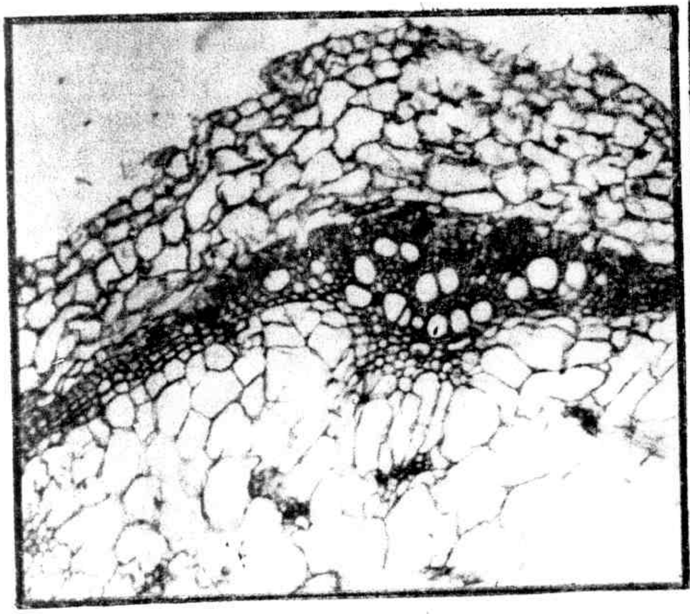


Fig. (46)

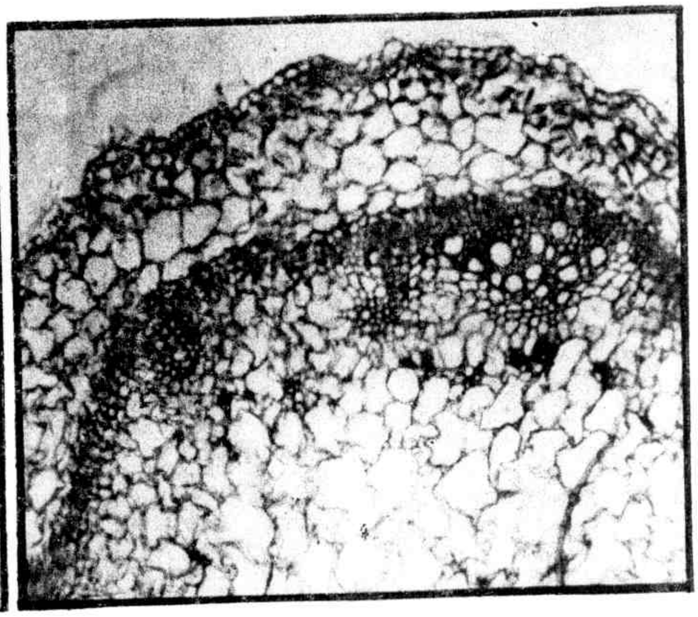


Fig. (47)

Fig. (48)

Figs. (46-48): Transverse sections through the main stem of tomato cv. Castle Rock as affected with the maximum tolerable salinity level of 5000 ppm alone and the untolerable salinity level of 6000 ppm preceded with paclobutrazol at 50 ppm (X 60).

Fig. (46): Of an untreated plant.

Fig. (47): Of a plant treated with salinity level of 5000 ppm.

Fig. (48): Of a plant treated with salinity level of 6000 ppm preceded with paclobutrazol at 50 ppm.

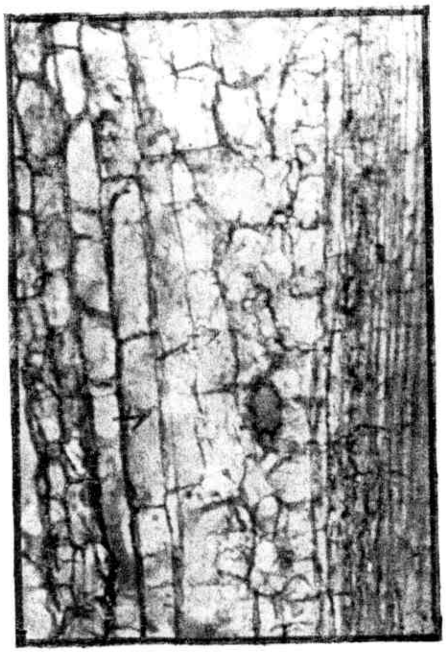


Fig. (49)

Fig. (50)

Fig. (51)

Figs. (49-51): Longitudinal sections through the main stem of tomato cv. Castle Rock as affected with the maximum tolerable salinity level of 5000 ppm alone and the untolerable salinity level of 6000 ppm preceded with paclobutrazol at 50 ppm (X 100).

Fig. (49): Of an untreated plant.

Fig. (50): Of a plant treated with salinity level of 5000 ppm.

Fig. (51): Of a plant treated with salinity level of 6000 ppm preceded with paclobutrazol at 50 ppm.

clearly show that the maximum tolerable salinity level (5000 ppm) applied alone and also the untolerable salinity levels (6000 and 7000 ppm) preceded with paclobutrazol (10 and 50 ppm) caused but a great reduction in this parameter - i.e. mean length of the cortical cells - that could be combined with the internodes shortness. Here, the reduction was directly proportional to the concentration of paclobutrazol and also the applied level of salinity.

2.4. Tomato cv. Edkawi:

Table (23) and Figs. (52-54) show that the application of salinity alone at the maximum tolerable level (7000 ppm) led to reduction in the stem diameter by about 9% than the control. On the other hand, the two applied concentration of paclobutrazol (10 and 50 ppm) before the treatment with the untolerable salinity levels (8000 and 9000 ppm) exhibited different effects in this respect. For instance, the low concentration of paclobutrazol (10 ppm) diminished the deleterious effect of salinity on the stem diameter. Since it caused reduction in this parameter by about 3 and 13% with the untolerable salinity levels of 8000 and 9000 ppm, respectively. Meanwhile, the high concentration of paclobutrazol (50 ppm) overcame the deleterious effect of salinity on the stem diameter as it was increased by about 9 and 3% with the two applied untolerable salinity levels (8000 and 9000 ppm), respectively.

The reduction that existed in the stem diameter with the maximum tolerable salinity level applied alone and also with the untolerable salinity levels preceded with the low concentration of paclobutrazol (10 ppm) was mainly due to the reduction in the thickness of some tissue e.g. the epidermis, the cortical collenchyma and parenchyma layers and also the parenchymatous pith layers. Although, the number of these layers was not affected,

Table (23): Mean counts and measurements related to the control in percent of certain histological features in transverse and longitudinal sections through the middle part of the fivth internode of the main stem of tomato cv. Edkawi.

Measurements (μ) & counts	Treatments											
	Tap water (control)		Salinity 7000 ppm		Paclobutrazol (ppm)							
					10				50			
					Salinity (ppm)				Salinity (ppm)			
					8000		9000		8000		9000	
	X	%	X	%	X	%	X	%	X	%	X	%
Stem diameter	4122.60	100.00	3762.00	91.25	4005.00	97.15	3603.60	87.41	4509.00	109.37	4230.00	102.61
Epidermis thickness	34.20	100.00	28.80	84.21	29.70	86.84	25.20	73.68	32.40	94.74	26.10	76.32
Cutical thickness	2.52	100.00	2.66	105.56	2.97	117.86	3.15	125.00	3.15	125.00	3.38	134.13
Cortex thickness	494.10	100.00	426.60	86.34	373.50	75.59	318.60	64.48	396.00	80.15	337.50	75.59
Thickness of cortical collenchyma layers	215.10	100.00	180.09	84.10	160.20	74.48	138.60	64.44	165.60	76.99	148.50	69.04
No. of cortical collenchyma layers	4.00	100.00	4.00	100.00	4.00	100.00	4.00	100.00	4.00	100.00	4.00	100.00
Mean thickness of the collenchyma layer	53.78	100.00	45.23	84.10	40.05	74.48	34.65	64.44	41.40	76.99	37.13	69.04
Thickness of cortical parenchyma layers	279.00	100.00	245.70	88.06	213.30	76.45	180.00	64.52	230.40	82.58	189.00	67.74
No. of cortical parenchyma layers	5.00	100.00	5.00	100.00	5.00	100.00	5.00	100.00	5.00	100.00	5.00	100.00
Mean thickness of the parenchyma layer	55.80	100.00	49.14	88.06	42.66	76.45	36.00	64.52	46.08	82.58	37.80	67.74
Parenchymatous pith thickness	2144.70	100.00	1981.80	92.40	2109.60	98.36	1980.00	92.30	2505.60	116.83	2491.20	116.16
No. of parenchmatous pith layer	19.00	100.00	19.00	100.00	22.00	115.79	22.00	115.79	25.00	131.58	26.00	136.84
Mean thickness of the pith layer	112.88	100.00	104.31	92.40	95.89	84.95	90.00	79.73	100.22	88.78	95.82	84.89
No. of large vascular bundles	5.00	100.00	5.00	100.00	5.00	100.00	5.00	100.00	5.00	100.00	5.00	100.00
No. of small vascular bundles	3.00	100.00	3.00	100.00	3.00	100.00	3.00	133.33	4.00	133.33	4.00	133.33
Total No. of vascular bundles	8.00	100.00	8.00	100.00	8.00	100.00	8.00	112.50	9.00	112.50	9.00	112.50
Length of the large v. bundle	460.35	100.00	434.70	94.43	544.50	118.28	468.00	101.66	573.30	124.54	505.80	109.87
Width of the large v. bundle	393.30	100.00	433.80	110.30	607.50	154.46	553.50	140.73	630.00	160.18	720.00	183.07
Thickness of the outer phloem tissue in the large v. bundle	44.10	100.00	40.50	91.84	45.00	102.04	35.10	79.59	49.50	112.24	45.90	112.24
Thickness of the inner phloem tissue in the large v. bundle	54.90	100.00	53.10	96.72	61.20	111.48	54.00	98.36	67.50	122.95	63.90	116.39
Thickness of the cambium region in the large v. bundle	61.20	100.00	59.40	97.06	65.07	106.32	41.40	67.65	72.00	117.65	55.80	91.18
Thickness of the xylem tissue in the large v. bundle	300.15	100.00	281.70	93.85	372.60	124.14	337.50	112.44	384.30	128.04	340.20	113.34
No. of the xylem vessels in the large v. bundle	28.00	100.00	30.00	107.14	33.00	117.86	35.00	125.00	35.00	125.00	40.00	142.86
Diameter of the widest xylem vessel	60.30	100.00	61.85	102.57	67.50	111.94	66.60	110.45	74.90	124.21	70.20	116.42
Wall thickness of widest xylem vessel	3.20	100.00	3.78	118.13	3.96	123.75	4.23	132.19	3.78	118.13	3.87	120.94
Mean length of the cortical collenchyma cell	270.90	100.00	198.90	73.42	212.40	78.41	201.60	74.42	180.00	66.45	175.50	64.78
Mean length of the cortical parenchyma cell	153.45	100.00	123.30	80.35	109.80	71.55	91.80	59.82	98.01	63.87	81.45	53.08

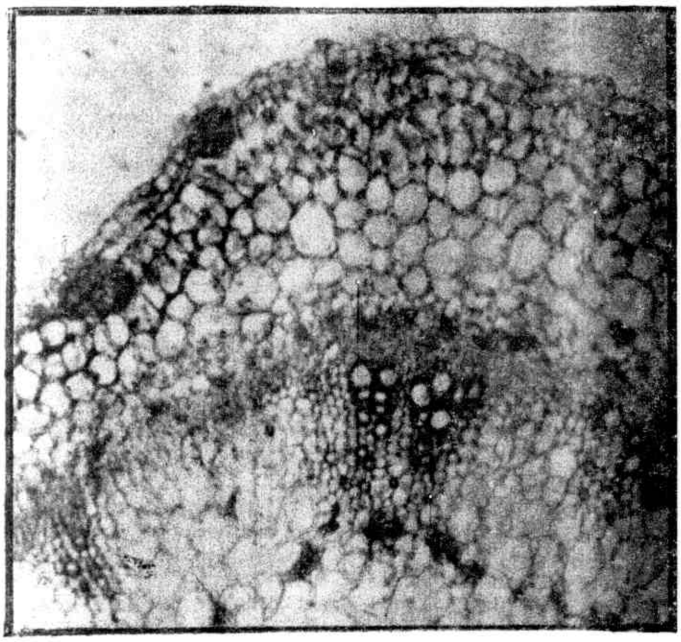


Fig. (52)

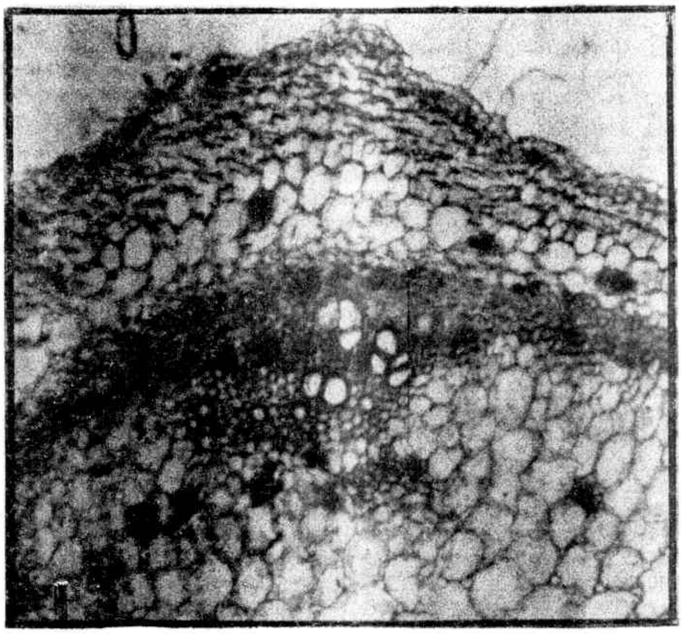


Fig. (53)

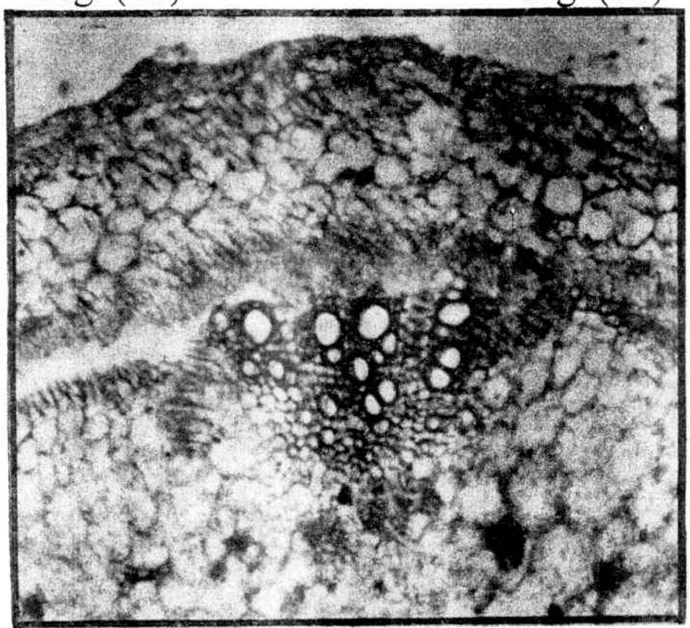


Fig. (54)

Figs. (52-54): Transverse sections through the main stem of tomato cv. Edkawi as affected with the maximum tolerable salinity level of 7000 ppm alone and the untolerable salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm (X 60).

Fig. (52): Of an untreated plant.

Fig. (53): Of a plant treated with salinity level of 7000 ppm.

Fig. (54): Of a plant treated with salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm.

yet the mean thickness of the collenchymatous and parenchymatous cells of the cortex and the parenchymatous cells of the pith as well was decreased. Of interest was that the increase that existed in many histological aspects which could be related to the salt tolerance phenomenon in this cultivar. For instance, the cuticle thickness, the dimensions of vascular bundles, the thickness of phloem regions even the outer or the inner ones, cambium region and xylem tissue, the number of xylem vessels, the diameter of xylem vessels and also the wall thickness of these vessels. Even though the number of both large and small bundles was not affected. The exceptions that existed were with the application of maximum tolerable salinity level alone, since it decreased the length of vascular bundles, the thickness of both outer and inner phloem tissues and the thickness of cambium region.

The increase that existed in the stem diameter with the untolerable salinity levels preceded with the high concentration of paclobutrazol (50 ppm) was mainly resulted from the increase in many histological features which could be played a great role in enhancement the ability of this cultivar to endure the high salinity levels. Of these are number of the small vascular bundles, dimensions of the vascular bundles, thickness of: the outer and inner phloem tissues, the cambium region and the xylem tissue, number of xylem vessels, wall thickness of the vessels, number of the parenchymatous pith layers and also the cuticle thickness (the increase in the cuticle thickness and the wall thickness of xylem vessels as well did not clearly add to the stem diameter). Meanwhile, reduction existed in the thickness of the epidermis and cortex (collenchyma and parenchyma layers). However, the number of vascular bundles and both cortical collenchyma and parenchyma layers was not affected.

As for the mean length of both collenchymatous and parenchymatous cells of the cortex, Table (23) and Figs. (55-57) clearly indicate that the maximum tolerable salinity level (7000 ppm) applied alone and the untolerable salinity levels (8000 and 9000 ppm) preceded with paclobutrazol (at 10 and 50 ppm) caused great reduction in this parameter that accompany internodes shortness. The reduction was directly proportional to the concentration of paclobutrazol and the applied level of salinity as well.

In general, it could be concluded from the data cited in Tables (22 and 23) and also Figs. (48, 49, 52 and 55) that there are many anatomical feature distinguish the main stem of the tomato cv. Edkawi (the more salt- tolerant) than that of the tomato cv. Castle Rock (the less salt-tolerant) grown under the normal conditions and irrigated with tap water. Of these features are the increase in thickness of the cuticle, thickness and number of both cortical collenchyma and parenchyma layers, number of the vascular bundles - especially the large bundles -, thickness of the cambium region, thickness of the outer and inner phloem tissues, number of the xylem vessels and also wall thikness of the vessels. Besides, the reduction in thickness of the xylem tissue and diameter of its vessels. This phenomenon is of interest as these anatomical features could be intimately related to the high ability of Edkawi cv. to act with salt tolerance more than that of Castle Rock cv.

The previous results also show that the histological response of the main stem to the applied maximum tolerable salinity levels (5000 ppm for Castle Rock cv. and 7000 ppm for Edkawi cv.) was nearly similar in the two tomato cultivars. Since, reduction existed in most studied histological characters. Even though increase was noticed in the cuticle thickness and the wall thickness of xylem

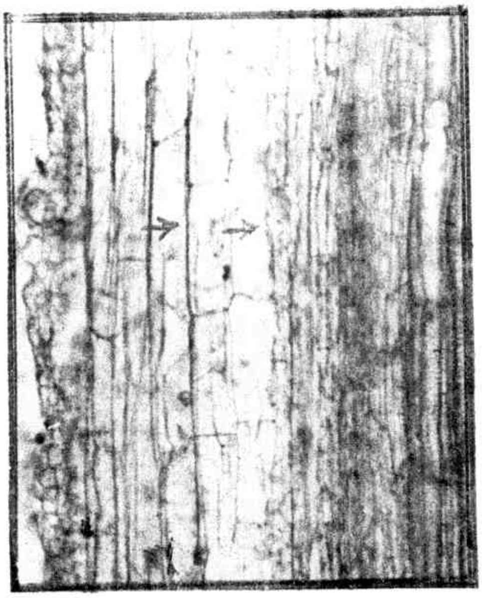


Fig. (55)

Fig. (56)

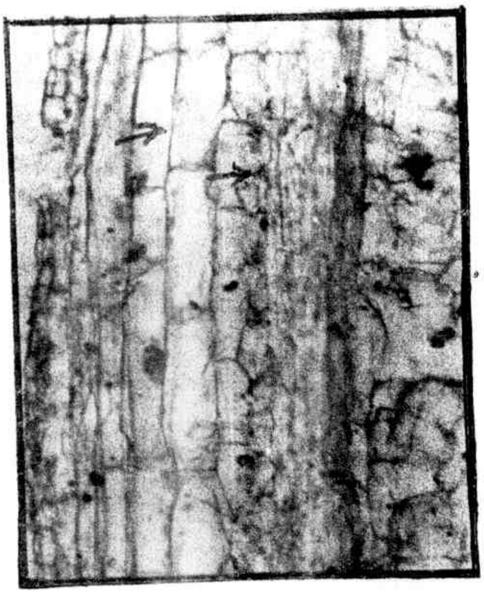


Fig. (57)

Figs. (55-57): Longitudinal sections through the main stem of tomato cv. Edkawi as affected with the maximum tolerable salinity level of 7000 ppm alone and the untolerable salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm (X 100).

Fig. (55): Of an untreated plant.

Fig. (56): Of a plant treated with salinity level of 7000 ppm.

Fig. (57): Of a plant treated with salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm.

vessels as well. While, the number of vascular bundles - even large or small bundles - was not affected. These positive and negative effects existed with salinity were more pronounced in Castle Rock than in Edkawi.

The situation with paclobutrazol when applied before the treatments of untolerable salinity was different in the two tomato cultivars. For instance in Castle Rock , the application of paclobutrazol at 10 and 50 ppm before the treatment with the untolerable salinity levels (6000 and 7000 ppm) led to reduction in most anatomical features under study. This reduction was not only proportional to the used concentration but also was more obvious than that existed with the maximum tolerable salinity level alone. However, increase existed in the cuticle thickness, the number of xylem vessels and also the wall thickness of these vessels. While, the number of vascular bundles and cortical parenchyma layers was not affected (Tables, 22 and Figs., 46-51). But in Edkawi , the application of paclobutrazol (at 10 and 50 ppm) before the treatment with the untolerable salinity levels (8000 and 9000 ppm) exhibited a clear compensating effect with regard to salinity. The expression was in many important trends for instance:

- diminish the adverse effect of salinity on some anatomical features e.g. the stem diameter and thickness of: the epidermis, the cortex (collenchyma and parenchyma layers) and the parenchymatous pith.
- increase of some important anatomical features in this respect e.g. thickness of: the cuticle, the phloem tissues - outer and inner -, the xylem tissue and the cambium region, number of the small vascular bundles (increased with about 33% more than the control with the high concentration of paclobutrazol (50 ppm) under the two applied untolerable salinity levels), dimensions of the vascular bundles, number and width of the xylem vessels, wall thickness of the vessels and also number of the pith layers

(Table, 23 and Figs., 52-57). Hence, paclobutrazol seemed to be a very effective agent for increasing the ability of this cultivar to endure high levels of salinity.

3. Effect of the maximum tolerable salinity levels alone and the untolerable salinity levels preceded with paclobutrazol on the histological features of the leaf:

Tables (24-27) and Figs. (58-69) show the effect of the maximum tolerable salinity levels when applied alone and the untolerable salinity levels preceded with paclobutrazol on the mean counts and measurements of certain histological features of the wheat leaves (cvs. Giza 163 and Sakha 92) and the tomato leaves (cvs. Castle Rock and Edkawi). These counts or measurements are then related - in percent - to the control.

3.1. Wheat cv. Giza 163:

Table (24) and Figs. (58-60) clearly show that the application of maximum tolerable salinity level alone (7000 ppm) and the untolerable salinity levels (8000 and 9000 ppm) preceded with paclobutrazol (10 and 50 ppm) led to reduction in the thickness of nearly all the studied histological aspects. This reduction was mostly more pronounced with the maximum tolerable salinity level alone than with the untolerable salinity levels preceded with paclobutrazol, especially with the high concentration (50 ppm). The reduction existed in the thickness of the central main vien, the lamina, the upper and lower epidermis, the motor cells, the mesophyll tissue, the bundle sheath and the phloem tissue, diamensions of the main vascular bundle, diameter of both protoxylem and metaxylem vessels, diameter of the xylem cavity and also thickness of the lowermost fiber layers. Even though increase existed in the thickness of the cuticle, number of the metaxylem vessels (the increase reached 50% more than the control with the untolerable salinity level of 9000 ppm preceded

Table (24): Mean counts and measurements related to the control in percent of certain histological features in transverse sections through the third leaf on the main stem of wheat cv. Giza 163.

Measurements (µ) & counts	Treatments											
	Tap water (control)		Salinity 7000 ppm		Paclobutrazol (ppm)							
					10				50			
					Salinity (ppm)				Salinity (ppm)			
					8000		9000		8000		9000	
	X	%	X	%	X	%	X	%	X	%	X	%
Central main vien thickness	990.00	100.00	864.00	87.27	720.00	72.73	716.40	72.36	820.80	82.91	927.00	93.64
Blade thickness	369.90	100.00	316.80	85.64	311.40	84.18	279.00	75.43	351.00	94.89	314.00	84.87
Upper epidermis thickness	29.70	100.00	22.95	77.27	23.85	80.30	22.50	75.76	23.40	78.79	22.50	75.76
Cuticle thickness	2.34	100.00	2.88	123.08	3.02	129.06	4.14	176.92	3.78	161.54	3.96	169.23
Lower epidermis thickness	23.85	100.00	20.70	86.79	22.05	92.45	19.35	81.13	22.50	94.34	20.70	86.79
Mesophyll tissue thickness	316.35	100.00	273.15	86.35	265.50	83.93	237.15	74.96	305.10	96.44	272.80	86.23
No. of mesophyll layers	8.00	100.00	8.00	100.00	8.00	100.00	8.00	100.00	8.50	106.25	8.25	103.13
Mean thickness of the mesophyll layer	39.54	100.00	34.14	86.35	33.19	83.93	29.64	74.96	35.89	90.77	33.07	83.64
No. of grouped motor cells	4.00	100.00	5.00	125.00	4.00	100.00	4.00	100.00	4.00	100.00	4.00	100.00
The largest motor cell thickness	58.05	100.00	53.10	91.47	45.90	79.07	43.20	74.42	57.60	99.22	54.00	93.02
Thickness of the lowermost fiber layers	131.40	100.00	115.20	87.67	99.00	75.34	103.50	78.77	117.00	89.04	135.00	102.74
No. of the lowermost fiber layers	8.00	100.00	8.50	106.25	8.00	100.00	8.00	100.00	8.00	100.00	9.00	112.50
mean thickness of the fiber layer	16.43	100.00	13.55	82.49	12.38	75.34	12.94	78.77	14.63	89.04	15.00	91.30
Length of the main vascular bundle	167.40	100.00	139.50	83.33	130.50	77.96	133.20	79.57	146.70	87.63	144.00	86.02
Width of the main vascular bundle	205.20	100.00	180.00	87.72	167.40	81.58	154.80	75.44	189.00	92.11	169.20	82.46
Mean thickness of the bundle sheath	18.90	100.00	17.10	90.48	15.57	82.38	13.05	69.05	19.80	104.76	14.85	78.57
Phloem tissue thickness	48.15	100.00	39.15	81.31	42.30	87.85	39.60	82.24	45.00	93.46	41.40	85.98
No. of metaxylem vessels in the main v. bundle	2.00	100.00	2.25	112.50	2.00	100.00	2.50	125.00	2.25	112.50	3.00	150.00
Widest metaxylem vessel diameter	44.10	100.00	36.90	83.67	32.85	74.49	31.05	70.41	40.50	91.84	33.30	75.51
Wall thickness of metaxylem vessel	2.61	100.00	3.06	117.24	3.15	120.69	3.69	141.38	2.93	112.26	3.15	120.69
No. of protoxylem vessels in the main v. bundle	1.00	100.00	1.00	100.00	1.00	100.00	1.00	100.00	1.00	100.00	1.00	100.00
Protoxylem vessel diameter	31.05	100.00	27.00	86.96	24.75	79.71	21.60	69.57	27.90	89.86	24.30	76.70
Wall thickness of protoxylem vessel	2.34	100.00	2.79	119.23	2.88	123.08	3.06	130.77	2.70	115.38	2.84	121.36
Xylem cavity diameter	27.90	100.00	17.55	62.90	18.90	67.74	15.75	56.45	15.30	54.84	12.15	43.51

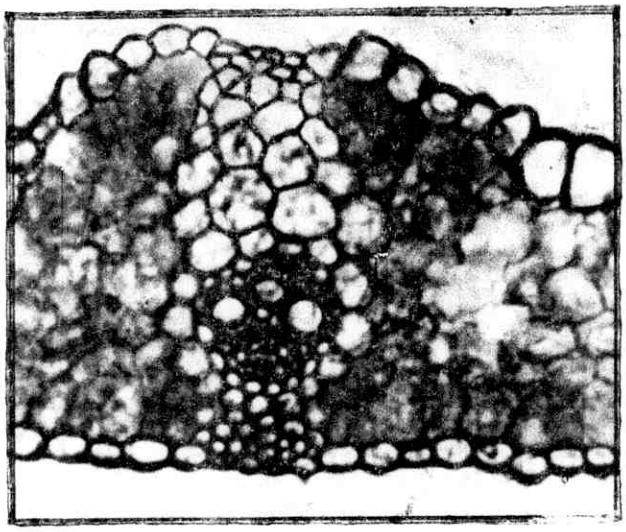


Fig. (58)

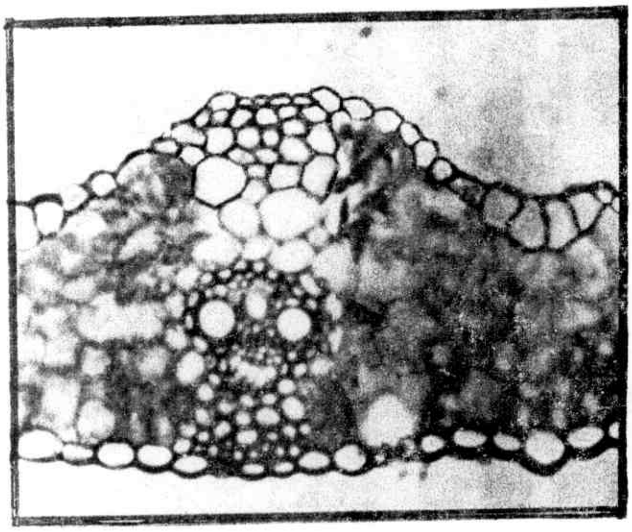


Fig. (59)

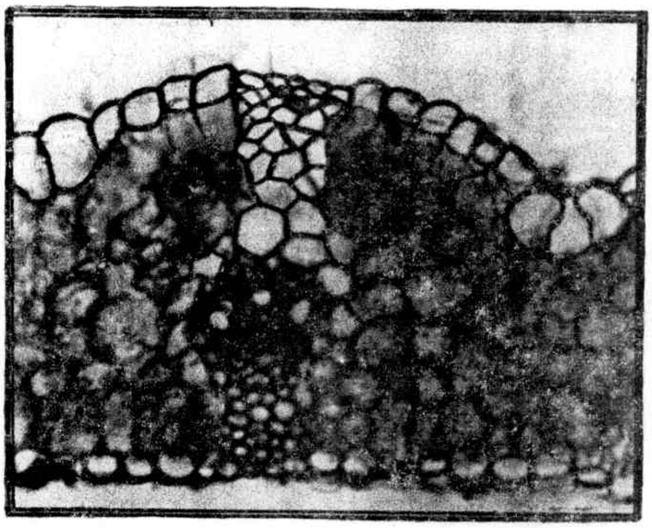


Fig. (60)

Figs. (58-60): Transverse sections through the blade of third leaf developed on the main stem of wheat cv. Giza 163 as affected with the maximum tolerable salinity level of 7000 ppm alone and the untolerable salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm (X 150).

Fig. (58): Of an untreated plant.

Fig. (59): Of a plant treated with salinity level of 7000 ppm.

Fig. (60): Of a plant treated with salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm.

with paclobutrazol at 50 ppm) and also wall thickness of the protoxylem and metaxylem vessels. The increase was more pronounced with the untolerable salinity levels preceded with paclobutrazol than with the maximu tolerable salinity level alone. Meanwhile, the number of: the grouped motor cells, the mesophyll layers and the protoxylem vessels was not affected. Exceptions were the increase that existed in the number of the grouped motor cells with the maximum tolerable salinity level alone (25% more than the control) and also the increase that existed in the number of mesophyll layers with the untolerable salinity levels preceded with the high concentration of paclobutrazol (50 ppm).

3.2. Wheat cv. Sakha 92:

Table (25) and Figs. (61-63) show that the application of salinity alone at the maximum tolerable salinity level (7000 ppm) caused reduction in nearly all the anatomical characters under study. The reduction included the thickness of: the central main vien, the lamina, the upper and lower epidermis, the motor cells, the mesophyll tissue, the bundle sheath and the phloem tissue, dimentions of the main vascular bundle, diameter of the protoxylem vessels, diameter of the xylem cavity and also thickness of the lowermost fiberous layers. While, the number of: the grouped motor cells, the mesophyll layers and the protoxylem and metaxylem vessels were not affected. On contrary, increase existed in the cuticle thickness and the wall thickness of both protoxylem and metaxylem vessels.

Of interest was that, the application of paclobutrazol with its two concentration (10 and 50 ppm) before the treatments with the untolerable salinity levels (8000 and 9000 ppm) led to increase in many histological characters under study. This increase was directly proportional to the applied concentration of paclobutrazol. The increase existed in the thickness of the lamina, the upper and

Table (25): Mean counts and measurements related to the control in percent of certain histological features in transverse sections through the third leaf on the main stem of wheat cv. Sakha 92.

Measurements (µ) & counts	Treatments											
	Tap water (control)		Salinity 7000 ppm		Paclobutrazol (ppm)							
					10				50			
					Salinity (ppm)				Salinity (ppm)			
					8000		9000		8000		9000	
	x	%	x	%	x	%	x	%	x	%	x	%
Central main vien thickness	774.00	100.00	733.50	94.77	729.00	94.19	684.00	88.37	762.00	98.45	720.00	93.02
Blade thickness	328.50	100.00	308.70	93.97	347.80	105.88	334.50	101.85	383.85	116.85	354.30	107.85
Upper epidermis thickness	25.20	100.00	22.95	91.07	23.28	92.38	22.10	87.70	29.70	117.86	26.85	106.55
Cuticle thickness	2.57	100.00	2.97	115.56	3.60	140.08	3.78	147.08	3.78	147.08	3.87	150.58
Lower epidermis thickness	21.15	100.00	19.35	91.49	20.35	96.62	19.05	92.20	23.85	112.77	22.20	104.96
Mesophyll tissue thickness	282.15	100.00	266.40	94.42	304.17	107.80	293.45	104.00	330.30	117.07	305.25	108.19
No. of mesophyll layers	8.00	100.00	8.00	100.00	9.50	118.75	9.00	112.50	9.75	121.88	9.00	112.50
Mean thickness of the mesophyll layer	35.27	100.00	33.30	94.42	32.18	90.78	32.60	92.44	33.88	96.06	33.92	96.16
No. of grouped motor cells	4.00	100.00	4.00	100.00	4.00	100.00	4.00	100.00	4.00	100.00	4.00	100.00
The largest motor cell thickness	64.35	100.00	57.60	89.51	55.80	86.71	55.80	86.71	72.00	111.89	58.50	90.91
Thickness of the lowermost fiber layers	90.00	100.00	81.00	90.00	82.35	91.50	74.50	82.50	81.00	90.00	77.40	86.00
No. of the lowermost fiber layers	6.00	100.00	6.00	100.00	6.00	100.00	6.00	100.00	6.00	100.00	6.00	100.00
mean thickness of the fiber layer	15.00	100.00	13.50	90.00	13.73	91.50	12.41	82.50	13.50	90.00	12.90	86.00
Length of the main vascular bundle	166.50	100.00	148.50	89.19	151.20	90.81	142.20	85.41	178.00	106.91	168.90	101.44
Width of the main vascular bundle	194.40	100.00	183.60	94.44	166.50	85.65	171.90	88.43	197.10	101.39	177.90	91.51
Mean thickness of the bundle sheath	20.35	100.00	17.45	85.75	16.25	79.85	16.65	77.41	21.25	104.42	21.00	103.19
Phloem tissue thickness	43.20	100.00	38.70	89.58	46.35	107.29	45.90	106.25	49.50	114.58	45.85	106.13
No. of metaxylem vessels in the main v. bundle	2.00	100.00	2.00	100.00	2.00	100.00	2.00	100.00	3.00	150.00	3.00	150.00
Widest metaxylem vessel diameter	42.75	100.00	38.70	90.53	37.80	88.42	37.80	88.42	40.95	95.79	33.30	87.89
Wall thickness of metaxylem vessel	2.97	100.00	3.21	108.08	3.51	118.18	3.60	121.21	3.33	112.12	3.96	133.33
No. of protoxylem vessels in the main v. bundle	1.00	100.00	1.00	100.00	1.00	100.00	1.00	100.00	2.00	200.00	2.00	200.00
Protoxylem vessel diameter	29.70	100.00	24.75	83.33	20.25	68.18	22.50	75.76	27.90	93.94	27.00	90.91
Wall thickness of protoxylem vessel	2.52	100.00	2.70	107.14	3.15	125.00	3.15	125.00	2.88	114.29	3.15	125.00
Xylem cavity diameter	27.90	100.00	25.20	90.32	17.55	62.90	18.90	67.74	0.00	0.00	0.00	0.00

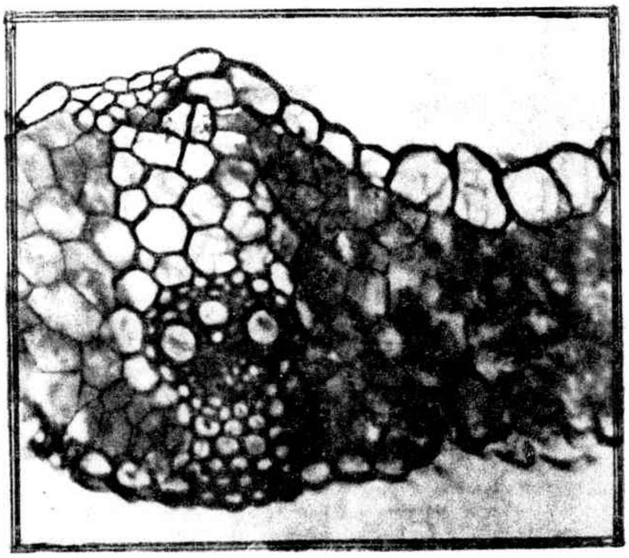


Fig. (61)

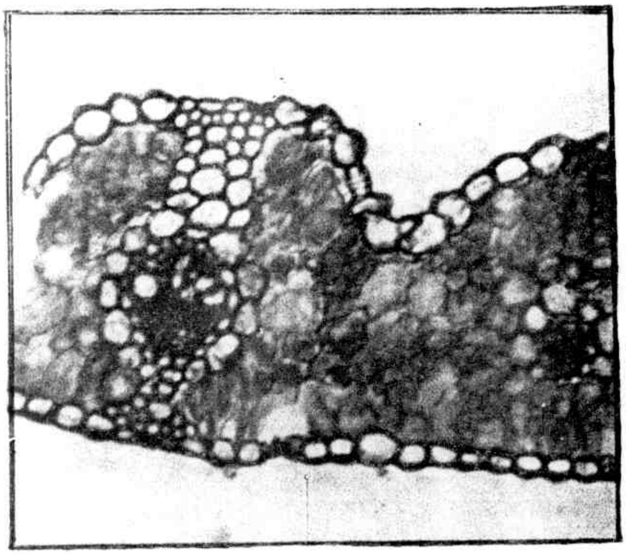


Fig. (62)

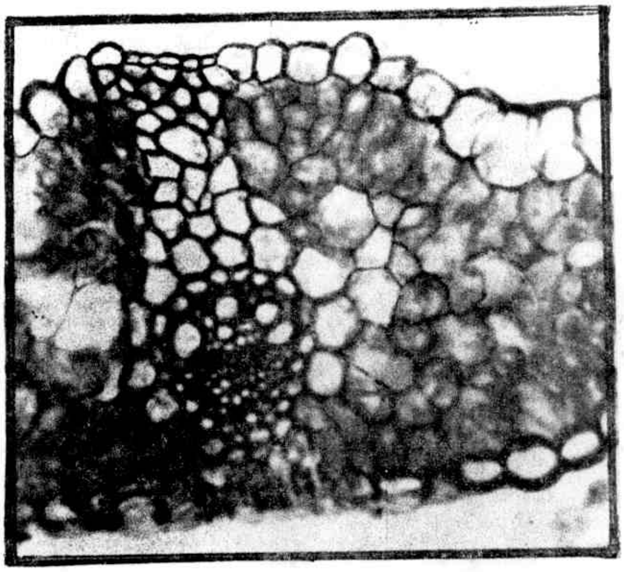


Fig. (63)

Figs. (61-63): Transverse sections through the blade of third leaf developed on the main stem of wheat cv. Sakha 92 as affected with the maximum tolerable salinity level of 7000 ppm alone and the untolerable salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm (X 150).

Fig. (61): Of an untreated plant.

Fig. (62): Of a plant treated with salinity level of 7000 ppm.

Fig. (63): Of a plant treated with salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm.

lower epidermis, the cuticle, the mesophyll and the phloem tissue, number of the mesophyll layers (the increase reached 22% of the control with the untolerable salinity level of 8000 ppm when preceded with paclobutrazol at 50 ppm), dimensions of the main vascular bundle, number of both protoxylem and metaxylem vessels (the increase reached 50 and 100%, respectively - more than the control - with the untolerable salinity levels that preceded with paclobutrazol at 50 ppm) and also wall thickness of the protoxylem and metaxylem vessels. The exceptions were with the untolerable salinity levels when preceded with the low concentration of paclobutrazol (10 ppm). As they caused reduction in the thickness of the upper and lower epidermis, dimensions of the main vascular bundle and the phloem tissue thickness, while did not affect the number of both protoxylem and metaxylem vessels. However, the two applied concentrations of paclobutrazol (10 and 50 ppm) preceded the treatment with the untolerable salinity levels led to reduction in some anatomical features e.g. thickness of the central main vien, diameter of both protoxylem and metaxylem vessels, diameter of the xylem cavity and also thickness of the lowermost fiberous layers. The reduction was mostly less than that existed with the application of the maximum tolerable salinity level alone.

Generally, it could be concluded from the data presented in Tables (24 and 25) and Figs. (58 and 61) that the most important anatomical features that characterize the leaves of the wheat cv. Sakha 92 (the more salt-tolerant) compared with those of the wheat cv. Giza 163 (the less salt-tolerant) grown under the normal conditions and irrigated with tap water were:

- decrease in the thickness of different leaf tissues such as the upper and lower epidermis, the mesophyll tissue, and the phloem tissue, dimension of the main vascular bundle and also diameter of the protoxylem and metaxylem vessels.

- increase in the cuticle thickness and the wall thickness of both protoxylem and metaxylem vessels. The previously mentioned characterstics could be intimately related with the high ability of Sakha 92 to act with salt tolerance phenomenon.

On the other hand, the obtained results clearly show that the effect of the maximum tolerable salinity level when applied alone and also the untolerable salinity levels preceded with paclobutrazol on the histological features of the leaf was nearly similar in the two wheat cultivars.

The application of maximum tolerable salinity level alone (7000 ppm) led to reduction in most studied anatomical features. Even though, increase existed in the cuticle thickness and also the wall thickness of both protoxylem and metaxylem vessels. While, the number of mesophyll layers and xylem vessels was not affected. These contradictory effects of salinity on the leaf histology were more pronounced in Giza 163 than in Sakha 92 .. (Tables, 24 & 25 and Fig., 58, 59, 61 & 62).

In case of the application of paclobutrazol at 10 and 50 ppm before the treatment with the untolerable salinity levels (8000 and 9000 ppm) showed a clear compensating effect with regard to salinity. This was expressed in many important trends for instance:

- diminish or overcome the deleterious effect of salinity on the thickness of the upper and lower epidermis and the mesophyll tissue as well.
- increase in the cuticle thickness.
- increase in the number of mesophyll layers, especially with the high concentration of paclobutrazol (50 ppm).
- increase in the number of both protoxylem and metaxylem vessels.

- increase in the wall thickness of both protoxylem and metaxylem vessels as well as decreare in their diameter.

This compensating effect of paclobutrazol was parallel to the applied concentration and also was more pronounced in Sakha 92 (the more salt-tolerant cv.) than in Giza 163 (the less salt-tolerant cv.). Hence, paclobutrazol seemed to be a very effective agent for increasing the tolerability of these cultivars to endure the high salinity levels.

3.3. Tomato cv. Castle Rock:

Table (26) and Figs. (64-66) clearly show that the application of salinity alone at the maximum tolerable level (5000 ppm) led to reduction in the thickness of both midrib and lamina. While, the application of paclobutrazol at 10 and 50 ppm before the treatment with the untolerable salinity levels (6000 and 7000 ppm) decreased the thickness of midrib though it increased the thickness of lamina compared with the control, (the only exception was that the high concentration of paclobutrazol applied before the untolerable salinity level of 6000 ppm increased the thickness of midrib by about 12% more than the control).

The decrease that existed in the midrib thickness was a result of reduction in many histological features such as thickness of both uppermost collenchyma and parenchyma tissue, number of the uppermost parenchyma layers, thickness of both lowermost collenchyma and parenchyma tissues, dimensions of the vascular region, thickness of the uppermost and lowermost phloem tissues, xylem tissue thickness and also diameter of the xylem vessels. While, the number of both uppermost and lowermost collenchyma layers and the number of lowermost parenchyma layers were not affected. Even though, increase existed in the number of xylem vessels and the wall thickness of xylem vessels.

Table (26): Mean counts and measurements related to the control in percent of certain histological features in transverse sections through the terminal leaflet of the fourth leaf on the main stem of tomato cv. Castle Rock.

Measurements (µ) & counts	Treatments											
	Tap water (control)		Salinity 5000 ppm		Paclobutrazol (ppm)							
					10				50			
					Salinity (ppm)				Salinity (ppm)			
					6000		7000		6000		7000	
	x	%	x	%	x	%	x	%	x	%	x	%
Midrib thickness	768.60	100.00	561.60	73.07	477.00	62.06	441.00	57.38	862.20	112.81	507.60	66.04
Blade thickness	117.00	100.00	100.80	86.15	127.60	109.23	119.70	102.31	168.30	143.85	177.30	151.54
Upper epidermis thickness	14.85	100.00	12.60	84.85	15.75	106.06	13.95	93.94	17.55	118.18	19.80	133.33
Cuticle thickness	1.98	100.00	2.21	111.62	2.21	111.62	2.21	111.62	2.48	125.25	2.57	129.80
Lower epidermis thickness	10.35	100.00	9.00	86.96	10.35	100.00	9.90	95.65	11.70	113.40	12.60	121.74
Palisade tissue thickness	37.80	100.00	30.60	80.95	44.10	116.67	40.95	108.33	52.75	139.55	59.40	157.14
No. of palisade layers	1.00	100.00	1.00	100.00	1.00	100.00	1.00	100.00	1.00	100.00	1.00	100.00
Spongy tissue thickness	54.00	100.00	48.60	90.00	57.00	106.67	54.90	101.67	86.30	159.81	85.50	158.33
No. of spongy layers	4.00	100.00	4.00	100.00	4.00	100.00	4.00	100.00	5.00	125.00	4.50	112.50
Mean thickness of the spongy layer	13.50	100.00	12.15	90.00	14.40	106.67	13.73	101.67	17.26	127.85	19.00	140.74
Thickness of the uppermost collenchyma tissue	34.20	100.00	0.00	0.00	29.70	86.84	24.30	71.05	42.30	123.68	40.05	117.11
No. of the uppermost collenchyma layers	1.00	100.00	0.00	0.00	1.00	100.00	1.00	100.00	1.00	100.00	1.00	100.00
Thickness of the uppermost parenchyma tissue	162.90	100.00	97.20	59.67	81.00	49.72	75.60	46.41	86.40	53.04	288.90	177.35
No. of the uppermost parenchyma layers	5.00	100.00	4.00	80.00	3.00	60.00	3.00	60.00	3.00	60.00	6.00	120.00
Thickness of the lowemost collenchyma tissue	53.10	100.00	45.90	86.44	39.60	74.58	39.15	73.73	43.20	81.36	51.30	96.61
No. of the lowermost collenchyma layers	1.00	100.00	1.00	100.00	1.00	100.00	1.00	100.00	1.00	100.00	1.00	100.00
Thickness of the lowemost parenchyma tissue	194.40	100.00	171.00	87.96	111.60	57.41	100.35	51.62	116.10	59.72	202.50	104.17
No. of the lowermost parenchyma layers	3.00	100.00	3.00	100.00	3.00	100.00	3.00	100.00	3.00	100.00	3.50	116.67
Lenght of the vascular region	236.70	100.00	163.80	69.20	166.50	70.34	148.95	62.93	270.00	114.07	166.50	70.34
Width of the vascular region	427.50	100.00	325.80	76.21	319.50	74.74	257.40	60.21	540.00	126.32	297.00	69.47
Thickness of the uppermost phloemtissue	22.50	100.00	18.00	80.00	19.35	86.00	16.20	72.00	24.30	108.00	17.10	76.00
Thickness of the lowermost phloem tissue	19.80	100.00	14.40	72.73	15.30	77.27	12.60	63.64	21.60	109.09	14.40	72.73
Thickness of the xylem tissue	194.40	100.00	131.40	67.59	131.85	67.82	120.15	61.81	224.10	115.28	135.00	69.44
No. of vessels in the vascular region	30.00	100.00	31.50	105.00	30.00	100.00	33.00	110.00	36.00	120.00	28.50	95.00
Widest vessel diameter	23.85	100.00	21.15	88.68	19.35	81.13	14.85	62.26	25.65	107.55	13.50	56.60
Wall thickness of widest vessel	2.07	100.00	2.16	104.35	2.34	113.04	2.43	117.39	2.57	124.15	2.43	117.39

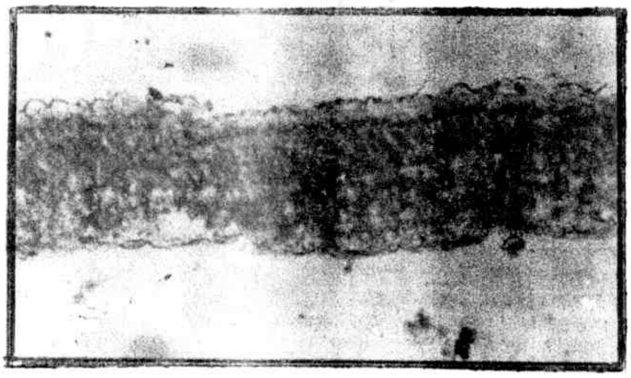


Fig. (64)

Fig. (65)

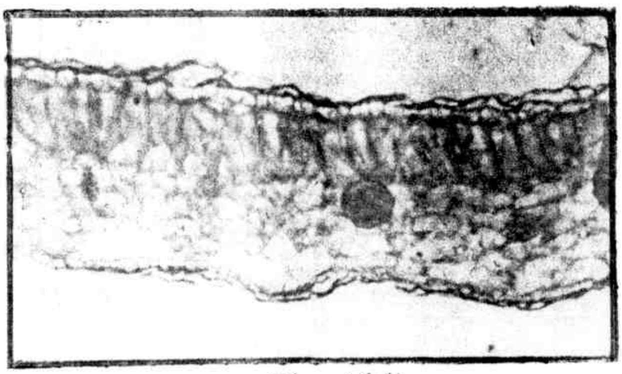


Fig. (66)

Figs. (64-66): Transverse sections through the blade of fourth leaf developed on the main stem of tomato cv. Castle Rock as affected with the maximum tolerable salinity level of 5000 ppm alone and the untolerable salinity level of 6000 ppm preceded with paclobutrazol at 50 ppm (X 100).

Fig. (64): Of an untreated plant.

Fig. (65): Of a plant treated with salinity level of 5000 ppm.

Fig. (66): Of a plant treated with salinity level of 6000 ppm preceded with paclobutrazol at 50 ppm.

The noticed increase in the midrib thickness caused by the high paclobutrazol concentration (50 ppm) preceded the untolerable salinity level of 6000 ppm could be attributed to the increase in: thickness and number of both uppermost collenchyma and parenchyma layers, dimensions of the vascular region, thickness of the uppermost and lowermost phloem tissues, xylem tissue thickness, diameter of the xylem vessels and also wall thickness of the vessels. However, reduction occurred in the thickness of both lowermost collenchyma and parenchyma tissues, while the number of their layers was not affected.

As for the reduction that existed in the thickness of lamina with the maximum tolerable salinity level (5000 ppm) applied alone (about 14% less than the control) was accompanied with reduction in the thickness of its tissue components. This reduction existed in the thickness of: the upper and lower epidermis and the palisade and spongy tissues as well. While, the number of both palisade and spongy layers was not affected. Even though, increase existed in the cuticle thickness.

But for the increase in the thickness of lamina existed with the untolerable salinity levels (6000 and 7000 ppm) preceded with paclobutrazol treatments (10 and 50 ppm) was accompanied with increase in the thickness of its tissue components. This increase was directly proportional to the applied concentration of paclobutrazol (the increase reached 44 and 52% with the untolerable salinity levels of 6000 and 7000 ppm, respectively when preceded with the high concentration of paclobutrazol (50 ppm). The increase existed in the thickness of: the upper and lower epidermis, the palisade and spongy tissues and the cuticle as well (the increase in the cuticle thickness did not clearly add to the lamina thickness). However, the number of both palisade and spongy layers was not affected. The only exception was that the high concentration of paclobutrazol led to increase in the number of spongy layers by 25 and 12.5% than the control with the untolerable salinity levels of 6000 and 7000 ppm, respectively.

3.4. Tomato cv. Edkawi:

Table (27) and Figs. (67-69) show that the application of maximum tolerable salinity level alone (7000 ppm) led to reduction in the thickness of both midrib and lamina. Meanwhile, the application of paclobutrazol at 10 and 50 ppm before the treatment with the untolerable salinity levels (8000 and 9000 ppm) reduced the midrib thickness, while increased the lamina thickness. The only exception was with the high paclobutrazol concentration (50 ppm) preceded the untolerable salinity level of 8000 ppm as the midrib thickness was increased by about 5% than the control.

Reduction in the midrib thickness existed with all applied treatments except with the untolerable salinity level (8000 ppm) preceded with the high concentration of paclobutrazol (50 ppm) could be due to the reduction in thickness and number of the uppermost parenchyma layers, thickness of the lowermost parenchyma layers, length and width of the vascular region and thickness of the xylem tissue. However, increase existed in both diameter and wall thickness of the xylem vessels. Exceptions that existed were with the thickness of the uppermost and lowermost collenchyma tissues, thickness of the phloem tissue - both the uppermost and the lowermost - and also number of the xylem vessels. Since, these characters were decreased with the maximum tolerable salinity level (7000 ppm) applied alone, while increased with the untolerable salinity levels (8000 and 9000 ppm) preceded with paclobutrazol at 10 ppm and also with the untolerable salinity level of 9000 ppm when preceded with paclobutrazol at 50 ppm.

Table (27): Mean counts and measurements related to the control in percent of certain histological features in transverse sections through the terminal leaflet of the fourth leaf on the main stem of tomato cv. Edkawi.

Measurements (µ) & counts	Treatments											
	Tap water (control)		Salinity 7000 ppm		Paclobutrazol (ppm)							
					10				50			
					Salinity (ppm)				Salinity (ppm)			
					8000		9000		8000		9000	
	X	%	X	%	X	%	X	%	X	%	X	%
Midrib thickness	1071.00	100.00	948.60	88.57	1008.00	94.12	882.00	82.35	1.00	105.04	968.40	90.42
Blade thickness	174.60	100.00	157.50	90.21	188.10	107.73	180.00	103.09	279.00	159.79	243.00	139.18
Upper epidermis thickness	16.65	100.00	14.85	89.19	18.90	113.51	18.00	108.11	21.15	127.03	19.35	116.22
Cuticle thickness	2.34	100.00	2.52	107.69	2.79	119.23	2.97	126.92	2.88	123.08	3.15	134.62
Lower epidermis thickness	11.25	100.00	10.35	92.00	12.15	108.00	11.70	104.00	13.50	120.00	12.60	112.00
Palisade tissue thickness	55.80	100.00	47.70	85.48	59.85	107.26	56.25	100.08	79.20	141.94	66.60	119.35
No. of palisade layers	1.00	100.00	1.00	100.00	1.00	100.00	1.00	100.00	1.00	100.00	1.00	100.00
Spongy tissue thickness	90.90	100.00	84.60	93.07	97.20	106.93	94.05	103.46	165.15	181.68	144.15	158.91
No. of spongy layers	4.00	100.00	4.00	100.00	4.00	100.00	4.00	100.00	5.00	125.00	5.00	125.00
Mean thickness of the spongy layer	22.73	100.00	21.15	93.07	24.30	106.93	23.51	103.46	33.03	145.31	28.89	127.10
Thickness of the uppermost collenchyma tissue	91.80	100.00	63.00	68.63	104.40	113.70	50.40	54.90	23.40	25.49	95.40	103.92
No. of the uppermost collenchyma layers	2.00	100.00	2.00	100.00	2.00	100.00	2.00	100.00	1.00	50.00	2.00	100.00
Thickness of the uppermost parenchyma tissue	327.60	100.00	234.00	71.43	289.80	88.46	209.70	64.10	333.00	101.65	192.60	58.79
No. of the uppermost parenchyma layers	7.00	100.00	6.00	85.71	6.00	85.71	6.00	85.71	8.00	114.29	4.00	57.14
Thickness of the lowemost collenchyma tissue	59.40	100.00	52.20	87.88	64.80	109.09	42.30	71.21	73.80	124.24	68.40	115.15
No. of the lowermost collenchyma layers	1.00	100.00	1.00	100.00	1.00	100.00	1.00	100.00	1.00	100.00	1.00	100.00
Thickness of the lowemost parenchyma tissue	246.60	100.00	166.50	67.52	268.20	108.76	215.10	78.23	270.00	109.49	235.80	95.62
No. of the lowermost parenchyma layers	4.00	100.00	3.00	75.00	4.00	100.00	4.00	100.00	4.00	100.00	4.00	100.00
Lenght of the vascular region	309.60	100.00	277.20	89.53	274.50	88.66	279.90	90.41	324.00	104.65	298.80	96.51
Width of the vascular region	639.00	100.00	608.40	95.21	526.50	82.39	608.40	94.65	675.00	105.63	399.60	62.54
Thickness of the uppermost phloen tissue	32.40	100.00	28.35	87.50	32.40	100.00	32.40	100.00	39.60	122.22	32.40	100.00
Thickness of the lowermost phloem tissue	23.40	100.00	19.80	84.62	27.90	119.23	27.00	115.38	28.80	123.08	28.80	123.80
Thickness of the xylem tissue	253.80	100.00	229.05	90.25	214.20	84.40	220.50	86.88	255.60	100.71	237.60	93.62
No. of vessels in the vascular region	42.00	100.00	38.50	91.67	45.00	107.14	50.00	119.05	43.50	103.57	46.50	110.71
Widest vessel diameter	22.50	100.00	22.95	102.00	23.40	104.00	23.40	104.00	25.65	114.00	24.30	108.00
Wall thickness of widest vessel	2.34	100.00	2.43	103.85	2.75	117.52	2.66	113.68	2.84	121.37	3.02	129.06

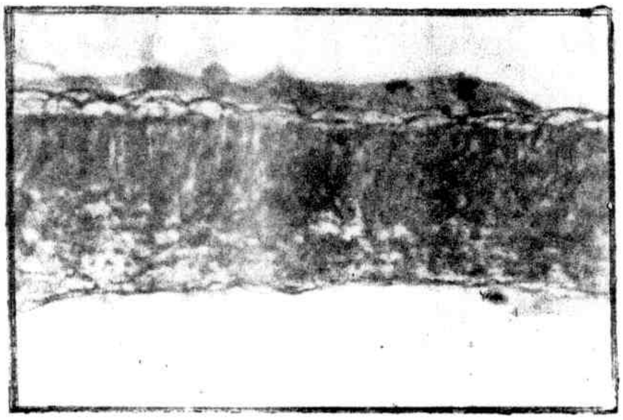


Fig. (67)

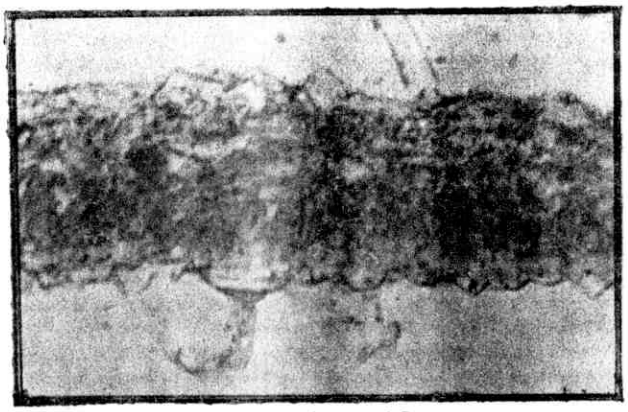


Fig. (68)

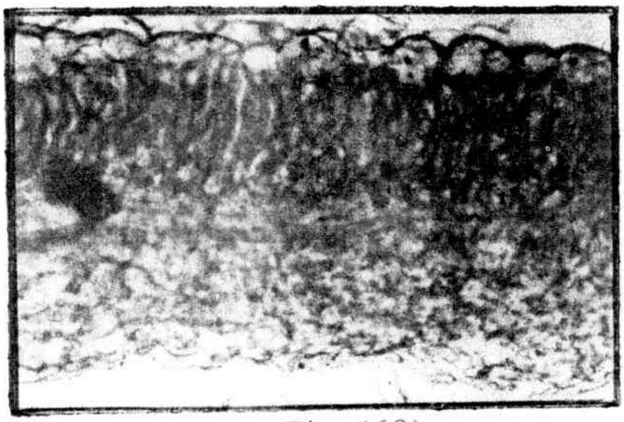


Fig. (69)

Figs. (67-69): Transverse sections through the blade of fourth leaf developed on the main stem of tomato cv. Edkawi as affected with the maximum tolerable salinity level of 7000 ppm alone and the untolerable salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm (X 100).

Fig. (67): Of an untreated plant.

Fig. (68): Of a plant treated with salinity level of 7000 ppm.

Fig. (69): Of a plant treated with salinity level of 8000 ppm preceded with paclobutrazol at 50 ppm.

For the increase in the midrib thickness caused by the high concentration of paclobutrazol (50 ppm) when preceded the untolerable salinity level (8000 ppm) could be attributed to the increase in thickness and number of the uppermost parenchyma layers, thickness of both lowermost collenchyma and parenchyma tissues, dimensions of the vascular region, thickness of both uppermost and lowermost phloem tissues, xylem tissue thickness and also number and diameter of the xylem vessels. Also, increase existed in the wall thickness of xylem vessels. Even though, reduction existed in thickness and number of the uppermost collenchyma layers.

For the reduction that occurred in the thickness of lamina - that was about 10% less than the control - with the maximum tolerable salinity level of 7000 ppm was mainly resulted from the reduction in thickness of the upper and lower epidermis, the palisade and spongy tissues. While, the number of both palisade and spongy layers was not affected. Even though, increase appeared in the cuticle thickness.

As for the increase that existed in the thickness of lamina with the untolerable salinity levels (8000 and 9000 ppm) preceded with paclobutrazol (10 and 50 ppm) was mainly resulted from the increase in thickness of its tissue components. This increase was directly proportional to the applied concentration of paclobutrazol. The increase existed in thickness of: the upper and lower epidermis and the palisade and spongy tissues. Also, the increase appeared in the cuticle thickness. However, the number of both palisade and spongy layers was not affected. The only exception was that the high concentration of paclobutrazol (50 ppm) applied before the treatment with the untolerable salinity levels (8000 and 9000 ppm) led to increase in the number of spongy layers with about 25 and 25%, respectively more than the control.

In general, it could be concluded from the data presented in Tables (26 and 27) and Figs. (64 and 67) that there are many histological features distinguish the leaves of the tomato cv. Edkawi (the more salt-tolerant) than those of the tomato cv. Castle Rock (the less salt-tolerant) grown under the normal conditions and irrigated with tap water. Of these features are:

- increase in the thickness of different leaf tissues e.g. the upper and lower epidermis, the palisade and spongy tissues, the uppermost and lowermost collenchyma and parenchyma tissues and the upper and lower phloem tissues and also the xylem tissue.
- increase in the number of: both uppermost and lowermost parenchyma layers and also the uppermost collenchyma layers, while these two tomato cvs. have the same number of both palisade and spongy layers.
- increase in the cuticle thickness, dimensions of the vascular region, number of the xylem vessels and also wall thickness of the vessels with a decrease in their diameter.

These features could be the casue of the high ability of Edkawi to endure higher levels of salinity than Castle Rock .

Besides, it could be concluded from the previous results that the effect of the maximum tolerable salinity levels applied alone and also the untolerable salinity levels preceded with paclobutrazol on the histological features of the leaf was nearly identical in the two tomato cultivars.

The application of the maximum tolerable salinity levels alone (5000 ppm for Castle Rock cv. and 7000 ppm for Edkawi cv.) led to reduction in the thickness of most studied histological features. While, the number of layers of different tissues was not affected. However, increase existed in the cuticle thickness, number of the xylem vessels and wall thickness of the vessels as well. These negative and positive effects of salinity on the leaf histology was more pronounced in Castle Rock cv. than in Edkawi cultivar.

The application of paclobutrazol (10 and 50 ppm) before the treatment with the untolerable salinity levels (6000 and 7000 ppm for Castle Rock cv. and 8000 and 9000 ppm for Edkawi cv.) exhibited a clear compensating effect with regard to salinity. The expression was in many important trends for instance:

- increase in the thickness of: the cuticle, the upper and lower epidermis and the palisade and spongy tissues, the number of xylem vessels and also the wall thickness of these vessels.
- diminish or overcome the adverse effect of salinity on the thickness of both uppermost and lowermost collenchyma tissues dimensions of the vascular region, thickness of both uppermost and lowermost phloem tissues and also xylem tissue thickness.

This compensating effect of paclobutrazol was directly proportional to the applied concentration and also was more pronounced in Edkawi than in Castle Rock . Hence, paclobutrazol seemed to be a very effective agent for increasing the ability of these cultivars to endure the high salinity levels.

Generally speaking, in wheat, Sakha 92 that is considered the more salt-tolerant cultivar normaly characterized by many specific phenomena in their anatomical features compared with Giza 163 which is considered the less salt-tolerant cultivar. Of these features that were noticed and have their relationship to salinity tolerance are the following:

- increase in the thickness of the cuticle on the epidermis of the young stems and that of the leaves. This increase helps very much in reducing the loss of water through the epidermal cells and hence improve the water blance in the plant.

- increase in the thickness and number of exodermal layers of the root. These characters help the root system to endure salinity to a certain extend.
- increase in the number of peripheral sclerenchyma layers (fiberous layers) of the stem. This character acts in protection and strengthing the internal tissues of the stem of plants grown under saline conditions.
- reduction in the size of the vascular bundles that were compensated by the increase in their number in both root and stem. Hence, under saline conditions the small bundles carry out their functions with more efficiency than the large and wide bundles.
- reduction in the width of the xylem vessels that were compensated by the increase in their number especially those of the root.
- increase in lignin thickness of the xylem vessels. This charachter with the previous mentioned one together help in the attraction of water to the xylem vessels and also help in raising up the solutes. This leads to more absorption of water in the case of the saline conditions.

Also, the present study included two tomato cultivars. The first is Edkawi which is considered the more salt-tolerant cultivar and the second is Castle Rock that is considered the less salt-tolerant cultivar. These two cultivars differed to a certain extend in their internal structure. Of interest was that nearly the same clear differences that existed in wheat (cvs. Sakha 92 and Giza 163) - previously mentioned - were noticed when comparison tooks place between the two tomato cultivars. The Edkawi cv. was normally characterized with the increase in the number of the collenchyma layers in the stem cortex (the collenchyma cells represent a part of increase of the peripheral sclerenchyma layers (fibers) which are also considered a part of the mechanical tissue. Then, generally the more salt-tolerant cv. even in wheat (as a monocot) or tomato (as a dicot) is characterized by the excess in the mechanical tissues.

Besides, it could be concluded from the obtained results that the application of salinity alone at the maximum tolerable levels (7000 ppm for wheat cv. Giza 163, cv. Sakha 92 and tomato cv. Edkawi, and 5000 ppm for tomato cv. Castle Rock) negatively affected most of the anatomical features under study of the different organs (roots, stems and leaves) of the assigned wheat and tomato cultivars. However, increase existed in some other anatomical features that could be related to the salt tolerance phenomenon. These contradictory effects of salinity could be summarized in the following.

1- In wheat cvs. (Giza 163 and Sakha 92) salinity caused:

- reduction in the root diameter, the stem diameter and the thickness of both midrib and lamina of the leaf.
- reduction in the thickness of the epidermis of root, stem and leaf.
- reduction in the thickness of: the cortex (here included the exodermis, cortical parenchyma and the endodermis), the vascular cylinder and the parenchymatous pith of the root.
- reduction in the thickness of the ground tissue (sclerenchyma and parenchyma layers) of the stem.
- reduction in the thickness of the mesophyll tissue of the leaf.
- reduction in the dimensions of the vascular bundles, thickness of the bundle sheath, thickness of the phloem tissue and also diameter of the xylem vessels in the root, stem and leaf.

- increase in the thickness of the cuticle on the epidermis of stems and leaves.
- increase in the number of exodermal layers of the root.
- increase in the number of peripheral sclerenchyma layers of the stem.
- increase in the number of vascular bundles in both root and stem.
- increase in the number of xylem vessels of both root and stem.
- increase in the wall thickness of xylem vessels in root, stem and leaf.
- increase in the number of grouped motor cells.

These contradictory effects of salinity was more pronounced in Giza 163 (the less salt-tolerant cv.) than in Sakha 92 (the more salt-tolerant cv.).

2- In tomato cvs. (Castle Rock and Edkawi) salinity caused:
- reduction in the stem diameter and the thickness of both midrib and lamina of the leaf.
- reduction in the thickness of the epidermis of both stem and leaf.
- reduction in the thickness of the cortex of root.
- reduction in the thickness of the cortex of stem (collenchyma and parenchyma layers).
- reduction in the thickness of both collenchyma and parenchyma tissues of the leaf.
- reduction in the thickness of parenchymatous pith of the stem.
- reduction in the thickness of the palisade and spongy tissues of the leaf.
- reduction in the dimensions of vascular bundles and the thickness of the phloem and xylem tissues in both stems and leaves.

- reduction in the diameter of xylem vessels of the root, stem and leaf.
- increase in the thickness of the cuticle on the epidermis of yound stems and that of the leaves.
- increase in the diameter of vascular cylinder of the root (included the increase that existed in the thickness of the phloem, cambium and xylem regions).
- increase in the number and wall thickness of xylem vessels of the root, stem and leaf.
- increase in the thickness and number of exodermal layers of the root.

These negative and positive effects of salinity was more obvious in Castle Rock (the less salt-tolerant cv.) than in Edkawi (the more salt-tolerant cv.).

In this respect, the obtained results nearly go with the findings obtained by **Nagdy *et al.* (1989)** on soybean, **Raafet *et al.* (1991)** on tomato and **Latif (1994)** on berseem.

On the other hand, the application of paclobutrazol at 10 and 50 ppm before the treatment with the untolerable salinity levels (8000 and 9000 ppm for wheat cv. Giza 163, cv. Sakha 92 and tomato cv. Edkawi but they were 6000 and 7000 ppm for tomato cv. Castle Rock) showed in wheat and tomato cvs. clear compensating effects with regard to salinity.

1- Application of paclobutrazol to wheat cvs. (Giza 163 and Sakha 92):

The application of paclobutrazol before the treatment with the untolerable salinity levels caused many important effects. Of these were:

- diminish or overcome the delelerious effect of salinity on the root diameter, the stem diameter and the thickness of both central main vein and lamina of the leaf.
- diminish or overcome the adverse effect of salinity on the thickness of: the epidermis, cortical parenchyma layers, vascular cylinder and parenchymatous pith of the root.
- diminish or overcome the delelerious effect of salinity on the thickness of: the upper and lower epidermis, the mesophyll tissue of the leaf.
- increase in the number of mesophyll tissue layers of the leaf.
- increase in the thickness of the cuticle on the epidermis of stems and that of the leaves.
- increase in the thickness and number of exodermal layers of the root.
- increase in the thickness and number of peripheral sclerenchyma layers of the stem.
- increase in the number of the vascular bundles in both root and stem.
- reduction in the dimensions of the vascular bundles of both stems and leaves.
- increase in the number of xylem vessels of the root, stem and leaf.
- increase in the wall thickness of xylem vessels of the root, stem and leaf.
- increase in the number of the ground parenchyma layers that sometimes led to the disappearance of the stem hollow pith.
- reduction in the mean length of the parenchymatous cells of the ground tissue in the stem.

This compensating effect was parallel to the applied concentration of paclobutrazol and also was more pronounced in Sakha 92 (the more salt-tolerant cv.) than in Giza 163 (the less salt-tolerant cv.).

2- Application of paclobutrazol to tomato cvs. (Castle Rock and Edkawi) caused:

- increase in the root diameter that was accompanied with increase in the thickness of its tissue components i.e. the cortex (exodermal and parenchyma layers), the phloem tissue, the cambium region and also the xylem tissue.
- diminish or overcome the adverse of salinity on the thickness of: the epidermis, the cortex (collenchyma and parenchyma layers) and the parenchymatous pith of the stem.
- increase in the number of the parenchymatous pith layers of the stem.
- increase in the number of vascular bundles of the stem - especially the small bundles -.
- increase in the dimensions of vascular bundles of the stem (included the increase that existed in the thickness of the phloem, cambial and xylem regions).
- increase in the number, width and wall thickness of xylem vessels of the root, stem and leaf.
- increase in the thickness of the leaf lamina which was accompanied with increase in the thickness of: the upper and lower epidermis and the palisade and spongy tissues and also the number of spongy layers.
- increase in the thickness of the cuticle on the epidermis of the young stems and leaves.

This compensating effect was proportional to the applied concentration of paclobutrazol and also was more pronounced in Edkawi (the more salt-tolerant cv.) than in Castle Rock (the less salt-tolerant cv.).

Hence, here paclobutrazol seemed to be a very effective agent for increasing the tolerability of wheat and tomato plants to endure the high salinity levels.

Since, paclobutrazol is still a new growth regulator, hence the literature dealing with its application with salinity is very much lacking and the present work could be considered a pionear work in this respect.

g. Effect of the maximum tolerable salinity levels alone and the untolerable salinity levels preceded with paclobutrazol on the endogenous phytohormones in the shoots of wheat and tomato plants:

1. Endogenous auxin-like substances:

Figs. (70 and 71) show that the application of salinity alone at the maximum tolerable level of each cultivar (7000 ppm for wheat cv. Giza 163, cv. Sakha 92 as well as tomato cv. Edkawi and 5000 ppm for tomato cv. Castle Rock) clearly decreased the endogenous level of auxin-like substances in the shoots of the experimental cutltivars of wheat and tomato plants (75 days after sowing). While, in case of the application of the untolerable salinity levels (8000 ppm for wheat cv. Giza 163, cv. Sakha 92 as well as tomato cv. Edkawi and 6000 ppm for tomato cv. Castle Rock) preceded with paclobutrazol at 10 and 50 ppm strictly decreased the endogenous level of auxin -like substances. This reduction of endogenous auxins was parallel to the applied concentration of paclobutrazol.

The above mentioned results could be answered many questions related with those modifications obtained in the internal structure of treated plants (see Tables, 20-23 and Figs. 37-39, 43-45, 49-51 & 55-57). Of these modifications was the reduction that existed in the mean length of: the parenchymatous cells of the ground tissue in wheat stems and also the collenchymatous and parenchymatous cells of the cortex in tomato stems. The above mentioned interactions between the endogenous auxins level and the ontogeny of different tissues are completely considered direct

Fig. (70): Effect of salinity alone and salinity preceded with paclobutrazol on the endogenous level of auxin-like substances in the shoots of wheat cvs. (Giza 163 and Sakha 92). The least significant difference between any two readings is 1.2 mm at the 1% level (the base of the black parts).

(A, B, C & D) = **Wheat cv. Giza 163.**

(E, F, G & H) = **Wheat cv. Sakha 92.**

(A & E) = Controls

(B & F) = Treatments of the maximum tolerable salinity level alone (7000 ppm)

(C & G) = Treatments of the untolerable salinity level (8000 ppm) preceded with paclobutrazol at 10 ppm.

(D & H) = Treatments of the untolerable salinity level (8000 ppm) preceded with paclobutrazol at 50 ppm

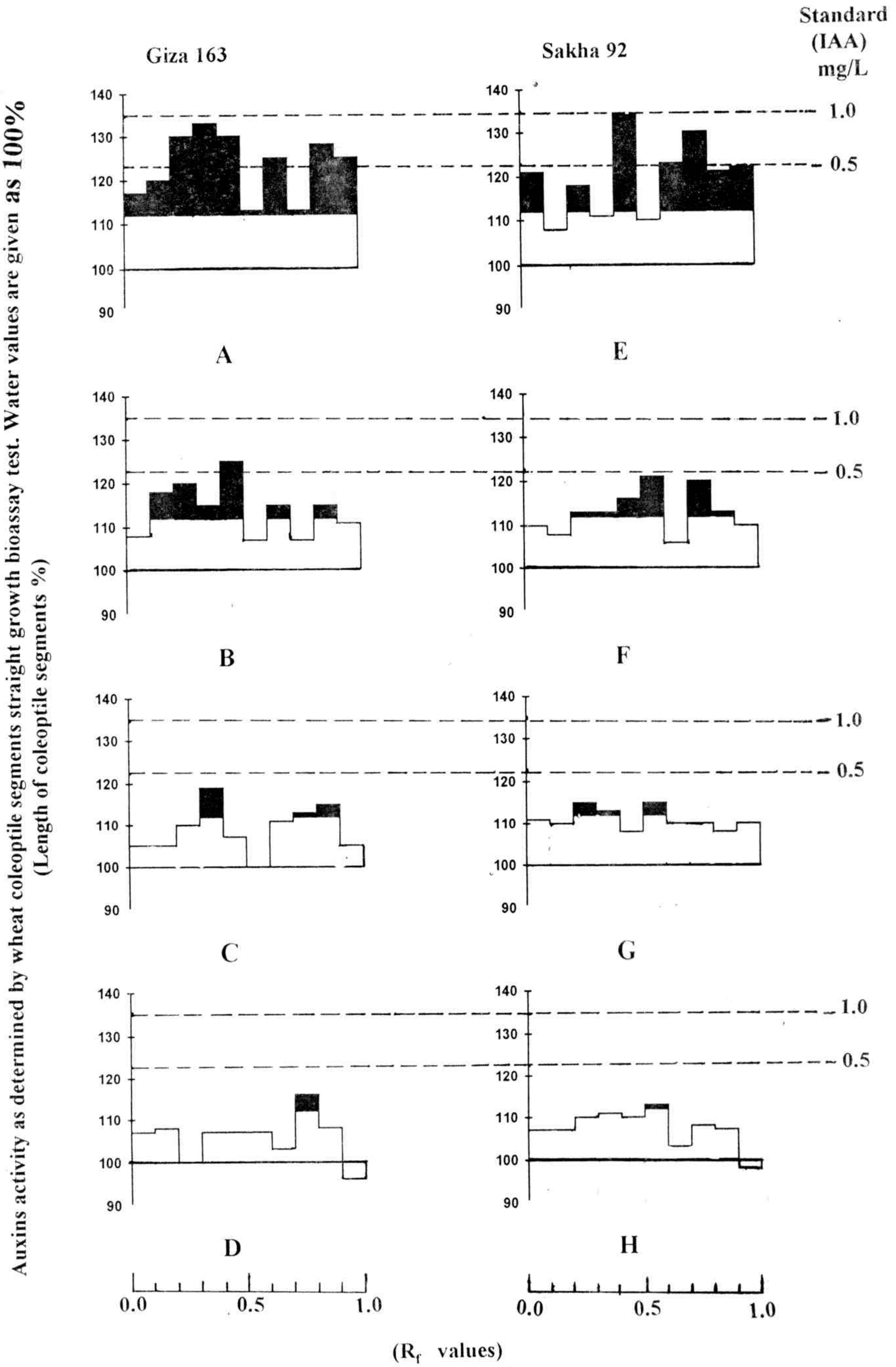

Standard (IAA) mg/L
Giza 163
Sakha 92
Auxins activity as determined by wheat coleoptile segments straight growth bioassay test. Water values are given as 100%
(Length of coleoptile segments %)
140
130
120
110
100
90
1.0
0.5
A
B
C
D
E
F
G
H
0.0
0.5
1.0
(Rf values)

Fig. (70)

Fig. (71): Effect of salinity alone and salinity preceded with paclobutrazol on the endogenous level of auxin-like substances in the shoots of tomato cvs. (Castle Rock and Edkawi). The least significant difference between any two readings is 1.2 mm at the 1% level (the base of the black parts).

(A, B, C & D) = **Tomato cv. Castle Rock .**

(A) = Control

(B) = Treatment of the maximum tolerable salinity level alone (5000 ppm)

(C) = Treatment of the untolerable salinity level (6000 ppm) preceded with paclobutrazol at 10 ppm.

(D) = Treatment of the untolerable salinity level (6000 ppm) preceded with paclobutrazol at 50 ppm

(E, F, G & H) = **Tomato cv. Edkawi.**

(E) = Control

(F) = Treatment of the maximum tolerable salinity level alone (7000 ppm)

(G) = Treatment of the untolerable salinity level (8000 ppm) preceded with paclobutrazol at 10 ppm.

(H) = Treatment of the untolerable salinity level (8000 ppm) preceded with paclobutrazol at 50 ppm

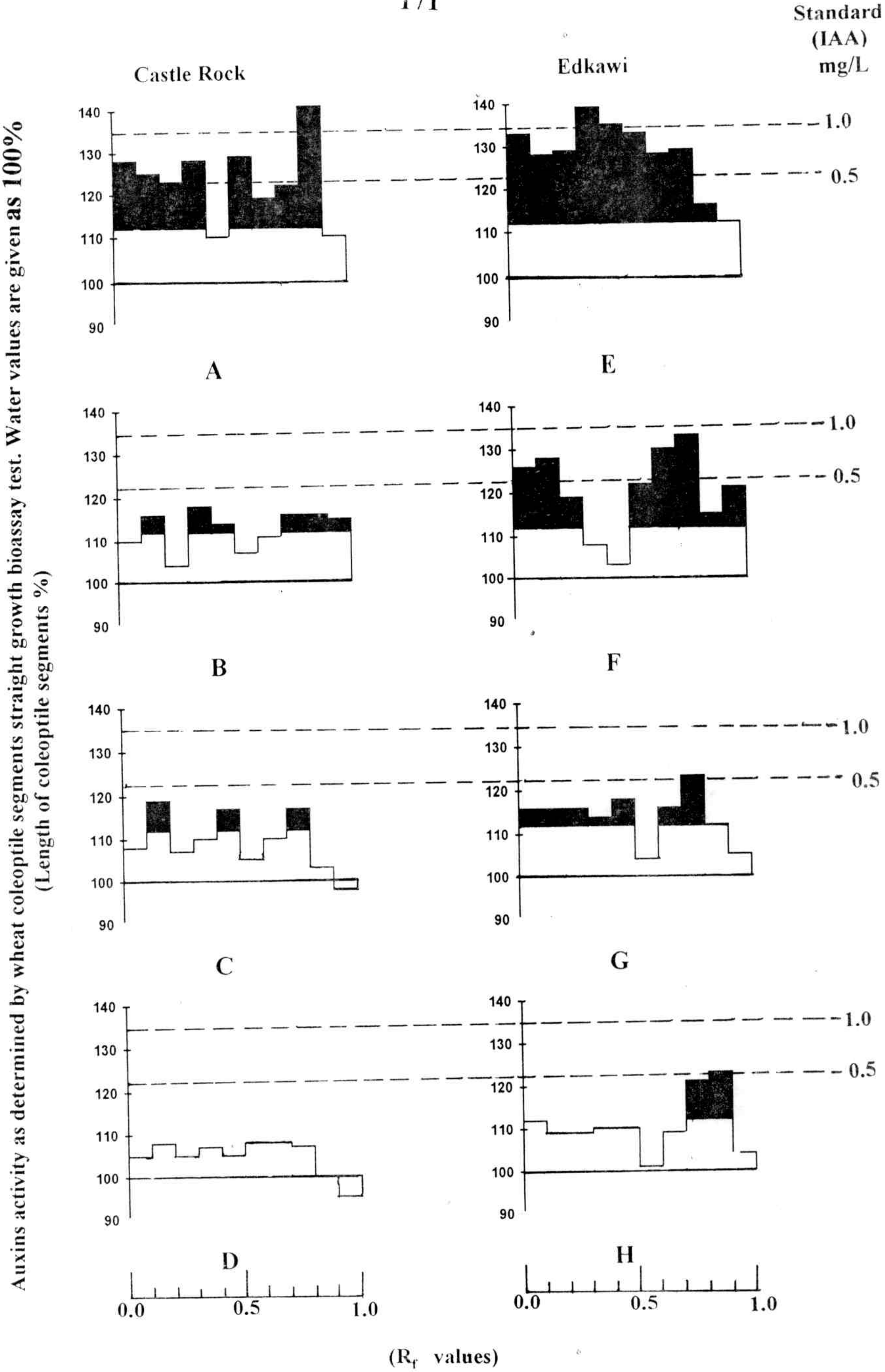

Standard
(IAA)
mg/L
Castle Rock
Edkawi
1.0
0.5
A
B
C
D
E
F
G
H
140
130
120
110
100
90
0.0
0.5
1.0
Auxins activity as determined by wheat coleoptile segments straight growth bioassay test. Water values are given as 100%
(Length of coleoptile segments %)
(R_f values)

Fig. (71)

effect of the confirmed physiological roles of auxins in plants **(Devlin and Witham, 1983)**. Also, it could be noticed that the reduction of endogenous auxins level even with the maximum tolerable salinity levels applied alone or the untolerable salinity levels preceded with paclobutrazol treatments not only affected the internal structure but also prolonged to alter different growth aspects of the treated plants. Of these alterations were the reduction that existed in the stem length and leaf area as well as the modifications that occurred in other studied growth characters mentioned in the first part of this study.

2. Endogenous gibberellin-like substances:

As shown in Figs. (72 and 73) the application of salinity alone at the maximum tolerable salinity level of each cultivar reduced the endogenous level of gibberellin-like substances in the shoots of the assigned wheat and tomato cultivars. The reduction of endogenous gibberellins level was more obvious in wheat cv. Giza 163 and tomato cv. Castle Rock (the less salt-tolerant cvs.) than in wheat cv. Sakha 92 and tomato cv. Edkawi (the more salt-tolerant cvs.). Also, the biological activity of antigibberellins was existed with the different experimented wheat and tomato cultivars under saline conditions. This inhibitors activity was higher in wheat cv. Giza 163 and tomato cv. Castle Rock than in the other two cultivars. With regard to the application of the untolerable salinity levels preceded with paclobutrazol treatments, the obvious effect was the sever reduction or complete disappearance of endogenous gibberellins and increasing their inhibitors in the shoots of the assigned wheat and tomato cultivars. This effect was more pronounced in the less salt-tolerant cvs. (Giza 163 and Castle Rock) than in the more salt-tolerant cvs. (Sakha and Edkawi).

Fig. (72): Effect of salinity alone and salinity preceded with paclobutrazol on the endogenous level of gibberellin-like substances in the shoots of wheat cvs. (Giza 163 and Sakha 92). The least significant difference between any two readings is 1.6 mm at the 1% level (the base of the black parts).

(A, B, C & D) = **Wheat cv. Giza 163 .**

(E, F, G & H) = **Wheat cv. Sakha 92 .**

(A & E) = Controls

(B & F) = Treatments of the maximum tolerable salinity level alone (7000 ppm)

(C & G) = Treatments of the untolerable salinity level (8000 ppm) preceded with paclobutrazol at 10 ppm.

(D & H) = Treatments of the untolerable salinity level (8000 ppm) preceded with paclobutrazol at 50 ppm

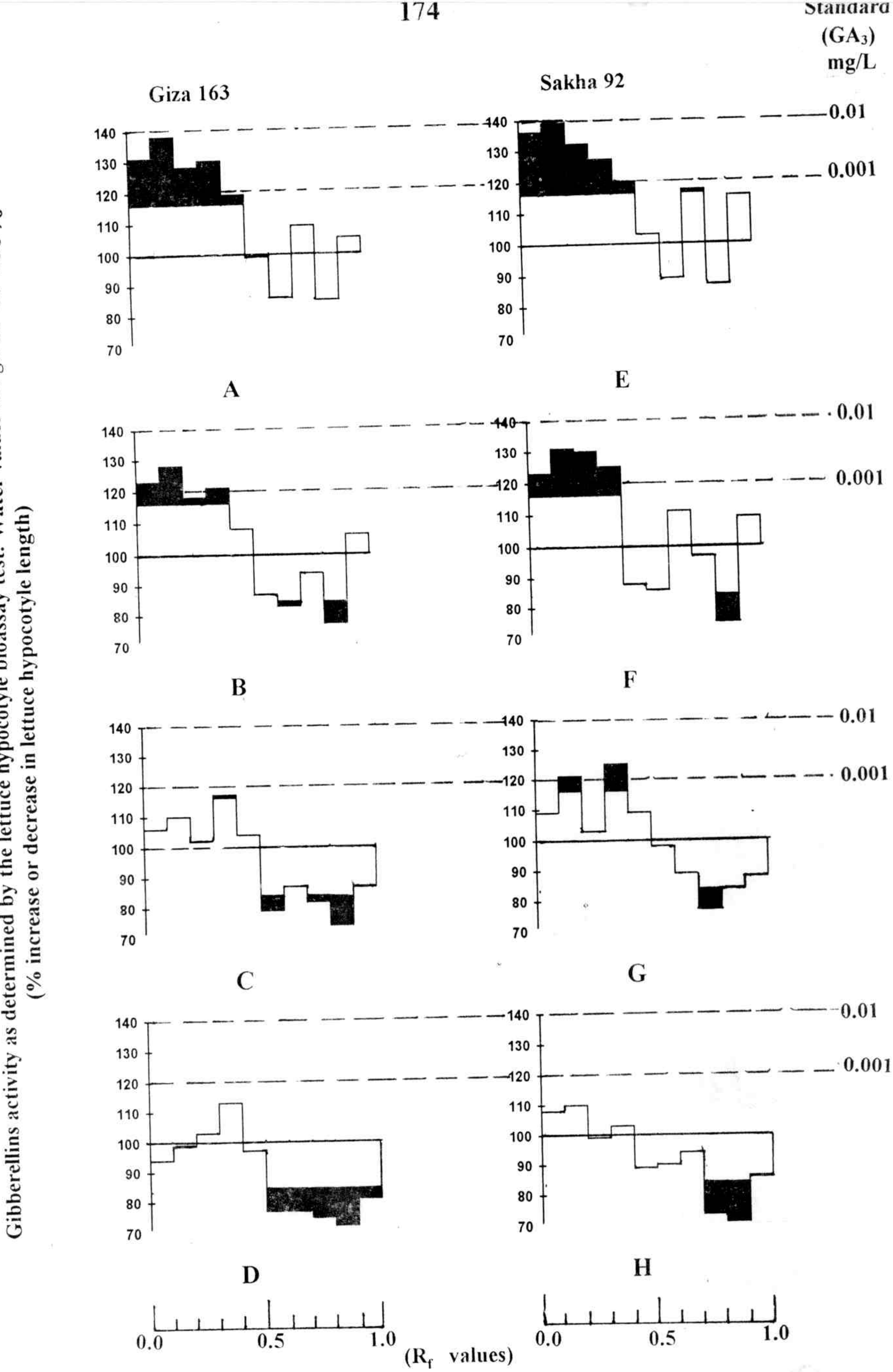

Standard
(GA3)
mg/L
Giza 163
Sakha 92
0.01
0.001
A
E
B
F
C
G
D
H
Gibberellins activity as determined by the lettuce hypocotyle bioassay test. Water values are given as 100%
(% increase or decrease in lettuce hypocotyle length)
140
130
120
110
100
90
80
70
0.0
0.5
1.0
(Rf values)

Fig. (72)

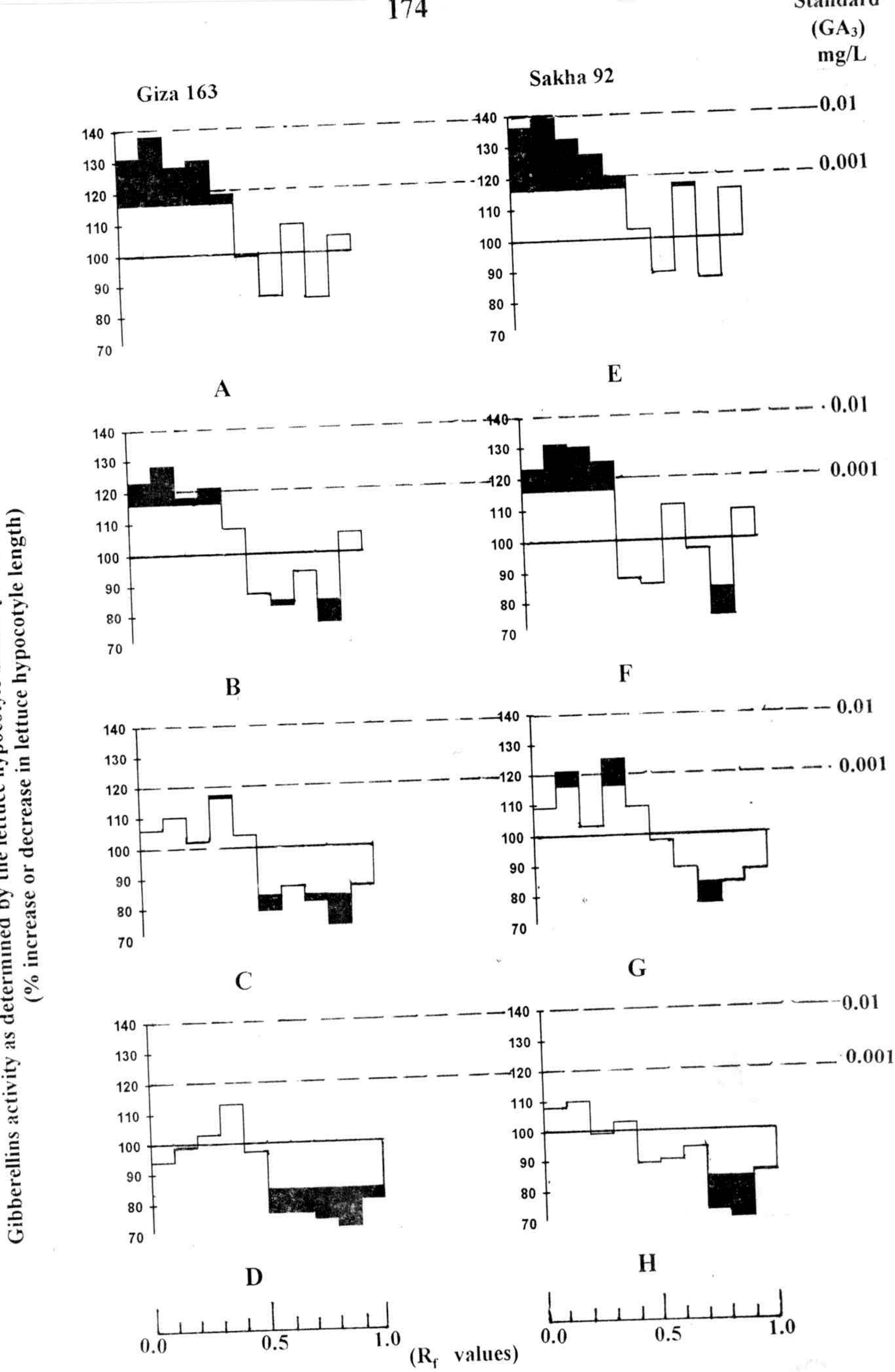

Standard
(GA_3)
mg/L
Giza 163
Sakha 92
0.01
0.001
A
E
B
F
C
G
D
H
140
130
120
110
100
90
80
70
0.0
0.5
1.0
(R_f values)
Gibberellins activity as determined by the lettuce hypocotyle bioassay test. Water values are given as 100%
(% increase or decrease in lettuce hypocotyle length)

Fig. (72)

Fig. (73): Effect of salinity alone and salinity preceded with paclobutrazol on the endogenous level of gibberellin-like substances in the shoots of tomato cvs. (Castle Rock and Edkawi). The least significant difference between any two readings is 1.6 mm at the 1% level (the base of the black parts).

(A, B, C & D) = **Tomato cv. Castle Rock.**

(A) = Control

(B) = Treatment of the maximum tolerable salinity level alone (5000 ppm)

(C) = Treatment of the untolerable salinity level (6000 ppm) preceded with paclobutrazol at 10 ppm.

(D) = Treatment of the untolerable salinity level (6000 ppm) preceded with paclobutrazol at 50 ppm

(E, F, G & H) = **Tomato cv. Edkawi.**

(E) = Control

(F) = Treatment of the maximum tolerable salinity level alone (7000 ppm)

(G) = Treatment of the untolerable salinity level (8000 ppm) preceded with paclobutrazol at 10 ppm.

(H) = Treatment of the untolerable salinity level (8000 ppm) preceded with paclobutrazol at 50 ppm

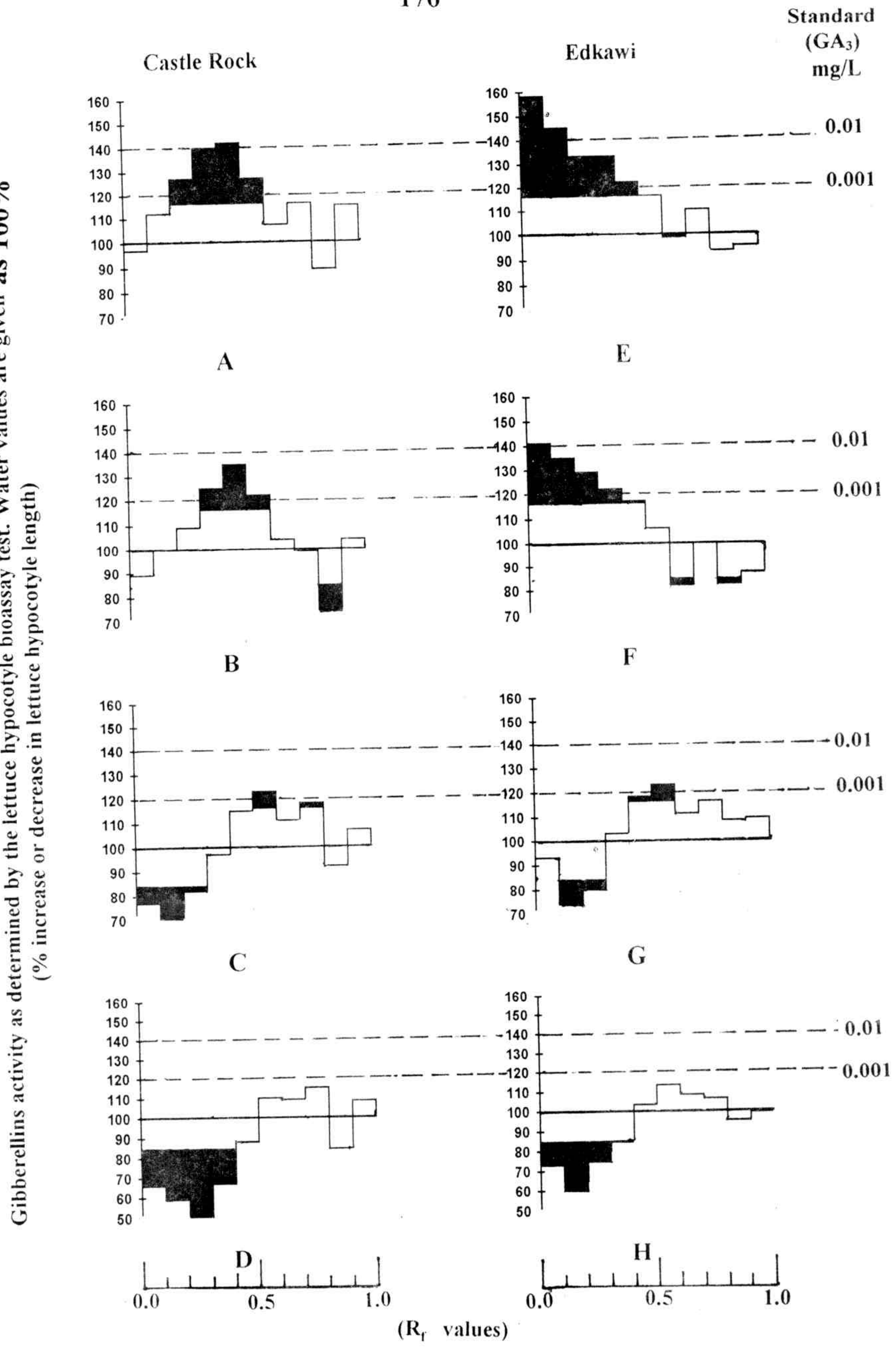

Standard (GA3) mg/L
Castle Rock
Edkawi
0.01
0.001
A
E
B
F
C
G
D
H
0.0
0.5
1.0
(Rf values)
Gibberellins activity as determined by the lettuce hypocotyle bioassay test. Water values are given as 100%
(% increase or decrease in lettuce hypocotyle length)

Fig. (73)

Of interest, is that the above mentioned results when related with the histological features of treated plants and also with their growth aspects. Since, gibberellin is known as a stimulating and individual hormone for longitudinal growth in different plants **(Devlin and Witham, 1983)**. Hence, reduction of endogenous gibberelline level led to reduction in the length of different cell types and consiquently reduction in the stem length and leaf area, especially when the reduction of both gibberellins and auxins is considered.

3. Endogenous cytokinin-like substances:

Figs. (74 and 75) indicate that the application of salinity alone at the maximum tolerable level of each cultivar (7000 ppm for wheat cv. Giza 163, cv. Sakha 92 as well as tomato cv. Edkawi and 5000 ppm for tomato cv. Castle Rock) decreased the endogenous level of cytokinin-like substances in the shoots of treated wheat and tomato plants. This reduction was more obvious in wheat cv. Giza 163 and tomato cv. Castle Rock (the less salt-tolerant cvs.) than in wheat cv. Sakha 92 and tomato cv. Edkawi(the more salt-tolerant cvs.). However, the application of paclobutrazol at 10 and 50 ppm before the treatment with the untolerable salinity levels (8000 ppm for wheat cvs. Giza 163, and Sakha 92 as well as tomato cv. Edkawi and 6000 ppm for tomato cv. Castle Rock) not only omitted the inhibitory effect of salinity on the endogenous cytokinins content but also led to striking increase in this content. This increase was directly proportional to the applied concentration of paclobutrazol and also was more pronounced in the more salt-tolerant cvs. (Sakha 92 and Edkawi) than in the less salt-tolerant cvs. (Giza 163 and Castle Rock). The increment of endogenous cytokinins levels with paclobutrazol treatments under the untolerable salinity conditions could be the main factor for the modifications in the different growth aspects of treated wheat and tomato plants. Of these modifications are the

Fig. (74): Chlorophyll levels in etiolated cucumber cotyledons as affected by the endogenous cytokinin-like substances extracted from the shoots of untreated or treated plants of wheat cvs. (Giza 163 and Sakha, 92).

(A, B, C & D) = **Wheat cv. Giza 163 .**

(E, F, G & H) = **Wheat cv. Sakha 92 .**

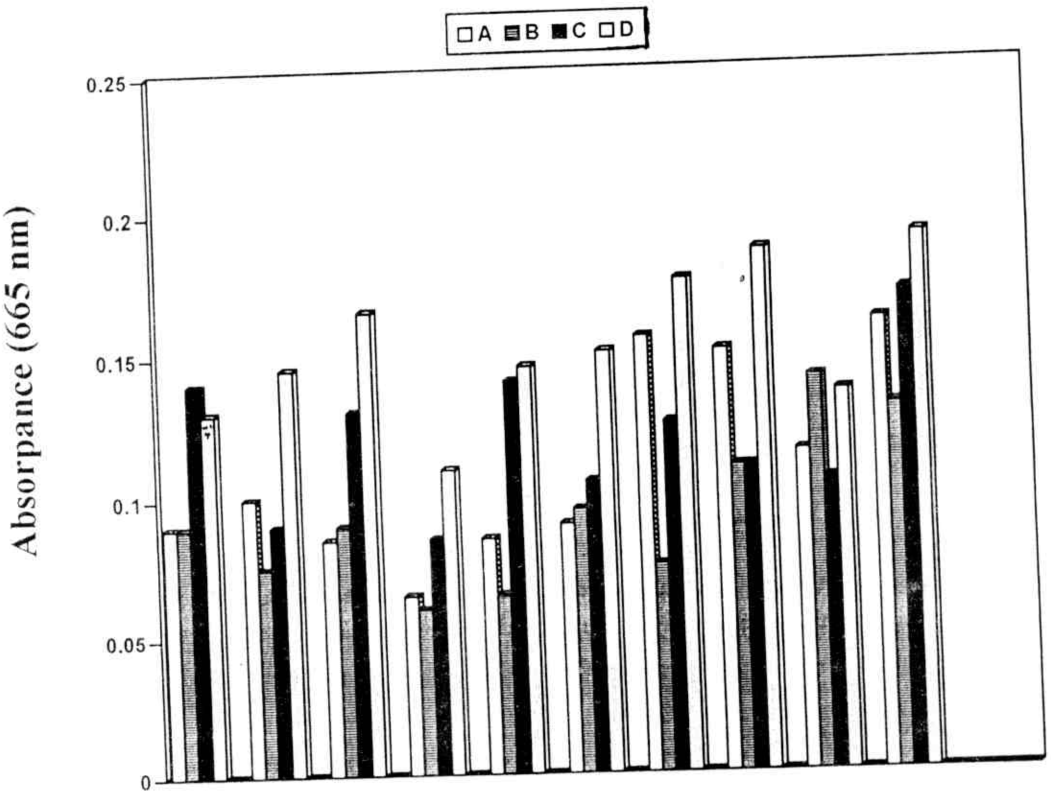
(A & E) = Controls

(B & F) = Treatments of the maximum tolerable salinity level alone (7000 ppm)

(C & G) = Treatments of the untolerable salinity level (8000 ppm) preceded with paclobutrazol at 10 ppm.

(D & H) = Treatments of the untolerable salinity level (8000 ppm) preceded with paclobutrazol at 50 ppm

Giza 163



Sakha 92

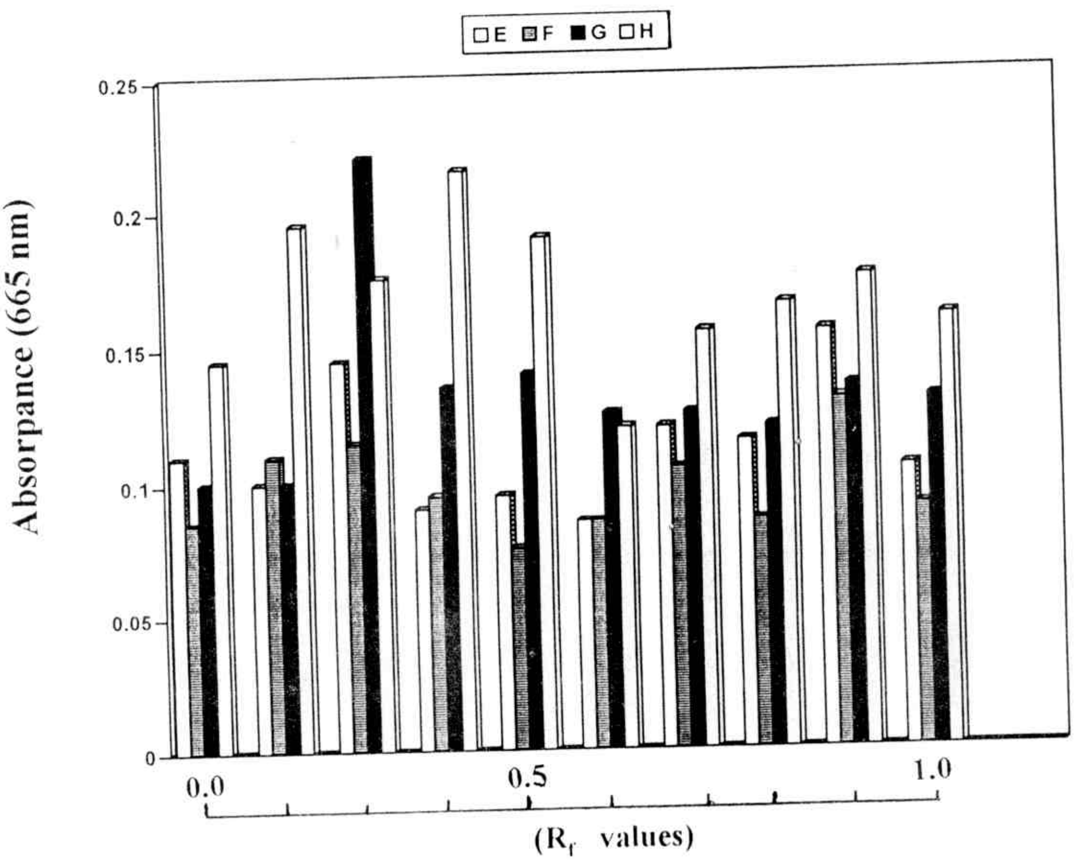


Fig. (74):

Fig. (75): Chlorophyll levels in etiolated cucumber cotyledons as affected by the endogenous cytokinin-like substances extracted from the shoots of untreated or treated plants of tomato cvs. (Castle Rock and Edkawi).

(A, B, C & D) = **Tomato cv. Castle Rock .**

(A) = Control

(B) = Treatment of the maximum tolerable salinity level alone (5000 ppm)

(C) = Treatment of the untolerable salinity level (6000 ppm) preceded with paclobutrazol at 10 ppm.

(D) = Treatment of the untolerable salinity level (6000 ppm) preceded with paclobutrazol at 50 ppm

(E, F, G & H) = **Tomato cv. Edkawi .**

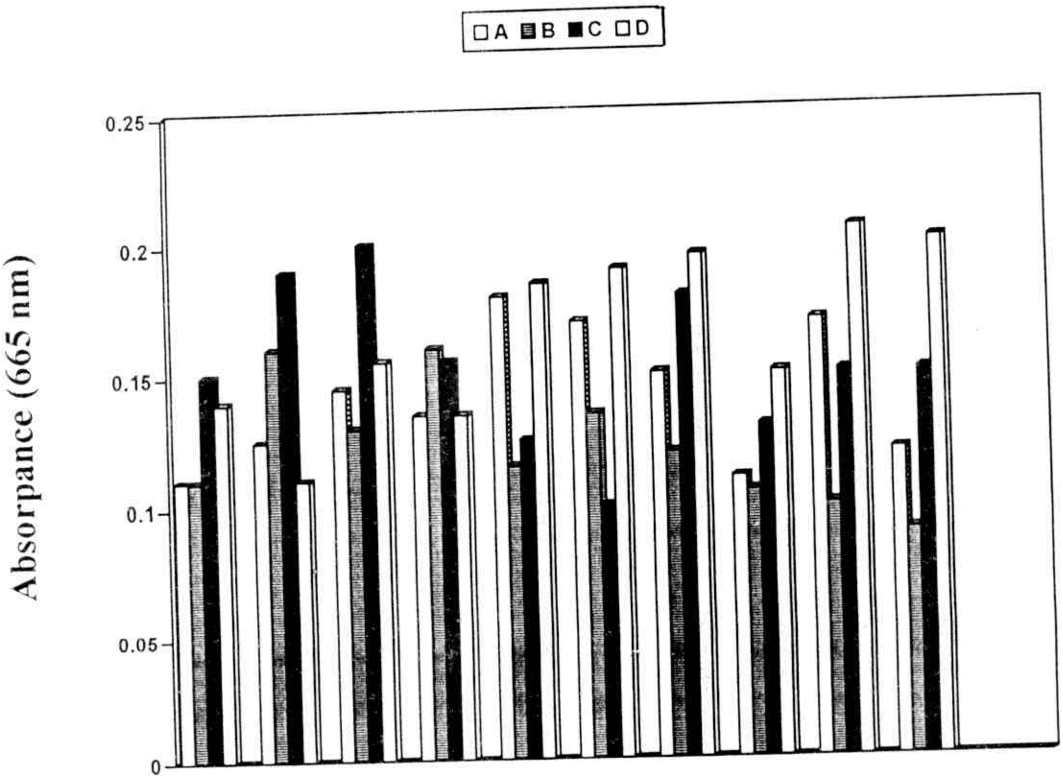
(E) = Control

(F) = Treatment of the maximum tolerable salinity level alone (7000 ppm)

(G) = Treatment of the untolerable salinity level (8000 ppm) preceded with paclobutrazol at 10 ppm.

(H) = Treatment of the untolerable salinity level (8000 ppm) preceded with paclobutrazol at 50 ppm

Edkawi



Castle Rock

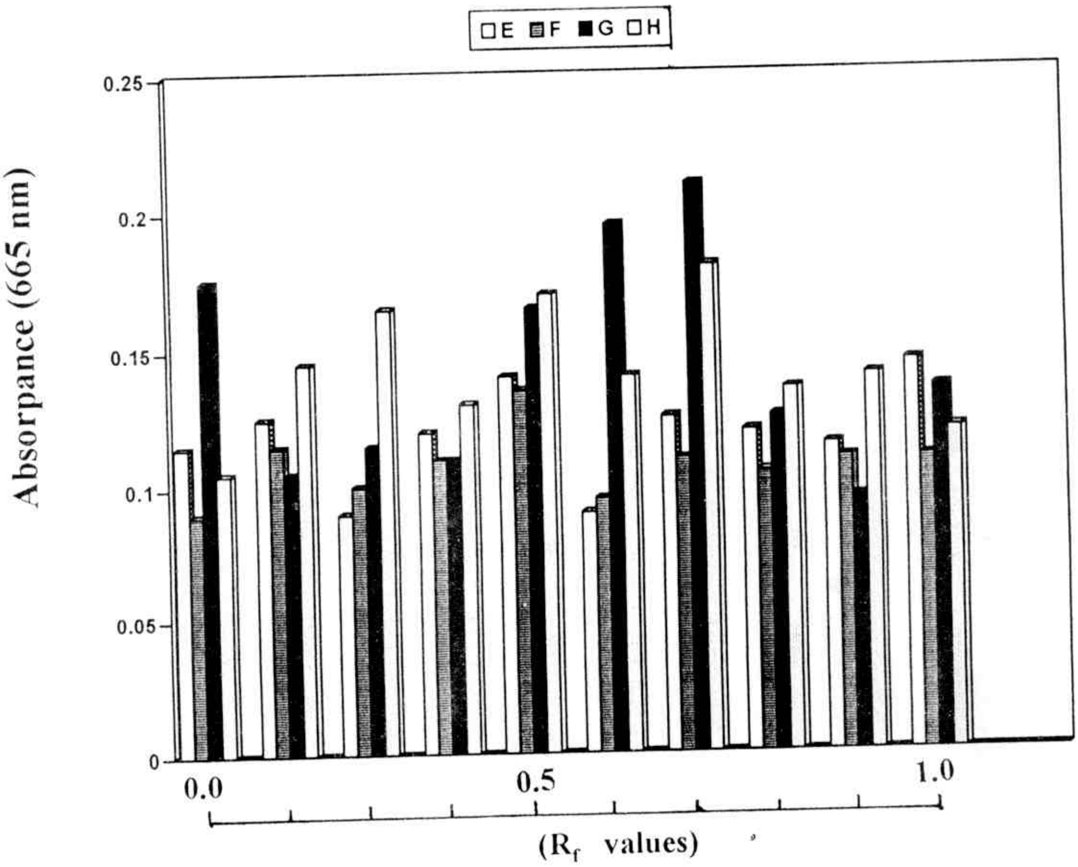


Fig. (75):

increase of: branching or tillering capacity, size of the root system, chlorophyll content, assimilation rate and also sink capacity (total carbohydrates, total soluble sugars, N P K and Vitamen C contents). In addition, the histological modifications that considered new findings of the present study e.g. increasing: the number of the vascular bundles and xylem vessels/bundle in the different organs of wheat and tomato plants, the cambium activity in both roots and stems of tomato cultivars and also the number of parenchymatous layers of both ground tissue of wheat stem and pith of tomato stems.

In this respect, other studies found similar results of salinity on the endogenous phytohormones activity in different plants. Of these studies were those mentioned by **Ghazi (1975)** on faba bean, **El-Kady *et al.* (1983a)** on bean, **El-Kady *et al.* (1983b)** on sugar beet and **El-Shami (1987)** on tomato.

h- Effect of the maximum tolerable salinity levels alone and the untolerable salinity levels preceded with paclobutrazol on free proline accumulation in the leaves of wheat and tomato plants:

Table (28) clearly show that the application of maximum tolerable salinity levels alone (7000 ppm for wheat cvs. Giza 163 and Sakha 92 as well as tomato cv. Edkawi, and 5000 ppm for tomato cv. Castle Rock) greatly increased the accumulation of the free amino acid proline in the leaves of the treated wheat and tomato plants. This increase was more obvious in wheat cv. Giza 163 and tomato cv. Castle Rock (the less salt-tolerant cvs.) than in wheat cv. Sakha 92 and tomato cv. Edkawi (the more salt-tolerant cvs.). However, the application of paclobutrazol at 10 and 50 ppm before the treatment with the untolerable salinity levels (8000 and 9000 ppm for wheat cvs. Giza 163 and Sakha 92 as well as tomato cv. Edkawi) and 6000 and 7000 ppm for tomato cv. Castle Rock)

Table (28) Effect of the maximum tolerable salinity levels alone and the untolerable salinity levels preceded with paclobutrazol treatments on free proline accumulation (mg/g fresh weight) in the leaves of wheat and tomato cultivars (season 1993/ 94).

	Treatments					
	Tap water (control)	Salinity 7000 ppm	Paclobutrazol 10 Salinity (ppm)		Paclobutrazol 50 Salinity (ppm)	
			8000	9000	8000	9000
	Wheat cv. Giza 163					
Free Proline	0.66	1.22	0.93	1.04	0.74	0.89
	Wheat cv. Sakha 92					
Free Proline	0.79	1.28	0.88	1.02	0.70	0.85

	Treatments					
	Tap water (control)	Salinity 5000 ppm	Paclobutrazol 10 Salinity (ppm)		Paclobutrazol 50 Salinity (ppm)	
			6000	7000	6000	7000
	Tomato cv. Castle Rock					
Free proline	0.71	1.16	1.04	1.15	0.83	0.99

	Treatments					
	Tap water (control)	Salinity 7000 ppm	Paclobutrazol 10 Salinity (ppm)		Paclobutrazol 50 Salinity (ppm)	
			8000	9000	8000	9000
	Tomato cv. Edkawi					
Free proline	0.96	1.34	1.02	1.18	0.72	0.83

diminished the stimulating effect of salinity on the accumulation of free proline in the leaves of the treated wheat and tomato cultivars. In other wards, paclobutrazol decreased the leaf content of free proline under the untolerable salinity levels compared with that of the plants treated with salinity alone. This reduction was parallel to the applied concentration of paclobutrazol and also was more pronounced in the more salt-tolerant cultivars (Sakha 92 and Edkawi) than in the less salt-tolerant cultivars (Giza 163 and Castle Rock).

In this respect, other studies found similar stimulating effect of salinity on free proline accumulation in different plants. Of these studies were those mentioned by **Nyan and Shyon (1984)** on rice, **Ayaad *et al.* (1991)** on guava seedlings, **Perez-Alfocea *et al.* (1993)** on tomato and **Al-Bahrany (1994)** on pepper.

For the accleration of free proline accumulation under saline conditions it could be attributed to (i) the inhibition of protein synthesis leading to extensive diversion of nitrogen to proline (ii) the breakdown of protein and (iii) the conversion of some amino acid resulted from the degradation of protein such as glutamic and asparatic acids to proline **(Reid and Wample, 1985)**.

With respect to the possible roles of proline in plants under saline conditions it was postulated that (i) proline may function as a compitable solute in the important role of balancing cytoplasmic and vacuolar water potentials **(Flowers *et al.*, 1977)**. (ii) proline may serve as a substrate for respiration, an energy source and a storage compound for the recovering plant following stress **(Ridge *et al.*, 1993)**.

But for the reduction in free proline accumulation under the untolerable salinity levels when preceded with paclobutrazol treatment, it could be interpreted on the basis that paclobutrazol stimulates protein synthesis **(El-Desouky and Abd El-Dayem, 1992; Wanas, 1992 and Ismail, 1995)**. So, an appropriate amount of free proline should be conjugated in the formed protein. In addition, increasing the vegetative and reproductive growth capacities with paclobutrazol treatments could be attracted other amounts of free proline to form other organic compounds. Furthermore, increasing of endogenous cytokinins as result of paclobutrazol treatment (other result of the present study) could be the main factor for the reduction of free proline content. Since, cytokinin is well established to increase protein synthesis, vegetative and plant survival or duration as well **(Kulaeva, 1979; Mohamed and El-Desouky, 1992 and El-Desouky and Abd El-Dayem, 1992c)**.

i- Effect of the maximum tolerable salinity levels alone and the untolerable salinity levels preceded with paclobutrazol on yield and yield components of wheat and tomato plants:

1. Wheat cvs. (Giza 163 and Sakha 92):

Data in Tables (29 and 30) clearly indicate that the application of salinity alone at the maximum tolerable level (7000 ppm) significantly decreased the length and weight of main spike, weight and number of grains/main spike, number of spikes/plant and the grain yield/plant as well as the grain index (weight of 1000-grains) in the two assigned wheat cultivars in the two seasons of this study. This reduction was more pronounced in Giza 163 (the less salt-tolerant cv.) than in Sakha 92 (the more salt-tolerant cv.). On contrary, the application of paclobutrazol at 10 and 50 ppm before the treatment with the untolerable salinity levels (8000 and 9000 ppm) overcame the inhibitory effect of salinity on the different measured aspects of yield and yield components of the wheat cultivars leading to significant increase in the yield and its components especially under the untolerable

Table (29) Effect of the maximum tolerable salinity level alone and the untolerable salinity levels preceded with paclobutrazol treatments on yield and yield components of wheat cultivars (season 1993/ 94).

Characters	Treatments						L.S.D (0.05)
	Tap water (control)	Salinity 7000 ppm	Paclobutrazol (ppm) 10 Salinity (ppm)		Paclobutrazol (ppm) 50 Salinity (ppm)		
			8000	9000	8000	9000	
	Wheat cv. Giza 163						
Grain yield (g)/ plant	14.54	10.72	15.48	11.98	16.23	12.47	0.88
No. of spikes/ plant	8.50	6.50	8.00	6.50	10.00	8.00	0.72
Length of the main spike(cm)	13.67	12.12	12.30	11.71	12.20	11.53	0.54
Weight of the main spike (g)	3.63	2.81	3.78	2.95	3.94	3.13	0.25
Weight of grains (g)/ main spike	2.53	1.72	2.77	2.02	2.82	2.04	0.16
No. of grains/ main spike	65.00	50.50	65.30	52.00	73.80	60.00	3.54
Weight of 1000 grain (g)	38.92	34.06	42.42	38.85	38.21	34.00	1.45
	Wheat cv. Sakha 92						
Grain yield (g)/ plant	9.57	8.15	13.81	9.89	14.38	9.06	0.77
No. of spikes/ plant	6.70	5.70	9.50	7.20	10.20	7.20	0.53
Length of the main spike(cm)	10.31	9.65	11.43	10.30	11.28	9.90	0.39
Weight of the main spike (g)	2.96	2.46	3.80	3.03	3.48	2.54	0.24
Weight of grains (g)/ main spike	1.94	1.58	2.53	1.93	2.28	1.69	0.19
No. of grains/ main spike	62.30	49.50	74.70	56.20	77.10	53.30	3.80
Weight of 1000 grain (g)	31.14	31.92	33.87	34.34	29.57	31.71	1.02

Table (30) Effect of the maximum tolerable salinity level alone and the untolerable salinity levels preceded with paclobutrazol treatments on yield and yield components of wheat cultivars (season 1994/ 95).

Characters	Treatments						L.S.D (0.05)
	Tap water (control)	Salinity 7000 ppm	Paclobutrazol (ppm)				
			10		50		
			Salinity (ppm)		Salinity (ppm)		
			8000	9000	8000	9000	
	Wheat cv. Giza 163						
Grain yield (g)/ plant	13.15	8.83	13.95	10.48	15.25	12.07	0.76
No. of spikes/ plant	7.20	5.70	7.20	6.00	9.00	7.50	0.75
Length of the main spike (cm)	13.20	11.50	12.40	11.22	12.09	11.27	0.62
Weight of the main spike (g)	3.46	2.49	3.67	2.75	3.65	3.10	0.18
Weight of grains (g)/ main spike	2.45	1.55	2.71	1.87	2.62	2.09	0.24
No. of grains/ main spike	62.50	46.50	64.00	48.00	76.00	56.50	3.24
Weight of 1000 grain (g)	39.20	33.33	42.34	38.96	34.47	36.99	1.72
	Wheat cv. Sakha 92						
Grain yield (g)/ plant	8.65	7.60	12.40	8.84	13.22	8.09	0.83
No. of spikes/ plant	6.20	5.70	9.00	6.50	9.20	7.00	0.69
Length of the main spike (cm)	10.05	9.47	11.17	10.13	10.98	9.63	0.48
Weight of the main spike (g)	2.73	2.40	3.39	2.77	3.26	2.52	0.16
Weight of grains (g)/ main spike	1.81	1.53	2.28	1.86	2.20	1.59	0.17
No. of grains/ main spike	57.00	47.70	67.50	55.20	72.50	48.50	3.30
Weight of 1000 grain (g)	31.75	32.08	33.78	33.69	30.34	32.78	1.28

salinity level of 8000 ppm compared with those of the untreated plants. This positive effect of paclobutrazol was parallel to the applied concentartion and also was more pronounced in Sakha 92 (the more salt-tolerant cv.) than in Giza 163 (the less salt-tolerant cv.). The above mentioned results directly mean that paclobutrazol made wheat plants able to tolerate the applied untolerable salinity levels and economically to be cultivated under such saline conditions.

In this respect, many research workers found similar negative effect of salinity on yield and yield components of wheat plants. Of those were **Maas and Poss (1989); Becket and Staden (1991); Parasher and Varma (1992) and Ismaeil *et al.* (1993)**.

The reduction of yield and its characters under saline conditions might be attributed to the negative effects of salinity on the early stages of wheat growth. Of these effects, the greatest one on chloroplast pigments synthesis, thus the effect on photosynthesis process should be expected. So, the translocation and accumulation of different assimilates seemed to be negatively affected which could reverse on the reduction of yield and its components as well.

In addition, improving of yield and its characters under the untolerable salinity levels when preceded with paclobutrazol could be mainly attributed to the induction of wheat growth under these treatments.

2. Tomato cvs. (Castle Rock and Edkawi):

As shown in Tables (31 and 32) the maximum tolerable salinity levels (5000 ppm for Castle Rock cv. and 7000 ppm for Edkawi cv.) when applied alone significantly decreased the number of fruits and percentage of fruit sitting per plant, the fruit

Table (31) Effect of the maximum tolerable salinity levels alone and the untolerable salinity levels preceded with paclobutrazol treatments on yield and yield components of tomato cultivars (season 1993/ 94).

Characters	Treatments						L.S.D (0.05)
	Tap water (control)	Salinity 5000 ppm	Paclobutrazol (ppm) 10		Paclobutrazol (ppm) 50		
			Salinity (ppm) 6000	Salinity (ppm) 7000	Salinity (ppm) 6000	Salinity (ppm) 7000	
	Tomato cv. Castle Rock						
Fruit yield (g)/ plant	310.52	156.53	466.40	247.75	349.83	250.25	20.24
No. of fruits/ plant	11.70	7.50	16.20	12.40	13.00	11.00	1.65
Percentage of fruit setting/ plant	62.57	56.81	66.94	65.26	68.42	66.67	1.77
Mean weight of the fruit (g)	26.54	20.87	28.79	19.98	26.91	22.75	1.70
Fruit diameter (cm)	3.85	3.11	4.26	3.06	3.88	3.30	0.30
Characters	Treatments						L.S.D (0.05)
	Tap water (control)	Salinity 7000 ppm	Paclobutrazol (ppm) 10		Paclobutrazol (ppm) 50		
			Salinity (ppm) 8000	Salinity (ppm) 9000	Salinity (ppm) 8000	Salinity (ppm) 7900	
	Tomato cv. Edkawi						
Fruit yield (g)/ plant	608.80	345.82	878.28	523.64	854.88	551.82	28.37
No. of fruits/ plant	16.00	12.70	21.50	19.00	24.00	17.00	1.75
Percentage of fruit setting/ plant	66.67	63.50	74.14	73.08	75.71	73.91	1.85
Mean weight of the fruit (g)	38.05	27.23	40.85	27.56	35.62	32.46	2.30
Fruit diameter (cm)	5.28	3.96	5.61	4.03	4.95	4.60	0.27

Table (32) Effect of the maximum tolerable salinity levels alone and the untolerable salinity levels preceded with paclobutrazol treatments on yield and yield components of tomato cultivars (season 1994/ 95).

Characters	Tap water (control)	Salinity 5000 ppm	Paclobutrazol 10 ppm, Salinity 6000 ppm	Paclobutrazol 10 ppm, Salinity 7000 ppm	Paclobutrazol 50 ppm, Salinity 6000 ppm	Paclobutrazol 50 ppm, Salinity 7000 ppm	L.S.D (0.05)
Tomato cv. Castle Rock							
Fruit yield (g)/ plant	290.64	151.22	439.49	245.27	322.69	215.65	23.18
No. of fruits/ plant	10.50	6.70	14.20	10.80	11.70	8.50	1.67
Percentage of fruit setting/ plant	63.64	57.26	66.05	63.53	70.90	68.00	1.27
Mean weight of the fruit (g)	27.68	22.57	30.95	22.71	27.58	25.37	1.80
Fruit diameter (cm)	4.15	3.38	4.58	3.40	4.05	3.55	0.27

Characters	Tap water (control)	Salinity 7000 ppm	Paclobutrazol 10 ppm, Salinity 8000 ppm	Paclobutrazol 10 ppm, Salinity 9000 ppm	Paclobutrazol 50 ppm, Salinity 8000 ppm	Paclobutrazol 50 ppm, Salinity 7900 ppm	L.S.D (0.05)
Tomato cv. Edkawi							
Fruit yield (g)/ plant	504.11	308.55	786.22	444.68	741.11	504.49	26.21
No. of fruits/ plant	13.80	11.00	19.00	16.50	21.50	15.80	1.25
Percentage of fruit setting/ plant	65.71	61.11	73.93	71.74	74.14	70.85	1.53
Mean weight of the fruit (g)	36.53	28.05	41.38	26.95	34.47	31.93	2.13
Fruit diameter (cm)	5.03	4.28	5.95	3.83	4.78	4.41	0.24
Percentage of dry matter/ fruit	7.98	7.54	8.28	8.11	8.61	8.43	0.25

diameter (cm), mean weight of the fruit and consiquently the fruits yield per plant in the two tomato cultivars in both experimental seasons. This reduction was more obvious in Castle Rock (the less salt-tolerant cv.) than in Edkawi (the more salt-tolerant cv.). On the other hand, the application of paclobutrazol at 10 and 50 ppm before the treatment with the untolerable salinity levels (6000 and 7000 ppm for Castle Rock cv. and 8000 and 9000 ppm for Edkawi cv.) successfully overcame the deleterious effect of salinity on yield and yield components of the two tomato cultivars. Since, paclobutrazol significantly increased the yield and its components of both tomato cultivars - especially under the untolerable salinity level of 6000 ppm for Castle Rock cv. and 8000 ppm for Edkawi cv. - compared with those of the untreated plants in the two seasons of this study. Also, the omission of salinity-inhibition of different estimated reproductive and fruiting aspects was parallel to the used concentration of paclobutrazol and also was more pronounced in Edkawi (the more salt-tolerant cv.) than in Castle Rock (the less salt-tolerant cv.).

In this respect, the negative effect of salinity on yield and yield components of tomato plants was reviewed, **Mahmoud *et al.* (1986b), Alam *et al.* (1989), Rossario *et al.* (1990) and Saleh and Al-Maghrabi (1991)**.

j- Effect of the maximum tolerable salinity levels alone and the untolerable salinity levels preceded with paclobutrazol on nitrate reductase activity and nitrate accumulation in tomato fruits at different stages of their growth:

Table (33) clearly indicate that the nitrate reductase activity as well as the nitrate accumulation were decreased with the maximum tolerable salinity levels alone (5000 ppm for Castle Rock cv. and 7000 ppm for Edkawi cv.) during the different stages of fruits growth in these two tomato cultivars.

Table (33): Effect of the maximum tolerable salinity levels alone and the untolerable salinity levels preceded with paclobutrazol treatments on nitrate reductase activity (NO_2 µg/g^{-1} F.W./h^{-1}) and nitrate accumulation (mg/g dry weight) in tomato fruit at different stages of their growth (season 1993/94).

Estimations	Treatments					
	Control (tap water)	Salinity 5000 ppm	Paclobutrazol (ppm) 10		Paclobutrazol (ppm) 50	
			Salinity (ppm)		Salinity (ppm)	
			6000	7000	6000	7000
Tomato cv. Castle Rock						
NO_2 µg/g^{-1} F.W./h^{-1}:						
New-set fruits	7.6±0.00	4.0±0.20	8.1±0.50	5.4±0.30	26.6±0.44	17.5±0.83
Mid-growth fruits	5.2±0.40	5.6±0.46	4.9±0.15	3.4±0.24	12.7±0.62	16.0±0.52
Ripening fruits	1.3±0.20	0.8±0.15	1.8±0.23	1.0±0.15	2.8±0.15	2.1±0.15
Nitrate-N mg/g D.W.:						
New-set fruits	0.85	0.50	0.42	0.33	0.27	0.21
Mid-growth fruits	0.67	0.70	0.33	0.29	0.19	0.17
Ripening fruits	0.23	0.17	0.13	0.15	0.09	0.08

Estimations	Treatments					
	Control (tap water)	Salinity 7000 ppm	Paclobutrazol (ppm) 10		Paclobutrazol (ppm) 50	
			Salinity (ppm)		Salinity (ppm)	
			8000	9000	8000	9000
Tomato cv. Edkawi						
NO_2 µg/g^{-1} F.W./h^{-1}:						
New-set fruits	18.6±0.74	9.7±0.54	24.7±0.73	20.3±0.90	38.0±0.29	34.7±1.20
Mid-growth fruits	12.0±0.40	10.3±0.39	20.4±0.21	17.2±0.28	25.0±0.29	22.1±0.61
Ripening fruits	2.3±0.28	1.8±0.15	3.1±0.29	2.5±0.27	4.4±0.00	3.4±0.29
Nitrate-N mg/g D.W.:						
New-set fruits	0.73	0.47	0.33	0.31	0.21	0.17
Mid-growth fruits	0.54	0.59	0.25	0.23	0.15	0.13
Ripening fruits	0.19	0.15	0.11	0.09	0.08	0.04

In this respect, the inhibitory effect of salinity on nitrate reductase activity and nitrate accumulation was reviewed by **Islam** *et al.* **(1984)** on barley, **Martinez and Cerda (1989)** on tomato and cucumber and **Perez-Alfocea** *et al.* **(1993)** on tomato.

With regard to the reduction of nitrate reductase activity and nitrate accumulation under salinity conditions, **Martinez and Cerda (1989)** reported that the nitrate reductase activity was directly affected by the presence of excessive Na and Cl ions in the root medium either as a result of interference with the uptake of NO_3 by the roots or inhibition of NO_3 transport from vacuole to cytosol.

On the other hand, the application of paclobutrazol at 10 and 50 ppm before the treatment with the untolerable salinity levels (6000 and 7000 ppm for Castle Rock cv. and 8000 and 9000 ppm for Edkawi cv.) highly increased the nitrate reductase activity and obviously decreased the nitrate accumulation during the different stages of fruits growth in both tomato cultivars. In this respect, paclobutrazol at 50 ppm showed the maximum enzyme activity and the lowest nitrate content at the ripening stage of tomato fruits under the applied untolerable salinity levels. These results are of interest, since minimizing of nitrate content in the marketable fruits (ripening stage) is desirable from the side of human health.

Furthermore, the stimulation of nitrate reductase activity and the reduction of nitrate content in the ripening fruits could be confirmed that increase of protein content in tomato fruits (Table, 37) existed with paclobutrazol treatments under the untolerable salinity levels. That it means that paclobutrazol led to stimulation of protein synthesis i.e. stimulated creation of protein synthesis enzymes. Also, those enzymes of nitrate conversion to ammonia (i.e. nitrate and nitrite reductase enzymes) and incorporation of ammonia into ketoacids to form amino acids.

k- Effect of the maximum tolerable salinity levels alone and the untolerable salinity levels preceded with paclobutrazol on total carbohydrate and sugar contents in wheat grains and tomato fruits:

1. Wheat cvs. (Giza 163 and Sakha 92):

Data in Table (34) show that the application of maximum tolerable salinity level alone (7000 ppm) decreased the grains content of total carbohydrates and non-reducing sugars, but increased their content of reducing sugars. Even though, the grains content of total soluble sugars (reducing and non-reducing sugars) was not affected. These results were true for the two wheat cultivars. Also, the effect of salinity on total carbohydrate and sugar contents was more obvious in Giza 163 (the less salt-tolerant cv.) than in Sakha 92 (the more salt-tolerant cv.). On the other hand, when paclobutrazol (at 10 and 50 ppm) applied before the treatment with the untolerable salinity levels (8000 and 9000 ppm) the grains content of total carbohydrates and total soluble sugars (or their fractions) was obviously increased. This increment was directly proportional to the applied concentration of paclobutrazol and also was higher in Sakha 92 than in Giza 163 .

In this respect, the inhibitory effect of salinity of total carbohydrates content was reviewed, by **Moursi *et al.* (1977)** on wheat and **Kamel *et al.* (1987)** on rice.

The reduction of carbohydrates content with the maximum tolerable salinity level applied alone and that increament existed in this content when paclobutrazol preceded the untolerable salinity levels could be directly related to the effects of these treatments on photosynthesis process, thus the reversion on assimilates

Table (34): Effect of the maximum tolerable salinity level alone and the untolerable salinity levels preceded with paclobutrazol treatments on total carbohydrate and sugar contents (mg/ g dry weight) in wheat grains (season 1993/ 94).

Characters		Treatments					
		Tap water (control)	Salinity 7000 ppm	Paclobutrazol (ppm)			
				10		50	
				Salinity (ppm)		Salinity (ppm)	
				8000	9000	8000	9000
		Wheat cv. Giza 163					
Total carbohydrates		605.00	545.00	629.00	601.00	668.00	622.50
Sugars	Reducing	5.00	7.00	6.00	7.00	8.00	9.00
	Non- reducing	39.00	37.00	48.00	47.00	56.00	49.00
	Total	44.00	44.00	54.00	54.00	64.00	58.00
		Wheat cv. Sakha 92					
Total carbohydrates		585.00	549.00	637.50	617.50	660.00	635.00
Sugars	Reducing	7.00	9.00	8.00	10.00	9.00	12.00
	Non- reducing	37.00	35.00	40.00	38.00	55.00	48.00
	Total	44.00	44.00	48.00	48.00	64.00	60.00

translocation and/or their accumulation. Alterations of assimilates flow pattern with growth regulators treatments has been established in other studies. Of these studies were those mentioned by **Sansavini *et al.* (1988)** on pear trees, **El-Désouky and Abd El-Dayem (1992b)** on rapeseed, **Wanas (1992)** on pea and fenugreek and **Ismaeil (1995)** on broad bean. Therefore, the effect of salinity alone and salinity preceded with paclobutrazol could be highly correlated with the alterations of the endogenous balances of phytohormones. Of these alterations the reduction in the endogenous of cytokinins level with salinity alone treatment and its increase with salinity preceded with paclobutrazol (other result of the present study). Cytokinin - as previously mentioned - activated a number of enzymes participating in a wide range of metabolic reactions. Activations of enzymes include pyro-phosphates which catalyze various synthesis, malic enzyme participating in organic acid metabolism and ribulose-diphosphate carboxylase with phosphoenol pyruvate carboxylase that function in photosynthesis. Beside, its role in enhancing the enzyme activities and induces de novo enzyme synthesis such as chloroplast RNA polymerase. Hence, it increase the net products of photosynthesis **(Kulaeva, 1979)**.

2. Tomato cvs. (Castle Rock and Edkawi):

Data in Table (35) clearly indicate that the fruits content of both total carbohydrates and total soluble sugars (reducing and non-reducing sugars) even under the maximum tolerable salinity levels alone (5000 ppm for Castle Rock cv. and 7000 ppm for Edkawi cv.) or the untolerable salinity levels (6000 and 7000 ppm for Castle Rock cv. and 8000 and 9000 ppm for Edkawi cv.) preceded with paclobutrazol treatments (10 and 50 ppm) were completely behaved the same trend as in wheat plants.

Table (35): Effect of the maximum tolerable salinity levels alone and the untolerable salinity levels preceded with paclobutrazol treatments on total carbohydrate and sugar contents (mg/ g dry weight) in tomato fruits (season 1993/ 94).

Estimations		Treatments					
		Tap water (control)	Salinity 5000 ppm	Paclobutrazol (ppm) 10		Paclobutrazol (ppm) 50	
				Salinity (ppm) 6000	7000	Salinity (ppm) 6000	7000
		Tomato cv. Castle Rock					
Total carbohydrates		127.00	107.00	144.00	137.00	178.00	166.00
Sugars	Reducing	30.00	46.00	52.00	56.00	58.00	65.00
	Non- reducing	51.00	35.00	57.00	53.00	69.00	62.00
	Total	81.00	81.00	109.00	109.00	127.00	127.00

Estimations		Treatments					
		Tap water (control)	Salinity 7000 ppm	Paclobutrazol (ppm) 10		Paclobutrazol (ppm) 50	
				Salinity (ppm) 8000	9000	Salinity (ppm) 8000	9000
		Tomato cv. Edkawi					
Total carbohydrates		161.00	147.00	203.00	188.00	244.00	218.00
Sugars	Reducing	66.00	74.00	92.00	101.00	104.00	112.00
	Non- reducing	45.00	37.00	57.00	44.00	80.00	62.00
	Total	111.00	111.00	149.00	145.00	184.00	174.00

In this respect, **Mizrahi (1982)** on tomato found similar positive effect of salinity on reducing sugars content.

I- Effect of the maximum tolerable salinity levels alone and the untolerable salinity levels preceded with paclobutrazol on NPK content in wheat grains and tomato fruits:

1. Wheat cvs. (Giza 163 and Sakha 92):

As shown in Table (36) the NPK content as well as the calculated crude protein and the nitrate nitrogen (NO_3-N) content were obviously decreased under the maximum tolerable salinity level alone (7000 ppm) in the two assigned wheat cultivars. This reduction was more pronounced in Giza 163 (the less salt-tolerant cv.) than in Sakha 92 (the more salt-tolerant cv.). Otherwise, the application of paclobutrazol at 10 and 50 ppm before the treatment with the untolerable salinity levels (8000 and 9000 ppm) successfully reversed the inhibitory effect of salinity on NPK content and the crude protein to stimulation. Meanwhile, the nitrate-nitrogen content under these untolerable salinity levels preceded with paclobutrazol treatments was behaved the same as the maximum tolerable salinity treatment. Also, it was noticed that reflection of the inhibitory effect of salinity on NPK content or on the crude protein was proportional to the applied concentration of paclobutrazol and also was more obvious in Sakha 92 (the more salt-tolerant cv.) than in Giza 163 (the less salt-tolerant cv.).

These results are of interest, since increase of NPK content as well as the reduction of nitrate nitrogen content are economically important and desirable from the side of human feeding as well.

In this respect, other studies found such inhibitory effect of salinity on NPK content in wheat plant. Of these studies were

Table (36): Effect of the maximum tolerable salinity level alone and the untolerable salinity levels preceded with paclobutrazol treatments on nitrogen, phosphorus and potassium contents (mg/ g dry weight) in wheat grains (season 1993/ 94).

Estimations	Treatments					
	Tap water (control)	Salinity 7000 ppm	Paclobutrazol			
			10		50	
			Salinity (ppm)		Salinity (ppm)	
			8000	9000	8000	9000
	Wheat cv. Giza 163					
Total nitrogen	38.04	30.03	37.04	35.03	40.14	37.24
Crude protein	237.75	187.69	231.50	218.94	250.88	232.75
* N0$_3$- N	0.30	0.24	0.21	0.18	0.16	0.12
Phosphorus	0.30	0.23	0.31	0.27	0.37	0.32
Potassium	5.00	4.25	6.00	4.75	7.75	6.25
	Wheat cv. Sakha 92					
Total nitrogen	35.04	31.03	38.54	36.04	42.04	38.74
Crude protein	219.00	193.94	240.88	225.25	262.75	242.13
N0$_3$- N	0.26	0.22	0.20	0.19	0.13	0.11
Phosphorus	0.35	0.31	0.38	0.35	0.47	0.41
Potassium	4.75	4.50	6.25	5.00	8.00	6.50

* N0$_3$- N = Nitrat- nitrogen

those mentioned by **Chippa and Lal (1985), Rabie *et al.* (1985) and El-Agrodi *et al.* (1988)**.

2. Tomato cvs. (Castle Rock and Edkawi):

Data in Table (37) clearly indicate that the NPK content as well as the calculated crude protein under the maximum tolerable salinity levels alone (5000 ppm for Castle Rock cv. and 7000 ppm for Edkawi cv.) or even under the untolerable salinity levels (6000 and 7000 ppm for Castle Rock cv. and 8000 and 9000 ppm for Edkawi cv.) were completely behaved the same as in wheat plants.

In this regard, **El-Kholi (1982), Mahmoud *et al.* (1986a), Gurrier (1988) and Rizk (1993)** found similar inhibitory effect of salinity on NPK content in tomato plants.

The reduction noticed in the total nitrogen content and the crude protein under saline condition could be discussed on the basis of the disturbance in the nitrogen metabolism **(Malyshev and Aleshin, 1975)** and substitution mechanism of sodium or antagonistic state between sodium and nitrogen present in the growth medium **(Abd El-Salam and Khalaf, 1979)**. Also, the reduction in phosphorus under saline conditions could be attributed to the reduction in phosphorus uptake and/or raising the pH of soils that reduces the availability of phosphorus **(Ashour *et al.*, 1976)**. As for the reduction in potassium content under saline conditions could be attributed to the increase in sodium concentration in the root medium that inhibits the absorption of potassium by plant roots **(El-Agrodi *et al.*, 1988)**.

With regard to the increase in NPK content and crude protein existed with paclobutrazol treatments under the untolerable salinity levels could be discussed on the basis that paclobutrazol caused an alteration in the endogenous balance of phytohormones those mentioned by **Chippa and Lal (1985), Rabie *et al.* (1985) and El-Agrodi *et al.* (1988)**.

2. Tomato cvs. (Castle Rock and Edkawi):

Data in Table (37) clearly indicate that the NPK content as well as the calculated crude protein under the maximum tolerable salinity levels alone (5000 ppm for Castle Rock cv. and 7000 ppm for Edkawi cv.) or even under`the untolerable salinity levels (6000 and 7000 ppm for Castle Rock cv. and 8000 and 9000 ppm for Edkawi cv.) were completely behaved the same as in wheat plants.

In this regard, **El-Kholi (1982), Mahmoud *et al.* (1986a), Gurrier (1988) and Rizk (1993)** found similar inhibitory effect of salinity on NPK content in tomato plants.

The reduction noticed in the total nitrogen content and the crude protein under saline condition could be discussed on the basis of the disturbance in the nitrogen metabolism **(Malyshev and Aleshin, 1975)** and substitution mechanism of sodium or antagonistic state between sodium and nitrogen present in the growth medium **(Abd El-Salam and Khalaf, 1979)**. Also, the reduction in phosphorus under saline conditions could be attributed to the reduction in phosphorus uptake and/or raising the pH of soils that reduces the availability of phosphorus **(Ashour *et al.*, 1976)**. As for the reduction in potassium content under saline conditions could be attributed to the increase in sodium concentration in the root medium that inhibits the absorption of potassium by plant roots **(El-Agrodi *et al.*, 1988)**.

With regard to the increase in NPK content and crude protein existed with paclobutrazol treatments under the untolerable salinity levels could be discussed on the basis that paclobutrazol caused an alteration in the endogenous balance of phytohormones

Table (37): Effect of the maximum tolerable salinity levels alone and the untolerable salinity levels preceded with paclobutrazol treatments on nitrogen, phosphorus and potassium contents (mg/ g dry weight) in tomato fruits (season 1993/ 94).

Estimations	Treatments					
	Tap water (control)	Salinity 5000 ppm	Paclobutrazol			
			10		50	
			Salinity (ppm)		Salinity (ppm)	
			6000	**7000**	**6000**	**7000**
	Tomato cv. Castle Rock					
Total nitrogen	33.03	23.52	32.03	28.53	36.04	31.03
Crude protein	206.44	147.00	200.19	178.31	225.25	193.94
Phosphorus	0.38	0.28	0.38	0.33	0.45	0.37
Potassium	27.25	22.75	28.50	27.75	29.75	28.25

Estimations	Treatments					
	Tap water (control)	Salinity 7000 ppm	Paclobutrazol			
			10		50	
			Salinity (ppm)		Salinity (ppm)	
			8000	9000	8000	9000
	Tomato cv. Edkawi					
Total nitrogen	31.03	28.50	36.54	33.53	42.54	37.04
Crude protein	193.94	178.13	228.38	209.56	265.88	231.50
Phosphorus	0.37	0.34	0.41	0.37	0.47	0.41
Potassium	27.25	27.25	31.00	28.50	33.50	30.50

e.g. increase of cytokinins content that stimulated different aspects of plant growth including size of the root system, number of both leaves and branches, absorption rates of estimated elements and also the protein synthesis.

m- Effect of the maximum tolerable salinity levels alone and the untolerable salinity levels preceded with paclobutrazol on total soluble solids percentage (T.S.S.%) and ascorbic acid (Vitamin C) content in tomato fruits:

Data in Table (38) clearly indicate that both total soluble soilds percentage and ascorbic acid content were decreased in tomato fruits with the applied maximum tolerable salinity level of each cultivar (5000 ppm for Castle Rock cv. and 700 ppm for Edkawi cv.). Meanwhile, this reduction was omitted and converted to stimulation when paclobutrazol treatments (10 and 50 ppm) preceded the application of the untolerable salinity levels of each cultivar (6000 and 7000 ppm for Castle Rock cv. and 8000 and 9000 ppm for Edkawi cv.).

In this respect, the obtained results of salinity on total soluble solids percentage are in disagreement with those obtained by **Mizrahi (1982) and Ohata *et al.* (1991)** on tomato and **Mendlinger *et al.* (1987) and El-Doweny *et al.* (1990)** on melon. On the other hand, **Ohata *et al.* (1991)** on tomato, found similar negative effect of salinity on the fruit content of ascorbic acid (Vitamin C).

For the explanation of the above mentioned results, also it could be attributed to the inhibitory effect of salinity or that stimulating effect of paclobutrazol on the growth behaviour of tomato plants especially on the efficiency of photosynthetic process.

Table (38): Effect of the maximum tolerable salinity levels alone and the untolerable salinity levels preceded with paclobutrazol treatments on total soluble solids percentage and ascorbic acid(Vitamin C) content in tomato fruits (season 1993/ 94)

Estimations	Treatments					
	Tap water (control)	Salinity 5000 ppm	Paclobutrazol (ppm)			
			10		50	
			Salinity (ppm)		Salinity (ppm)	
			6000	7000	6000	7000
	Tomato cv. Castle Rock					
Percentage of total soluble solids	7.50	7.35	8.10	8.20	8.40	8.40
Ascorbic acid mg/ 100g F.W.	1.41	1.29	1.76	1.69	1.90	1.80
Estimations	Treatments					
	Tap water (control)	Salinity 7000 ppm	Paclobutrazol (ppm)			
			10		50	
			Salinity (ppm)		Salinity (ppm)	
			8000	9000	8000	9000
	Tomato cv. Edkawi					
Percentage of total soluble solids	8.10	8.05	9.30	9.10	10.70	10.20
Ascorbic acid mg/ 100g F.W.	1.59	1.52	2.05	1.76	2.12	1.90