4.- RESULTS AND DISCUSSION

This part represents the discussion of results obtained from a series of laboratory and greenhouse experiments aiming to investigate the capability of some plants to tolerate the adverse effects of total salinity and specific ion as well as the effects due to drought on the seed germination, plant growth and chemical composition of plant shoots as follows:-

4.1. Laboratory experiments:-

The laboratory experiments deals with the germination percentage and germination rate of some plant seeds as affected by the studied parameters i.e total salinity, specific ion and drought.

4.1.1. Effect of total water salinity on seed germination

4.1.1.1. germination percentage

Data in Table (5) and Fig (1) show that the germination percentage of tested plant seeds at 0 salt concentration (distilled water i.e control treatment) varied from 93 % for cotton and tomato (E.) up to 100 % for tomato (S.). barley, beans and sorghum showed intermediate values of seed germination of about 98 % .

The total salinity concentrations of (2.5 dS m^{-1} i.e 25 me L^{-1}) reduced the germination percentage of tested plant seeds to values ranging from 87 % for cotton to about 98 % for beans. The corresponding figures of seed germination percentage of the other plant seeds are 92 % for barley and tomato (E.) and 97 % for tomato (S.) and sorghum. The germination percentage of the tested plant seeds were reduced to about 85 % for cotton, 92 % for barley, 95 % for beans, tomato (S.) and sorghum and 88 % for tomato (E.), by using the saline solution concentrations of (5 dS m^{-1} i.e 50 me L^{-1}) .

Also the total salinity concentration of (7. dS m^{-1} i.e 75 me L^{-1}), reduced the germination percentage of tested plant seeds to values varied from about 82 % for tomato (E) to 95 % for beans and sorghum. The corresponding figures of seed germination percentage of the other plant seeds are 83 %, 88 % and 93 % for cotton, barley, and tomato (S.), respectively.

Total salt concentrations of (9 dS m^{-1} i.e. 100 me L^{-1}) reduced the germination percentage of plant seeds to values ranging from 58 % for tomato (E.) to about 95 % for sorghum. At this concentration the values of germination pencentage are about 77, 83, 88 and 93% for cotton, barley beans and tomato (S.) respectively .

The increase in total salt to (14.5 dS m^{-1} i.e 150 me L^{-1}) resulted in reduced the germination perceutage of tested plant seeds to values of about 25, 55,77, 85, 87 and 95 % for tomato (E.), cotton, barley,. beans, tomato (S.) and sorghum, respectively.

The germination percentage values of tested plant seeds were reduced to about 0.0, 25, 35, 57, 72 and 82 % for tomato (E.) cotton, barley, tomato (S.), beans and sorghum , respectively, at total salt concentration of (19 dS m^{-1} i.e 200 me L^{-1}).

At total salinity concentration of (27.5 dS m^{-1} i.e 300 me L^{-1}) the germination percentage values were 0.0 % for cotton and tomato (E.) and about 7, 10, 18 and 68 % for barley, tomato (S.), beans and sorghum, respectively.

According to these results it may be concluded that the maximum level of tolerable salinity (i.e the salinity level at which the germination percentage is about 50 % of the control) was among (100 to 150 me L^{-1}), (150 to 200 me L^{-1}), (200 to 300 me L^{-1}) and 300 me L^{-1} for tomato (E.), (cotton and barley), (beans and tomato (S.)) and sorghum respectively.

From the previous data the six studied plants can be arranged according to their ability to tolerate salinity at the germination stage as follows:

Sorghum > beans > tomato (S) > barley > cotton > tomato (E)

4.1.1.2. Germination rate:-

Table (5) and Fig (2) show that the germination of tested plant seeds at 0 salt concentration (distilled water i.e. the control treatment) started at 3.05, 3.11, 3.27, 3.50, 3.75 and 5.85 days from the start of incubation for sorghum, beans, cotton, tomato (S.), tomato (E.) and barley, respectively. Seeds in such high salt solutions continued to germinate until 4.06 days for cotton at (19 dS m^{-1} i.e 200 me L^{-1}) and 7.13 days for tomato (E.) at (14.5 dS m^{-1} i.e 150 me L^{-1}) and 3.58, 4.61, 7.17 and 8.0, days for sorghum, beans, tomato (S.) and barley, respectively at (27.5 dS m^{-1} i.e 300 me L^{-1}).

It could be concluded that increasing total salinity concentration resulted in a significant decreasing in germination percentage, whereas increasing the germination rate (i.e increased the mean number of days required for germination). Similar results were obtained by Kumar et al. (1960) and Abd El. Rahman et al. (1979) on barley; Farah et al (1981) and Ahmed et al (1995) on cotton; Francois et al. (1983); Marambe and Andot (1995) on sorghum; Frachina and Chiesa (1993) and Singer (1994) on tomato and Gueishman et al. (1993) on beans.

The observed reduction in germination percentage or increase in germination rate with increasing total salinity concentration may be attributed to one or more of the following reasons:

a) Salinity progressively diminsh the endogenous gibbrelines that are supposed to be the controlling factor of seed germination (Delvin and Withman, 1983).
b) The osmotic pressure of the saline solution being higher than that of the cell therefore the seeds can't absorb all water required for their germination (Strogonov, 1962).
c) Retardation of seed germination under saline conditions may be attributed to the decrease in the rate of water uptake from saline solution, since high salt concentration reduces water absorption by germinating seeds, consequently the number of days required for germination under saline conditions become greates, (El - Monayeri, 1968 and El. Shourbagy, 1974).

Table (5) Effect of salinity on germination of some plant seeds.

* TSS me L^{-1}	Cotton G 85 line 96		Barley G 123		Beans tebary 16		Tomato super straine B		Tomato Edkawi		Sorghum S.V. 10017	
	Gremination		Germination		Germination		Germination		Germination		Germination	
	%	Rate	%	Rate	%	Rate	%	Rate	%	Rate	%	Rate
0 (Control)	93	3.27	98	5.85	98	3.11	100	3.50	93	3.75	98	3.05
25	87	3.31	92	5.87	98	3.26	97	3.64	92	4.24	97	3.16
50	85	3.39	92	6.05	95	3.38	95	3.88	88	4.79	95	3.19
75	83	3.42	88	6.53	95	3.42	93	3.98	82	5.16	95	3.21
100	77	3.87	83	6.84	88	3.49	93	4.26	58	5.77	95	3.21
150	55	3.92	77	7.46	85	3.52	87	4.91	25	7.13	90	3.29
200	25	4.06	35	8.18	72	3.70	57	6.10	0	0.00	82	3.32
300	0	0.00	7	8.0	18	4.61	10	7.17	0	0.00	68	3.58

*** Total solubale salts**

L.S.D for salinity levels

(a) Germination percent
0.0 5 = 3.73
0.01 = 3.95

(b) Germination rate
0.05 = 0.14
0.01 = 0.19

Fig (1) Effect of water salinity on germination percent of some plant seeds.

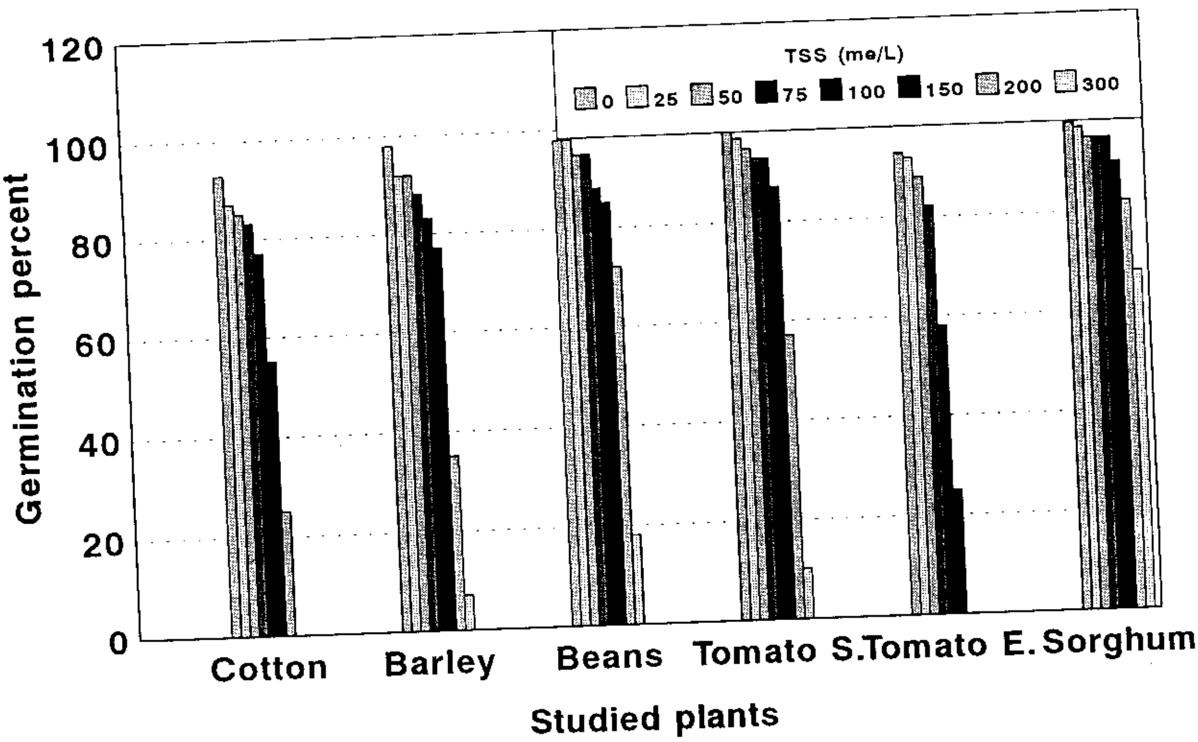
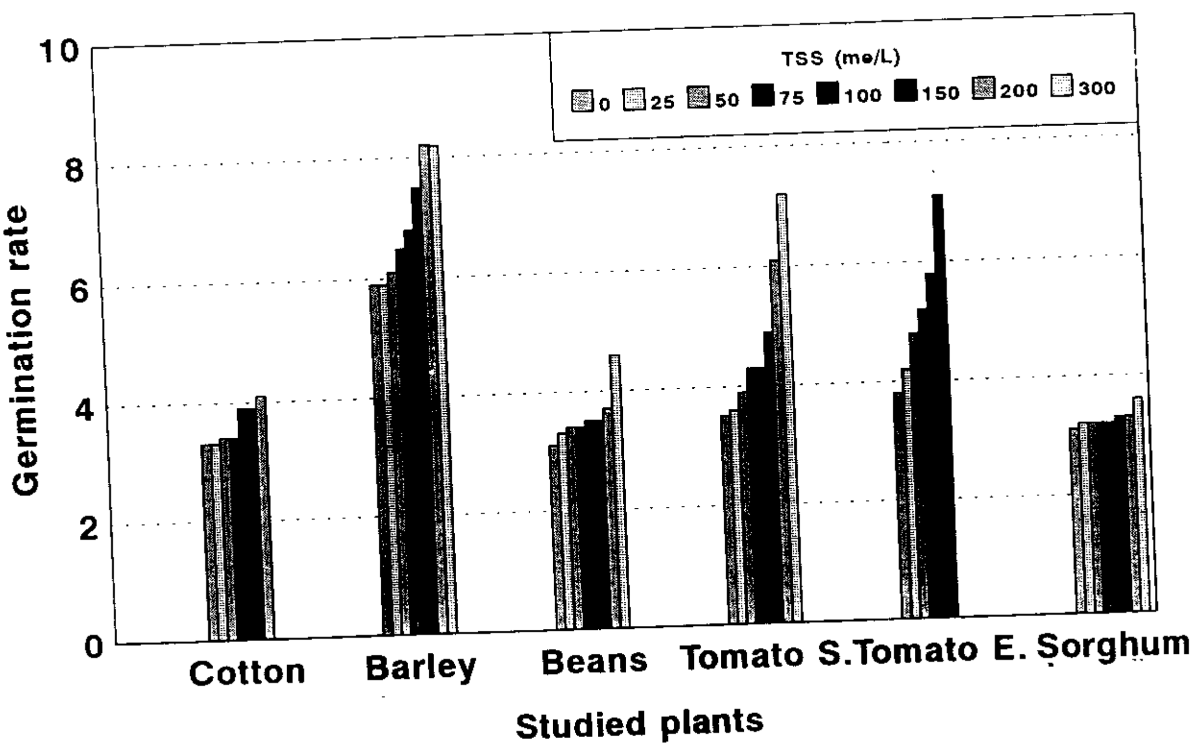


Fig (2) Effect of water salinity on germination rate. of some plant seeds



The differences among the studied plant seeds in germination may be attributed to the differences in the degree of imbibition from saline solution by seeds due to differences in their chemical composition as well as the ratio of organic to inorganic constituents which give rise to osmotically active substances (Strogonov, 1962).

4.1.2.- Specific ion effect on seed germination:-

Table (6 and 7) and Figs (3, 4, 5 and 6) show the effect of specific ion on seed germination of the studied plants at total salinity concentrations of 100 and 150 me L^{-1}.

4.1.2.1.- Effect of sodicity on seed germination:-

Results in Table (6) and figs (3 and 4) indicate that at total salinity concentration of 100 me L^{-1}, increasing the sodium adsorption ratio (SAR) value of salt solution from 21 to 34 (Soln. 1 and Soln. 2) i.e. increasing the solution content of Na^+ on the expense of Ca by 11.1 me L^{-1} reduced the germination percentage according to the following order: from (58 to 48), (77 to 65), (83 to 82), (88 to 86), (93 to 87) and from (95 to 93) for tomato (E.), cotton, barley, beans, tomato (S.) and sorghum, respectively. This effect was highly significant in case of cotton and tomato (S and E) and insignificant for the other tested plants. On the other hand, increasing the SAR value from (21 to 34) increased the germination rate from (3.2 to 3.3), (3.5 to 3.6), (3.9 to 4.1), (4.3 to 5.5), (5.8 to 6.3) and from (6.8 to 7.1) days for sorghum, beans, cotton, tomato (S.), tomato (E.) and barley, respectively. However, this effect was insignificant only with barley.

Table (6) Specific ion effect on germination of some plant seeds at total salinity concentration of 100 me L^{-1} (EC, 9.25 dS m^{-1}).

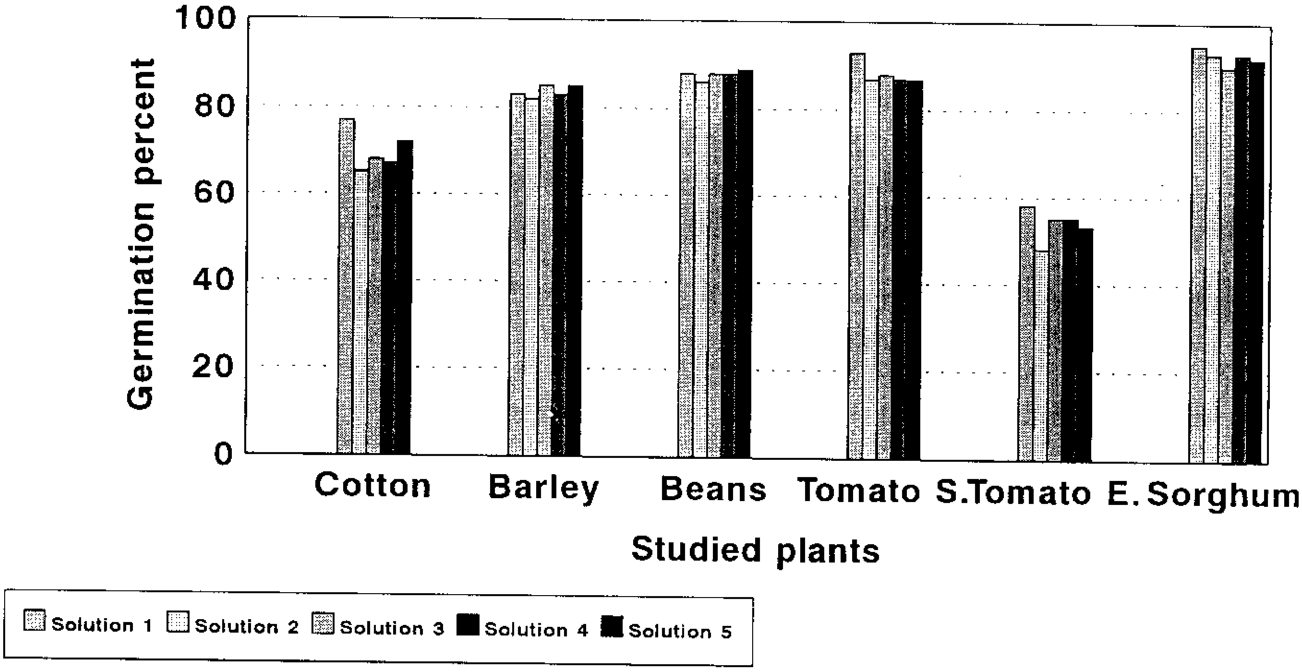
Solution No.	Ions concentration me L^{-1}					SAR	Cotton G 85 line 96		Barley G 123		Beans tebary 16		Tomato super straine B		Tomato Edkawi		Sorghum S.V. 10017	
	Na^+	Ca^{2+}	Mg^{2+}	Cl^{-1}	SO_4^{2-}		Gremination		Germination		Germination		Germination		Germination		Germination	
							%	Rate	%	Rate	%	Rate	%	Rate	%	Rate	%	Rate
1	75.0	25.0	0.0	90.0	10.0	21.0	77	3.91	83	6.81	88	3.52	93	5.31	58	6.31	**95**	**3.21**
2	86.7	13.3	0.0	90.0	10.0	34.0	65	4.11	82	7.11	86	3.61	87	5.53	48	6.32	**93**	**3.34**
3	86.7	13.3	0.0	66.7	33.3	34.0	68	3.92	85	7.01	88	3.62	88	5.32	55	6.53	**90**	**3.42**
4	75.0	5.0	20.0	90.0	10.0	21.0	67	3.92	83	6.82	88	3.53	87	5.22	55	6.21	**93**	**3.22**
5	55	5.0	40.0	90.0	10.0	12.0	72	3.93	85	6.72	88	3.53	87	5.22	53	6.42	**92**	**3.31**

L.S.D. for

Germination percent
0.05 = 3.8
0.01 = 5.1

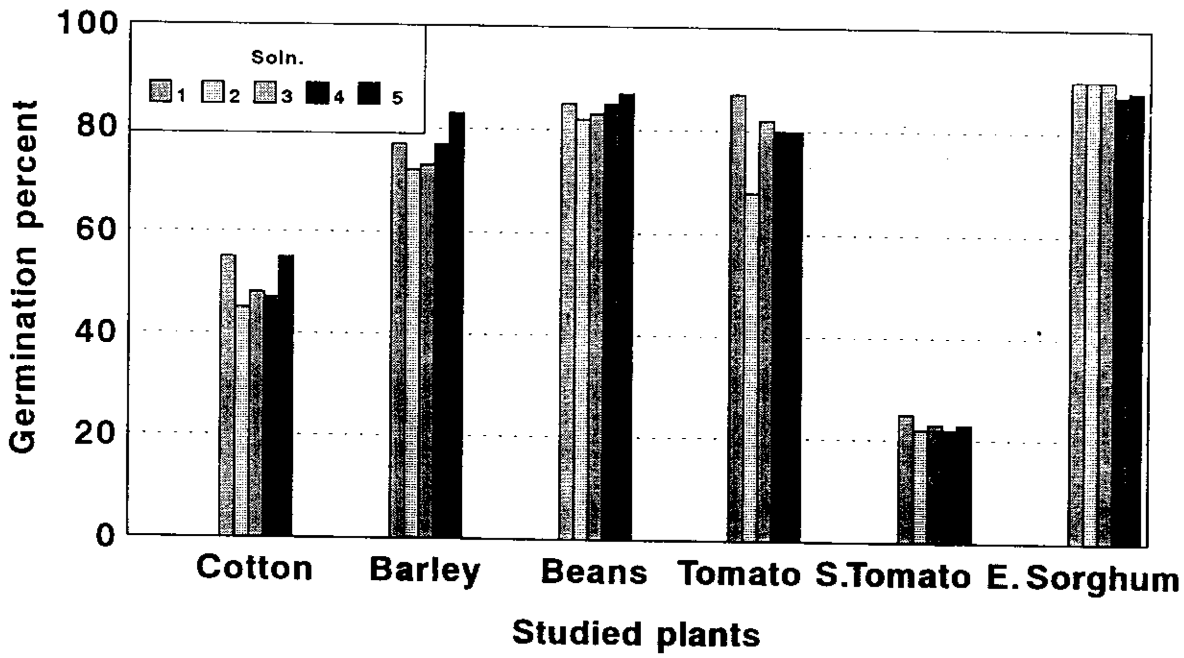
Germination rate
0.05 = 0.24
0.01 = 0.32

Fig (3) Specific ion effect on germination percent of some plant seeds at TSS concentration of 100 me/L (EC 9.0 dS/m)



Tomato S = Tomato Super Strain B
Tomato E = Tomato Edkawi

Fig (4) Specific ion effect on germination percent of some plant seeds at total salinity concentration of 150 me/L (EC 14.5 dS/m)



Tomato S = Tomato Super Strain B
Tomato E = Tomato Edkawi

Results in Table (7) and Figs (5 and 6) indicate that at total salinity concentration of 150 me L^{-1} increasing the SAR va;ue of the salt solution from 26 to 41 i.e. increasing the Na^{+} concentration of sol.1 by 17.5 me L^{-1} (from 112.5 to 130.0 me L^{-1}) on the expense of Ca which was reduced from 37.5 to 20 me L^{-1} (Soln 2). Such effect was only significant (at 1 % level) with cotton and tomato (S) but no significant effect could be detected with the other tested plants. (Sol. 1 and Sol. 2) reduced the germination percentage from (25 to 22), (55 to 45), (77 to 72), (85 to 82), (87 to 68) for tomato (E.), cotton, barley, beans and tomato (S.), respectively while sorghum was not affected.

Increasing the SAR value from 26 to 41, increased the germination rate from (3.3 to 3.4), (3.5 to 3.7), (3.9 to 4.2), (4.9 to 6.0), (7.1 to 7.7) and from (7.5 to 7.9) days for sorghum, beans, cotton, tomato (S.), tomato (E.) and barley, respectively. The delaying periods of germination rate were highly significant with cotton and tomato (E) but no significant effects was recorded with other tested plants.

These results may suggest that sorghum followed by tomato (S.), beans and barley are the most tolerating seeds to sodicity conditions at the germination stage while tomato (E.) followed by cotton were of the least tolerance capability aganist sodic conditions.

It may be interesting to observe that sorghum which was proved to be the most tolerant plant, at germination stage, to total salinity stress behaved similarly with sodicity effect which may draw attention to a probable similarty of the mechanism responsible for such tolerance in both cases.

Table (7) Specific ion effect on germination of some plant seeds at total salinity concentration of 150 me L^{-1} (EC = 14 dS m^{-1}).

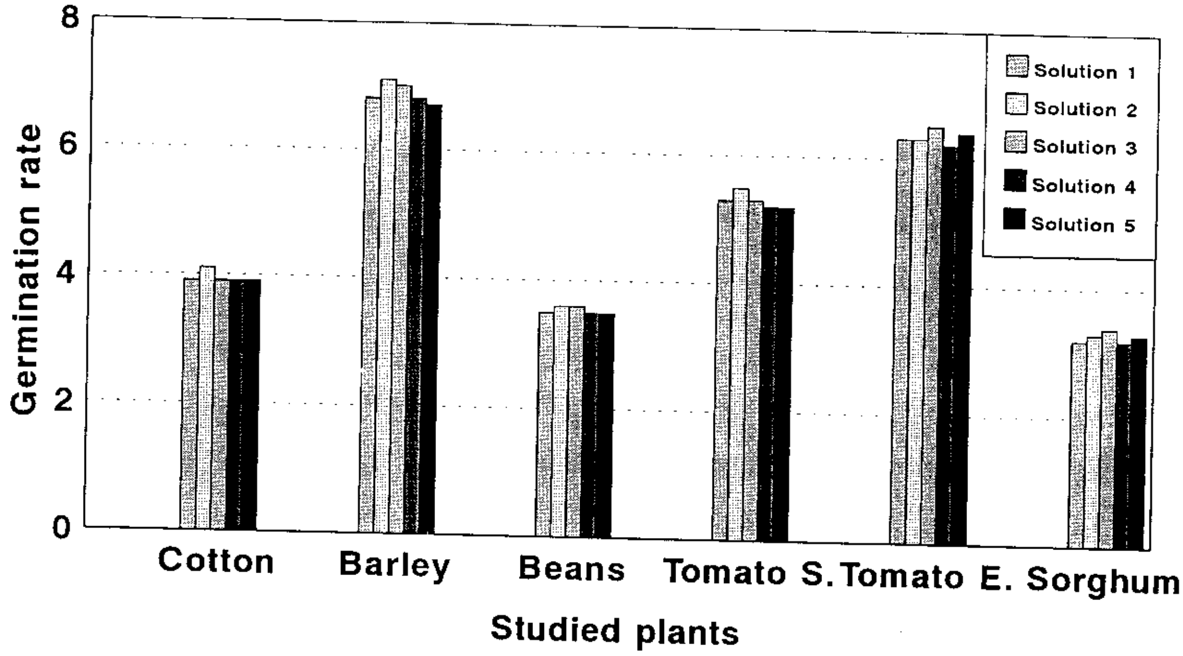
Solution No	Ions concentration me L^{-1}					SAR	Cotton G 85 line 96		Barley G 123		Beans tebary 16		Tomato super straine B		Tomato Edkawi		Sorghum S.V. 10017	
	Na^+	Ca^{2+}	Mg^{2+}	Cl^{-1}	SO_4^{2-}		Gremination		Germination		Germination		Germination		Germination		Germination	
							%	Rate	%	Rate	%	Rate	%	Rate	%	Rate	%	Rate
1	112.5	37.5	0.0	135.0	15.0	26.0	55	3.91	77	7.5	85	3.51	87	4.92	25	7.11	90	3.31
2	130.0	20.0	0.0	135.0	15.0	41.0	45	4.21	72	7.9	82	3.73	68	5.02	22	7.71	90	3.42
3	130.0	20.0	0.0	100.0	50.0	41.0	48	4.12	73	7.5	83	3.53	82	4.91	23	7.33	90	3.43
4	112.5	7.5	30.0	135.0	15.0	26.0	47	4.33	77	7.5	85	3.54	80	5.03	22	7.04	87	3.44
5	82.0	7.5	60.0	135.0	15.0	14.0	55	4.53	83	7.0	87	3.64	80	5.04	23	7.23	88	3.44

L.S.D. for

Germination percent
0.05 = 4.8
0.01 = 6.4

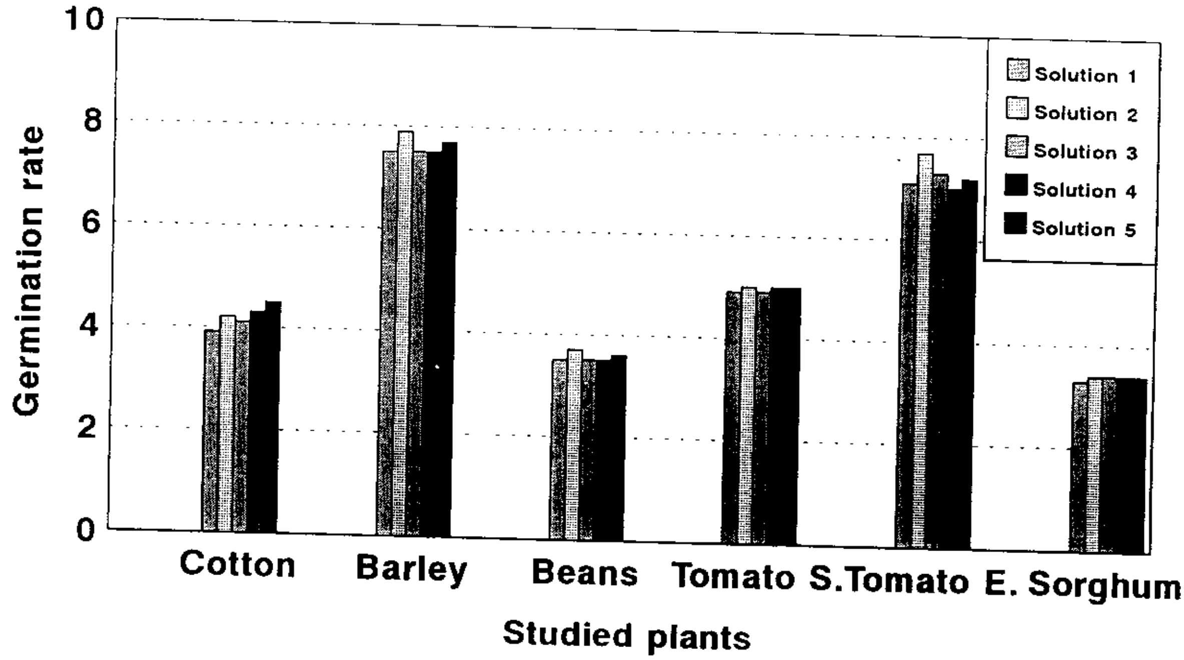
Germination rate
0.05 = 0.23
0.01 = 0.31

Fig (5) Specific ion effect on germination rate of some plant seeds at total salinity concentration of 100 me/L (EC 9.0 dS/m))



Tomato S = Tomato Super Strain B
Tomato E = Tomato Edkawi

Fig (6) Specific ion effect on germination rate of some plant seeds at total salinity concentration of 150 me/L (EC 14.5 dS/m)



Tomato S = Tomato Super Strain B
Tomato E = Tomato Edkawi

According to the previous results it is also evident that increasing the SAR value decreased the germination percentage and increased the germination rate but the effect is more pronounced at total salinity concentration of 150 me L^{-1} rather than at 100 me L^{-1}.

It can be concluded that increasing both total salinity concentration or SAR valueof the tested salt solutions, resulted in a decrease in the germination percentage and an increase in the germination rate. Alsmot similar results were obtained by Kumar et al. (1980) and Abd El - Rahman et al. (1979) on barley; Strogonov, (1962), Farah et al. (1981) and Ahmed et al. (1995) on cotton; Francois et al. (1983), Marambe and Ando (1995) an sorghum, Frachina and Chiesa (1993) and Singer (1994) on tomato and Guieshiman et al. (1993) on beans.

The reduction in germination percentage with increasing the SAR values of salt solutions can be attributed to the specific toxic effect of Na Cl as well as to the osmotic pressure of the salt solution (Bernstien and Pearson, 1956 and strogonov, 1962). The specific toxic effect of Na Cl on germination of plant seeds may be attributed to the adverse effect of Na Cl on the enzymatic processes through some interaction between Na Cl and the organic substances of the cell (Oertil, 1966). The opposite effect of monovalents cation (such as Na^{+}) on the cell protoplasm may be due to desperse of the colloids and the protoplasm (Grillot, 1956).

4.1.2.2. Effect of sulfate ion on seed germination:-

Result in Table (6) and Figs (3 and 4) also show that at total salinity concentration of 100 me L^{-1} and SAR value of 34 (Soln. 2 and

Soln. 3), increasing the $SO_4^=$ concentration from 10 to 33 me L^{-1} on the expense of Cl^-, increased the germination percentage of the tested plant seeds from (48 to 58), (65 to 68), (82 to 85), (86 to 88) and from (87 to 88) for tomato (E.), cotton, barley, beans and tomato (S.), respectively. However, the observed effect was always insignificant, except with tomato (E), where it was highly significant. On the other hand the germination percentage of tested sorghum seeds was decreased from (93 to 90).

Results in Table (7) and Figs (5 and 6) also indicate that at total salinity concentration of 150 me L^{-1} and SAR value of 41 (Sol. 2 and Sol. 3), increasing the $SO_4^=$ concentration from 10 to 33 me L^{-1} on the expense of Cl^-, increased the germination percentage of the tested plant seeds from (22 to 23), (45 to 48), (68 to 82), (72 to 73) and from (81 to 83) for tomato (E.), cotton, tomato (S.), barley, and beans, respectively, while sorghum germination percentage was constant 90 % with both tested solutions (2 and 3).

As for the germination rate, it is evident that increasing the SO_4^{2-} ion concentration of the tested saline solution (from 15 to 50 me L^{-1}) on the expense of Cl^- resulted in no significant effect except with barley and tomato E, where a highly significant adverse effect was recorded. The observed results could be explained on a basis that Cl^- ion may adversely affect both germination percentage and rate while the sulfate ion may did not exhibit such adverse effect that could be stimulated in particular in solutions of high salt salinity concentrations (Grillot, 1956 and Hayward, 1956).

4.1.2.3.- Effect of magnesium ion on seed germination:-

Results in Table (6) and Fig (3 and 4) indicate that increasing Mg^{2+} concentration from 20 (Soln 4) to 40 (Soln 5) meg L^{-1} on the expense of Na^{+}, at the presence of 5 meq L^{-1} Ca^{2+} and total salinity of 100 me L^{-1}, in general tended to induce the germination percentage of different tested plant seeds but there were insignificant effect either at 5 % or 1 % level. As for the germination rate, no significant effect could be detected with the all tested plant seeds.

Results in Table (7) and Fig (5 and 6) indicated that total salinity concentration of 150 me L^{-1}, constant anionic composition and Ca conc. of 7.5 me L^{-1}, increasing Mg conc. from 30 (soln 4) to 60 me L^{-1} (soln 5) on the expense of sodium and thus reducing the SAR from 26 to 14, in general tended to induce the germination percentage of different tested plant seeds at rates differing from highly significant (cotton) and only significant (barley) to non significant for all the other tested plant seeds. As for the germination rate, it was significantly (5 %) increased only in case of barley while no significant effect could be detected with the other plant seeds.

4.1.3. Drought effect on seed germination:-

Table (8) and Fig (7 and 8) show that different levels of available soil moisture (i.e 100, 70, 65, 60, 40 and 30 % of Av.W.) almost significantly affected seed germination of the tested plants expresed either as percentage or rate.

The germination percentage at 100 % of Av.W (control) which amounted to 85, 100, 95, 90, 88 and 85 % for cotton, barley, beans, tomato (S), tomato (E) and sorghum, respectively, were considered as a control for the other levels of available soil moisture (i.e 100 % germinatiom).

Results obtained reveal that significant adverse effect due to drought on germination percentage of the tested plant seeds began at about 70 % of Av.W. for sorghum (at 1 % level), 60 % Av.W for cotton (at 1 % level) and only (at 5 % level) for both tomato (S.) and tomato (E.), while beans did not show such effect only at 30 % Av.W. It is interesting to observe that barley germination percentage didnot significantly adversely affected even at the lowest level of Av.W (i.e 30 %) exhibiting an excellent tolerance for drought effect at the germination stage.

As for germination rate it was highly significant (1 % level) for cotton, tomato (E.) and sorghum only at 30 % Av.W, but at 70 % Av. W for tomato (S.) and at 65 % Av.W for beans and no significant effect was recorded with barley seeds.

According to these results the tested germinated seeds could be arranged descendingly in the arder:

barley > beans > tomato (S) > tomato (E.) > sorghum > cotton E.)

Almost smilar results were obtained by Ross and Hegarty (1979), Serag (1983), Taha et al. (1984)and Bhatt and Rao (1987) on tomato and Ounruen et al. (1981) on beans and sorghum.

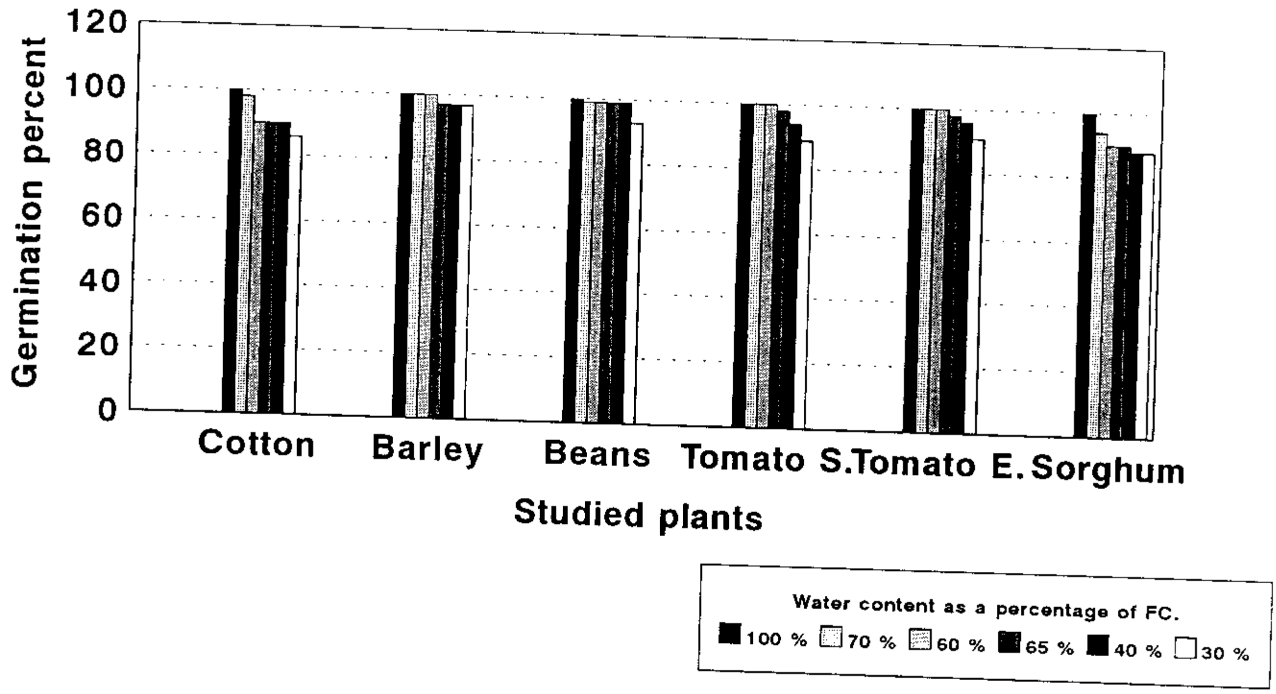
Table (8) Effect of drought on germination of some plant seeds.

Moisture content as a % of Av.W	Cotton G 85 line 96		Barley G 123		Beans tebary 16		Tomato super straine B		Tomato Edkawi		Sorghum S.V. 10017	
	Gremination		Germination		Germination		Germination		Germination		Germination	
	%	Rate	%	Rate	%	Rate	%	Rate	%	Rate	%	Rate
100 (Cont.)	100	3.82	100	4.01	100	2.91	100	3.31	100	4.21	100	3.11
70	98	3.91	100	4.01	99	3.02	100	3.72	100	4.22	94	3.21
60	90	3.91	100	4.02	99	3.13	100	3.81	100	4.22	90	3.22
65	90	4.02	97	6.03	99	3.24	98	4.11	98	4.24	90	3.32
40	90	4.01	97	6.03	99	3.32	94	4.21	96	4.43	88	3.34
30	86	4.22	97	6.04	93	3.32	89	4.52	91	4.73	88	3.41

L.S.D for **(a) Germination percent**
0.0 5 = 3.6
0.01 = 4.78

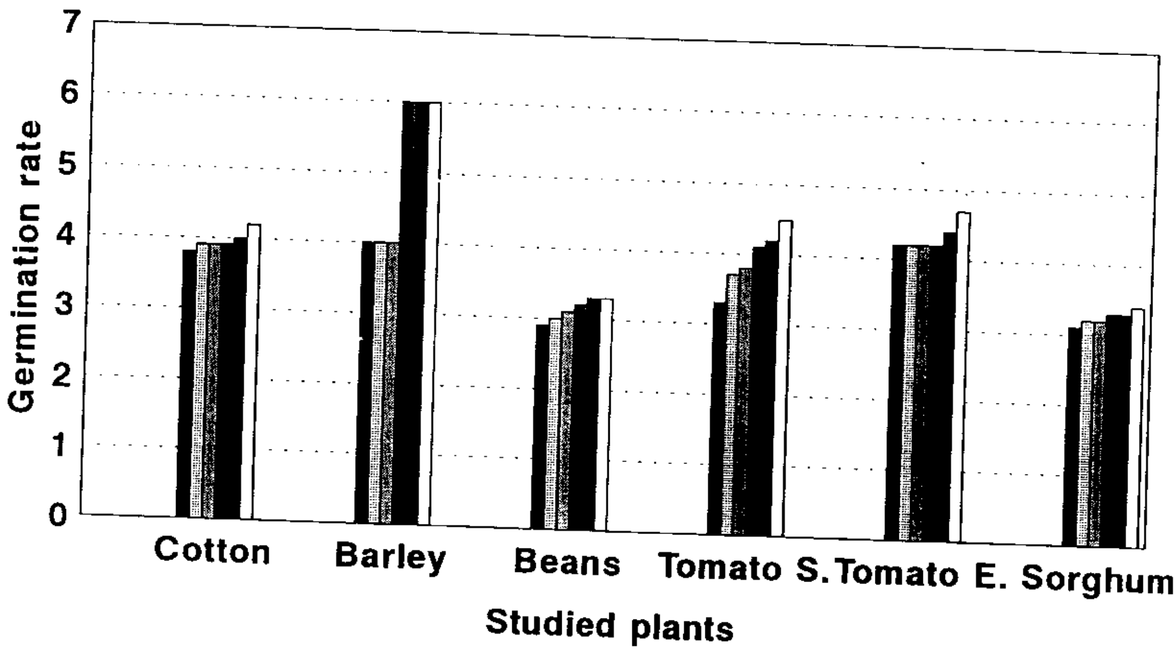
(b) Germination rate
0.05 = 0.22
0.01 = 0.29

Fig (7) Effect of drought on germination percent of some plant seeds.



Tomato S = Tomato Super Strain B
Tomato E = Tomato Edkawi

Fig (8) Effect of drought on germination rate of some plant seeds.



Tomato S = Tomato Super Strain B
Tomato E = Tomato Edkawi

In this respect the unfavorable effect of water stress on seed germination may be attributed to the following :-

1 - Depression in the quantity and rate of water absorbed by seeds as the osmotic pressure of the germinating medium was increased (Matev and Dulov, 1972 and Manohor and Matur, 1977).

2 - Other possibility may be related to the endogenous hormones, where IAA content is increasing in the water stressed seeds above the initial ammount occurred in the seeds (Ross and Hegarty, 1979).

3 - On the other hand, the differences among the tested plant seeds in germination may attributed to the genetical basis which could be probably due to variations of their colloidal content (Taha, 1978).

The results of the laboratory experiments indicate clearly that the arrangement of :

1 - Sorghum was the first for tolerating salinity whereas was the last for tolerating drought.

2 - Beansn and tomat (S.) were the second and the third, respectively either for tolerating salinity or drought.

3 - Barley was the first for tolerating drought whereas was the fourth for tolerating salinity.

4 - Tomato (E.) was the last for tolerating salinity and the fourth for tolerating drought.

5 - Cotton was the last and the last before for tolerating drought and salinity, respectively.

4.2.- Greenhouse experiments:-

This part of the study was consisted of some pot trials aiming to investigate the effects of salinity and the specific ion effect as well as the drought effect on growth and chemical composition of some plants that were found mostly tolerant to both salinity and drought at germination stage as indicated from the previous laboratory experiments. These plants are barley, tomato (S.) and sorghum.

4.2.1. Effect of water salinity on plant

4.2.1.1.- Effect of water salinity on plant growth

4.2.1.1.1.- Dry weight

Results indicating the effect of water salinity on dry weight of shoots and roots of the three studied plants, (i.e.barley, tomato (S.) and sorghum) are shown in Table (9) and illustrated graphically in Fig (9 and 10). It can be noticed that increasing the water salinity concentration from (0 up to 100 me L^{-1}) tended to adversaly affect the dry weight of the studied plants at different degrees, as shown in the following:-

a) Barley:

The dry matter yield of barley plants at water salinity levels of 25, 50, 75 and 100 me L^{-1} were 5.22, 4.92, 4.90 and 4,72 g/pot for shoots and 2.71, 2.40, 2.30 and 2.21 g/pot for roots, respectively. The percentage of reduction in total dry matter yield at the abovementioned salinity levels, as a percentage from the control treatments, were 1.89, 7.55, 7.55 and 11.32 % for shoots and 0.00, 11.11, 14.81 and 18.52 for roots, respectively.

However, while the statistical analysis showed that the observed yield reduction in plant shoots reached the limite of significancy (5 % level) at irrigation water salinity 100 me L^{-1}, the root dry matter yield was adversely affected (at 1 % level) with salinity concentratio of 50 me L^{-1}.

b) Tomato (S.)

The dry matter yield of tomato (S.) plants at water salinity levels of 25, 50, 75 and 100 me L^{-1} was about 7.32, 6.51, 6.30, and 5.81 g/pot for shoots and 2.80, 2.63, 2.61 and 2.50 g/pot for roots, respectively. The percentage of reduction in total dry matter yield at the abovementioned salinity levels, as a percentage from the control treatment, were 3.95, 14.47, 17.11 and 23.68 % for shoots and 0.00, 7.14, 7.14 and 10.71 for roots, respectively. However, while statistical analysis showed that the observed yield reduction in plant shoots reached the limite of significancy (1 % level) at irrigation water salinity 50 me L^{-1}, the root dry matter yield was adversely affected (at 1 % level) with salinity concentratio of 100 me L^{-1}.

C) Sorghum

The mean number of dry matter yield of sorghum plants at salinity levels 25, 50, 27 and 100 me L^{-1} is about 8.62, 7.52, 6.71, and 6.52 g/pot for shoots and, 6.81, 6.62, 5.60 and 5.33 g/pot for roots, respectively. The percentage of reduction in total dry matter yield at the abovementioned salinity levels, as a percentage from the control treatments were 8.51, 20.21, 28.72 and 30.85 % for shoots and 4.23, 7.04, 21.13 and 25.35 % for, roots, respectively. However, while statistical analysis showed that the observed yield reduction in plant shoots reached the limite of significancy (5 % level) at irrigation water salinity 25 me L^{-1}, the root dry matter yield

Table (9) Salinity effect on dry weight (g/pot) of the studied plants

Studied plants	Total soluble salts me/L									
	0 (Cont.)	25	50	75	100	0 (cont.)	25	50	75	100
	Shoots dry weight (g/pot)					Roots dry weight (g/pot				
Barley G 123	5.31	5.22	4.92	4.90	4.72	2.73	2.71	2.40	2.30	2.21
Tomato super strain B	7.62	7.32	6.51	6.30	5.81	2.84	2.80	2.63	2.61	2.50
Sorghum S.V. 10017	9.43	6.62	7.52	6.71	6.52	7.11	2.81	6.62	5.60	5.33

L.S.D for (a) **Shoots**
0.0 5 = 0.49
0.01 = 0.67

(b) Roots
0.05 = 0.21
0.01 = 0.28

Fig (9) Effect of water salinity on shoots dry weight of plants.

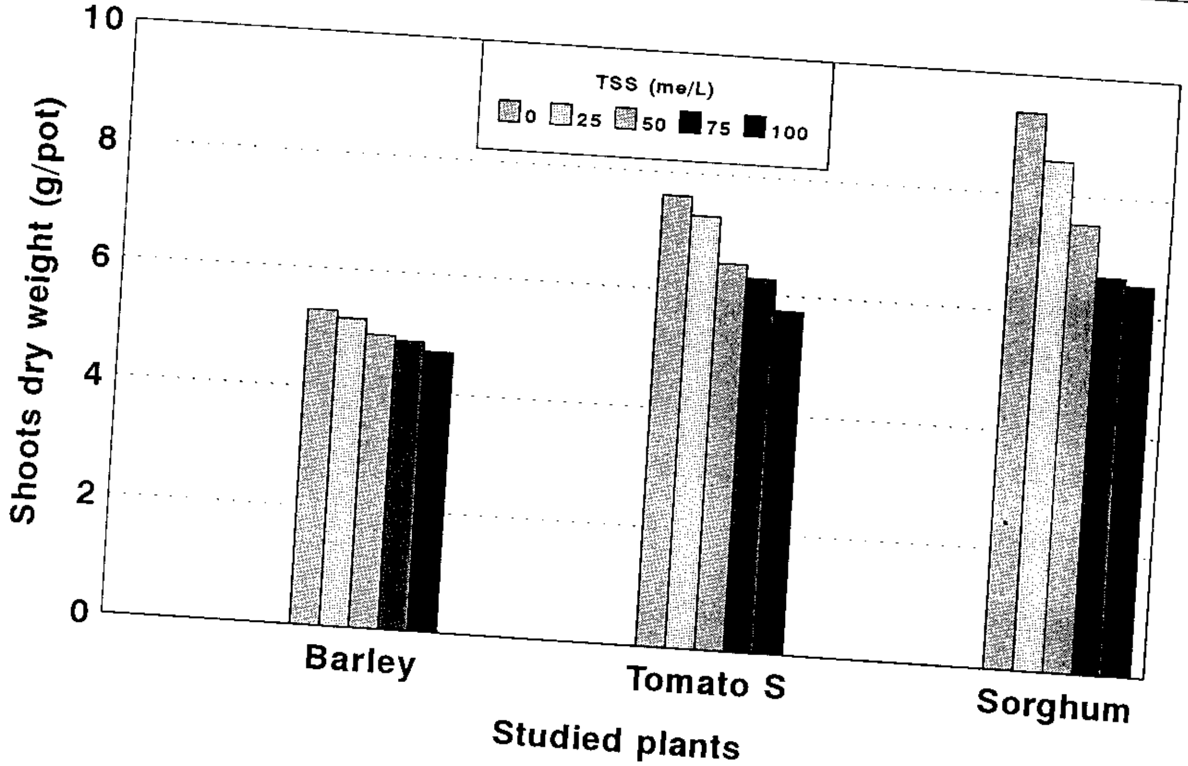
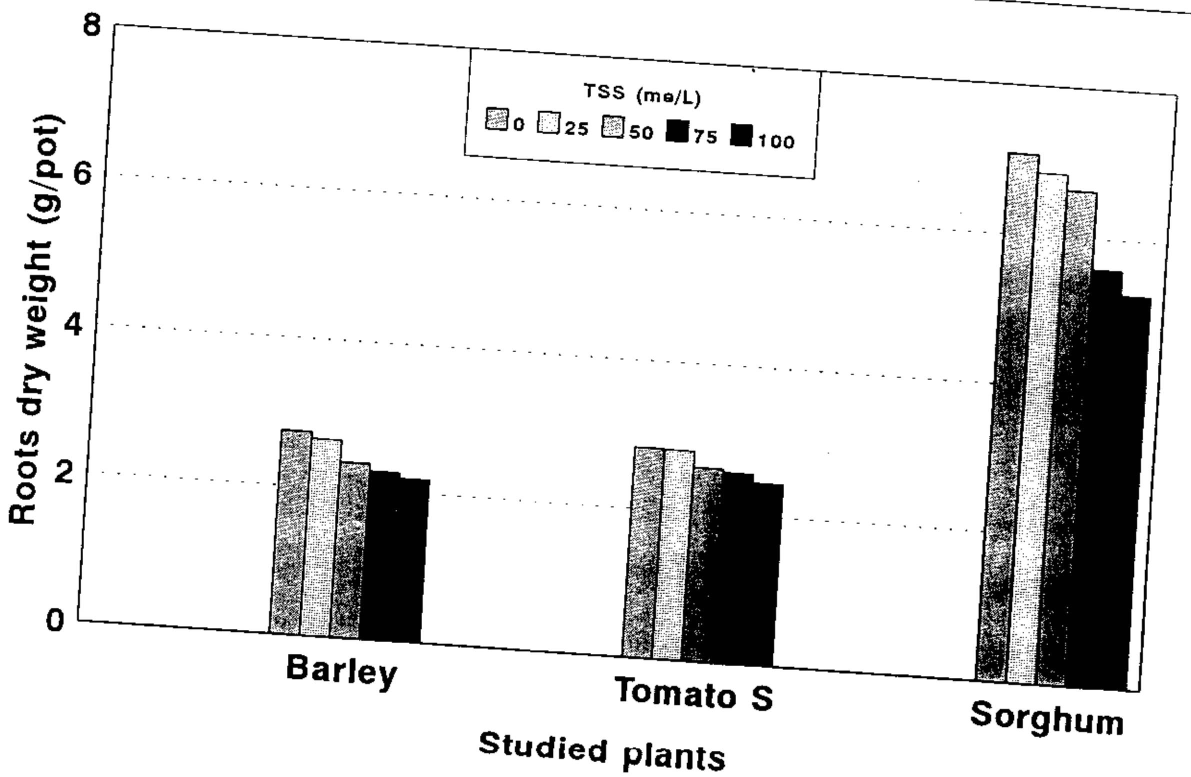


Fig (10) Effect of water salinity on roots dry weight of plants.



was adversely affected (at 1 % level) with salinity concentratio of 25 me L^{-1}.

It can be concluded that the reduction in dry weight of whole plant at 100 me L^{-1} as compared with control amounted to 13.75, 20.19 and 28.48 % for barley, tomato (S.) and sorghum, respectively. These results indicate clearly that plants can be arranged according to their ability for tolerating salinity as follows:

Barley > tomato (S.) > Sorghum.

Similar results were obtained by Brown and Hayward (1956), Bernstein and pearson (1956) and El - Monayeri (1968), El shourbagy (1974), Nassar (1983) and Kishk (1992). The depression in growth of plants cause by high salinity level may be attribtued to the decrease in the partial molar free energy of water by increasing its osmotic pressure and decreasing its availability to the growing plants and also to the inability of sub cellular osmotic units to be adjusted to higher osmotic pressure which may itself limit the growth (Bernstien, 1963 and Oertil, 1966).

4.2.1.1.2.- Plant height:

Data presented in Table (10) and Fig (11 and 12) show the effect of salinity on shoots and roots height (in cm) of both shoots and roots of the three studied plants. Results reveal that water salinity has a dwarfing effect on the studied plants. Increasing water salinity concentration from 0 to 100 me L^{-1} decreased the height of plant shoots and roots. These results explain the reduction in dry matter yield of whole plants.

a) Barley

The obtained results show that increasing the salinity level from 0 to 100 me L^{-1} decreased shoots and roots length from 55.74 to 52.34 cm and from 32.02 to 27.74 cm, respectively. The percentag of reduction being 6.1 and 13.43 % for shoots and roots, resplectively. However, such reducing effect did not reach the significancy level with respect to barley shoots length except at the lighest rate of salinity (100 me L^{-1}). As for barley roots length the decreasing began to be significant at salinity level 50 me L^{-1}.

b) Tomato (S.)

Data show that shoots and roots length decreased from 29.72 to 25.33 cm and from 27.74 to 24.02 cm, respectively, by increasing salinity level from 0 to 100 me L^{-1}, the percentage of reduction being 14.81 and 13.36 % for shoots and roots, respectively. However, this effect was significant (1 % level) only for shoots at 50 me L^{-1} being increased gradually with higher salinity levels.

c) Sorghum

Results show that length of sorghum shoots and roots decreased from 67.34 to 58.00 cm and from 29.02 to 23.70 cm, respectively, by increasing salinity level from 0 to 100 me L^{-1}, the percentage of reduction being 13.82 and 18.28 % for shoots and roots, respectively. However such adverse effect was significant at salinity level of 75 and 100 me L^{-1} for sorghum shoots and at 50 up to 100 me L^{-1} for sorghum roots.

Table (10) Salinity effect on shoots and roots lenght (cm) of the studied plants.

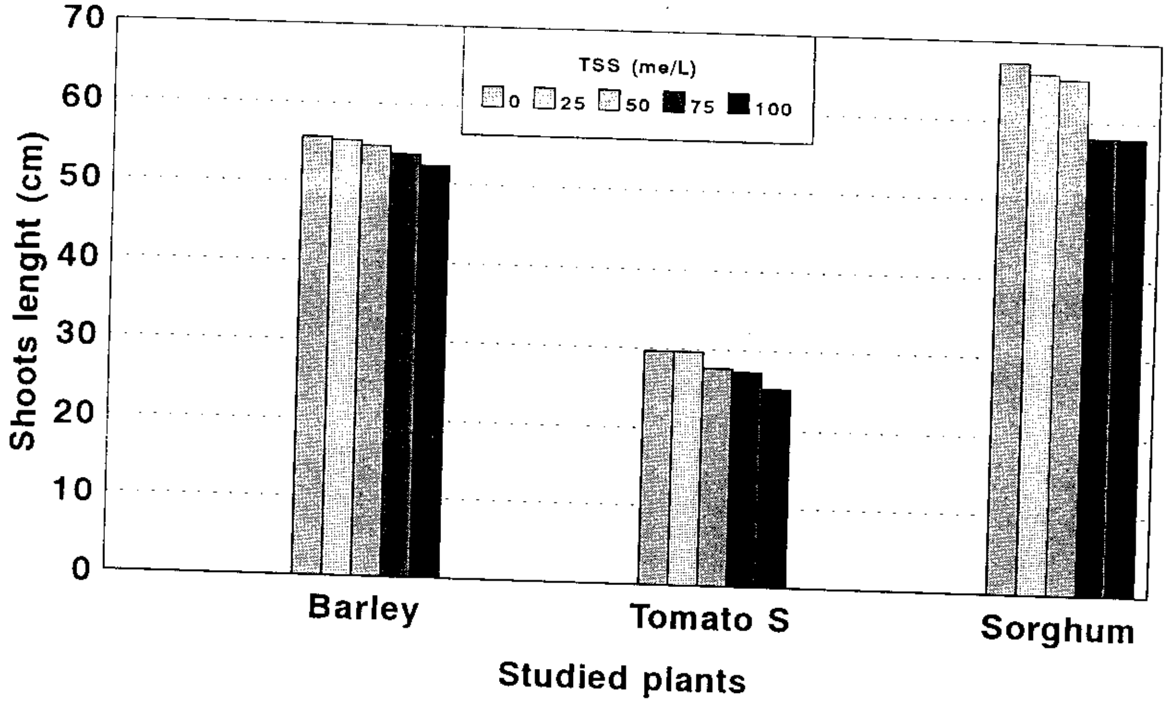
Studied plants	Total soluble salts me/L									
	0 (Cont.)	25	50	75	100	0 (cont.)	25	50	75	100
	Shoots lenght (cm)					**Roots lenght (cm)**				
Barley G 123	55.74	55.32	54.72	53.73	52.34	32.02	30.71	30.03	28.32	27.74
Tomato super strain B	29.72	29.70	27.73	27.31	25.33	27.74	27.30	25.33	24.72	24.02
Sorghum S.V. 10017	67.34	66.03	65.32	58.03	58.00	29.02	27.01	25.71	24.02	23.70

L.S.D. for

(a) Shoots
0.05 = 2.73
0.01 = 3.68

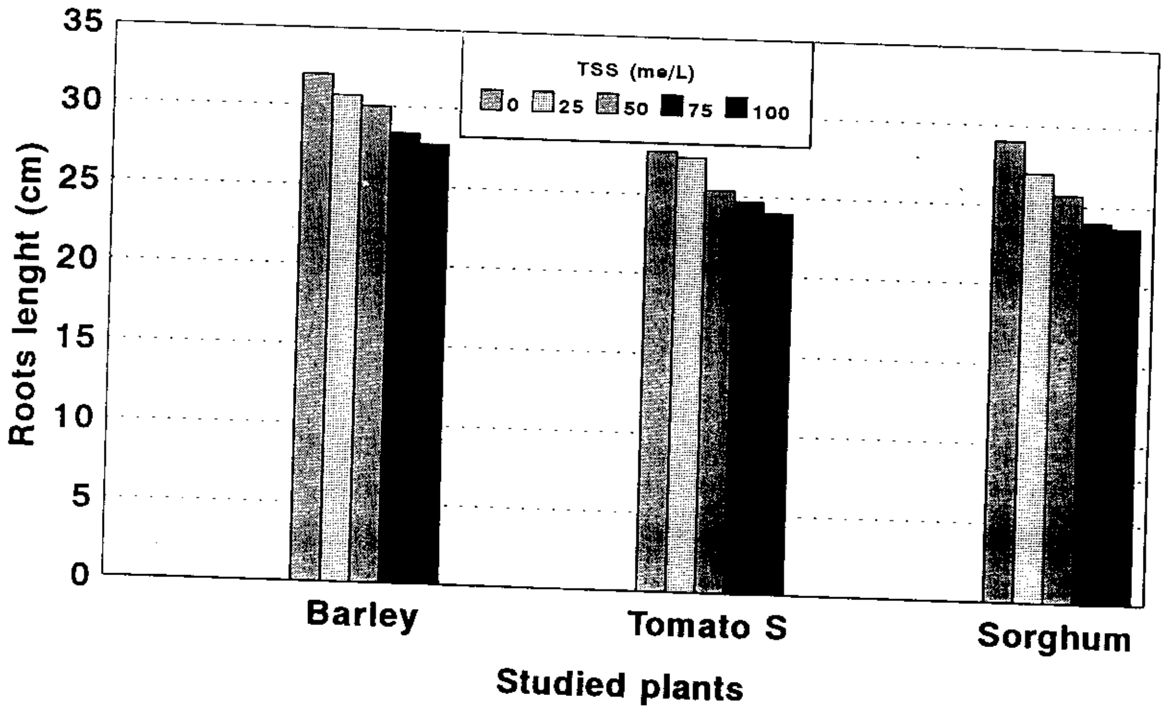
(b) Roots
0.05 = 1.74
0.01 = 2.34

Fig (11) Effect of water salinity on shoots length of plants



Tomato S = Tomato Super Strain B

Fig (12) Effect of water salinity on roots length of plants



Tomato S = Tomato Super Strain B

From the previous data the studied plant could be arranged according to their capability for salt tolerance at growth stage as follows :

Barley > Tomato (S.) > Sorghum

Similar results were obtained by Bernstein and pearson (1965) and El - Monayeri (1968), Shalaby (1970), El shourbagy (1974), Nassar (1983) and Kishk (1992).

The depression in the plant height with increasing water salinity concentration may be attributed to the reduction in cell size or number of cells per unit area (Bernstein, 1962 and Strogonove, 1962).

4.2.1.2.- Effect of water salinity on chemical composition of plant shoots:-

Results presented in Table (11) and illustrated in Fig (13) show the effect of total salinity (ranging from 0 up to 100 me L^{-1} on the elemental (N, P, K, Na, Ca and Mg) content in shoots of the tested plants i.e barley, tomato and sorghum.

Nitrogen content

Results indicate that there was a progressive and consistent decrease in N - concentration in the tissues of shoots as concentration of salts increased in the root medium . The obtained data show that increasing salinity level from 0 to 100 me L^{-1} decreased N - content from 2.94 to 1.87, from 3.22 to 2.58 and from 2.18 to 1.72 (g/100 g) for barley, tomato (S.) and sorghum, respectively. The percentage values of reduction in N - content at the highest salinity level as compared with the control were 19.88, 21.10 and 36.39 % for tomato (S.), sorghum, and barley, respectively.

Similar results were obtained by Strogonov, (1962) on cotton, Nassar (1983) on some range plants, El - Sayed (1990) on cotton and Kishk (1992) on barley.

The reduction of protein nitrogen within plant tissues grown under high water salinity may be attributed to one or more of the following factors:

a) Failure of plants grown in high water salinity to make full consumption of nitrogen compounds, and hence the accumulation of nitrogen compounds is more rapid than their utilization in bulding new cells and organs (Strogonov, 1962).

b) The hydrolytic effect of salinity on protein as well as the inhibition of new protein synthesis. Therefore, there is an accumulation of the intermediary substances containing nitrogen such as ammonia, amino acids, amides and urea (Strogonov, 1962; klysher and Rokova, 1964 and Saakvan and petroyan, 1964).

Phosphorous content:-

Results indicate that increasing salinity level resulted in a slightly increase P - concentration in the tissues of plant shoots. As the salinity level increased from 0 to 100 me L^{-1}, P - content increased from 0.80 to 0.89, from 0.57 to 0.62 and from 0.83 to 0.90 g/100 g for barley, tomato (S) and sorghum respectively. The percentage of the increases in P - content at salinity levels 25, 50, 75 and 100 me L^{-1} was 0.0, 1.2, 3.6 and

8.4; 0.0, 3.5, 8.8, and 8.8 ; 3.8, 3.8, 8.8, and 11.3 for sorghum, tomato (S.) and barley, respectively. However, these effects were always not significant. The increase in P - content of plant shoots with increasing water salinity concentration may be attributed to plant increasing needs to P for several biological and physiological activities (Mass et al, 1979).

These results are in agreement with those of Lagerwerrf (1958), El - Shourbagy (1974) and Mass et al. (1979), but are not in complete agreement with those obtained by Salem (1982), Nour et al. (1989) and Kishk (1992).

Potassium content :-

Results indicate that increasing salinity level resulted in a decrease in K - concentration within the tissues of plant shoots. As the salinity level increased from 0 to 100 me L^{-1}, K - content decreased from 2.84 to 2.23, from 1.86 to 1.56 and from 1.66 to 1.47 g/100 g for barley, tomato (S.) and sorghum, respectively. The percentage of the decreases in K - content within plant tissues at salinity levels of 25, 50, 75 and 100 me L^{-1} were 18.3, 18.7, 19, and 21.5 ; 8.1, 9.1, 11.8, and 16.1; 3.6, 8.4, 11.5, and 12.1 % for barley, tomato (S.) and sorghum, respectively. Also, results indicate significant differences among the three studied plants in K - content within plant tissues.

Similar results were obtained by Bollard and Butler (1966), Abd - El Rahman et al (1979), Kumar et al (1980), Nassar (1983), Nour et al. (1989) and Kishk (1992).

From the previous results it could be deduced that increasing the salinity level had unfavorable effect on K - content of plants. The decrease in K - content within plant tissues with increasing water salinity concentration may be attributed to an antagonistic effect of sodium on potassium uptake and hence the increasing presence of excess sodium ions in the root medium may affects adversely the availability of potassium to plants (Kelly, 1951 and Bollard and Butler, 1966).

Sodium content :-

Results indicate that increasing the water salinity concentration resulted in clear increments in Na - concentration within the tissues of plant shoots. As the salinity level increased from 0 to 100 me L^{-1}, Na - content increased from 0.78 to 1.11, from 0.58 to 0.98 and from 0.12 to 0.18 g/100 g for barley, tomato (S.) and sorghum, respectively. The percentage of the increase in Na - content within plant tissues at salinity levels 25, 50, 75 and 100 me L^{-1} was 7.7, 12.8, 25.6 and 42.7 ; 0.0, 8.3, 50.0 and 50.0 ; 3.5, 15.5, 31.1 and 68.5 % for barley, sorghum and tomato (S.), respectively.

These results are in harmony with those obtained by Bollard and Butler, 1966; El Monayeri, 1968; Ackerson and Youngener, 1975; Francois, 1976; Abd El - Rahman et al., 1979; Kumar et al. 198; Nassar, 1983 and Kishk, 1992.

In this respect it may be mentioned that at high water salinity concentrations the protoplasm of plant cells is damaged and as a result the selective salt absorption is replaced by a passive absorption. which causes an abnormal accumulation of ions (such as Na) in plant organs (Strogonov, 1962 and Bollard and Butler, 1966).

Calcium content :-

Results indicate that increasing the water salinity concentration resulted in an increase in Ca - concentration within the tissues of plant shoots. As the salinity level increased from 0 to 100 me L^{-1}, Ca - content increased from 1.67 to 2.50; from 4.06 to 5.28 and from 2.11 to 4.00 g/100 g for barley, tomato (S.) and sorghum, respectively. The percentage of the increase in Ca - content within plant tissues at salinity levels 25, 50, 75 and 100 me L^{-1} was 3.9, 5.4, 12.1, and 30.1 ; 0.0, 36.5, 43.1, and 49.7 ; 13.3, 34.1, 47.4 and 89.6 % for tomato (S.) barley and sorghum, respectively. Results also indicate clearly that there was a significant differences among the studied plants with increasing water salinity level.

Similar results were obtained by Bierhwzen and Ploegman (1967), Ackerson and Youngener, (1975), Abd El - Rahman et al., 1979, Thomas (1980) Martinez et al (1987), Nassar, (1983) and Kishk, (1992). In this respect calcium is generally needed in relatively high quantities for plant to support the state of active cell division. Besides, the high retention of Ca within plant tissues (at high level of salinity) in pectate form, mainely lead to absorbtion of Ca to maintain the dynamic equilibrium between the ions within the cell and those in the external solutions (George, 1967; Ackerson and Youngener, 1975 and Thomas, 1980).

Magnesium content :-

Results indicate that increasing the water salinity concentration resulted in a decrease in Mg - concentration within the plant tissues. As the salinity level increased from 0 to 100 me L^{-1}, Mg - concentration decreased from 0.47 to 0.33; from 2.02 to 1.73 and from 0.63 to 0.57 g/100 g for barley, tomato (S.) and sorghum, respectively. The percentage of the decrease in Mg - content within plant tissues at salinity levels 25, 50, 75 and 100 me L^{-1} was 4.8, 4.8, 9.5 and 9.52 ; 7.4, 9.4, 9.4 and 14.4 ; 14.9, 21.3, 29.8 and 29.8 % for sorghum, tomato (S.) and barley, respectively.

Similar results were obtained by Lagerwerrff (1958), Bollard and Butler (1966), El Monayeri (1968), Lashin and Atanosin (1973), Mass et al. (1973), Ackerson and Youngener, (1975), Abd El - Rahman et al., (1979), Rathert (1983), Papadopoulos and Rending (1985), Lotfy et al. (1987) and El - Sayed (1990).

The decrease in Mg - content within plant tissues with increasing water salinity concentration may be attributed to the antagonistic effect among Ca and Mg (Muhammad, 1983).

According to the above discussed results, it may be concluded that increased the total salinity of the some rational composition from 0 to gradually up to 100 me L^{-1} of irrigation water led to the followings:

a) A consistant increase in all plants content of P, Na and Ca, however, this increase was insignificant with P but highly significant (mostly) in case of Na and Ca as well.

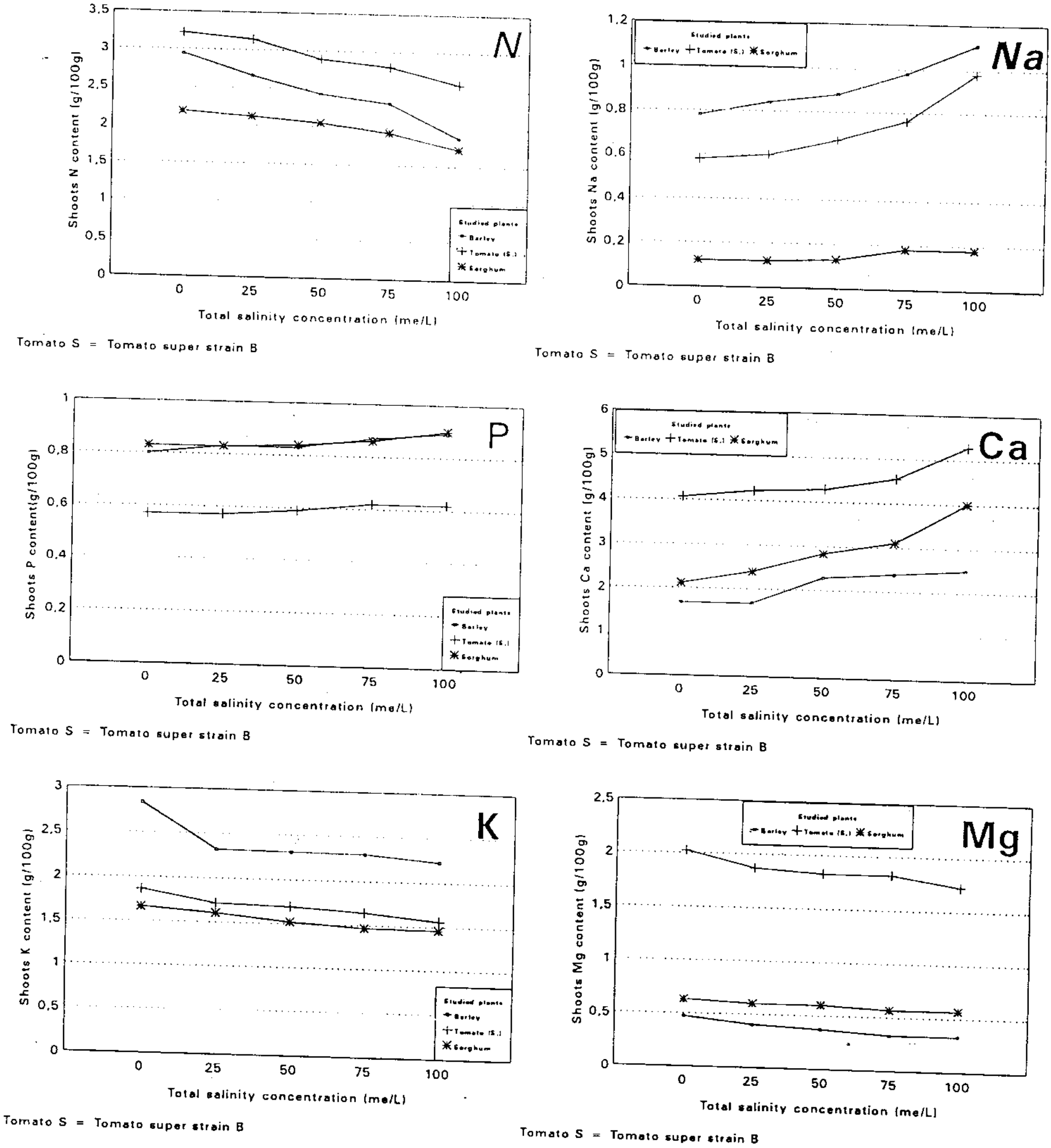
b) On the other hand the plant shoots content of N, K, and Mg were depressed significantly with increasing salinity through the abovementioned range.

Table (11) Salinity effect on N, P, K, Na, Ca and Mg contents of plant shoots (g/100 g)

TSS me L^{-1}	Barley G 123						Tomato super strain B						Sorghum S.V. 10017					
	N	P	K	Na	Ca	Mg	N	P	K	Na	Ca	Mg	N	P	K	Na	Ca	Mg
0 (Cont.)	2.94	0.80	2.84	0.78	1.67	0.47	3.22	0.57	1.86	0.58	4.06	2.02	2.18	0.83	1.66	0.12	2.11	0.63
25	2.66	0.83	2.32	0.84	1.67	0.40	3.14	0.57	1.71	0.60	4.22	1.87	2.12	0.83	1.60	0.12	2.39	0.60
50	2.43	0.83	2.31	0.88	2.28	0.37	2.89	0.59	1.69	0.67	4.28	1.83	2.05	0.84	1.52	0.13	2.83	0.60
75	2.32	0.87	2.30	0.98	2.39	0.33	2.80	0.62	1.64	0.76	4.55	1.83	1.93	0.86	1.47	0.18	3.11	0.57
100	1.87	0.89	2.23	1.11	2.50	0.33	2.58	0.62	1.56	0.98	5.28	1.73	1.72	0.90	1.46	0.18	4.00	0.57

L.S.D at	0.05	0.01 for
N	= 0.21	0.28
P	= 0.17	0.23
K	= 0.06	0.08
Na	= 0.05	0.07
Ca	= 0.42	0.57
Mg	= 0.15	0.20

Fig (13) Effect of water salinity on mineral content of plant shoots.



c) The observed reduction in plant N concentration at higher salinity levels may suggest a disturbance in plant N metabolism under such conditions while such a phenomenon was not detected with plant P concentration which was not adversely affected by salinity.

d) The increasing concentration of Ca combined with decreasing ones for Mg in plant shoots may suggest an antagonistic effect due to Ca on Mg either in growth media or in plant tissues or both while Mg could not compete calcium in this respect.

e) The consistent increase in Na plant shoot concentration may suggest a controlling role of Na under salinity stress and an antagonistic effect on other cations such as K and probably Mg. Also it may adversely affect N utilization by plants or N metabolism through its tissues.

f) However such suggestions should be reviewd in the light of the total elemental uptake to obtain more accuratestatments concerning such composited interactionships.

4.2.2.- Specific ion effect on plant:-

4.2.2.1.- Specific ion effect on plant growth :-

Tables (12, 13, 14 and 15) and Figs. (14, 15, 16 and 17) show the effect of specific ion on dry weight and height of the three studied plants as follows:

Dry weight:-

Results indicate that at total salinity concnetration of 100 me L^{-1}, increasing the SAR value of salt solution (from 21 to 34) (Soln. 1 and

Table (12) Specific ions effect on shoots dry weight (g/pot) of the studied plants

Solution No.	SAR	Ions concentration (me L^{-1})					Shoots dry weight (g/pot)		
		Na^+	Ca^{2+}	Mg^{2+}	Cl^-	SO_4^{2-}	Barley G 123	Tomato super strain B	Sorghum S.V. 10017
1	21.0	75.0	25.0	00.0	90.0	10.0	4.74	5.81	6.52
2	34.0	86.7	13.3	00.0	90.0	10.0	4.52	5.33	6.33
3	34.0	86.7	13.3	00.0	66.7	33.3	4.61	5.73	6.32
4	21.0	75.0	5.0	20.0	90.0	10.0	4.83	5.72	6.51
5	12.0	55.0	5.0	40.0	90.0	10.0	4.84	5.92	6.62

L.S.D

0.0 5 = 0.36
0.01 = 0.48

Table (13) Specific ions effect on roots dry weight (g/pot) of the studied plants

Solution No.	SAR	Ions concentration (me L^{-1})					Roots dry weight (g/pot)		
		Na^+	Ca^{2+}	Mg^{2+}	Cl^-	SO_4^{2-}	Barley G 123	Tomato super strain B	Sorghum S.V. 10017
1	21.0	75.0	25.0	00.0	90.0	10.0	2.23	2.51	4.93
2	34.0	86.7	13.3	00.0	90.0	10.0	2.21	2.33	4.81
3	34.0	86.7	13.3	00.0	66.7	33.3	2.22	2.43	4.84
4	21.0	75.0	5.0	20.0	90.0	10.0	2.22	2.42	4.92
5	12.0	55.0	5.0	40.0	90.0	10.0	2.23	2.52	4.92

L.S.D. 0.05 = 0.10

0.01 = 0.14

Fig (14) Specific ion effect on shoots dry weight of plants.

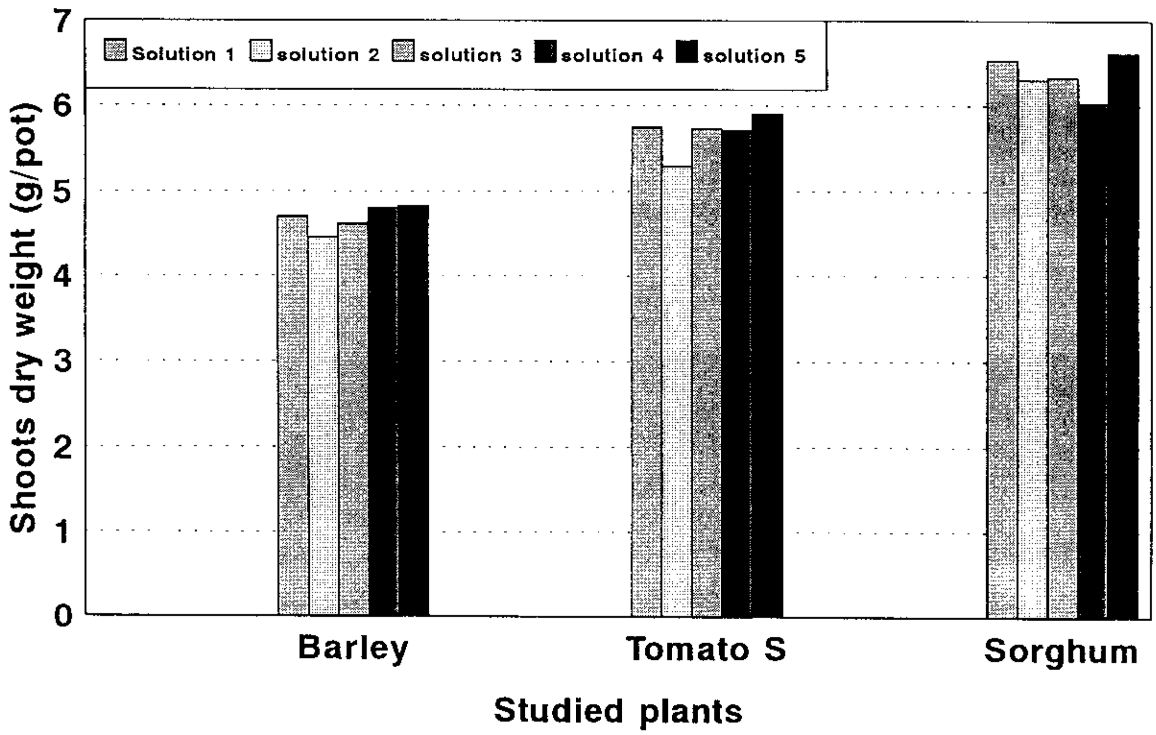
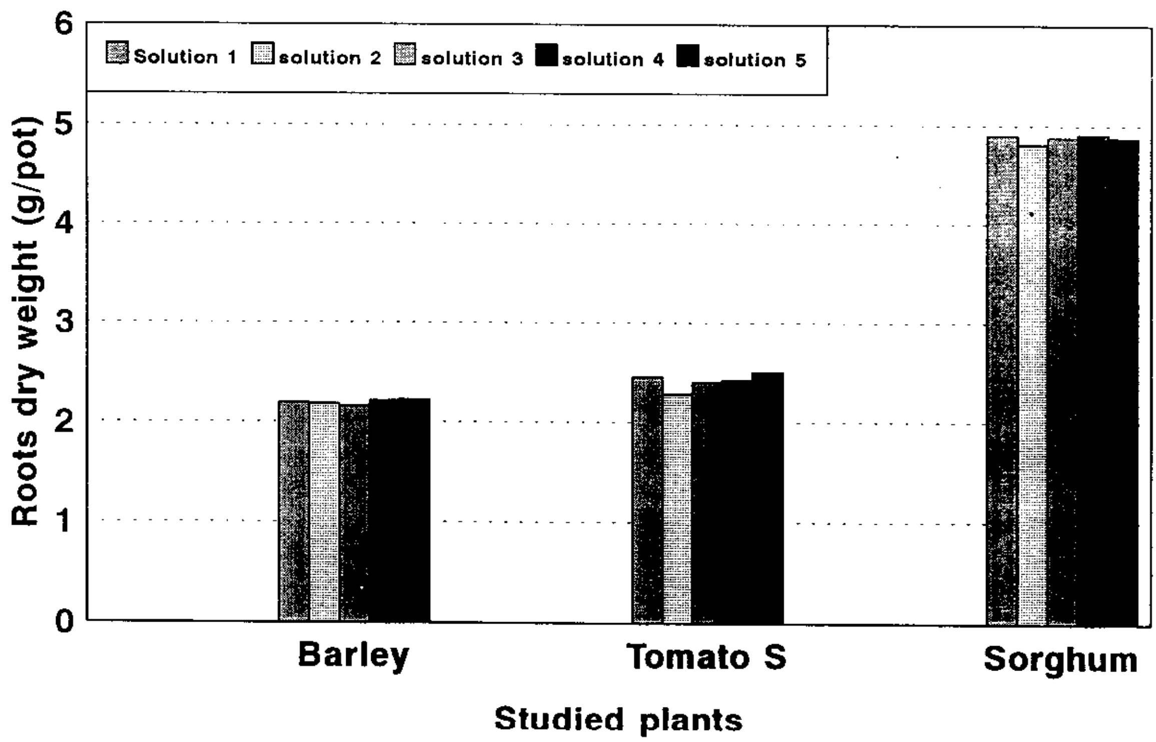


Fig (15) Specific ion effect on roots dry weight of plants



Soln. 2) reduced the shoot dry weight of the three studied plants from 4.74 to 4.52, from 5.81 to 5.33 and from 6.52 to 6.33 (g/pot), and roots dry weight from 2.23 to 2.21, from 2.51 to 2.33 and from 4.93 to 4.81 (g/pot) of barley, tomato (S.) and sorghum, respectively. Results indicate no significant differences among the solutions pairs of specific ion nither on the shoots and nor on roots dry weight of the studied plants.

Plant height:-

Results of shoots and roots length of the tested three plants as affected by specific ion treatments are shown in Tables (14 and 15) and illustrated in figs (16 and 17)

Shoots length

Results reveal that increasing Na^+ concentration (from 75 to 86.7 me L^{-1}) in irrigation water, on the expense of Ca^{2+} tended to reduce shoots length of all the tested plants. However this reduction was significant only with sorghum which may ensure the hazardous effect on shoots length of the tested three plants.

Increasing the SO_4^{2-} ion concentration (from 10 to 33.3 me L^{-1}) on the expense of Cl^- tended to induce the plant shoots length though this effect always insignificant.

Increasing the Mg^{2+} ion concentration (from 20 to 40 me L^{-1}) on the expense of Na^+ tended to induce the plant shoots length but always below the level of significancy.

Roots length:-

The specific ion effects on roots length of the studied plants are given in Table (15) and illustrated in Fig (17).

Results reveal that increasing the SAR value (from 21 to 34) by increasing Na^+ concentration (from 75 to 86.7 me L^{-1}) in irrigation water, on the expense of Ca^{2+} (reduced from 25 to 13.3 me L^{-1} significantly inhibited the root length of the tested plants. However this effect was highly significant in case of barley and only significant (at 5 % level) for both tomato (S.) and sorghum.

On the other hand it is obvious that increasing the SAR of irrigation water at the same rate (from 21 to 34) by increasing Na^+ concentration on the expense of Mg yielded different effect (but insignificant) which may suggest that Ca is more effective than Mg as a factor for minimizing the hazardous effect of Na on plant roots length.

The highest rate of SAR reduction (to 12) led to highest length of plant roots with all the tested plants.

From the previous results it can be concluded that the different ions have significant specific effects on growth of the three studied plants, that could be arranged according to their capability for tolerate high Cl^- concentration at seedling stage as follows:

Tomato (S.) > Barley > Sorghum

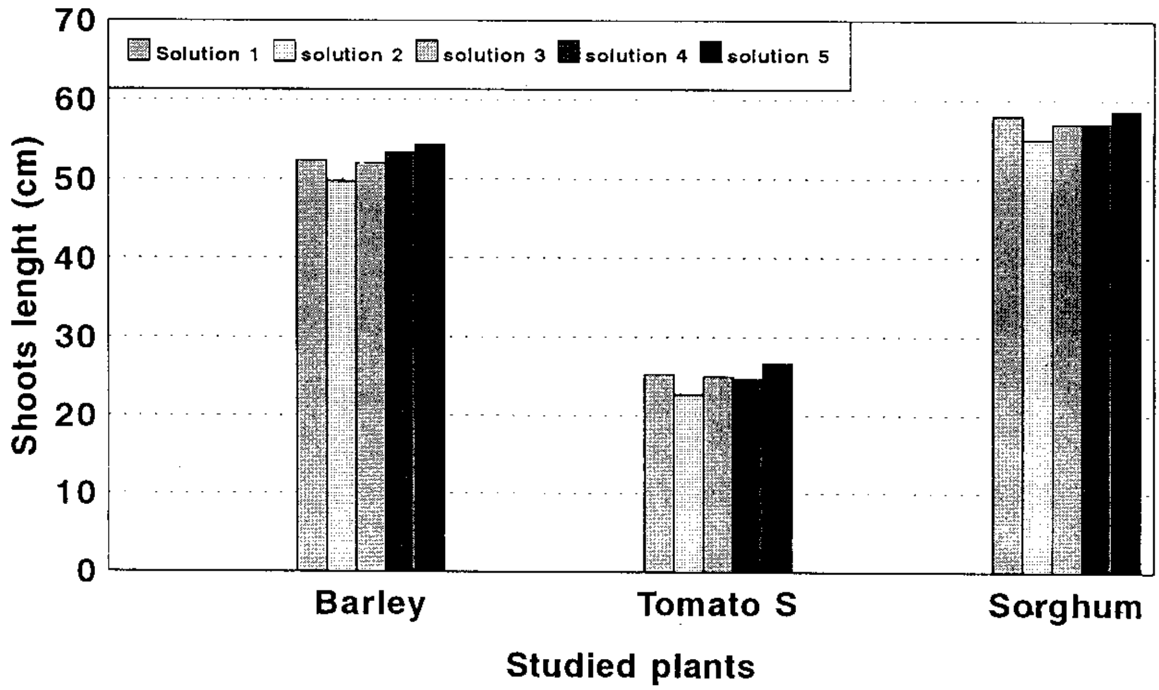
Table (15) Specific ions effect on roots length (cm) of the studied plants

Solution	SAR	Ions concentration (me L^{-1})					Roots lenght (cm)		
No.		Na^+	Ca^{2+}	Mg^{2+}	Cl^-	SO_4^{2-}	Barley G 123	Tomato super strain B	Sorghum S.V. 10017
1	21.0	75.0	25.0	00.0	90.0	10.0	27.71	24.01	23.72
2	34.0	86.7	13.3	00.0	90.0	10.0	26.71	23.02	21.73
3	34.0	86.7	13.3	00.0	66.7	33.3	27.02	23.02	22.72
4	21.0	75.0	5.0	20.0	90.0	10.0	28.02	23.33	22.02
5	12.0	55.0	5.0	40.0	90.0	10.0	28.73	24.33	23.32

L.S.D. 0.05 = 1.86

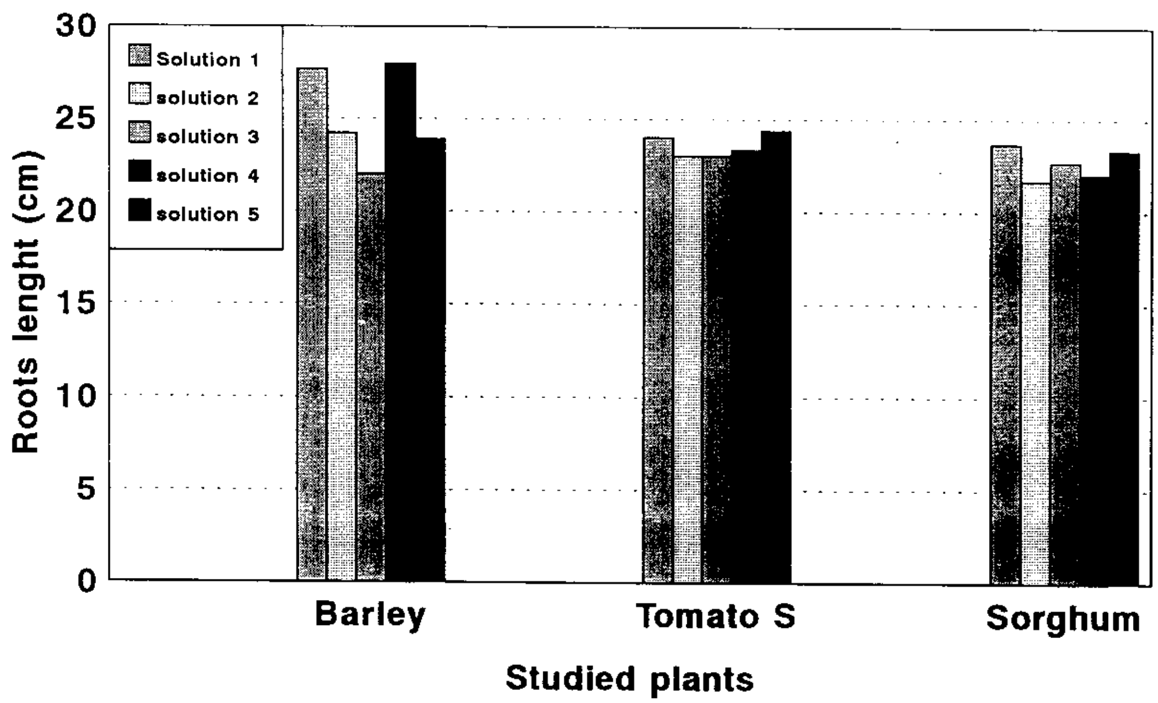
0.01 = 2.5

Fig (16) Specific ion effect on length of plant shoots



Tomato S = Tomato super strain B

Fig (17) Specific ion effect on length of plant roots.



Tomato S = Tomato super strain B

The chloride injury is attributed to its depressing effect on the availability of nutritional elements particularley phosphorous and sulfate (Grillot, 1956; Hayward, 1956; Corbett and Gausman, 1960).

4.2.2.2.- Specific ion effect in relation to the chemical composition of plant shoots:-

Table (16) and Fig (18) show the specific ion effect in relation to the chemical composition of the studied plant shoots (i.e. N, P, K, Na, Ca and Mg - content (g/100 g)). Results indicate clearly that there is no significant effect among the solutions pairs of the specific ion on N, P, K, Na, Ca and Mg - content within tissues of the studied plant shoots.

4.2.3.- Effect of drought on plant

4.2.3.1 Effect of drought on plant growth:-

Dry weight:-

The effect of drought on the dry matter yield of the three studied plants is shown in Table (17) and Fig (19 and 20). Results indicate that decreasing the soil moisture content resulted in a decrease in the dry matter yield of the three studied plants.

a) Barley

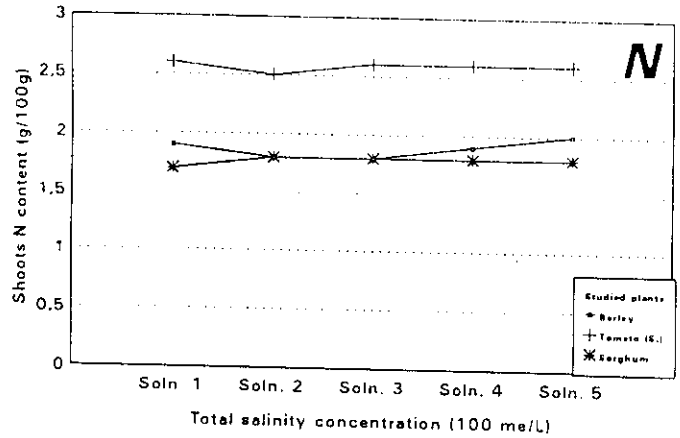
The dry matter yield of barley plants at soil moisture contents corresponding to 45, 40 and 35 % of the available water were 5.33, 5.30

Table (16) Specific ions effect on N, P, K, Na, Ca and Mg contents of plant shoots (g/100 g)

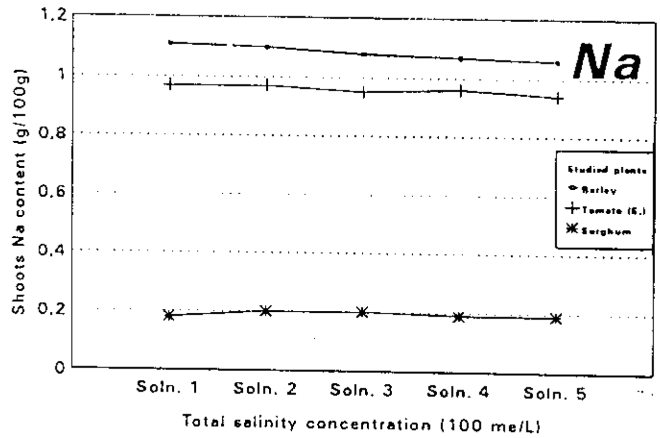
Solution No.	SAR	Ions concentration (me L^{-1})					Shoots dry weight (g/pot)																	
		Na^+	Ca^{2+}	Mg^{2+}	Cl^-	SO_4^{2-}	Barley G 123						Tomato super strain B						**Sorghum S.V. 10017**					
							N	P	K	Na	Ca	Mg	N	P	K	Na	Ca	Mg	**N**	**P**	**K**	**Na**	**Ca**	**Mg**
1	21.0	75.0	25.0	00.0	90.0	10.0	1.91	0.89	2.23	1.11	2.50	0.37	2.6	0.62	1.56	0.98	5.28	1.73	1.74	0.83	1.46	1.18	4.04	0.60
2	34.0	86.7	13.3	00.0	90.0	10.0	1.84	0.85	2.15	1.14	1.95	0.4	2.5	0.61	1.54	0.98	4.81	1.77	1.80	0.83	1.45	0.20	3.92	0.70
3	34.0	86.7	13.3	00.0	66.7	33.3	1.83	0.87	2.17	1.08	2.00	0.43	2.6	0.62	1.55	0.97	4.65	1.67	1.81	0.84	1.46	0.20	3.93	0.67
4	21.0	75.0	5.0	20.0	90.0	10.0	1.90	0.88	2.21	1.07	1.94	0.47	2.6	0.62	1.55	0.96	4.28	1.77	1.82	0.86	1.48	0.19	2.63	0.70
5	12.0	55.0	5.0	40.0	90.0	10.0	2.00	0.89	2.21	0.99	1.89	0.47	2.6	0.63	1.57	0.90	4.22	1.73	1.81	0.96	1.48	0.19	2.70	0.73

L.S.D for	N	P	K	Na	Ca	Mg
0.05	0.80	0.11	0.05	0.07	0.44	0.12
0.01	1.1	0.15	0.06	0.09	0.60	0.16

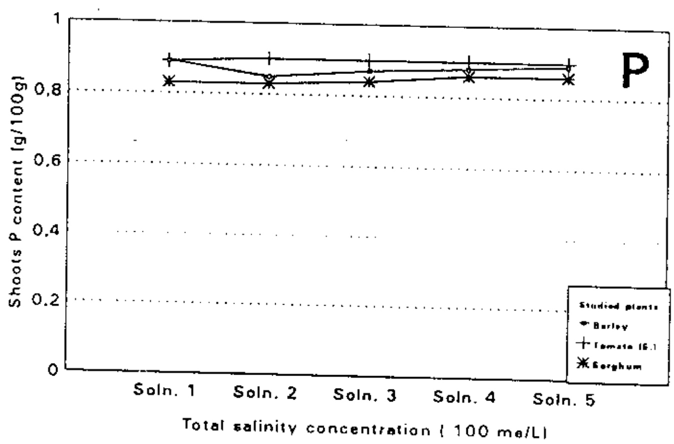
Fig (18) Specific ion effect on mineral content of plant shoots.



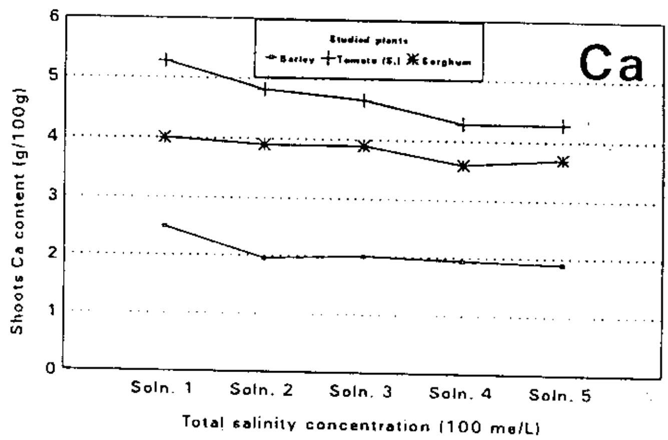
Tomato S = Tomato super strain B



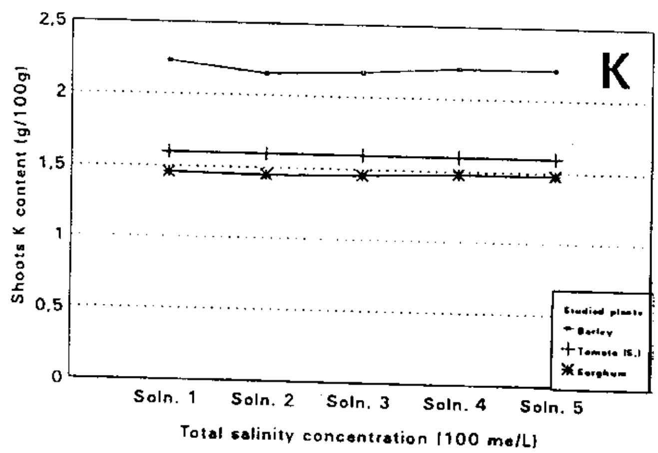
Tomato S = Tomato super strain B



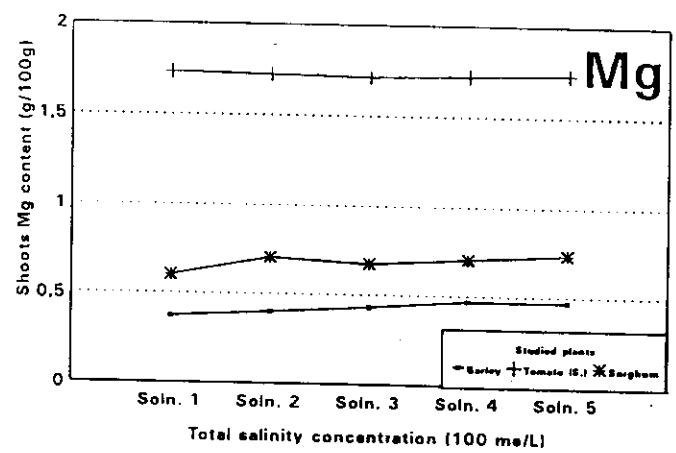
Tomato S = Tomato super strain B



Tomato S = Tomato super strain B



Tomato S = Tomato super strain B



Tomato S = Tomato super strain B

and 4.91 g/pot for shoots; and 2.81, 2.70 and 2.51 g/pot for roots, respectively.

b) Tomato (S.)

The dry matter yield of tomato (S.) plants at soil moisture contents equal to 45, 40 and 35 % of the maximum available soil water were 7.92, 6.53 and 6.23 g/pot for shoots; and 2.94, 2.81 and 2.50 g/pot for roots, respectively.

c) Sorghum

The dry matter yields of sorghum plants at soil moisture content of 45, 40 and 35 % of the available water was 9.52, 8.61 and 7.43 g/pot for shoots; and 7.42, 6.82 and 6.41 g/pot for roots, respectively.

Results also indicate a significant depression effect on shoots and roots dry weights of the tested plants with decreasing the soil moisture content from 45 to 35 % of the available soil water reduced the plant dry weights by 7.55, 21.52 and 22.11 % for shoots and and 10.71, 13.79 and 17.95 % for roots of barley, tomato (S.) and sorghum, respectively. Decreasing the soil moisture content from 45 to 35 % of the available water decreased the dry weight of the whole plants by 18.26, 35,31 and 40.06 % barley, tomato (S.) and sorghum, respectively.

These results may indicate that clearly barley is the most drought tolerant plant, tomato (S.) is medium and sorghum is the lowest. Similar results were obtained by Grinfel (1965, Talha, 1966; El - Monayeri, 1970; El - Shorbagy, 1974, Nassar, 1983 and Kishk, 1992.

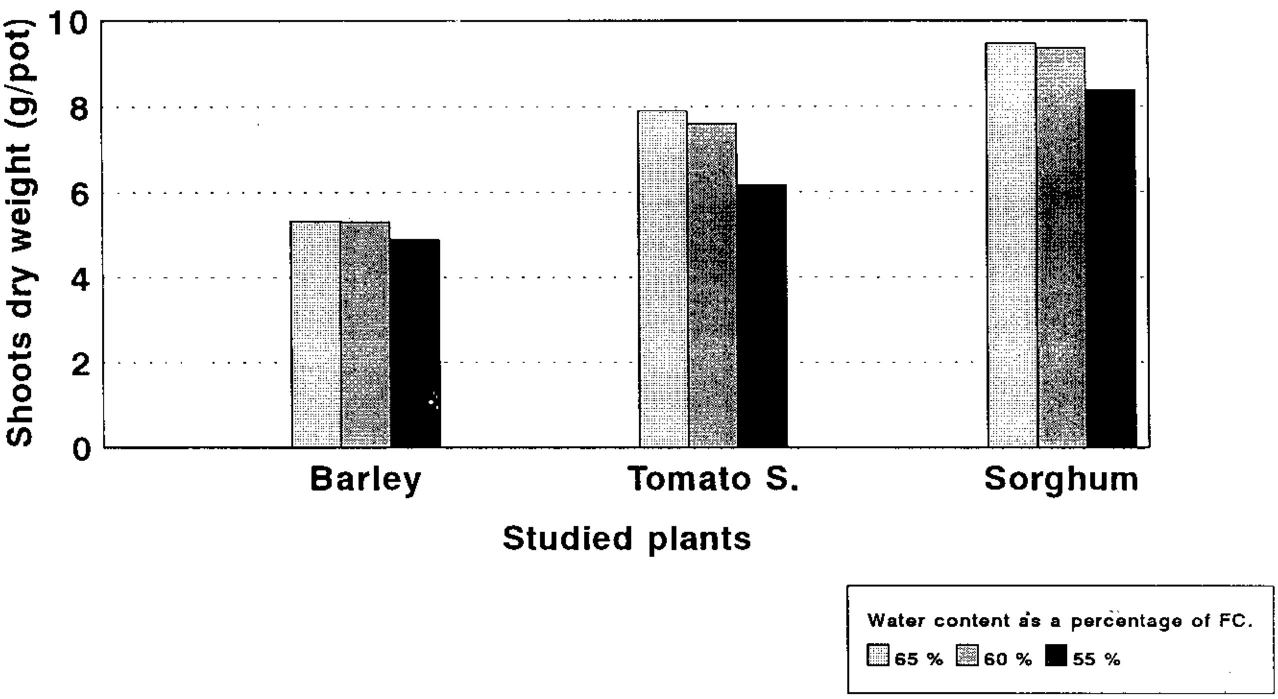
Table (17) Drought effect on dry weight (g/pot) of the studied plants

Studied plants	Moisture content as a percentage of Av.W					
	45 (Cont.)	40	35	45 (Cont.)	40	35
	Shoots dry weight (g/pot)			Roots dry weight (g/pot)		
Barley G 123	5.33	5.30	4.91	2.81	2.70	2.51
Tomato super strain B	7.92	5.33	6.23	2.94	2.81	2.50
Sorghum S.V. 10017	9.52	7.61	8.43	7.12	7.12	6.41

L.S.D. for (a) Shoots
0.05 = 0.24
0.01 = 0.34

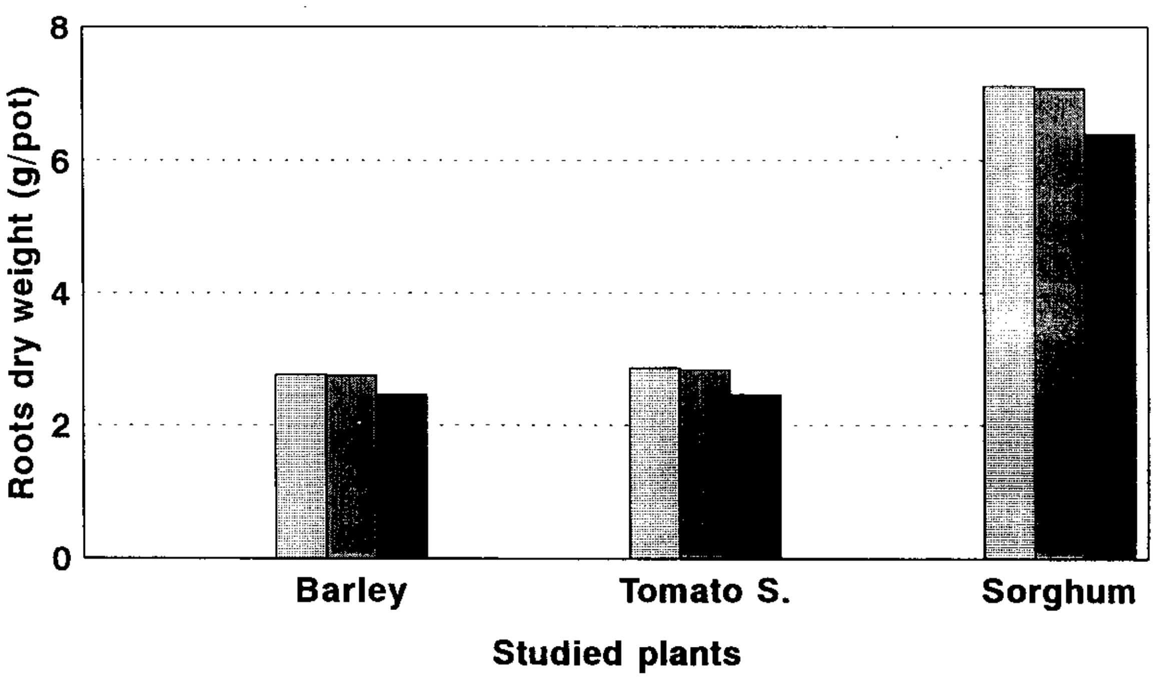
(b) Roots
0.05 = 0.84
0.01 = 1.15

Fig (19) Effect of drought on shoots dry weight of plants



Tomato S = Tomato Super Strain B

Fig (20) Effect of drought on roots dry weight of plants



Tomato S = Tomato Super Strain B

Plant height:-

The effect of drought on shoots and roots length of the three studied plants is shown in Table (18) and Fig (21 and 22). Results indicat that decreasing the soil moisture content tended to reduce the length of the three studied plants.

a) Barley

The length of the shoots and roots of barley plants at soil moisture contents of 45, 40 and 35 % of the available water were 55.74, 55.70 and 54.73 cm for shoots and 33.72, 32.00 and 30.71 cm for roots, respectively.

b) Tomato (S.)

The length values of both shoots and roots of tomato (S.) plants at soil moisture contents of 45, 40 and 35 % of the maximum available soil water were 30.32, 29.71 and 28.32 cm for shoots; and 28.30, 27.74 and 25.73 cm for roots, respectively.

c) Sorghum

The lengths of both shoots and roots of sorghum plants at soil moisture content 45, 40 and 35 % of the maximum available soil water were 71.03, 67.32 and 57.03 cm for shoots; and 30.04, 29.02 and 25.32 cm for roots, respectively.

Data also indicate that decreasing soil moisture content from 45 to 35 % of the available water caused adwarfing effect on plant height . The reduction is by 1.80, 6.60 and 19.72 % for shoots and by 8.9, 9.19 and 15.67 % for roots of barley, tomato (S.) and sorghum, respectively.

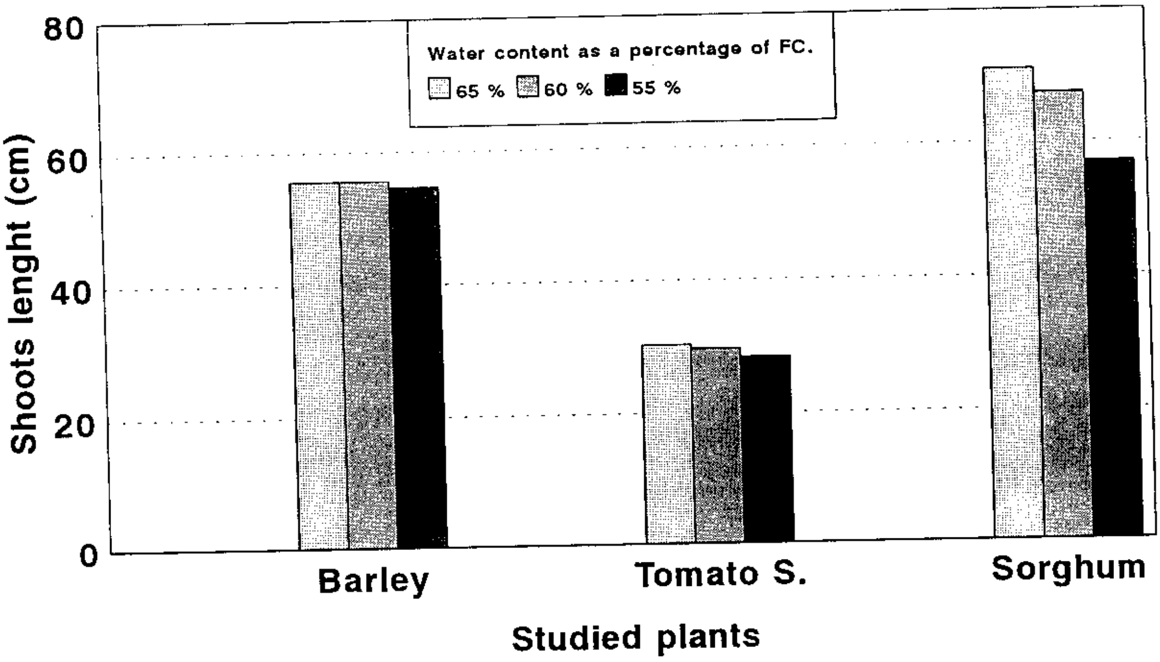
Table (18) Drought effect on shoots and roots lenght (cm) of the studied plants

Studied plants	Moisture content as a percentage of Av.W					
	45 (Cont.)	40	35	45 (Cont.)	40	35
	Shoots length (cm)			Roots length (cm)		
Barley G 123	55.74	55.70	54.73	33.72	32.00	30.71
Tomato super strain B	30.32	29.71	28.32	28.30	27.74	25.73
Sorghum S.V. 10017	71.02	67.32	57.03	30.04	29.02	25.32

L.S.D. for (a) Shoots
0.05 = 2.63.
0.01 = 3.6

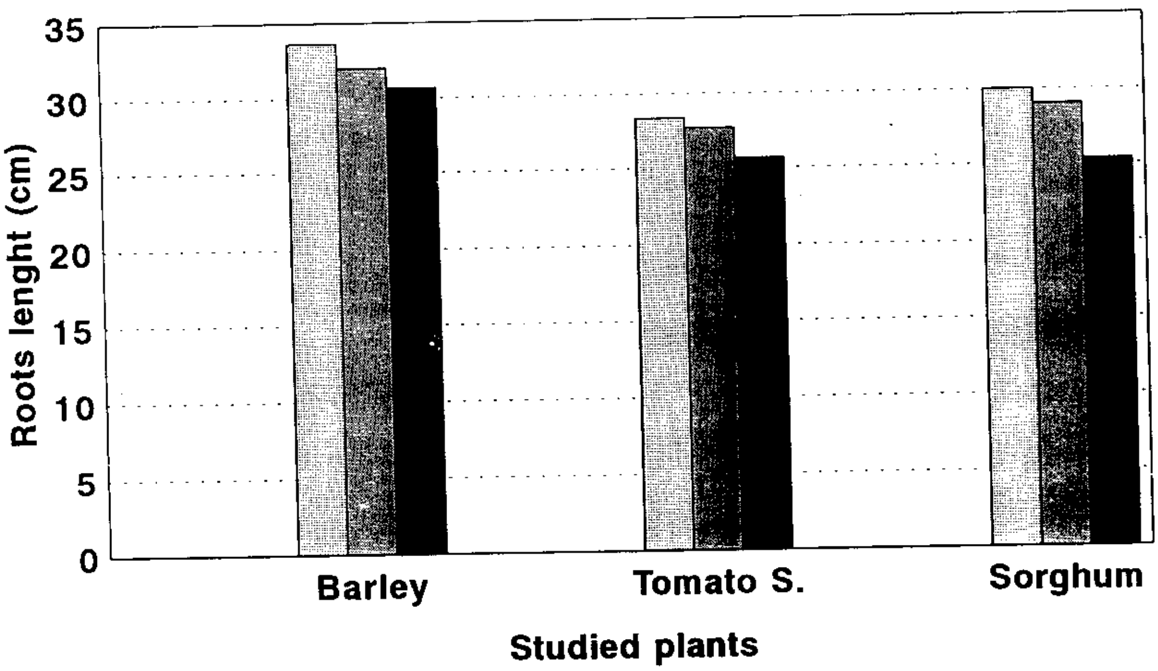
(b) Roots
0.05 = 2.21
0.01 = 3.03

Fig (21) Effect of drought on shoots length of plants.



Tomato S = Tomato Super Strain B

Fig (22) Effect of drought on roots length of plants



Tomato S = Tomato Super Strain B

According to the above discussed results it may be concluded, in general, that decreasing the soil content of available moisture from 45 % to 40 % or 35 % tended to reduce the length of shoots and roots of the tested plants. However, the rates of reduction resulted were insignificant for both shoots and roots of both barley and tomato (S.) but were significant for sorghum where the highly significant dwarfing effect on shoots occurred with both levels of 40 and 35 % Av.W and at the Av.W of 35 % only for roots.

Accordingly it can be concluded that both barley and tomato (S.) can very much tolerate drought effect as compared with sorghum.

Similar results were obtained by Tadros and Ibrahim, 1958; Talha, 1966; Abd El - Rahman and El - Monayeri, 1968; Hiller et al., 1972; El - Shurbagy, 1974; Salem, 1982; Nassar, 1983 and Kishk, 1992.

Reduction in plant growth with decreasing the soil moisture content may be attributed to a general retardation of enzymatic processes particularly those concerned with photosynthesis (kramer, 1959 and 1963). In addition indirect effects of turgor pressure operated mechanism coincide with rapid decrease in the dry matter production rate (Slayter, 1967). However, reducing turgor pressure as a result of reduction of water content within tissues leads to a complete or alsmot complete closure of stomata. This in turn causes a depression in both transpiration and photosynthesis. In this respect Ordin (1960) reported that reduced turgor pressure lowered cell wall metabolism and elongation through some aspects of cellulose synthesis. He added that the effect of reduced turgor pressure on cell enlargement could be indirect since the reduction in cell size results in reduction in leaf area and hence reduced in growth rate. Turgor pressure is low enlarging cells, but some minimum levels of turgor is necessary for cell expansion. Turgor also is important in relation to the opening and closing of stomata, expansion of leaves, flowers and various movements of plant parts. On the other hand, enzyme mediated processes are pressumably controlled more directly by water potential (Gates et al., 1967 and Kramer, 1980). In this conection Sionit and Kramer (1977 reported that water stress usually has multiple effects on plant growth. For example under water stress conditions, photosynthesis is reduced due to closure of stomata and shortage of carbondioxide.

4.2.3.2. Effect of drought on chemical composition of plant shoots:

4.2.3.2.1. Nitrogen content:-

Data in Table (19) and Fig (23) show the effect of drought on N - content within the plant tissues of the studied plant shoots. The results indicat that decreasing the moisture content of the from 45 to 35 % available water caused a slight and gradual increase in N - content of the studied plant. N - content increased from 2.7to 3.1; from 2.9 to 3.3 and from 1.0 to 2.2 g/100g for barley, tomato (S.) and sorghum respectively. Results also indicate clearly that decreasing the soil moisture content from 45 to 35 % of the available water significantly increased the N - content of plant shoots by 13.8, 14.81 and 15.71 % for tomato (S.), barley and sorghum, respectively. Similar findings were obtained by Cannell et al., 1960; Bourget and Carson, 1962; Kumakhova and Matukhin, 1963, Barnett and Naylor ,1966; Dubetz and Bole, 1973; Fedak and Mack, 1977; Nassar, 1983 and Kishk, 1992.

The increase in nitrogen content in the tissues of the studied plants with decreasing the soil moisture content may be attributed to one or more of the following factors:

a) The disturbance in the energy metabolism in plants grown under drought, this results in an increase of the amino - acid because of the failure consumption of these substances into protein. Consequently, protien synthesis is supressed (Kumakova and Matukhin, 1963).

b) The hydrolysis of protein as well as the accumulation of nitrogen degradation products translocated from the roots under drought stress condition (Saunier et al, 1968).

Reduction in the hydration of protoplasmic proteins, this in turn affects protein metabolism (Wadleigh and Ayers, 1945).

4.2.1.2.2.- Phosphorous, potassium, sodium, calcium and magnesium contents:-

Data in Table (19) and Fig (23) show the effect of drought on P, K, Na, Ca and Mg - content in the shoots of the tested plants. Results indicate that decreasing soil moisture content from 45 to 35 % of the A.W resulted in a slight increase in P, K, Na, Ca and Mg - content in the tissues of the studied plant shoots.

Concerning barley, the mineral content of the plant shoots increased from 0.76 to 0.87; from 2.3 to 2.4; from 0.61 to 0.98; from 1.3 to 1.7 and from 0.37 to 0.47 g/100 for P, K, Na,Ca and Mg, respectively. In tomato plants, the increase in mineral content was from 0.54 to 0.58; from 1.8 to 1.9; from, 0.43 to 0.58; from 3.4 to 4.8 and from 1.6 to to 1.9 for P, K, Na, Ca and Mg ,respectively. In sorghum plants, the mineral content increased from 0.83 to 0.90; from 1.6 to 1.7; from 0.12 to 0.15; from 1.8 to 2.2; and from 0.43 to 0.70 for P, K, Na, Ca and Mg, respectively. It could be noticed that decreasing soil moisture content from 45 to 35 % of the A.W increased the mineral content by 14.5, 7.4 and 8.4 % for P and 3.1, 3.3 and 1.2 % for K and 60.66, 39.0 and 27.5 for Na and 34.4, 26.5 and 21.3 % for Ca and 27.03, 18.8 and 62.8 % for Mg within tissues of barley, tomato (S.) and sorghum, respectively.

The increase in mineral concentration within tissues of the studied plants caused by decreasing soil moisture supply may be attributed to the effect of water supply on growth rate in regard to the rate of mineral uptake. However, it is known that increasing moisture stress depresses plant growth as well as mineral uptake with a more rapid rate in the former stage than in the latter. The result is an increase in the concentration of minerals and total ash within plant tissues.

The decrease in the total uptake of minerals under drought conditions (Table, 20) may be attributed to one or more of the following factors:

a) Reduction in roots growth which leads to a reduction in the absorbing surfaces of plants (Low and Piper, 1960).

b) Reduction in the thikness of moisture films arround soil particles and consequently, ion transfer from soil to roots is impeded due to the lack of continous water films (Brown, 1953).

c) Changes in the geometry of water, ion diffusion and ion transport accompanying the changes in moisture content (Gardner, 1960; Olsen et al., 1961 and Peters and Russell, 1960).

Table (19) Drought effect on N, P, K, Na, Ca and Mg contents of plant shoots (g/100 g)

Soil Moisture content as a % of Av.W	Barley G 123						Tomato super strain B						Sorghum S.V. 10017					
	N	**P**	**K**	**Na**	**Ca**	**Mg**	**N**	**P**	**K**	**Na**	**Ca**	**Mg**	**N**	**P**	**K**	**Na**	**Ca**	**Mg**
45 (Cont.)	2.70	0.08	2.31	1.06	1.30	0.37	2.91	0.05	1.80	0.43	3.81	1.60	1.92	0.08	1.62	0.12	1.82	0.43
40	2.94	0.08	2.33	0.78	1.71	0.40	3.24	0.06	1.92	0.58	4.12	1.84	2.23	0.08	1.70	0.12	2.13	0.60
35	3.12	0.09	2.44	0.98	1.74	0.47	3.32	0.06	1.94	0.67	4.83	1.93	2.24	0.09	1.73	0.15	2.24	0.70

L.S.D for	N	P	K	Na	Ca	Mg
0.05	0.21	0.12	0.05	0.04	0.29	0.14
0.01	0.29	0.16	0.07	0.06	0.40	0.19

Table (20) Drought effect on N, P, K, Na, Ca and Mg -uptake of plant shoots (g/pot)

Soil Moisture content as a % of Av.W	Barley G 123						Tomato super strain B						Sorghum S.V. 10017					
	N	P	K	Na	Ca	Mg	N	P	K	Na	Ca	Mg	N	P	K	Na	Ca	Mg
45 (Cont.)	0.156	0.043	0.124	0.048	0.088	0.023	0.245	0.043	0.145	0.044	0.309	0.139	0.204	0.079	0.155	0.013	0.197	0.059
40	0.151	0.042	0.122	0.041	0.084	0.021	0.229	0.043	0.141	0.041	0.299	0.126	0.186	0.078	0.155	0.011	0.186	0.056
35	0.141	0 040	0.115	0.033	0.068	0.020	0.200	0.036	0.117	0.038	0.294	0.117	0.187	0.075	0.139	0.011	0.173	0.041

L.S.D for	N	P	K	Na	Ca	Mg
0.05	0.018.	0.001	0.006	0.004	0.024	0.011
0.01	0.024	0.002	0.008	0.005	0.033	0.014

Fig (23) Effect of drought on chemical composition of plant shoots