RESULTS AND DISCUSSION

I- Low temperature and germination of squash seeds:

The effect of low temperature as a pre-sowing treatment on germination percentages and rates of squash seeds during 1998 and 1999 seasons is shown in **Table (2)** and **Fig (2)**. The applied low temperatures were –1, -2, -3 and -4°C for two exposure times "12 and 24 hours".

The obtained data show that, exposing squash seeds to low temperature for 12 hours before sowing exhibited significant increase in their germination percentages at the two levels of significance either during 1998 or 1999 seasons compared with the control. Also, of interest is that in the two seasons of the present study the low temperature of -2°C exhibited the highest values of germinated seeds. The, values were 93.33 and 91.67% during 1998 and 1999 seasons, respectively. While, -1°C had the lowest significant increase in squash seed germination.

While, for the exposure of 24 hours the different low temperature-treated seeds as –1, -2, -3 and -4°C also showed significant increase in germination of squash seeds but only at the 5% level of significance in 1998 and 1999 seasons. Meanwhile, germination percentage in most cases did not reach the 1% level of significance when compared with the control.

On the other hand, the germination rates of squash seeds plant exhibited insignificant reduction in their values during the two seasons of the present study. That was true for the two applied

Table (2): Effect of low temperature as a pre-sowing treatment on germination process of squash (*Cucurbita pepo* L.) seeds during 1998 and 1999 seasons.

Characters		1998		1999	
Treatments		Germination			
Low temperature °C	Exposure duration (hours)	%	rate	%	rate
-1	12	88.25	7.29	86.67	7.33
-2	12	93.33	6.27	91.67	6.29
-3	12	89.98	7.14	88.33	7.16
-4	12	91.58	6.76	90.00	6.80
-1	24	79.65	7.43	80.00	7.42
-2	24	84.91	7.31	83.33	7.34
-3	24	76.32	8.06	76.67	8.04
-4	24	81.40	8.18	81.67	8.16
Control		74.56	8.99	73.33	9.03
L.S.D. at	0.05	5.54	3.46	5.06	4.89
	0.01	7.64	4.77	6.99	6.75

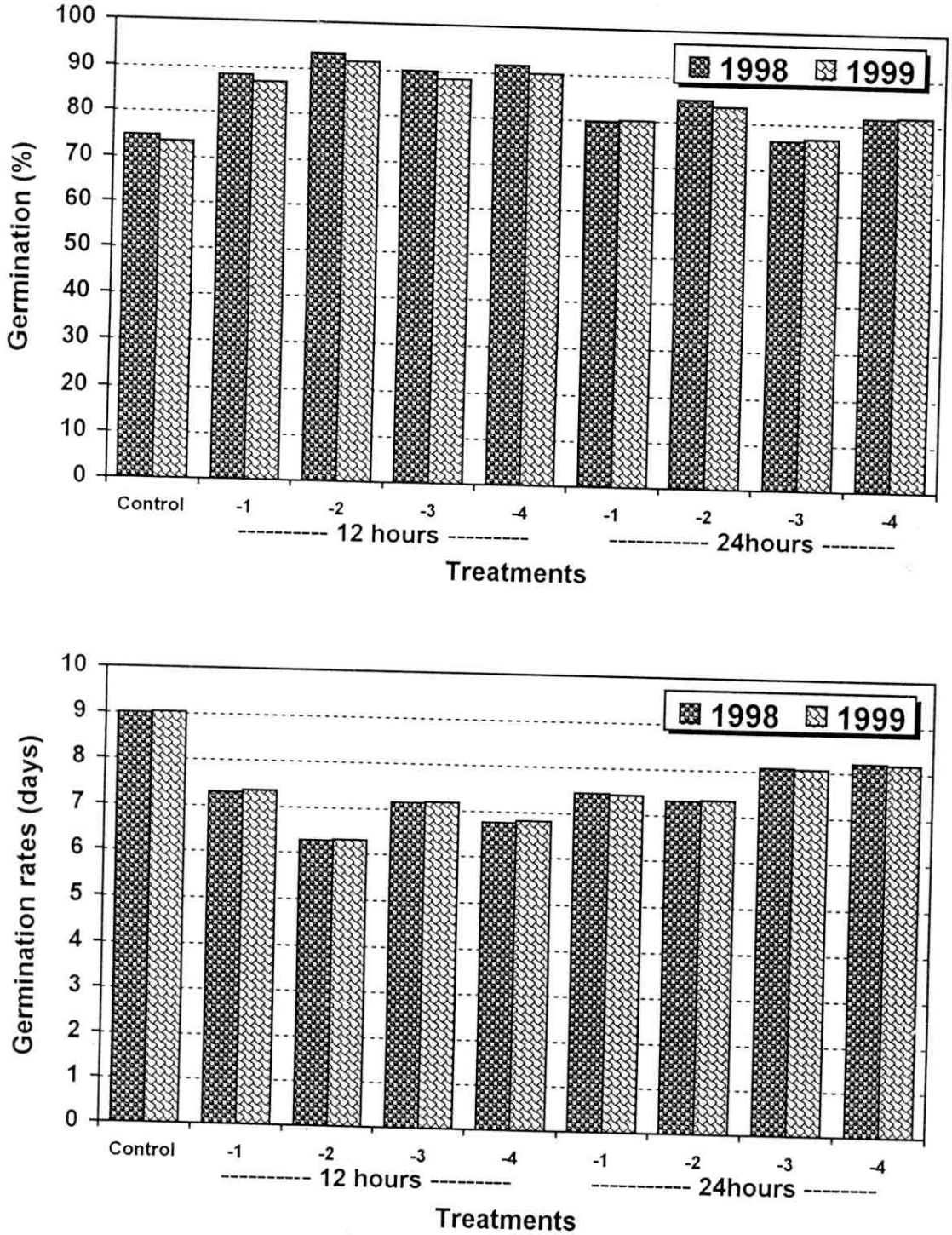

Fig. (2): Effect of low temperature as a pre-sowing treatments on germination process (percentage and rates) of squash (*Cucurbita pepo* L.) seeds during 1998 and 1999 seasons.

exposure times (12 and 24 hours). Also, it could be noticed that -2°C had the lowest rate of squash seed germination during the two exposure times.

From the previous mentioned results it could be concluded that different low temperatures for 12 or 24 hours accelerated the germination of squash seeds and reduced the number of days required for germination in most treatments.

Regarding, the effect of low temperature as a pre-sowing treatments on the germination of squash seeds as well as other plants, - to our knowledge - there are few studies have been carried out; **Hennart (1985)** on some vegetable crops including squash, **Scott** and **Jones (1986)**, **Coolbear *et al.* (1987)** and **Gabal (1990)** on tomato and **Ahmed (1997)** on squash. In general they reached the conclusion that low temperature as a pre-sowing treatment of seeds substantially increased germination percentages and reduced germination rates.

The stimulation of squash seed germination by the low temperature application could be attributed to the physiological effects upon enzyme activities (**Hall *et al.* 1970**), or the hormone profile (**Staub *et al.*, 1987**) and/or creating certain specific bio-constituents due to the sudden exposure for the low temperature. In this respect other stresses e.g. high temperature have been reported to create specific compounds such as shock protein (**Lafeuenta *et al.*, 1991 and Collins *et al.*, 1995**). Hence, low temperature stress during this early stage of growth i.e. germination stage could be highly affected either during this stage itself or prolonged to the

other stages of squash growth. So, the present study followed up the behaviour of squash plants during its further growth stages.

II- Effect of the low temperature as a pre-sowing treatment on squash growth:

1- Root growth:

Data in **Table** (**3**) and **Fig** (**3**) clearly indicate that low temperature as a pre-sowing treatment for squash seeds showed high significant increase in the root size and length of the resulting plants with the two exposure time in the two seasons under study. Also, data show that the two root parameters were in parallel increase to the applied low temperatures. Since, the highest values of the two parameters were 15.67 & 49.67; 14.33 & 46.33 and 15.33 & 50.33 and 13.33 & 45.67 for the root size and length in 1998 and 1999 seasons, respectively.

On the other hand, the root diameter was to some extend, variously responded since its high significant increase existed with the four applied low temperature levels in case of 12 hours exposure time. Meanwhile, for the 24 hour exposure time its high significance was obtained with –1 and -3°C levels, yet insignificant increase was existed with –2 and -4°C of the low temperature levels compared with the control during the 1998 season. While, in 1999 season, root diameter was increased to reach the high level of significance (i.e. at 1% level) with –1 and -3°C of the applied low temperature levels and also showed its significance at the 5% level with –2 and -4°C.

Also, it is interest is that the obtained enhancement in the size and length of the root system was completely reflected upon its fresh

Table (3): Effect of low temperature as a pre-sowing treatment on root and stem characteristics of squash (*Cucurbita pepo* L.) plants at 60 days after sowing during 1998 and 1999 seasons.

Treatments		1998							1999						
		Root				Stem			Root				Stem		
Low temp.°C	Exposure duration (hours)	Size (cm^3)	Length (cm)	Diameter (cm)	Fresh weight g/plant	Diameter (cm)	Length (cm)	Fresh weight g/plant	Size (cm^3)	Length (cm)	Diameter (cm)	Fresh weight g/plant	Diameter (cm)	Length (cm)	Fresh weight g/plant
-1	12	13.67	43.67	0.73	3.73	1.03	6.07	2:77	13.33	42.67	0.70	3.40	1.00	6.00	2.63
-2	12	13.33	43.67	0.83	5.17	1.03	7.00	2.77	12.33	43.00	0.73	5.00	1.00	6.67	4.17
-3	12	15.67	44.33	0.87	6.00	1.23	6.93	4.83	15.33	43.33	0.83	5.83	1.17	6.50	4.83
-4	12	15.67	49.67	0.67	9.10	1.17	5.93	3.57	15.33	50.33	0.63	9.03	1.03	5.50	3.40
-1	24	11.33	45.33	0.63	3.47	0.80	5.70	3.07	10.67	44.67	0.60	3.07	0.83	5.17	2.87
-2	24	14.00	46.33	0.53	3.70	1.13	5.17	2.50	14.33	46.00	0.57	3.37	1.03	5.17	2.30
-3	24	14.00	48.00	0.63	6.67	0.93	5.33	3.67	13.00	47.33	0.60	6.47	0.87	5.50	3.60
-4	24	14.33	46.33	0.53	7.10	0.97	5.53	4.60	13.33	45.67	0.47	6.90	0.83	3.67	4.47
Control		9.67	35.00	0.50	2.60	0.80	3.70	2.70	10.00	34.33	0.43	2.97	0.77	3.67	2.57
LSD	0.05	1.38	1.42	0.11	0.79	0.16	0.49	1.42	1.11	1.67	0.13	0.82	0.17	1.05	0.57
	0.01	1.90	1.96	0.16	1.09	0.22	0.68	N.S	1.53	2.30	0.17	1.13	0.23	1.45	0.79

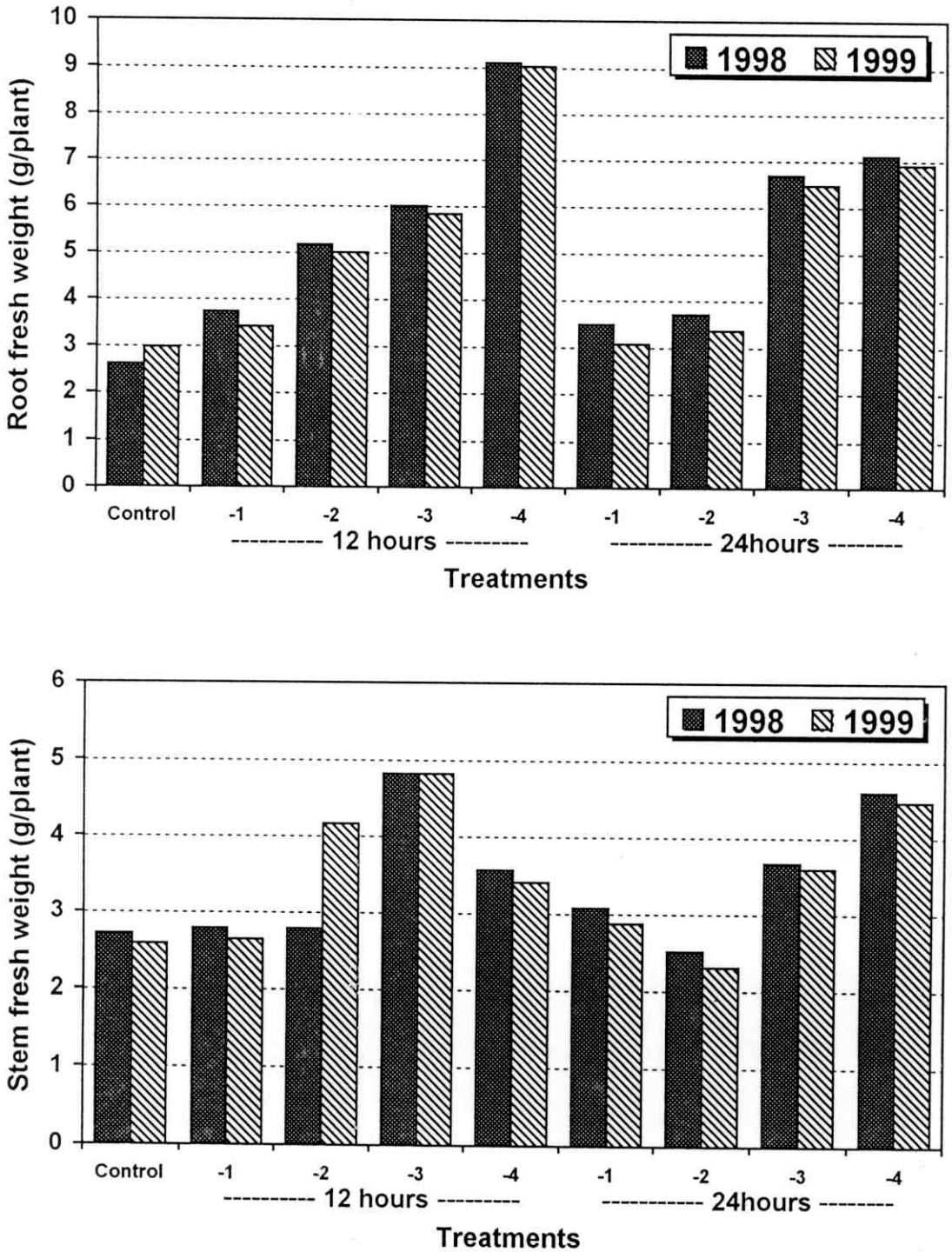

Fig. (3): Effect of low temperature as a pre-sowing treatments on root and stem fresh weight (g/plant) of squash (*Cucurbita pepo* L.) plants during 1998 and 1999 seasons.

weight. Also, it is evident that root fresh weight was parallel in its increment to the applied low temperature level. Since, the value was 3.37 g/ plant with -1°C level whereas rose up to reach 9.10 g/plant with -4°C low temperature level for 12 hours exposure time and from 3.47 to 7.10 g/plant for the 24 hours exposure time for the same low temperature levels during 1998 season. While, values of the root fresh weight were increased from 3.40 with -1°C level to reach 9.03 g/plant with -4°C low temperature level for the 12 hours of exposure time and from 3.07 with -1°C to reach 6.90 g/plant with -4°C low temperature level during 1999 season.

Concerning the stimulation of root growth characteristics under low temperature as a pre-sowing treatment could be attributed to the expected alterations in creating of many bioconstituents under low temperature regime. Of these alterations might be the endogenous level of cytokinins and auxins in which has been recommended to be the main factor for the growth and development of the root system (**Noggle** and **Fritz, 1992, Wien, 1997** and **El-Desouky *et al.*, 1998**).

2- Stem growth characters:

Data in **Table (3)** indicate that stem diameter and stem length were positively responded to the low temperature as a pre-sowing treatment during 1998 and 1999 seasons. Low temperature treatments increased the two parameters to reach the high level of significance. Also, it could be noticed that -2°C gave the highest stem length, yet -3°C exhibited the highest diameter of squash stem in the 12 hours time of exposure. While, for the 24 hours exposure

time, the greatest significant increase of stem diameter and length was obtained with -4°C level during 1998 season. Whereas that was obtained with -3°C level during 1999 season.

With regard to the stem fresh weight/plant, it was insignificantly increased with –1 and -2°C levels for the 12 hours exposure time in 1998 season as well as –1 °C level at 1999 season. In most cases significant or highly significant increase of this parameter was existed. The only insignificant reduction that was existed was with -2°C level for the 24 hours exposure time in 1998 and 1999 seasons.

Regarding the effect of low temperature as a pre-sowing treatment upon stem characteristics growth were studied by some investigators: **Robert** and **Melton (1990)**, **Gabal (1990)** and **Fathy (1995)** on tomato, **Mohamed (1995)** on eggplant, **El-Nagar (1996)** on sweet pepper and **Ahmed (1997)** on squash. They reported that low temperature as a pre-sowing treatment of seeds increased stem growth expressed as stem diameter, stem length and stem fresh weight.

3- Leaf growth characters:

Regarding the number of leaves and total leaf area/plant, data in **Table (4)** indicate that, different low temperature levels as -1°C up to -4°C in the two applied exposure times as well as in the two seasons were high significantly responded. The only exception was that significant increase at 5% level existed with the number of leaves at -1°C for the 12 hour exposure time in 1999 season and also at -1°C level for the 24 hour exposure time in the two seasons.

Table (4): Effect of low temperature as a pre-sowing treatment on leaf characteristics of squash (*Cucurbita pepo* L.) plants at 60 days after sowing during 1998 and 1999 seasons.

Characters		1998		1999	
Treatments		No. of leaves/ plant	Leaf area/plant (cm^2)	No. of leaves/ plant	Leaf area/plant (cm^2)
Low temperature °C	Exposure duration (hours)				
-1	12	6.00	373.61	5.67	369.61
-2	12	7.33	494.23	7.00	491.65
-3	12	6.67	544.25	6.33	540.63
-4	12	6.33	643.86	6.67	641.51
-1	24	5.33	379.86	5.67	378.86
-2	24	7.67	478.91	7.67	480.70
-3	24	6.33	540.11	6.67	538.40
-4	24	7.33	632.61	7.00	630.63
Control		4.33	318.76	4.33	279.54
L.S.D. at	0.05	0.88	43.99	1.31	58.96
	0.01	1.22	60.66	1.80	81.32

Meanwhile, for the total leaf area/plant its significant increase was obtained with -1°C level for 12 hour exposure time in 1998 season whereas the rest of treatments gave high significant increase in this parameter.

Of interest is that the total leaf area was increased parallely to the applied low temperature level despite the number of the formed leaves. Since, -2°C level of low temperature exhibited the greatest number of leaves in the two exposure time in 1998 and 1999 seasons whereas the greatest leaf area was obtained with –3 and -4°C levels in aseconding order.

The obtained data revealed that there is an intimate relation between the applied low temperature level and the leaf area parameter. Since, its value was parallely of increase with the applied temperature level. Also, this result might be attributed to the effect of low temperature upon the hormone levels. In addition, low temperature might has a specific effect on phytochrom synthesis and it could convert its forms ($P_r \leftrightarrow P_{fr}$). Recently the role of phytochrom regarding the full expansion of leaves was established (**Noggle** and **Fritz 1992** and **Mohr** and **Schopfer 1995**). Furthermore, this obvious increase of leaf area/plant could be highly affected the following stages of squash growth including flowering and fruiting ones as will be mentioned afterwords. In this respect, **El-Nagar (1996)** and **Ahmed (1997)** concluded that leaf area increases could be highly affected photosynthesis process and its efficiency as well.

4- Dry matter distribution:

The dry matter distribution i.e. partitioning and allocation of their different bioconstituents among roots, stems and leaves of

squash plants under the low temperature as a pre-sowing treatment are indicated in **Table (5)** and **Fig (4)** for 1998 season and **Table (6)** and **Fig (5)**for 1999 season. Data indicate that treatment by low temperature as a pre-sowing led to the accumulation of more dry matter in roots of treated plants to reach the high level of significance with different applied low temperature levels in case of the two exposure times in the two seasons under study. Also, the effect was nearly proportional to the applied level of low temperature.

As for the dry weight, in most cases dry matter was accumulated to reach either the 5% or 1% level of significance except with –1 and –2°C levels for the 24 hours period of exposure in which showed only insignificant increase of this parameter. Meanwhile, dry matter being allocated to be accumulated in leaves to reach the high level of significance when compared with the control. Exception, was only insignificant reduction that existed with –2°C for the 24 hours exposure. The accumulation of dry matter in different squash organs being reversed on the total dry weight/plant. Since, high significant values of this parameter were dominantly existed. Exception was only that insignificant increase of this parameter with -2°C at 24 hours exposure during 1998 season. Also, data in **Table (5)** showed that the percentage of dry matter distribution in different organs exhibited significant increase in roots while, significant reduction existed for stem with -4°C for the 12 hours exposure and insignificant reduction with -3°C for the 24 hours time. On the other hand, in case of leaves, significant

Table (5): Effect of low temperature as a pre-sowing treatment on dry matter partitioning and accumulation in different organs of squash (*Cucurbita pepo* L.) plants at 60 days after sowing during 1998 season.

Characters / Treatments		Root dry weight g/plant	Stem dry weight g/plant	Leaves dry weight g/plant	Total dry weight g/plant	% distribution of dry matter in different plant organs			Dry weight % related to the control	Root/ shoot ratio	Assimilation rate (g/cm^2)
Low temperature °C	Exposure duration (hours)					Roots	Stems	Leaves			
-1	12	0.30	0.25	1.65	2.20	13.77	11.20	75.03	114.79	0.16	4.43
-2	12	0.38	0.36	2.22	2.96	12.75	12.19	75.06	153.84	0.15	4.35
-3	12	0.41	0.39	2.28	3.08	13.37	12.63	74.00	160.60	0.16	4.20
-4	12	0.50	0.24	2.79	3.53	14.06	6.75	79.19	185.27	0.17	4.34
-1	24	0.27	0.21	2.29	2.77	9.84	7.69	82.47	144.67	0.11	6.04
-2	24	0.29	0.22	1.48	1.99	14.72	11.02	74.26	103.87	0.17	3.09
-3	24	0.47	0.25	2.01	2.73	17.26	9.06	73.68	141.86	0.21	3.72
-4	24	0.34	0.35	2.09	2.78	12.16	12.51	75.33	144.24	0.14	3.30
Control		0.21	0.19	1.52	1.92	11.11	9.89	79.00	100.00	0.12	4.73
L.S.D	0.05	0.04	0.03	0.07	0.11	1.10	0.99	1.77	5.20	0.02	0.41
	0.01	0.53	0.05	0.10	0.15	1.52	1.37	2.44	7.17	0.03	0.56

Table (6): Effect of low temperature as a pre-sowing treatment on dry matter partitioning and accumulation in different organs of squash (*Cucurbita pepo* L.) plants at 60 days after sowing during 1999 season.

Characters / Treatments		Root dry weight g/plant	Stem dry weight g/plant	Leaves dry weight g/plant	Total dry weight g/plant	% distribution of dry matter in different plant organs			Dry weight % related to the control	Root/ shoot ratio	Assimilation rate (g/cm^2)
Low temperature °C	Exposure duration (hours)					Roots	Stems	Leaves			
-1	12	0.28	0.23	1.61	2.12	13.24	10.72	76.04	115.80	0.15	4.38
-2	12	0.35	0.33	2.20	2.88	12.05	11.59	76.36	152.79	0.14	4.50
-3	12	0.37	0.36	2.27	3.00	12.42	12.12	75.46	159.52	0.14	4.20
-4	12	0.48	0.21	2.77	3.46	13.86	6.77	79.37	183.99	0.16	4.35
-1	24	0.28	0.19	2.27	2.71	8.81	7.02	83.17	143.80	0.10	5.99
-2	24	0.27	0.18	1.46	1.91	13.97	9.59	76.44	101.50	0.16	3.04
-3	24	0.45	0.21	1.98	2.64	17.03	8.06	74.91	140.59	0.21	3.69
-4	24	0.31	0.32	2.05	2.68	11.45	11.94	76.61	142.27	0.13	3.26
Control		0.20	0.18	1.51	1.89	10.44	9.55	80.01	100	0.12	5.51
L.S.D	0.05	0.02	0.03	0.09	0.10	1.65	1.00	1.72	5.43	0.01	0.81
	0.01	0.03	0.04	0.12	0.14	2.27	1.38	2.38	7.49	0.02	1.11

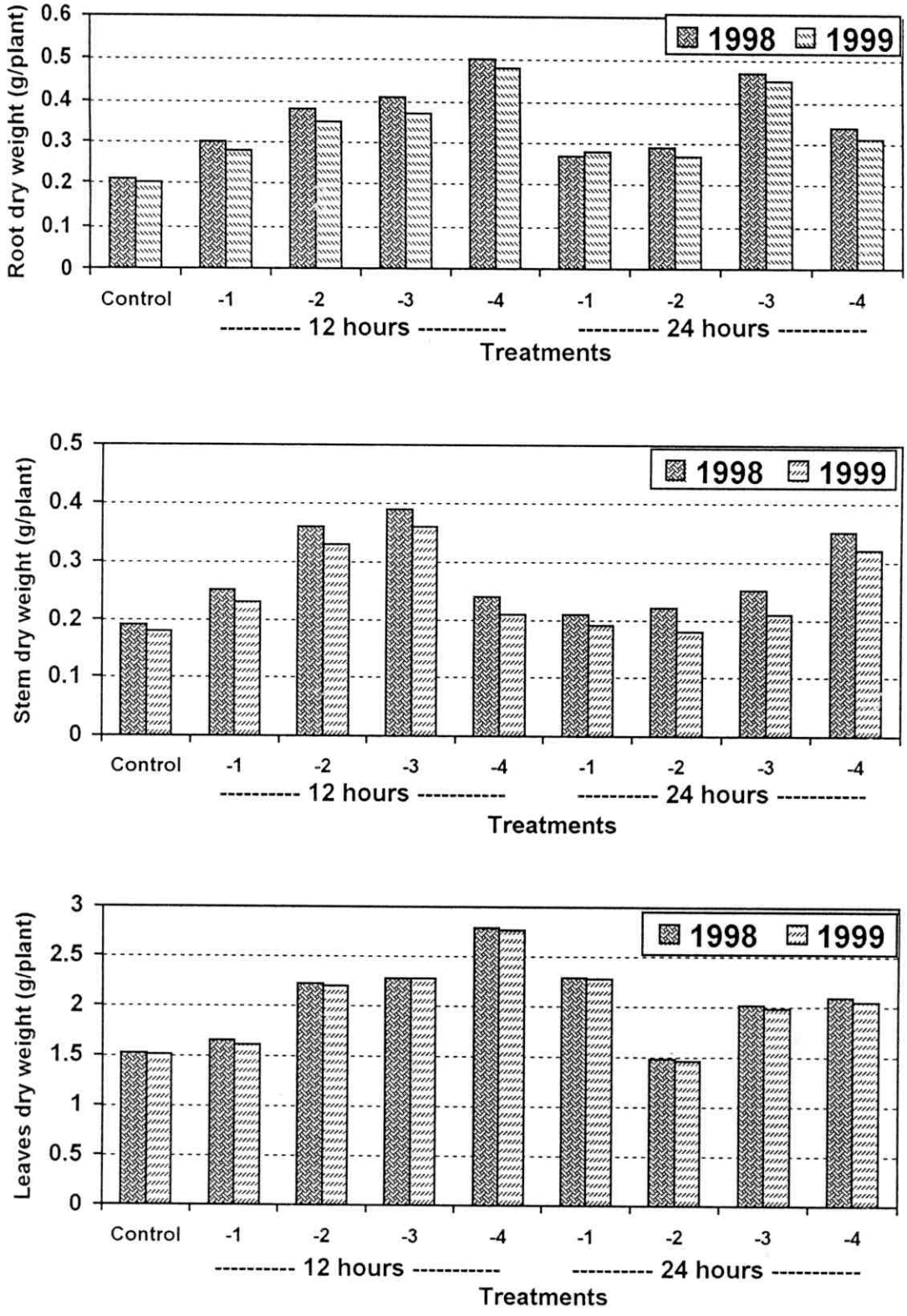

Fig.(4): Effect of low temperature as a pre-sowing treatments on roots, stems and leaves dry weight (g/plant) of squash (*Cucurbita pepo* L.) plants during 1998 and 1999 seasons.

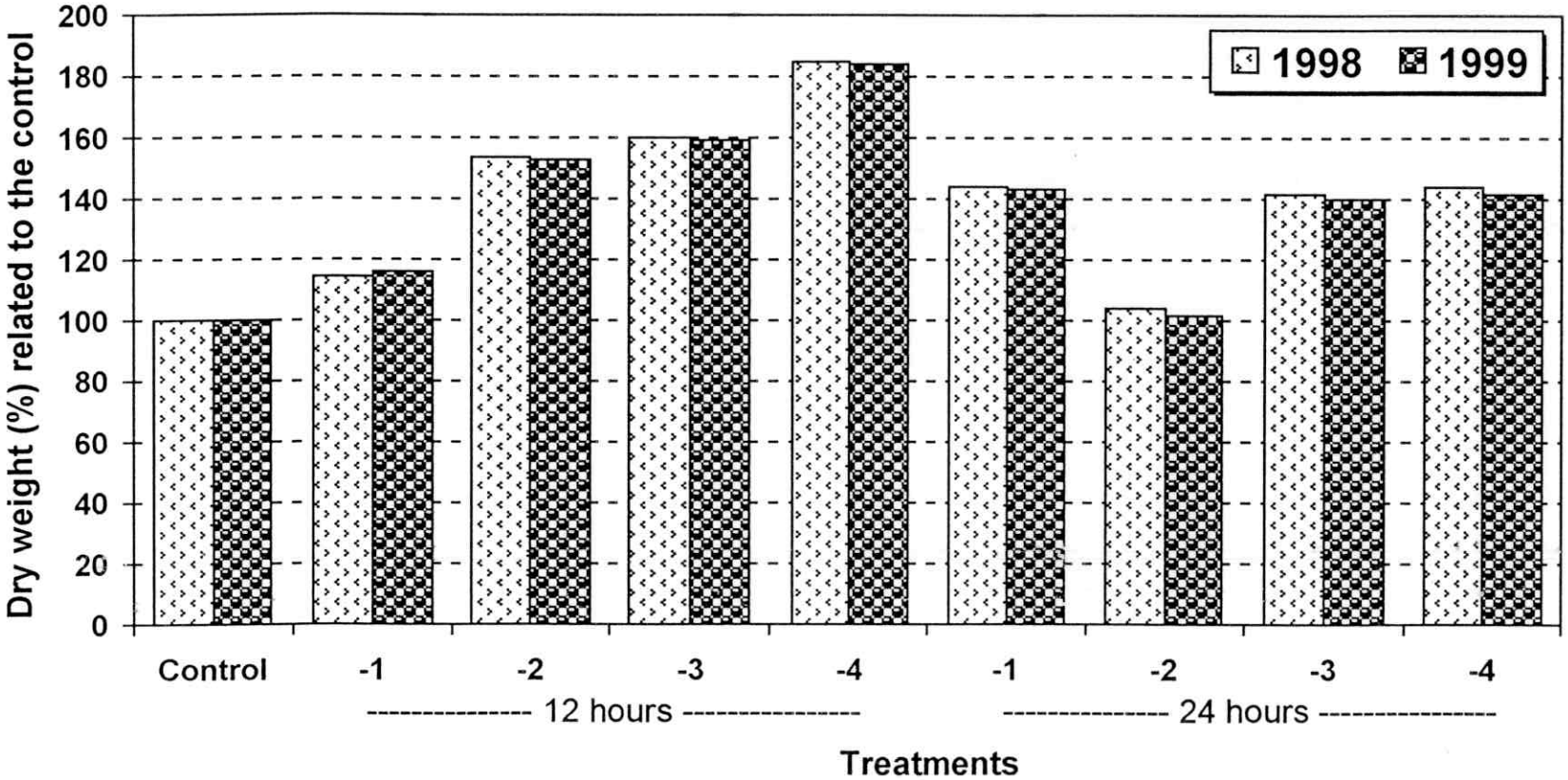

Fig. (5): Effect of low temperature as a pre-sowing treatments on dry weight (%) related to the control of squash (*Cucurbita pepo* L.) seeds during 1998 and 1999 seasons.

reduction in the percentages of their dry matter distribution in most cases existed. The only exception was that high significant increase with -1°C at 24 hours exposure period.

With regard to the root/shoot ratio, that obtained with different applied low temperature levels for the 12 hour exposure time; its high significant increase were existed as well as with -2°C and -3°C in case of the 24 hours exposure time. Meanwhile, for the 24 hours exposure times the -1°C showed insignificant reduction and insignificant increase with -4°C.

Concerning the assimilation rate that calculated for different treatments, the only -1°C for 24 hours exposure time showed its significant increase, yet the rest of treatments showed either its insignificant or significant reduction in most cases specially with 24 hours of exposure time.

Also, during 1999 season **Table (6)** and **Fig** (5) indicate that nearly squash plants similarly responded as in 1998 season.

As for the percentage of dry matter distribution in stems it was significantly increased with –2 and -3°C for the 12 hours exposure time and only with -4°C for the 24 hours of exposure time. While, other treatments showed either insignificant increase or even its significant reduction. Meanwhile, leaves were responded similarly as in the first season.

The dry weight percentages and the root/shoot ratios as well as the assimilation rates nearly behaved as in 1998 season. These results are in agreement with those obtained by **Fathy (1995), El-Nagar (1996)** and **Ahmed (1997)**.

In general, regarding the obtained results with different squash organs, during this stage of vegetative growth (i.e. the stage that ends with the first flower appearance) to some extend were different.

Despite of the significant increases in the amount of dry matter that being accumulated in leaves with most applied low temperature, their distribution percentages were significantly decreased compared with the control. That is because the control plants had the lowest total dry weight compared with different low temperature as a pre-sowing treated plants. Also, that could be partially attributed to the increment of dry matter accumulation in both roots and stems of treated plants compared with the control.

Moreover, of interest is that in most cases, the root/shoot ratio was significantly increased. That means more dry matter was directed to be accumulated in roots and hence vigorous root system accompanied with high efficiency of water, minerals and nutrients uptake being attained. This could be also, reversed on the further growth stages as will be mentioned afterwards.

Also, more beneficial effects of low temperature as a pre-sowing treatment upon the dry weight increment of squash plants could be excepted. Since, such treatments considerably increased the number of leaves and leaf area (**Table, 4**), increased chlorophyll a, b and carotenoids (**Table, 7**), highly increased N, P, K, Ca and Mg contents (**Table, 8**) and also increase in carbohydrates and sugar contents (**Table, 9**).

In addition, it has been reported that high levels of proteins and sugars formation in plant tissues are accompanied with the cold acclimation. Also, the enhancement of an enzymes group that are

2- Effect of the low temperature as a pre-sowing treatments on early fruit yield (as the first four pickings where considered):

Data in **Table (12)** and **Fig** (10) indicate that the low temperature as a pre-sowing treatments in all cases increased the number of early fruits per plant during the two seasons under study. This increase reached the two levels of significance with both –2 & -4°C for the 12 hrs exposure periods and with –2, -3 & -4°C for the 24 hrs exposure period in the two seasons. Meanwhile, it was reached the 5% level with -3°C and with -1°C for the 12 hrs and 24 hrs exposure periods, respectively. The insignificant increase only was existed with -1°C for the 12 hrs. exposure period in the two seasons and in the second season with the 24 hrs. exposure period.

With regard to the weight of early fruit yield/plant, and the early yield percentage, their values were increased to reach the two levels of significance with different low temperature levels and periods of exposure in the two seasons under study.

These results are of great economic importance, since they are completely verified the aim of the present study.

In this respect, other studies reported nearly similar effects of low temperature as a pre-sowing treatments upon the earlness of squash fruiting (**Zaghloul *et al.*, 1992; Fathy, 1995 and Ahmed, 1997**).

Also, of interest is that the obtained results upon early fruiting of squash plant affected by low temperature treatments intimately expressing reversion enhancement of squash growth during the first

leading to the activation of the plant metabolism. That, in turn, could stimulate plant growth and dry matter accumulation.

This interpretation is in agreement with the findings of **Gusta and Weiser (1972), James and Brown (1975) and Fathy (1995)**.

Furthermore, in this respect, **Olien and Smith (1981), Sennerby-Forsse and Fircks (1987) and Sutinen (1992)** reported that, the total dry matter content was increased due to a thickening of cell wall, lignification of xylem and accumulation of cryoprotectants in cells

5- Effect of low temperature as a pre-sowing treatment on the photosynthetic pigments:

Data in **Table** (7) and **Fig** (6) indicate that different photosynthetic pigments as chlorophyll a, b and caroteniods were positively responded to the low temperature as a pre- sowing treatment. Also, enhancement of photosynthetic pigments formation was in parallel to the applied low temperature level. The only exception was that with -2°C at the two assigned exposure periods since this level of low temperature exhibited the greatest photosynthetic pigments content.

As for the effect of low temperature on the photosynthetic pigments during 1999 season, it was nearly as the same as in the first season. Although, contents in the second season were slightly lower than in the first one. These differences could be attributed to variation in weather conditions between the two seasons. In this respect other studies reported that nearly similar results were reached regarding the effect of low temperature as a pre-sowing

Table (7): Effect of low temperature as a pre-sowing treatment on photosynthetic pigments of squash (*Cucurbita pepo* L.) plants at 60 days after sowing during 1998 and 1999 seasons (calculated as mg/g fresh weight).

Characters		1998					1999				
Treatments		Chlorophyll			Carot.	Chl.(a+b)/ Carot.	Chlorophyll			Carot.	Chl.(a+b)/ Carot.
Low temperature °C	Exposure duration (hours)	a	b	a + b			a	b	a + b		
-1	12	0.547	0.437	0.984	0.471	2.089	0.500	0.417	0.917	0.482	1.902
-2	12	0.761	0.461	1.222	0.664	1.840	0.750	0.398	1.148	0.673	1.706
-3	12	0.607	0.529	1.36	0.547	2.077	0.581	0.473	1.054	0.562	1.875
-4	12	0.686	0.573	1.259	0.578	2.178	0.705	0.546	1.251	0.572	2.187
-1	24	0.568	0.495	1.063	0.501	2.122	0.555	0.470	1.025	0.501	2.046
-2	24	0.810	0.584	1.394	0.658	2.119	0.807	0.560	1.367	0.656	2.084
-3	24	0.655	0.563	1.218	0.571	2.133	0.659	0.546	1.205	0.572	2.107
-4	24	0.727	0.622	1.349	0.635	2.124	0.696	0.576	1.272	0.646	1.969
Control		0.508	0.340	0.848	0.364	2.330	0.494	0.295	0.789	0.370	2.132

Chl. = Chlorophyll

Carot. = Caroteniods

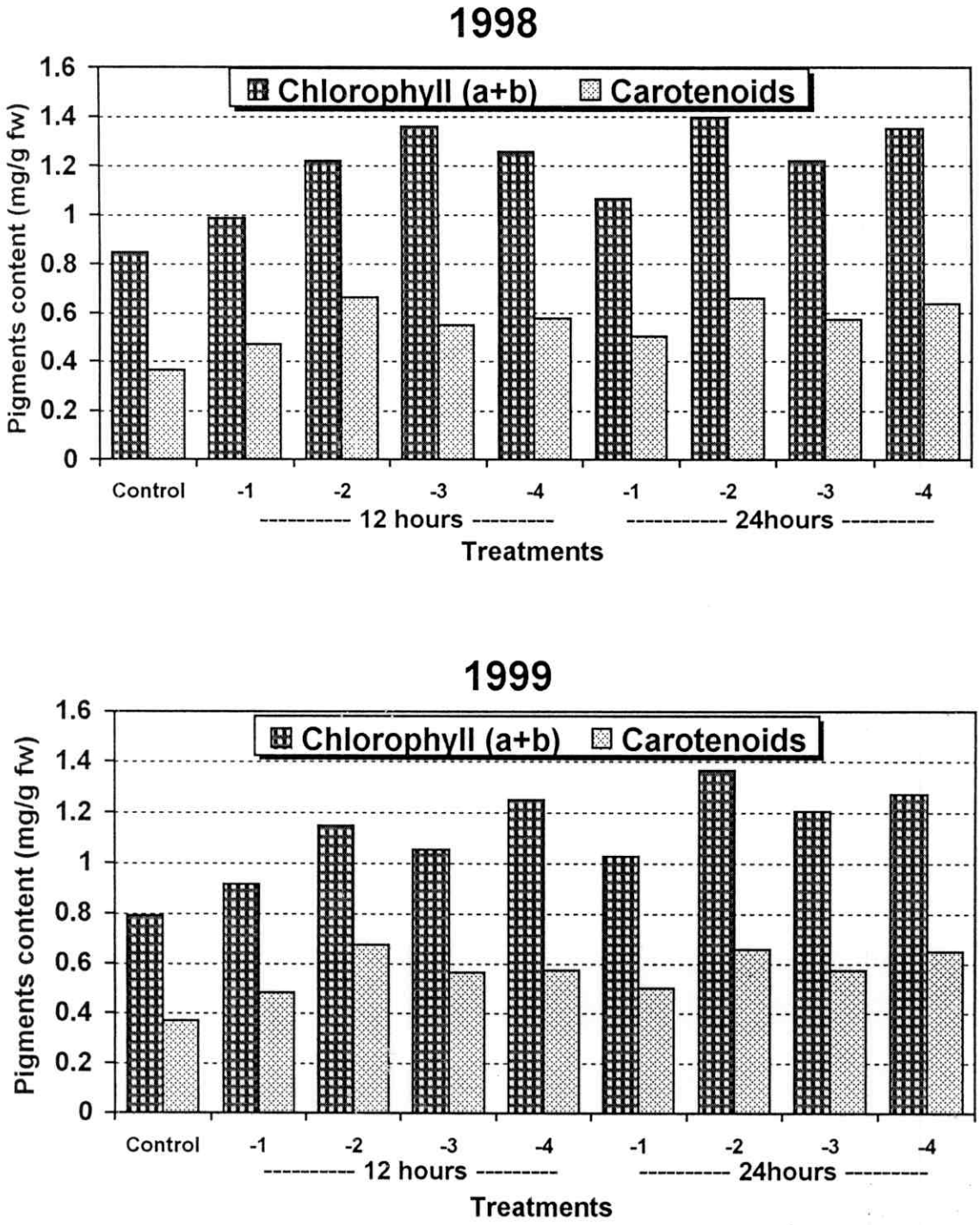

Fig. (6): Effect of low temperature as a pre-sowing treatments on chlorophyll (a+b) and carotenoids content (mg/g fresh weight) of squash (*Cucurbita pepo* L.) plants during 1998 and 1999 sesaons.

treatments either on the squash or other plants **Robert and Melon (1990), Tewari and Tripathy (1998) and Venema *et al.* (1999).**

In addition, stimulation of the photosynthetic pigments formation could be attributed to the vigorous growth that attained in different parameters under such treatments as previously mentioned. Also, this enhancement was prolonged to flowering and fruiting stages as will be mentioned afterwards.

III- Effect of low temperature as a pre-sowing treatments on some mineral contents and some bio-constituents of squash leaves:

1- Mineral contents:

Data in **Table (8)** and **Fig (7)** clearly indicate that, the dominant effect of the low temperature as a pre-sowing treatment either for 12 or 24 hrs. increased N, P, K, Ca and Mg contents as well as the calculated crude protein in leaves of treated plants.

These results are accompanied not only with the obtained data on the improvement of root growth but also with the vigour uptake of these minerals under such treatment. In this respect, **Fathy (1995), El-Nagar (1996) and Ahmed (1997)** reported nearly similar resulted on the stimulation of minerals uptake in squash or other plants treated by the low temperature as a seed pre-sowing treatment.

2- Some bioconstituents:

Data in **Table (9)** and **Figs** (8 and 9) indicate that total soluble solids (T. S. S.), Total sugars and the total carbohydrates positively responded to the treatments by the low temperature in leaves of squash plants during 1999 season. Also, it could be noticed that the

Table (8): Effect of low temperature as a pre-sowing treatment on mineral and crude protein content of squash (*Cucurbita pepo* L.) leaves at 60 days after sowing during 1999 season.

Characters / Treatments		N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Total elements (%)	crude protein (%)
Low temperature °C	Exposure duration (hours)							
-1	12	4.93	0.250	2.78	3.50	1.20	12.660	30.81
-2	12	3.63	0.397	2.85	4.50	2.16	13.537	22.69
-3	12	2.63	0.258	2.69	3.90	1.80	11.278	16.44
-4	12	3.17	0.290	2.61	4.00	1.50	11.570	19.81
-1	24	4.11	0.292	2.65	4.10	1.32	12.472	25.69
-2	24	3.67	0.372	2.93	4.80	2.04	13.812	22.94
-3	24	3.97	0.265	2.73	4.60	1.74	13.305	24.81
-4	24	3.35	0.282	2.77	4.20	1.38	11.982	20.94
Control		2.57	0.224	2.57	2.90	1.17	9.434	16.06

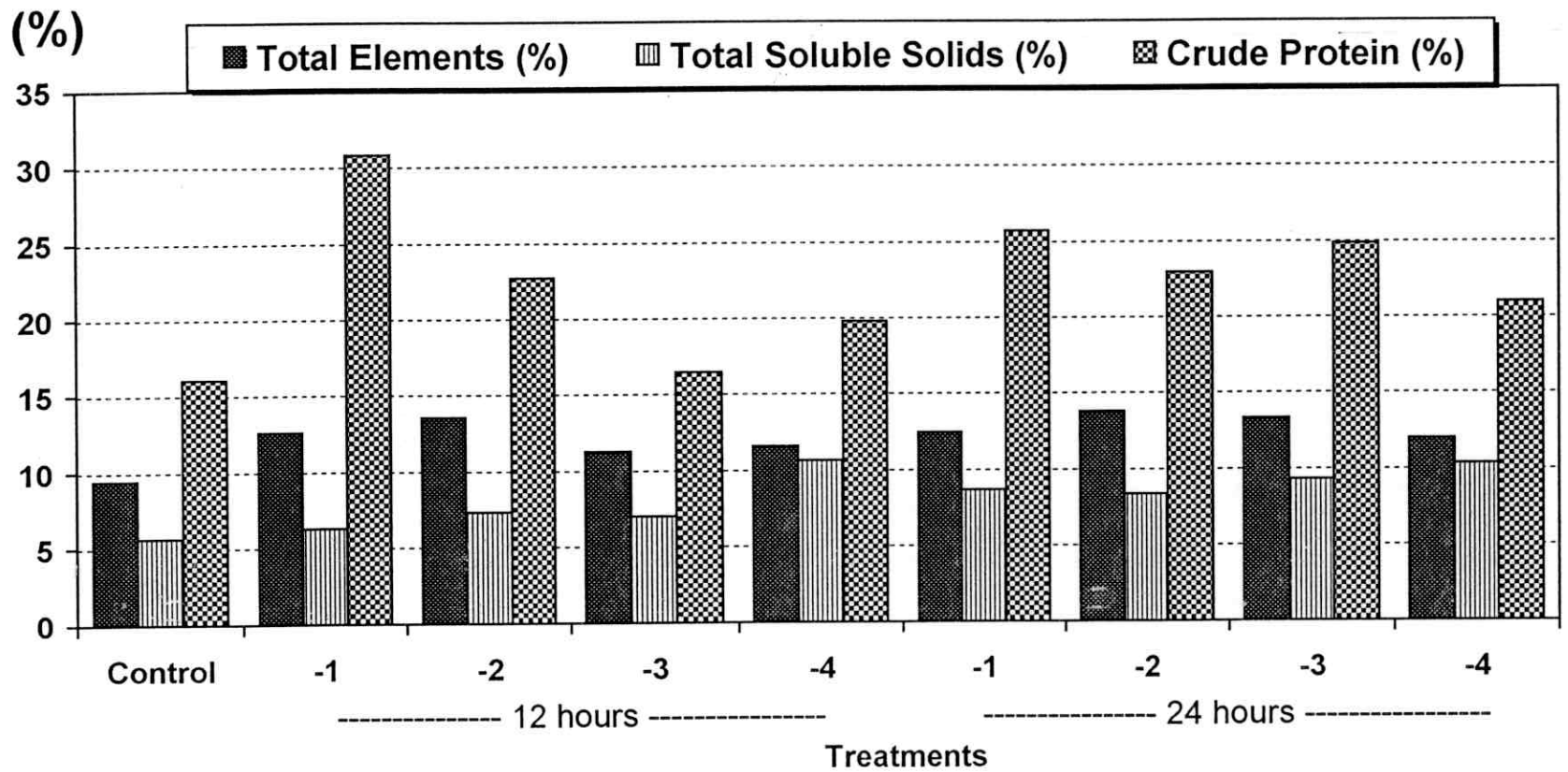

Fig. (7): Effect of low temperature as a pre-sowing treatments on percentages of total elements, total soluble solids and crude protein contents of squash (*Cucurbita pepo* L.) leaves during 1999 season.

Table (9): Effect of low temperature as a pre-sowing treatment on sugars, carbohydrates and total soluble solids contents of squash (*Cucurbita pepo* L.) leaves at 60 days after sowing during 1999 season.

Characters / Treatments		Reducing sugars mg/g. f.w.	Non-reducing sugars mg/g. f.w.	Total sugars mg/g. f.w.	Total carbohydrates mg/g. D.W.	Total soluble solids (%)
Low temperature °C	Exposure duration (hours)					
-1	12	9.58	6.55	16.13	479.29	6.33
-2	12	12.67	10.66	23.33	618.40	7.33
-3	12	6.84	5.90	12.74	584.50	7.00
-4	12	10.44	6.41	16.85	654.64	10.67
-1	24	8.64	6.27	14.91	493.90	8.67
-2	24	12.02	8.14	20.16	618.99	8.33
-3	24	7.56	6.26	13.82	590.35	9.33
-4	24	8.93	7.34	16.27	660.49	10.33
Control		5.47	2.45	7.92	467.60	5.67

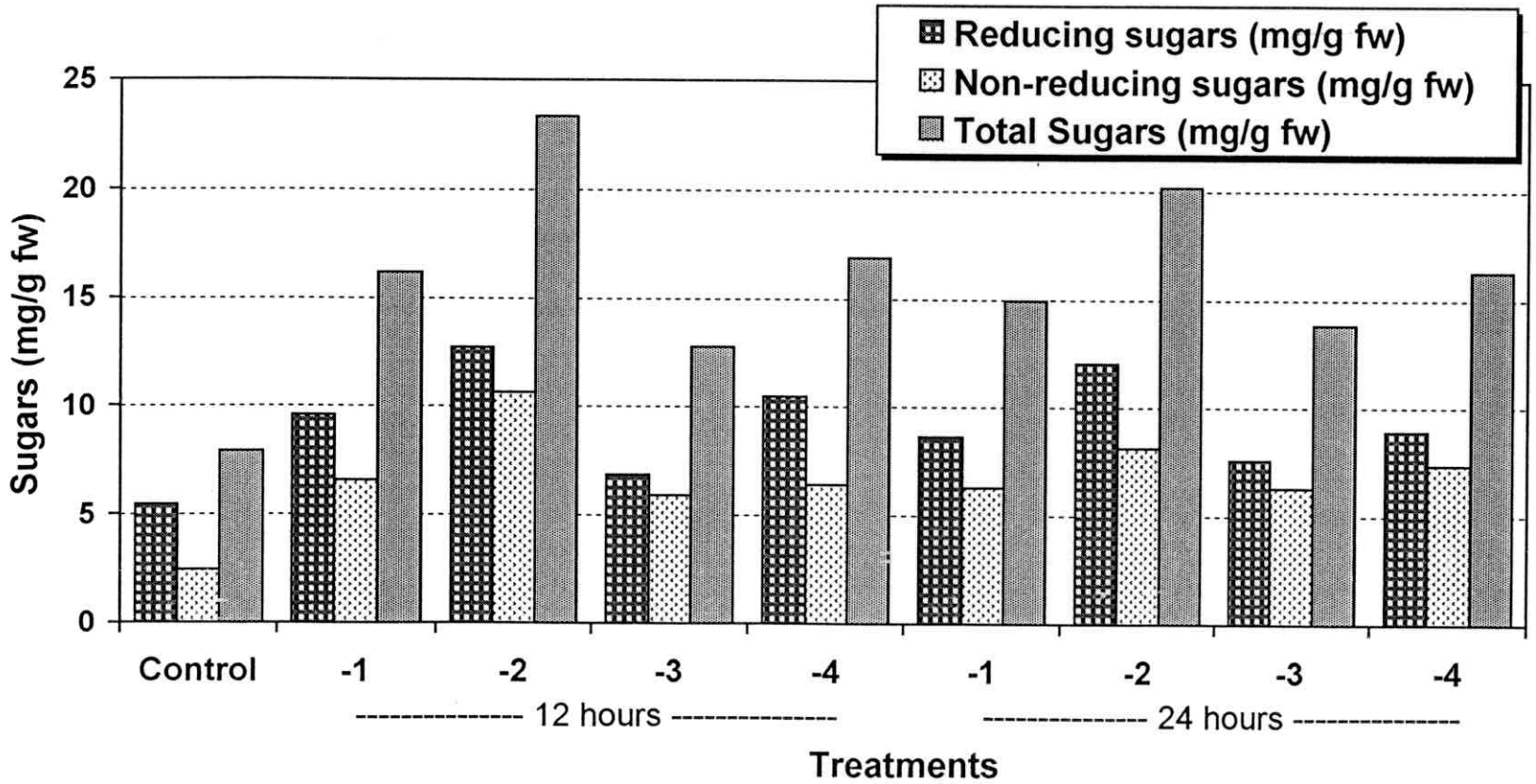

Fig. (8): Effect of low temperature as a pre-sowing treatments on reducing, non-reducing and total sugars content (mg/g fresh weight) of squash (*Cucurbita pepo* L.) leaves during 1999 season

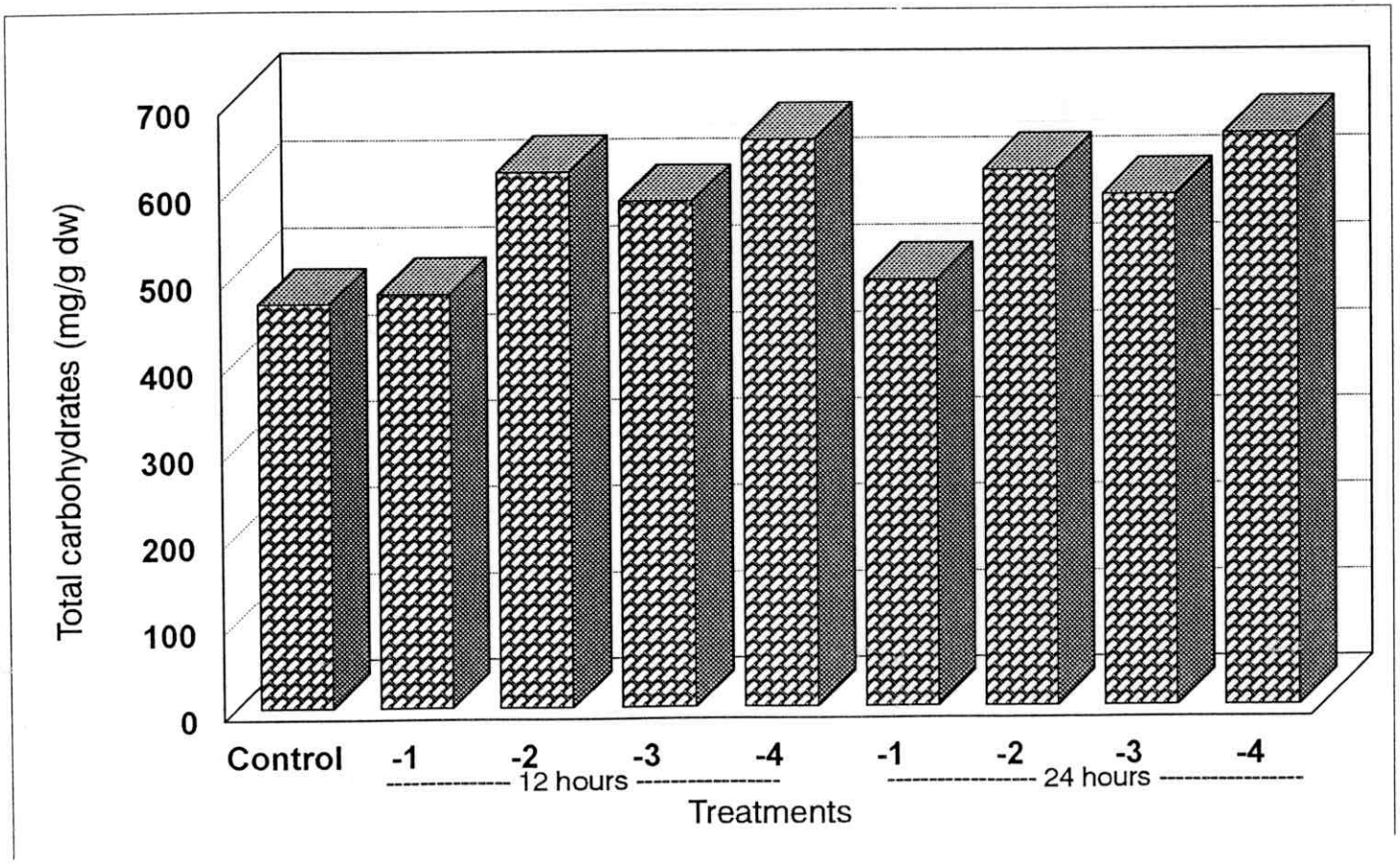

Fig. (9): Effect of low temperature as a pre-sowing treatments on total carbohydrates content (mg/g dry weight) of squash (*Cucurbita pepo* L.) leaves during 1999 season.

Table (10): Effect of low temperature as a pre-sowing treatment on nitrate reductase activity (NRA) and nitrate-nitrogen content of squash (*Cucurbita pepo* L.) leaves at 60 days after sowing during 1999 season.

Characters / Treatments		Nitrate reductase activity (NRA) $\mu g\ No_2/g^{-1}\ f.w./h^{-1}$	Nitrate-nitrogen No_3-N (%)
Low temperature °C	Exposure duration (hours)		
-1	12	1.050	0.668
-2	12	0. 950	0.762
-3	12	0.720	0.548
-4	12	0.930	0.962
-1	24	0.810	1.130
-2	24	0.750	1.362
-3	24	0.690	1.501
-4	24	0.580	1.603
Control		0.540	1.403

-2°C level was more pronounced either when applied for 12 or 24 hrs. as a pre-sowing treatments. Moreover, increment of the total sugars as well as total carbohydrates in squash leaves is of great significance. Since, these bioconstituents strongly referred to the amount of photosynthates that either in ready form for translocation throw out the leaves (non-reducing sugars) or that function as temporary storage to support supply of photosynthates during dark hours and compensate the dilemma of photosynthesis (**Hopkins, 1995**).

The previous mentioned results could be of a great importance as the economic view be considered.

3- Nitrate reductase activity and nitrate-nitrogen content:

Data in **Table (10)** clearly indicate that the nitrate reductase activity (NRA)either at 12 hrs or 24 hrs of exposure time at different low temperature levels were increased. Also, the treatment of 12 hrs exposure period was more pronounced in this respect.

On the other hand, nitrate-nitrogen percentages were in contrast with that obtained with the enzyme activities. Since, the reduction of nitrate nitrogen level was obtained in the 12 hrs exposure period of the low temperature as a pre-sowing treatments.

IV- Squash productivity:

1- Effect of low temperature as a pre-sowing treatments on flowering:

Data in **Table (11)** indicate the effect of low temperature as a pre-sowing treatments at –1, -2, -3 and –4°C levels for the two exposure periods of 12 and 24 hours during 1998 and 1999 seasons.

Table (11): Effect of low temperature as a pre-sowing treatment on flowering and sex expression of squash (*Cucurbita pepo* L.) plants during 1998 and 1999 seasons.

Characters / Treatments		1998				1999			
		No. of flowers/plant			Flowering longevity (days)	No. of flowers/plant			Flowering longevity (days)
Low temperature °C	Exposure duration (hours)	male ♂	female ♀	♂/ ♀ ratio		male ♂	female ♀	♂/ ♀ ratio	
-1	12	26.60	20.20	1.32	48.60	26.20	20.00	1.31	48.40
-2	12	21.80	21.60	1.01	46.60	21.20	21.20	1.00	46.40
-3	12	28.40	23.20	1.22	48.20	28.00	22.80	1.23	48.00
-4	12	28.60	23.40	1.22	47.60	28.20	23.20	1.22	47.40
-1	24	26.40	26.80	0.98	48.00	26.00	26.40	0.99	47.80
-2	24	21.00	27.80	0.75	46.20	20.60	27.60	0.74	46.00
-3	24	23.60	21.80	1.08	47.00	23.20	21.80	1.06	46.00
-4	24	24.80	22.60	1.10	47.60	24.40	22.40	1.09	47.20
Control		52.80	17.60	3.00	58.00	52.20	17.40	3.00	57.40
L.S.D	0.05	4.46	4.24	0.13	4.26	4.96	4.48	0.13	1.87
	0.01	5.98	5.71	0.18	5.74	6.67	6.03	0.17	2.52

The total number of formed flowers per plant was significantly decreased by different low temperature treatments in the two seasons under study. Also, it could be noticed that this significant reduction in flowers number per plant under low temperature treatments is mainly due to the reduction in male flowers compared with the control. Since, the greatest number of male flowers was 28.6 per plant at -4°C for the 12 hrs exposure time at 1998 season, yet it rose to 52.8 for the control plants.

On the other hand, the number of female flowers in case of low temperature treatments was completely in contrast with the number of the male ones. Since, this number was either insignificantly or significantly increased with the low temperature treatments compared with the control. That means the low temperature treatments of -1 up to -4°C either for the 12 or 24 hrs exposure period increased the number of female flowers in the two assigned seasons. That is of high economic values as these female flowers form the fruits afterwards.

In addition, under the efficient supply of minerals by roots and photosynthates by leaves; fruits yield of squash plants could be more promising. Moreover, under these conditions cultivation of squash plant during winter and the early summer months could be accepted by both growers and consumers. Despite, the flowering longevity (i.e. range of time for picking fruits) were significantly decreased with different low temperature as a pre-sowing treatments. But for the wide flowering longevity in control plants (i.e. plant grown up from low temperature-untreated seeds); experimentally was

attributed to the tendency of this plant to from male flowers and not female ones.

In this respect other studies have been also reported that flowering of squash and some other plants were positively affected with the low temperature as a pre-sowing treatments. Of these are **Shih and Jung (1971); Hess (1981) and Gabal (1990)** who attributed this stimulatory effect of low temperature upon flowers formation to the conditions of cold induction of genes involves in flower formation, thereby, the synthesis of RNA and protein and hence differentiation of flowers being attained.

In addition, this effect may be correlated with the existed vigorous growth of squash plants under the low temperature treatments through the alteration of phytohormones profile and for providing well supply of both minerals and photosynthates. This interpretation could be more acceptable when the obtained results are considered. Since, in this respect flowering process (including sex ratio) has been recommended to be genetically controlled despite that many studies have been carried out trying to alter sex expression of *Cucurbitaceae* plants by using exogenous application of growth substances and/or different fertilizers (**Longo *et al.*, 1982 and Ibrahim *et al.*, 1985 and 1986**).

In general femaleness is promoted by auxins and cytokinins while, maleness by gibbereillic and absicsic acids (**Schenider *et al.*, 1977**). Therefore, increase of femaleness of squash plant may be initiated with the sufficient supply of mineral and/or alteration of the endogenous phytohormones profile.

2- Effect of the low temperature as a pre-sowing treatments on early fruit yield (as the first four pickings where considered):

Data in **Table (12)** and **Fig** (10) indicate that the low temperature as a pre-sowing treatments in all cases increased the number of early fruits per plant during the two seasons under study. This increase reached the two levels of significance with both –2 & -4°C for the 12 hrs exposure periods and with –2, -3 & -4°C for the 24 hrs exposure period in the two seasons. Meanwhile, it was reached the 5% level with -3°C and with -1°C for the 12 hrs and 24 hrs exposure periods, respectively. The insignificant increase only was existed with -1°C for the 12 hrs. exposure period in the two seasons and in the second season with the 24 hrs. exposure period.

With regard to the weight of early fruit yield/plant, and the early yield percentage, their values were increased to reach the two levels of significance with different low temperature levels and periods of exposure in the two seasons under study.

These results are of great economic importance, since they are completely verified the aim of the present study.

In this respect, other studies reported nearly similar effects of low temperature as a pre-sowing treatments upon the earlness of squash fruiting (**Zaghloul *et al.*, 1992; Fathy, 1995 and Ahmed, 1997**).

Also, of interest is that the obtained results upon early fruiting of squash plant affected by low temperature treatments intimately expressing reversion enhancement of squash growth during the first

Table (12): Effect of low temperature as a pre-sowing treatment on early yield as the first four pickings of squash (*Cucurbita pepo* L.) plants during 1998 and 1999 seasons.

Characters / Treatments		1998			1999		
Low temperature °C	Exposure duration (hours)	Early fruits No./plant	Early yield (g)/ plant	Early yield (%)	Early fruits No./plant	Early yield (g)/ plant	Early yield (%)
-1	12	2.13	143.13	7.72	2.00	142.26	7.66
-2	12	3.50	206.98	9.76	3.25	204.44	9.70
-3	12	2.63	170.40	8.55	2.50	168.31	8.56
-4	12	3.25	184.89	9.10	3.00	181.53	8.97
-1	24	2.50	154.69	7.37	2.25	152.10	7.41
-2	24	4.00	291.54	11.65	3.50	289.58	11.63
-3	24	3.00	176.18	8.50	2.75	174.41	8.40
-4	24	3.38	192.86	8.33	3.25	191.88	8.33
Control		1.75	102.91	7.02	1.50	102.58	7.03
L.S.D	0.05	0.75	2.87	0.22	0.89	3.08	0.20
	0.01	1.01	3.95	0.31	1.20	4.24	0.28

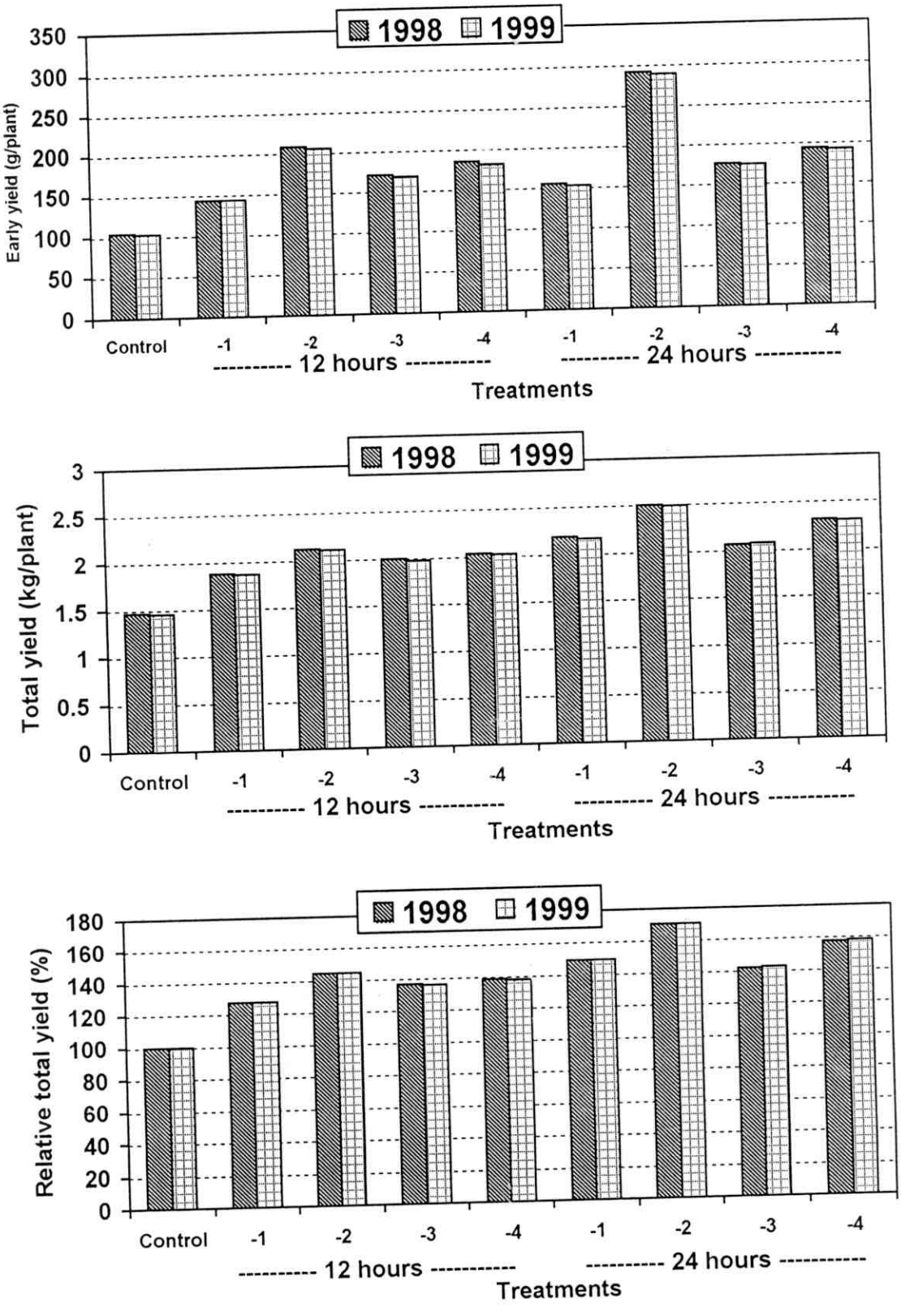

Fig. (10): Effect of low temperature as a pre-sowing treatments on early yield (g/plant), total yield (kg/plant) and relative total yield (%) of squash (*Cucurbita pepo* L.) plants during 1998 and 1999 seasons.

stage of growth under the low temperature that usually are prevailing during early time of normal squash cultivation.

3- Effect of the low temperature as a pre-sowing treatments on fruit yield of squash plants:

Data in **Table (13)** and **Fig** (10) indicate that, during 1998 and 1999 seasons and with the two assigned exposure periods, different applied low temperature (-1 up to –4°C) exhibited high significant increases of the following: total fruits number/plant, total fruit yield/plant, and the calculated relative total yield percentages (i.e. % to the control). Exception was that significant of the total yield/plant at the 5% level of significance with -1°C for the 12 hrs. exposure period only at 1999 season.

Regarding the above mentioned data it could be concluded that low temperature enhanced the early vegetative growth of squash plants **Tables** (3 to 6), that also was reversed upon the data of flowers appearance and the number of female flowers as well. Then all of these where reflected on the number of fruits **Table** (13).

Also, of interest is that the ultimate fruit yield of squash plants under the low temperature treatments reached to 170.74 & 170.58 and 157.32 & 157.80% of the control with –2 and -4°C for the 24 hrs period of exposure in 1999 season. Regarding this significant increase of yield in addition to its earliness yield; all of these advantages favour the low temperature treatments to be recommended as an important and effective agriculture practice for squash cultivation.

Table (13): Effect of low temperature as a pre-sowing treatment on the total fruit yield of squash (*Cucurbita pepo* L.) plants during 1998 and 1999 seasons.

Characters / Treatments		1998			1999		
Low temperature °C	Exposure duration (hours)	Total fruits No./plant	Total yield (kg) / plant	Relative total yield (%)	Total fruits No./plant	Total yield (kg) / plant	Relative total yield (%)
-1	12	12.63	1.87	127.39	12.50	1.86	127.18
-2	12	16.75	2.12	144.60	16.50	2.11	144.62
-3	12	13.88	2.00	136.16	13.75	1.98	135.72
-4	12	15.50	2.03	138.68	15.25	2.02	137.90
-1	24	14.13	2.19	149.11	14.00	2.17	148.64
-2	24	18.75	2.50	170.74	18.50	2.49	170.58
-3	24	14.75	2.07	141.40	14.50	2.08	142.26
-4	24	16.38	2.31	157.32	16.25	2.30	157.80
Control		10.75	1.47	100	10.50	1.46	100
L.S.D	0.05	1.09	0.03	2.02	0.92	0.03	2.35
	0.01	1.47	0.04	2.79	1.25	0.04	3.24

Also, in this respect other studies dealt with the effect of low temperature upon growth, flowering and productivity of squash or some other plants (**Abdalla *et. al.*, 1983; Gabal, 1990; El-Nagar, 1996 and Ahmed, 1997**).

4- Effect of the low temperature as a pre-sowing treatments on the biological and economical yields of squash plants:

The main important results of the present study was that related with the partitioning of dry matter among different plant organs. Since, as indicate in **Table** (14) and **Fig** (11 & 12) results regarding the total dry matter accumulation of squash plants are presented and expressed by the two useful terms those used to describe partitioning of dry matter by the plant i.e., the biological yield and economic yield. Here, the term biological yield is represented the total dry matter being accumulated in the plant system i.e. in roots, shoots and fruits. While, economic yield (i.e., agricultural yield or harvestable yield) have been used to refer to the weight of fruits that constitute the product of economic or agricultural value. Also, the proportion of biological yield represented by economic yield has been called the ***harvest index***, the coefficient of effectiveness, or the migration coefficient.

As indicated in **Table** (14) both the two periods (i.e., 12 and 24 hours) with the four applied low temperature levels (-1, -2,-3 and –4°C) increased the economical and biological yields during the two seasons of the present study. Also, it could be noticed that, increment of the two yields reached the two levels of significance in the two seasons.

Table (14): Effect of low temperature as a pre-sowing treatment on biological and economical yields as well as the harvest index of squash (*Cucurbita pepo* L.) plants during 1998 and 1999 seasons.

Characters / Treatments		1998			1999		
Low temperature °C	Exposure duration (hours)	Economical yield (g)	Biological yield (g)	Harvest index (%)	Economical yield (g)	Biological yield (g)	Harvest index (%)
-1	12	132.63	150.45	88.16	137.20	154.26	88.96
-2	12	166.87	181.31	91.98	166.47	180.50	92.23
-3	12	156.99	170.09	92.32	158.88	171.44	92.68
-4	12	141.44	160.87	89.79	144.39	160.30	90.07
-1	24	159.87	180.39	88.67	163.09	183.40	88.93
-2	24	159.59	173.35	92.07	155.84	169.43	91.98
-3	24	154.05	177.78	86.65	160.90	183.99	87.45
-4	24	159.43	175.54	90.83	167.02	182.61	91.48
Control		105.17	119.59	87.95	103.42	117.16	88.29
L.S.D	0.05	5.10	4.81	1.26	2.36	4.40	1.47
	0.01	7.04	6.64	1.74	3.25	6.06	2.03

* The biological yield included roots weight because the facility obtaining these values in case of pots sowing.

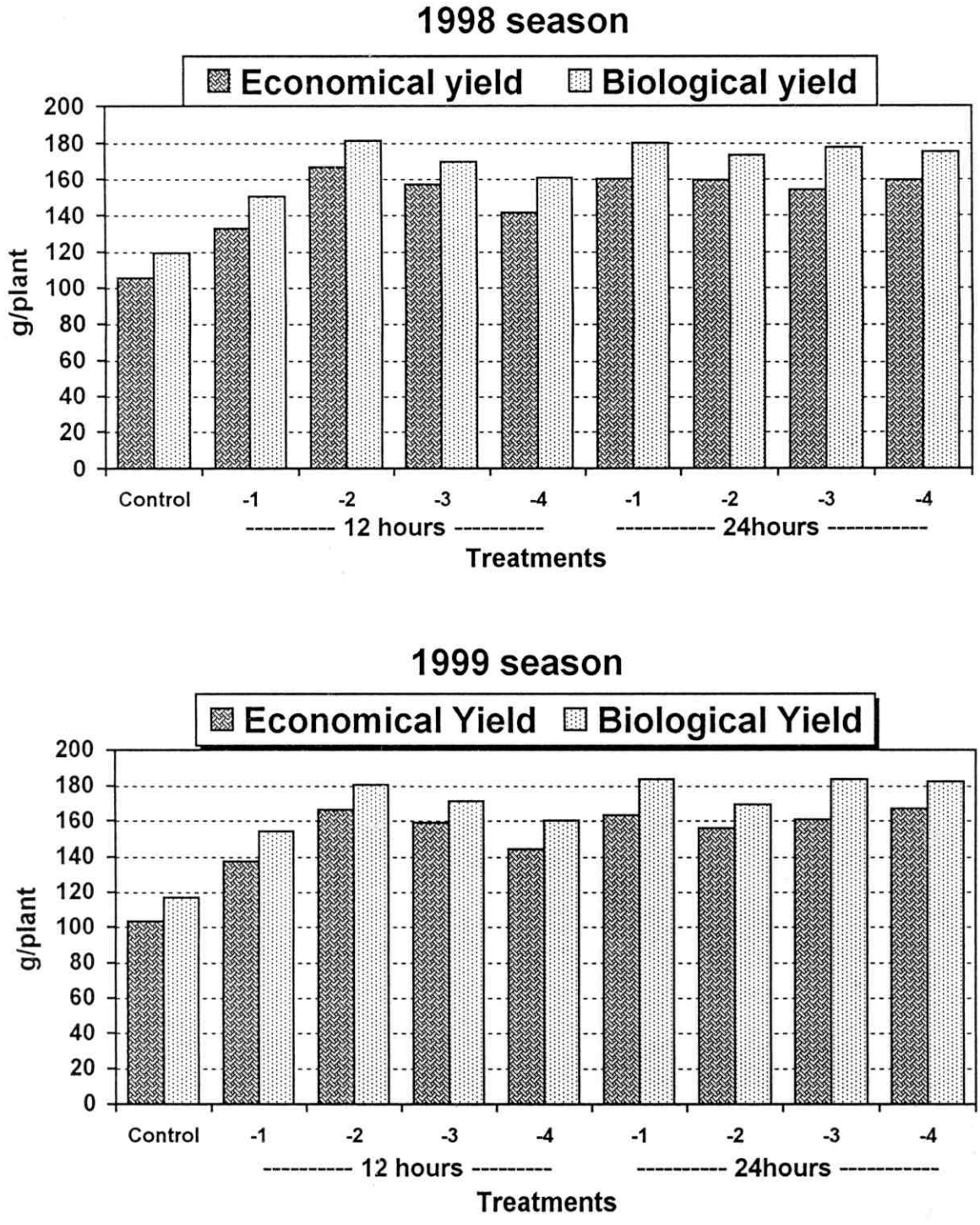

Fig. (11): Effect of low temperature as a pre-sowing treatments on economical and biological yield (g/plant) of squash (*Cucurbita pepo* L.) plants during 1998 and 1999 seasons.

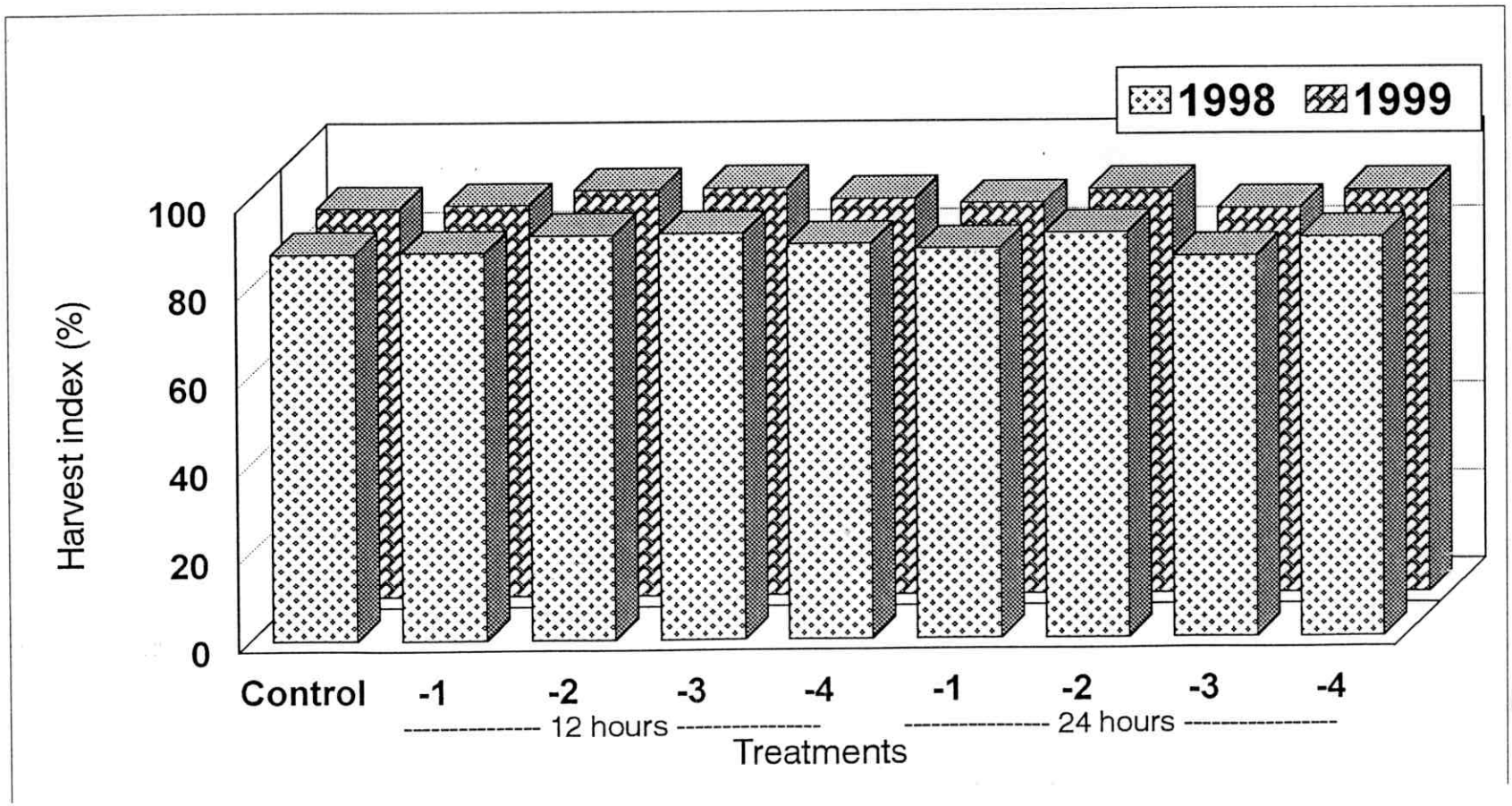

Fig. (12): Effect of low temperature as a pre-sowing treatments on harvest index (%) of squash (*Cucurbita pepo* L.) plants during 1998 and 1999 seasons.

These results clearly indicate that low temperature as a pre-sowing treatments led to enhance the vegetative growth as well as fruiting as well.

Here, since the crop yield can be increased either by increasing the total dry matter produced in the field or by increasing the proportion of economic yield (the harvest index) or both (**Gardener *et al.*, 1985; Hopkins, 1995** and **Hendrix, 1995**). Also, regarding the results of the present study it could be noticed that, there is a potential for increasing yields by both methods.

In this respect there are many studies have been carried out on different environmental factors such as temperature, light and nutrients which influence in both partitioning of assimilate and productivity (**Miceli *et al.*, 1995** and **Abbate, *et al.*, 1998**).

With regard to ***harvest index*** it could be noticed that the 12 hours of exposure time with the four low temperature levels increased its value in the two seasons under study. This increase was significant only with -1°C of low temperature level in the two seasons. While, other low temperature levels increased it to reach the 1% level of significance in most cases.

On the other hand, with the 24 hours exposure time the -1°C insignificantly increase it and –2 and -4°C showed its significant increase yet -3°C insignificantly reduced it in the two seasons of the present study.

In general the present study clearly revealed that the low temperature as a pre-sowing treatment of its four levels (-1, -2, -3 & -4°C) the only for 24 hours exposure time could be practically of a

great importance. Since, these treatments specially –2 and -3°C exhibited nearly the highest values of economical and biologically yields as well as their harvest index. These values for the economical yield, biological yield and harvest index were 166.87, 181.31 & 91.98 and 166.47, 180.5 & 92.23 with -2°C in 1998 and 1999 seasons, respectively. Also, these values were 156.99, 170.09 & 92.32 and 158.88, 171.44 & 92.68 with -3°C in the same order.

These results also, could be considered as a complete reversion of growth enhancement that obtained with such low temperature treatments upon germination capacity (**Table, 2**), vegetative growth (**Tables, 3 to 10**) and flowering as well as fruiting **Tables (11 to 13)** of plants grown up from treated seeds. Also, low temperature treatments that increased the total yield of squash plants where extended to improve many characteristics of squash fruit quality (**Tables, 15 to 18**).

V- Fruit quality:

1- Effect of the low temperature as a pre-sowing seeds treatment on fruit characters:

Data in **Table (15)** indicate that, the mean fruit fresh weight insignificantly increased with different applied low temperatures for the two exposure periods during 1998 and 1999 seasons.

As for the mean of fruit dry weight, their values were increased during 1998 and 1999 seasons to reach the 5% level of significance with –2 and -4°C and with –3 and -4°C for 12 hrs and 24 hrs of exposure periods, respectively. Meanwhile, its insignificant

increase was existed with–1 & -3°C and with –1 & -2°C for 12 hrs and 24 hrs exposure period, respectively.

On the other hand, the increase did not reach the 1% level of significance with any of the low temperature treatments in the two seasons under study.

With regard to the fruit dimensions as indicated by fruit length and diameter could be noticed that different low temperature treatments increased the mean fruit length to reach the 1% level of significance during the two seasons under study. But for the mean fruit diameter was insignificantly increased in most low temperature treatments during the two seasons of the present study.

The only exception was that insignificant reduction existed with -1°C for the 24 hrs exposure period in the two seasons and with -1°C for 12 hrs exposure period only in 1999 season. These two measurements (i.e. fruit length and diameter) were reflected on fruit shape index. Since, increment of fruit length more than that of fruit diameter led to -in most cases - significant increase of the fruit shape index.

Considering the previous mentioned data regarding the weight of fresh and dry fruit as well as fruit length and diameter it could be concluded that under the low temperature treatments all of these parameters were stimulated. Since, these data revealed that the fruit growth under the low temperature treatments were highly stimulated. Hence, fruits could be picked at shorter time than that needed for control plants. Also, these data could be related and explained with the early fruit yield that excepted with the low temperature treatment (**Table, 12**).

Table (15): Effect of low temperature as a pre-sowing treatment on fruit characteristics of squash (*Cucurbita pepo* L.) plants during 1998 and 1999 seasons.

Characters		1998					1999				
Treatments		Fruit		Fruit dimensions		Fruit shape index L/D	Fruit		Fruit dimensions		Fruit shape index L/D
Low temperature °C	Exposure duration (hours)	Fresh weight (g)	Dry weight (g)	Length (cm)	Diameter (cm)		Fresh weight (g)	Dry weight (g)	Length (cm)	Diameter (cm)	
-1	12	68.10	4.83	11.25	2.87	3.92	67.80	5.01	11.15	2.83	3.94
-2	12	67.97	5.35	11.30	2.93	3.86	67.96	5.37	11.40	2.90	3.93
-3	12	58.48	4.53	11.05	2.82	3.92	57.85	4.65	10.98	2.80	3.84
-4	12	74.33	5.28	11.70	3.03	3.86	74.13	5.29	11.55	3.00	3.85
-1	24	64.97	4.75	11.45	2.70	4.24	66.13	4.97	11.25	2.71	4.15
-2	24	72.94	4.65	11.90	2.93	4.06	72.70	4.55	11.70	2.94	3.98
-3	24	78.87	5.86	11.65	2.92	3.99	78.86	6.11	11.60	2.95	3.93
-4	24	77.26	5.34	11.55	2.94	3.93	76.95	5.58	11.45	2.93	3.91
Control		58.43	4.19	9.90	2.87	3.45	57.88	4.10	9.75	2.86	3.41
L.S.D	0.05	N.S	0.99	0.83	N.S	0.34	N.S	1.08	0.91	N.S	0.41
	0.01	N.S	N.S	1.10	N.S	0.45	N.S	N.S	1.20	N.S	N.S

Furthermore, these data could be a prolongation and as ultimate results of the previous obtained enhancement of different growth and productivity characters.

In this respect others studies also reported similar positive effects of the pre-sowing low temperature treatment on the improvement of squash fruits quality (**Gabal, 1990; El-Nagar, 1991 and *Mohamed*, 1995**).

2- Effect of the low temperature as a pre-sowing seeds treatment on minerals and total carbohydrates in fruits of squash plants:

Data in **Table (16)** clearly indicate that, different low temperatures as a pre-sowing seed treatments in the two assigned exposure period during 1999 season increased all the determined elements and total carbohydrates as well.

This increment of either elements or total carbohydrates were existed in different pickings periods during the whole fruit production time.

Since, different pickings were considered as early (from the first to the fourth), medium (from the fifth to the eight) and the late (from the ninth to the end) pickings.

Of interest is that the total carbohydrate contents in the fruits were increased with the low temperature treatments. This could be indicated by improvement the squash growth during the growing seasons. Concerning efficient photosynthesis and improvement the translocation of their products as well, since, the fruits represent the ultimate yield of the squash plant.

Table (16): Effect of low temperature as a pre-sowing treatment on chemical composition of squash (*Cucurbita pepo* L.) fruits during different picking times during 1999 season.

Treatments		Early pick (1 & 4 pick)							Medium pick (5 & 8 pick)							Late pick (9 & 12 pick)						
Low temperature °C	Exposure duration (hours)	N %	P %	K %	Ca %	Mg %	Crude protein %	Total carb mg/g d.w.	N %	P %	K %	Ca %	Mg %	Crude protein %	Total carb mg/g d.w.	N %	P %	K %	Ca %	Mg %	Crude protein %	Total carb mg/g d.w.
-1	12	2.21	0.430	3.00	1.80	0.19	13.81	666.33	2.42	0.45	2.87	2.90	0.36	15.13	806.61	2.47	0.503	3.32	3.20	0.17	15.44	718.94
-2	12	2.61	0.513	2.96	2.40	0.24	16.31	689.71	2.01	0.468	2.81	3.20	0.42	12.56	833.50	2.04	0.425	3.00	2.90	0.18	12.75	748.16
-3	12	2.41	0.440	3.04	2.20	0.18	15.06	590.35	2.26	0.363	2.85	3.80	0.30	14.13	783.23	1.91	0.475	3.04	2.60	0.36	11.94	783.23
-4	12	2.15	0.530	2.95	2.30	0.48	13.44	619.57	2.19	0.417	2.89	3.10	0.36	13.69	780.31	1.93	0.423	2.96	3.10	0.18	12.06	771.54
-1	24	2.30	0.501	2.85	2.10	0.66	14.38	593.27	2.33	0.380	2.93	2.40	0.30	14.56	824.73	2.47	0.410	2.93	3.90	0.30	15.44	806.61
-2	24	2.13	0.426	2.81	1.90	0.72	13.31	692.63	2.52	0.443	2.81	2.10	0.33	15.75	835.25	2.66	0.360	2.87	3.80	0.18	16.63	800.77
-3	24	2.51	0.595	3.24	1.80	0.66	15.69	683.87	2.16	0.400	2.83	2.90	0.36	13.50	829.99	2.26	0.445	3.04	3.20	0.24	14.13	683.87
-4	24	2.25	0.573	2.93	2.40	0.30	14.06	686.20	2.22	0.363	2.89	2.40	0.48	13.89	825.90	2.27	0.468	3.47	2.70	0.21	14.19	730.63
Control		2.02	0.382	2.73	1.50	0.12	12.63	587.42	1.85	0.342	2.81	1.80	0.13	11.56	771.54	1.90	0.35	2.85	2.50	0.12	11.88	648.45

Also, of interest is that the increases of different nutrients i.e., N, P, K, Ca and Mg in fruits also refered to the high rates of their absorption and translocation so, being accumulated in fruits with the obtained high rates. Thereby, the obtained squash fruits under the pre-sowing low temperature treatments were of good quality. Therefore, - as previously mentioned - low temperature as a pre-sowing treatment led to vigorous growth, increasing femaleness, earlness of fruit production and ended with high fruit yield of good quality.

In this respect, **Fathy (1995); El-Nagar (1996) and Ahmed (1997)** reported nearly similar effect of the low temperature up on fruit quality.

For example, **Ahmed (1997)** reported that low temperature at –2C for 12 hours exposure period led to increase each of N, P, K and Ca contents in squash fruits.

3- Effect of the low temperature as a pre-sowing seeds treatment on sugars, nitrate reductase activity (NRA) and nitrate nitrogen:

Data in **Table (17)** indicate that, total sugars content in fruits of squash plants was increased with different levels of pre-sowing low temperature treatments (-1 up to -4°C) and for the two exposure periods (12 and 24 hrs) in 1999 season. Also, it could be noticed that the percentages of reducing sugars were higher than the non-reducing ones. That could be considered an addition to favour of the fruit quality. While, in case of leaves higher content of non reducing sugars being more essential and needed since this form of sugars resemble the common translocated photosynthates from leaves

Table (17): Effect of low temperature as a pre-sowing treatment on sugars, nitrate reductase activity (NRA) and nitrate-nitrogen of squash (*Cucurbita pepo* L.) fruits during marketable size (*i.e* , 10 cm of fruit long) during 1999 season.

Characters / Treatments		Reducing sugars mg/g fresh weight	Non-reducing sugars mg/g fresh weight	Total sugars mg/g fresh weight	Nitrate reductase activity (NRA) μ g NO_2/g^{-1} f.w/h^{-1}	Nitrate-nitrogen (NO_3-N) %
Low temperature °C	Exposure duration (hours)					
-1	12	25.06	10.51	35.57	0.081	0.689
-2	12	26.06	12.09	38.15	0.094	0.788
-3	12	33.26	7.94	40.75	0.044	0.640
-4	12	23.40	8.64	32.04	0.042	0.475
-1	24	41.62	9.93	51.55	0.047	0.663
-2	24	34.85	11.09	45.94	0.024	0.363
-3	24	35.71	8.35	44.06	0.022	0.775
-4	24	36.29	8.49	44.78	0.045	0.643
Control		18.58	7.34	25.92	0.042	0.441

(sources) to the fruits (sinks) (**Giaquinta, 1983; Gardener *et al.*, 1985 and Hopkins, 1995**).

In fruits, no clear relation existed with regard to the nitrate reductase activity. Since, no increase or decrease existed compared with the control.

On the other hand, nitrate nitrogen content in most cases was higher in the fruits of low temperature treatments compared with the control fruits.

Nitrate reductase (NR) is a highly regulated cytosolic enzyme catalyzing the first and late-limiting steps in the nitrate assimilation pathway, reducing nitrate (NO_3^-) to nitrite (NO_2^-). The regulation of NR activity is complex and can involve modulation of the enzyme level through the regulation of synthesis and degradation (***Solomonson and Barber, 1990; Hoff et al., 1994 and Kaiser and Huber, 1997***).

No available researches dealing with the effect of low temperature as a pre-sowing treatment on nitrate reductase activity and nitrate accumulation as well.

4- Effect of the low temperature as a pre-sowing seeds treatment on vitamin C, total soluble solids and titratable acidity contents:

For the other characteristics of fruits quality were the vitamin C, total soluble solids and titratable acidity as indicated in **Table (18)**. Here, it could be noticed that all of these parameters well increased with low temperatures as a pre-sowing treatments during 1998 and 1999 seasons.

Table (18): Effect of low temperature as a pre-sowing treatment on chemical constituents of squash (*Cucurbita pepo* L.) fruits during 1998 and 1999 seasons.

Characters / Treatments		1998			1999		
Low temperature °C	Exposure duration (hours)	Vitamin C mg/100 g. fresh fruit	Total soluble solids (%)	Titratable acidity (%)	Vitamin C mg/100 g. fresh fruit	Total soluble solids (%)	Titratable acidity (%)
-1	12	10.35	4.25	0.494	10.01	3.75	0.468
-2	12	13.11	5.25	0.559	12.77	5.00	0.533
-3	12	12.42	4.25	0.455	11.73	4.50	0.442
-4	12	11.04	4.50	0.546	12.08	4.25	0.520
-1	24	11.39	4.75	0.507	10.70	4.00	0.481
-2	24	15.18	5.75	0.572	14.84	5.50	0.546
-3	24	13.80	4.50	0.507	12.42	4.50	0.475
-4	24	14.15	5.00	0.546	13.80	4.75	0.533
Control		9.66	3.50	0.390	9.32	3.25	0.377

Also, of interest to note that the increment of T. S. S. in addition to that increase of vitamin C led to consider the fruits of good quality. Since, vitamin C is greatly needed regarding public health and the high rates of T. S. S. make fruits more firm and that for consumers being more acceptable.

In this respect **Fathy (1995) and Ahmed (1997)** reported similar effects of low temperature as a pre-sowing treatments upon fruit quality.

Also, **Ahmed (1997)** reported that, low temperature as a pre-sowing treatment at –2°C for 12 exposure time increased characteristics of fruit quality.