4. RESULTS AND DISCUSSIONS

4.1. First experiment

"Effect of N-fertilizer sources, biofertilizer inoculation and foliar spray with Delfan or garlic extract on growth, yield and fruit quality of sweet peppers grown in summer season"

4.1.1. Vegetative growth:

4.1.1.1. Effect of N-fertilizer sources

Data presented in Table (9) show that plants supplied with 30 kg organic-N + 30 kg mineral-N, improved plant growth; plant height, leaf area , fresh and dry weight than those received all nitrogen dose (60kg N/fed.) either in the organic or in the mineral forms. This trend was true in both seasons. Data also show that treatments received 60kg mineral-N came in the second rank followed by those received 60kg organic-N with significant differences in all vegetative growth characteristics as a general trend in both seasons.

In this connection, Abd-El-Aty (1997) and Shams (2003) on sweet pepper and Ramadan et al. (2008) on tomato plants found that the addition of organic manure combined with chemical fertilizers improved vegetative growth. The superiority of using 50% of the required N in the organic and 50% in the mineral form on vegetative growth may be due to the favorable effect of the mineral nitrogen application on the activity of microorganisms responsible for organic fertilizer decay in the soil (Follett *et al.*, 1981) which increased soil available N,

Table (9): Effect of N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments on vegetative growth of sweet pepper plants during the summer seasons of 2004 & 2005.

Characters / Treatments	First Season (2004)					Second Season (2005)				
	Plant height cm	Stem diameter cm	Leaf area cm^2/plant	Fresh weight g/plant	Dry weight g/plant	Plant height cm	Stem diameter cm	Leaf area cm^2/plant	Fresh weight g/plant	Dry weight g/plant
N-fertilizer sources										
60 kg organic-N/fed.	40.75 C	1.25 A	3371 C	324.9 C	126.8 C	41.92 C	1.38 C	3423 C	336.0 C	118.5 C
60 kg mineral-N/fed.	46.86 B	1.37 A	4346 B	403.1 B	159.5 B	48.13 B	1.51 B	4397 B	420.2 B	150.0 B
30 kg organic-N/fed. +30 kg mineral-N/fed.	50.13 A	1.38 A	4863 A	426.6 A	179.3 A	50.75 A	1.62 A	4966 A	437.0 A	171.2 A
Biofertilizer										
Without biofertilizer	44.81 B	1.32 A	3885 B	363.7 B	146.7 B	46.08 B	1.47 B	3937 B	378.3 B	137.5 B
Biofertilizer (Microbin)	47.01 A	1.35 A	4501 A	406.1 A	163.7 A	47.78 A	1.54 A	4588 A	417.1 A	155.6 A
Foliar application										
Without foliar application	45.28 B	1.31 A	4068 B	374.0 C	149.1 C	46.08 B	1.49 B	4120 B	385.1 C	140.0 C
Delfan (amino acids)	47.28 A	1.38 A	4466 A	397.4 A	163.7 A	48.50 A	1.53 A	4569 A	413.9 A	156.0 A
garlic extract	45.19 B	1.31 A	4045 C	383.3 B	152.9 B	46.21 B	1.50 AB	4097 C	394.2 B	143.7 B

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

N-uptake and consequently encouraged vegetative growth of these plants.

4.1.1.2. Effect of biofertilizer

Biofertilizer inoculation with Microbin (Table, 9) significantly increased vegetative growth characteristics i.e., plant height, leaf area, fresh and dry weight over the treatment with no biofertilizers inoculation, in both seasons.

This superiority in plant growth by inoculating seeds and also transplants roots with Microbin (N-free living bacteria + Phosphorus dissolving bacteria) is in agreement with the results obtained by Moustafa and Omar (1990) using *Bacillus* and *Azospirillum,* Saber (1993) using Microbin and Gomaa (1995) using *Azospirillum, Azotobacter* and *Bacillus* who mentiond that N-fixing bacteria increased the available N in the soil. Moreover, the role of N-free living bacteria in production of phytohormones and/or improving the availability and acquisition of nutrients or by both, may explain the encouraged growth of plants inoculated with these non-symbiotic N-fixing bacteria (Barakat and Gabr, 1998). Furthermore, *Azotobacter and Azospirillum* could produce IAA and cytokinins which increase the surface area per unit root length and were responsible for root hair branching with an eventual increase in acquisition of nutrients from the soil (Jain and Patriquin, 1985).

Many organic acids which are produced by rhizosphere micro-organisms are effective in solubilizing soil phosphates (Marschner, 1997 and Ashour, 1998). When phosphate dissolving bacteria (PDB) are inoculated to neutral or alkaline

soils, the acid production decreases the rhizosphere pH and consequently favoring the solubility of calcium phosphates and micronutrients (Follett *et al.*, 1981).

4.1.1.3. Effect of foliar application

Data presented in Table (9) show that treatments sprayed with Delfan as a source of amino acids gave the highest values regarding plant height, leaf area, fresh and dry weight followed by treatments sprayed with garlic extract which came in the second. Meanwhile, treatments with no spray came in the third rank as to their effects on fresh and dry weight in both seasons. The favourable effect of garlic extract application on plant growth is in harmony with those of Shafshak *et al.* (2004) on squash and Mohamed (2008) on strawberry

4.1.1.4. Effect of the interaction between N-fertilizer source, biofertilizer and foliar spray treatments

From data in Tables (10 and 11) it could be concluded that, the plants fertilized with 30kg organic-N + 30kg mineral-N, inoculated with the biofertilizer Microbin and foliar sprayed with Delfan (amino acids) showed the best plant growth; the largest leaf area, the heaviest fresh and dry weight with significant increase as compared with all other treatments in both seasons. Regarding plant height results show that it was increased in plants supplied with amino acids and biofertilizer, especially when N was added as 60 kg organic-N or 60 kg mineral-N. However, plants received 30 kg organic-N + 30 kg mineral-N did not differ in plant height when sprayed with amino acids otherwise treated or not with biofertilizer.

Table (10): Effect of interaction between N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments of Delfan (amino acids) and garlic extract on vegetative growth of sweet pepper plants during the summer season of 2004.

Treatments		Characters	Plant height cm	Stem diameter cm	Leaf area cm^2/plant	Fresh weight g/plant	Dry weight g/plant
60 kg organic-N/fed.	Without biofertilizer	Without foliar application	38.6 G	1.20 B	3074 R	261.8 N	101.5 L
		Delfan (amino acids)	39.0 G	1.33 AB	3305 P	306.3 L	118.7 J
		garlic extract	39.5 G	1.18 B	3189 Q	282.8 M	110.1 K
	Biofertilizer (Microbin)	Without foliar application	39.0 G	1.23 B	3356 O	345.7 K	133.4 I
		Delfan (amino acids)	44.1 F	1.31 AB	3795 M	389.8 H	155.4 FG
		garlic extract	44.1 F	1.25 B	3506 N	363.2 J	141.7 H
60 kg mineral-N/fed.	Without biofertilizer	Without foliar application	49.1 BCDE	1.35 AB	4696 F	418.5 E	168.8 E
		Delfan (amino acids)	46.0 EF	1.30 AB	3832 L	372.0 I	145.7 H
		garlic extract	44.5 F	1.35 AB	4035 I	402.0 G	155.8 FG
	Biofertilizer (Microbin)	Without foliar application	46.3 DEF	1.35 AB	4186 H	391.3 H	152.4 G
		Delfan (amino acids)	49.6 ABCD	1.50 A	4785 E	425.9 CD	175.6 CD
		garlic extract	45.5 F	1.38 AB	4542 G	408.8 F	159.0 F
30 kg organic-N/fed. +30 kg mineral-N/fed.	Without biofertilizer	Without foliar application	46.6 DEF	1.38 AB	3864 K	393.7 H	159.4 F
		Delfan (amino acids)	52.6 A	1.46 A	5079 D	424.3 D	187.2 B
		garlic extract	47.1 CDEF	1.35 AB	3891 J	411.8 F	173.1 DE
	Biofertilizer (Microbin)	Without foliar application	51.8 AB	1.38 AB	5232 B	433.2 B	178.9 C
		Delfan (amino acids)	52.1 AB	1.38 AB	6002 A	465.8 A	199.4 A
		garlic extract	50.3 ABC	1.36 AB	5110 C	430.8BC	177.8 CD

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

Table (11): Effect of interaction between N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments of Delfan (amino acids) and garlic extract on vegetative growth of sweet pepper plants during the summer season of 2005.

Treatments			Plant height cm	Stem diameter cm	Leaf area cm^2/plant	Fresh weight g/plant	Dry weight g/plant
60 kg organic-N/fed.	Without biofertilizer	Without foliar application	40.0 F	1.35 F	3126 R	272.5 H	93.9 M
		Delfan (amino acids)	40.5 F	1.35 F	3357 P	318.5 F	108.6 K
		garlic extract	40.2 F	1.35 F	3241 Q	295.5 G	101.5 L
	Biofertilizer (Microbin)	Without foliar application	40.7 F	1.35 F	3408 O	357.5 E	124.9 J
		Delfan (amino acids)	45.5 DE	1.45 EF	3848 M	398.5 D	148.2 FG
		garlic extract	44.5 E	1.45 EF	3558 N	373.3 E	133.8 I
60 kg mineral-N/fed.	Without biofertilizer	Without foliar application	50.0 BC	1.55 DE	4748 F	431.5 BC	158.0 E
		Delfan (amino acids)	47.5 BCDE	1.45 EF	3885 L	417.3 CD	137.9 HI
		garlic extract	46.5 DE	1.50 DE	4085 I	413.0 CD	145.2 FG
	Biofertilizer (Microbin)	Without foliar application	47.2 BCDE	1.50 DE	4240 H	401.8 D	143.3 GH
		Delfan (amino acids)	50.5 AB	1.55 DE	4833 E	438.0 BC	165.9 CD
		garlic extract	47.0 CDE	1.55 DE	4596 G	419.5 BCD	150.0 F
30 kg organic-N/fed. +30 kg mineral-N/fed.	Without biofertilizer	Without foliar application	48.0 BCD	1.50 DE	3914 K	402.8 D	149.1 FG
		Delfan (amino acids)	53.5 A	1.65 BC	5133 D	432.5 BC	180.3 B
		garlic extract	48.5 BCD	1.55 DE	3944 J	421.5 BCD	163.2 DE
	Biofertilizer (Microbin)	Without foliar application	50.5 AB	1.70 AB	5284 B	444.5 B	170.6 C
		Delfan (amino acids)	53.5 A	1.75 A	6363 A	478.5 A	195.6 A
		garlic extract	50.5 AB	1.60 CD	5162 C	442.5 B	168.8 CD

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

Regarding to the treatment of 60kg organic-N, the addition of biofertilizer significantly increased leaf area, fresh and dry weight in both seasons compared to non addition of biofertilizer. Also, foliar application with amino acids in this case gave the best vegetative growth i.e. leaf area, fresh and dry weight with significant increase compared to foliar application with garlic extract or without foliar application, this trend was true in both seasons. While by using 60kg organic-N without both biofertilizer and without foliar application gave the lowest plant growth i.e., leaf area, fresh and dry weight per plant as compared with all other treatments in both seasons.

4.1.2. Chlorophyll content:

4.1.2.1. Effect of N-fertilizer sources

Concerning the effect of N-fertilizer source on chlorophyll content of leaves, data (Table, 12) show that adding 30kg organic-N + 30kg mineral-N, 60 kg mineral-N or 60 kg organic-N differed significantly from each other in a descending order, with respect to their effect on chlorophyll a, b and total chlorophyll content in both seasons. These results are in harmony with those of El-Shimi (1998) on cabbage, Ali (2000) on pea, Younes (2003) on pepper and Mohamed (2008) on strawberry.

4.1.2.2. Effect of biofertilizer

Biofertilizer inoculation increased chlorophyll a, b and total chlorophyll over the treatments when no bio fertilizers were added, with significant increase as shown in both seasons.

Table (12): Chlorophyll content (mg/100g fresh weight) in leaves of sweet pepper plants at flowering stage as affected by N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments during the summer seasons of 2004 & 2005.

Characters / Treatments	First Season (2004)			Second Season (2005)		
	Chlorophyll a	Chlorophyll b	Total chlorophyll	Chlorophyll a	Chlorophyll b	Total chlorophyll
N-fertilizer sources						
60 kg organic-N/fed.	94.71 C	39.20 C	133.9 C	96.13 C	40.08 C	136.2 C
60 kg mineral-N/fed.	102.9 B	44.37 B	147.3 B	103.8 B	44.47 B	148.3 B
30 kg organic-N/fed. +30 kg mineral-N/fed.	105.0 A	45.07 A	150.1 A	106.1 A	45.08 A	151.1 A
Biofertilizer						
Without biofertilizer	99.66 B	42.45 B	142.1 B	100.5 B	42.56 B	143.1 B
Biofertilizer (Microbin)	102.1 A	43.31 A	145.4 A	103.5 A	43.86 A	147.3 A
Foliar application						
Without foliar application	99.88 B	43.03 B	142.9 B	101.4 B	43.05 B	144.5 B
Delfan (amino acids)	102.1 A	43.12 A	145.2 A	103.6 A	43.87 A	147.5 A
garlic extract	100.7 B	42.48 C	143.1 B	101.0 B	42.72 C	143.7 B

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

Results are in harmony with Barakat and Gabr (1998) on tomato plants, who indicated a significant increase in leaf chlorophyll content of plants with increasing N applied rate up to 100 kg N / fed. or inoculation with either the single or mixed biofertilizer (*Azotobacter* , *Azospirillum* and *Klebsiella*).

4.1.2.3. Effect of foliar application

Foliar application with Delfan containing amino acids resulted in the highest chlorophyll a, b and total chlorophyll content in leaves with significant increase as shown in both seasons. Meanwhile, foliar application with garlic extract or without foliar application came in the second rank with no significant difference in chlorophyll a and total chlorophyll content in both seasons.

4.1.2.4. Effect of the interaction between N-fertilizer sources, biofertilizer and foliar spray treatments

Data (Tables, 13 and 14) indicate that the highest chlorophyll a, b and total chlorophyll content in leaves were obtained by using 30kg organic-N + 30kg mineral-N with biofertilizer and foliar application with amino acids as compared with all other treatments followed by using 30kg organic-N + 30kg mineral-N with biofertilizer and without foliar application. Furthermore, using 60 kg organic-N without biofertilizer and without foliar application led to the least content of chlorophyll a, b and total chlorophyll in leaves, and equal with that of the treatments which received 60 kg organic-N without biofertilizer with foliar application with amino acids or with garlic extract

Table (13): Chlorophyll content (mg/100g fresh weight) in leaves of sweet pepper plants at flowering stage as affected by N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments of Delfan (amino acids) and garlic extract during the summer season of 2004.

Treatments / Characters			Chlorophyll a	Chlorophyll b	Total chlorophyll
60 kg organic-N/fed.	Without biofertilizer	Without foliar application	91.10 F	38.95 I	130.1 H
		Delfan (amino acids)	93.10 EF	37.95 K	131.1 GH
		garlic extract	92.10 EF	38.45 J	130.6 GH
	Biofertilizer (Microbin)	Without foliar application	93.77 E	38.95 I	132.7 G
		Delfan (amino acids)	101.1 C	40.95 G	142.1 E
		garlic extract	97.10 D	39.95 H	137.1 F
60 kg mineral-N/fed.	Without biofertilizer	Without foliar application	103.1 BC	44.95 B	148.1 BC
		Delfan (amino acids)	103.1 BC	44.95 B	148.1 BC
		garlic extract	102.1 C	42.95 F	145.1 D
	Biofertilizer (Microbin)	Without foliar application	103.1 BC	44.45 D	147.6 C
		Delfan (amino acids)	103.1 BC	44.95 B	148.1 BC
		garlic extract	103.1 BC	43.95 E	147.1 CD
30 kg organic-N/fed. +30 kg mineral-N/fed.	Without biofertilizer	Without foliar application	103.1 BC	44.95 B	148.1 BC
		Delfan (amino acids)	106.1 A	43.95 E	150.1 AB
		garlic extract	103.1 BC	44.95 B	148.1 BC
	Biofertilizer (Microbin)	Without foliar application	105.1 AB	45.95 A	151.1 A
		Delfan (amino acids)	106.1 A	45.95 A	152.1 A
		garlic extract	106.4 A	44.65 C	151.1 A

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

Table (14): Chlorophyll content (mg/100g fresh weight) in leaves of sweet pepper plants at flowering stage as affected by N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments of Delfan (amino acids) and garlic extract during the summer season of 2005.

Treatments		Characters	Chlorophyll a	Chlorophyll b	Total chlorophyll
60 kg organic-N/fed.	Without biofertilizer	Without foliar application	92.70 G	38.35 M	131.1 K
		Delfan (amino acids)	93.90 G	39.15 K	133.1 K
		garlic extract	93.30 G	38.75 L	132.1 K
	Biofertilizer (Microbin)	Without foliar application	96.00 F	40.05 J	136.1 J
		Delfan (amino acids)	103.1 DE	42.95 H	146.1 GH
		garlic extract	97.80 F	41.25 I	139.1 I
60 kg mineral-N/fed.	Without biofertilizer	Without foliar application	105.1 BCD	44.95 C	150.1 CDE
		Delfan (amino acids)	104.1 CD	44.95 C	149.1 CDEF
		garlic extract	101.8 E	43.25 G	145.1 H
	Biofertilizer (Microbin)	Without foliar application	103.6 DE	44.45 D	148.1 EFG
		Delfan (amino acids)	105.2 BCD	45.28 B	150.5 CD
		garlic extract	103.1 DE	43.95 F	147.1 FGH
30 kg organic-N/fed. +30 kg mineral-N/fed.	Without biofertilizer	Without foliar application	104.0 CDE	44.55 D	148.6 DEF
		Delfan (amino acids)	106.1 BC	44.95 C	151.1 C
		garlic extract	103.9 CDE	44.15 E	148.1 EFG
	Biofertilizer (Microbin)	Without foliar application	107.1 AB	45.95 A	153.1 B
		Delfan (amino acids)	109.1 A	45.95 A	155.1 A
		garlic extract	106.1 BC	44.95 C	151.1 C

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

with no significant difference in chlorophyll a and total chlorophyll content in both seasons.

4.1.3. N uptake

4.1.3.1. Effect of N-fertilizer sources

Concerning the effect of fertilizer sources on total nitrogen uptake per plant, data (Table, 15) show that adding (30kg organic-N + 30kg mineral-N), 60 kg mineral-N or 60 kg organic-N significantly differed from each other in a descending order in total nitrogen uptake. This trend was true in both seasons. These results are in harmony with those of Midan (1995) on pepper and Mohamed (2008) on strawberry.

4.1.3.2. Effect of biofertilizer inoculation

Biofertilizer treatments resulted in the highest significant accumulated N in leaves, fruits and consequently total nitrogen uptake per plant over the control treatment when no bio fertilizers were added. This trend was true in both seasons and results could be referred to the role of Microbin on increasing the availability of soil nitrogen as a result of N fixation by *Azospirillum* and *Azotobacter* included in Microbin. These results are in harmony with those of Gomaa (1995) on tomato and Poi (1998) on pepper and tomato plants.

4.1.3.3. Effect of foliar application

Pepper plants sprayed with Delfan (amino acids) showed the highest N accumulation in their stems, leaves, fruits and consequently total nitrogen uptake per plant with a significant increase as compared with other foliar application treatments i.e.

Table (15): N-content of sweet pepper plant parts as affected by N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments during the summer seasons of 2004 & 2005.

Characters / Treatments	First Season (2004)				Second Season (2005)			
	mg N/plant				mg N/plant			
	Leaves	Stem	Fruit	Total	Leaves	Stem	Fruit	Total
N-fertilizer sources								
60 kg organic-N/fed.	937.8 C	620.6 B	1195 C	2753 C	940 B	616.0 A	1205 C	2761 C
60 kg mineral-N/fed.	1446.0 A	567.8 C	2011 A	4025 B	1352 A	505.3 B	2015 A	3873 B
30 kg organic-N/fed. +30 kg mineral-N/fed.	1426.0 B	649.6 A	1974 B	4049 A	1366 A	613.7 A	1986 B	3966 A
Biofertilizer								
Without biofertilizer	1100 B	609.5 B	1580 B	3289 B	1082 B	596.7 A	1591 B	3269 B
Biofertilizer (Microbin)	1440 A	615.8 A	1873 A	3929 A	1357 A	559.9 B	1881 A	3798 A
Foliar application								
Without foliar application	1251 C	600.5 B	1735 B	3586 B	1199 B	566.1 B	1743 B	3508 B
Delfan (amino acids)	1298 A	654.3 A	1742 A	3694 A	1256 A	629.1 A	1754 A	3638 A
garlic extract	1261 B	583.3 C	1703 C	3547 C	1204 B	539.8 C	1710 C	3454 C

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

garlic or control in both seasons. The amino acids content of Delfan may explain the high accumulation of N in plant tissues after spraying with Delfan.

4.1.3.4. Effect of the interaction between N-fertilizer sources, biofertilizer and foliar spray treatments

Data (Table, 16) clearly showed that the highest N-uptake in leaves, fruits and total uptake per plant was found in plants inoculated with Microbin and fertilized with 30kg organic-N + 30kg mineral-N and foliar applied with amino acids as compared with all other treatments in both seasons. Plants received 30kg organic-N + 30kg mineral-N with biofertilizer and without foliar application came in the second rank in total nitrogen uptake per plant, followed by the treatment which received 60kg mineral-N without biofertilizer and without foliar application. However, using 60kg organic-N without biofertilizer and without foliar application had the lowest nitrogen uptake in leaves, stem, fruits and total nitrogen per plant as compared with all other treatments.

On the other hand, plants supplied with 60 kg N/fed. in the mineral form without biofertilizer accumulated less N in leaves, stem and fruits as compared with plants supplied with biofertilizer (Microbin). Results are confirmed with those indicated by Monib *et al.* (1990), Gomaa (1995) on tomato , Poi (1998) on chili and tomato and Ouda (2000) on tomato who mentioned the favorable role of Nitrobin (*Azotobacter or Azospirillum*) on N uptake by plant roots.

Table (16): N-content of sweet pepper plant parts as affected by N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments of Delfan (amino acids) and garlic extract during the summer seasons of 2004 & 2005.

Treatments		Characters	First Season (2004) mg N/plant				Second Season (2005) mg N/plant			
			Leaves	Stem	Fruit	Total	Leaves	Stem	Fruit	Total
60 kg organic-N/fed.	Without biofertilizer	Without foliar application	691 R	497.3 N	1095 R	2283 P	738 K	517.6 H	1101 Q	2357 O
		Delfan (amino acids)	773 P	538.6 L	1136 P	2449 N	754 K	526.5 G	1148 O	2429 N
		garlic extract	732 Q	518.0 M	1116 Q	2366 O	751 K	524.1 GH	1124 P	2400 N
	Biofertilizer (Microbin)	Without foliar application	1049 O	676.3 G	1186 O	2912 M	1031 J	653.4 E	1195 N	2879 M
		Delfan (amino acids)	1232 I	767.6 A	1429 M	3428 K	1234 G	763.1 A	1446 L	3443 K
		garlic extract	1149 M	726.0 E	1206 N	3080 L	1132 I	711.3 D	1218 M	3061 L
60 kg mineral-N/fed.	Without biofertilizer	Without foliar application	1623 D	550.5 K	2370 C	4543 B	1470 D	447.8 J	2379 B	4297 C
		Delfan (amino acids)	1173 L	738.0 D	1536 L	3447 K	1179 H	741.4 C	1545 K	3465 K
		garlic extract	1409 G	438.5 P	2095 G	3942 F	1282 F	386.8 K	2093 F	3762 G
	Biofertilizer (Microbin)	Without foliar application	1313 H	609.3 H	1823 H	3745 G	1256 FG	557.7 F	1829 G	3642 H
		Delfan (amino acids)	1707 B	590.0 I	2133 D	4430 C	1570 B	518.7 GH	2133 C	4222 D
		garlic extract	1454 F	480.5 O	2110 F	4044 E	1355 E	379.2 K	2113 E	3848 F
30 kg organic-N/fed. +30 kg mineral-N/fed.	Without biofertilizer	Without foliar application	1194 K	748.9 C	1555 K	3498 J	1190 H	751.7 B	1571 J	3513 J
		Delfan (amino acids)	1088 N	695.8 F	1742 I	3525 I	1134 I	709.2 D	1763 H	3606 I
		garlic extract	1216 J	759.8 B	1574 J	3550 H	1236 G	765.2 A	1591 I	3592 I
	Biofertilizer (Microbin)	Without foliar application	1637 C	520.5 M	2380 B	4537 B	1506 C	468.2 I	2385 B	4359 B
		Delfan (amino acids)	1814 A	595.5 I	2480 A	4889 A	1661 A	515.8 H	2488 A	4665 A
		garlic extract	1605 E	577.0 J	2117 E	4299 D	1466 D	472.2 I	2122 D	4060 E

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

4.1.4. P uptake

4.1.4.1. Effect of N-fertilizer sources

Concerning the effect of fertilizer source on phosphorus uptake, data (Table, 17) show that adding 30kg organic-N + 30kg mineral-N, 60 kg mineral-N or 60 kg organic-N significantly differed from each other in a descending order in P content of pepper fruits and total phosphorus uptake per plant during both seasons of this experiment. These results are in harmony with those of Midan (1995) on pepper.

4.1.4.2. Effect of biofertilizer

Biofertilizer inoculation resulted in the highest significant accumulation of P in leaves, fruits and consequently total phosphorus uptake per plant over the control treatment when no bio fertilizers were added. This trend was true in both seasons and results could be referred to the role of Microbin on increasing the availability of soil phosphorus, especially it contained PDB. These results are in harmony with those of Poi (1998) on pepper and tomato plants and Ouda (2000) on tomato.

4.1.4.3. Effect of foliar application

Data presented in Table (17) show that foliar application with amino acids resulted in the highest significant P accumulation in leaves, stem and consequently total phosphorus uptake per plant followed by those sprayed with garlic extract as compared with the control without foliar applications, in both seasons.

Table (17): P-content of sweet pepper plant parts as affected by N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments during the summer seasons of 2004 & 2005.

Characters / Treatments	First Season (2004)				Second Season (2005)			
	mg P/plant				mg P/plant			
	Leaves	Stem	Fruit	Total	Leaves	Stem	Fruit	Total
N-fertilizer sources								
60 kg organic-N/fed.	93.77 B	62.63 B	124.5 C	281.0 C	82.30 B	56.88 B	126.0 C	265.2 C
60 kg mineral-N/fed.	93.02 B	57.14 C	204.5 B	354.6 B	81.88 B	49.49 C	205.5 B	336.9 B
30 kg organic-N/fed. +30 kg mineral-N/fed.	112.6 A	66.88 A	210.2 A	389.6 A	101.5 A	59.91 A	212.1 A	373.5 A
Biofertilizer								
Without biofertilizer	99.27 B	63.67 A	161.8 B	324.8 B	87.87 B	57.53 A	163.5 B	308.9 B
Biofertilizer (Microbin)	100.3 A	60.77 B	197.6 A	358.7 A	89.26 A	53.31 B	198.9 A	341.5 A
Foliar application								
Without foliar application	93.93 C	60.19 B	176.1 B	330.2 C	82.21 C	53.18 B	177.5 B	312.9 C
Delfan (amino acids)	107.0 A	66.30 A	181.6 A	355.0 A	96.59 A	60.12 A	183.3 A	340.0 A
garlic extract	98.43 B	60.17 B	181.4 A	340.0 B	86.88 B	52.97 B	182.9 A	322.8 B

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

4.1.4.4. Effect of the interaction between N-fertilizer source, biofertilizer and foliar spray treatments

Data (Table, 18) clearly show that the highest significant P accumulation in leaves, stem and consequently total phosphorus uptake per plant was found in plants fertilized with 30kg organic-N + 30kg mineral-N, with or without biofertilizer and foliar sprayed with amino acids as compared with all other treatments in both seasons. However, using 60kg organic-N without biofertilizer and without foliar application gave the lowest phosphorus uptake in leaves, stem, fruits and consequently total phosphorus uptake per plant as compared with all other treatments. It seems that Delfan (amino acids) application induced favourable effect on P-uptake specialty on plants received both organic and mineral N together.

4.1.5. K uptake

4.1.5.1. Effect of N-fertilizer sources

Concerning the effect of fertilizer source on potassium uptake, data (Table, 19) show that plants supplied with (30kg organic-N + 30kg mineral-N), 60 kg mineral-N or 60 kg organic-N significantly differed from each other in a descending order in leaves, stem and total potassium uptake. This trend was true in both seasons. These results are in harmony with those of Midan (1995) on pepper.

4.1.5.2. Effect of biofertilizer

Biofertilizer inoculation induced the highest significant K accumulation in leaves, stem, fruits and consequently total

Table (18): P-content of sweet pepper plant parts as affected by N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments of Delfan (amino acids) and garlic extract during the summer seasons of 2004 & 2005.

Treatments		Characters	First Season (2004) mg P/plant				Second Season (2005) mg P/plant			
			Leaves	Stem	Fruit	Total	Leaves	Stem	Fruit	Total
60 kg organic-N/fed.	Without biofertilizer	Without foliar application	62.90 J	47.20 H	113.9 L	224.1 N	51.67 K	42.00 K	115.2 L	208.9 L
		Delfan (amino acids)	86.50 H	59.00 E	118.3 K	263.9 L	73.73 I	53.03 G	119.7 K	246.5 J
		garlic extract	74.70 I	53.10 G	116.1 KL	243.9 M	62.87 J	47.02 IJ	117.4 KL	227.3 K
	Biofertilizer (Microbin)	Without foliar application	105.1 D	68.30 C	123.6 J	297.0 K	91.73 E	61.67 E	125.1 J	278.5 I
		Delfan (amino acids)	117.3 C	74.40 B	149.5 I	341.3 GH	109.9 C	71.17 C	151.6 I	332.7 F
		garlic extract	116.1 C	73.80 B	125.7 J	315.6 J	103.9 D	66.37 D	127.2 J	297.5 H
60 kg mineral-N/fed.	Without biofertilizer	Without foliar application	95.40 F	58.90 E	219.4 CD	373.6 E	85.10 F	51.17 GH	220.4 CD	356.6 E
		Delfan (amino acids)	99.10 E	65.30 D	160.9 H	325.4 I	85.27 F	58.30 F	162.3 H	305.8 H
		garlic extract	84.10 H	47.00 H	217.1 D	348.2 FG	74.20 I	40.23 K	218.5 D	333.0 F
	Biofertilizer (Microbin)	Without foliar application	91.30 G	57.35 EF	189.8 E	338.5 H	79.28 H	49.80 HI	190.8 E	319.9 G
		Delfan (amino acids)	104.7 D	64.90 D	221.0 C	390.5 CD	94.30 E	56.30 F	221.8 C	372.4 CD
		garlic extract	83.50 H	49.40 H	218.7 CD	351.6 F	73.13 I	41.13 K	219.5 CD	333.8 F
30 kg organic-N/fed. +30 kg mineral-N/fed.	Without biofertilizer	Without foliar application	116.9 C	74.20 B	162.9 GH	354.1 F	104.2 D	67.78 D	165.0 GH	337.0 F
		Delfan (amino acids)	139.0 A	85.20 A	182.8 F	407.0 A	130.7 A	81.17 A	185.7 F	397.6 A
		garlic extract	134.8 B	83.10 A	165.0 G	383.0 D	123.0 B	77.10 B	167.6 G	367.7 D
	Biofertilizer (Microbin)	Without foliar application	91.90 G	55.20 FG	246.9 B	394.0 BC	81.27 GH	46.67 J	248.4 B	376.3 BCD
		Delfan (amino acids)	95.30 F	49.00 H	257.4 A	401.6 AB	85.70 F	40.77 K	258.6 A	385.1 B
		garlic extract	97.40 EF	54.60 FG	245.9 B	397.9 BC	84.13 FG	45.97 J	247.4 B	377.5 BC

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

Table (19): K-content of sweet pepper plant parts as affected by N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments during the summer seasons of 2004 & 2005.

Characters / Treatments	First Season (2004)				Second Season (2005)			
	mg K/plant				mg K/plant			
	Leaves	Stem	Fruit	Total	Leaves	Stem	Fruit	Total
N-fertilizer sources								
60 kg organic-N/fed.	1402 C	1152 C	1273 B	3827 C	1193 C	1046 C	1284 C	3523 C
60 kg mineral-N/fed.	1868 B	1496 B	1902 A	5265 B	1668 B	1338 B	1911 B	4917 B
30 kg organic-N/fed. +30 kg mineral-N/fed.	2294 A	1705 A	2224 A	6010 A	2110 A	1583 A	2029 A	5722 A
Biofertilizer								
Without biofertilizer	1747 B	1353 B	1604 B	4705 B	1537 B	1230 B	1617 B	4383 B
Biofertilizer (Microbin)	1962 A	1549 A	1995 A	5364 A	1777 A	1415 A	1866 A	5057 A
Foliar application								
Without foliar application	1724 C	1392 C	1690 A	4806 C	1519 C	1253 C	1702 C	4474 C
Delfan (amino acids)	2010 A	1532 A	1771 A	5313 A	1827 A	1429 A	1786 A	5041 A
garlic extract	1830 B	1429 B	1937 A	4983 B	1624 B	1286 B	1736 B	4646 B

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

potassium uptake per plant over the control treatment when no bio fertilizer was added. This trend was true in both seasons.

4.1.5.3. Effect of foliar application

Data (Table, 19) show that foliar application of amino acids, garlic extract or without foliar application significantly differed from each other in a descending order in leaves, stem and total potassium uptake during both seasons.

4.1.5.4. Effect of the interaction between N-fertilizer sources, biofertilizer and foliar spray treatments

Data (Table, 20) clearly show that the highest total potassium uptake was found in plants fertilized with 30kg organic-N + 30kg mineral-N, inoculated with Microbin and foliar sprayed with amino acids with a significant increase as compared with all other treatments, especially in the second season, followed by using 30kg organic-N + 30kg mineral-N with amino acids spray but without biofertilizer application with significant difference in the first season. It seems that adding 50% of the required-N in the organic + 50% in the mineral form combined with foliar spray with amino acids had the most favourable effect on K-uptake. However, using 60kg organic-N without biofertilizer and without foliar application resulted in the least potassium accumulation in leaves, stem, fruits and consequently total potassium uptake per plant as compared with all other treatments.

able (20): K-content of sweet pepper plant parts as affected by N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments of Delfan (amino acids) and garlic extract during the summer season of 2004 & 2005.

Treatments		Characters	First Season (2004) mg K/plant				Second Season (2005) mg K/plant			
			Leaves	Stem	Fruit	Total	Leaves	Stem	Fruit	Total
60 kg organic-N/fed.	Without biofertilizer	Without foliar application	733 Q	818 P	1160 D	2712 P	541 Q	720 R	1168 R	2430 Q
		Delfan (amino acids)	1211 O	1057 N	1207 CD	3475 N	1009 O	953 P	1216 P	3178 O
		garlic extract	972 P	937 O	1183 D	3093 O	775 P	837 Q	1192 Q	2805 P
	Biofertilizer (Microbin)	Without foliar application	1596 N	1250 M	1263 CD	4109 M	1386 N	1144 O	1273 O	3803 N
		Delfan (amino acids)	2068 H	1485 H	1539 BCD	5092 I	1843 H	1373 I	1557 M	4773 J
		garlic extract	1831 J	1367 K	1286 CD	4484 L	1600 J	1251 K	1296 N	4147 M
60 kg mineral-N/fed.	Without biofertilizer	Without foliar application	2034 I	1666 F	1985 BCD	5685 G	1845 H	1483 G	1996 E	5323 G
		Delfan (amino acids)	1684 M	1294 L	1660 BCD	4638 K	1458 M	1181 N	1669 L	4307 L
		garlic extract	1747 L	1379 J	1965 BCD	5090 I	1562 K	1222 M	1973 G	4756 J
	Biofertilizer (Microbin)	Without foliar application	1749 L	1382 J	1820 BCD	4950 J	1542 L	1233 L	1829 I	4603 K
		Delfan (amino acids)	2180 C	1784 B	2001 BCD	5965 E	1975 D	1622 C	2010 D	5606 E
		garlic extract	1813 K	1471 I	1979 BCD	5263 H	1628 I	1288 J	1989 F	4904 I
30 kg organic-N/fed. +30 kg mineral-N/fed.	Without biofertilizer	Without foliar application	2090 G	1496 G	1681 BCD	5267 H	1856 G	1381 H	1697 K	4934 H
		Delfan (amino acids)	2760 A	1831 A	1892 BCD	6483 A	2525 A	1713 B	1916 H	6154 B
		garlic extract	2496 B	1699 E	1702 BCD	5897 F	2259 B	1579 D	1725 J	5562 F
	Biofertilizer (Microbin)	Without foliar application	2141 E	1741 C	2233 BC	6115 C	1946 E	1557 E	2250 B	5753 C
		Delfan (amino acids)	2160 D	1738 C	2330 A	6228 B	2153 C	1729 A	2346 A	6228 A
		garlic extract	2121 F	1723 D	2224 BC	6068 D	1920 F	1538 F	2241 C	5699 D

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%

4.1.6. Early and total yield:

4.1.6.1. Effect of N-fertilizer sources

Data (Table, 21 and Fig. 1) show that treatments supplied with (30kg organic-N + 30kg mineral-N) produced the highest early and total yield per plant and per feddan, followed by treatment which received 60kg N in the mineral form with significant increase as compared with those received all nitrogen dose (60kg N/fed.) in the organic form. The same trend was clear in both seasons. These results are in harmony with those of Abd-El-Aty (1997) and Shams (2003) on sweet pepper, Ramadan et al. (2007a) on tomato and Mohamed (2008) on strawberry.

The superiority of adding 50% of N in the organic form (30 kg) + 50% (30 kg N) in the mineral form over adding all N-fertilizer (100%) either in the organic or mineral form (60 kg N/fed.) may be referred to the increase in microorganisms activity in the presence of both organic and mineral nitrogen sources and increasing adsorbing capacity of essential nutrients against leaching. Moreover adding mineral + organic fertilizer together will improve the mineralization of organic-N (Tisdale and Nelson, 1975).

4.1.6.2. Effect of biofertilizer

Data (Table, 21 and Fig., 1) show that inoculation with Microbin resulted in higher early and total yield per plant and per feddan as compared with no biofertilizer inoculation, as shown in both seasons. The enhancing effect of biofertilizer application could be referred to the role of free living bacteria on

Table (21): Effect of N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments on early and total yield of sweet pepper plants during the summer seasons of 2004 & 2005.

Characters / Treatments	First Season (2004)				Second Season (2005)			
	Early yield		Total yield		Early yield		Total yield	
	g/plant	ton/fed	g/plant	ton/fed	g/plant	ton/fed	g/plant	ton/fed
N-fertilizer sources								
60 kg organic-N/fed.	17.48 C	0.279 C	437.6 C	6.999 C	30.40 C	0.488 C	450.4 C	7.277 C
60 kg mineral-N/fed.	23.77 B	0.355 B	506.6 B	8.316 B	35.87 B	0.576 B	531.4 B	8.570 B
30 kg organic-N/fed. +30 kg mineral-N/fed.	27.21 A	0.435 A	582.0 A	9.049 A	40.24 A	0.654 A	594.5 A	9.579 A
Biofertilizer								
Without biofertilizer	21.60 B	0.337 B	498.5 B	7.796 B	34.31 B	0.551 B	510.9 B	8.244 B
Biofertilizer (Microbin)	24.04 A	0.375 A	519.0 A	8.447 A	36.69 A	0.595 A	539.9 A	8.707 A
Foliar application								
Without foliar application	22.65 B	0.338 B	504.1 B	7.982 B	34.95 B	0.561 B	516.8 B	8.336 B
Delfan (amino acids)	24.60 A	0.393 A	517.1 A	8.377 A	37.40 A	0.609 A	542.8 A	8.753 A
garlic extract	21.20 C	0.338 B	505.0 B	8.005 B	34.15 B	0.548 C	516.8 B	8.337 B

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

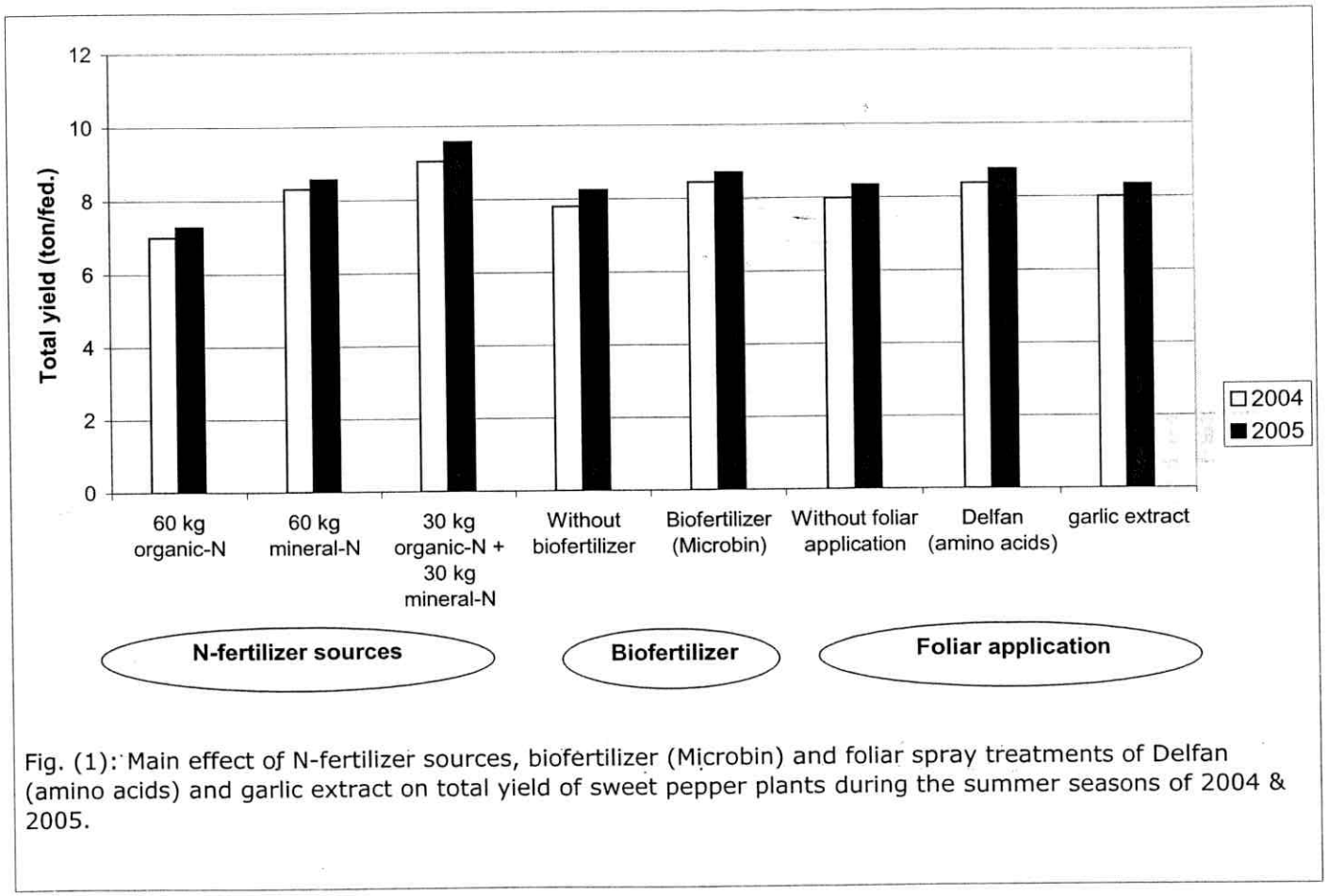


Fig. (1): Main effect of N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments of Delfan (amino acids) and garlic extract on total yield of sweet pepper plants during the summer seasons of 2004 & 2005.

N-fixation in the soil and the role of PDB on increasing the available-P in the soil (Rai, 2006). Moreover, the mechanism of microorganisms on plant growth and fruit yield depends on producing growth promoting substances (El-Hadad *et al.*, 1986) and enhancing nutrients uptake (Sarig *et al.*, 1984). This explanation is in harmony with data of plant growth (Table, 9), N-uptake (Table, 15) and P-uptake (Table, 17).

Such stimulating effect of free living N-fixing bacteria and PDB involved in Microbin on increasing plant growth, chlorophyll content, N and P uptake may justify the increase in fruit early and total yield of sweet peppers obtained when plants were inoculated with Microbin.

Results on the favourable effect of biofertilizer application on early and total yield have been mentioned by Moustafa and Omar (1990) and Gomaa (1995) on tomato and Shams (2003) working on sweet pepper inoculated with Nitrobin and Phosphorin.

4.1.6.3. Effect of foliar application

Data (Table, 21 and Fig. 1) show that treatments sprayed with Delfan as a source of amino acids gave the highest early and total yield per plant and per feddan with a significant increase as compared with foliar application by garlic extract or without foliar application during both seasons. The superiority of foliar application with Delfan may be referred to the role of amino acids content required to proteins synthesis. Moreover, data show that garlic extract application did not increase early or total yield than the control (without foliar application).

Furthermore, garlic extract application decreased early fruit yield per plant and per feddan only in one season of this experiment, but had a similar effect on total fruit yield as compared with the control, as shown in both seasons.

4.1.6.4. Effect of the interaction between N-fertilizer sources, biofertilizer and foliar spray treatments

Data (Tables, 22 and 23 and Fig. 2) show that, the treatment fertilized with 30kg organic-N + 30kg mineral-N and inoculated with microbin biofertilizer and foliar sprayed with Delfan (amino acids) gave the highest early and total yield per plant and per feddan with a significant increase as compared to all other treatments, in both seasons. This increase reached 37.20 and 16.05 % as an average of both seasons for early and total yield per feddan respectively, as compared with plants supplied with 60 kg mineral-N without biofertilizer or spraying treatments. Moreover, the plants received 30kg organic-N + 30kg mineral-N + biofertilizer without foliar application or with garlic extract came in the second rank.

While by adding 60kg mineral-N and spraying with amino acids without biofertilizer inoculation significantly increased total yield per plant and per feddan in both seasons compared with other treatments under the same N-fertilizer source. It could be clearly observed that using the foliar application of Delfan (amino acids) had a beneficial effect for increasing total yield, while supplying with biofertilizer in the presence of full dose of mineral-N had no effect on the total yield. This result may be

Table (22): Effect of interaction between N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments of Delfan (amino acids) and garlic extract on early and total yield of sweet pepper plants during the summer season of 2004.

Treatments		Characters	Early yield		Total yield	
			g/plant	ton/fed	g/plant	ton/fed
60 kg organic-N/fed.	Without biofertilizer	Without foliar application	16.51 G	0.260 GH	400.7 N	6.273 J
		Delfan (amino acids)	15.77 G	0.243 H	424.6 L	6.583 I
		garlic extract	15.19 G	0.250 H	413.3 M	6.470 IJ
	Biofertilizer (Microbin)	Without foliar application	16.23 G	0.256 GH	447.2 K	7.190 H
		Delfan (amino acids)	23.53 CDE	0.386 BCDE	487.5 I	8.270 EFG
		garlic extract	17.68 FG	0.280 GH	452.4 J	7.207 H
60 kg mineral-N/fed.	Without biofertilizer	Without foliar application	25.27 BCD	0.354 DEF	514.1 G	8.314 DEFG
		Delfan (amino acids)	22.93 DE	0.372 CDE	535.7 E	8.643 C
		garlic extract	20.24 EF	0.310 FG	507.5 H	8.217 FG
	Biofertilizer (Microbin)	Without foliar application	25.30 BCD	0.339 EF	525.9 F	8.284 EFG
		Delfan (amino acids)	25.76 BCD	0.402 BCD	442.3 K	8.240 FG
		garlic extract	23.10 DE	0.352 DEF	513.8 G	8.197 G
30 kg organic-N/fed. +30 kg mineral-N/fed.	Without biofertilizer	Without foliar application	25.41 BCD	0.388 BCDE	543.3 D	8.507 CDEF
		Delfan (amino acids)	26.83 BC	0.441 B	594.2 B	8.589 CD
		garlic extract	26.23 BCD	0.418 BC	552.7 C	8.568 CDE
	Biofertilizer (Microbin)	Without foliar application	27.21 B	0.429 BC	593.3 B	9.326 B
		Delfan (amino acids)	32.80 A	0.517 A	618.2 A	9.935 A
		garlic extract	24.79 BCD	0.418 BC	590.5 B	9.372 B

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

Table (23): Effect of interaction between N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments of Delfan (amino acids) and garlic extract on early and total yield of sweet pepper plants during the summer season of 2005.

Treatments		Characters	Early yield		Total yield	
			g/plant	ton/fed	g/plant	ton/fed
60 kg organic-N/fed.	Without biofertilizer	Without foliar application	28.25 G	0.450 M	413.0 P	6.680 K
		Delfan (amino acids)	29.09 G	0.470 K	436.8 N	7.060 I
		garlic extract	28.67 G	0.460 L	424.9 O	6.870 J
	Biofertilizer (Microbin)	Without foliar application	29.24 G	0.471 K	460.8 M	7.440 H
		Delfan (amino acids)	36.68 DE	0.590 F	501.1 K	8.090 G
		garlic extract	30.46 FG	0.490 J	465.6 L	7.520 H
60 kg mineral-N/fed.	Without biofertilizer	Without foliar application	36.86 DE	0.592 F	527.7 HI	8.511 EF
		Delfan (amino acids)	36.84 DE	0.592 F	549.4 F	8.859 D
		garlic extract	32.35 F	0.520 I	519.3 J	8.376 F
	Biofertilizer (Microbin)	Without foliar application	35.97 DE	0.578 G	537.3 G	8.665 E
		Delfan (amino acids)	38.08 CD	0.612 E	529.4 H	8.539 EF
		garlic extract	35.10 E	0.564 H	525.2 I	8.471 EF
30 kg organic-N/fed. +30 kg mineral-N/fed.	Without biofertilizer	Without foliar application	38.01 CD	0.611 E	556.3 E	8.969 CD
		Delfan (amino acids)	39.54 BC	0.635 C	607.6 B	9.790 B
		garlic extract	39.19 C	0.630 CD	563.3 D	9.080 C
	Biofertilizer (Microbin)	Without foliar application	41.36 B	0.664 B	605.4 BC	9.753 B
		Delfan (amino acids)	44.19 A	0.760 A	632.2 A	10.18 A
		garlic extract	39.13 C	0.628 D	602.2 C	9.702 B

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

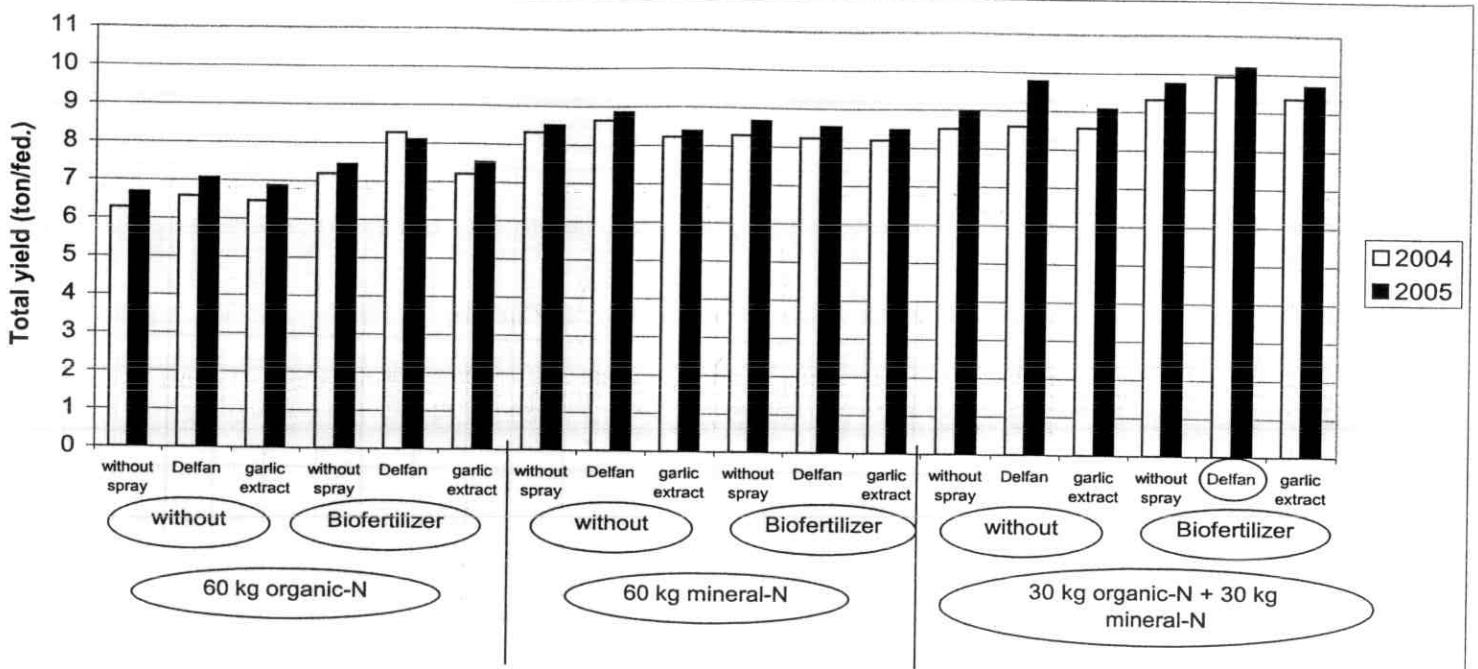


Fig. (2): Effect of interaction between N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments of Delfan (amino acids) and garlic extract on total yield of sweet pepper plants during the summer seasons of 2004 & 2005.

due to that the addition of mineral-N at full dose inhibit the activation of biofertilizer's microorganisms (Rai, 2006).

Furthermore, plants supplied with full N (60kg N/fed.) as organic-N without biofertilizer and without foliar application gave the lowest total yield per plant and per feddan with a significant difference as compared with all treatments in both seasons. Regarding to the treatment of 60kg organic-N, the addition of biofertilizer significantly increased total yield per plant and per feddan in both seasons compared to non addition of biofertilizer. The positive effect of biofertilizer in this case indicated that there were no competition between plants and microorganisms for mineral-N uptake, hence, biogas the source of organic-N was well decomposed, this explanation is in harmony with Rai (2006).

4.1.7. Fruit physical characteristics

4.1.7.1. Effect of N-fertilizer sources

According to the effect of fertilizer sources on fruit quality, data (Table, 24) show that adding 30 kg organic-N + 30 kg mineral-N gave larger fruit length, diameter, siz and consequently weight as compared with that of plants received all applied-N (60 kg /fed.) in either organic or mineral form, in both seasons.

Data also show that adding all N-requirements (60 kg N/fed.) in the organic form mostly depressed all physical characteristics of fruit quality. These results elucidate that solely organic-N application is not enough to supply sweet pepper

Table (24): Effect of N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments on fruit physical characteristics of sweet pepper plants during the summer seasons of 2004 & 2005.

Characters / Treatments	First Season (2004)				Second Season (2005)			
	Fruit length cm	Fruit diameter cm	Fruit size cm^3/fruit	Fruit weight (g)	Fruit length cm	Fruit diameter cm	Fruit size cm^3/fruit	Fruit weight (g)
N-fertilizer sources								
60 kg organic-N/fed.	7.08 B	6.31 C	150.9 B	90.67 B	8.03 C	6.83 C	161.8 B	91.83 C
60 kg mineral-N/fed.	7.99 A	6.65 B	154.7 B	122.1 A	8.67 B	7.20 B	161.9 B	127.9 B
30 kg organic-N/fed. +30 kg mineral-N/fed.	8.02 A	6.94 A	168.6 A	123.6 A	8.83 A	7.45 A	179.4 A	129.9 A
Biofertilizer								
Without biofertilizer	7.42 B	6.50 B	154.8 B	106.9 B	8.30 B	7.01 B	164.1 B	111.8 B
Biofertilizer (Microbin)	7.98 A	6.77 A	161.3 A	117.3 A	8.72 A	7.31 A	171.4 A	121.3 A
Foliar application								
Without foliar application	7.79 A	6.52 B	156.5 B	110.6 A	8.52 B	7.10 B	167.2 A	113.9 C
Delfan (amino acids)	7.62 A	6.79 A	162.9 A	113.4 A	8.58 A	7.26 A	170.2 A	120.1 A
garlic extract	7.69 A	6.60 B	154.7 B	112.3 A	8.43 C	7.13 B	165.8 A	115.7 B

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

plants with N required for plant growth, yield and consequently may be not adequate to improve fruit physical characteristics. Abd-El-Aty (1997) found that addition of organic manure combined with chemical fertilizers gave the best fruit quality. Also, these results are in harmony with those of Youssef *et al.* (2001) on tomato.

4.1.7.2. Effect of biofertilizer

Biofertilizer inoculation significantly increased fruit length, diameter, size and average fruit weight over the treatments when no biofertilizer was added. This trend was true in both seasons. It means that the role of biofertilizer on improving physical characteristics of sweet pepper fruit was more pronounced than when no biofertilizer was added.

4.1.7.3. Effect of foliar application

The treatments which sprayed amino acids gave the largest fruit length and diameter with the heaviest weight with significantly increase in the second season.

The superiority of foliar application amino acids may be referred to the role of Delfan (amino acids) protein synthesis. Data of N uptake by sweet pepper plants (Table, 15) indicate that plants sprayed with Delfan had accumulated more N in plant organs.

4.1.7.4. Effect of the interaction between N-fertilizer sources, biofertilizer and foliar spray treatments

Data (Tables, 25 and 26) show that treatment which received (30kg organic-N + 30kg mineral-N + biofertilizer with

Table (25): Effect of interaction between N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments of Delfan (amino acids) and garlic extract on fruit physical characteristics of sweet pepper plants during the summer season of 2004.

Treatments		Characters	Fruit length cm	Fruit diameter cm	Fruit size cm^3/fruit	Fruit weight (g)
60 kg organic-N/fed.	Without biofertilizer	Without foliar application	7.01 CD	5.73 G	144.7 H	80.8 G
		Delfan (amino acids)	6.26 D	6.26 EF	150.0 EFGH	81.4 G
		garlic extract	7.26 C	6.13 F	146.3 FGH	84.4 FG
	Biofertilizer (Microbin)	Without foliar application	7.36 BC	6.26 EF	151.3 EFG	94.7 EFG
		Delfan (amino acids)	7.25 C	6.93 ABC	160.4 CD	102.1 CDE
		garlic extract	7.36 BC	6.56 CDE	152.3 EF	100.5 DEF
60 kg mineral-N/fed.	Without biofertilizer	Without foliar application	8.31 AB	6.70 ABCD	156.2 DE	124.3 AB
		Delfan (amino acids)	7.58 ABC	6.60 BCDE	156.3 DE	112.5 BCD
		garlic extract	7.64 ABC	6.43 DEF	145.9 GH	124.9 AB
	Biofertilizer (Microbin)	Without foliar application	7.93 ABC	6.61 BCDE	155.8 DE	118.8 ABC
		Delfan (amino acids)	8.47 A	6.90 ABC	161.9 CD	127.5 AB
		garlic extract	8.03 ABC	6.70 ABCD	152.2 EF	124.3 AB
30 kg organic-N/fed. +30 kg mineral-N/fed.	Without biofertilizer	Without foliar application	7.56 ABC	6.71 ABCD	158.8 CD	113.8 ABCD
		Delfan (amino acids)	7.63 ABC	7.06 A	172.2 AB	125.0 AB
		garlic extract	7.56 ABC	6.86 ABC	162.9 C	115.0 ABCD
	Biofertilizer (Microbin)	Without foliar application	8.56 A	7.10 A	172.2 AB	131.3 A
		Delfan (amino acids)	8.54 A	7.00 AB	176.9 A	131.6 A
		garlic extract	8.29 AB	6.90 ABC	168.9 B	124.8 AB

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

Table (26): Effect of interaction between N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments of Delfan (amino acids) and garlic extract on fruit physical characteristics of sweet pepper plants during the summer season of 2005.

Treatments		Characters	Fruit length cm	Fruit diameter cm	Fruit size cm^3/fruit	Fruit weight (g)
60 kg organic-N/fed.	Without biofertilizer	Without foliar application	7.95 H	6.4 H	155.0 GH	84.0 K
		Delfan (amino acids)	7.95 H	6.6 G	161.0 EFGH	86.0 J
		garlic extract	7.95 H	6.5 GH	158.0 FGH	85.0 JK
	Biofertilizer (Microbin)	Without foliar application	8.05 G	6.9 F	162.0 EFGH	89.0 I
		Delfan (amino acids)	8.25 F	7.4 BC	170.0 BCDEF	116.0 G
		garlic extract	8.05 G	7.2 CDE	165.0 DEFGH	91.0 H
60 kg mineral-N/fed.	Without biofertilizer	Without foliar application	8.95 C	7.3 CD	168.0 CDEFG	131.0 C
		Delfan (amino acids)	8.35 F	7.1 E	151.0 H	118.0 F
		garlic extract	8.45 E	7.1 E	157.0 FGH	131.0 C
	Biofertilizer (Microbin)	Without foliar application	8.50 E	7.1 DE	164.5 EFGH	124.5 D
		Delfan (amino acids)	9.15 B	7.4 BC	169.0 BCDEFG	132.0 C
		garlic extract	8.65 D	7.2 CDE	162.0 EFGH	131.0 C
30 kg organic-N/fed. +30 kg mineral-N/fed.	Without biofertilizer	Without foliar application	8.35 F	7.2 CDE	170.5 BCDEF	119.5 EF
		Delfan (amino acids)	8.45 E	7.5 AB	182.0 ABC	131.0 C
		garlic extract	8.35 F	7.4 BC	174.0 BCDE	121.0 E
	Biofertilizer (Microbin)	Without foliar application	9.35 A	7.6 A	183.0 AB	135.3 B
		Delfan (amino acids)	9.35 A	7.6 A	188.0 A	137.3 A
		garlic extract	9.15 B	7.4 BC	179.0 ABCD	135.3 B

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

or without foliar application by amino acids or garlic extract gave heavier fruit weight with larger diameter and length as a general trend, especially in the second season. However, the treatments which supplied by (60kg organic-N) without biofertilizer and with or without foliar application gave the least values as compared with all other treatments in fruit weight and size as a general trend in both seasons.

4.1.8. Fruit chemical constituents

4.1.8.1. Fruit acidity, vitamin-C, sugars content

4.1.8.1.1. Effect of N-fertilizer sources

Concerning the effect of N-fertilizer source on fruit chemical characteristics, data (Table, 27) show that using 60kg organic-N, 30kg organic-N + 30kg mineral-N or 60 kg mineral-N significantly differed from each other in ascending order, with respect to acidity during both seasons. In addition, fruits obtained from plants supplied with 60 kg N as organic biogas had the highest vitamin-C, reducing, non reducing and total sugars content followed by those received 30kg organic-N + 30kg mineral-N as a general trend, especially in the second season. On the other hand, plants received 60 kg N as ammonium sulphate had the least significant values of vitamin-C and sugars as compared with the other N-sources, in both seasons. These results are in harmony with those of Shams (2003) on sweet pepper and Shafshak *et al.* (2007) on squash.

Table (27): Effect of N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments on fruit chemical constituents of sweet pepper plants during the summer seasons of 2004 & 2005.

Characters / Treatments	First Season (2004)						Second Season (2005)					
	Acidity mg/100 cm^3	T.S.S %	Vitamin C mg/100g	Sugars mg/100g (F.W.)			Acidity mg/100 cm^3	T.S.S %	Vitamin C mg/100g	Sugars mg/100g (F.W.)		
				Reducing	Non-reducing	Total				Reducing	Non-reducing	Total
N-fertilizer sources												
60 kg organic-N/fed.	194.3 C	5.81 A	174.4 A	103.0 A	146.4 B	249.4 A	206.2 C	6.01 A	180.3 A	104.5 A	154.1 A	253.1 A
60 kg mineral-N/fed.	199.3 A	5.39 B	171.0 B	70.83 C	127.3 C	198.2 C	209.9 A	5.74 B	175.9 C	72.33 C	127.5 C	199.8 C
30 kg organic-N/fed. +30 kg mineral-N/fed.	197.1 B	5.54 AB	173.8 A	85.83 B	149.7 A	235.6 B	208.6 B	5.94 A	178.8 B	88.42 B	150.9 B	239.3 B
Biofertilizer												
Without biofertilizer	196.4 A	5.55 A	172.4 B	82.78 B	139.6 B	222.4 B	207.8 B	5.85 B	177.8 B	85.44 B	140.4 B	222.1 B
Biofertilizer (Microbin)	197.4 A	5.60 A	173.8 A	90.33 A	142.7 A	233.1 A	208.6 A	5.95 A	178.8 A	91.41 A	148.0 A	239.4 A
Foliar application												
Without foliar application	196.0 B	5.62 A	172.6 A	83.00 C	139.9 B	222.9 B	208.0 B	5.91 A	178.1 A	84.78 C	141.4 B	220.6 B
Delfan (amino acids)	198.1 A	5.61 A	173.5 A	91.50 A	145.2 A	236.7 A	208.8 A	5.91 A	178.8 A	93.50 A	148.7 A	242.2 A
garlic extract	196.6 AB	5.51 A	173.1 A	85.17 B	138.3 B	223.5 B	207.9 B	5.87 A	178.1 A	87.00 B	142.6 B	229.6 B

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

4.1.8.1.2. Effect of biofertilizer

Data (Table, 27) show that biofertilizer inoculation reflected in the highest values of fruit vitamin-C, reducing, non-reducing and total sugars as compared with the control i.e. without biofertilizer addition, as shown in both seasons. These results are in harmony with those of Abo El-Hamd *et al.* (2006) on strawberry.

4.1.8.1.3. Effect of foliar application

Treatments sprayed with Delfan (amino acids) highest values of acidity, reducing, non-reducing and total sugars content of fruits with a significant increase as compared with other spraying treatments i.e. garlic extract or without any application in both seasons (Table, 27). With respect to T.S.S and vitamin-C content of sweet pepper fruit, plants which sprayed by amino acids, garlic extract or without foliar application were not significantly differed from each other, in both seasons.

4.1.8.1.4. Effect of the interaction between N-fertilizer sources, biofertilizer and foliar spray treatments

Data (Tables, 28 and 29) show that adding 60kg organic-N with biofertilizer and foliar application with Delfan or without any foliar application or adding 60kg organic-N without biofertilizer and sprayed with amino acids had no significant difference from each other with respect to total sugars content of fruits in both seasons.

Data also show that adding 60kg organic-N or 30kg organic-N + 30kg mineral-N with or without biofertilizer

Table (28): Effect of interaction between N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments of Delfan (amino acids) and garlic extract on fruit chemical constituents of sweet pepper plants during the summer season of 2004.

Treatments		Characters	Acidity mg/100cm^3	T.S.S %	Vitamin C mg/100g	Sugars mg/100g (F.W.)		
						Reducing	Non-reducing	Total
60 kg organic-N/fed.	Without biofertilizer	Without foliar application	193.0 E	5.61 ABC	173.1 ABC	99.33 C	142.7 CD	242.0 BCD
		Delfan (amino acids)	193.7 E	6.03 A	175.1 A	106.3 A	144.7 CD	251.0 AB
		garlic extract	194.0 E	5.76 ABC	174.4 AB	105.3 AB	141.0 DE	246.3 BC
	Biofertilizer (Microbin)	Without foliar application	194.3 DE	5.96 AB	174.1 AB	100.3 BC	160.7 A	261.0 A
		Delfan (amino acids)	196.2 BCDE	5.83 ABC	175.2 A	105.3 AB	155.3 AB	260.7 A
		garlic extract	194.3 DE	5.66 ABC	174.6 AB	101.3 ABC	134.3 EF	235.7 CD
60 kg mineral-N/fed.	Without biofertilizer	Without foliar application	196.8 BCDE	5.40 BC	169.2 D	54.33 K	130.7 FG	185.0 G
		Delfan (amino acids)	200.9 AB	5.26 C	170.3 CD	64.33 I	124.0 G	188.3 G
		garlic extract	197.2 ABCDE	5.35 C	169.5 D	59.33 J	127.7 FG	187.0 G
	Biofertilizer (Microbin)	Without foliar application	199.7 ABC	5.36 BC	171.8 ABCD	76.33 H	114.7 H	191.0 FG
		Delfan (amino acids)	201.7 A	5.50 ABC	173.8 AB	92.33 DE	143.3 CD	235.7 CD
		garlic extract	199.7 ABC	5.46 ABC	171.5 BCD	78.33 GH	123.7 G	202.0 F
30 kg organic-N/fed. +30 kg mineral-N/fed.	Without biofertilizer	Without foliar application	196.3 BCDE	5.83 ABC	173.9 AB	79.33 GH	141.7 CD	221.0 E
		Delfan (amino acids)	196.3 BCDE	5.40 BC	172.0 ABCD	93.33 D	148.7 BCD	242.0 BCD
		garlic extract	199.0 ABCD	5.36 BC	173.8 AB	83.33 FG	155.3 AB	238.7 BCD
	Biofertilizer (Microbin)	Without foliar application	195.7 CDE	5.58 ABC	173.4 ABC	88.33 DEF	149.3 BC	237.7 CD
		Delfan (amino acids)	199.7 ABC	5.63 ABC	174.7 AB	87.33 EF	155.3 AB	242.7 BCD
		garlic extract	195.3 CDE	5.46 ABC	174.8 AB	83.33 FG	148.0 BCD	231.3 DE

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

Table (29): Effect of interaction between N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments of Delfan (amino acids) and garlic extract on fruit chemical constituents of sweet pepper plants during the summer season of 2005.

Treatments		Characters	Acidity mg/100cm^3	T.S.S %	Vitamin C mg/100g	Sugars mg/100g (F.W.)		
						Reducing	Non-reducing	Total
60 kg organic-N/fed.	Without biofertilizer	Without foliar application	205.0 F	6.05 AB	179.0 ABC	102.0 B	146.5 EF	215.2 DEF
		Delfan (amino acids)	206.0 EF	5.76 ABCD	180.5 AB	110.5 A	151.0 D	261.5 AB
		garlic extract	205.3 F	6.10 A	179.5 ABC	107.5 A	143.0 F	250.5 ABC
	Biofertilizer (Microbin)	Without foliar application	206.0 EF	6.10 A	180.5 AB	100.2 BC	163.0 A	263.2 A
		Delfan (amino acids)	208.0 CDE	6.10 A	181.5 A	107.5 A	159.0 B	266.5 A
		garlic extract	207.0 DEF	6.00 ABC	180.5 AB	99.50 BC	162.3 AB	261.8 AB
60 kg mineral-N/fed.	Without biofertilizer	Without foliar application	209.0 ABCD	5.60 D	174.5 E	58.50 K	125.0 G	183.5 G
		Delfan (amino acids)	210.0 ABC	5.70 BCD	175.5 DE	64.50 J	125.0 G	189.5 FG
		garlic extract	209.0 ABCD	5.65 CD	175.0 E	61.50 JK	125.0 G	186.5 G
	Biofertilizer (Microbin)	Without foliar application	210.3 AB	5.80 ABCD	176.5 CDE	75.50 I	121.2 G	196.5 FG
		Delfan (amino acids)	211.0 A	5.90 ABCD	177.5 BCDE	92.50 DE	148.0 DE	240.5 ABCD
		garlic extract	210.0 ABC	5.80 ABCD	176.5 CDE	81.50 H	121.0 G	202.5 EFG
30 kg organic-N/fed. +30 kg mineral-N/fed.	Without biofertilizer	Without foliar application	209.0 ABCD	6.00 ABC	179.5 ABC	81.50 H	143.2 F	224.5 CDE
		Delfan (amino acids)	209.0 ABCD	6.00 ABC	178.5 ABCD	96.50 CD	150.0 DE	246.5 ABC
		garlic extract	208.0 CDE	5.80 ABCD	178.5 ABCD	86.50 FG	155.0 C	241.5 ABCD
	Biofertilizer (Microbin)	Without foliar application	208.5 BCD	5.95 ABCD	178.5 ABCD	91.00 EF	149.5 DE	240.5 ABCD
		Delfan (amino acids)	209.0 ABCD	6.00 ABC	179.5 ABC	89.50 EFG	159.0 B	248.5 ABC
		garlic extract	208.0 CDE	5.90 ABCD	178.5 ABCD	85.50 GH	149.0 DE	234.5 BCD

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

addition gave similar and higher vitamin-C content of sweet pepper fruits than all other treatments as a general trend in both seasons.

The treatments which received 60kg organic-N with or without biofertilizer and 30kg organic-N + 30kg mineral-N with biofertilizer gave similar and higher T.S.S of sweet pepper fruits as compared with all other treatments in both seasons.

The highest values of acidity were obtained by using 60kg mineral-N and biofertilizer inoculation with or without foliar application, the treatment with 60kg mineral-N without biofertilizer and foliar application with amino acids or garlic extract or the treatment supplied with 30kg organic-N + 30kg mineral-N with biofertilizer and foliar application with amino acids were not significantly differed from each other, in both seasons. However the treatments which supplied by 60kg mineral-N without biofertilizer inoculation gave the least values of fruit chemical constituents; TSS, vitamin-C, reducing and total sugars as a general trend in both seasons.

4.1.8.2. Fruit nitrate-N content

Data (Table, 30 and Fig. 3) show that nitrate accumulation in fruits was relatively low in plants received organic-N, medium in plants fertilized with 30kg mineral-N+30kg organic-N and high in plants supplied with 60kg mineral-N within all treatments. This result is in harmony with the results of total-N uptake in leaves and fruits of plants supplied with 60 kg mineral-N (Table, 15). It is clear also that plants supplied with all N dose (60 kg N) in the mineral form with or without biofertilizer

Table (30): Effect of interaction between N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments of Delfan (amino acids) and garlic extract on heavy metals and nitrate nitrogen (mg / kg DW) content of sweet pepper fruits during the summer seasons of 2004 & 2005.

Treatments / Characters			First Season (2004)				Second Season (2005)			
			Cd	Ni	Pb	NO_3-N	Cd	Ni	Pb	NO_3-N
60 kg organic-N/fed.	Without biofertilizer	Without foliar application	ND	2.4	1.21	193.2 G	ND	2.4	0.9	195.4 G
		Delfan (amino acids)	ND	2.8	0.75	174.7 H	ND	2.3	0.5	178.0 H
		garlic extract	0.06	2.5	0.94	192.3 G	0.05	2.7	0.7	197.2 G
	Biofertilizer (Microbin)	Without foliar application	ND	2.8	0.45	164.4 I	ND	2.8	1.6	166.7 I
		Delfan (amino acids)	ND	2.9	1.48	118.7 K	0.05	2.9	0.8	122.6 K
		garlic extract	0.05	2.3	1.18	135.9 J	0.06	2.7	1.3	138.0 J
60 kg mineral-N/fed.	Without biofertilizer	Without foliar application	ND	2.7	0.87	270.8 AB	ND	2.5	0.5	279.3 A
		Delfan (amino acids)	ND	2.9	0.63	257.0 CD	ND	2.1	1.3	260.6 C
		garlic extract	ND	2.7	1.76	265.2 ABC	ND	2.6	0.7	269.6 B
	Biofertilizer (Microbin)	Without foliar application	ND	2.7	1.29	273.1 A	ND	2.4	1.4	277.7 A
		Delfan (amino acids)	ND	2.9	2.29	252.8 D	ND	2.7	0.8	261.8 C
		garlic extract	ND	3.1	0.74	263.2 BC	ND	2.6	0.6	266.5 B
30 kg organic-N/fed. +30 kg mineral-N/fed.	Without biofertilizer	Without foliar application	ND	2.8	0.88	235.1 E	0.04	2.8	1.5	238.3 D
		Delfan (amino acids)	0.05	2.3	1.51	230.9 EF	0.05	2.3	2.2	233.1 E
		garlic extract	0.05	2.8	0.53	234.6 E	0.05	2.2	0.8	237.2 DE
	Biofertilizer (Microbin)	Without foliar application	ND	2.1	1.41	223.7 F	ND	2.5	1.4	216.7 F
		Delfan (amino acids)	ND	2.5	1.13	194.4 G	ND	3.0	0.8	197.7 G
		garlic extract	ND	3.1	0.60	199.0 G	ND	2.8	0.7	198.5 G

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

ND = Not detected.

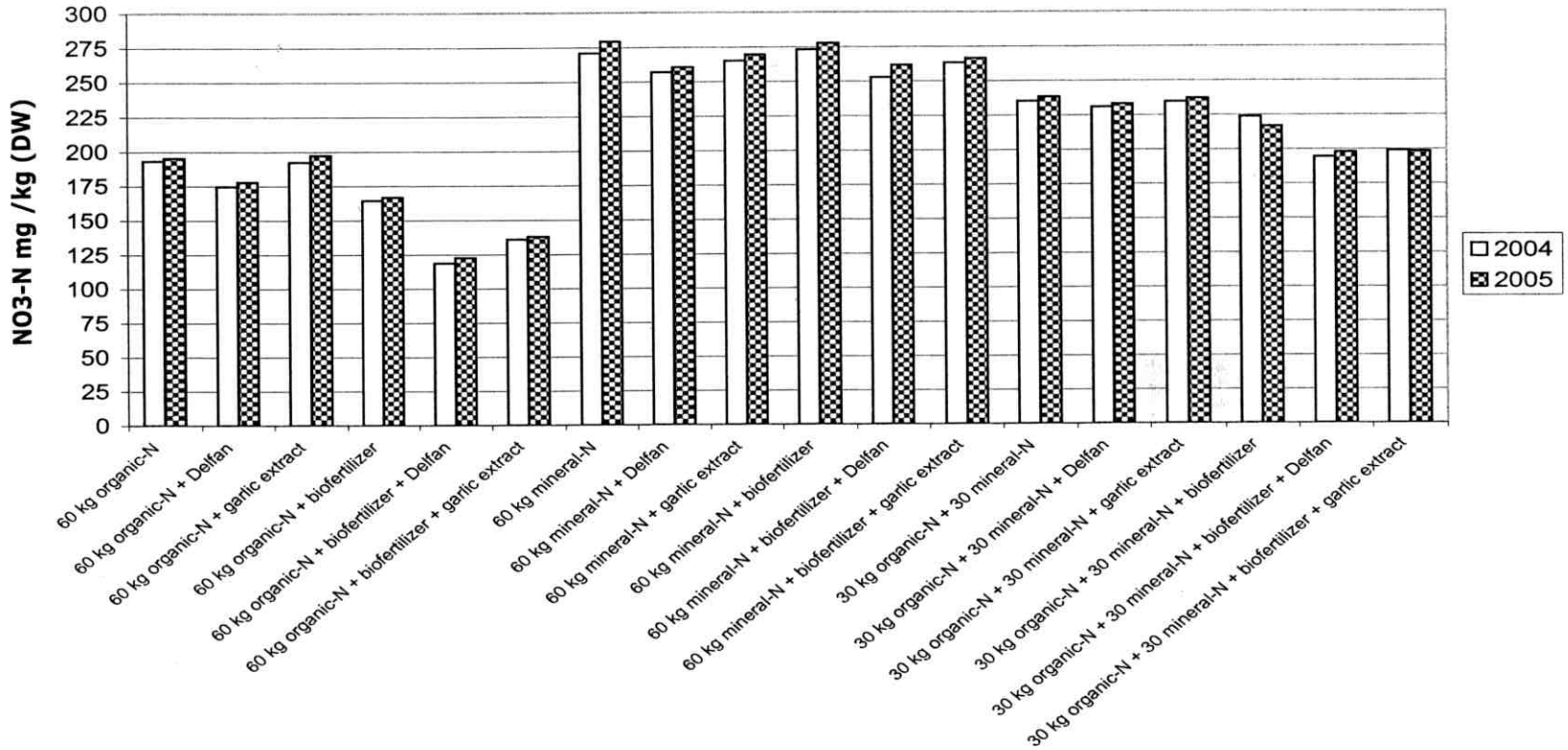


Fig. (3): Effect of interaction between N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments of Delfan (amino acids) and garlic extract on nitrate content of sweet pepper fruits during the summer seasons of 2004 & 2005.

inoculation and no foliar spray showed the highest nitrate-N accumulation in fruits reached 270.8-279.3 ppm, this result reflect the high N-uptake in such treatments which led to high nitrate accumulation as a general trend in both seasons.

On the other hand, the lowest NO_3-N accumulation in fruit was 118.7-122.6 ppm (Table, 30) in plants fertilized with all N in the organic form (60 kg N as biogas) and inoculated with microbin and sprayed with Delfan (amino acids). This result reflect the high N-assimilation of this treatment as compared with all other treatments which led to good plant growth, moderate fruit yield with less nitrate accumulation in fruits. Therefore, application of all N as biogas (organic-N) and inoculation with microbin could be recommended to get the lowest nitrate-N accumulation in fruits.

It is worthy to mention that NO_3-N concentration in sweet pepper fruits found in this experiment is still in the safe border for human consumption. These results are in harmony with Gabal (1983) who mentioned that NO3-N accumulation was high in stem and leaves however it was very low in sweet pepper fruits ranged from 50 – 750 ppm NO3-N due the cultivar, level and source of N-fertilizer.

4.1.8.3. Fruit heavy metal content

From data Table (30) and Figs (4 and 5) it could be concluded that Cd, Ni and Pb content of sweet pepper fruits in all treatments and in the two seasons did not exceed the critical limits which are 5-700 ppm Cd and 50-200 ppm Ni according to

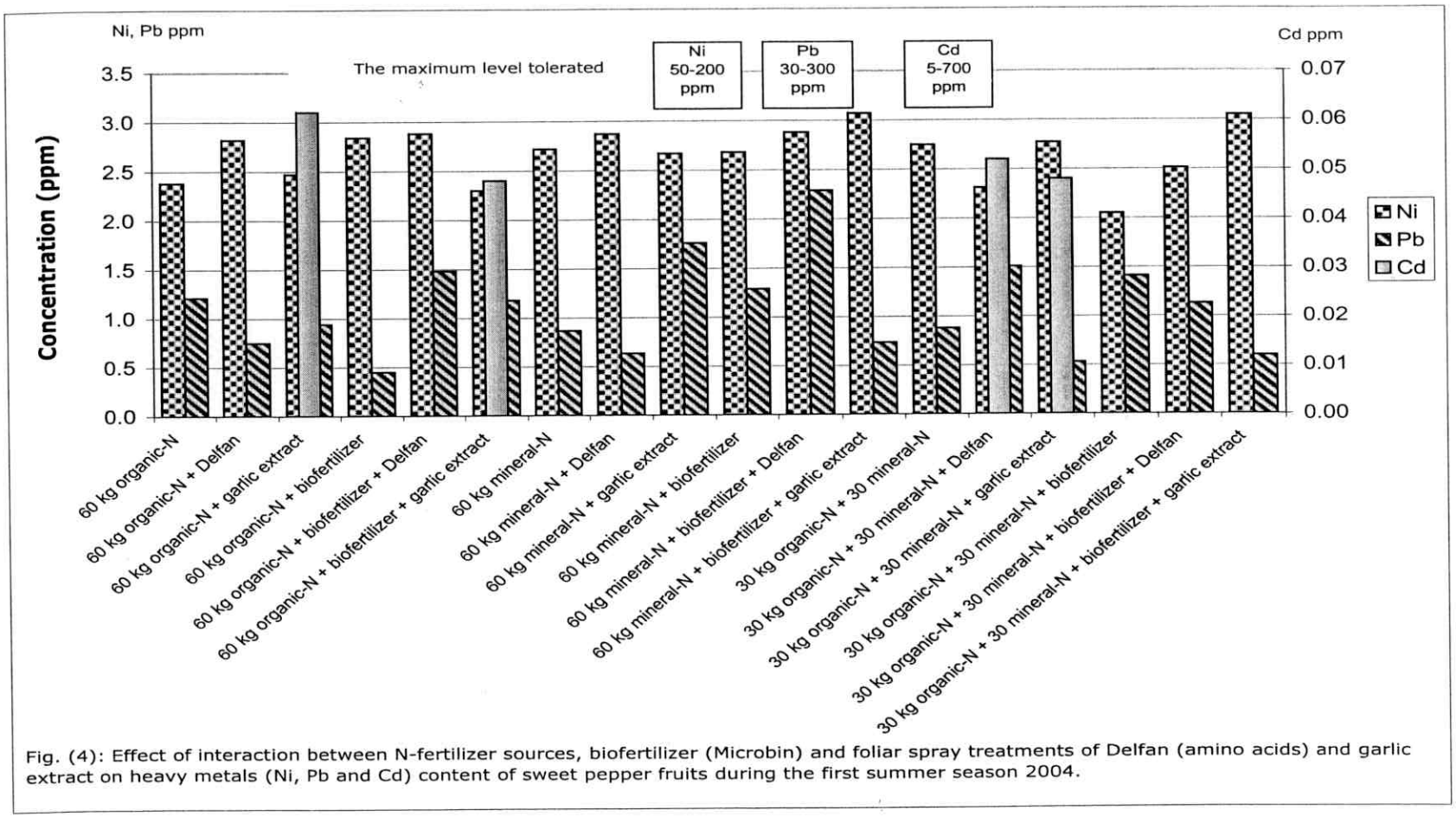


Fig. (4): Effect of interaction between N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments of Delfan (amino acids) and garlic extract on heavy metals (Ni, Pb and Cd) content of sweet pepper fruits during the first summer season 2004.

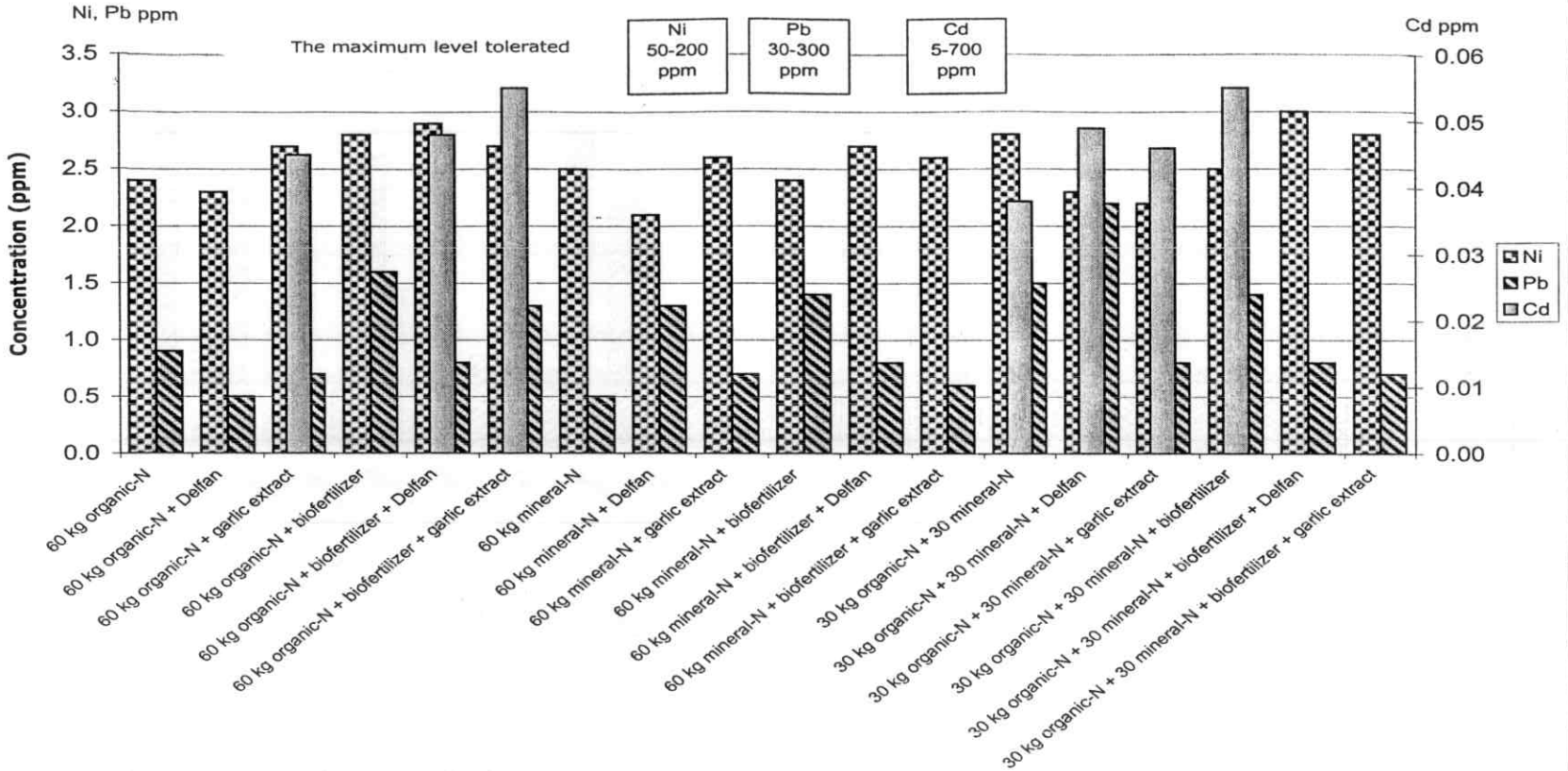


Fig. (5): Effect of interaction between N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments of Delfan (amino acids) and garlic extract on heavy metals (Ni, Pb and Cd) content of sweet pepper fruits during the second summer season 2005.

Brown et al. (1983) and 30-300 ppm Pb as mentioned by Kabata-Pendias and Pendias (2000).

With regard to Cd concentration in pepper fruits tissue in all treatments in the two seasons, the maximum value was 0.06 ppm and the lowest value was 0.00 (not detected) while there was a clear positive relation between the content of Cd in fruits tissue and biogas manure application and garlic spray. Hence the treatments supplied with nitrogen fertilizer as 60 kg organic-N or 30 kg organic-N + 30 kg mineral-N recorded Cd accumulation in pepper fruits tissue (0.05 ppm Cd). However, no accumulation of Cd was detected in the treatments supplied with 60 kg mineral-N in the two seasons. The high Cd content of biogas fertilizer (0.198-0.203 ppm Cd) may explain the presence of Cd in treatment supplied with 60kg N as biogas or 30kg N as biogas + 30kg N as $(NH_4)_2SO_4$. These results are in harmony with those of Eissa (1996) on sweet pepper.

Regarding with Ni and Pb content in pepper fruit tissues it could be concluded that the highest content of Ni (3.1 ppm) and Pb (2.29 ppm) among all treatments during two seasons. The maximum relative Ni content of fruit was found in plants fertilized with 60kg mineral-N or 30kg mineral-N + 30kg organic-N and inoculated with Microbin and sprayed with Delfan or garlic extract. Furthermore fruits of plants supplied with 60 kg organic-N as biogas and inoculated with Microbin and sprayed with Delfan or not sprayed showed a relative high Ni content ranged from 2.8 - 3.1 ppm Ni, as a general trend in both seasons. It is worth to mention that Ni content of fruits still

at the safe border for human consumption according to Brown *et al.* (1983) who mentioned that 50 – 200 ppm of Ni is still safe.

With respect to pb content of fruits it ranged from 0.45 – 2.29 ppm, whereby the relative high content was found in fruits of plants fertilized with 60kg organic-N, inoculated with Microbin and sprayed with Delfan. Moreover, plants fertilized with 30kg organic-N + 30kg mineral-N, without biofertilizer inoculation and sprayed with Delfan showed relative high pb content in fruits (1.51 – 2.2 ppm), as shown in both seasons. It seems that organic-N application (biogas) and foliar spray with Delfan (amino acids) tended to produce fruits with relatively high Pb. Whereas Pb content of fruits still in the safe border in both seasons according to Kabata-Pendias and Pendias (2000) who mentioned that 30 – 300 ppm Pb is still safe for human toxicity.

4.1.8.4. Fruit micronutrients content

Data Table (31) and Figs (6, 7 and 8) showed that fruit tissue analysis for Fe, Zn, Mn and Cu in all treatments are still at the safe normal concentration ranges, as a general trend in both seasons.

It could be concluded that the Fe accumulation in pepper fruits tissue ranged between 68-197 in the two seasons and in all treatments which matched with normal concentration range as 25-300 ppm Fe according to Beeson, 1941, Chapman, 1973 and Chaney, 1989. Plants supplied with 60kg organic-N, inoculated with Microbin and sprayed with Delfan showed the highest relative Fe content of fruits. Moreover, plants supplied with 30kg

Table (31): Effect of interaction between N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments of Delfan (amino acids) and garlic extract on micronutrients (mg/kg DW) content of sweet pepper fruits during the summer seasons of 2004 & 2005.

Treatments		Characters	First Season (2004)				Second Season (2005)			
			Fe	Zn	Mn	Cu	Fe	Zn	Mn	Cu
60 kg organic-N/fed.	Without biofertilizer	Without foliar application	81	24	24	14.7	76	25	22	15.5
		Delfan (amino acids)	73	25	25	16.5	70	22	26	14.3
		garlic extract	108	22	21	14.6	101	26	24	18.4
	Biofertilizer (Microbin)	Without foliar application	105	22	24	14.7	102	28	28	16.7
		Delfan (amino acids)	197	30	26	15.0	191	26	21	17.4
		garlic extract	79	27	23	14.2	74	30	26	14.5
60 kg mineral-N/fed.	Without biofertilizer	Without foliar application	87	28	22	13.3	80	31	24	15.8
		Delfan (amino acids)	131	33	27	19.4	130	27	28	16.7
		garlic extract	171	36	28	18.4	175	25	27	17.1
	Biofertilizer (Microbin)	Without foliar application	76	25	22	16.4	74	24	29	15.3
		Delfan (amino acids)	92	25	23	17.5	87	31	23	18.2
		garlic extract	82	30	22	16.8	85	26	24	16.5
30 kg organic-N/fed. +30 kg mineral-N/fed.	Without biofertilizer	Without foliar application	117	27	25	17.3	122	28	25	14.3
		Delfan (amino acids)	120	24	22	15.7	114	22	21	13.7
		garlic extract	113	26	24	14.2	111	27	30	15.3
	Biofertilizer (Microbin)	Without foliar application	192	27	30	16.0	197	28	26	17.4
		Delfan (amino acids)	68	22	21	14.4	70	25	27	16.5
		garlic extract	79	26	21	14.8	82	27	28	15.4

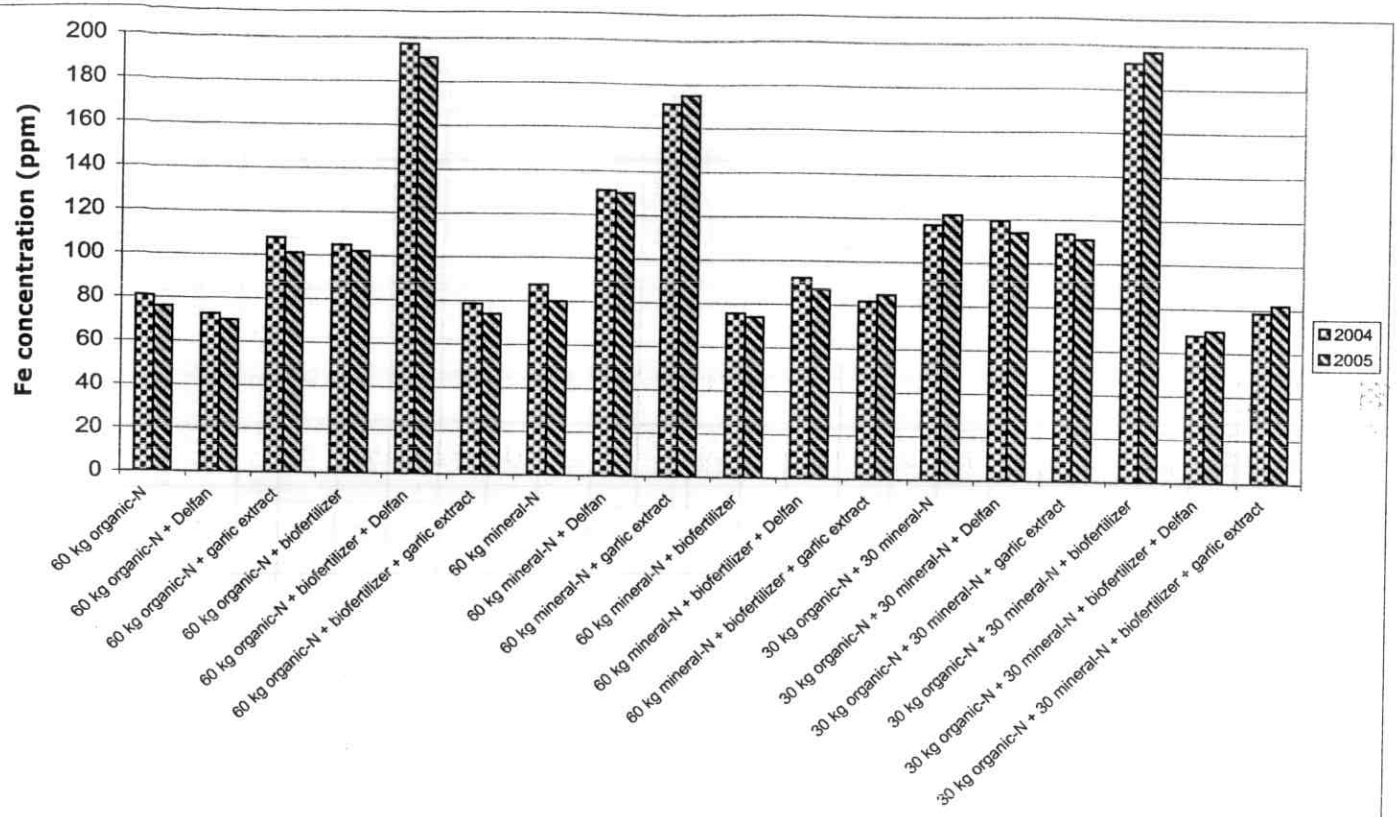


Fig. (6): Effect of interaction between N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments of Delfan (amino acids) and garlic extract on Fe content of sweet pepper fruits during the summer seasons of 2004 & 2005.

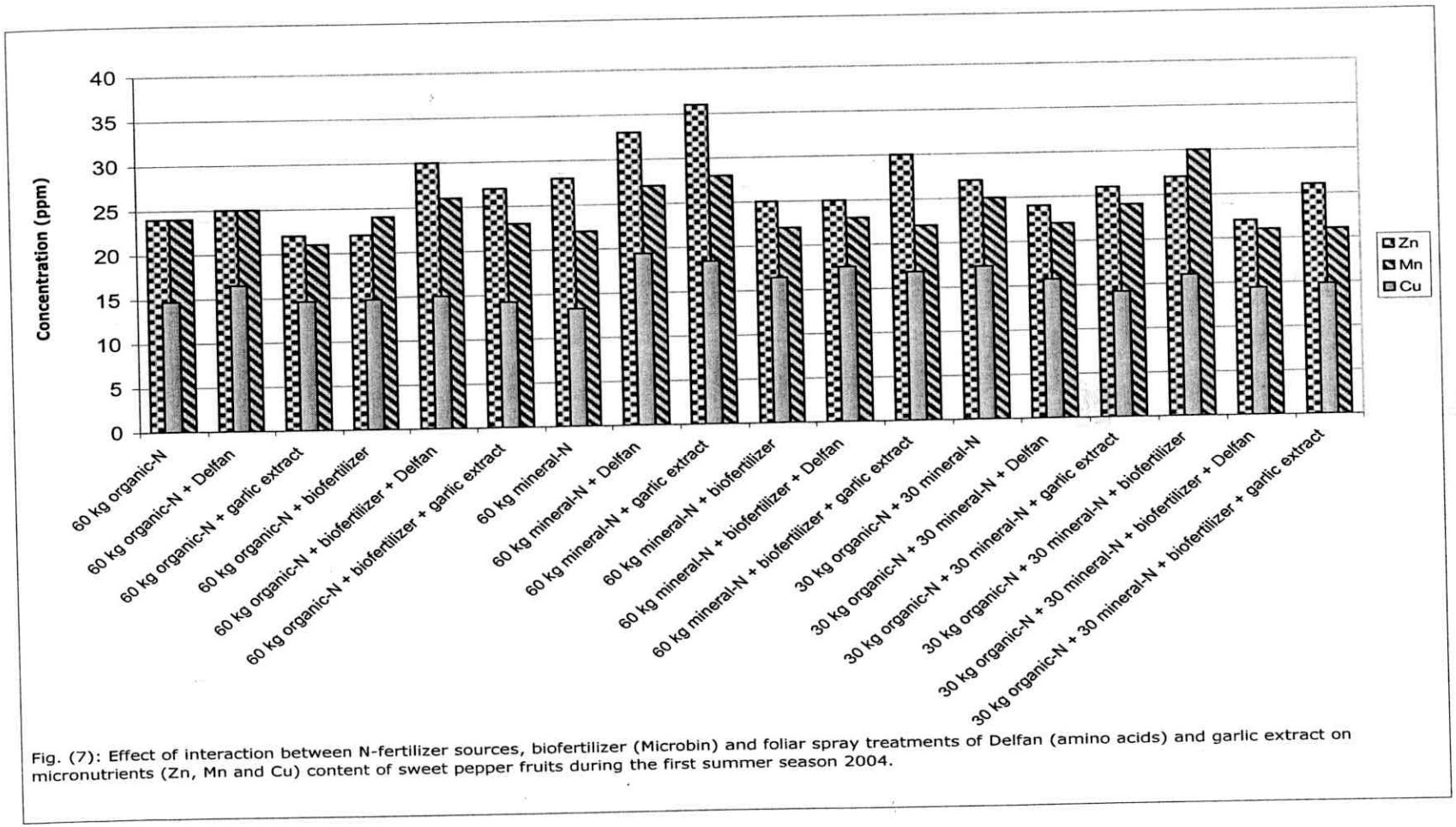


Fig. (7): Effect of interaction between N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments of Delfan (amino acids) and garlic extract on micronutrients (Zn, Mn and Cu) content of sweet pepper fruits during the first summer season 2004.

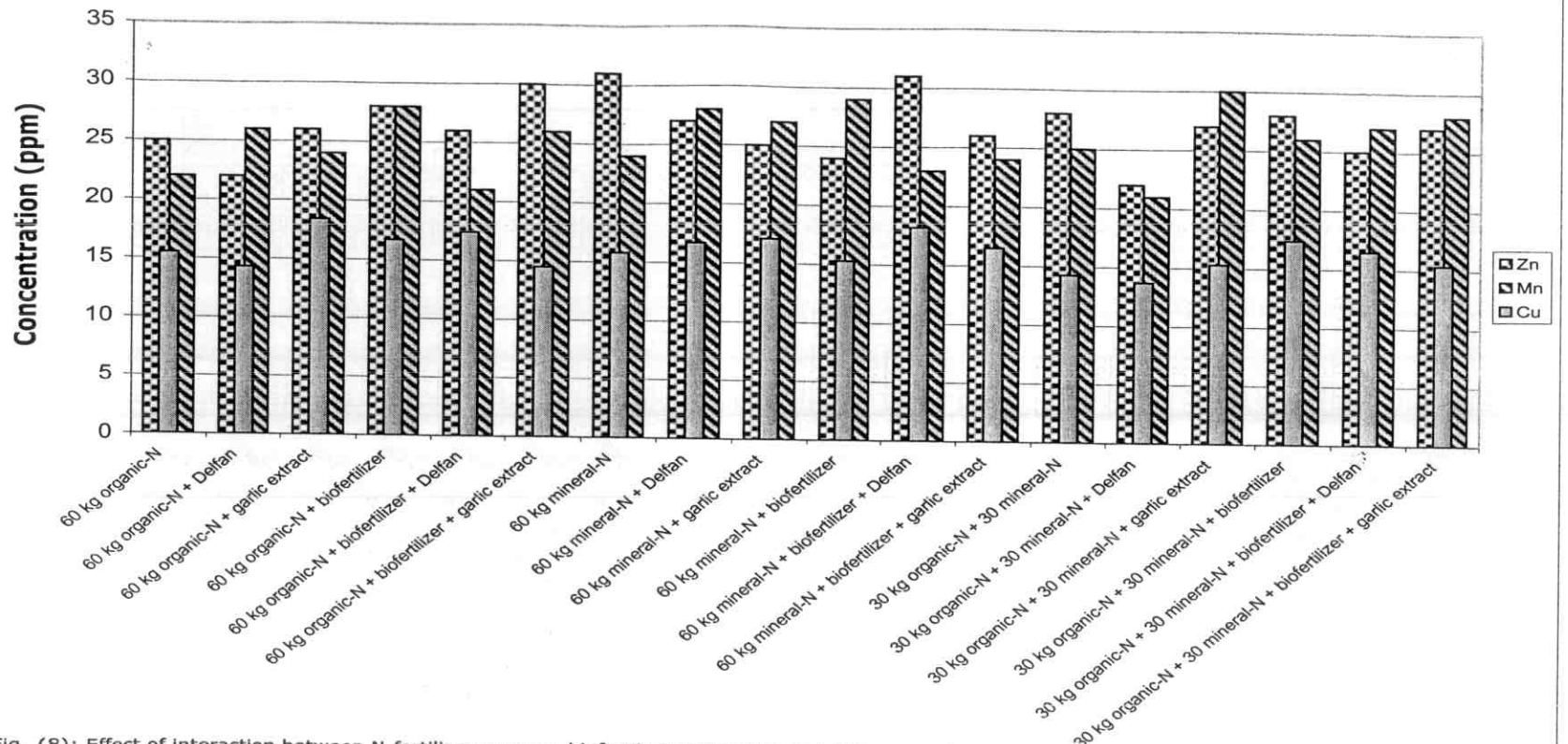


Fig. (8): Effect of interaction between N-fertilizer sources, biofertilizer (Microbin) and foliar spray treatments of Delfan (amino acids) and garlic extract on micronutrients (Zn, Mn and Cu) content of sweet pepper fruits during the second summer season 2005.

organic-N + 30kg mineral-N, inoculated with Microbin showed a relative high Fe-content of fruits. Furthermore, plants received 60kg mineral-N with biofertilizer and sprayed with garlic acid or Delfan accumulated relatively high Fe in fruit tissues. It seems that Fe accumulation in fruits was associated with organic fertilizer (biogas) application as well as biofertilizer inoculation treatments.

Regarding to Zn accumulation in pepper fruit tissues it ranged between 22-36 ppm in the two seasons and in all treatments that was in the normal range of 10-100 reported by Beeson (1941) and Chapman (1973). Data (Table, 31 and Figs. 7 & 8) show that Delfan (amino acids) and garlic foliar spray were the more effective treatments which relatively increased Zn content of fruits when plants were fertilized with 60kg N in the organic or mineral form.

Also, Mn accumulation in pepper fruits tissue was in the range of 21-30 in the two seasons and in all treatments that was matched with the normal concentration range 35-300 according to Beeson (1941) and Chapman (1973). Hence Cu accumulation in pepper fruits tissue was in the range of 13.3-19.44 ppm in the two seasons and in all treatments that was in the normal range 3-20 ppm according to Chaney (1989).

Conclusion

It could be recommended that inoculating sweet pepper seeds just before seed sowing and transplant roots before transplanting process with the biofertilizer "Microbin" and supplying developed plants with 30 kg N in the organic form

(Biogas manure) + 30 kg N in the mineral form (ammonium sulphate) and sprayed with Delfan (amino acids, 3 ml/ℓ) seven times at 14 days intervals starting 21 days after transplanting, led to the highest vegetative growth, early and total fruit yield as well as the best physical and chemical fruit quality of sweet pepper, cv. California Wonder when grown in clay loam soil.

4.2. Second experiment

"Effect of protecting method, chilling seeds and foliar application treatments with Delfan, sucrose and micronutrients on cold tolerance and productivity of sweet pepper grown at winter season"

Pepper plant considered as a tropical plant as it couldn't take its temperature requirements for growth and flowering in winter under Egyptian condition thus the decrease in temperature degrees (10-13°C) might retard plant growth and initiation of floral buds (Hassan, 1989), hence if it planted under low plastic tunnels in winter it will give a good growth, Shafshak (1983) on winter sweet pepper and Saleh (1992) and Darwesh (1996) on tomato plants.

In this experiment we try to increase or improve cold tolerance of sweet pepper plants grown in winter season in the open field or under polyethylene tunnels by mean of chilling swollen seeds under -1°C for 24 hrs before sowing or by spraying plants with amino acids, micronutrients (Fe, Zn, Mn), sucrose or with a mixed of micronutrients, sucrose and amino acids. This study included 3 factors which are protecting method,

seed chilling and foliar spray treatments. Results were recorded on the effect of these 3 factors and its interaction on:

1- Vegetative growth of sweet pepper plants

2- Chemical composition of plant foliage

3- Flowering time and fruit setting

4- Early and total yield

5- Fruit physical characteristics

6- Fruit chemical constituents

4.2.1. Vegetative growth:

4.2.1.1. Effect of low plastic tunnels:

Protecting sweet pepper cv. California Wonder in winter season under low plastic tunnels (Table, 32) significantly increased vegetative growth characteristics i.e., plant height, stem diameter, leaf area, fresh and dry weight than that of the open field. This trend was true in both seasons. Results are confirmed with those indicated by Shafshak (1983) on winter sweet pepper and Saleh (1992) and Darwesh (1996) on tomato plants.

4.2.1.2. Effect of seeds chilling:

Treating seeds pre sowing at low temperature (Table, 32) significant increased vegetative growth characteristics i.e., leaf area, fresh and dry weight as compared with unchilled seeds. This trend was true in both seasons.

Treating pepper seeds after dipping in water with low temperature increased plant tolerance to low temperature subjected during winter conditions, which called adaptation, that

Table (32): Effect of plants protecting method, pre-sowing seeds chilling treatment or foliar spray treatments on vegetative growth of sweet pepper plants during the winter seasons of 2005/2006 & 2006/2007.

Characters / Treatments	First Season (2005/2006)					Second Season (2006/2007)				
	Plant height cm	Stem diameter cm	Leaf area cm^2/plant	Fresh weight g/plant	Dry weight g/plant	Plant height cm	Stem diameter cm	Leaf area cm^2/plant	Fresh weight g/plant	Dry weight g/plant
Protecting method										
Open field	24.05 B	1.11 B	1494 B	178.5 B	55.4 B	23.84 B	1.10 B	1479 B	170.8B	57.3 B
Under low plastic tunnels	49.81 A	1.42 A	5333 A	423.8 A	168.0 A	50.03 A	1.43 A	5333 A	420.3 A	169.6 A
Seeds chilling										
Unchilled seeds	36.31 A	1.25 A	3211 B	291.4 B	105.8 B	36.46 A	1.26 A	3205 B	284.2 B	107.8 B
Chilled seeds (-1°c)	37.55 A	1.27 A	3616 A	310.9 A	117.6 A	37.41 A	1.28 A	3607 A	306.9 A	119.1 A
Foliar application										
Without foliar application	36.45 A	1.27 A	3362 D	296.7 C	109.9 D	36.41 B	1.26 BC	3356 D	290.8 C	111.1 C
Delfan (amino acids)	37.38 A	1.26 A	3453 B	305.8 A	112.8 AB	37.27 AB	1.29 AB	3440 B	299.4 A	114.7 AB
Micronutrients	36.92 A	1.26 A	3410 C	301.5 B	111.5 BC	37.04 AB	1.25 C	3403 C	294.1 B	112.9 BC
Sucrose	36.43 A	1.25 A	3363 D	295.4 C	110.3 CD	36.35 B	1.24 C	3357 D	291.8 C	111.8 C
Mixed foliar application	37.48 A	1.28 A	3481 A	306.3 A	114.2 A	37.60 A	1.30 A	3474 A	301.8 A	116.7 A

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

could be explain the obtained positive results of chilled seeds on plant growth (Abdallah *et al.*,1984 on sweet pepper and Abdelhalim, 1990 and Gabal, 1990 on tomato plants).

Many investigators reported such favourable effect of exposing seeds to low temperature. They attributed this effect for hardening plants against frost. This may be due to the increase in total sugars and soluble protein in the cellular level (Ledov'skii and Bondarenko, 1974). Moreover, Chen and Li (1974) suggested that during cold acclimatization, higher abscisic acid (ABA) levels induce synthesis of specific proteins which are responsible for the increase of frost hardness. Exposure of tomato plant leaves to low temperature may help plants afterwards to induce frost injury through the effect on the degree of stomatal aperture (Levitt, 1980).

4.2.1.3. Effect of foliar application:

Concerning the effect of foliar application on vegetative growth, data (Table, 32) show that foliar application with amino acids, micronutrients or mixed significantly improved plant growth, with respect to most studied vegetative growth parameters as compared with sucrose or not treated (control). Moreover, data show that sucrose application did not increase all vegetative growth characteristics than the control. Moreover, plant sprayed with mixed foliar application (sucrose, micronutrients and amino acids) significantly resulted the highest leaf area as compared with other spray materials. Data also show that spraying plants with amino acids or mixed treatment increased plant growth with respect to fresh and dry

weight with no significant difference between each other, as a general tread in both seasons.

In this connection, El-Fadaly (1992) on cucumber plants found that, applying a mixture of Fe, Zn and Mn as chelate (EDTA) improved vegetative growth. Maini and Sgattoni (1999) found that, the positive effect of foliar application of an amino acid on sweet pepper due to the anti-stress activity of the hydrolysed protein.

4.2.1.4. Effect of the interaction between seeds chilling and plant foliar spray treatments under low plastic tunnels or in the open field:

Data Tables (33 and 34) show that chilling seeds at -1°C and growing plants under low plastic tunnels had a considerable effect on improving plant growth, especially leaf area, dry weight and fresh weight as a general trend in both seasons. Moreover, data show that spraying plants with amino acids or with mixed foliar application and chilling seeds at low temperature and growing plants under low plastic tunnels gave the highest value of fresh and dry weight with significant difference as compared with all other treatments in both seasons. Spraying plants with micronutrients or amino acids came in the second rank due to plant growth when grown under plastic and chilling seeds at -1°C.

In spite of chilling treatments and foliar application, plants grown in open field had deleterious effects on plant height, stem diameter, leaf area as well as fresh and dry weight as without significant differences in both seasons. From the previous results

Table (33): Effect of interaction between protecting method, seeds chilling treatment and foliar spray treatments on vegetative growth of sweet pepper plants during the winter season of 2005/2006.

Treatments		Characters	Plant height cm	Stem diameter cm	Leaf area cm^2/plant	Fresh weight g/plant	Dry weight g/plant
Open field	Unchilled seeds	Without foliar application	22.78 C	1.15 B	1464 KL	173.9 J	52.6 I
		Delfan (amino acids)	23.75 C	1.08 B	1462 L	174.0 J	53.1 I
		Micronutrients	23.73 C	1.08 B	1461 L	172.3 J	52.8 I
		Sucrose	23.29 C	1.13 B	1456 L	173.1 J	52.9 I
		Mixed foliar application	24.09 C	1.06 B	1461 L	174.1 J	53.0 I
	Chilled seeds (-1°c)	Without foliar application	24.27 C	1.11 B	1491 K	178.0 IJ	56.7 H
		Delfan (amino acids)	25.03 C	1.08 B	1542 J	184.6 HI	57.9 GH
		Micronutrients	24.22 C	1.11 B	1490 K	182.4 HI	56.7 H
		Sucrose	25.18 C	1.16 B	1555 J	185.0 HI	58.2 GH
		Mixed foliar application	24.17 C	1.11 B	1563 J	187.5 H	60.1 G
Under low plastic tunnels	Unchilled seeds	Without foliar application	49.14 AB	1.35 A	4875 I	403.9 F	155.9 F
		Delfan (amino acids)	49.21 AB	1.46 A	5038 G	419.7 E	160.7 DE
		Micronutrients	49.18 AB	1.41 A	4967 H	413.2 E	158.9 EF
		Sucrose	47.77 B	1.38 A	4865 I	393.9 G	155.9 F
		Mixed foliar application	50.17 AB	1.43 A	5065 F	415.8 E	162.2 D
	Chilled seeds (-1°c)	Without foliar application	49.63 AB	1.47 A	5619 D	431.0 CD	174.2 C
		Delfan (amino acids)	51.53 A	1.41 A	5769 B	444.8 AB	179.5 AB
		Micronutrients	50.54 AB	1.43 A	5721 C	438.2 BC	177.4 B
		Sucrose	49.49 AB	1.33 A	5576 E	429.6 D	174.1 C
		Mixed foliar application	51.49 A	1.50 A	5835 A	447.6 A	181.3 A

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

Table (34): Effect of of interaction between protecting method, seeds chilling treatment and foliar spray treatments on vegetative growth of sweet pepper plants during the winter season of 2006/2007.

Treatments		Characters	Plant height cm	Stem diameter cm	Leaf area cm^2/plant	Fresh weight g/plant	Dry weight g/plant
Open field	Unchilled seeds	Without foliar application	23.51 E	1.09 E	1443 PQ	161.7 K	55.7 F
		Delfan (amino acids)	23.60 E	1.09 E	1442 PQ	163.2 K	56.4 F
		Micronutrients	23.68 E	1.09 E	1444 PQ	161.6 K	54.1 F
		Sucrose	23.49 E	1.09 E	1441 Q	162.5 K	55.0 F
		Mixed foliar application	23.39 E	1.09 E	1446 P	163.4 K	55.9 F
	Chilled seeds (-1°c)	Without foliar application	23.74 E	1.10 E	1495 N	174.7 J	56.6 F
		Delfan (amino acids)	24.28 E	1.12 E	1515 M	179.9 I	58.3 EF
		Micronutrients	23.92 E	1.10 E	1486 O	174.8 J	59.2 EF
		Sucrose	24.32 E	1.13 E	1534 L	180.5 I	58.9 EF
		Mixed foliar application	24.50 E	1.15 E	1549 K	185.5 H	62.6 E
Under low plastic tunnels	Unchilled seeds	Without foliar application	48.96 CD	1.41 BCD	4884 I	399.6 G	156.1 D
		Delfan (amino acids)	49.81 BCD	1.50 A	5031 G	412.9 E	163.7 C
		Micronutrients	49.51 BCD	1.40 CD	4976 H	406.1 F	160.2 CD
		Sucrose	48.15 D	1.38 D	4869 J	398.4 G	156.8 D
		Mixed foliar application	50.50 ABC	1.48 AB	5077 F	412.9 E	164.2 C
	Chilled seeds (-1°c)	Without foliar application	49.43 BCD	1.46 ABC	5602 D	427.0 D	175.8 B
		Delfan (amino acids)	51.37 AB	1.45 ABCD	5770 B	441.5 B	180.2 AB
		Micronutrients	51.06 AB	1.41 BCD	5707 C	434.0 C	178.1 B
		Sucrose	49.47 BCD	1.38 D	5585 E	425.6 D	176.6 B
		Mixed foliar application	51.99 A	1.48 AB	5824 A	445.2 A	184.2 A

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

it could be concluded that the foliar applications had no significant effect on vegetative growth in plants grown in open field.

Finally, it could be concluded that plants cultivated under low plastic tunnels gave the higher vegetative growth with significant differences as compared with that grown in the open field. This trend was true in both seasons.

It was found that tolerant plants produced soluble proteins and starch hydrolyzation (Öpik and Rolfe, 2005), so that the treatment with amino acids and sucrose induced plants to tolerate frost conditions. It could be concluded that using foliar application with mixed or amino acids alone improved growth and yield due to warm condition under low plastic tunnels comparing with untreated plant (open field). Also, it could be observed that no significant difference between plants which supplied with foliar application in open field but the differences between plants could be due to chilling treatments which applied to plant seeds.

4.2.2. Chlorophyll content:

4.2.2.1. Effect of low plastic tunnels:

Planting under low plastic tunnels (Table, 35) significantly increased chlorophyll a, b and total chlorophyll over the treatments in the open field. This trend was true in both seasons. These results are in harmony with those of Shafshak (1983) on sweet pepper and Darwesh (1996) on tomato plants and could be refered to the effect of plastic tunnels on air and soil temperature

Table (35): Effect of plants protecting method, pre-sowing seeds chilling treatment or foliar spray treatments on chlorophyll content (mg/100g fresh weight) in leaves of sweet pepper plants at flowering stage during the winter seasons of 2005/2006 & 2006/2007.

Characters / Treatments	First Season (2005/2006)			Second Season (2006/2007)		
	Chlorophyll a	Chlorophyll b	Total chlorophyll	Chlorophyll a	Chlorophyll b	Total chlorophyll
Protecting method						
Open field	65.96 B	25.08 B	91.0 B	65.36 B	25.45 B	90.8 B
Under low plastic tunnels	103.3 A	44.33 A	147.6 A	103.6 A	44.54 A	148.1 A
Seeds chilling						
Unchilled seeds	84.28 A	34.46 B	118.7 A	83.92 B	34.86 B	118.8 B
Chilled seeds (-1°c)	84.99 A	34.95 A	119.9 A	85.01 A	35.12 A	120.1 A
Foliar application						
Without foliar application	83.49 B	34.12 D	117.6 C	83.09 D	34.40 E	117.5 D
Delfan (amino acids)	85.01 AB	35.10 B	120.1 AB	85.39 B	35.40 B	120.8 B
Micronutrients	84.92 AB	34.61 C	119.5 B	84.37 C	34.90 C	119.3 C
Sucrose	83.68 B	34.21 D	117.9 C	83.33 D	34.53 D	117.9 D
Mixed foliar application	86.07 A	35.49 A	121.6 A	86.14 A	35.74 A	121.9 A

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

since it was warmer with 5-6°C than that of open field, (Somes, 1973).

4.2.2.2. Effect of seeds chilling:

Chilling seeds at low temperature (Table, 35) significantly increased chlorophyll a, b and total chlorophyll over that of unchilled seeds, especially in the second season. However, chlorophyll b was significantly increased in plant grown after seed chilling, as a general trend in both seasons. Results are confirmed with those indicated by Abdallah *et al.* (1984) on winter sweet pepper

4.2.2.3. Effect of foliar application:

Concerning the effect of foliar application on chlorophyll content of leaves, data (Table, 35) show that foliar application (mixed, amino acids and micronutrients) significantly differed from each other in a descending order, with respect to chlorophyll a, b and total chlorophyll, especially in the second season. Moreover, data show that sucrose application did not increase chlorophyll a and total chlorophyll content of leaves than the control (without foliar application).

4.2.2.4. Effect of the interaction between seeds chilling and plant foliar spray treatments under low plastic tunnels or in the open field:

Data Tables (36 and 37) show that chilling seeds at -1°C or not and grown under low plastic tunnels with mixed foliar application gave the highest chlorophyll a, b and total chlorophyll content of leaves with significant increase than other

Table (36): Effect of of interaction between protecting method, seeds chilling treatment and foliar spray treatments on chlorophyll content (mg/100g fresh weight) in leaves of sweet pepper plants at flowering stage during the winter season of 2005/2006.

Treatments		Characters	Chlorophyll a	Chlorophyll b	Total chlorophyll
Open field	Unchilled seeds	Without foliar application	64.96 C	24.23 I	89.1 G
		Delfan (amino acids)	66.17 C	25.06 H	91.2 EFG
		Micronutrients	65.85 C	24.55 I	90.4 EFG
		Sucrose	65.23 C	24.23 I	89.4 FG
		Mixed foliar application	66.44 C	25.19 GH	91.6 EFG
	Chilled seeds (-1°c)	Without foliar application	65.35 C	25.18 GH	90.5 EFG
		Delfan (amino acids)	65.43 C	25.57 FG	91.0 EFG
		Micronutrients	65.33 C	25.10 H	90.4 EFG
		Sucrose	67.21 C	25.63 F	92.8 EF
		Mixed foliar application	67.62 C	26.10 E	93.7 E
Under low plastic tunnels	Unchilled seeds	Without foliar application	101.8 AB	43.54 D	145.3 CD
		Delfan (amino acids)	103.7 A	44.70 BC	148.4 ABC
		Micronutrients	104.0 A	44.38 C	148.4 ABC
		Sucrose	99.60 B	43.45 D	143.1 D
		Mixed foliar application	105.0 A	45.31 A	150.3 A
	Chilled seeds (-1°c)	Without foliar application	101.8 AB	43.52 D	145.4 CD
		Delfan (amino acids)	104.7 A	45.07 AB	149.8 A
		Micronutrients	104.5 A	44.41 C	148.9 AB
		Sucrose	102.7 AB	43.54 D	146.2 BCD
		Mixed foliar application	105.2 A	45.34 A	150.6 A

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

Table (37): Effect of of interaction between protecting method, seeds chilling treatment and foliar spray treatments on chlorophyll content (mg/100g fresh weight) in leaves of sweet pepper plants at flowering stage during the winter season of 2006/2007.

Treatments / Characters			Chlorophyll a	Chlorophyll b	Total chlorophyll
Open field	Unchilled seeds	Without foliar application	64.01 K	24.77 M	88.7 K
		Delfan (amino acids)	65.79 HIJ	25.55 J	91.3 HI
		Micronutrients	65.26 IJK	25.24 K	90.5 IJ
		Sucrose	63.81 K	24.77 M	88.5 K
		Mixed foliar application	66.25 HI	25.76 I	92.0 GH
	Chilled seeds (-1°c)	Without foliar application	64.47 JK	25.25 K	89.7 JK
		Delfan (amino acids)	66.20 HI	25.86 H	92.0 GH
		Micronutrients	64.54 JK	25.17 L	89.7 JK
		Sucrose	66.27 HI	25.92 H	92.1 GH
		Mixed foliar application	66.93 H	26.18 G	93.1 G
Under low plastic tunnels	Unchilled seeds	Without foliar application	101.2 FG	43.78 E	144.9 EF
		Delfan (amino acids)	104.0 CD	45.03 C	149.0 C
		Micronutrients	102.9 DE	44.57 D	147.5 D
		Sucrose	100.8 G	43.65 F	144.5 F
		Mixed foliar application	105.1 ABC	45.49 A	150.5 AB
	Chilled seeds (-1°c)	Without foliar application	102.7 DE	43.78 E	146.5 D
		Delfan (amino acids)	105.6 AB	45.16 B	150.7 A
		Micronutrients	104.7 BC	44.61 D	149.3 BC
		Sucrose	102.4 EF	43.78 E	146.2 DE
		Mixed foliar application	106.3 A	45.53 A	151.9 A

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

treatments except treatment sprayed with amino acids with chilling seed and grown under plastic, which gave simillar chlorophyll a and total chlorophyll content in leaves, as shown in both seasons. Oppositely, the treatments in open field gave the lowest content of chlorophyll a, b and total chlorophyll in leaves.

4.2.3. N uptake

4.3.1. Effect of low plastic tunnels:

Data (Table, 38) show that plants grown under low plastic tunnels contained the highest significant N accumulation in leaves, stems, fruits and whole plant over the treatments in the open field. This trend held true in both seasons.

4.2.3.2. Effect of seeds chilling:

Data (Table, 38) show that plants developed from chilled seeds had the highest significant N accumulation in leaves, stems, fruits and whole plant as compared with plants developed from unchilled seeds during both seasons.

4.2.3.3. Effect of foliar application:

Data (Table, 38) show that foliar application (mixed, amino acids, micronutrients and sucrose) significantly differed from each other in a descending order in leaves, stem, fruits total nitrogen uptake, this trend was true in both seasons. In addition plants sprayed with sucrose alone showed total-N uptake similar with unsprayed plants. i.e. sucrose application was not able to improve N-uptake than the control.

Table (38): Effect of plants protecting method, pre-sowing seeds chilling treatment or foliar spray treatments on N-content various plant parts of sweet pepper during the winter seasons of 2005/2006 & 2006/2007.

Characters / Treatments	First Season (2005/2006)				Second Season (2006/2007)			
	mg N/plant				mg N/plant			
	Leaves	Stem	Fruit	Total	Leaves	Stem	Fruit	Total
Protecting method								
Open field	397.7 B	132.8 B	355.7 B	886.2 B	388.0 B	142.8 B	358.7 B	889.6 B
Under low plastic tunnels	1537.0 A	509.0 A	2308.0 A	4354.0 A	1475.0 A	477.2 A	2311.0 A	4263.0 A
Seeds chilling								
Unchilled seeds	917.9 B	305.2 B	1130.0 B	2354.0 B	883.2 B	297.5 B	1132.0 B	2313.0 B
Chilled seeds (-1°c)	1017.0 A	336.6 A	1533.0 A	2887.0 A	979.4 A	322.5 A	1538.0 A	2840.0 A
Foliar application								
Without foliar application	952.5 D	316.3 D	1310 D	2579.0 D	917.0 D	305.7 D	1313 D	2536 D
Delfan (amino acids)	976.8 B	323.8 B	1346 B	2646.0 B	940.0 B	312.8 B	1349 B	2602 B
Micronutrients	966.3 C	320.6 C	1330 C	2617.0 C	929.2 C	309.6 C	1333 C	2572 C
Sucrose	952.8 D	316.5 D	1311 D	2581.0 D	918.9 D	305.9 D	1314 D	2539 D
Mixed foliar application	989.3 A	327.3 A	1363 A	2680.0 A	951.5 A	316.0 A	1366 A	2634 A

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

4.2.3.4. Effect of the interaction between seeds chilling and plants foliar spray treatments under low plastic tunnels or in the open field:

Data presented in Table (39) clearly show that pepper plants developed from chilled seeds and grown under low plastic tunnels and foliar sprayed with mixed, amino acids or micronutrients contained in a descending order the highest significant N accumulation in their leaves, stems, fruits and consequently the whole plant as compared with either sucrose or unsprayed plants which did not significantly differ from each other in most traits during both seasons.

On the contrary, the treatments in open field and unchilled seeds showed the lowest accumulation of N uptake in leaves, stems and total N uptake per plant. In this connection, no data could be taken regarding fruits, because under such conditions, no fruits could be produced.

4.2.4. P uptake

4.2.4.1. Effect of low plastic tunnels:

Data (Table, 40) show that plants grown under low plastic tunnels gave the highest significant P accumulation in leaves, stems, fruits and whole plant over the treatments grown in the open field. This trend was true in both seasons.

4.2.4.2. Effect of seeds chilling:

Data (Table, 40) show that plants developed from chilled seeds gave the highest significant P accumulation in leaves,

Table (39): Effect of of interaction between protecting method, seeds chilling treatment and foliar spray treatments on N-content various plant parts of sweet pepper during the winter seasons of 2005/2006 & 2006/2007.

Treatments		Characters	First Season (2005/2006) mg N/plant				Second Season (2006/2007) mg N/plant			
			Leaves	Stem	Fruit	Total	Leaves	Stem	Fruit	Total
Open field	Unchilled seeds	Without foliar application	378.4 N	131.1 K	NA	509.5 O	368.6 L	141.0 GH	NA	509.6 N
		Delfan (amino acids)	379.2 N	130.8 K	NA	509.9 O	369.1 L	140.7 H	NA	509.8 N
		Micronutrients	378.8 N	130.9 K	NA	509.7 O	369.2 L	140.8 H	NA	510.0 N
		Sucrose	378.3 N	131.1 K	NA	511.2 O	370.8 L	141.1 GH	NA	512.0 N
		Mixed foliar application	379.6 N	131.3 K	NA	510.9 O	368.7 L	141.1 GH	NA	509.8 N
	Chilled seeds (-1°c)	Without foliar application	408.4 M	132.5 JK	698.8 M	1240.0 N	400.5 JK	142.6 GH	704.6 M	1248.0 M
		Delfan (amino acids)	415.5 L	134.8 IJK	711.0 L	1261.0 M	406.5 JK	145.1 GH	716.9 L	1268.0 L
		Micronutrients	407.2 M	132.1 JK	696.7 M	1236.0 N	397.7 K	142.0 GH	702.5 M	1242.0 M
		Sucrose	419.6 L	136.1 IJ	718.1 K	1274.0 L	407.9 J	146.4 GH	724.1 K	1278.0 K
		Mixed foliar application	431.9 K	137.4 I	732.4 J	1302.0 K	421.4 I	147.8 G	738.5 J	1308.0 J
Under low plastic tunnels	Unchilled seeds	Without foliar application	1433 I	471.7 H	2224.0 H	4128.0 I	1371 H	446.9 F	2227.0 H	4045.0 I
		Delfan (amino acids)	1475 G	484.9 F	2288.0 F	4248.0 G	1413 F	459.5 DE	2291.0 F	4164.0 G
		Micronutrients	1459 H	480.0 G	2264.0 G	4203.0 H	1397 G	454.9 E	2267.0 G	4119.0 H
		Sucrose	1428 J	470.2 H	2216.0 I	4114.0 J	1375 H	445.5 F	2220.0 I	4041.0 I
		Mixed foliar application	1490 F	489.8 E	2312.0 E	4292.0 F	1428 E	464.1 D	2315.0 DE	4207.0 F
	Chilled seeds (-1°c)	Without foliar application	1591 D	530.0 D	2317.0 D	4438.0 D	1528 D	492.3 C	2320.0 D	4340.0 D
		Delfan (amino acids)	1638 B	544.9 B	2384.0 B	4566.0 B	1571 B	506.0 AB	2387.0 B	4464.0 B
		Micronutrients	1620 C	539.4 C	2359.0 C	4519.0 C	1553 C	500.9 B	2362.0 C	4416.0 C
		Sucrose	1586 E	528.4 D	2309.0 E	4423.0 E	1521 D	490.7 C	2313.0 E	4324.0 E
		Mixed foliar application	1655 A	550.5 A	2409.0 A	4614.0 A	1588 A	511.1 A	2412.0 A	4511.0 A

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

NA= not applicable. No fruits were obtained using these treatments

Table (40): Effect of plants protecting method, pre-sowing seeds chilling treatment or foliar spray treatments on P-content various plant parts of sweet pepper during the winter seasons of 2005/2006 & 2006/2007.

Characters / Treatments	First Season (2005/2006)				Second Season (2006/2007)			
	mg P/plant				mg P/plant			
	Leaves	Stem	Fruit	Total	Leaves	Stem	Fruit	Total
Protecting method								
Open field	40.99 B	28.33 B	36.49 B	105.8 B	42.92 B	30.35 B	37.04 B	110.3 B
Under low plastic tunnels	82.31 A	46.42 A	239.7 A	368.4 A	77.85 A	42.13 A	241.0 A	361.0 A
Seeds chilling								
Unchilled seeds	59.82 B	38.63 A	117.4 B	215.8 B	58.58 B	37.43 A	118.3 B	214.3 B
Chilled seeds (-1°c)	63.47 A	36.12 B	158.8 A	258.4 A	62.18 A	35.05 B	159.7 A	256.9 A
Foliar application								
Without foliar application	60.74 C	36.91 B	135.8 D	233.5 D	58.86 B	35.71 A	137.0 C	231.6 C
Delfan (amino acids)	62.12 AB	37.63 AB	139.5 B	239.3 B	60.36 AB	36.45 A	139.9 B	236.7 AB
Micronutrients	61.46 BC	37.27 AB	137.9 C	236.6 C	61.18 A	36.13 A	138.8 B	236.1 ABC
Sucrose	60.93 C	37.03 B	135.9 D	233.9 D	60.25 AB	36.05 A	137.0 C	233.3 BC
Mixed foliar application	62.97 A	38.03 A	141.3 A	242.3 A	61.26 A	36.88 A	142.4 A	240.5 A

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

fruits and whole plant as compared with plants developed from unchilled seeds during both seasons.

4.2.4.3. Effect of foliar application:

Data (Table, 40) show that plants sprayed with mixed substances (Delfan, micronutrients and Sucrose) gave the highest significant phosphorus uptake in fruits and whole plant as compared with other foliar applications, in both seasons. But the plants sprayed with sucrose were equal with those unsprayed (control) in leaves, stem, fruits and total phosphorus uptake, this trend was true in both seasons.

4.2.4.4. Effect of the interaction between seeds chilling and plant foliar spray treatments under low plastic tunnels or in the open field:

Data (Table, 41) show that the plants developed from chilled seeds and grown under low plastic tunnels with mixed foliar application gave the highest significant P accumulation in leaves, fruits and total phosphorus uptake as compared with all other treatments, except the plants sprayed with amino acids or micronutrients under the same conditions which had equal P accumulation in leaves, this trend was true in both seasons.

On the contrary, the treatments in open field and unchilled seeds showed the lowest accumulation of P uptake in leaves, stems and total P uptake per plant. In this connection, no data could be taken regarding fruits, because under such conditions, no fruits could be produced. Also, it could be observed that foliar

Table (41): Effect of of interaction between protecting method, seeds chilling treatment and foliar spray treatments on P- content various plant parts of sweet pepper during the winter seasons of 2005/2006 & 2006/2007.

Treatments		Characters	First Season (2005/2006) mg P/plant				Second Season (2006/2007) mg P/plant			
			Leaves	Stem	Fruit	Total	Leaves	Stem	Fruit	Total
Open field	Unchilled seeds	Without foliar application	39.03 H	27.99 C	NA	67.03 H	39.71 F	29.95 C	NA	69.66 E
		Delfan (amino acids)	39.11 H	27.90 C	NA	67.03 H	40.76 EF	29.89 C	NA	70.65 E
		Micronutrients	39.07 H	27.94 C	NA	67.01 H	42.73 EF	29.91 C	NA	72.65 E
		Sucrose	39.20 H	27.99 C	NA	67.19 H	42.32 EF	30.12 C	NA	72.44 E
		Mixed foliar application	39.16 H	28.01 C	NA	67.18 H	40.79 EF	29.97 C	NA	70.77 E
	Chilled seeds (-1°c)	Without foliar application	42.04 G	28.26 C	71.71 J	142.0 G	44.14 EF	30.15 C	73.00 G	147.3 D
		Delfan (amino acids)	42.75 FG	28.74 C	72.94 IJ	144.4 FG	44.47 E	30.66 C	74.24 G	149.4 D
		Micronutrients	41.92 G	28.18 C	71.50 J	141.6 G	44.39 EF	30.09 C	73.44 G	147.9 D
		Sucrose	43.16 FG	29.01 C	73.67 HI	145.9 FG	44.75 E	31.19 C	74.63 G	150.6 D
		Mixed foliar application	44.39 F	29.30 C	75.11 H	148.8 F	45.11 E	31.57 C	75.08 G	151.8 D
Under low plastic tunnels	Unchilled seeds	Without foliar application	79.19 E	48.53 A	230.9 G	358.6 E	74.40 D	44.09 A	233.3 F	351.8 C
		Delfan (amino acids)	81.49 CD	49.86 A	237.5 E	368.9 CD	76.67 BCD	45.40 A	238.3 DE	360.3 BC
		Micronutrients	80.64 DE	49.37 A	235.1 F	365.1 D	76.64 BCD	44.93 A	237.1 E	358.7 BC
		Sucrose	78.93 E	48.38 A	230.1 G	357.5 E	75.07 CD	44.17 A	232.9 F	352.1 C
		Mixed foliar application	82.35 BCD	50.35 A	240.0 D	372.7 BC	76.71 BCD	45.87 A	241.7 CD	364.3 B
	Chilled seeds (-1°c)	Without foliar application	82.71 BC	42.85 B	240.6 D	366.2 D	77.19 BCD	38.63 B	241.7 CD	357.5 BC
		Delfan (amino acids)	85.11 A	44.03 B	247.5 B	376.7AB	79.53 ABC	39.84 B	246.9 B	366.3 B
		Micronutrients	84.22 AB	43.60 B	245.0 C	372.8 BC	80.97 AB	39.59 B	244.7 BC	365.3 B
		Sucrose	82.44 BCD	42.72 B	239.9 D	365.0 D	78.85 ABCD	38.72 B	240.6 DE	358.1 BC
		Mixed foliar application	86.00 A	44.46 B	250.1 A	380.6 A	82.43 A	40.10 B	252.8 A	375.4 A

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

NA= not applicable. No fruits were obtained using these treatments

applications treatments did not appear any considerable effect on phosphorus uptake of open field plants.

4.2.5. K uptake

2.5.1. Effect of low plastic tunnels:

Data (Table, 42) show that plants grown under low plastic tunnels gave the highest significant K accumulation in leaves, stems, fruits and whole plant over the treatments in the open field. This trend was true in both seasons.

4.2.5.2. Effect of seeds chilling:

Data (Table, 42) show that plants developed from chilled seeds gave the highest significant K accumulation in leaves, stems, fruits and whole plant as compared with plants developed from unchilled seeds during both seasons.

4.2.5.3. Effect of foliar application:

Data (Table, 42) show that foliar application of mixed, amino acids, micronutrients and sucrose significantly differed from each other in a descending order in leaves, stems, fruits and total potassium uptake, this trend was true in both seasons. But the plants sprayed with sucrose was equal with unsprayed plants with respect to K-uptake of plant organs.

4.2.5.4. Effect of the interaction between seeds chilling and plant foliar spray treatments under low plastic tunnels or in the open field:

Data (Table, 43) show that plants grown under low plastic tunnels developed from either chilled seeds or not and sprayed

Table (42): Effect of plants protecting method, pre-sowing seeds chilling treatment or foliar spray treatments on K-content various plant parts of sweet pepper during the winter seasons of 2005/2006 & 2006/2007.

Characters / Treatments	First Season (2005/2006)				Second Season (2006/2007)			
	mg K/plant				mg K/plant			
	Leaves	Stem	Fruit	Total	Leaves	Stem	Fruit	Total
Protecting method								
Open field	225.7 B	89.98 B	363.0 B	678.7 B	250.9 B	111.9 B	365.6 B	728.4 B
Under low plastic tunnels	1950.0 A	1639.0 A	2172.0 A	5761.0 A	1901.0 A	1593.0 A	2178.0 A	5672.0 A
Seeds chilling								
Unchilled seeds	1056 B	843.4 B	1063 B	2963.0 B	1021 B	810.4 B	1066 B	2898 B
Chilled seeds (-1°c)	1119 A	885.3 A	1472 A	3477.0 A	1130 A	894.6 A	1477 A	3502 A
Foliar application								
Without foliar application	1070 D	850.8 D	1247 D	3167 D	1058 D	838.3 D	1250 D	3147 D
Delfan (amino acids)	1100 B	873.9 B	1281 B	3254 B	1087 B	862.3 B	1285 B	3235 B
Micronutrients	1088 C	865.1 C	1265 C	3218 C	1076 C	853.6 C	1270 C	3200 C
Sucrose	1069 D	848.9 E	1248 D	3166 D	1057 D	838.6 D	1252 D	3148 D
Mixed foliar application	1112 A	882.9 A	1297 A	3293 A	1100 A	869.7 A	1301 A	3271 A

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

Table (43): Effect of of interaction between protecting method, seeds chilling treatment and foliar spray treatments on K- content various plant parts of sweet pepper during the winter seasons of 2005/2006 & 2006/2007.

Treatments		Characters	First Season (2005/2006) mg K/plant				Second Season (2006/2007) mg K/plant			
			Leaves	Stem	Fruit	Total	Leaves	Stem	Fruit	Total
Open field	Unchilled seeds	Without foliar application	214.7 N	88.86 L	NA	303.5 K	237.9 M	109.7 I	NA	347.6 L
		Delfan (amino acids)	215.1 N	88.59 L	NA	303.7 K	238.4 M	110.7 I	NA	349.1 L
		Micronutrients	214.9 N	88.68 L	NA	303.6 K	239.5 M	112.2 I	NA	351.7 L
		Sucrose	215.6 N	88.86 L	NA	304.5 K	240.9 M	111.4 I	NA	352.3 L
		Mixed foliar application	215.4 N	88.95 L	NA	304.3 K	238.3 M	108.8 I	NA	347.2 L
	Chilled seeds (-1°c)	Without foliar application	231.6 M	89.76 KL	713.2 M	1035 J	258.6 KL	112.2 I	716.8 M	1088.0 K
		Delfan (amino acids)	235.6 L	91.27 KL	725.6 L	1052 IJ	262.7 KL	114.1 I	730.7 L	1107.0 J
		Micronutrients	230.9 M	89.50 KL	711.0 M	1031 J	256.8 L	110.5 I	717.6 M	1085.0 K
		Sucrose	237.9 L	92.19 KL	732.9 K	1063 IJ	264.3 K	115.2 I	737.7 K	1117.0 J
		Mixed foliar application	244.9 K	93.10 K	747.5 J	1085 I	271.8 J	114.0 I	753.1 J	1139.0 I
Under low plastic tunnels	Unchilled seeds	Without foliar application	1865.0 I	1572.0 I	2091.0 H	5529 H	1773.0 I	1484.0 H	2099.0 H	5356.0 H
		Delfan (amino acids)	1920.0 G	1617.0 G	2152.0 F	5689 F	1825.0 G	1528.0 F	2160.0 F	5513.0 F
		Micronutrients	1900.0 H	1600.0 H	2130.0 G	5630 G	1807.0 H	1512.0 G	2135.0 G	5454.0 G
		Sucrose	1859.0 J	1567.0 J	2085.0 I	5511 H	1767.0 I	1483.0 H	2091.0 I	5341.0 H
		Mixed foliar application	1941.0 F	1633.0 F	2174.0 E	5748 E	1847.0 F	1544.0 E	2180.0 E	5571.0 E
	Chilled seeds (-1°c)	Without foliar application	1969.0 D	1652.0 D	2182.0 D	5803 D	1964.0 D	1647.0 D	2186.0 D	5797.0 D
		Delfan (amino acids)	2027.0 B	1699.0 B	2245.0 B	5971 B	2024.0 B	1696.0 B	2249.0 B	5969.0 B
		Micronutrients	2006.0 C	1682.0 C	2221.0 C	5909 C	2000.0 C	1680.0 C	2228.0 C	5909.0 C
		Sucrose	1962.0 E	1647.0 E	2175.0 E	5784 D	1957.0 E	1644.0 D	2179.0 E	5781.0 D
		Mixed foliar application	2049.0 A	1716.0 A	2268.0 A	6033 A	2042.0 A	1712.0 A	2273.0 A	6027.0 A

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

NA= not applicable. No fruits were obtained using these treatments.

with (mixed, amino acids, micronutrients, sucrose and unsprayed) significantly differed from each other in a descending order, with respect to K uptake in leaves, stems, fruits and total K uptake and this trend was true in both seasons.

On the contrary, the treatments in open field and unchilled seeds showed the lowest accumulation of K uptake in leaves, stems and total K uptake per plant. In this connection, no data could be taken regarding fruits, because under such conditions, no fruits could be produced.

Also, it could be observed that foliar applications did not induce any considerable positive effects on K uptake under open field conditions with unchilled seeds.

4.2.6. Flowering

4.2.6.1. Effect of low plastic tunnels:

Data Table (44) show that anthesis of the first flower under open field conditions was earlier than the plants grown under low plastic tunnels. However, fruit setting % showed a contra trend .i.e. fruit setting % was significantly higher when plants grown under plastic tunnels.

4.2.6.2. Effect of seeds chilling:

Concerning with the effect of seed chilling it delayed anthesis of the first flower but increased fruit setting % as compared with seeds grown without chilling seeds. This trend was true in both seasons. These results are in harmony with those of Shafshak (1983) on winter sweet pepper.

Table (44): Effect of plants protecting method, pre-sowing seeds chilling treatment or foliar spray treatments on flowering time and fruit setting % of sweet pepper plants during the winter seasons of 2005/2006 & 2006/2007.

Characters / Treatments	First season (2005/2006)		Second season(2006/2007)	
	Anthesis of 1st Flower (days)	Fruit setting (%)	Anthesis of 1st Flower (days)	Fruit setting (%)
Protecting method				
Open field	37.35 A	50.00 B	37.43 A	50.00 B
Under low plastic tunnels	67.00 B	59.50 A	67.20 B	59.49 A
Seeds chilling				
Unchilled seeds	33.57 A	28.74 B	33.68 A	28.54 B
Chilled seeds (-1°c)	70.78 B	80.76 A	70.95 B	80.95 A
Foliar application				
Without foliar application	52.54 A	54.90 A	52.64 A	55.10 A
Delfan (amino acids)	51.93 A	55.23 A	52.10 A	55.23 A
Micronutrients	51.88 A	55.80 A	52.05 A	55.47 A
Sucrose	52.26 A	52.42 B	52.43 A	52.43 B
Mixed foliar application	52.25 A	55.41 A	52.36 A	55.51 A

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

4.2.6.3. Effect of foliar application:

With respect to the effect of foliar application treatments, data (Table, 44) variances in anthesis time and fruit setting were not considerably clear.

4.2.6.4. Effect of the interaction between seeds chilling and plant foliar spray treatments under low plastic tunnels or in the open field:

According the effect of interaction treatments data Table (45) show that chilling seeds at low temperature before sowing in the open field gave 100% fruit setting which their plants produced 1-3 flowers per plant during the season and all of these flowers were sited forming fruits. Also, these treatments were late in flower anthesis time about one week comparing with plant under low plastic tunnels. These results are in harmony with those of Ravinder and Srivastava (2000) on tomato. On the other hand, plants grown from unchilled seeds failed to flower and fruit set when grown under open field conditions at winter season.

Pepper plant is considered as a tropical plant as it couldn't obtain its temperature requirements for growth and flowering in winter under Egyptian condition so as to the decrease in temperature degrees (10- 13°C) stopping plant growth and initiation of floral buds (Hassan, 1988). Hence if it planted under low plastic tunnels in winter it could grow and flower well.

Treating swollen seeds at low temperature after dipping in water induced plants to be tolerant to low temperature of

Table (45): Effect of of interaction between protecting method, seeds chilling treatment and foliar spray treatments on flowering time and fruit setting % of sweet pepper plants during the winter seasons of 2005/2006 & 2006/2007.

Treatments		Characters	First Season (2005/2006)		Second Season (2006/2007)	
			Anthesis of 1st Flower (days)	Fruit setting (%)	Anthesis of 1st Flower (days)	Fruit setting (%)
Open field	Unchilled seeds	Without foliar application	NA	NA	NA	NA
		Delfan (amino acids)	NA	NA	NA	NA
		Micronutrients	NA	NA	NA	NA
		Sucrose	NA	NA	NA	NA
		Mixed foliar application	NA	NA	NA	NA
	Chilled seeds (-1°c)	Without foliar application	75.12 E	*100.0	75.20 E	*100.0
		Delfan (amino acids)	74.21 D	*100.0	74.43 D	*100.0
		Micronutrients	74.40 D	*100.0	74.62 D	*100.0
		Sucrose	74.52 D	*100.0	74.74 D	*100.0
		Mixed foliar application	75.22 E	*100.0	75.34 E	*100.0
Under low plastic tunnels	Unchilled seeds	Without foliar application	67.20 B	59.30 E	67.42 B	59.58 E
		Delfan (amino acids)	67.08 B	57.63 F	67.30 B	57.06 F
		Micronutrients	66.61 A	62.22 BC	66.84 A	60.60 D
		Sucrose	67.42 BC	52.87 H	67.63 BC	52.31 H
		Mixed foliar application	67.40 BC	55.42 G	67.61 BC	55.86 G
	Chilled seeds (-1°c)	Without foliar application	67.83 C	60.28 DE	67.95 C	60.82 CD
		Delfan (amino acids)	66.44 A	63.30 B	66.66 A	63.84 B
		Micronutrients	66.52 A	60.97 CD	66.74 A	61.26 C
		Sucrose	67.12 B	56.82 FG	67.33 B	57.40 F
		Mixed foliar application	66.40 A	66.21A	66.48 A	66.18 A

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

NA= not applicable. No flowers were obtained using these treatments

* The plants which produced 1-3 flowers per plant during the season and all of these flowers were sited forming fruits.

winter season conditions, which is called adaptation. Results agree with that of Abdallah *et al.* (1984) on winter sweet pepper and Abdelhalim (1990) and Gabal (1990) on tomato plants.

Meanwhile, sowing swollen seeds with unchilled in the open field didn't produce any flowers along both seasons.

The highest significant fruit sitting was obtained by the treatment which sprayed with mixed foliar application and chilled treated seeds under low plastic tunnels compared to all other treatments in both seasons. The earliest significant flower opening time was obtained when chilled seeds were grown under low plastic tunnels and sprayed with amino acids, micronutrients or mixed as compared to other treatments in both seasons. Meanwhile unchilled seeds and grown under plastic tunnels and sprayed with micronutrients also gave similar early anthesis.

In this connection, Shafshak (1987) found that using foliar application of Fe, Zn and Mn on eggplant increased each of fruit setting percent and number of fruits per plant. Darwesh (1996) found that, tomato plants grown under polyethylene tunnels improved percentage of fruit set than these of the open field.

4.2.7. Early and total yield:

4.2.7.1. Effect of low plastic tunnels:

Data (Table, 46 and Figs 9 and 10) show that plants grown in winter under open field conditions did not produce early yield, but give very low quantity of total yield comparing with the plants gown under low plastic tunnels. The highest early and total yield per plant and per feddan resulted when plants were

Table (46): Effect of plants protecting method, pre-sowing seeds chilling treatment or foliar spray treatments on early and total yield of sweet pepper plants during the winter seasons 2005/2006 & 2006/2007.

Characters / Treatments	First Season (2005/2006)				Second Season (2006/2007)			
	Early yield		Total yield		Early yield		Total yield	
	g/plant	ton/fed	g/plant	ton/fed	g/plant	ton/fed	g/plant	ton/fed
Protecting method								
Open field	NA	NA	30.31 B	0.479 B	NA	NA	32.64 B	0.522 B
Under low plastic tunnels	33.01 A	0.525 A	541.8 A	8.572 A	37.73 A	0.599 A	566.30 A	8.903 A
Seeds chilling								
Unchilled seeds	15.29 B	0.239 B	263.3 B	4.152 B	17.66 B	0.281 B	276.7 B	4.351 B
Chilled seeds (-1°c)	17.73 A	0.286 A	308.8 A	4.899 A	20.06 A	0.318 A	322.2 A	5.074 A
Foliar application								
Without foliar application	16.37 A	0.255 B	283.2 A	4.437 C	18.66 BC	0.287 C	295.4 BC	4.628 C
Delfan (amino acids)	16.35 A	0.270 A	282.9 A	4.596 AB	18.98 AB	0.294 C	299.7 BC	4.779 A
Micronutrients	16.61 A	0.261 B	287.6 A	4.521 BC	18.91 ABC	0.307 B	300.6 B	4.729 B
Sucrose	16.32 A	0.254 B	282.6 A	4.444 C	18.32 C	0.290 C	294.8 C	4.608 C
Mixed foliar application	16.89 A	0.274 A	294.0 A	4.630 A	19.31 A	0.321 A	306.9 A	4.819 A

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

NA= not applicable. No fruits were obtained using these treatments.

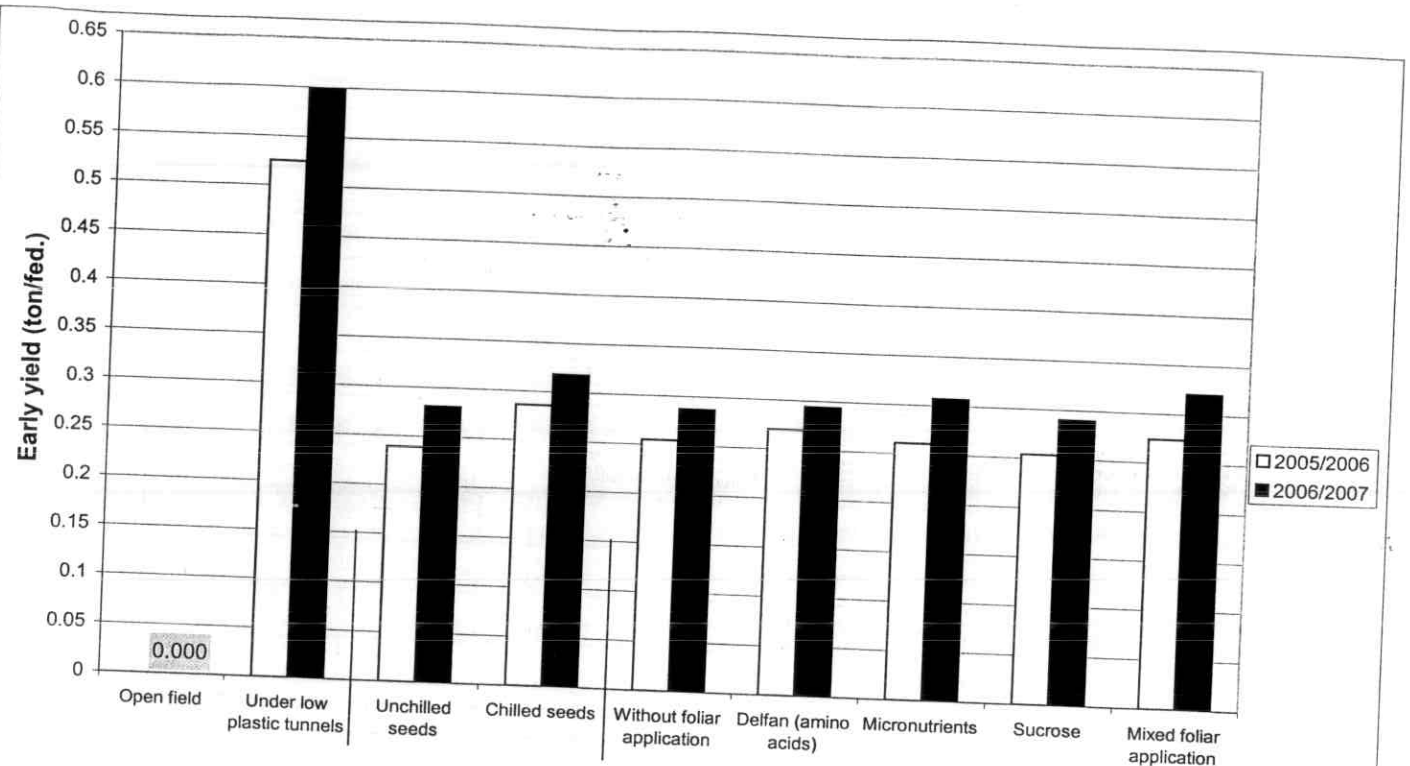


Fig. (9): Main effect of plants protecting method, pre-sowing seed chilling treatment or foliar spray treatments on early yield of sweet pepper plants during the winter seasons of 2005/2006 & 2006/2007.

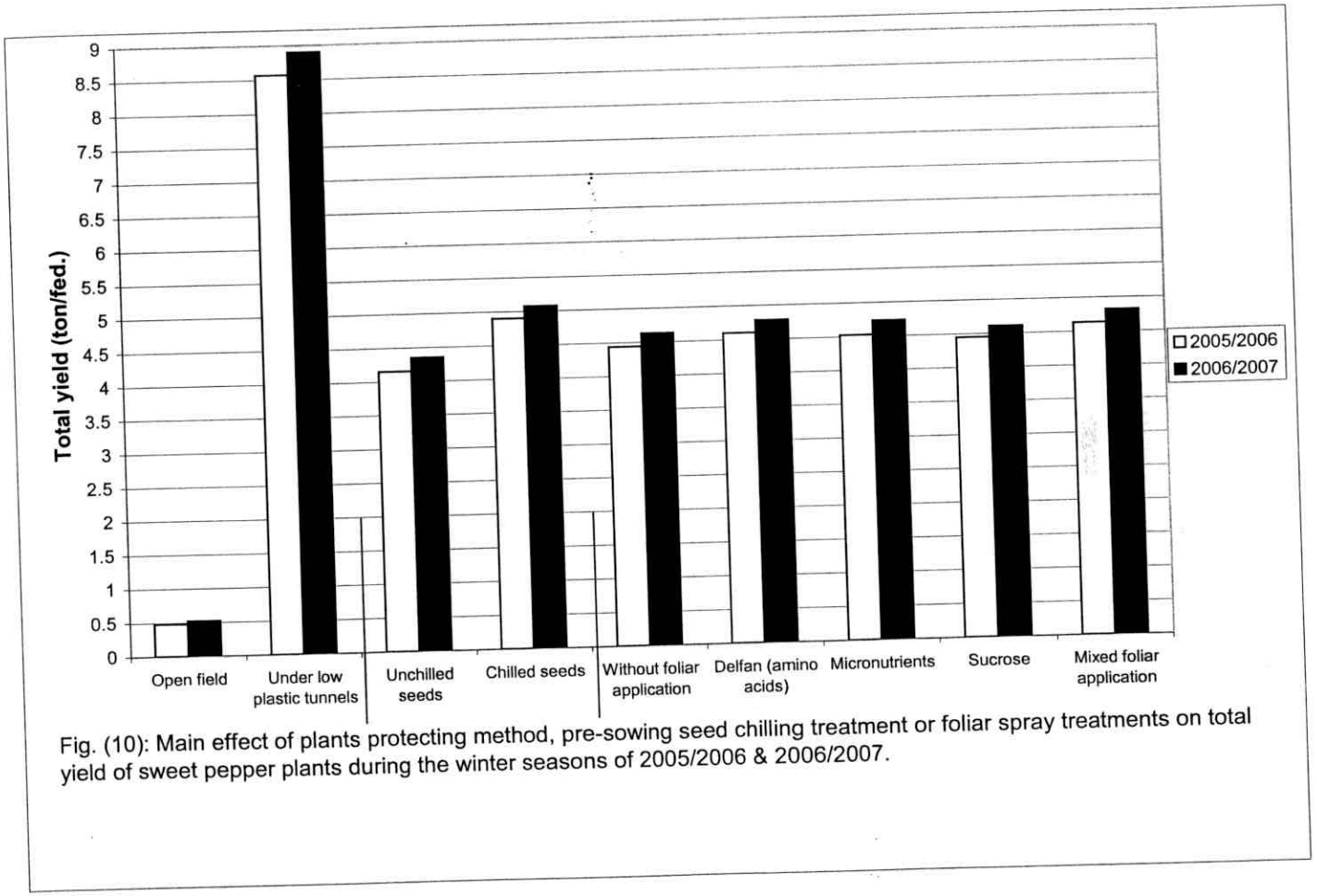


Fig. (10): Main effect of plants protecting method, pre-sowing seed chilling treatment or foliar spray treatments on total yield of sweet pepper plants during the winter seasons of 2005/2006 & 2006/2007.

grown under plastic tunnels with a great significant difference than that grown in the open field. These results could be referred to the warm conditions under plastic tunnels as compared with cold weather conditions in the open field (Somos, 1973). These results are in harmony with those of Shafshak (1983) on sweet pepper and Saleh (1992) and Youssef *et al.* (2001) on tomato.

4.2.7.2. Effect of seeds chilling:

From (Table, 46 and Figs 9 and 10) it could be observed that plants developed from chilled seeds produced high early and total yield per plant and per feddan with significant differences as compared with those developed from unchilled seeds. It means that seed chilling at low temperature -1°C before sowing produce plants more tolerant to the cold conditions of winter season. Abdallah *et al.* (1984) and Gabal (1990) reached to the same result and referred it to the increase of T.S.S, cell sap sugars content in chilled seedlings.

4.2.7.3. Effect of foliar application:

Data (Table, 46 and Figs 9 and 10) show that treatments sprayed with amino acids (Delfan) or mixed foliar (sucrose, micronutrients and Delfan) application gave the highest values of early and total yield per plant and per feddan in both seasons. In this connection, El-Fouly (2004) found that spraying strawberry plants with three micro nutrients Fe, Mn and Zn increased fruit yield compared to the control (without foliar application). Maini and Sgattoni (1999) found that, the positive effect of foliar application of an amino acid on sweet pepper may be due to the anti-stress activity of the hydrolysed protein.

Moreover, data show that sucrose application did not increase early and total yield per plant and per feddan than the control.

4.2.7.4. Effect of the interaction between seeds chilling and plant foliar spray treatments under low plastic tunnels or in the open field:

From Tables (47 and 48) and Figs (11 and 12) It could be concluded that the highest significant early and total yield per plant (g) and per feddan (ton) were obtained from plants grown under plastic tunnels and developed from chilled seeds or not and using foliar spray or not. Moreover, plants grown under plastic tunnels, using chilled seeds and sprayed with mixed foliar application of (sucrose, micronutrients and Delfan) or Delfan alone (amino acids) produced the highest early yield per plant (g) and total yield per feddan (ton) comparing with other treatments in both seasons, followed by the treatment with micronutrient foliar application under the previous conditions respecting with early and total yield per feddan comparing to other treatments in both seasons.

However, the treatments with sucrose or without foliar applications with chilled seeds and grown under low tunnels were equaled in early and total yield per plant (g) and per feddan (ton) with no significant differences between each other in both seasons.

From this table also it could be observed that no early or total fruit yield was obtained in the two seasons when plants grown in open field without chilling seeds.

Table (47): Effect of of interaction between protecting method, seeds chilling treatment and foliar spray treatments on early and total yield of sweet pepper plants during the winter season 2005/2006.

Treatments		Characters	Early yield		Total yield	
			g/plant	ton/fed	g/plant	ton/fed
Open field	Unchilled seeds	Without foliar application	NA	NA	NA	NA
		Delfan (amino acids)	NA	NA	NA	NA
		Micronutrients	NA	NA	NA	NA
		Sucrose	NA	NA	NA	NA
		Mixed foliar application	NA	NA	NA	NA
	Chilled seeds (-1°c)	Without foliar application	NA	NA	59.79 E	0.945 G
		Delfan (amino acids)	NA	NA	60.89 E	0.949 G
		Micronutrients	NA	NA	58.35 E	0.934 G
		Sucrose	NA	NA	62.13 E	1.011 G
		Mixed foliar application	NA	NA	61.93 E	0.957 G
Under low plastic tunnels	Unchilled seeds	Without foliar application	29.84 D	0.466 E	518.6 D	8.141 F
		Delfan (amino acids)	30.31 CD	0.491 CD	533.3 CD	8.437 DE
		Micronutrients	29.85 D	0.478 DE	527.4 D	8.318 E
		Sucrose	30.91 CD	0.446 F	515.5 D	8.122 F
		Mixed foliar application	31.96 C	0.507 C	538.0 CD	8.505 CD
	Chilled seeds (-1°c)	Without foliar application	35.63 AB	0.554 B	554.6 ABC	8.663 C
		Delfan (amino acids)	35.11 AB	0.588 A	537.3 CD	8.999 A
		Micronutrients	36.57 A	0.566 B	564.5 AB	8.831 B
		Sucrose	34.35 B	0.569 B	552.6 BC	8.642 C
		Mixed foliar application	35.60 AB	0.591 A	575.9 A	9.057 A

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

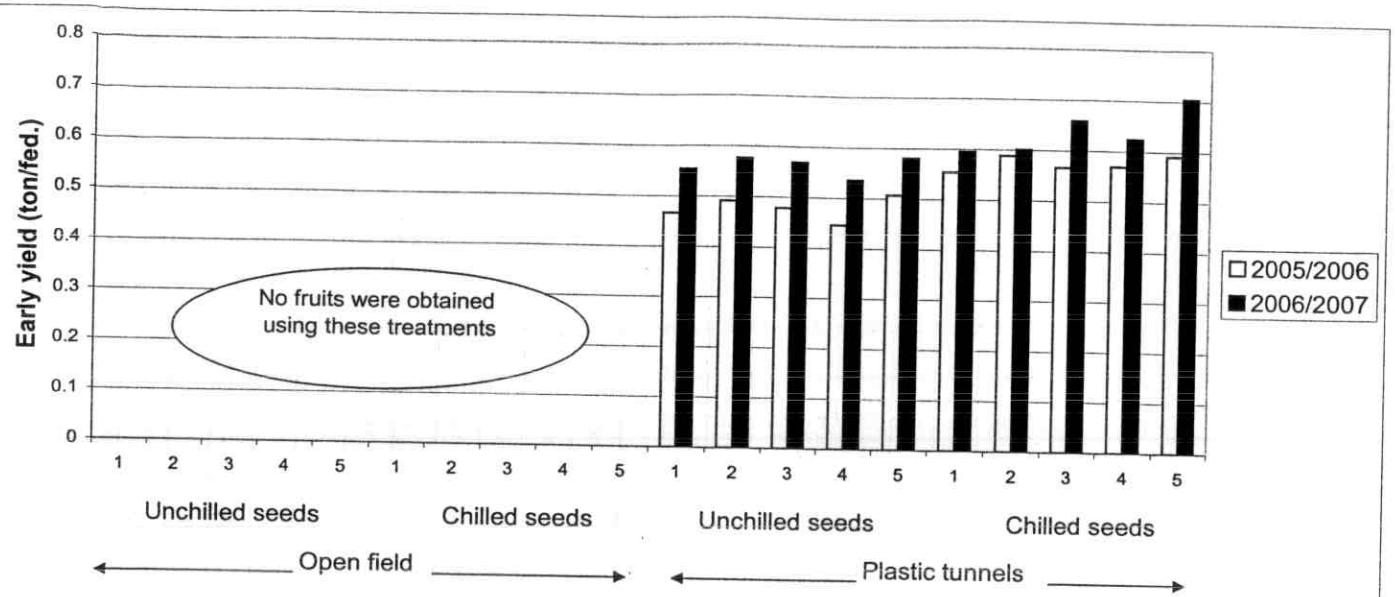
NA= not applicable. No fruits were obtained using these treatments

Table (48): Effect of of interaction between protecting method, seeds chilling treatment and foliar spray treatments on early and total yield of sweet pepper plants during the winter season 2006/2007.

Treatments		Characters	Early yield		Total yield	
			g/plant	ton/fed	g/plant	ton/fed
Open field	Unchilled seeds	Without foliar application	NA	NA	NA	NA
		Delfan (amino acids)	NA	NA	NA	NA
		Micronutrients	NA	NA	NA	NA
		Sucrose	NA	NA	NA	NA
		Mixed foliar application	NA	NA	NA	NA
	Chilled seeds (-1°c)	Without foliar application	NA	NA	64.23 H	1.016 G
		Delfan (amino acids)	NA	NA	65.82 H	1.053 G
		Micronutrients	NA	NA	64.26 H	0.999 G
		Sucrose	NA	NA	65.71 H	1.046 G
		Mixed foliar application	NA	NA	66.35 H	1.101 G
Under low plastic tunnels	Unchilled seeds	Without foliar application	34.88 DE	0.554 E	544.5 FG	8.497 F
		Delfan (amino acids)	35.73 CD	0.576 D	560.0 DE	8.856 DE
		Micronutrients	35.18 DE	0.569 D	554.2 EF	8.758 E
		Sucrose	34.64 E	0.536 F	542.6 G	8.505 F
		Mixed foliar application	36.20 C	0.581 D	565.9 CD	8.897 D
	Chilled seeds (-1°c)	Without foliar application	39.76 B	0.595 CD	572.7 C	8.998 C
		Delfan (amino acids)	40.77 A	0.601 C	572.8 C	9.206 A
		Micronutrients	40.44 AB	0.659 B	583.7 B	9.158 B
		Sucrose	38.63 B	0.624 C	570.8 CD	8.880 CD
		Mixed foliar application	41.04 A	0.704 A	595.4 A	9.278 A

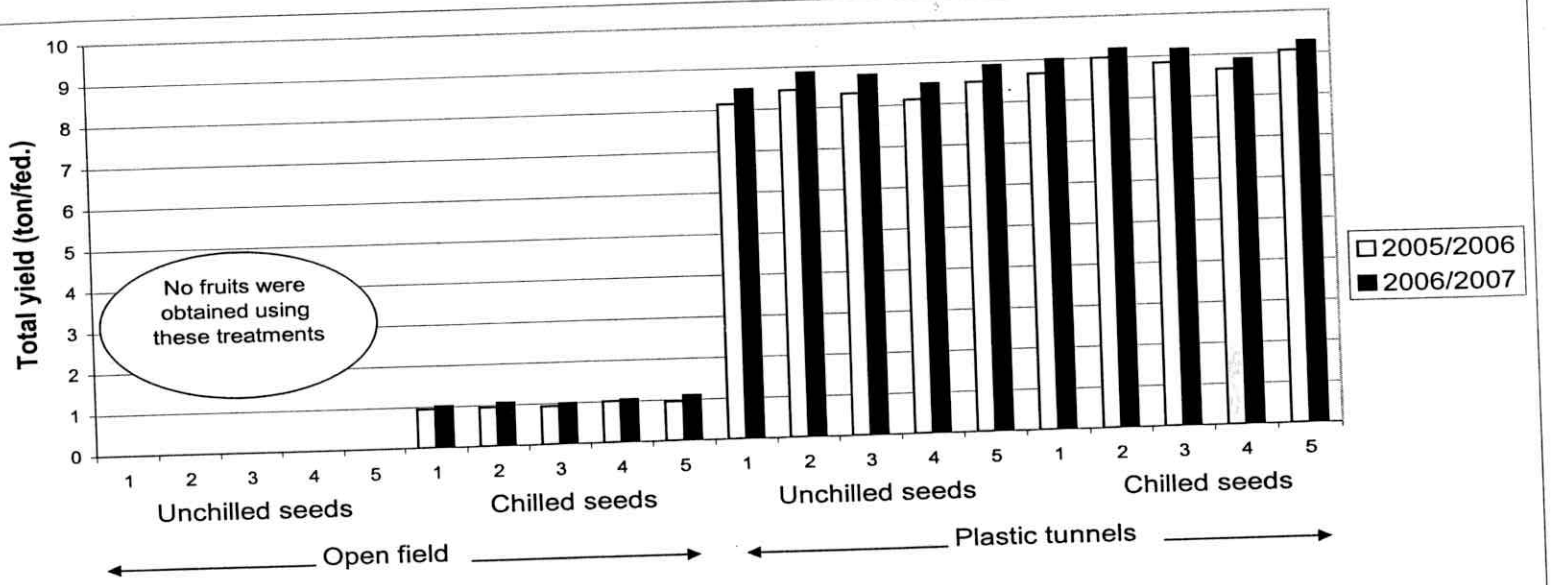
Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

NA= not applicable. No fruits were obtained using these treatments



1 (Without foliar application), 2 Delfan (amino acids), 3 (Micronutrients), 4 (Sucrose), 5 (Mixed foliar application).

Fig. (11): Effect of interaction between protecting method, seed chilling treatment and foliar spray treatments on early yield of sweet pepper plants during the winter seasons of 2005/2006 & 2006/2007.



1 (Without foliar application), 2 Delfan (amino acids), 3 (Micronutrients), 4 (Sucrose), 5 (Mixed foliar application).

Fig. (12): Effect of interaction between protecting method, seed chilling treatment and foliar spray treatments on total yield of sweet pepper plants during the winter seasons of 2005/2006 & 2006/2007.

Meanwhile, pepper plants grown in open field using chilled seeds did not produce any early yield, but it yielded very low total yield comparing with other treatments. Also, foliar application did not induce any effect on early and total yield per plant (g) or per feddan, especially when plants were grown in the open field.

Finally, it could be concluded that plants grown under low tunnels expressed higher early and total yield per plant (g) and per feddan, especially when used chilled seeds at -1°C combined with spraying plants with mixed substances (Delfan, micronutrients and Sucrose). The high vegetative growth (Tables, 33 and 34), chlorophyll content (Tables, 36 and 37), N, P and K uptake (Tables, 39, 41 and 43) of this treatments may explain such superiority. It may be taken in consideration that pepper plants considered as tropical plants can not grow successfully under circumstances similar to Kalubia governorate during winter cultivation, in the open field.

4.2.8. Fruit physical characteristics

4.2.8.1. Effect of low plastic tunnels:

The treatments under low plastic tunnels (Table, 49) significantly increased fruit physical characteristics i.e fruit length, diameter, size and weight over the treatments in the open field. This trend was true in both seasons. Results are confirmed with those indicated by Shafshak (1983) on winter sweet pepper and Youssef *et al.* (2001) on tomato

Table (49): Effect of planting plants protecting method, pre-sowing seeds chilling treatment or foliar spray treatments on fruit physical characteristics of sweet pepper plants during the winter seasons of 2005/2006 & 2006/2007.

Characters / Treatments	First Season (2005/2006)				Second Season (2006/2007)			
	Fruit length cm	Fruit diameter cm	Fruit size cm^3/fruit	Fruit weight (g)	Fruit length cm	Fruit diameter cm	Fruit size cm^3/fruit	Fruit weight (g)
Protecting method								
Open field	3.61 B	2.81 B	51.0 B	32.2 B	3.55 B	2.83 B	48.7 B	31.8 B
Under low plastic tunnels	8.88 A	7.71 A	190.3 A	133.9 A	9.09 A	7.61 A	168.1 A	133.3 A
Seeds chilling								
Unchilled seeds	4.22 B	3.50 B	95.2 B	66.1 B	4.44 B	3.62 B	75.7 B	67.4 B
Chilled seeds (-1°c)	8.28 A	7.03 A	146.2 A	100.0 A	8.20 A	6.82 A	141.0 A	97.6 A
Foliar application								
Without foliar application	6.17 C	5.12 C	117.9 D	81.8 C	6.19 E	5.11 C	114.6 D	80.3 D
Delfan (amino acids)	6.31 AB	5.33 AB	122.4 AB	83.3 B	6.41 B	5.32 A	117.9 B	83.5 B
Micronutrients	6.23 BC	5.24 BC	120.3 BC	83.1 B	6.32 C	5.21 B	116.3 BC	82.0 C
Sucrose	6.20 C	5.21 BC	119.3 CD	81.9 C	6.23 D	5.12 C	115.5 C	81.3 D
Mixed foliar application	6.33 A	5.40 A	123.7 A	85.1 A	6.45 A	5.34 A	119.9 A	85.5 A

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

4.2.8.2. Effect of seeds chilling:

The treatments with low temperature treated seeds (Table, 49) significantly increased fruit physical characteristics over the treatments without chilling. This trend was true in both seasons. These results are in harmony with those of Abdalla (1984) on winter sweet pepper and Gabal (1990) on tomato plants.

4.2.8.3. Effect of foliar application:

Data (Table, 49) show that spraying with mixed foliar application resulted in the heaviest fruit weight with significantly increase in both seasons.

While the treatments sprayed with either mixed or amino acids produced the largest fruits length, diameter and size with no significantly increase in the first season.

Moreover, data show that sucrose application did not affect fruit physical characteristics as compared with the control (without foliar application). This finding is not in accordance with that of Abd-El-Maksoud *et al.* (1974) and Shafshak (1983) on winter sweet pepper.

4.2.8.4. Effect of the interaction between seeds chilling and plant foliar spray treatments under low plastic tunnels or in the open field:

From Tables (50 and 51) It could be concluded that the largest length and diameter fruits were obtained by the treatment with mixed or amino acids foliar applications with low temperature treated seeds under low plastic tunnels. In addition, the treatments with mixed or amino acids foliar applications with

Table (50): Effect of of interaction between protecting method, seeds chilling treatment and foliar spray treatments on fruit physical characteristics of sweet pepper plants during the winter season of 2005/2006.

Treatments		Characters	Fruit length cm	Fruit diameter cm	Fruit size cm^3/fruit	Fruit weight (g)
Open field	Unchilled seeds	Without foliar application	NA	NA	NA	NA
		Delfan (amino acids)	NA	NA	NA	NA
		Micronutrients	NA	NA	NA	NA
		Sucrose	NA	NA	NA	NA
		Mixed foliar application	NA	NA	NA	NA
	Chilled seeds (-1°c)	Without foliar application	7.19 F	5.51 F	99.3 G	63.2 H
		Delfan (amino acids)	7.29 F	5.59 F	104.3 F	65.3 GH
		Micronutrients	7.11 F	5.53 F	101.1 FG	63.7 GH
		Sucrose	7.25 F	5.56 F	102.8 FG	64.5 GH
		Mixed foliar application	7.28 F	5.96 E	103.3 FG	65.6 G
Under low plastic tunnels	Unchilled seeds	Without foliar application	8.36 DE	6.61 D	186.6 DE	131.0 EF
		Delfan (amino acids)	8.52 D	7.24 C	193.2 AB	130.3 F
		Micronutrients	8.45 DE	7.08 C	189.5 BCDE	133.4 CD
		Sucrose	8.31 E	7.03 C	187.6 CDE	129.9 F
		Mixed foliar application	8.54 D	7.03 C	195.5 A	136.6 AB
	Chilled seeds (-1°c)	Without foliar application	9.13 C	8.37 AB	185.5 E	132.9 DE
		Delfan (amino acids)	9.44 A	8.49 AB	191.9 ABC	137.6 AB
		Micronutrients	9.36 AB	8.36 AB	190.7 BCD	135.5 BC
		Sucrose	9.24 BC	8.28 B	186.8 DE	133.4 CD
		Mixed foliar application	9.50 A	8.63 A	196.0 A	138.2 A

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

NA= not applicable. No fruits were obtained using these treatments

Table (51): Effect of of interaction between protecting method, seeds chilling treatment and foliar spray treatments on fruit physical characteristics of sweet pepper plants during the winter season of 2006/2007.

Treatments		Characters	Fruit length cm	Fruit diameter cm	Fruit size cm^3/fruit	Fruit weight (g)
Open field	Unchilled seeds	Without foliar application	NA	NA	NA	NA
		Delfan (amino acids)	NA	NA	NA	NA
		Micronutrients	NA	NA	NA	NA
		Sucrose	NA	NA	NA	NA
		Mixed foliar application	NA	NA	NA	NA
	Chilled seeds (-1°c)	Without foliar application	6.99 H	5.52 H	94.8 E	60.8 H
		Delfan (amino acids)	7.17 FG	5.73 G	98.5 D	64.5 G
		Micronutrients	7.01 H	5.62 H	95.0 E	62.7 H
		Sucrose	7.12 G	5.62 H	98.9 D	64.6 G
		Mixed foliar application	7.21 F	5.80 G	99.6 D	65.1 G
Under low plastic tunnels	Unchilled seeds	Without foliar application	8.70 E	7.07 F	181.9 C	131.4 E
		Delfan (amino acids)	9.03 C	7.44 D	187.0 AB	136.2 B
		Micronutrients	8.91 D	7.27 E	185.3 B	133.9 CD
		Sucrose	8.72 E	7.12 F	181.6 C	131.3 E
		Mixed foliar application	9.11 C	7.35 DE	190.1 A	141.3 A
	Chilled seeds (-1°c)	Without foliar application	9.08 C	7.84 C	181.5 C	129.0 F
		Delfan (amino acids)	9.46 A	8.13 A	186.2 B	133.3 D
		Micronutrients	9.35 B	7.96 B	184.8 B	131.4 E
		Sucrose	9.09 C	7.76 C	181.4 C	129.1 F
		Mixed foliar application	9.51 A	8.21 A	189.7 A	135.6 BC

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

NA= not applicable. No fruits were obtained using these treatments

unchilled seeds was equaled with the treatment with mixed foliar application with low temperature treated seeds under low plastic tunnels and gave the largest fruit size with significant differences as compared with all other treatments in both seasons.

The treatment with mixed foliar applications with unchilled seeds under low plastic tunnels gave the heaviest fruit weight with significantly increase in both seasons.

However, the treatment with sucrose or without foliar applications was equaled in all physical characteristics of fruits i.e. length, diameter, size and fruit weight under low tunnels with chilling seeds or not. This trend was true in both seasons.

While, plants which subjected to open field and developed from low temperature treated seeds and sprayed with mixed, amino acids or sucrose was equaled in size and weight of fruits without significant differences in both seasons. Also, micronutrients foliar application and without foliar applications under the previous conditions were equaled in all physical characteristics of fruits i.e. length, diameter, size and weight. This trend was true in both seasons.

The plants which subjected to open field and developed from unchilled seeds did not give fruits to can take any measure on it.

4.2.9. Fruit chemical constituents

4.2.9.1. Effect of low plastic tunnels:

The treatments under low plastic tunnels (Table, 52) produced fruits with the best quality (acidity, T.S.S, vitamin-C,

Table (52): Effect of plants protecting method, pre-sowing seeds chilling treatment or foliar spray treatments on fruit chemical constituents of sweet pepper plants during the winter seasons of 2005/2006 & 2006/2007.

Characters / Treatments	First Season (2005/2006)						Second Season (2006/2007)					
	Acidity mg/100 cm^3	T.S.S %	Vitamin C mg/100g	Sugars mg/100g (F.W.)			Acidity mg/100 cm^3	T.S.S %	Vitamin C mg/100g	Sugars mg/100g (F.W.)		
				Reducing	Non-reducing	Total				Reducing	Non-reducing	Total
Protecting method												
Open field	97.95 B	2.33 B	84.17 B	18.43 B	36.39 B	54.8 B	95.67 B	2.42 B	82.71 B	17.80 B	36.09 B	53.8 B
Under low plastic tunnels	194.5 A	5.48 A	167.2 A	96.28 A	148.8 A	245.1 A	199.4 A	5.77 A	169.5 A	96.29 A	149.2 A	245.5 A
Seeds chilling												
Unchilled seeds	96.8 B	2.74 B	83.56 B	47.28 B	74.72 B	122.0 B	99.4 B	2.88 B	84.53 B	46.75 B	75.29 B	122.0 B
Chilled seeds (-1°c)	195.6 A	5.07 A	167.9 A	67.43 A	110.5 A	177.9 A	195.7 A	5.31 A	167.6 A	67.33 A	110.0 A	177.3 A
Foliar application												
Without foliar application	144.4 C	3.84 B	123.8 B	56.49 B	91.05 C	147.5 B	145.2 E	4.03 E	124.1 D	56.09 C	91.06 D	147.1 C
Delfan (amino acids)	147.2 B	3.91 B	125.8 B	57.66 AB	93.51 AB	151.2 AB	148.8 B	4.13 B	127.2 B	57.60 AB	93.50 B	151.1 AB
Micronutrients	145.7 C	3.87 B	124.6 B	57.29 AB	92.33 BC	149.6 B	146.8 C	4.08 C	125.4 C	56.93 BC	92.35 C	149.3 BC
Sucrose	144.6 C	3.86 B	125.1 B	56.17 B	91.29 C	147.5 B	146.2 D	4.05 D	124.9 C	56.16 BC	91.29 CD	147.5 C
Mixed foliar application	149.3 A	4.03 A	129.3 A	59.18 A	94.83 A	154.0 A	150.8 A	4.19 A	128.9 A	58.43 A	94.99 A	153.4 A

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

reducing, non-reducing and total sugars) with significant increase over the treatments in the open field. This trend was true in both seasons. Results are confirmed with those indicated by Abdalla *et al.* (1984) on winter sweet pepper and Darwesh (1996) on tomato.

4.2.9.2. Effect of seeds chilling:

Plants developed from low temperature treated seeds (Table, 52) showed significant better fruits chemical properties (acidity, T.S.S, vitamin-C, reducing, non-reducing and total sugars) as compared with those developed from unchilled seeds. This trend was true in both seasons. These results are in harmony with those of Tropina and Nezhdanova (1975) and Abdalla (1984) on winter sweet pepper and Yasins'ka (1972) and Gabal (1990) on tomato plants.

4.2.9.3. Effect of foliar application:

Data (Table, 52) show that pepper plants with mixed, amino acids or sucrose in a descending order produced fruits with better chemical properties as compared with unsprayed control plants which came in the last rank.

4.2.9.4. Effect of the interaction between seeds chilling and plant foliar spray_treatments under low plastic tunnels or in the open field:

Data (Tables, 53 and 54) show that plants with mixed foliar application with chilled seeds or not under low plastic tunnels produced fruits with the best quality (acidity, T.S.S, vitamin C and total sugars) and equal with the plants sprayed with

Table (53): Effect of of interaction between protecting method, seeds chilling treatment and foliar spray treatments on fruit chemical constituents of sweet pepper plants during the winter season of 2005/2006.

Treatments		Characters	Acidity mg/100cm^3	T.S.S %	Vitamin C mg/100g	Sugars mg/100g (F.W.)		
						Reducing	Non-reducing	Total
Open field	Unchilled seeds	Without foliar application	NA	NA	NA	NA	NA	NA
		Delfan (amino acids)	NA	NA	NA	NA	NA	NA
		Micronutrients	NA	NA	NA	NA	NA	NA
		Sucrose	NA	NA	NA	NA	NA	NA
		Mixed foliar application	NA	NA	NA	NA	NA	NA
	Chilled seeds (-1°c)	Without foliar application	193.8 CD	4.55 C	166.6 CD	36.79 E	70.87 F	107.7 E
		Delfan (amino acids)	195.3 BC	4.60 C	167.1 CD	35.67 E	73.33 F	109.0 E
		Micronutrients	193.0 CD	4.53 C	165.5 CD	36.39 E	71.40 F	107.8 E
		Sucrose	197.3 AB	4.64 C	170.0 ABC	36.73 E	74.13 F	110.9 E
		Mixed foliar application	200.0 A	5.00 B	172.5 A	38.75 E	74.20 F	112.9 E
Under low plastic tunnels	Unchilled seeds	Without foliar application	191.1 DE	5.42 A	164.1 D	93.31 CD	147.4 CDE	240.8 CD
		Delfan (amino acids)	195.3 BC	5.53 A	167.7 BCD	96.25 ABCD	151.0 ABC	247.2 ABC
		Micronutrients	194.4 C	5.48 A	166.4 CD	94.43 BCD	149.2 BCD	243.7 BCD
		Sucrose	188.7 E	5.40 A	164.9 D	91.62 D	146.1 DE	237.7 D
		Mixed foliar application	198.7 A	5.56 A	172.5 A	97.23 ABC	153.4 A	250.6 AB
	Chilled seeds (-1°c)	Without foliar application	192.7 CD	5.41 A	164.3 D	95.86 BCD	145.9 DE	241.8 CD
		Delfan (amino acids)	198.0 AB	5.53 A	168.5 ABCD	98.71 AB	149.7 ABCD	248.4 ABC
		Micronutrients	195.3 BC	5.48 A	166.7 CD	98.36 AB	148.7 BCDE	247.0 ABC
		Sucrose	192.3 CD	5.41 A	165.3 D	96.32 ABCD	144.9 E	241.2 CD
		Mixed foliar application	198.7 A	5.56 A	172.0 AB	100.7 A	151.8 AB	252.5 A

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

NA= not applicable. No fruits were obtained using these treatments

Table (54): Effect of of interaction between protecting method, seeds chilling treatment and foliar spray treatments on fruit chemical constituents of sweet pepper plants during the winter season of 2005/2006.

Treatments		Characters	Acidity mg/100cm^3	T.S.S %	Vitamin C mg/100g	Sugars mg/100g (F.W.)		
						Reducing	Non-reducing	Total
Open field	Unchilled seeds	Without foliar application	NA	NA	NA	NA	NA	NA
		Delfan (amino acids)	NA	NA	NA	NA	NA	NA
		Micronutrients	NA	NA	NA	NA	NA	NA
		Sucrose	NA	NA	NA	NA	NA	NA
		Mixed foliar application	NA	NA	NA	NA	NA	NA
	Chilled seeds (-1°c)	Without foliar application	188.3 HI	4.77 I	162.8 G	34.94 G	70.81 G	105.8 F
		Delfan (amino acids)	191.6 GH	4.86 H	165.6 F	35.50 G	72.00 G	107.5 EF
		Micronutrients	187.7 I	4.76 I	162.3 G	34.84 G	70.60 G	105.4 F
		Sucrose	193.6 FG	4.91 G	167.3 F	35.83 G	72.70 FG	108.5 EF
		Mixed foliar application	195.5 EF	4.96 F	169.0 E	36.82 G	74.80 F	111.6 E
Under low plastic tunnels	Unchilled seeds	Without foliar application	195.6 EF	5.67 D	166.3 F	91.97 F	148.1 D	240.1 D
		Delfan (amino acids)	201.2 ABC	5.84 B	171.1 CD	94.62 DEF	152.4 AB	247.0 ABC
		Micronutrients	199.1 CDE	5.78 C	169.3 E	93.64 EF	150.8 BC	244.4 BCD
		Sucrose	195.0 FG	5.66 E	165.8 F	91.68 F	147.6 D	239.3 D
		Mixed foliar application	203.2 AB	5.90 A	172.9 AB	95.60 DE	154.0 A	249.6 AB
	Chilled seeds (-1°c)	Without foliar application	196.8 DEF	5.67 D	167.1 F	97.45 BCD	145.3 E	242.8 CD
		Delfan (amino acids)	202.4 ABC	5.84 B	171.9 BC	100.3 AB	149.6 CD	249.8 AB
		Micronutrients	200.3 BCD	5.78 C	170.1 DE	99.22 ABC	148.0 D	247.2 ABC
		Sucrose	196.2 EF	5.66 E	166.6 F	97.14 CD	144.9 E	242.0 CD
		Mixed foliar application	204.4 A	5.90 A	173.7 A	101.3 A	151.1 BC	252.4 A

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

NA= not applicable. No fruits were obtained using these treatments

amino acids with chilled seeds or not under low plastic tunnels in acidity and total sugars as shown in both seasons.

The plants which subjected to open field and developed from unchilled seeds did not give fruits to can make any analysis on it.

Conclusion

It could be generally concluded that in winter season, sweet pepper plants responded better when swollen seeds were chilled at -1°C for 24 hrs before sowing and developed plants were grown under low plastic tunnels and sprayed with mixed foliar application i.e. Delfan (amino acids, 3 ml/ℓ) and sucrose (10%) seven times at 14 days intervals starting 21 days after transplanting and micronutrients (60 ppm Fe + 30 ppm Zn + 30 ppm Mn) three times at 21 days interval staring 30 days after transplanting and using drip irrigation system and supplemented with 30kg N in organic form (chicken manure) + 30 kg N in mineral form (ammonium nitrate 33.5 % N) + 64 kg P_2O_5 + 96 kg K_2O/fed. Such treatments induced the best results regarding vegetative growth, early and total yield with the best physical as well as chemical fruit characteristics of sweet pepper cv. California Wonder when grown under winter conditions in clay loam soil.