IV. RESULTS AND DISCUSSION

IV.1. First Experiment:

Effect of some commercial folifertilizers on plant growth, chemical composition, yield and quality of artichoke flower heads:

1.1. Plant growth characteristics:

Data concerning the effect of commercial folifertilizers application on artichoke growth are given in table (5). From such data, it is clear that foliar application of Irral, Bayfolan or folifertile within all used concentrations had a significant promotive effect on plant vegetative growth characteristics expressed as plant height and number of leaves per plant as well as the 4th leaf weight and length during both seasons of this experiment.

Regarding effect on percentage of dry matter, it is evident that application of different used fertilizers within all used concentrations had either no significant effect or mostly depressed dry matter percentage of the 4th leaf than the control.

It is also obvious that foliar spray of each of Irral at 0.1%, Bayfolan at 0.4% or Folifertile at 0.2% gave the most favourable effects on studied plant growth characteristics as compared with all other treatments, in both seasons of 1983/1984 and 84/1985.

Table (5) : Vegetative growth characteristics of artichoke plants as affected by some commercial folifertilizers foliar application.

Treatments	ppm.	1983/1984					1984/1985				
				4th leaf					4th leaf		
		Plant height (cm)	No. leaves/ plant	Fresh wt.(g)	Dry wt. %	Length (cm)	Plant height (cm)	No. leaves/ plant	Fresh wt.(g)	Dry wt. %	Length (cm)
Control		90.8	25.0	162.5	12.28	96.5	91.0	26.0	174.3	9.58	95.0
Irral	0.1%	118.5	41.0	243.5	12.57	115.5	119.5	42.3	249.8	9.69	115.8
	0.2%	108.5	36.3	237.0	12.36	106.0	106.8	36.3	233.0	9.50	106.3
	0.4%	106.0	34.3	214.8	11.55	104.3	106.3	34.5	213.5	8.83	106.0
Bayfolan	0.1%	109.0	34.0	238.3	11.56	105.8	105.5	29.8	241.5	10.88	106.8
	0.2%	109.3	35.3	244.5	11.27	106.3	107.3	32.3	248.8	9.95	107.8
	0.4%	113.5	41.5	248.0	11.12	109.8	113.5	33.5	255.0	8.83	111.5
Folifertile	0.1%	109.3	33.5	235.5	11.63	105.5	108.3	36.0	236.3	9.79	112.8
	0.2%	117.0	36.3	242.0	11.47	112.8	114.5	37.3	245.3	9.19	114.0
	0.4%	115.0	32.8	225.3	11.28	106.5	108.0	35.8	227.0	9.33	106.5
L.S.D at 5 %		3.19	3.0	10.64	0.829	5.43	3.95	6.14	9.65	N.S.	5.03

Obtained results showing the stimulative effect of used nutrients on plant vegetative growth such as leaf fresh weight, leaf length, number of leaves per plant and plant height are in harmony with those of Thorne (1954), Silva and Fontana (1979), El-Sawah (1981) and Gabal (1984) on tomato.

Results including the promotive effect of spraying plants with different compound fertilizers on fresh weight per plant are in agreement with those obtained by Thorne (1954), working on tomato, Hodossi and Brosos (1973) on different vegetable crops and Balasa et al., (1977), El-Sawah (1981) and Gabal (1984) all working on tomato.

Regarding effect of used concentration, obtained data agree with those reported by Gabal (1984) who found that spraying tomato plants with Bayfolan at 0.4%, Irral at 0.2% or Fetrilon - Combi at 0.6% increased fresh weight per plant.

1.2. Chemical composition of leaves:

1.2.a. Chlorophyll and carotene content:

Concerning the effect of some commercial foli-fertilizers application on chlorophyll and carotene contents (mg/100g fresh weight) of artichoke leaves, data obtained are given in table (6). From such data,

Table (6) : Chlorophyll and carotein content (mg/100g fresh Wt.) of artichoke leaves as affected by some commercial folifertilizers foliar application.

Treatments		1983/1984				1984/1985			
		Chlorophyll			Carotene	Chlorophyll			Carotene
		(a)	(b)	total		(a)	(b)	total	
Control		62.12	23.14	85.26	43.78	76.25	31.82	108.07	53.00
Irral	0.1%	84.22	33.32	117.84	55.49	85.69	38.26	123.95	70.38
	0.2%	74.78	28.63	103.41	51.92	81.05	36.41	117.46	79.22
	0.4%	72.97	28.62	101.59	49.69	75.95	34.43	110.38	62.09
Bayfolan	0.1%	74.67	29.82	104.49	48.08	72.84	32.21	105.05	68.20
	0.2%	76.01	30.55	106.56	49.74	76.04	34.40	110.44	69.59
	0.4%	83.63	33.37	117.00	48.13	83.26	37.09	120.35	66.70
Folifertile	0.1%	85.33	34.34	119.67	56.42	86.33	38.42	124.75	68.41
	0.2%	91.45	36.15	127.60	61.70	89.87	40.73	130.60	70.14
	0.4%	83.38	33.31	116.69	67.92	85.11	38.69	123.80	84.08
L.S.D. at 5 %		4.51	1.84	4.81	3.12	3.04	2.27	3.77	5.88

it is clear that each of Irral, Bayfolan or Folifertile application within all used concentrations had a significant promotive effect on chlorophyll a,b and total chlorophyll as well as carotene contents of leaves than the control, especially in the first season. Whereas, in the second reason the same trend was detected except that increments of chlorophyll - a,b and total chlorophyll content in leaves of plants treated with Irral 0.4%, Bayfolan 0.1% and 0.2% were not significant.

According to the effect of folifertilizers concentration, data at the same table indicate that the application of Folifertile 0.2% followed by Irral 0.1% and Bayfolan 0.4% had the most favourable effect on either chlorophyll a,b and total chlorophyll content of leaves in both seasons. Data of plant growth shown at table (5) which show that artichoke plants sprayed with Irral 0.1%, Bayfolan 0.4% and Folifertile 0.2% resulted in the largest growth vigour are associated with high chlorophyll content of plants of such treatments, can explain it.

Concerning carotene content, data in table (6) showed that Irral, Bayfolan or Folifertile application within all used concentrations significantly increased carotene pigment content of artichoke leaves in both seasons than the control. Increasing levels of Irral

had a flactuated effect on leaf's carotene content. Whereas, carotene content was not significantly improved by increasing levels of Bayfolan application from 0.1% up to 0.4%. However, increasing levels of Folifertile application from 0.1 up to 0.4% showed a gradual significant increase in carotene content of leaves reached the maximum in plants sprayed with 0.4% Folifertile.

The stimulative effect of Irral, Bayfolan and Folifertile foliar application on chlorophyll and carotene content of leaves have been mentioned by Balasa et al., (1977) and Gabal (1984) both working on tomato and Abdalla et al (1984) on sweet pepper.

1.2.b. N, P and K content of plant leaves:

Data of N, P and K (%) in artichoke leaves are shown at table (7). Such data clearly indicate that each of Irral, Bayfolan or Folifertile application within all used concentrations increased all N,P and K% in leaves than the control. Although, the same trend was noticed in both seasons, variances were only significant in the first one for both of N and P%. Data also show that N, P and K% in leaves were greatly affected with the level and kind of the used folifertilizer. Plants sprayed with the medium level (0.2%) of each of Irral, Folifertile or Bayfolan had the maximum N and P% in leaves as compared with all other

Table (7) : Total-N, P and K content of artichoke leaves as affected by some commercial folifertilizers foliar application.

Treatments	ppm.	1983/1984			1984/1985		
		N%	P%	K%	N%	P%	K%
Control		2.17	0.136	2.36	2.28	0.143	2.42
Irral	0.1%	2.95	0.150	3.64	2.72	0.154	3.84
	0.2%	3.22	0.172	3.28	2.85	0.171	3.08
	0.4%	2.37	0.142	4.06	2.52	0.168	4.14
Bayfolan	0.1%	2.66	0.153	3.40	2.92	0.165	3.97
	0.2%	2.92	0.162	3.97	2.96	0.169	4.58
	0.4%	2.24	0.141	3.20	2.56	0.154	3.26
Folifertile	0.1%	2.24	0.146	3.70	2.71	0.160	4.32
	0.2%	3.05	0.168	3.64	3.77	0.183	4.32
	0.4%	2.85	0.163	3.26	2.80	0.165	2.82
L.S.D at 5 %		0.17	0.015	0.47	N.S	N.S	0.61

treatments. Regarding effect on K% in plant leaves, data presented at table (7) also indicate that 0.4% Irral, 0.2% Bayfolan or 0.1% Folifertile were the treatments which showed highest increments in this respect. Generally, it is evident that leaf analysis (Tables 6, 7 and 8) of well developed plants (Table 5) which produced higher early yield (Table 9) had a moderate values of N, P and K (Table 7) in leaves at this time of sampling, i.e. 120 days after planting. This result may be refered to the dilution of nutrients in high vigour plants added to its translocation to the early flower buds developed at this time.

The stimulating effects of used commerical folifertilizer foliar application on N,P and K content of leaves are in agreement with those of Thorne (1954) Chandhuri and Rajwat (1975), Balasa et al (1977), Ilie et al (1977), El-Sawah (1981) and Gabal (1984) all working on the effect of various complex fertilizers on tomato plants.

1.2.c. Reducing, non-reducing and total sugars of plant leaves:

Data concerning the effect of some commercial folifertilizers application on sugar content of artichoke leaves are given in table (8). Such data show that application of Irral, Bayfolan or Folifertile within all used concentrations significantly increased the reducing and total sugars concentration than

Table (8) : Reducing, non-reducing and total sugars (mg/g dry weight) of artichoke leaves as affected by some commercial folifertilizers foliar application.

Treatments		1983/1984			1984/1985		
		reducing	non-reducing	total	reducing	non-reducing	total
Control		49.2	10.5	59.7	34.7	16.4	51.1
Irral	0.1 %	58.0	15.7	73.7	65.5	11.3	76.8
	0.2 %	53.7	12.7	66.4	56.6	13.1	69.7
	0.4 %	58.6	11.7	70.3	55.1	15.6	70.7
Bayfolan	0.1 %	50.7	11.9	62.6	53.0	15.6	68.6
	0.2 %	51.8	11.2	63.0	59.7	13.2	72.9
	0.4 %	62.8	13.5	76.3	61.6	14.2	75.8
Folifertile	0.1 %	52.6	13.5	66.1	57.6	11.1	68.7
	0.2 %	60.7	13.6	74.3	55.3	15.7	71.0
	0.4 %	56.8	12.6	69.4	53.1	17.2	70.3
L.S.D. at 5 %		4.6	2.3	4.7	6.9	2.9	2.6

the control, in both seasons of this work.

It is also evident from the same data that, increasing levels of Irral application from 0.1 up to 0.2% decreased total and reducing sugars. However, increasing levels of Bayfolan from 0.1, 0.2 up to o.4% gradually increased both reducing and total sugars content of leaves, reached the maximum in plants sprayed with 0.4%, as shown in both seasons. According to the effect of Folifertile, data reveal that the middle concentration (0.2%) gave the highest values of reducing and total sugars in the first reason, while no considerable variances in this respect were detected in the second one.

Generally, it is concluded that reducing and total sugars content of leaves were greatly differed due to the kind and concentration of the used folifertilizer. In this respect, treatment of Irral at 0.1%, Bayfolan at 0.4% and Folifertile at 0.2% resulted in the highest values of reducing and total sugars content of plant leaves as shown in both seasons. This result may be refered to the superior growth as well as chlorophyll content of plants treated with Irral, Bayfolan or Folifertile at 0.1, 0.4 or 0.2% of each, respectively as shown in tables (5 and 6). The positive correlation between chlorophyll

content and photosynthesis intensity of plant leaves have been mentioned by Balasa et al. (1977).

Concerning, non-reducing sugars, no definite trend could be concluded, since most folifertilizers treatments increased it in the first season, but decreased it in the second one as compared with the control. Obtained results are in line with those of Khalil et al.(1985.b) who indicated that the highest amounts of total carbohydrates, soluble and non-reducing sugars were resulted in the leaves of lettuce plants sprayed with Irral, Bayfolan, Folifertile or Foliatrin.

1.3. Early yield of artichoke flower heads:

Data concerning the effect of some commercial folifertilizers application on flower head early yield are given in table (9) and Fig.(1).

With respect to average flower head weight, data presented at table (9) show that all folifertilizer treatments significantly increased flower head weight, at both seasons of this work. Furthermore, it is clear that the three applied concentrations (0.1, 0.2 and 0.4%). of each of Irral, Bayfolan and Folifertile increased number and weight of flower heads early yield per plant as well as early yield per feddan than the control as shown in both seasons of 1983/1984 and 1984/1985. Such increments were only significant

Table (9) : Early yield of artichoke flower heads as affected by some commercial folifertilizers foliar application.

Treatments	ppm.	1983/1984 Flower head wt.(g)	No./ Plant	Kg./ Plant	Ton/ fed	% of total yield	1984/1985 Flower head wt.(g)	No./ Plant	Kg./ Plant	Ton/ fed	% of total yield
Control		375.3	1.15	0.432	0.977	8.62	358.8	1.38	0.495	1.089	10.64
Irral	0.1%	439.6	2.45	1.077	3.058	16.46	399.3	3.10	1.237	3.031	16.09
	0.2%	445.0	1.89	0.842	2.366	14.90	394.0	2.88	1.134	2.723	19.09
	0.4%	430.7	1.80	0.775	2.015	15.50	385.0	2.53	0.972	2.342	16.87
Bayfolan	0.1%	442.7	1.67	0.742	2.047	15.94	399.0	3.20	1.277	3.218	23.25
	0.2%	450.5	1.47	0.663	1.829	12.36	404.7	2.78	1.127	2.919	19.70
	0.4%	406.2	2.40	0.973	2.809	17.66	388.5	3.48	1.349	3.530	21.12
Folifertile	0.1%	430.5	1.97	0.850	2.414	16.35	394.2	3.63	1.428	3.754	25.61
	0.2%	438.7	1.52	0.668	1.935	10.44	404.5	2.73	1.104	2.760	16.75
	0.4%	438.5	1.25	0.548	1.583	9.50	400.0	2.75	1.099	2.799	18.36
L.S.D. at 5%		9.41	0.65	0.282	0.718		10.24	0.61	0.242	0.677	

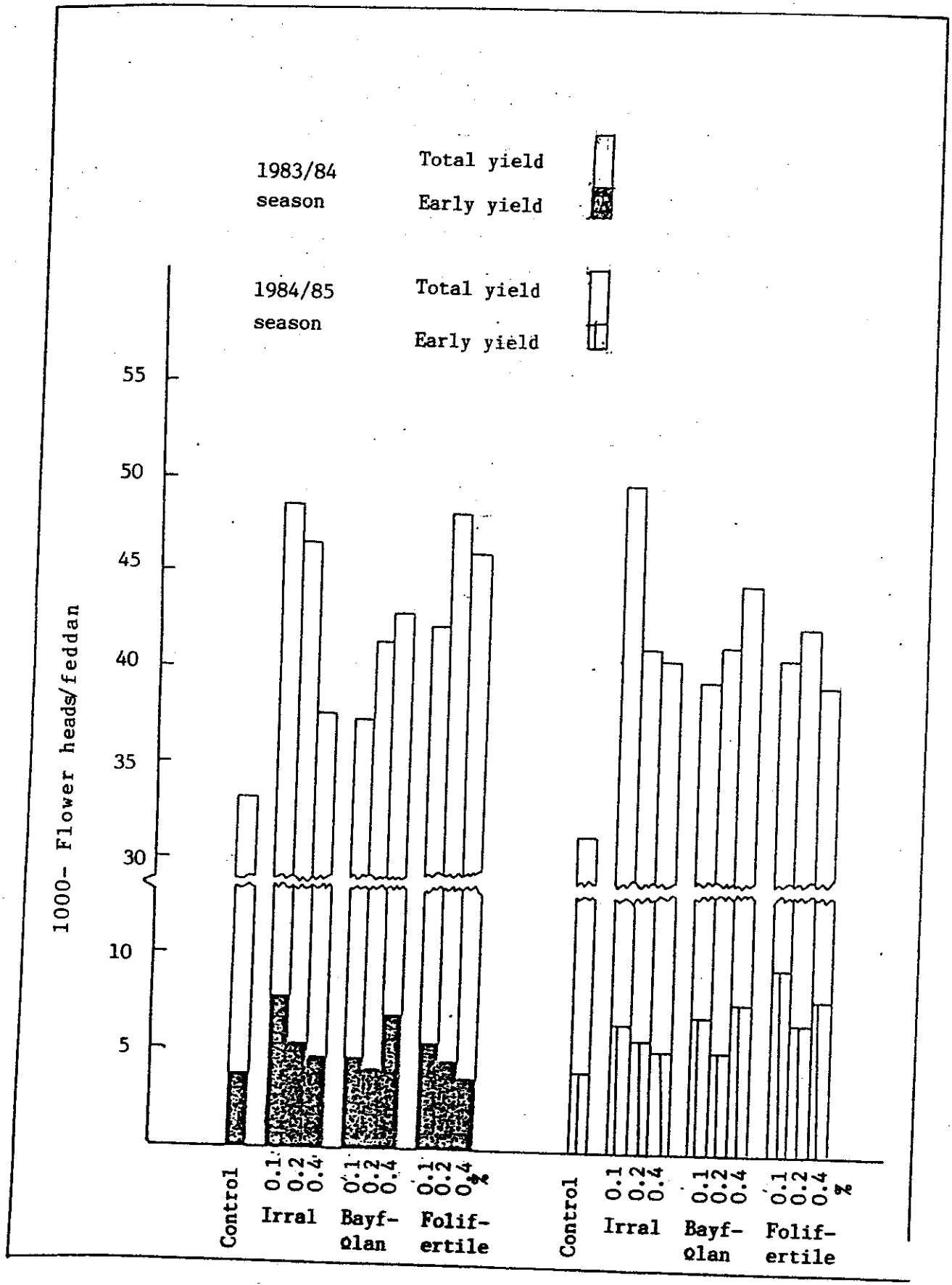

Fig. (1): Effect of some commercial folifertilizers foliar application on early and total flower head yield by number (in 1000) during 1983/84 and 1984/85 seasons.

in case of using 0.1% of either Irral or Folifertile and 0.4% of Bayfolan in the first season (1983/1984), meanwhile, all used doses of different tested folifertilizers were of significant improving effect at the second season (1984/1985).

It could be concluded that foliar application of Irral at 0.1%, Bayfolan at 0.4% and of Folifertile at 0.1% had the most favourable effect on artichoke flower head early yield by number and weight, hence it increased early yield as kg/plant by 150, 149 or 143%, respectively over the control during both seasons. The high vegetative growth, chlorophyll, reducing and total sugars content in leaves of plants (Tables 5,6 and 7) treated with Irral at 0.1%,Bayfolan at 0.4% or Folifertile at 0.1% may offer an explanation for the superior effect of these treatments on artichoke early yield.

Regarding the percentage of early yield based on total yield as ton per feddan, data of table (9) show to a great extent similar results to those of the absolute early yield.

The promotive effects of each of Irral, Bayfolan and Folifertile on yield earliness of artichoke are in harmony with those reported by Hodossi (1973), Tanev and Stanchev (1978) and Gabal (1984) all working

on tomato. Moreover, Abdalla et al. (1984) mentioned that spraying sweet pepper plants with 0.1 - 0.2% Irral had a superior effect on early yield. On the other hand, they mentioned that plants received 0.4% Bayfolan had no promising effect on yield earliness.

1.4. Total yield of artichoke flower heads:

Data concerning the effect of some commercial folifertilizers application on total flower head yield are illustrated at table (10) and Fig. (1). Such data show clearly that most used concentrations of different applied folifertilizers increased average weight of flower heads, total yield by weight and number either per plant or per feddan than the control treatment. Such increments are statistically significant than the control in the second season for all used treatments. However, increments due to some treatments were not significant in the first season.

Concerning the effect of used dose, it is reaveld from the same data that low used level of Irral (0.1%), higher one of Bayfolan (0.4%) and medium used level (0.2%) of folifertile resulted in the highest values of yield components compared with other used treatments, hence it increased total yield as kg/plant by 55, 34 and 44%, respectively over the control. This result may be refered to the high vegetative growth

Table (10): Total yield of artichoke flower heads by weight and number as affected by some commercial folifertilizers foliar application.

Treatments		1983/1984				1984/1985			
		Fresh weight/ head (g)	No./ Plant	Kg./ Plant	Ton/ Fed.	Fresh Weight/ head(g)	No./ Plant	Kg./ Plant	Ton./ Fed.
Control		340.8	13.5	4.600	11.330	327.5	13.0	4.265	10.236
Irral	0.1%	380.3	16.5	6.299	18.575	377.5	19.5	7.378	18.836
	0.2%	345.0	15.5	5.345	15.874	347.0	16.5	5.723	14.261
	0.4%	344.8	14.3	4.914	12.996	341.5	16.0	5.458	13.879
Bayfolan	0.1%	341.3	13.3	4.523	12.845	352.5	15.0	5.285	13.838
	0.2%	353.5	14.8	5.203	14.793	354.5	15.5	5.490	14.814
	0.4%	373.3	15.3	5.682	16.023	374.3	16.5	6.174	16.714
Folifertile	0.1%	346.3	14.8	5.072	14.769	359.3	15.0	5.390	14.656
	0.2%	383.3	16.3	6.224	18.532	384.3	17.0	6.538	16.475
	0.4%	361.3	15.5	5.589	16.641	374.5	15.5	5.800	15.242
		21.91	1.15	0.451	1.700	20.82	1.15	0.615	1.589

of plants treated with 0.1% Irral, 0.4% Bayfolan or 0.2% Folifertile as previously discussed in table (5).

The stimulative effect of Irral, Bayfolan and Folifertile on number and weight of total flower head yield per plant as well as per feddan are in agreement with Hodossi (1973), Hodossi and Hamar (1976) and Balasa et al. (1977), who mentioned that the complete folifertilizers had a promising effect on tomato total yield. Moreover, Tanev and Stnchev (1978) showed also that, spraying tomato plant with 0.2% Bayfolan increased total yield. Gabal (1984) found also that spraying tomato plants with 0.1% Bayfolan and 0.2% Irral increased weight of fruits per plant and consequently total yield per feddan. On the other hand, total yield of tomato was not significantly increased as a result of 0.3% Wuxal foliar application (El-Sawah; 1981).

1.5. Physical characteristics of inflorescence (Flower heads):

Concerning the effect of some commercial folifertilizers application on physical characteristics of artichoke flower heads, data presented at table (11), show clearly that foliar application of used fertilizers improved size of artichoke flower heads and the edible part parameters than the control. It is evident also that most used concentrations

Table (11) : Physical characteristics of inflorescence (Flower head) of artichoke as affected by some commercial folifertilizers foliar application.

Treatments		1983/1984					1984/1985				
		Flower head		Receptacle			Flower head		Receptacle		
		Length (cm)	Diameter (cm)	Diameter (cm)	Thickness (cm)	Fresh wt.(g)	Length (cm)	Diameter (cm)	Diameter (cm)	Thickness (cm)	Fresh wt.(g)
Control		8.8	8.4	6.2	2.9	54.4	9.0	8.3	6.2	2.8	55.6
Irral	0.1%	9.9	9.3	6.7	3.5	81.3	9.9	9.5	6.7	3.4	80.5
	0.2%	9.3	8.7	6.4	3.1	70.9	9.7	8.8	6.4	3.1	70.1
	0.4%	9.6	8.5	6.4	3.1	65.6	9.8	8.9	6.4	3.2	64.6
Bayfolan	0.1%	9.4	8.6	6.4	3.0	65.1	9.6	8.9	6.4	3.2	64.4
	0.2%	9.4	8.6	6.5	3.2	73.6	9.7	8.6	6.5	3.2	73.4
	0.4%	9.4	8.8	6.8	3.3	80.6	10.1	9.0	6.8	3.3	79.8
Folifertile	0.1%	10.0	9.2	6.8	3.2	75.3	10.2	9.3	6.8	3.5	75.1
	0.2%	10.6	9.3	7.3	3.5	82.8	10.5	9.4	7.3	3.6	81.6
	0.4%	9.9	9.2	6.6	3.3	78.3	10.3	9.3	6.6	3.3	79.5
L.S.D. at 5 %		0.52	0.84	0.26	0.23	7.04	0.59	0.25	0.32	0.10	7.75

as applied fertilizers showed significant increments in flower heads and edible part parameters than control treatment, specially in the second season of this work.

Generally, it may be noticed that plants sprayed with 0.1% Irral, 0.4% Bayfolan or 0.2% folifertile produced flower heads of the best physical characters which gave receptacle of superior weight and size.

Results on the stimulative effect of folifertilizers application on fresh weight and size of artichoke flower heads and receptacle are in agreement with those of Hodossi (1973), Hodossi and Hamar (1976) and Balasa et al.(1977), who mentioned that the application of such complete folifertilizers showed a promising effect on tomato fruit weight and size. Gabal (1984) found that spraying tomato plants with various commercial folifertilizers including Irral and Bayfolan led to an increase in fruit length and diameter compared with control. In this connection, average fruit weight was highest in plants sprayed with 0.4% Bayfolan or 0.1% irral.

1.6. Chemical composition of the edible part (receptacle):

1.6.a. Dry matter N, P and K percentages:

Data concerning the effect of some commercial folifertilizers application on dry matter, N, P and

Table (12) : Dry matter, N, P and K content of artichoke edible part as affected by some commercial folifertilizers foliar application.

Treatment		1983/1984				1984/1985			
		Dry matter %	N %	P %	K %	Dry matter %	N %	P %	K %
Control		14.8	1.94	0.200	2.00	13.2	2.39	0.219	1.82
Irral	0.1%	14.5	2.42	0.234	3.49	16.3	2.44	0.243	3.00
	0.2%	15.9	2.68	0.273	2.40	15.9	2.85	0.270	2.64
	0.4%	14.3	2.57	0.216	1.88	15.6	2.65	0.225	1.88
Bayfolan	0.1%	15.3	2.50	0.220	2.48	16.7	2.52	0.270	2.18
	0.2%	14.9	2.60	0.232	2.86	15.5	2.80	0.245	2.70
	0.4%	14.4	2.12	0.259	2.98	15.0	2.74	0.294	2.88
Folifertile	0.1%	16.2	2.75	0.210	2.48	16.4	2.92	0.231	2.94
	0.2%	15.5	2.21	0.202	4.98	14.6	2.80	0.244	2.84
	0.4%	14.9	2.61	0.253	2.56	14.9	2.88	0.282	2.94
L.S.D. at 5 %		N.S.	N.S.	N.S.	0.61	1.24	0.20	N.S.	0.60

K percentages in the edible part are given in table (12). Such data show that Irral, Bayfolan and Folifertile application within all used concentrations increased the values of such constituents than control. The increments resulted in the dry matter, and N% were only significant during the second season. However, data on P% were not significant during both seasons of this work. Whereas, K% was increased significantly by spraying plants with 0.1% Irral, 0.2 or 0.4% Bayfolan and 0.2% folifertile as compared with control in both seasons.

The favourable effect of Irral on dry matter, N, P and K percentage of the edible part have been mentioned by Abdalla et al (1984) working on sweet pepper, who found that Irral at 0.2% led to the highest values of N and K contents in pepper fruits.

1.6.b. Reducing, non-reducing and total sugars of the edible part:

Data showing the effect of some commercial folifetilizers on reducing, non-reducing and total sugars content (mg/g dry Wt.) of the edible part of artichoke are recorded at table (13). Such data clearly reveal that all folifertilizer treatments increased reducing and total sugars content of the edible part of artichoke flower heads than those of the control.

Table (13): Reducing, non-reducing and total sugars content (mg/g dry weight) of artichoke edible part as affected by some commercial folifertilizers foliar application.

Treatments		1983/1984			1984/1985		
		Reducing	non-reducing	total	Reducing	non-reducing	total
Control		46.7	13.9	60.6	38.3	17.9	56.2
Irral	0.1 %	59.7	8.8	68.5	47.1	17.5	64.6
	0.2 %	63.5	17.0	80.5	50.9	20.3	71.2
	0.4 %	56.1	17.2	73.3	47.4	22.2	69.6
Bayfolan	0.1 %	60.6	12.0	72.6	51.7	15.3	67.0
	0.2 %	63.0	14.9	77.9	56.8	14.8	71.6
	0.4 %	63.3	14.8	78.1	57.9	15.3	73.2
Folifertile	0.1 %	59.3	18.8	78.1	58.9	15.6	74.5
	0.2 %	66.3	10.9	77.2	57.7	20.7	78.4
	0.4 %	54.5	15.5	70.0	45.5	15.3	60.8
L.S.D. at 5 %		6.5	3.9	7.9	8.3	2.7	18.4

This result is true at both seasons. It is also obvious that increments in this respect are statistically significant.

Referring to non-reducing sugars, data show that it was significantly affected by foliar nutrition whereas, some treatments did not improve the non-reducing percentage of the edible part where others were of improving effect in this respect. Treatments showed the highest values were Irral and Bayfolan at 0.2 or 0.4% as well as 0.1 or 0.2% Folifertile.

As a general conclusion, the application of Irral at 0.2%, Bayfolan at 0.4% or Folifertile at 0.2% may be recommended to increase reducing, non-reducing and total sugars content of the edible part of artichoke. The well vegetative growth of plants sprayed with used folifertilizers, especially at such concentrations may be reflected on sugars content as a result of high photosynthesis rate in such treatments.

Results on the stimulating effect of Irral, Bayfolan and Folifertile on sugars content of the edible part are in harmony with those of Zibene (1974), El-Sawah (1981) and Gabal (1984) who found an enhancing effect of various folifertilizers on reducing, non-reducing and total sugars content of tomato fruits.

IV.2. Second Experiment :

Effect of some micronutrients on plant growth, chemical composition, yield and quality of artichoke flower heads:

2.1. Plant growth characteristics:

Data concerning the effect of Fe-DTPA, Mn-EDTA and Zn-EDTA foliar application on vegetative growth of artichoke plants expressed as plant height, number of leaves per plant , length, fresh and dry weight of the 4th leaf are given in Table (14). From such data, it is clear that Fe, Mn or Zn foliar application within three concentrations for each significantly increased plant height and number of leaves per plant as well as fresh weight and length of the 4th leaf than that of the control plants, in both seasons. However, increment in dry matter of the fourth leaf of treated plants than that of the control was not significant. Furthermore, it is evident from obtained data that spraying artichoke plants with Mn or Fe at medium used level and Zn or Mn at high used level significantly exceeded all other treatments. This result may be refered to the physiological role of Fe, Zn and Mn on oxidation enzymes activity and chlorophyll formation as well as the role of Zn on endogenous IAA (Follette et al.,1981), which consequently increased plant height and number of leaves per plant.

Table (14) : Vegetative growth characteristics of artichoke as affected by some micronutrients foliar application

Treatments	ppm.	1983/1984					1984/1985				
				4th leaf					4th leaf		
		Plant height (cm)	No. leaves/ plant	Fresh wt.(g)	Dry wt. %	Length (cm)	Plant height (cm)	No. leaves/ plant	Fresh wt.(g)	Dry wt. %	Length (cm)
Control		104.0	47.0	181.3	9.91	98.6	103.0	46.3	185.0	9.83	99.0
Fe- DTPA	60	116.0	52.0	239.0	9.75	114.6	121.6	74.3	240.3	10.00	108.6
	90	123.3	66.6	251.6	10.00	117.6	131.6	75.6	255.0	10.16	112.3
	120	120.6	62.3	237.6	10.25	103.3	124.0	68.0	231.0	10.16	100.0
Mn- EDTA	192	117.0	57.6	233.3	9.16	106.0	137.6	71.6	234.3	9.10	103.0
	288	127.6	68.6	261.6	10.25	120.6	144.0	79.3	255.3	10.13	120.6
	384	121.6	61.3	238.3	10.28	116.0	137.0	74.0	249.3	10.30	115.6
Zn- EDTA	112	114.6	49.0	208.3	10.16	106.3	113.3	63.0	219.0	10.16	103.0
	168	115.3	52.0	216.6	10.15	107.6	115.6	67.3	223.3	10.23	108.6
	244	118.0	56.3	245.0	10.25	114.3	120.6	70.0	246.0	10.60	114.0
L.S.D. at 5 %		8.42	3.97	17.27	N.S.	9.50	16.15	6.25	17.10	N.S.	4.29

The promotive effects of these micronutrients on plant growth are in confirmity with Pilliai and Vadivelu (1966); Pais et al.(1969); Bojcenko (1970), Mohapatra and Kiba (1971) Ashour (1973), Zaki et al (1981.b) and Gabal (1984) on tomato; Midan (1972), Kanwar and Thakur (1973) and and Gabal et al.(1984) on common bean; El-Beheidi et al(1978) on cucumber; Zaki et al. (1979) on Squash and El-Shewy (1982) on lettuce. In this connection, Magnifico and Lattanizio (1976 and 1981) on artichoke calculated the amounts of Fe, Mn, and Zn removed at plant population of 690° plants/ha pointing out the necessity of such elements to artichoke plant growth.

2.2. Chemical composition of leaves:

2.2.a. Chlorophyll and carotene content:

Data showing the effect of some micronutrients foliar application (Fe, Mn and Zn) on the chlorophyll and carotene contents of artichoke leaves are presented in Table (15).

Such data show that some used concentrations of applied nutrients significantly increased a,b and total chlorophyll as well as carotene leaves content. Moreover, it is obvious that the treatments resulted in the highest values in this respect, were those of the low and medium used level of Zn and Mn,

Table (15) : Chlorophyll and caroteine contents (mg/100 g fresh wt.) of artichoke leaves as affected by some micronutrients foliar application.

Treatments	ppm.	1983/1984				1984/1985			
		Chlorophyll			Carotene	Chlorophyll			Carotene
		(a)	(b)	total		(a)	(b)	total	
Control		90.49	59.06	149.55	68.61	90.03	58.47	148.50	64.63
FE- DTPA	60	100.65	44.43	145.08	70.87	101.95	44.73	146.69	71.85
	90	96.99	48.01	145.00	63.58	96.45	49.14	145.59	65.26
	120	79.90	64.59	144.49	60.70	82.00	65.04	147.04	61.76
Mn- EDTA	192	90.09	66.78	156.87	61.61	90.38	67.35	157.73	62.09
	288	119.19	64.69	183.88	79.92	109.22	64.72	173.94	77.93
	384	83.03	51.07	134.10	62.32	83.30	52.35	135.65	62.49
Zn- EDTA	112	128.68	60.87	189.55	79.74	124.72	61.04	185.76	79.79
	168	88.15	73.04	161.19	75.02	88.67	73.05	161.72	75.32
	224	102.74	55.52	158.26	67.36	102.66	55.84	158.50	65.64
L.S.D. at 5 %		9.81	3.91	11.51	5.26	8.07	3.57	8.24	3.68

respectively. This result could be refered to the favourable effect of Zn and Mn application on chlorophyll a and b which consequently increased total chlorophyll content in plants.

The promotive effect of Fe, Mn and Zn foliar application on chlorophyll and carotene pigments are in agreement with Vaganova and Sorokia (1970) working on cucumber, Albegove (1972) and Shafshak (1983) on sweet pepper; Gabal et al.(1984) on common bean; and Gabal (1984) on tomato all found that Fe, Mn and Zn application increased leaf's chlorophyll and carotene content.

2.2.b. N, P and K content of plant leaves:

Data of N, P and K content of plant leaves are presented in Table (16). It is clearly evident that all used micronutrients treatments increased plant leaves contents of N, P and K compared to control. It is also obvious that treatments which showed the highest significant increments in this respect, were those of medium used rate of Fe, or low one of each of Zn and Mn. However, increments in phosphorus percentage in plant leaves were not significant during both seasons of this study.

Obtained results showing the favourable effect of Fe, Mn and Zn foliar application on N, P and K% of

Table (16): Total-N, P and K content of artichoke leaves as affected by some micronutrients foliar application.

Treatment	ppm.	1983/1984 N%	1983/1984 P%	1983/1984 K%	1984/1985 N%	1984/1985 P%	1984/1985 K%
Control		2.62	0.149	3.42	2.45	0.150	3.33
Fe - DTAP	60	2.72	0.162	4.08	2.71	0.158	3.76
	90	3.80	0.222	5.06	3.77	0.198	4.62
	120	2.84	0.168	4.42	3.33	0.166	4.46
Mn - EDTA	192	3.79	0.210	5.48	3.70	0.200	5.68
	288	3.16	0.175	4.28	3.00	0.179	4.25
	384	2.70	0.165	4.18	2.50	0.160	4.13
Zn - EDTA	112	3.04	0.168	4.11	3.42	0.180	4.18
	168	2.93	0.157	3.62	3.33	0.156	3.67
	224	3.20	0.166	3.86	3.50	0.165	4.05
L.S.D. at 5%		0.61	N.S.	0.66	0.56	N.S.	0.41

plant leaves are in harmony with those of Duffek (1972) and Gabal (1984) who found that Mn and Fe foliar application increased N, P and K content in tomato leaves. Moreover, Mohaptra and Kibe (1971) on tomato, Abd El Maksoud et al.(1974) on sweet pepper, and Gabal et al. (1984) on common bean emphasized the enhancing effect of Zn foliar application on N, P and K content of plant foliage.

2.2.c. Reducing, non-reducing and total sugars of plant leaves :

Data illustrating sugars content of artichoke leaves are presented in Table (17). Such data show that Fe, Mn and Zn foliar application within all tested concentrations significantly increased the reducing and total sugars of leaves compared to control during both seasons of this experiment. However, non-reducing sugars were only significantly affected during the first season, where medium used concentrations of each of Fe and Zn as well as high one of Mn showed highest values in this respect.

Such results showing the favourable effect of Fe, Mn and Zn foliar application on reducing, non-reducing and total sugars of plant leaves are in agreement with those of Midan (1972) on common bean using 0.25% $MnSo_4$, Hassan (1982) on bean using 0.4%

Table (17): Reducing, non-reducing and total sugars (mg/g dry weight) of artichoke leaves as affected by some micronutrients foliar application.

Treatments	ppm.	1983/1984			1984/1985		
		Reducing	non-reducing	total	Reducing	non-reducing	total
Control		43.1	11.1	54.2	38.4	16.5	54.9
Fe - EDTA	60	61.3	14.1	75.4	59.9	12.7	72.6
	90	56.2	16.9	73.1	56.7	15.7	72.4
	120	56.2	8.1	64.3	52.0	16.8	68.8
Mn - EDTA	192	62.3	10.1	72.4	59.4	15.0	74.4
	288	59.0	13.0	72.0	56.5	15.0	71.5
	384	59.1	13.7	72.8	58.6	18.1	76.7
Zn - EDTA	112	53.4	14.3	67.7	51.5	15.2	66.7
	168	56.8	17.0	73.8	60.1	16.9	77.0
	224	57.8	13.8	71.6	58.6	13.8	72.4
L.S.D. at 5 %		4.1	2.3	4.9	5.9	N.S.	7.6

$ZnSO_4$ and Turkey (1982) on celery using 200 ppm Zn as foliar spray.

From data of chlorophyll analysis (Table, 15), it is noticed that plants sprayed with low-Zn or medium- Mn had the highest chlorophyll content associated herein with a moderate values of sugars as shown in Table (17). This result may be due to the high translocation of sugars from leaves in well developed plants of such treatments.

2.3. Early yield of artichoke flower heads:

Data concerning the effect of Fe, Mn and Zn application on early yield of artichoke flower heads are given in Table (18) and Fig. (2). From such data it is clear that either Fe, Mn or Zn application within all used concentrations significantly increased early yield of artichoke expressed as average flower head weight, number and weight of flower heads per plant as well as per feddan than control during both seasons of this study. Increasing level of Fe, Zn or Mn from the low up to the medium one was not able to increase early yield of flower heads either by weight or number. However, increasing concentration up to the highest used level significantly increased early yield by weight and number of flower heads compared to lower concentrations of such micronutrients.

Table (18) : Early yield of artichoke flower head as affected by some micronutrients foliar application

Treatments	ppm.	1983/1984 Flower head wt. (g)	No./ Plant	Kg./ plant	Ton/ fed.	% of total yield	1984/1985 Flower head wt. (g)	No./ Plant	Kg./ Plant	Ton / fed.	% of total yield
Control		354.7	1.40	0.496	1.287	11.36	353.6	1.16	0.410	1.068	10.68
Fe-DTPA	60	370.3	2.53	0.937	2.527	17.64	367.3	2.17	0.797	2.043	14.00
	90	368.7	2.33	0.859	2.363	12.48	356.6	2.10	0.748	2.015	12.42
	120	371.0	3.70	1.372	3.661	23.79	370.6	3.00	1.111	2.870	18.85
Mn-EDTA	192	372.3	2.53	0.942	2.812	16.38	385.0	2.33	0.897	2.274	14.94
	288	371.3	2.40	0.891	2.564	13.01	381.6	2.17	0.828	2.060	11.42
	384	376.6	3.36	1.265	3.755	20.97	395.0	2.63	1.038	2.644	15.78
Zn-EDTA	112	381.0	2.66	1.013	2.991	19.70	384.0	2.43	0.933	2.292	16.87
	168	367.6	2.45	0.900	2.624	16.44	365.0	2.20	0.803	2.074	14.10
	224	387.6	3.77	1.461	4.137	23.07	387.3	3.43	1.328	3.269	21.43
L.S.D. at 5 %		11.08	0.453	0.178	0.762		11.68	0.508	0.186	0.670	

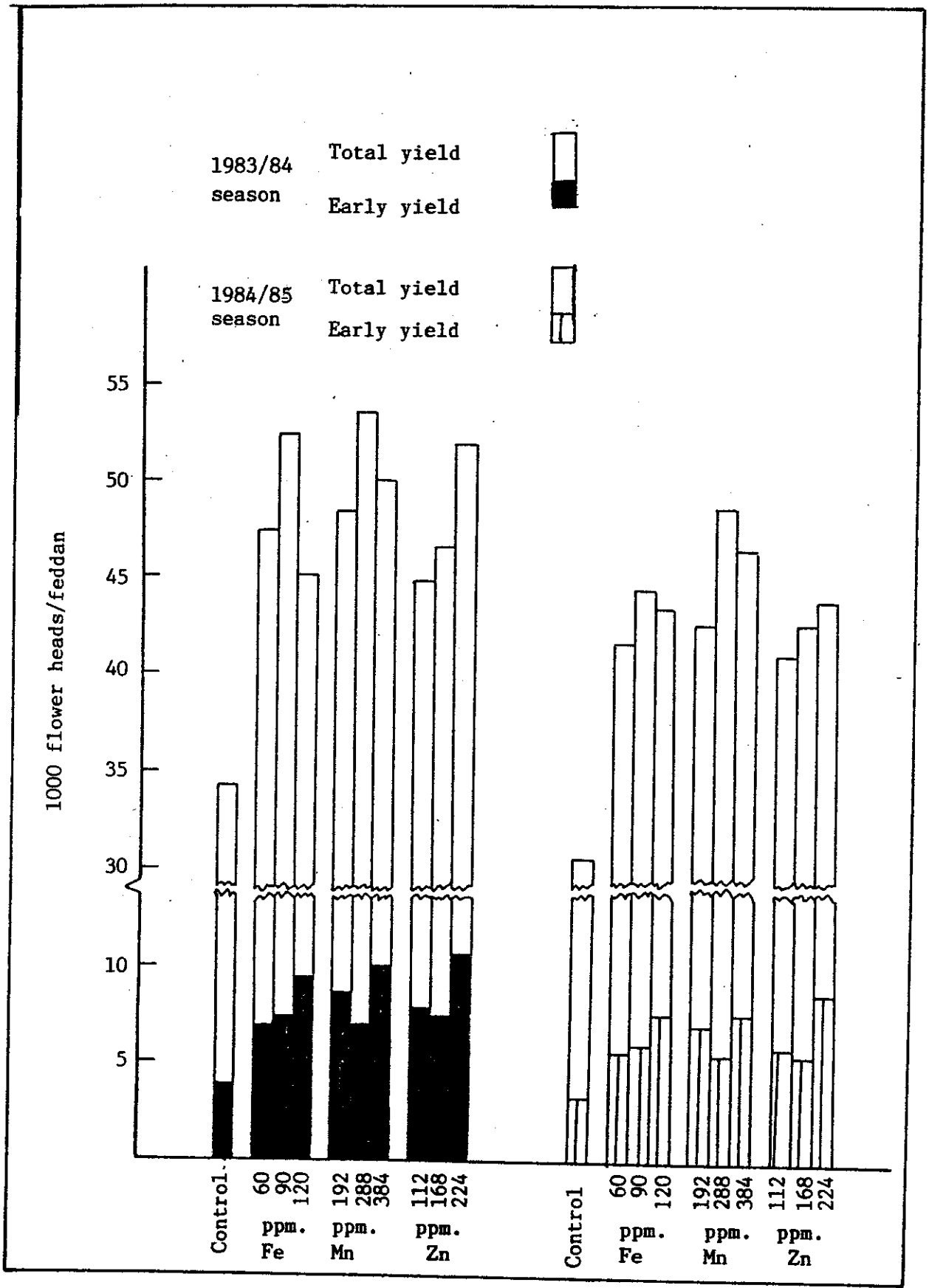

Fig. (2) Effect of some micronutrients foliar application on early and total flower head yield by number (in 1000) during 1983/84 and 1984/85 seasons.

It may be concluded in this respect that the highest early yield productivity either per plant or per feddan was obtained from plants supplied with high used rate of Zn followed by those received high rate of either Fe or Mn, where no significant variances were detected between both latter nutrients. Such increments by high Fe, Mn and Zn application reached about 174, 154 and 209%, respectively over than the control during both seasons.

Results on the favourable effect of Fe, Mn and Zn foliar application on number and weight of early flower heads per plant as well as per feddan are in haromony with those of Genchev and Gyurov (1975), Zaki et al.(198 b) and Gabal (1984) on tomato and shafshak (1983) on sweet pepper, who found that application of micronutrients including Fe; Mn or Zn increased fruit early yield as compared with the control.

2.4. Total yield of artichoke flower heads:

Data concerning the effect of spraying artichoke plants with Fe, Mn and Zn on average weight of flower head, total yield of flower heads by weight and number per plant as well as per feddan are shown at Table (19) and Fig.(2). Such data clearly indicate that Fe, Mn and Zn application within all used concentrations significantly increased average flower head weight,

Table (19) : Total yield of artichoke flower heads by weight and number as affected by some micronutrients foliar application.

Treatments		1983/1984				1984/1985			
		Fresh weight/ head (g)	Total yield			Fresh weight/ head (g)	Total yield		
			No./ Plant	Kg./ Plant	Ton/ fed.		No./ Plant	Kg./ Plant	Ton/ fed.
Control		327.3	12.0	3.957	11.325	326.0	11.3	3.692	10.038
Fe- DTPA	60	345.6	16.7	5.756	14.318	348.6	16.0	5.581	14.588
	90	354.0	17.3	6.136	18.923	361.0	16.7	6.021	16.220
	120	343.6	15.7	5.385	15.385	347.6	16.3	5.670	15.218
Mn-EDTA	192	356.6	16.0	5.700	17.163	355.6	16.0	5.688	15.215
	288	373.6	18.3	6.850	19.707	373.3	17.7	6.566	18.023
	384	357.3	16.3	5.834	17.904	358.3	17.0	6.095	16.749
Zn-EDTA	112	339.6	15.0	5.090	15.178	339.0	15.3	5.198	13.582
	168	345.0	15.3	5.290	15.954	344.3	16.0	5.506	14.701
	224	347.6	17.0	5.909	17.928	347.0	16.3	5.663	15.250
		10.28	1.87	0.596	0.798	11.90	1.49	0.645	0.587

number and weight of artichoke flower heads either per plant or per feddan as compared with the control, in both seasons of this study. The highest values in this respect were obtained as a result of spraying plants with the medium rate of either Mn or Fe and the high one of Zn. In this respect, the super treatment was spraying plants with medium Mn concentration i.e. (288 ppm of Mn-EDTA) resulting in 73-77% in weight and 53-57% in number of flower heads per plant over the control, as shown in both seasons.

The superiority of Mn or Fe application at its medium levels on total yield could be refered to the promotive effect of Mn and Fe application on number of flower heads per plant and the improvement in average flower heads weight, since medium-Mn application significnatly increased flower head weight as compared with all other treatments.

These results are in agreement with those of Shkvaruk et al. (1973) using 250 ppm $MnSO_4$, Duffek (1975) using 1000-2000 ppm $MnSO_4$, Zaki et al.(1981 b) using 50 ppm Mn and Gabal (1984) using 25-50 ppm Mn on tomato plants, grown at clay loam soil. Concerning effect of Fe on total yield, obtained results are in confirmity with those of Gabal (1984) working on tomato, who reported that spraying plants 3 times with $FeSO_4$ at 400 ppm Fe inceased fruit total yield.

Moreover, obtained results regarding the stimulative effect of Zn application on total yield of artichoke flower heads are in coincidence with those of Ashour (1973) and Shkvaruk et al. (1973) on tomato and Abd El-Maksoud et al. (1974) and Shafshak (1983) on sweet pepper.

2.5. Physical characteristics of flower heads:

Data presented at table (20) show clearly that physical characters of either flower head i.e. length and diameter or receptacle i.e. diameter, thickness and fresh weight were mostly significant increased as a result of spraying plants with different rates of either Fe, Mn or Zn compared to control during both seasons of this study. It is also evident that the highest values of studied characters could be detected as a result of using the medium rate of either Fe or Mn and the high one of Zn. Obtained results are going in the same trend at both the two seasons of this study.

The improving effect of Fe, Mn or Zn application on flower head size herein is in harmony with that reported by Genchev and Gyurov (1975) concerning Zn, and Gabal (1984) with regard to Fe, Mn or Zn application on tomato plants.

However, obtained results are not incomplete agreement with those of Woods and Nolan (1968), who

Table (20) : Physical characteristics of infloresence (Flower head) of artichoke as affected by some micronutrients foliar applications.

Treatments	ppm.	1983/1984					1984/1985				
		Flower head		Receptacle			Flower head		Receptacle		
		Length (cm)	Diameter (cm)	Diameter (cm)	Thickness (cm)	Fresh wt.(g)	Length (cm)	Diameter (cm)	Diameter (cm)	Thickness (cm)	Fresh wt.(g)
Control		9.2	8.2	5.3	2.7	49.8	8.7	8.4	5.6	2.8	49.6
Fe-ETPA	60	9.7	8.9	6.7	3.5	62.8	9.8	9.1	6.6	3.4	62.0
	90	10.2	9.5	7.1	3.8	71.1	10.3	9.5	6.9	3.5	70.3
	120	9.8	9.3	6.6	3.5	59.5	9.8	9.4	6.5	3.4	59.1
Mn-EDTA	192	9.9	9.4	6.8	3.8	64.8	10.0	9.4	6.6	3.7	63.8
	288	10.5	9.6	7.3	4.0	75.0	10.7	9.7	7.2	3.8	73.8
	384	10.2	9.5	7.1	3.9	70.8	10.1	9.5	7.0	3.6	70.0
Zn-EDTA	112	9.5	8.5	5.9	3.3	56.1	9.4	8.5	5.8	3.2	56.0
	168	9.5	8.5	5.9	3.3	59.0	9.5	8.9	5.9	3.3	59.6
	224	9.7	9.2	6.3	3.5	67.6	9.8	9.2	6.3	3.5	65.6
L.S.D. at 5%		N.S.	0.68	0.85	0.46	9.21	0.85	1.10	0.64	0.29	8.10

mentioned that Fe applied either in mineral or chelated form had no pronouncing effect on tomato fruit size.

2.6. Chemical composition of the edible part (receptacle):

2.6.a. Dry matter, N, P and K percentage:

Data concerning the effect of Fe, Mn and Zn foliar application on dry matter, N,P and K percentages of the edible part (receptacle) of artichoke are illustrated at Table (21). It is evident from such data that all used concentrations of Fe, Mn and Zn increased dry matter, N,P and K percentages in the edible part of artichoke than control treatment. It is also obvious that such improving effect on the edible part constituents show statistical singnificant increments in all studied chemical characters except in case of P at both seasons and K at the second one of this study. Regarding dry matter percentage of edible part as affected by used micronutrients, obtained data at table (21) reveal that high used level of Mn followed by the low one of Fe show the highest values in this respect. The superiority of high Mn application on dry matter accumulation may be refered to the role of Mn on chlorophyll formation and protein synthesis (Follett et al.,1981).

With regard to N, P and K% of the edible part of artichoke flower heads as affected by used treatments of this study, the same data (Table,21) show

Table (21) : Dry matter,N, P and K content of artichoke edible part as affected by some micronutrients foliar application.

Treatments	ppm.	1983/1984				1984/1985			
		Dry matter %	N %	P %	K %	Dry matter %	N %	P %	K %
Control		11.9	2.52	0.241	2.58	11.6	2.41	0.243	2.67
Fe - DTPA	60	14.2	2.80	0.264	3.08	13.6	2.75	0.268	3.27
	90	13.5	3.37	0.274	3.71	13.3	3.36	0.280	3.73
	120	13.1	3.43	0.285	3.52	13.3	3.34	0.281	3.60
Mn - EDTA	192	13.0	2.72	0.285	3.09	13.3	2.75	0.291	2.95
	288	13.4	2.80	0.270	2.63	13.5	2.85	0.254	2.94
	384	15.1	2.95	0.273	2.86	15.4	2.98	0.281	2.82
Zn - EDTA	112	13.2	3.16	0.246	3.01	12.9	3.19	0.246	3.07
	168	13.2	3.52	0.282	3.90	13.0	3.31	0.290	4.23
	224	13.5	3.92	0.267	3.64	13.2	3.86	0.253	3.68
L.S.D. at 5%		0.62	0.72	N.S.	0.32	0.60	0.40	N.S.	N.S.

that either medium or high used concentrations of both Fe and Zn resulted in highest values in this respect. In addition, the lower N, P and K% in the edible part of Mn treated plants compared to those treated with either Fe or Zn could be refered to the great development of flower head growth expressed as size weight (Table, 20) which consequently may dilute its mineral content.

2.6.b. Reducing, non-reducing and total sugars of the edible part:

Dat showing the effect of Fe, Mn and Zn application sugar content of artichoke edible part are presented at table (22). Such data show that both of reducing and total sugars content of the artichoke edible part were significantly increased as a result of spraying plants with any one of the used micronutrients within all used concentrations when compared with the control treatment. This result was the same at both seasons of this study. Moreover, treatments of low used rate of Fe and those of medium rate of either Mn or Zn resulted in highest values in this respect.

Regarding effect on non-reducing sugars, the same data at Table (22) show that no significant differences could be detected at the first season while significant increments due to micronutrients foliar spray than control were noticed . The highest

Table (22): Reducing, non-reducing and total sugars (mg/g dry weight) or artichoke edible part as affected by some micronutrients foliar application.

Treatments	ppm.	1983/1984			1984/1985		
		Reducing	non-reducing	total	Reducing	non-reducing	total
Control		34.3	12.5	46.8	40.9	6.5	47.4
Fe - DTPA	60	56.0	13.0	69.0	55.4	16.6	72.0
	90	41.3	14.1	55.4	38.9	14.6	53.5
	120	49.1	16.5	65.6	52.2	12.6	64.8
Mn - EDTA	192	43.0	16.6	59.6	38.5	17.7	56.2
	288	58.6	16.4	75.0	61.4	13.3	74.7
	384	43.9	17.4	61.3	53.7	15.6	69.3
Zn - EDTA	112	49.2	15.3	64.5	45.3	19.7	65.0
	168	52.3	14.1	66.4	55.3	12.0	67.3
	224	44.1	11.6	55.7	44.4	11.3	55.7
L.S.D. at 5 %		0.38	N.S.	0.50	0.41	0.34	0.65

non-reducing sugars content of the artichoke edible part were those of plants treated with the low used levels of either Fe, Mn or Zn.

Generally, it may be concluded that both total and reducing sugars were found at their maximum values in the edible parts of artichoke flower heads whose plants were sprayed with medium used rates of either Mn or Zn and low rate of Fe. However, low used rate of any one of Fe, Mn or Zn resulted in highest non reducing sugars content of the edible part. The superiority of medium Mn application on total sugars content of the edible part could be refered to its favourable effect on chlorophyll content of plant leaves.

The stimulative effect of Fe, Mn and Zn on sugars content of the edible part have been also mentioned by El-Behéidi et al.(1978) on cucumber using 100 ppm $ZnSO_4$, Mallick and Muthukrishama (1980) on tomato plants sprayed with 5000 ppm each of Zn, Fe or Mn and Gabal (1984) on tomato using 25, 200 and 400 ppm for Mn, Zn and Fe, respectively.

However, obtained results did not agree with those of Silva and Fontana (1979), who found that Mn, Zn and Fe application tended to decrease sucrose content of tomato fruits.

IV.3. Third Experiment:

Effect of some growth regulators on growth, chemical composition, yield and quality of artichoke flower heads:

3.1. Plant growth characteristics:

Data on plant growth expressed as plant height, number of leaves per plant and leaf length, fresh as well as dry weight of the fourth leaf are given in table (23). It is evident from such data that all growth regulators used within all tested concentrations, significantly increased plant height than the control during both seasons of this study. Plants sprayed with GA_3 were superior compared with those sprayed with either CCC or NAA. A gradual increasing tendency in plant height was detected as GA_3 concentration from 50, 100 up to 2000 ppm increased, whereby no clear trend could be detected in case of both CCC and NAA.

Such stimulative effect of GA_3 on artichoke plant height has been also mentioned by Metwally et al.(1979), El-Shewy (1982), Gabal et al.(1985) and Bekhit et al. (1986) working on tomato, lettuce, broad bean and artichoke, respectively.

The moderate enhancing effect of CCC on the height of artichoke plants supports the findings of Gabal et al.(1985), who emphasized that 500 up to

Table (23) : Vegetative growth characteristics of artichoke plants as affected by some growth regulators foliar application.

Treatments	ppm.	1983/1984					1984/1985				
				4 th leaf					4th leaf		
		Plant height (cm)	No. leaves/ plant	Fresh wt.(g)	Dry wt. %	Length (cm)	Plant height (cm)	No. leaves/ Plant	Fresh wt.(g)	Dry wt. %	Length (cm)
Control		110.7	35.2	213.0	13.6	102.5	103.2	44.7	213.7	11.9	91.0
GA_3	50	130.0	33.2	244.7	13.2	112.5	124.0	43.5	249.5	12.5	110.0
	100	137.0	41.0	228.2	12.5	113.2	131.0	53.5	233.2	11.6	111.0
	200	148.0	38.7	212.2	12.2	114.2	138.2	50.5	223.2	11.6	113.5
CCC	500	122.7	44.5	219.0	12.8	99.2	117.0	55.2	187.2	11.3	94.2
	1000	126.0	47.5	250.0	12.8	105.7	118.0	58.0	265.2	11.6	104.0
	2000	121.2	38.7	238.7	13.7	99.5	113.7	50.5	227.5	12.0	98.7
NAA	100	128.0	41.0	236.5	12.8	108.0	121.0	53.2	227.2	11.4	102.5
	200	129.5	48.5	248.2	12.5	111.2	122.7	61.5	233.0	11.2	109.0
	400	124.0	42.5	239.7	11.2	107.2	118.2	55.5	219.0	11.5	100.7
L.S.D. at 5 %		11.59	5.80	11.329	N.S.	8.62	7.9	5.5	21.80	0.68	10.8

2000 ppm CCC application did not decrease stem height of broad bean plants. However, obtained results did not agree with those of Denna (1962), Kuraishi and Muir (1963) and Zaki et al.(1976) working on cucumber and squash, pea and tomato, respectively using concentrations ranged from 500 up to 1500 ppm. It is well known that the specific effect of CCC depends on the dose used, type of plant as well as time and frequency of application. Moreover, it seems that under this experiment circumstances, the highest used CCC level (2000 ppm) was not high enough to induce the expected restrictive effect on artichoke plant height.

Refering to the stimulative effect of NAA on plant height, obtained results are in coincidence with those of Takahashi and Nakayama (1961), Kumar and Sreekumer (1981), Zaki et al.(1981 a) and El-Assiouty (1983) working on various vegetable crops. However, results obtained herein did not agree with those reported by Singh and Upahyay (1967), who emphasized the retarding effect of NAA on tomato plant height.

Concerning the effect of growth regulators foliar application on number of leaves per plant, data given in table (23) clearly indicate that all used growth

substances within one or more specific concentration significantly increased number of leaves/plant than the control. Plants sprayed with 100 ppm GA_3, 500 or 1000 ppm CCC and 200 or 400 ppm NAA induced the most pronouncing effect in this respect during both seasons of the experiment.

Obtained results on GA_3 are in agreement with those of Said et al. (1966) on cowpea, Farrag (1971) on tomato, Foury et al.(1977) on artichoke and Deka and Das (1978) and El-Assiouty (1983) on common bean, who mentioned that GA_3 application increased number of leaves per plant. However, results of this work did not agree with those of Aly (1983) on artichoke, who did not find any significant effect due to 25,50 or 75 ppm GA_3 foliar application.

Concerning the significant stimulating effect of the low (500 ppm) or medium (1000 ppm) doses of CCC on the number of leaves per plant, obtained results disagree with those of Zaki et al.(1976) on tomato and Abdalla et al.(1979) on eggplant and pepper, who found that CCC application up to 1500 ppm showed depressive effects. In this connection, it seems that the retardant dose of CCC required for globe artichoke is higher than that of previoulsy mentioned solanaceous crops and seems to be more than 2000 ppm.

With regard to the favourable effect of NAA on number of leaves per plant, obtained results completely agree with those of Zaki et al.(1981.a) and El-Assiouty (1983), who found that 100-200 ppm and 100 ppm of NAA enhanced number of leaves in tomato and common bean plants, respectively.

Refering to the effect of various used growth regulators on fresh weight of the 4th leaf of artichoke plants, data presented in table (23) clearly indicate significant favourable effects in this respect compared to control except in case of 200 ppm GA_3 and 500 CCC during first and second seasons, respectively. Furthermore, it is also clear that plants sprayed with 50 ppm GA_3 or 1000 ppm CCC produced the highest fresh weight of the 4th leaf than all other treatments in both seasons of this work.

Obtained results are in harmony with those of Said et al.(1966), Khalifa (1972), Omar (1977), Abd-El-Fattah (1978), El-Assiouty (1983) and Gabal et al. (1985) all working on the effect of GA_3 on the fresh weight of different crops and with Kumar and Sreekumer (1981), Zaki et al.(1981.a) and El-Assiouty (1983) studying the effect of NAA on fresh weight of some vegetables.

With regard to the effect on dry matter percentage of the 4th leaf, the used growth regulators generally, seemed to have a retarding effect in this respect, meanwhile differences failed to reach the 5% level of significancy during the first season.

As for the effect on the length of the 4th leaf, data presented in table (23) obviously indicate that GA_3 and NAA foliar application with all tested concentrations increased leaf length of artichoke plants than the control, whereby GA_3 showed superiority in this respect. Furthermore, used levels of both growth substances did not differ significantly in their effect on leaf length during both seasons. Obtained results support the view of the enchancing effect of GA_3 and to a lesser extent to NAA as an exogenous auxin on cell elongation and therefore on the longitudinal growth of plant organs. On the other hand, application of the growth retardant substance CCC generally decreased leaf length than control, except medium concentration (1000 ppm), which proved to be the most effective treatment (compared to 500 or 2000 ppm) on number of leaves per plant and fresh weight of the 4th leaf as well.

3.2. Chemical composition of leaves:

3.2.a: Chlorophyll and carotene content:

Data of the effect of growth regulators foliar

application on chlorophyll and carotene content of globe artichoke leaves are shown at table (24). It is clear from such data that either GA_3, NAA or CCC within all used concentrations had no significant effect on both chlorophyll a and carotene content in both seasons of the experiment. However, chlorophyll b content was gradually increased as GA_3 and NAA levels increased. Contra results were obtained in case of CCC application. Such trend was true during both seasons, but variances were significant only in the first one (1983/1984). As for total chlorophyll content, medium level of GA_3 (100 ppm) as well as highest level of NAA (400 ppm) showed the most pronouncing effect in this respect, whereas various CCC levels did not differ significantly from each other in this respect.

The stimulative effect of GA_3 on chlorophyll contnet had been also reported by El-Assiouty (1983) on common bean, where chlorophyll content increased as GA_3 levels from 25 up to 100 ppm increased. Obtained results, however did not agree with those of Simao et al.(1960) and Flamee and Vereeck (1977) on lettuce and Sadek (1976) and Abo-Sedera (1981) on spinach. Results regarding the effect of CCC on photosynthetic pigments are not in line with those of Knavel (1969), Metwally et al.(1979) and Shafshak (1983) on various solanaceous crops. The non-signficant effect of NAA on

Table (24): Chlorophyll and carotene contents (mg/100 g fresh weight) of artichoke leaves as affected by some growth regulators foliar application.

Treatments	ppm.	1983/1984				1984/1985			
		Chlorophyll			Carotene	Chlorophyll			Carotene
		(a)	(b)	total		(a)	(b)	total	
Control		89.19	27.32	116.51	69.35	93.18	39.97	133.15	72.98
GA_3	50	97.49	27.55	125.04	81.16	80.31	39.37	119.68	64.85
	100	109.70	38.86	148.56	80.33	85.84	49.77	135.61	64.27
	200	93.97	44.70	138.67	75.40	74.35	55.58	129.93	57.30
CCC	500	87.62	30.13	117.75	69.83	84.17	50.92	135.09	68.60
	1000	91.02	28.64	119.66	66.55	85.02	44.21	129.23	65.82
	2000	91.78	23.01	114.79	61.59	90.09	40.90	130.99	63.89
NAA	100	87.82	25.95	113.77	54.02	83.53	37.49	121.02	60.05
	200	79.26	24.72	103.98	57.62	85.75	41.19	126.94	68.18
	400	100.15	28.55	128.70	74.13	102.06	45.82	147.88	70.62
L.S.D. at 5 %		N.S.	4.48	16.19	N.S.	N.S.	N.S.	N.S.	N.S.

chlorophyll and carotene content is in harmony with those of Metwally et al.(1979), who found no relation between NAA application and the content of such pigments in tomato leaves.

3.2.b.: N,P and K content of plant leaves:

Results on the effect of GA_3, CCC and NAA on N, P and K content of globe artichoke leaves are presented in table (25). It is evident from such data, that GA_3 mostly increased studied minerals content of artichoke leaves compared to the control, however differences did not reach the 5% level of significance. Obtained results coincide those of Khalifa (1972) and Omar (1977) regarding N content of bean leaves and Farrag (1971) concerning P and K content of tomato leaves. However, such results contradict those of El-Assiouty (1983), who found that increasing GA_3 levels from 50 up to 100 ppm greatly decreased N, P and K uptake of common bean plants.

As for the effect of CCC application on N, P, K concentrations in artichoke leaves, data of table (25) cleary show that all used levels of CCC had no significant effect in this respect, except the lowest level (500 ppm) which increased significantly N content only during the first seasons of the experiment. In this connection, Knavel (1969) reported that CCC application increased N, P but decreased k

Table (25): Total-N,P, and K content of artichoke leaves as affected by some growth regulators foliar application.

Treatments	ppm.	1983/1984			1984/1985		
		N%	P%	K%	N%	P%	K%
Control		2.35	0.157	3.84	2.35	0.180	4.04
GA_3	50	2.70	0.141	4.05	3.28	0.181	4.08
	100	2.70	0.160	4.08	3.05	0.177	5.00
	200	2.10	0.166	3.90	2.90	0.186	4.46
CCC	500	3.28	0.160	4.14	2.78	0.168	4.05
	1000	2.37	0.156	4.32	2.73	0.168	4.06
	2000	2.80	0.165	4.24	2.77	0.163	3.16
NAA	100	2.90	0.177	3.84	3.29	0.168	3.36
	200	2.55	0.142	3.64	3.18	0.195	4.57
	400	2.65	0.177	3.84	3.23	0.216	4.92
L.S.D. at 5%		0.59	N.S.	N.S.	N.S.	N.S.	1.08

content of tomato leaves. In addition, Shafshak (1983) emphasized the enhancing effect of CCC of N, P and K uptake of sweet pepper plants.

Regarding effect of NAA foliar spray in this respect, data in table (25) indicate that N and P content of artichoke leaves mostly increased due to NAA application, however differences were not significant during both seasons. Although K content did not vary greatly as a result of NAA foliar application during the first season, it obviously increased during the second season of this work, especially when NAA was applied at 200 or 400 ppm. Obtained results agree to some extent with those of Amer (1981), who reported that spraying tomato plants 3 times with 100 or 200 NAA increased N, P and K content of leaf tissues.

3.2.c: Reducing, non-reducing and total sugars of plant leaves:

It is clear from data presented at table (26) that increasing GA_3 concentration induced a significant increasing tendency regarding reducing sugars content of artichoke leaves, especially during the first season. Application of 200 ppm GA_3 was superior in this regard compared with either lower used levels (50 and 100 ppm) or control as well. However, significant effect on reducing sugars was found due to GA_3 application within all used concentrations during the second seasons of this experiment. Similar trend

Table (26) : Reducing, non-reducing and total sugras (mg/g dry weight) of artichoke leaves as affected by some growth regulators foliar application.

Treatments	ppm	1983/1984			1984/1985		
		Reducing	non-reducing	total	Reducing	non-reducing	total
Control		54.6	14.0	68.6	59.5	15.9	75.4
GA_3	50	50.0	13.0	63.0	57.4	18.5	75.9
	100	60.0	12.4	72.4	58.5	12.2	70.7
	200	61.4	13.0	74.4	59.1	12.9	72.0
CCC	500	55.1	13.5	68.6	63.6	11.0	74.6
	1000	49.9	16.1	66.0	53.3	15.2	68.5
	2000	39.9	13.8	53.7	49.9	14.9	64.8
NAA	100	56.8	14.1	70.9	52.6	15.6	68.2
	200	55.0	14.9	69.9	42.5	17.3	59.8
	400	61.4	12.3	73.7	62.8	10.7	73.5
L.S.D. at 5 %		5.5	N.S.	7.7	6.7	3.4	4.8

was found regarding NAA application, where the highest used level (400 ppm) induced the most promoting effect on reducing sugars compared to the control during both seasons, but differences reached the 5% of level of significancy only during the first seasons. Lower used NAA concentrations (100 and 200 ppm) were found to be of similar (First season) or less effect (second season) on reducing sugars as control treatment. Contra trend was detected regarding CCC aplication, whereas the highest used concentration (2000 ppm) led to the highest significant diminishing effect on reducing sugars content of artichoke leaves during both seasons.

As for non-reducing sugars content of artichoke leaves, data presented at table (26) indicate that, with few exceptions all growth regulators used within all used concentrations decreased non-reducing sugars content but differences were not great enough to reach the 5% level of significancy during the first seasons of this study. Compared to the control treatment, increasing tendency was found only in case of 50 pmm GA_3 application (during the second season), 1000 ppm CCC (during the first season) and 200 ppm NAA (during both seasons).

Concerning the effect of various used growth regulators on total sugars content of artichoke

leaves, it is clear from data tabulated in table 26) that it followed the same manner as previously mentioned by reducing sugars hence the latent one constitute more than 75% of the total sugars content.

Obtained results regarding the effect of GA_3 application on reducing as well total sugars content are in agreement with those of Khalifa (1972) on common bean, who emphasized the enhancing effect of GA_3 foliar spray on the total carbohydrates contnet of leaves till following stage of bean plants. however, obtained results did not agree with those of Said et al.(1966) and El-Assiouty (1983) working on the effect of GA_3 application on reducing sugars of cowpea shoots and total carbohydrate accumulation of common bean leaves, respectively. The obtained decreasing effect of CCC on different sugars components support the findings of Zaki et al.(1976) on tomato, Abdalla et al.(1979) on eggplant and pepper and Abd-El-Hamid et al.(1979) on cucumber, who reported the inhibiting effect of 500, 1000 or 1500 ppm on the accumulation of total carbohydrates in leaves of studied plants. Obtained results regarding the effect of low or medium concentrations of NAA foliar spray on the sugars components of artichoke leaves are in line with those reported by El-Assiouty (1983), who mentioned the decreasing effect of 100 and 200 ppm NAA on the total carbohydrates accumulation in common bean leaves

at full bloomingstage.

3.3. Early yield of artichoke flower heads:

Data concerning the effect of growth regulators foliar application on flower head early yield are given in table (27). It is clear from such data that all used growth regulators increased significantly average weight of flower head compared to control treatment during both seasons of the experiment. The early harvested flower heads of GA_3 sprayed plants were heavier than those obtained from plants sprayed with either NAA or CCC during the first season, however contratrend was found during the second season of the study. It is worthy to mention herein that the lower the concentration used of growth regulators, the larger flower head could be harvested. This was true for GA_3, CCC and NAA during the first season and for GA_3 and CCC only during the second season of the experiment.

As for the early yield productivity by weight and number of flower heads either per plant or per feddan, data of table (27) and Fig.(3) show superiority of all used growth regulators over the control. During both seasons, GA_3 treated plants ranked first followed by those treated with NAA, whereby those sprayed with CCC came last in this respect. Such superiority of GA_3 application regarding absolute

Table (27) : Early yield of artichoke flower heads as affected by some growth regulators foliar application.

Treatments	ppm.	1983/1984 Flower head wt.(g)	No./ plant	Kg./ plant	Ton/ fed.	% of total yield	1984/1985 Flower head wt.(g)	No./ plant	Kg./ plant	Ton/ fed.	% of total yield
Control		378.0	0.91	0.346	1.020	9.20	365.5	1.50	0.550	1.315	12.50
GA_3	50	431.7	2.03	0.877	2.631	13.32	391.8	2.44	0.916	2.748	15.22
	100	428.0	2.03	0.871	2.650	15.12	365.2	2.55	0.929	2.783	18.25
	200	404.8	3.55	1.436	4.336	25.53	353.5	3.47	1.233	3.329	22.83
CCC	500	428.0	0.88	0.374	1.140	6.73	409.7	1.76	0.721	1.946	11.66
	1000	403.0	1.27	0.510	1.581	11.02	383.7	1.65	0.632	1.896	13.64
	2000	403.2	1.30	0.525	1.590	12.80	390.2	1.89	0.738	1.942	15.21
NAA	100	446.7	1.03	0.458	1.351	8.98	390.7	1.49	0.581	1.589	10.29
	200	381.7	1.75	0.667	2.001	11.80	403.7	2.50	1.009	2.806	16.60
	400	421.7	0.91	0.384	1.163	7.08	386.5	1.70	0.656	1.779	11.42
L.S.D. at 5 %		8.68	0.56	0.233	0.140		11.81	0.50	0.189	0.127	

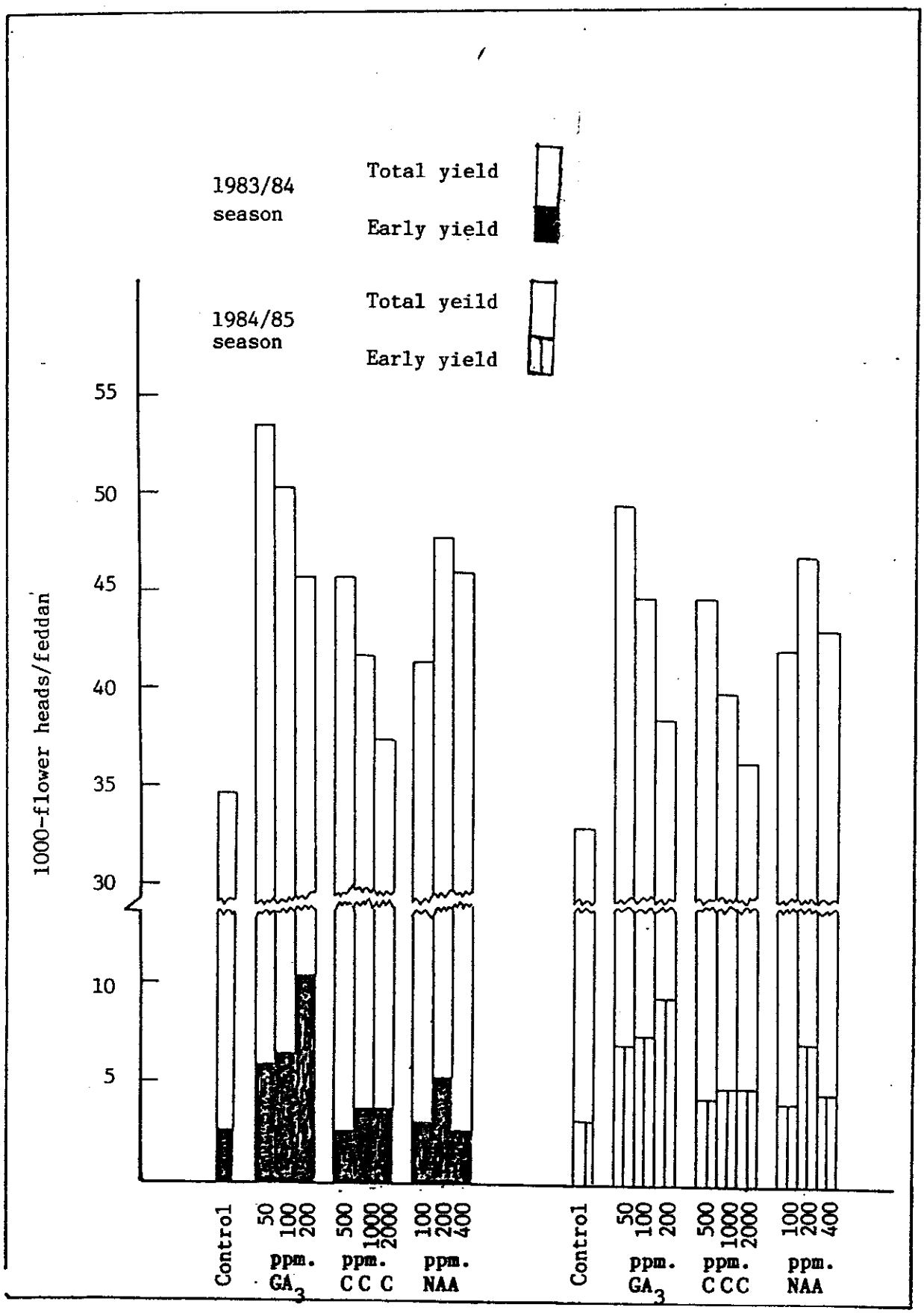

Fig. (3): Effect of some growth regulators foliar application on early and total flower head yield by number (in 1000) during 1983/84 and 1984/85 seasons.

early yield production held true also regarding the relative early yield as shown from table (27).

An increasing tendency in absolute as well as relative early flower head yield could be observed as GA_3 concentration increased. In this concentration, spraying of 200 ppm GA_3 proved to be the best compared to either 100 or 50 ppm. hence it increased early flower head yield as kg/plant by 220% over control as average of both seasons.

As for CCC spray, it is evident from data at table (27) that no significant differences regarding absolute early yield could be observed between different used levels (500, 1000 and 2000 ppm), especially during the second seasons of study, however, an increasing trend with regard to the relative early yield could be detected as CCC concentration increased during both seasons. In this respect, 2000 ppm. CCC resulted in 43% increment in early yield as kg/plant over control during both seasons.

Regarding NAA application, the medium level (200 ppm) was found to be of the most pronouncing effect on absolute as well as relative flower head early yield production compared to either 100 or 400 ppm during both seasons of this work. Such treatment (200 ppm NAA) produced 88% early yield as kg/plant over control as average of both seasons.

The stimulative effect of GA_3 foliar application on flower head early yield production of artichoke plants has been mentioned by Pochard (1964), Casilli (1969), Turner and Lagaude (1970), Ziv (1970), Snyder et al.(1971), Radwan and Stino (1973), Doel and Martinoli (1976), El-Shal et al.(1977), Abd El-Fattah (1978) and Aly (1983). Furthermore, in recent studies, Bekhit et al. (1986) and El-Fadaly and Abou El-Hassan (1986) emphasized the favourable effect of 50-150 ppm GA_3 application on flower head early yield productivity of artichoke plants by weight and number during December, January and February compared to either CCC or control treatments.

Obtained results concerning the less stimulative effect of CCC on flower head early yield production is in haromony with the findings reported by Hossny (1974) using 500, 1000 or 1500 ppm CCC on artichoke plants. No considerable effects on early yield due to spraying artichoke plants twice with CCC at 250, 500 or 1000 ppm were also reported by El-Fadaly and Abou El-Hassan (1986).

The benefecial effect of the medium level of NAA (200 ppm) compared to either 100 or 400 ppm on artichoke flower head early yield productivity led to the assumption that such NAA level seemed to be adequate for inducing yield earliness in artichoke

under these experimental circumstances. In this connection, Aly (1983) found that using 50, 100 or 150 ppm IAA did not induce significant effects on early yield of artichoke plants.

3.4. Total yield of artichoke flower heads:

It is evident from data presented in table (28) and Fig. (3) that growth regulators GA_3, CCC and NAA within all tested concentrations significantly increased flower heads total yield by weight and number either per plant or per feddan compared to untreated control treatment during both seasons of this study. In this connection, plants sprayed with GA_3 exceeded all those sprayed with other growth substances followed by NAA, meanwhile CCC treated plants ranked the last in their total flower head yield productivity. Although application of 200 ppm GA_3 resulted in the heaviest average flower head, it reduced significantly their number per plant as well as per feddan and consequently a gradual decreased in total yield productivity by weight could be detected as GA_3 concentration increased.

In this respect, it may be concluded that among tested GA_3 levels, 50 ppm foliar spray is found to be the elite treatment that can meet the requirement of artichoke plants for producing the highest yield. Such treatment led to 65% increment in total flower

Table (28): Total yield of artichoke flower heads by weight and number as affected by some growth regulators foliar application.

Treatments		1983/1984				1984/1985			
		Fresh weight/ head (g)	Total yield			Fresh weight/ head (g)	Total yield		
			No./ plant	kg./ plant	Ton/ fed.		No./ plant	Kg./ plant	Ton/ fed
Control		317.7	11.3	3.577	11.088	318.5	12.2	3.902	10.519
GA_3	50	369.0	17.0	6.269	19.747	365.0	16.5	6.019	18.057
	100	347.7	15.8	5.479	17.532	339.2	15.5	5.258	15.248
	200	374.0	14.5	5.425	16.984	378.7	14.2	5.400	14.580
CCC	500	370.0	15.0	5.552	16.933	371.0	15.0	5.563	16.689
	1000	343.0	13.5	4.628	14.346	349.7	13.7	4.795	13.905
	2000	331.0	12.0	3.969	12.422	352.5	12.7	4.481	12.770
NAA	100	363.7	13.0	4.730	15.041	367.5	14.0	5.148	15.444
	200	353.5	15.0	5.299	16.956	360.7	15.5	5.601	16.900
	400	355.5	14.8	5.248	16.426	362.5	14.7	5.408	15.575
L.S.D. at 5 %		11.38	1.46	0.541	1.223	19.29	0.707	0.767	1.127

head yield as kg/plant over control during both seasons.

As for CCC application, data of table (28) and Fig.(3) clearly indicate that flower head production by weight and number decreased in a descending order as used concentrations increased. In this regard, 500 ppm proved to be the best treatment inducing highest flower head yield production of artichoke plants, hence it resulted in 49% increment as kg/plant over control during both seasons. Obtained results did not agree with those found by Hossny (1974), who reported that spraying artichoke plants with 500, 1000 or 1500 ppm CCC decreased total flower head yield by number and weight. In addition, no consistent effects were found due to spraying artichoke plants twice with 250, 500 or 1000 ppm CCC compared to control (El-Fadaly and Abou El-Hassan 1986).

Although all used levels of NAA did not differ significantly in average flower head weight, the medium level (200 ppm) exceeded other ones (100 or 400 ppm) in number of flower heads per plant as well as per unit area and consequently yield production by weight (Table, 28 and Fig. 3) Scuh treatment led to 46% increase in total flower head yield in kg/plant over control during both seasons.

Obtained results regarding the benefecial effect

of GA_3 application especially at is lowest level i.e. 50 ppm on flower head total yield productivity are in agreement with those reported by Casilli (1969), De-Angelis (1970), Turner and Lagaude (1970), Harboui et al.(1976) and Harboui and Verlodt (1977. b). In recent study, Bekhit et al.(1986) emphasized the benefecial effect of 50 ppm GA_3 application which was mainly due to the increase in number of heads per plant more to the increase in average head weight. El-Fadaly and Abou El-Hassan (1986) came to similar conclusion using 50 - 150 ppm GA_3.

However, obtained results are not in complete harmony with those reported by Snyder et al.(1971), Radwan and Stino (1973) El-Shall et al.(1977), Harboui et al.(1976), El-Baz et al.(1979) and Mangano and Signorelli (1981). Such contradictive results in the review regarding the effect of GA_3 application on total flower head yield production may be mainly due to experiment location, used artichoke cultivar, GA_3 concentration, number of sprays and or time of application.

According to obtained results of this work, it is advisable under Kalubia province to spray artichoke plants of Herious cv. with 50 ppm GA_3 three times starting 60 days after planting to get the highest flower head yield productivity.

3.5. Physical characteristics of flower heads:

Data showing the effect of growth regulators foliar application on flower head characteristics are illustrated at table (29). It is evident from such data that only all GA_3 treatments increased significantly flower head length than control in an ascending order with increasing concentrations. On the other hand, CCC application within all used concentrations had a gradual shortening effect, meanwhile NAA used treatments did not show any significant effects on flower head length during both seasons of the experiment. Contra trend was observed with regard to flower head diameter, where NAA sprayed plants produced flower heads of largest diameter followed by those treated with CCC, meanwhile plants sprayed with GA_3 did not differ significantly from those untreated control ones during both seasons of this study.

Concerning the effect of growth regulators foliar application on receptacle characteristics (edible part), data at table (29) did not show significant variances regarding its thickness compared to control treatment during both seasons of this work. Otherwise, all used growth regulators treatments increased significantly receptacle diameter compared to control one during both seasons of this experiment. Treatments

Table (29): Physical characteristics of inflorescence (Flower head) of artichoke as affected by growth regulators foliar application.

Treatments	ppm	1983/1984					1984/1985				
		Flower head		Receptacle			Flower head		Receptacle		
		length (cm)	Diameter(cm)	Diameter (cm)	Thickness (cm)	Fresh Wt.(g.)	Length (cm)	Diameter(cm)	Diameter(cm)	Thickness (cm)	Fresh Wt.(g.)
Control		9.4	8.6	5.2	3.0	51.2	9.6	8.7	5.6	3.0	54.8
GA_3	50	9.8	8.4	5.5	3.2	61.6	9.5	8.5	6.4	3.3	63.8
	100	9.9	8.6	5.8	3.2	64.5	9.7	8.6	6.4	3.2	64.1
	200	10.1	8.7	5.9	3.3	68.0	9.9	8.7	6.6	3.4	67.5
CCC	500	9.5	9.4	5.2	3.5	78.7	9.3	9.3	6.5	3.3	79.7
	1000	9.1	9.2	5.4	3.2	64.7	9.1	9.0	6.3	3.2	78.1
	2000	9.1	9.0	5.2	3.3	61.2	9.1	9.0	6.2	3.2	77.1
NAA	100	9.7	9.5	6.0	3.5	71.7	9.6	9.3	6.9	3.4	91.3
	200	9.3	9.3	5.9	3.3	65.1	9.4	9.3	6.5	3.3	75.7
	400	9.3	9.2	5.9	3.4	62.7	9.4	9.1	6.4	3.3	77.2
L.S.D. at 5 %		0.42	0.36	0.16	N.S.	5.19	0.14	0.17	0.35	N.S.	4.98

of NAA sprayed plants were the leader followed by those of GA_3 where those treated with CCC ranked last in this respect.

As for receptacle fresh weight, data at table (29) obviously indicate the enhancing effect of all growth regulators within all used concentrations compared to control treatment during both seasons of this study. Application of NAA proved to be best followed by CCC and then GA_3. A gradual increasing tendency in receptacle fresh weight as concentrations increased was found only in case of GA_3, however a decreasing tendency was noticed in case of each of NAA and CCC as their concentrations increased.

Obtained results regarding the gradual improving effect of increasing GA_3 foliar spray concentrations from 50 up to 200 ppm are in agreement with those of Harboui and Verlodt (1977.a and 1977.b), who pointed out that spraying globe artichoke plants twice with 30 ppm or once with 10 ppm GA_3 improved flower head quality and increased capitulum size. However, obtained results did not agree with those of Radwan and Stino (1973) and El-Shal *et al.*(1977) emphasizing a reducingeffect of GA_3 application on flower head weight and Abd El-Fattah (1978) and Aly (1983) reporting the less effect on flower head weight and length. Furthermore, obtained results regarding the

non-significant effect of all used GA_3 concentrations (50 - 200 ppm) on flower head diameter are in harmony with those reported by El-Shal *et al*. (1977) using 25 ppm GA_3 and Abd El-Fattah (1978) and Aly (1983) both using 25 up to 100 ppm GA_3.

The decreasing effects of increased CCC concentrations from 500, 1000 up to 2000 ppm on flower head length and diameter, found herein, are in harmony with those reported by Zaki *et al*.(1976) on tomato, who mentioned that increasing CCC foliar spray concentrations from 500, 1000 up to 1500 ppm did not affect either fruit height or diameter. With regard to the enhancing effect of CCC application on flower head weight, obtained results are in line with those of Abdalla *et al*.(1979) on eggplant and pepper and Khalil *et al*.(1985 .a) on snap bean but did not agree with those of Zaki *et al*.(1976) on tomato.

Obtained results on the improving effect of NAA foliar application on flower head weight and diameter and the less effect on flower head length are in harmony with those of Amer (1981) on tomato with regard to weight and length, but not with regard to fruit diameter.

3.6. Chemical composition of edible part (receptacle):

3.6.a. Dry matter, N,P and K percentages:

Dat concerning the dry matter percentage of

the edible parts of artichoke as affected by growth regulators foliar application on plants are shown at table (30). It is obvious from such data that all growth regulators used within all tested concentrations significantly enhanced dry matter content during the first season compared to control. However, differences did not reach the 5% level of significancy during the second season of this study. The same data show also that stimulative effect, due to GA_3 application, is diminished in a descending order as tested concentrations increased, however in case of either CCC or the NAA the effect of concentration was flactuated. In this respect, plants sprayed with 50 ppm GA_3, 500 ppm CCC or 200 ppm NAA produced flower heads of the highest dry matter percentages.

As for the effect of growth regulators foliar spray on the mineral content of globe artichoke flower heads, data presented at table (30) show a significant enhancing effect of most studied treatments compared to control. With regard to GA_3 tested concentrations, 100 ppm had the most pronouncing effect on N and K percentages. Regarding P%, it is evident that 200 ppm GA_3 application showed the highest values in this respect during both seasons of this study. As for CCC application, an increasing tendency in the percentage of all studied minerals

Table (30) : Dry matter, N, P and K contents of artichoke edible part as affected by some growth regulators application.

Treatment	ppm.	1983/1984 Dry matter %	N %	P %	K %	1984/1985 Dry matter %	N %	P %	K %
Control		13.30	2.41	0.212	2.48	14.03	2.45	0.237	2.82
GA_3	50	16.50	2.20	0.196	2.24	14.75	2.60	0.249	2.30
	100	15.78	2.71	0.234	2.46	13.49	2.67	0.249	3.16
	200	15.86	2.07	0.243	1.86	13.13	2.28	0.282	2.82
CCC	500	15.51	2.40	0.202	2.24	14.49	2.30	0.240	1.89
	1000	14.36	2.45	0.217	2.54	13.96	2.40	0.235	2.48
	2000	16.06	3.32	0.229	3.24	14.59	3.01	0.267	2.64
NAA	100	15.03	2.65	0.217	2.00	14.18	2.70	0.270	3.32
	200	16.03	3.15	0.207	1.76	14.28	3.12	0.273	2.80
	400	14.36	2.45	0.228	2.36	13.39	2.60	0.283	2.06
L.S.D. at 5%		1.38	0.222	0.024	0.383	N.S.	0.241	0.034	0.351

was observed as concentrations used increased reaching its maximum at 2000 ppm. Concerning effect of NAA application, the same data at table (30) show that low NAA dose (100 ppm) showed superiority regarding K%. This held true in case of medium dose (200 ppm) regarding N%. Meanwhile the highest used NAA dose (400 ppm) induced the highest phosphorus percentage of artichoke edible part during both seasons. In this connection, El-Assiouty (1983) mentioned that foliar application of GA_3 at 50 ppm and NAA at 25 ppm increased N, P and K uptake in dry bean seeds.

3.6.b. Reducing, non-reducing and total sugars of the edible part:

Data regarding the effect of GA_3, CCC and NAA foliar application on reducing, non-reducing as well as total sugars content of the edible part of artichoke plants are presented in table (31). It is evident from such data, that GA_3 aplication within tested concentrations showed a tremendous depressive effect on reducing as well as total sugars content, with the exception of the low used dose (50 ppm) which led to an increment in this respect compared to control treatment. Differences reached the 5% level of significancy only during the second season. As for non-reducing sugar, all used GA_3 concentrations induced a depressive effect during both seasons.

Table (31): Reducing, non-reducing and total sugars (mg/g dry weight) of artichoke edible part as affected by some growth regulators foliar application.

Treatments	ppm.	1983/1984			1984/1985		
		reducing	non-reducing	total	reducing	non-reducing	total
Control		50.8	16.3	67.1	51.0	16.8	67.8
GA_3	50	61.6	12.5	74.1	59.2	12.4	71.6
	100	47.0	16.2	63.2	39.1	16.6	55.7
	200	44.5	11.5	56.0	33.4	11.6	45.0
CCC	500	61.3	14.5	75.8	64.5	12.7	77.2
	1000	53.4	16.3	69.7	58.1	16.1	74.2
	2000	56.3	13.2	69.5	59.9	11.7	71.6
NAA	100	59.9	16.9	76.8	54.6	14.4	69.0
	200	59.3	14.5	73.8	50.9	14.2	65.1
	400	54.5	18.4	72.9	33.3	15.8	49.1
		10.22	N.S	10.97	14.55	2.08	14.24

The depressive effect of GA_3 on sugars content of globe artichoke edible part has been previously mentioned by Abd El-Fattah (1978), who found that either low (25 ppm) or medium GA_3 (50 ppm) dose decreased reducing sugars, meanwhile high dose (100 ppm) did not affect non-reducing sugar content compared to control.

Concerning the effect of CCC foliar application on reducing as well as total sugars content in globe artichoke edible parts, data included in table (31) show stimulating effect due to different CCC treatments. In this connection, increments were not significant except in case of low concentration (500 ppm). However, a retarding effect on non-reducing sugars content could be detected as a result of CCC applications.

The high amount of reducing sugars accumulated in artichoke leaves due to low CCC application i.e. 500 ppm (table, 26) may be mainly translocated to the edible part showing enrichment of reducing as well as total sugars in the receptacle. Obtained results are in agreement with those found by Hossny (1979) on artichoke using CCC at 500, 1000 and 1500 ppm regarding reducing and total sugars but contradict those of non-reducing sugars. Working on other crops, Zaki et al.(1976) and Khalil et al(1985.a)came to similar conclusion regarding reducing as well as

total sugars accumulation tin tomato and snap bean fruits, respectively.

With regard to the effect of NAA, data at table (31) clearly indicate moderate but not significant stimulative effect on reducing and total sugars in a descending order as NAA concentrations increased during both seasons, with the exception of the highest used level (400 ppm) during the second season, which led to a significant decreasing effect compared to control treatment. However, the effect of NAA application on non-reducing sugars during both seasons was flactuated.

Although NAA application, especially at its highest used concentration (400 ppm) induced the highest reducing and total sugars percentages in artichoke leaves table,(26) it seemed to have a bad effect on sugars translocation to the edible part which showed the least percentages in this respect.

Obtained results reglarding the promoting effect of NAA foliar spray on total sugars are in complete agreement of those found by Amer (1981), who found that spraying tomato plants with 100 or 200 ppm NAA led to an increase in total soluble sugars in tomato fruits.