

**EFFECT OF VERNALIZATION AND GIBBERELIC ACID ON EARLINESS,  
 TOTAL YIELD AND QUALITY OF GLOBE ARTICHOKE.**

BY

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**ABSTRACT**

**Two** field experiments were conducted at Kaha Vegetables Research Farm, Horticulture Research Institute, Agriculture Research Centre to study the effect of vernalization treatment and GA<sub>3</sub> spraying, on vegetative growth, yield and its quality as well as chemical constituents of globe artichoke. The obtained results show that vernalizing of old crowns at 5 °C for 7 days before transplanting enhanced plant height while each of leaves and offshoots number per plant were significantly decreased with vernalization treatment (7 days) or with GA<sub>3</sub> application up to 40 ppm. Obtained data indicate also, that there were no significant differences between the values of head weight, head length and edible part fresh weight as a result of vernalization treatments while this characteristics were significantly higher in case of the control treatment. Furthermore, head diameter was increased while number of days from transplanting until emergence of first flower were significantly decreased by vernalization treatment. Vernalization for 7 days before transplanting plus GA<sub>3</sub> spraying at 20 ppm increased number of early heads per plant and per fed., while the control treatment (without application of GA<sub>3</sub> and vernalization) possess higher late and total yield. Application of GA<sub>3</sub> at 20 ppm significant increased total nitrogen, protein and inulin percentages of globe artichoke heads, while GA<sub>3</sub> at 40 ppm as single or combined with vernalization at 7 days gave the highest values of crude fibers in the heads of globe artichoke.

**Key words:** Globe Artichoke, vernalization, GA<sub>3</sub>, vegetative growth, yield and quality as well as nitrogen, protein, inulin and crude fibers.

**INTRODUCTION**

Globe artichoke (*Cynara scolymus* L.) is considered one of the most important vegetable crops in the countries bordering the Mediterranean basin including Egypt. These days, in Egypt more attention is given to promoting globe artichoke production to satisfy the increased demands of local consumption as well as for exportation. The early harvest period from December to February for globe artichoke in Egypt is economically interesting because there is no production in most European countries during these months. In order to accelerate the early production of heads and obtain increased benefits from higher prices vernalization, low level of GA<sub>3</sub> and / or their interaction can use. Since the use of growth substances for fresh market vegetable production may have some residual

effects, it was through to use other physical treatments that can replace or reduce the injurious effect of growth regulators, i.e., vernalization. Low temperatures treatments the vernalization is promotion of the flowering (Salisbury and Ross, 1999). The biennial vegetables initiate the floral formation after the exhibition prolonged (several weeks or months) to the low temperatures. In artichoke, the change from vegetative to reproductive stage requires an exposure to certain amount of cold hours (García, *et al.*, 2004). Low temperature improved the effectiveness of GA<sub>3</sub> on bolting, start of harvest and heads produced during the winter and at the end of the cropping cycle. This, probably, suggests that vernalization and GA<sub>3</sub> effects are additive (Mauromicale, *et al.*, 2005).

The aim of this research work was to produce early, high yield and good quality of globe artichokes cv. local "Balady" by apply-

ing different vernalization and gibberellic acid ( $GA_3$ ) treatments, which were used on old crowns and plants in the field respectively.

## MATERIALS AND METHODS

Two field experiments were conducted at Kaha Vegetables Research Farm, Horticulture Research Institute, Agriculture Research Centre during the two successive seasons of 2005/2006 and 2006/2007 to study the effect of vernalization,  $GA_3$  and their interaction on vegetative growth, earliness, yield

and its quality of globe artichoke. Random soil samples were collected from the experimental soil at the depth of 0-35 cm before planting for the physical and chemical properties of soil according to methods described by Jackson (1969). Data of physical and chemical analysis are shown in Table (1):

Table (1): The physical and chemical properties of the soil:

Variable	2005/2006	2006/2007
<b>1- Physical properties</b>		
Clay%	59.80	60.50
Silt %	20.90	21.00
Total sand%	18.50	17.60
<b>Texture</b>		<b>Clay loam</b>
<b>2- Chemical properties</b>		
Available		
N ppm	97.90	98.60
P ppm	5.90	5.60
K ppm	214.8	215.6
pH	7.70	7.60

### The experimental design:

The experimental design was split plot design with four replicates. It included 6 treatments which were the combination of two vernalization treatments with three gibberellic acid concentrations. The vernalization treatments were arranged in the main plots while the gibberellic acids levels were distributed randomly in the sub plots. Each experimental plot included four ridges each ridge was 4 m in length and 1m in width with an area about 16 m<sup>2</sup>. The local variety of globe artichoke was used in this investigation. Planting dates were on July 25<sup>th</sup> and 28<sup>th</sup> in 2005/2006 and 2006/2007, respectively. Old crowns were divided longitudinally to suitable pieces. Pieces were divided into two half, the pieces of the first half were placed in peat and watered in perforated plastic bags, then exposed to low temperatures at 5 °C and kept at this temperature for one week and the pieces of the second half were directly set in the field without cold storage as a control. The

plants were sprayed with each concentration  $GA_3$  used three times beginning at 6-8 leaf stage with 15 days intervals.

### Experimental treatments:-

#### (I) Vernalization treatments.

- (1) Without vernalization (control)
- (2) 7 days (168 hours) at 5 °C.

#### (II) Gibberellic acids concentrations.

- (1) Control (0 ppm  $GA_3$ )
- (2) 20 ppm
- (3) 40 ppm

Agricultural practices were done according to the recommendations of ministry of agriculture.

### Data recorded:

A random sample of six plants was taken from each experimental plot at 90 days after transplanting in both seasons of study for measuring the growth characters of globe artichoke expressed as follows:

**A. Vegetative growth characteristics:**

- (1) Plant height (cm). Plant height was measured from base of soil surface to the tip of the largest linear blade in plant.
- (2) Number of leaves / plant. Number of leaves calculated as the average number of green leaves per plant.
- (3) Number of offshoots /plant. This property was accounted at harvesting time

**B. Early heads parameters:**

A random sample of six heads from each experimental plot at 160 days after transplanting were taken from the early yield for determining the following parameters

- (1) Average head weight (g).
- (2) Average head length (cm).
- (3) Average head diameter (cm)
- (4) Average edible part fresh weight (g).

**C. Late heads parameters:**

From the first of March until the end of May (late yield) random sample of six heads from each experimental plot were taken for determining the following parameters

- (1) Average head weight (g).
- (2) Average head length (cm).
- (3) Average head diameter (cm)
- (4) Average edible part fresh weight (g).

**D. Early and late yield and its components:**

- (1) Number of early heads /plant.
- (2) Early yield /plant (kg).

- (3) Early yield ton /fed.
- (4) Number of late heads /plant.
- (5) Late yield /plant (kg).
- (6) Late yield ton /fed.
- (7) Total heads number /plant.

**(V) Chemical constituents of heads**

- (1) Total nitrogen
- (2) Protein
- (3) Inulin
- (4) fibers

Samples of heads edible part were taken at the beginning and the end of harvesting season and dried in an electric oven to constant weight at 70°C in addition the digested dry matter of each heads were taken to determined, total nitrogen percentage was determined according to the method described by Pregl (1945) using micro-kjeldahl apparatus. Meanwhile, protein percentage was determined as nitrogen content and converted to its equivalent protein content by multiplying by 6.25 as described by Pregl (1945) and inulin concentration was determined according to (Winton and Winton, 1958), while the fibers were determined according to A.O.A.C., 1975.

**Statistical analysis:**

All collected experimental data were statistically analyzed with General Liner Model procedure of SAS Institute (1989). F-test and the least significant difference (LSD) were used for the comparison among treatments means at 5 % probability level.

**RESULTES AND DISCUSSION**

**A. Vegetative growth characteristics:**

**1. Effect of vernalization:**

Data in Table (2) reveal that vernalization treatment for old crowns at 5 °C for 7 days before transplanting enhanced plant height compared with the control treatment, but these differences did not reach the level of significance during both seasons of study. On the other hand, number of leaves /plant and number of offshoots were significantly decreased as a result of the vernalization treatment in the second season only. These results my be due to vernalization induce flowering by restricted or stopping the initiation of new leaves

and accumulating nutrients in the leaves already existent and in the stem (Fernandez, *et al.*, 1997).

**2. Effect of gibberellic acid concentrations:**

Data presented in the same Table show also that spraying globe artichoke plants with GA<sub>3</sub> changed its growth characteristics effectively i.e., plant height was significantly increased while each of number of leaves and of offshoots per plant were significantly decreased with increasing gibberellic acid concentrations from 0 up to 40 ppm. The stimulating effect of GA<sub>3</sub> on plant height is due to

its effect on cell elongation and cell division. Similar results of GA<sub>3</sub> effect were obtained by Foury (1977) and Bekhit *et al.*, (1985), El – Greadly (1994), Sharaf-Eldin (2002), El-

Bassiouny, and Hassan (2003) they found that number of leaves per plant were not affected by GA<sub>3</sub> applications in all treatments and in all stages of growth.

**Table (2): Effect of vernalization, gibberellic acid and their interaction on vegetative growth characteristics of globe artichoke during 2005/2006 and 2006/2007 seasons.**

Season		2005/2006			2006/2007		
Treatments		Plant height (cm)	No. of leaves /plant	Offshoots /plant	Plant height (cm)	No. of leaves /plant	Offshoots /plant
Vernalization	GA <sub>3</sub>						
Zero day		45.22	31.97	2.49	43.25	30.47	2.49
7 days		46.59	28.18	1.89	44.56	27.21	1.80
L.S.D at 0.05		n.s	n.s	n.s	n.s	3.19	0.11
	0 ppm	37.0	35.33	3.28	33.78	33.82	3.12
	20 ppm	45.05	29.94	1.73	42.93	27.87	1.77
	40 ppm	55.67	24.95	1.55	55.00	24.83	1.56
L.S.D at 0.05		2.58	1.40	0.778	2.42	1.63	0.15
Zero day	Control	36.67	35.00	3.06	35.55	33.33	2.96
Zero day	20 ppm	43.67	35.00	2.36	41.86	31.08	2.40
Zero day	40 ppm	55.33	25.91	2.04	53.67	27.00	2.11
7 days	0 ppm	37.33	35.67	3.50	32.00	34.30	3.27
7 days	20 ppm	46.44	24.89	1.11	44.00	24.67	1.13
7 days	40 ppm	56.00	23.98	1.06	57.67	22.67	1.01
L.S.D at 0.05		3.65	1.98	1.10	3.42	3.31	0.208

### 3. Effect of the interaction between vernalization and gibberellic acid treatments.

Data illustrated in Table (2) show that the combination of vernalization at 5 °C for 7 days before planting plus gibberellic acid spray at 40 ppm gave the highest values of plant height. Moreover, vernalization at 5 °C for 7 days without gibberellic acid led to a significant increase in number of leaves and number of offshoots /plant compared with other treatment. Meanwhile, application of vernalization at 5 °C plus gibberellic acid at 40 ppm gave the lowest values in these respects.

### B. Early heads characteristics and number of days from transplanting until emergence of first flower of globe artichoke:

#### 1. Effect of vernalization:

Data presented in Table (3) and Fig. (1) show clearly that there were no significant differences between the studied treatments in average head weight, head length and edible part fresh weight but head diameter and num-

ber of days from transplanting until emergence of first flower were significantly affected due to vernalization treatment in both seasons of study. In this respect, average of head diameter was significantly increased while number of days till the anthesis of the first head was decreased in both season as a result of vernalization treatment. This may be due to that vernalization treatment accelerated the transformation of vegetative buds to flowering one and this required the carbohydrate levels must reach a minimum threshold level in the apex, which is obtained earlier with vernalizing treatments. This increase in nutrients may arise, in the case of low temperature, from restraining the activity of other sinks (new leaves) close to the apex, or in the case of gibberellins, from their influence in hastening the sink activity in certain organs (Morris and Newell, 1987). Low temperatures and certain growth regulators are cited by Dieleman and Heuvelink (1992) as factors capable of increasing the competitive

potential of the apex to obtain assimilates, as well as those factors that increase the total amount of assimilates in the plant, and those responsible for the decrease in the number of leaves that precede the development of the first inflorescence in tomato.

**2. Effect of gibberellic acid concentrations:**

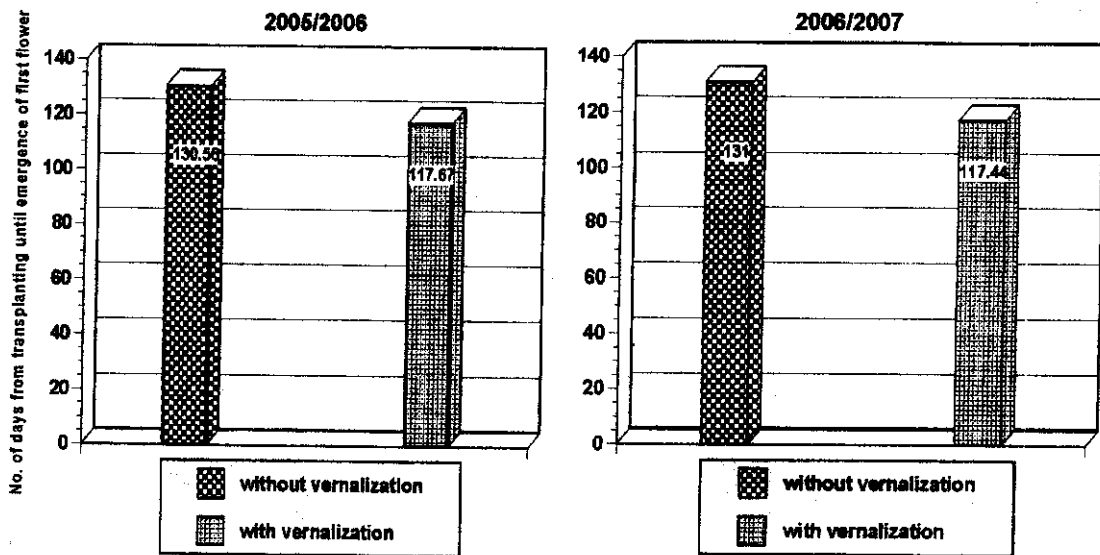
Data related to early heads characteristics and number of days elapsed from transplanting until emergence of first flower as affected by foliar spraying with different concentrations of GA<sub>3</sub> are presented in Table (3) and Fig. (2). Such data reveal that head

weight, head length, head diameter and edible part fresh weight were significantly decreased with increasing the concentration of GA<sub>3</sub> used compared to the control treatment.

These results were not in agreement with Mansour (1983) who found that both diameter and length of head were not affected by either GA<sub>3</sub> or IAA concentrations used for such characteristics. On the other hand, number of days from transplanting until emergence of first flower was decreased with increasing GA<sub>3</sub> treatments from 0 up to 40 ppm.

**Table (3): Effect of vernalization, gibberellic acid and their interaction on early heads characteristics of globe artichoke during 2005/2006 and 2006/2007 seasons.**

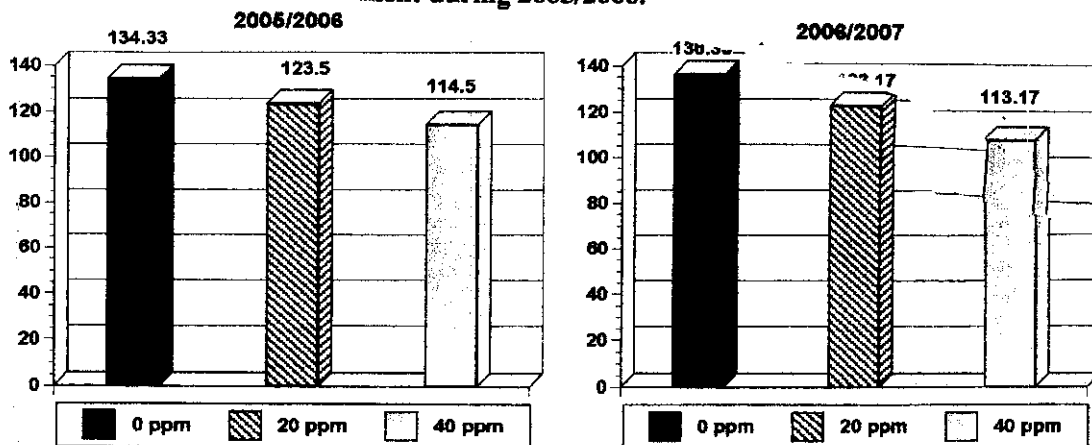
Season		2005/2006			
Treatments		Head weight (g)	Head length (cm)	Head diameter (cm)	Edible weight (g)
Vernalization	GA <sub>3</sub>				
Zero day		273.44	9.19	7.386	81.39
7 days		275.67	9.09	7.468	81.26
L.S.D at 0.05		n.s	n.s	0.071	n.s
	0 ppm	283.67	9.34	7.573	84.13
	20 ppm	275.33	9.23	7.391	81.17
	40 ppm	264.67	8.84	7.318	78.67
L.S.D at 0.05		5.93	0.223	0.134	3.74
Zero day	0 ppm	282.33	9.32	7.480	83.82
Zero day	20 ppm	272.67	9.21	7.350	80.82
Zero day	40 ppm	265.33	9.02	7.330	79.54
7 days	0 ppm	285.00	9.36	7.666	84.44
7 days	20 ppm	278.00	9.25	7.433	81.52
7 days	40 ppm	264.00	8.65	7.306	77.80
L.S.D at 0.05		8.40	0.316	0.202	5.29
		2006/2007			
Zero day		268.44	9.02	7.32	78.88
7 days		271.67	9.02	7.45	79.55
L.S.D at 0.05		n.s	n.s	0.05	n.s
	0 ppm	281.83	9.20	7.58	82.50
	20 ppm	270.67	9.06	7.33	79.00
	40 ppm	257.67	8.80	7.25	76.16
L.S.D at 0.05		3.09	0.082	0.06	1.07
Zero day	0 ppm	279.33	9.16	7.42	81.66
Zero day	20 ppm	267.67	9.000	7.26	78.00
Zero day	40 ppm	258.33	8.90	7.26	77.00
7 days	0 ppm	284.33	9.24	7.73	83.33
7 days	20 ppm	273.67	9.12	7.40	80.00
7 days	40 ppm	257.00	8.70	7.24	75.33
L.S.D at 0.05		4.37	0.115	0.09	1.52



L.S.D. at 0.05 = 3.73

L.S.D. at 0.05 = 3.88

Fig. (1): Number of days from transplanting until emergence of first flower as affected by vernalization treatment during 2005/2006.



L.S.D. at 0.05 = 1.66

L.S.D. at 0.05 = 4.13

Fig.(2): Number of days from transplanting until emergence of first flower as affected by foliar spraying of GA<sub>3</sub> during 2005/2006 and 2006/2007 seasons.

### 3. Effect of the Interaction between vernalization and gibberellic acid.

The same data presented in Table (3) and Fig. (3) show the effect of the interaction between vernalization and GA<sub>3</sub> concentrations on early head characteristics and number of days from transplanting until emergence of the first flower. In this connect, all early head characteristics i.e., head weight, head length, head diameter and edible part fresh weight were significantly increased in case of vernalization only at 5°C for 7 days without application of GA<sub>3</sub>. On the other hand, vernalization of old crowns at 5°C for 7 days plus

foliar spray with GA<sub>3</sub> at 40 ppm had the lowest values during both seasons of study.

This result was in agreement with Kasim, (1994), Mauromicale *et al.* (2005) who suggested the cold treatment (5°C) increased number and weight of early heads per plant. Furthermore, seed + seedling vernalization improved the effectiveness of GA<sub>3</sub> on bolting, start of harvest and heads produced during the winter and at the end of cycle. This, probably, suggests that vernalization and GA<sub>3</sub> treatments are additive. The same effects occurred

in cauliflower, as reported by De-Ping *et al.*, 2004 who suggested that these effects may be due to that the stem apex of cauliflower changes from a vegetative to reproductive state, this change requires cold treatment which is generally considered to be perceived at the apex in most plant (Lang 1965, Friend 1985, Fernandez, *et al.*, 1997)

**C- Late head characteristics of globe artichoke:**

**1. Effect of vernalization:**

Data in Table (4) indicate that the differences in values of average head weight, head length and head diameter were not significantly affected during the first season only. On the other hand, average head and edible part fresh weight were significantly decreased as a result of vernalization treatment during the seasons of study.

**Table (4): Effect of vernalization, gibberellic acid and their interaction on late heads characteristics of globe artichoke during 2005/2006 and 2006/2007 seasons.**

Season		2005/2006			
Treatments		Head weight (g)	Head length (cm)	Head diameter (cm)	Edible part weight (g)
Vernalization	GA <sub>3</sub>				
Zero day		152.56	8.04	8.05	62.58
7 days		150.00	7.93	7.41	58.67
L.S.D at 0.05		n.s	n.s	n.s	1.03
	0 ppm	152.17	8.07	7.43	58.03
	20 ppm	155.00	8.29	8.04	64.00
	40 ppm	146.67	7.59	7.71	59.83
L.S.D at 0.05		7.46	0.59	0.33	2.52
Zero day	0 ppm	147.33	8.01	6.79	57.08
Zero day	20 ppm	157.00	8.17	7.20	64.67
Zero day	40 ppm	153.00	7.93	8.23	66.00
7 days	0 ppm	157.00	8.14	8.07	59.00
7 days	20 ppm	152.67	8.41	8.88	63.33
7 days	40 ppm	140.33	7.23	7.19	53.67
L.S.D at 0.05		10.54	0.83	0.47	3.56
Season		2006/2007			
Zero day		151.89	8.00	7.93	61.33
7 days		149.33	8.01	7.26	57.00
L.S.D at 0.05		2.08	2.08	n.s	0.05
	0 ppm	152.00	8.01	7.30	56.50
	20 ppm	153.00	8.30	7.82	61.50
	40 ppm	146.83	7.71	7.68	59.50
L.S.D at 0.05		1.98	1.08	0.107	0.09
Zero day	0 ppm	148.00	7.92	6.40	56.01
Zero day	20 ppm	155.33	8.20	7.00	53.10
Zero day	40 ppm	152.33	7.88	8.20	65.00
7 days	0 ppm	156.00	8.10	8.00	57.00
7 days	20 ppm	150.67	8.40	8.65	60.13
7 days	40 ppm	141.33	7.53	7.16	54.00
L.S.D at 0.05		2.80	2.80	0.151	0.129

**2. Effect of gibberellic acid:**

It is clear from the data presented in Table (4) that all obtained data on late head characteristics i.e., average head weight, head length, head diameter and edible part fresh

weight were gradually increased with increasing GA<sub>3</sub> concentrations from 0 up to 20 ppm. On the other hand, application of GA<sub>3</sub> at 40 ppm gave the lowest values in all tested late head parameters. These results are agree with

those obtained by Mauromicale *et al.* (2000) who found that GA<sub>3</sub> applications generally increased the head length/width ratio, and the stalk length.

### 3. Effect of the interaction between vernalization and gibberellic acid:

Data presented in Table (4) show clearly that spraying plants with 20 ppm GA<sub>3</sub> without pre-planting vernalization treatment gave the highest values of head weight during both seasons. Whereas, vernalization for 7 days plus spraying with GA<sub>3</sub> at 20 ppm enhanced the values of head length and head diameter. In addition, the edible part fresh weight was significantly increased with vernalization at 0 days plus GA<sub>3</sub> at 40 ppm.

### D- Early and late yield expressed as head number, yield per plant and ton per feddan.

#### 1. Effect of vernalization:

Data related to early and late yield are presented in Table (5). Results are expressed as number and weight of head per plant as well as yield ton per feddan. In this concern, vernalization treatment enhanced each of early and late yield and its components in both seasons of study whereas, its effect on heads number per plant, yield per plant and per feddan were highly significant in the second season only. This effect may be due to that, there is a slow rise or decline in the levels of a compound or compounds during prolonged cold exposure, and when the levels cross a threshold, the processes that provide competence to flower are initiated.

#### 2. Effect of gibberellic acid concentrations:

The same data in Table (5) show that number of early heads /plant, early yield /plant and early yield ton/fed. were significantly increased with increasing GA<sub>3</sub> concentrations from 0 up to 40 ppm. In this regard, application of GA<sub>3</sub> at 20 ppm reflected the highest early yield and its components during both seasons of study. On the other hand, number of late heads /plant, late yield /plant and late yield ton /fed. were gradually decreased with increasing GA<sub>3</sub> concentrations from 0 up to 40 ppm. In this respect, Gnnur Kocer., 1999 studied assessment of the effects of rooted offshoot properties and GA<sub>3</sub> applications on

the yield of the Globe artichoke. In this study, the effects of rooted offshoot properties and number of GA<sub>3</sub> applications, 30 ppm in concentration, on the early and total yield of the globe artichoke cv. Osakyzo, produced in one year, were tested. It was determined that when the offshoots, which were at the vegetative growth stage, were used in plantation, higher early and total yields were obtained than that of the generative growth stage. This positive result gained with offshoots at the vegetative stage was also improved significantly with all GA<sub>3</sub> applications, 30 ppm in concentration when compared with untreated plants. Double GA<sub>3</sub> application gave better results than a single application only for early yield. Gibberellic acid (GA<sub>3</sub>) treatment caused earlier harvest in vegetatively propagated varieties (Foti and La Malfa, 1981; Mangano and Signorelli, 1981, Patourel and Foury, 1982 and Foury, *et al.*, 1983). Recent research performed on seed-grown varieties indicated that GA<sub>3</sub> effectiveness on earliness depends on sowing dates, the sensitivity of each variety to GA<sub>3</sub> and the number of GA<sub>3</sub> treatments (Elia *et al.*, 1992, Schrader, 1992, Basnizki and Goldschmidt, 1994, Mauromicale, 1994). On the other hand, Mauromicale *et al.* (2000) found that GA<sub>3</sub> applications generally decreased the head weight.

#### 3. Effect of the interaction between vernalization and gibberellic acid.

Data presented in Table (5) on the effect of the interaction between vernalization and gibberellic acid show that there were significant differences in number and weight as well as total yield of early heads per plant in both seasons of study compared with the control treatment. Generally, keeping plant materials for 7 days at 5 °C plus foliar spray with GA<sub>3</sub> at 20 ppm gave the best values of early yield by number, early yield per plant and per feddan. On the other hand, the interaction between vernalization and GA<sub>3</sub> had not any significant effect on late heads number, late yield per plant and per feddan. The maximal increase of late heads number and late yield per plant or /fed. were obtained by vernalization of old crowns only for 7 days before transplanting without GA<sub>3</sub> application.



Table (5): Effect of vernalization, gibberellic acid and their interaction on early and late yield and its components of globe artichoke during 2005/2006 and 2006/2007 seasons.

Season		2005/2006					
Treatments		Early			Late		
Vernalization	GA <sub>3</sub>	No. of heads /plant	yield /plant (kg)	Yield ton /fed.	No. of heads /plant	yield /plant (kg)	Yield ton /fed.
Zero day		2.05	0.558	2.232	7.55	1.146	4.595
7 days		2.61	0.7193	2.877	7.06	1.064	4.269
L.S.D at 0.05		0.21	n.s	n.s	n.s	n.s	n.s
	0 ppm	1.67	0.475	1.901	8.36	1.270	5.093
	20 ppm	2.99	0.825	3.298	7.22	1.116	4.482
	40 ppm	2.33	0.616	2.464	6.32	0.930	3.723
L.S.D at 0.05		0.50	0.134	0.535	1.01	0.034	0.679
Zero day	0 ppm	1.18	0.333	1.332	8.49	1.250	5.004
Zero day	20 ppm	2.62	0.716	2.864	7.51	1.176	4.727
Zero day	40 ppm	2.36	0.625	2.500	6.62	1.013	4.056
7 days	0 ppm	2.17	0.618	2.470	8.23	1.292	5.182
7 days	20 ppm	3.36	0.933	3.733	6.93	1.056	4.236
7 days	40 ppm	2.30	0.607	2.429	6.03	0.846	3.390
L.S.D at 0.05		0.71	0.190	0.758	1.44	0.048	0.960
		2006/2007					
Zero day		2.06	0.569	2.276	7.37	1.198	4.795
7 days		2.56	0.773	3.092	7.02	1.082	4.328
L.S.D at 0.05		0.24	0.09	0.364	0.124	0.50	0.202
	0 ppm	1.66	0.486	1.945	8.26	1.320	5.280
	20 ppm	2.29	0.902	3.610	7.08	1.144	4.576
	40 ppm	2.99	0.624	2.498	6.25	0.957	3.828
L.S.D at 0.05		0.137	0.136	0.546	0.09	0.02	0.092
Zero day	0 ppm	1.22	0.347	1.389	8.51	1.330	5.320
Zero day	20 ppm	2.58	0.725	2.901	7.17	1.212	4.850
Zero day	40 ppm	2.39	0.635	2.540	6.43	1.053	4.213
7 days	0 ppm	2.09	0.625	2.501	8.00	1.310	5.241
7 days	20 ppm	2.40	1.08	4.318	7.00	1.075	4.301
7 days	40 ppm	2.19	0.614	2.457	6.06	0.861	3.442
L.S.D at 0.05		0.193	0.193	0.773	0.136	0.03	0.130

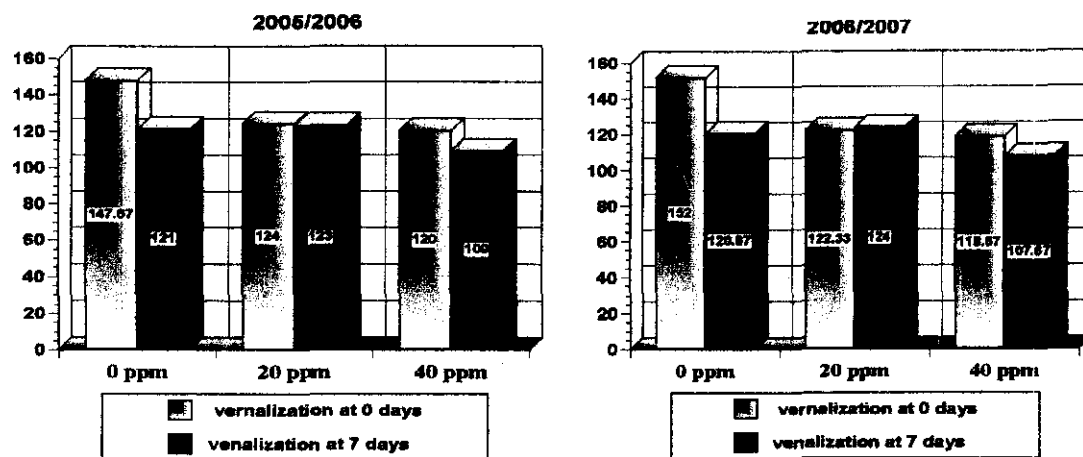


Fig. (3): Number of days from transplanting until emergence of first flower as affected by the interaction between vernalization and foliar spraying of GA<sub>3</sub> during 2005/2006 and 2006/2007 seasons.

E- Effect of vernalization, gibberellic acid and their interaction on nitrogen, protein, inulin and fiber percentage of globe artichoke heads.

1. Effect of vernalization:

Data presented in Table (6) show clearly that all assayed chemical constituents

under this trial i.e., total nitrogen, protein and inulin percentage tended to increase while fibers percentage tended to decrease as a result of vernalization (7 days at 5°C) before transplanting but these increments were not arrived to significant effect.

Table (6): Effect of vernalization, gibberellic acid and their interaction on nitrogen, protein, inulin and fiber of globe artichoke heads during 2005/2006 and 2006/2007 seasons.

Season		2005/2006			
Treatments		Total N%	Protein (%)	Inulin mg/g DW	Fibers (%)
Vernalization	GA <sub>3</sub>				
Zero day		1.25	7.80	1.55	11.209
7 days		1.32	8.27	1.68	11.119
L.S.D at 0.05		n.s	n.s	n.s	n.s
	0 ppm	1.15	7.19	1.51	10.595
	20 ppm	1.39	8.71	1.72	11.302
	40 ppm	1.31	8.21	1.62	11.595
L.S.D at 0.05		0.067	0.419	0.182	0.263
Zero day	0 ppm	1.11	6.93	1.42	10.650
Zero day	20 ppm	1.29	8.04	1.60	11.297
Zero day	40 ppm	1.35	8.44	1.64	11.680
7 days	0 ppm	1.19	7.44	1.59	10.540
7 days	20 ppm	1.50	9.38	1.85	11.307
7 days	40 ppm	1.28	7.98	1.60	11.510
L.S.D at 0.05		0.095	0.59	0.257	0.372
		2006/2007			
Zero day		1.27	7.95	1.59	11.09
7 days		1.37	8.57	1.71	11.01
L.S.D at 0.05		n.s	n.s	n.s	n.s
	0 ppm	1.17	7.36	1.53	10.44
	20 ppm	1.45	9.07	1.76	11.23
	40 ppm	1.33	8.34	1.66	11.49
L.S.D at 0.05		0.06	0.374	0.179	0.267
Zero day	0 ppm	1.13	7.08	1.46	10.48
Zero day	20 ppm	1.31	8.23	1.65	11.25
Zero day	40 ppm	1.37	8.54	1.67	11.54
7 days	0 ppm	1.22	7.64	1.61	10.40
7 days	20 ppm	1.58	9.92	1.87	11.13
7 days	40 ppm	1.30	8.15	1.65	11.43
L.S.D at 0.05		0.084	0.529	0.253	0.378

2. Effect of gibberellic acid concentrations:

The same data in Table (6) show that exogenous GA<sub>3</sub> application at 20 ppm gave significant effect on nitrogen, protein and inulin percentage in heads of Globe artichoke. On the contrary, the highest concentration (40

ppm) of GA<sub>3</sub> gave the highest values on fiber content during both seasons of study. This variation may be due to a complex metabolic process occurring during the growth and development of the plant and its flowers. This result was in conformity with Sharaf-Eldin

(2002) who suggested that application of GA<sub>3</sub> had a negative effect on inulin contents in edible part of globe artichoke. Total protein content were highest by T3 (GA<sub>3</sub> was sprayed 8 weeks after transplanting date) and lowest in the untreated control plants

### 3. Effect of the interaction between vernalization and gibberellic acid.

The interaction between vernalization and GA<sub>3</sub> presented in Table (6) show that vernalization of old crown for one week

before transplanting plus spraying the plants with GA<sub>3</sub> at 20 ppm significantly increased total nitrogen, protein and inulin content of globe artichoke heads, while, GA<sub>3</sub> at 40 ppm only without vernalization treatment gave the lowest effect on quality of heads. In this connect; the fiber percentage in heads was increased with increasing GA<sub>3</sub> concentration up to 40 ppm. This result may be due to the increasing the GA<sub>3</sub> application which cause the senility in plants.

## CONCLUSION

Pre-transplanting vernalization treatment at 5°C for 7 days and spraying plants with GA<sub>3</sub> at 20 ppm should be valuable

application for increasing number of heads /plant and yield per plant and per fed. As well as improve the heads quality.

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## تأثير الإرتباع وحمض الجبريليك على التبكير والمحصول الكلى والجودة والمحتوى الكيماوي فى الخرشوف

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أجريت تجربتان حقليتان فى محطة التجارب الزراعية بقها بمحافظة القليوبية التابعة لمعهد بحوث البساتين خلال موسمى الزراعة ٢٠٠٥/٢٠٠٦ و ٢٠٠٦/٢٠٠٧ على صنف الخرشوف البلدى وذلك لدراسة تأثير الإرتباع لقطع التقاوى لمدة ٧ أيام على درجة حرارة ٥ مئوية وكذلك الرش بحمض الجبريليك بتركيز ٢٠ و ٤٠ جزء فى المليون على صفات النمو الخضري والتبكير والمحصول الكلى والجودة والمحتوى الكيماوي. وفيما يلى أهم النتائج المتحصل عليها:-

أنت معاملة الإرتباع على درجة ٥ درجة مئوية لمدة ٧ أيام لقطع التقاوى قبل زراعتها إلى زيادة قيم ارتفاع النبات فى حين لم تكن هذه الزيادة معنوية مقارنة بالكنترول ، بينما انخفض عدد الأوراق والأفرع للنبات معنوياً مع معاملة الإرتباع (٧ أيام) أو مع رش النباتات بالجبريللين حتى ٤٠ جزء فى المليون. كما تشير النتائج أيضاً إلى عدم وجود اختلافات معنوية بين قيم كل من متوسط وزن النورة وطول النورة وكذلك الجزء الصالح للأكل (التخت النورى) كنتيجة لمعاملة الإرتباع بينما أنت معاملة الكنترول إلى حدوث زيادة معنوية مقارنة بمعاملة الإرتباع . بالإضافة إلى ذلك فقد أنت معاملة الإرتباع (٧ أيام قبل الزراعة) للحصول على زيادة معنوية فى قطر النورة وتقليل عدد الأيام اللازمة لظهور أول نوره كما أن معاملة الإرتباع (٧ أيام قبل الزراعة + رش النباتات بالجبريللين بتركيز ٢٠ جزء فى المليون أنت إلى زيادة عدد النورات المبكرة للنبات والفدان فى حين تفوقت معاملة الكنترول على باقى المعاملات فى زيادة المحصول المتأخر والكلى للنبات والفدان. كذلك أدى استخدام معاملة الجبريللين بتركيز ٢٠ جزء فى المليون للحصول على زيادة معنوية فى محتوى النورات من النتروجين والبروتين والأنبولىين بينما أدى رش النباتات بالجبريللين بتركيز ٤٠ جزء فى المليون منفرداً أو بالتفاعل مع معاملة الإرتباع (٧ أيام قبل الزراعة) للحصول على أعلى القيم فى محتوى نورات الخرشوف من الألياف الخام .