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EFFECTS OF DECAPITATION TIME AND NITROGEN RATE ON VEGETATIVE GROWTH, YIELD AND QUALITY CHARACTERISTICS OF GLOBE ARTICHOKE.

Feleafel , M.N.
Vegetable Crops Dept., Faculty of Agriculture, Alexandria University.

ABSTRACT

The responses of growth, yield, yield pattern and quality of globe artichoke plants cv. "French Hyrious" to four varying N rates; 60, 90,120 and 150 kg N fed^{-1} under three decapitation treatments (non-decapitation; control, and decapitation after 3 or 4 months from planting), were studied. Two field experiments were conducted, during the seasons of 2000/2001 and 2001/2002, at the Agricultural Experimental Station Farm (at Abis), Faculty of Agricultural, Alexandria University. The results indicated that early decapitation treatment; after 3 months from planting, of globe artichoke plants, led to significant increments in number of basal shoots and leaves and leaf dry matter as well as early and total yield characters, i.e., number and weight of heads plant^{-1}. However, plant height, head length and diameter as well as receptacle weight were statistically decreased with decapitation treatments. The results, also, showed that the addition of 150 kg N fed^{-1} to globe artichoke plants, significantly, reflected positive influences on vegetative growth characters, i.e., number of basal shoots, plant height and early and total yield characters. Moreover, increasing N applied, significantly, increased N and K contents of the leaves, head weight and length as well as receptacle weight. On the other side, dry matter percentage of leaves and edible parts and T.S.S percentage were, significantly, decreased with increasing N applied rates. Generally, early and total yield and head quality of globe artichoke could be improved through the

early decapitation (after 3 months from planting) and fertilization with N at the rate of 150 kg N fed^{-1}.

Key Words: globe artichoke, decapitation time, nitrogen rate, vegetative growth, early and total yield, yield pattern, heads quality.

INTRODUCTION

Globe artichoke *(Cynara scolymus* L.) is one of the most important vegetable crops. The immature flower bud (head) is the edible part, which includes the fleshy receptacle and fleshy tender basis of bracts. It is, really, a good source of crude protein, amino acids, crude fiber, reducing and total sugars and many minerals such as (N, P, K, Ca, Mg, Fe, Cu, Mn and Zn (Lattanzio *et al.*,1981).In addition, it has a high medicinal value (Hammouda *et al*.,1993). Egypt is considered as one of the countries with the highest artichoke productivity per unit area in the world (FAO, 1999). According to 2003 statistics, the total cultivated area of artichoke was on 13711 fed, which produced110348 tons of head yields with an average of 8.05 tons fed^{-1} (The year book of Agric. Statistics and Economic Agric. Dept., Ministry of Agric., Egypt,2003). Globe artichoke has its considerable rank as an exportable crop to the European and some Arabian markets, especially, during December, January and February. Nevertheless, in Egypt, the largest portion of its production is produced during the months of March, April and May. Hence, the modification of the yield pattern via cultural practices would be of a great interest to meet the exportation demands (Abdel-Al and Moustafa, 1973).

Several investigators attempted to shift the yield pattern of globe artichoke by improving the propagation methods (El-Shal *et al.*,1993 and El-Abagy,1993) or by using different planting times (Abdel-Al and Moustafa, 1973, Elia *et al.*,1991; Mauromicale and lerna, 1995) or through the use growth regulators such as GA_3 (El-Abagy,1993; Mauromicale and lerna, 1995). However, decapitation (topping) or apex removal of main stem may have shift the yield pattern of globe artichoke, through encourage basal branching and accelerate shoot growth of globe artichoke (Rubinstein and Nagao, 1976; La-Malfa and

Foury ,1973; Trigo-Colina,1980; Manromicale and Copani ,1990; El-Shal *et al.* ,1993) . The positive or negative effect of decapitation depends, largely, on time of decapitation performance. Barakat and Abdel-Razik (1990) found that, decapitation of tomato seedlings at 4^{th} or 5^{th} leaf stage significantly enhanced basal branching, gave more number of flowering clusters, and higher total yield compared to non-decapitation plants. On the other extreme, at 6^{th} leaf stage, fruit size, No. of fruits plant $^{-1}$, as well as early and total yield were decreased.

Among the major nutrients nitrogen plays an essential role for plant production. Nitrogen is an essential constituent of metabolically active compounds such as proteins, enzymes, nucleic acids and chlorophyll. It plays a major role in cell division and improves photosynthesis process, which results in higher accumulation of organic matter in plant tissues (Marschner, 1986). Fertilization with suitable rates of nitrogen had a key role for improving the vegetative growth and yield of globe artichoke plants, since the artichoke plants are known to produce a huge vegetative biomass during a long growing season (El-Abagy, 1993 and Pedreno *et al.*,1996) . Salamah (1997) found that growth characters of globe artichoke were markedly increased when N fertilization increased from 95 to 285 kg N ha^{-1}.Therefore, the nitrogen fertilization is ought to play an important role in artichoke productivity (Baroccio 1969; Gerakis and Honma 1969; Prado *et al*.,1983; Elia *et al.*,1991; Salamah ,1997). Foti *et al.*(2000) demonstrated that earliness and total yield were better by 200 kg N ha^{-1}.

Therefore, the main objective of this study was to investigate the effect of decapitation at different times and various rates of N on vegetative growth characters, early and total yield, yield pattern and some heads quality characteristics of globe artichoke.

MATERIALS AND METHODS

Two field experiments were carried out during the two successive seasons of 2000/2001 and 2001/2002 at the Agricultural Experimental Station Farm (at Abis), Faculty of Agriculture, Alexandria University. The globe artichoke cv. French Hyrious was used, in the two experiments, to study the effects of twelve treatment combinations of three decapitation treatments (non-decapitation; control, and

decapitation after 3 and 4 months) and four nitrogen rates (60,90,120 and 150 kg N fed^{-1}). Preceding the initiation of each experiment, soil samples of 30 cm depth were collected and analysed according to the published procedures (Page *et al.*,1982), and the results of soil physical and chemical properties are presented in Table 1.

Table 1. Soil physical and chemical properties of the experimental sites during the two seasons of 2000/2001 and 2001/2002.

Seasons	Soil Properties								
	Physical				Chemical				
	Sand %	Silt %	Clay	Texture	EC. $ds.m^{-1}$	PH	T.N. %	P %	K %
2000/2001	21.2	38.0	40.8	Clay	1.53	8.53	0.18	0.15	0.18
2001/2002	19.0	38.9	42.1	Clay	1.45	8.13	0.13	0.10	0.17

Stumps (seed pieces from the old crown) were soaked for 20 minutes in aqueous solution of fungicide Topsin M-70 at the rate of 2 gm $liter^{-1}$ and planted, on July 7, 2000 and July 15, 2001, in rows 5 m long and 1.2 m wide at an intrarow spacing 70 cm. The experimental layout was a split–plot system in a randomized complete blocks design with three replications. Decapitation (topping) treatments, were randomly arranged in the main plots, meanwhile, N rates were randomly distributed in the sub–plots. Each sub-plot consisted of 3 rows, having an area of 18 m^2 and each two adjacent plots were separated by a guard row.

Apex of the main stem, of globe artichoke plants, was manually removed using a sharp knife after 3 or 4 months from planting. Nitrogen application was achieved in the form Ammonium sulphate (20.5 % N) at four equal applications; after 8, 12, 16 and 20 weeks from planting. All sub-plots received identical amounts of P and K fertilizers at the rates of 60 kg P_2O_5 fed^{-1} as calcium superphosphate (15.5% P_2O_5) and 90 kg K_2O as potassium sulphate (48% K_2O). All calcium superphosphate was broadcasted during soil preparation and potassium sulphate was applied in two equal applications; 8 weeks after planting and at blooming stage. Recommended agriculture practices were followed as commonly used in the commercial production of globe artichoke.

Data Recorded

Vegetative growth characters; after 120 days from planting, a random sample of five plants was taken from the outer rows of each sub-plot to measure plant height and count number of basal shoots and leaves plant^{-1}.

Dry matter and mineral contents of leaves; just before blooming, random sample of the youngest expanded mature leaves from each treatment, was collected, washed with distilled water, weighed, oven dried at 70 °C till constant weight and the dry matter percentage was calculated. The dried leaf samples were grind and homogenized, wet digested; using concentrated sulfuric acid and H_2O_2, and the contents of N, P and K were determined according to the methods described in FAO (1980).

Early heads yield plant^{-1}; the number and weight of all harvested heads per plant starting from the beginning of harvest until the end of February were considered.

Total heads yield plant^{-1}; expressed as the number and weight of all harvested heads throughout the entire harvesting season.

Yield pattern distribution plant^{-1}; expressed as the number and percentage of harvested heads gained each month relatively to the total harvested heads throughout the entire harvesting period.

Head quality characters; five randomly heads, from each treatment, at the peak of harvesting period, during March, were chosen to find out the head and receptacle weight and the head length and diameter. The edible portions (receptacles) of the heads were used to determine total soluble solids (T.S.S) using a hand refractometer, total carbohydrates as outlined by Malik and Singh (1980) and head dry matter content.

All obtained data of the present study were, statistically, analyzed according to the design applied using Costat software (1985). The comparisons among means of the different treatments were carried out, using the Revised L.S.D. test as illustrated by Al-Rawi and Khalf-Allah (1980).

RESULTS AND DISCUSSION

Vegetative growth characters

Data in Table 2 showed that the decapitation of globe artichoke plants led to significant increments in number of basal shoots and leaves per plant, while decreased plant height compared with those of the non-decapitated plants , in both seasons of 2000/2001 and 2001/2002. Early decapitation; 3 months after planting, was more effective and gave more number of basal shoots and leaves per plant than the late one; 4 months after planting. The promoting effect of decapitation on number of basal shoots and leaves can be discussed on the basis that removing the apex of main stem terminated the apical dominance and inhibited the vertical growth which in turn promoted the basal buds to grow strongly (Rubinstein and Nagao, 1976). The obtained results are in agreement with those reported by La-Malfa and Foury (1973), Trigo-Colina (1980), Manromicale and Copani (1990) and El-Shal *et al.* (1993) who found that the principal bud cutting of globe artichoke stimulated the growth of basal shoots and shortened shoot length.

Progressive significant increases in number basal shoots and leaves plant^{-1} accrued as a result of increasing N applied from 60 up to 150 kg N fed^{-1}, in both seasons (Table, 2). The same effect on plant height was obvious up to 120kg N fed^{-1}. The enhancing effect of N on the vegetative growth characters may be attributed to the beneficial effect of N on stimulating the meristemic activity and producing more tissues and organs. Moreover, N plays a major role in protein and nucleic acids synthesis and protoplasm formation (Marschner, 1986). The previous mentioned results were in general accordance with those reported by El-Abagy (1993), Pedreno *et al.* (1996). Salamah (1997) who indicated that the growth characteristics of globe artichoke were markedly increased when N fertilization increased from 95 to 285 kg N ha^{-1} .

Concerning the interaction effects between decapitation treatments and N fertilizer rates on the vegetative growth characters of globe artichoke, the results in Table 2 showed significant differences, within each studied vegetative growth character, in both seasons. Comparisons among the mean values of the different treatments combination indicated that, at any decapitation treatment, fertilizing with 120 or 150 kg N fed^{-1} significantly increased plant height and

number of basal shoots and leaves plant^{-1} compared with the lower N rates (60 and 90 kg N fed^{-1}). The combined treatment, which included decapitation after 3 months from planting and fertilizing with 150 kg N fed^{-1}, was the best , as it significantly gave the highest mean values for the number of basal shoots and leaves plant^{-1}. However, plants which were early decapitated and fertilized with 60 kg N fed^{-1} significantly gave the lowest mean value of plant height. These results matching with those reported by Hosny *et al.* (1991) and Ghoneim (2000) .

Table 2. Vegetative growth characters of globe artichoke, as affected by decapitation time and nitrogen rate, during the seasons of 2000/2001 and 2001/2002.

Treatments		2000-2001			2001-2002		
Decapitation time	N rate kg fed^{-1}	Plant height (cm)	No of basal shoots plant^{-1}	No of leaves plant^{-1}	Plant height (cm)	No of basal shoots plant^{-1}	No of leaves plant^{-1}
D_0**		77.8A*	5.7C	58.6C	77.4A	5.8C	57.0C
D_1		67.6C	8.7A	74.0A	66.3C	8.4A	72.8A
D_2		71.8B	6.2B	66.0B	71.3B	6.4B	65.5B
	60	65.8C	5.9D	60.0D	65.4C	6.0D	58.9D
	90	69.1B	6.4C	63.3C	68.8B	6.4C	62.9C
	120	77.2A	7.4B	69.8B	74.4A	7.3B	67.0B
	150	77.6A	7.8A	72.0A	76.4A	7.8A	71.6A
D_0	60	68.0fg	5.1d	53.0k	68.0de	5.2g	52.0j
	90	73.0cd	5.3d	55.0j	73.0bc	5.5fg	55.0i
	120	85.7a	6.1c	63.0h	81.7a	6.3e	59.0h
	150	84.7a	6.1c	63.3h	83.0a	6.3e	62.0g
D_1	60	63.3i	7.4b	67.0f	61.7g	7.4cd	62.7g
	90	65.1gh	8.0b	70.0d	64.0f	7.5c	70.0d
	120	71.0de	9.8a	78.3b	67.7de	8.9b	74.6b
	150	71.0de	9.8a	81.7a	71.7c	9.8a	80.7a
D_2	60	66.0gh	5.3d	60.0i	66.7e	5.4g	59.0h
	90	69.3ef	5.8cd	65.0g	69.3d	6.2ef	63.7f
	120	75.0bc	6.3c	68.0e	74.3b	6.7de	67.3e
	150	77.0b	7.6b	71.0c	74.7b	7.3cd	72.0c

*Values marked with the same letter(s) for each character are statistically similar using Revised LSD test at p = 0.05.

**D_0 = non-decapitation (control). D_1 = decapitation after 3 months of planting. D_2 = decapitation after 4 months of planting.

Dry matter and mineral contents of leaves

The present results in Table 3 illustrated that decapitation globe artichoke plant, after 3 or 4 months from planting, led to significant increase in leaf dry matter percentage over the control treatment, in both seasons. On the other hand, decapitation treatments did not affect the leaf N, P and K contents of globe artichoke, in both seasons. Results of the current study agreed those of Olasantan (1986) and Ghoneim (2000) who indicated that decapitation, significantly, increased the dry matter content of okra leaves.

The results of Table 3, clearly illustrated that increasing N application rate more than 60 kg N fed^{-1}, significantly, reduced leaf dry matter content of globe artichoke, in both seasons. However, each increment in N applied rate associated with significant increase in leaf N content, while leaf P content was not affected, in two years. Moreover, the response of leaf K content to N application rate was significantly the best at 150 kg N fed^{-1}, in both seasons. Similar results were reported by Pomares *et al.* (1993) who clarified that leafN content of globe artichoke tended to increase with increasing N applied rate from 200 to 600 kg N ha^{-1}. However, the content of P and K was not influenced by N application rates. On the other hand, Salamah (1997) reported that leaf N, P and K contents of globe artichoke increased gradually with increasing the application rate of N from 95 to 385 kg N ha^{-1}.

The interactions of decapitation treatments by N rates for dry matter and N contents of leaves were significant in both seasons (Table 3). On the other side, leaves P and K contents were not affected. The combination treatments; early or late decapitation with the application of 60 kg N fed^{-1} attained the highest magnitude of leaf dry matter, while late decapitation and 150kg N fed^{-1} recorded the best value for leaves N content.

Early and total yield $plant^{-1}$

Table 4 shows that decapitation of globe artichoke plants had significant effects on heads early and total yield (expressed as the number and weight of heads $plant^{-1}$), in both experments. Early decapitation i.e. after 3 months from planting, significantly, increased heads early and total yield $plant^{-1}$ relative to late decapitation i.e. after 4 months from planting. The differences between early yield $plant^{-1}$ of the control (non-decapitated) and early decapitated plants were too

small to be significant, in both seasons. The obtained results are in harmony with those reported by El-Shal *et al.* (1993) who found that no significant difference, in weight of early heads yield plant^{-1}, was detected due to the principal bud cutting compared to the control.

Table 3. Leaves dry matter and mineral contents of globe artichoke, as affected by decapitation and nitrogen rate, during the seasons of 2000/2001 and 2001/2002.

Treatments		2000-2001				2001-2002			
Decapitation time	N rate kg fed^{-1}	Dry matter %	N%	P%	K%	Dry matter %	N%	P%	K%
D_0**		14.1B*	2.60A	0.423A	2.17A	13.4B	2.44A	0.403A	1.83A
D_1		15.0A	2.90A	0.481A	2.19A	15.3A	2.76A	0.464A	2.20A
D_2		15.4A	2.84A	0.577A	2.34A	15.3A	2.87A	0.517A	2.45A
	60	15.9A	2.29D	0.403A	1.90B	15.5A	2.31D	0.373A	1.90D
	90	15.0B	2.64C	0.470A	2.06B	14.9B	2.56C	0.418A	2.10C
	120	14.5B	2.97B	0.533A	2.20B	14.4B	2.82B	0.498A	2.26B
	150	13.9B	3.22A	0.567A	2.77A	13.9C	3.07A	0.556A	2.37A
D_0	60	15.6ab	2.15c	0.360a	1.64a	14.3e	2.05e	0.330a	1.53a
	90	14.3de	2.35bc	0.380a	1.95a	13.6f	2.23de	0.336a	1.83a
	120	13.5fg	2.67abc	0.450a	1.93a	12.9g	2.50cd	0.440a	1.94a
	150	13.0g	3.22a	0.500a	3.15a	12.6g	2.96ab	0.480a	2.01a
D_1	60	16.1a	2.36bc	0.380a	1.94a	16.0ab	2.33de	0.350a	2.03a
	90	15.2bc	2.83ab	0.450a	1.99a	15.7abc	2.67ab	0.430a	2.12a
	120	14.7cd	3.18a	0.523a	2.32a	15.2c	2.94ab	0.500a	2.25a
	150	14.1ef	3.21a	0.570a	2.51a	14.5e	3.11ab	0.577a	2.43a
D_2	60	16.1a	2.35bc	0.470a	2.12a	16.1a	2.55bc	0.440a	2.15a
	90	15.4b	2.73abc	0.580a	2.25a	15.4bc	2.78ab	0.463a	2.36a
	120	15.3b	3.06a	0.627a	2.35a	15.1cd	3.01ab	0.553a	2.62a
	150	14.7cde	3.22a	0.630a	2.65a	14.5de	3.16a	0.610a	2.66a

*Values marked with the same letter(s) for each character are statistically similar using Revised LSD test at p = 0.05.

**D_0 = non-decapitation (control). D_1 = decapitation after 3 months of planting. D_2 = decapitation after 4 months of planting.

The results presented in Table 4, generally, indicated that increasing the application of N fertilizer rates, to the growing globe artichoke plants, from 60 to 90 and fatherly to 120 kg N fed^{-1}, associated with progressive and significant increases in the number and weight of early and total heads yield plant^{-1}, in both seasons.

Further increase of N application to 150 kg N fed^{-1}, however, did not reflect any appreciable influence on number and weight of early heads

Table 4. Early and total heads yield of globe artichoke, as affected by decapitation and nitrogen rate, during the seasons of 2000/2001 and 2001/2002.

Treatments		2000-2001				2001-2002			
Decapitation time	N rate kg fed^{-1}	Early heads yield plnt^{-1}		Total heads yield plant^{-1}		Early heads yield plnt^{-1}		Total heads yield plnt^{-1}	
		Number	Weight (g)	Number	Weight (kg)	Number	Weight (g)	Number	Weight (kg)
D_0**		5.45A*	794.4A	17.7C	3.79C	5.52A	796.4A	17.1C	3.64C
D_1		5.34A	788.6A	20.2A	4.23A	5.20A	788.6A	20.2A	4.16A
D_2		4.93B	664.8B	19.3B	4.04B	4.78B	641.7B	19.3B	3.95B
	60	4.69C	605.9C	17.8D	3.57C	4.61C	610.2C	17.4D	3.35D
	90	5.09B	716.2B	18.8C	3.98B	4.95B	706.6B	18.7C	3.78C
	120	5.47A	841.2A	19.5B	4.25A	5.46A	824.2A	19.3B	4.11B
	150	5.70A	833.7A	20.0A	4.26A	5.64A	827.9A	20.0A	4.39A
D_0	60	4.66ef	653.3e	15.4f	3.00c	4.81de	667.0d	14.6h	2.88d
	90	5.47bc	772.0c	17.6e	3.74b	5.44bc	757.0b	16.8g	3.45cd
	120	5.70ab	889.7a	18.5de	4.01ab	5.88a	876.0a	17.9f	3.93bc
	150	5.97a	862.7b	19.4cd	4.40ab	5.95a	885.7a	19.0de	4.29ab
D_1	60	4.85de	639.3e	19.6bc	3.96ab	4.70ef	647.0d	19.2cd	3.65cd
	90	4.99de	734.0d	19.9abc	4.27ab	4.82de	742.7b	19.9bc	4.01abc
	120	5.52bc	897.7a	20.5ab	4.57a	5.41c	886.7a	20.4b	4.26ab
	150	5.98a	883.3ab	20.9a	4.11ab	5.86ab	878.0a	21.4a	4.71a
D_2	60	4.56f	525.0 f	18.5de	3.76bc	4.32g	516.7f	18.4ef	3.53bcd
	90	4.82de	642.7 e	19.1cd	3.94ab	4.59fg	620.0e	19.3cd	3.89bc
	120	5.18cd	736.3 d	19.6bc	4.19ab	5.08cd	710.0c	19.6cd	4.15abc
	150	5.14cd	755.0cd	19.8bc	4.28ab	5.12cd	720.0c	19.7bcd	4.18abc

*Values marked with the same letter(s) for each character are statistically similar using Revised LSD test at p = 0.05.

**D_0 = non-decapitation (control). D_1 = decapitation after 3 months of planting. D_2 = decapitation after 4 months of planting.

yield plant^{-1} ,but showed significant increases in number and weight of total heads yield plant^{-1} ,in both seasons except total heads weight plant^{-1}, in the 1st season. The beneficial effect of N on the heads yield of globe artichoke plants could be attributed to the role of N in activating the vegetative growth as stated earlier which probably in turn promoted the production of more photosynthetic substances required for heads formation and development. Similar findings were, also, documented by Baroccio (1969), Gerakis and Honma (1969),

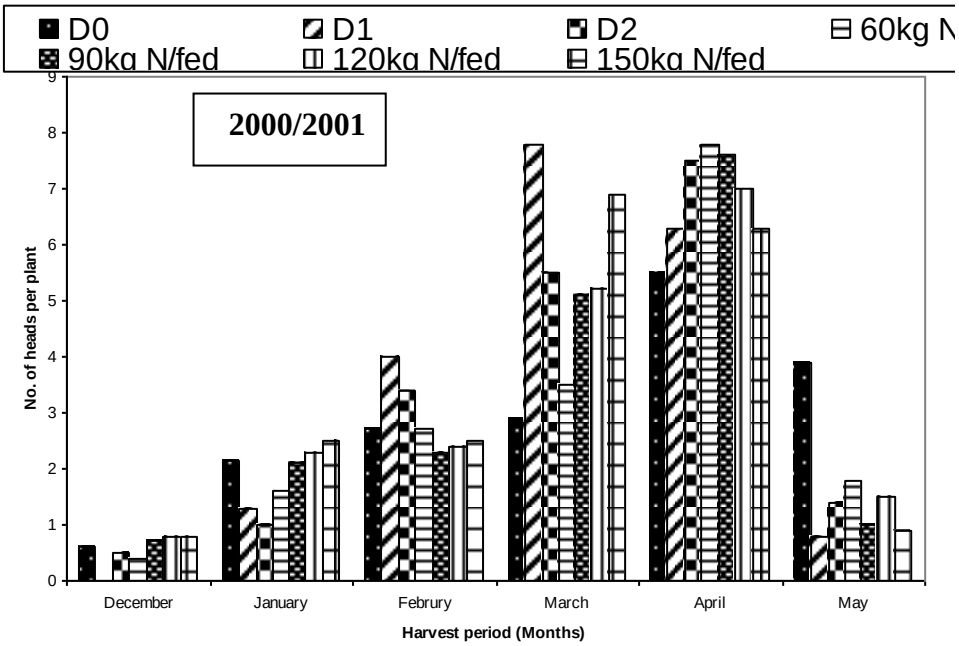
Prado *et al.* (1983), Elia *et al.* (1991), Salamah (1997) and Foti *et al.* (2000) who demonstrated that earliness and total yield were better with addition of 200 kg N ha^{-1}. However, Pomares et al. (1993) and Pedreno et al. (1996) who detected that head yield of globe artichoke was not affected by increasing N application from 300 to 500 kg N ha^{-1}.

The interaction effects between the decapitation and application of N fertilizer, on number and weight of early and total heads yield $plant^{-1}$ was significant, in the two seasons (Table 4). Generally, the combined treatment which included early decapitation; 3 months after planting and application of N at 120 or 150 kg N fed^{-1} gave the highest mean values of early and total heads yield plant $^{-}$.

Yield pattern:

The results in Fig 1 illustrated the effects of decapitation and nitrogen fertilizer rates on yield pattern distribution of globe artichoke heads throughout the harvesting period, expressed as number of total heads yield $plant^{-1}$, in the two growing seasons of 2000/2001 and 2001/2002. The results indicated that the major peaks of the heads yield of globe artichoke were found to be concentrated in March and April Months. Also, the early decapitated plants (after 3 months from planting) or which were fertilized with application of 150 kg N fed^{-1}, produced more amount of heads in March than the other treatments. Meanwhile, high amount of heads of the non-decapitated plants (control) or which were fertilized with low rate of N (60 kg N fed^{-1}), was concentrated in April. This result confirmed those obtained by Abdel-AL and Moustafa (1973) and El-shal *et al*. (1993).

The results presented in Table 5 exhibited the effects of decapitation time and nitrogen fertilizer rates on yield pattern distribution of globe artichoke heads throughout the harvesting period, expressed as percentage from the total heads yield $plant^{-1}$, in the two growing seasons of 2000/2001 and 2001/2002. The results showed that the percentages of yield pattern distribution for the plants which were early decapitated, as average of both seasons in the first four months (December to March), were 65.6% compared to 50.4% for the non-decapitated plants, whereas applying N at 150 kg N fed^{-1} gave 64% compared to 51% for the plants fertilized with 60kg N fed^{-1}.



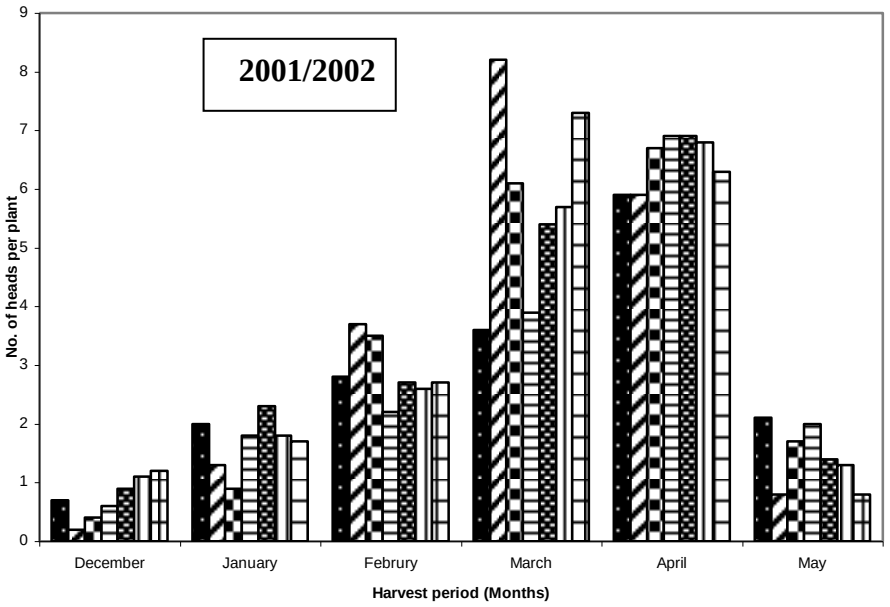


Fig 1 : Yield pattern distribution of globe artichoke heads as affected by decapitation and nitrogen fertilizer rates, during the seasons of 2000/2001 and 2001/2002.

Table 5. The yield pattern of globe artichoke heads as affected by decapitation time and nitrogen fertilizer rate, during the seasons of 2000/2001 and 2001/2002.

Months	Decapitation time			Nitrogen rate (kg fed^{-1})			
	D_0*	D_1	D_2	60	90	120	150
% from the total yield plant^{-1}							
2000/2001							
December	3.4	0.0	2.6	2.2	3.7	4.2	4.0
January	12.4	6.4	5.2	9.0	11.2	12.0	12.5
February	15.3	19.8	17.6	14.6	12.2	12.5	12.5
March	16.4	38.6	28.5	19.7	27.1	27.1	34.5
April	31.1	31.7	38.9	43.8	40.4	36.5	31.5
May	21.4	3.5	7.2	10.7	5.4	7.7	5.0
2001/2002							
December	4.1	1.0	2.1	3.4	4.3	5.7	6.0
January	11.7	6.4	4.7	10.3	12.3	9.3	8.5
February	16.4	18.3	18.1	12.6	14.4	13.5	13.5
March	21.1	40.6	31.6	22.4	28.9	29.5	36.5
April	34.5	29.2	35.8	39.7	36.9	35.2	31.6
May	12.2	4.5	7.7	11.6	3.2	6.8	3.9

*D_0 = non-decapitation (control). D_1 = decapitation after 3 months of planting. D_2 = decapitation after 4 months of planting.

Head quality characters

The results presented in Table 6 appeared that decapitation of glob artichoke plants, irrespective of the decapitation time, did not reflect any significant effect, on average head weight, dry matter percentage, total soluble solids and total carbohydrates content in the edible parts, compared with those of the non-decapitated plants, in both seasons. However, head diameter, head length and receptacle weight, were significantly decreased with than without the decapitation plants, in the two experiments. Mentioned results are in harmony with those reported by El-Shal *et a.l* (1993) who found that cutting the principal bud of globe artichoke plants did not show any significant increase on head weight.

Regarding the effect of fertilizing globe artichoke plants with nitrogen at various rates, the results in Table 6 indicated that average head weight, head length and receptacle weight as well as total carbohydrates percentage in the edible parts, were significantly increased with increasing N applied rate up to 120 kg N fed^{-1}, in the two experimental seasons. Similarly, increasing N applied rate up to

150 kg N fed^{-1}, progressively and significantly, increased head diameter but reduced both dry matter and total soluble solids percentages in the edible parts, in the two seasons. The promotive effects of N application on some heads quality characteristics of globe artichoke seemed to be logic true, since the application of N fertilizer increased the vegetative growth characters, as appeared in Table 2, which in turn, increased the carbohydrate assimilates and their translocation to the reproductive tissues (heads) resulting in improving its quality. The previous mentioned results were in general accordance with those reported by Salamah (1997) who found an improvement of bud quality, e.g., weight and length as well as the diameter of receptacle, with increasing N fertilization rates up to 95 kg N ha^{-1}, while increasing the application rates of N from 190 to 380 kg N ha^{-1} did not show any further improvement of these characters. Nevertheless, the weight of marketable buds was highest with nitrogen application at 320 kg N ha^{-1} (Prado *et al.,* 1983) and 150 kg of N ha^{-1} (Elia *et al.,* 1991) compared to the untreated control.

Concerning the interaction effects between decapitation treatments and rates of N fertilizer on the studied head quality characters of globe artichoke, the results in Table 6 showed significant differences, within head length and diameter, receptacle weight and dry matter percentage of the edible parts of globe artichoke heads, in both seasons. The application of N at the rate 150kg N fed^{-1} coupled with the non-decapitation, was the best treatment combination for head length, head diameter and receptacle weight, but it was the lowest treatment combination for dry matter content in edible parts of artichoke heads. However, the other studied head quality characteristics did not significantly respond to the interaction effects of the two studied factors.

Based on the results of this study, the combination treatment of early decapitation (after 3 months after planting) and applying N at 150 kg N fed^{-1}, during the growing season, appear to be the most efficient combination treatment, which gave the best results for growth and yield characters of globe artichoke plant, under the environmental conditions of Alexandria.

Table 6. Head quality characters of globe artichoke, as affected by decapitation time and nitrogen rate, during the seasons of 2000/2001 and 2001/2002.

Decapitation time	N rate kg fed^{-1}	Head weight (g)	Head Length (cm)	Head Diameter (cm)	Receptacle weight (g)	Dry matter %	T.S.S %	Total carbohydrates %
2000/2001								
D_{0}**		257.0A*	10.7A	9.3A	70.2A	19.9A	9.54A	1.29A
D_1		249.5A	7.6B	7.6B	58.0B	19.2A	9.35A	1.30A
D_2		246.3A	8.0B	8.1B	62.3B	20.2A	10.23A	1.43A
	60	236.4C	7.3C	7.5D	55.3C	22.3A	10.66A	1.11C
	90	248.2B	8.5B	8.1C	60.7B	20.7B	9.97B	1.30B
	120	256.3A	9.1A	8.6B	67.3A	18.8C	9.53B	1.44A
	150	262.8A	10.2A	9.2A	70.7A	17.2D	8.67C	1.51A
	60	242.0a	8.2d	8.3de	61.7fg	23.1a	10.87a	0.97a
D_0	90	256.0a	10.7b	8.9c	66.0cd	21.3c	9.80a	1.28a
	120	261.7a	11.4b	9.7b	74.7b	18.4e	9.30a	1.37a
	150	268.3a	12.5a	10.3a	78.3a	16.7g	8.20a	1.54a
	60	234.0a	6.4f	6.6g	47.3i	21.4c	10.20a	1.13a
D_1	90	244.0a	7.2e	7.5f	55.0h	19.4d	9.60a	1.25a
	120	255.0a	7.8de	7.9ef	63.3ef	18.5e	9.10a	1.36a
	150	265.0a	9.0c	8.5cd	66.3c	17.4f	8.50a	1.44a
	60	233.3a	7.4de	7.5f	57.0h	22.5b	10.90a	1.23a
D_2	90	244.7a	7.6de	7.8ef	61.0g	21.3c	10.50a	1.37a
	120	252.3a	8.1d	8.3de	64.0de	19.6d	10.20a	1.58a
	150	255.0a	9.1c	8.9c	67.3c	17.5f	9.30a	1.56a
2001/2002								
D_0		257.6A	10.7A	9.0A	68.0A	19.6A	9.88A	1.20A
D_1		150.8A	8.0B	7.6B	57.8B	19.2A	9.91A	1.26A
D_2		242.0A	8.0B	8.1B	61.3B	19.4A	10.23A	1.37A
	60	234.2B	7.5C	7.2D	55.8B	21.9A	10.97A	1.06C
	90	241.9B	8.5B	8.0C	59.3B	20.1B	10.36A	1.23B
	120	253.0A	9.4A	8.5B	66.0A	18.3C	9.76B	1.36A
	150	258.0A	10.2A	9.2A	68.3A	17.2D	8.96C	1.46A
	60	248.3a	8.5ef	8.0d	60.3e	22.4a	11.07a	0.85a
D_0	90	250.0a	10.2c	8.7bc	64.7cd	20.2c	10.43a	1.19a
	120	264.0a	11.7b	9.2b	72.0b	18.2ef	9.53a	1.29a
	150	268.0a	12.4a	10.2a	75.0a	17.5g	8.50a	1.49a
	60	225.0a	6.8h	6.3f	52.0g	22.0a	10.63a	1.12a
D_1	90	237.0a	7.5g	7.3e	54.3f	19.6d	10.33a	1.23a
	120	245.0a	8.2ef	8.2cd	61.0e	18.1f	9.67a	1.29a
	150	256.0a	9.5d	8.4cd	63.7d	17.1g	9.00a	1.39a
	60	229.3a	7.3gh	7.3e	55.0f	21.2b	11.20a	1.21a
D_2	90	238.7a	7.6g	7.9d	59.0e	20.5c	10.30a	1.28a
	120	250.0a	8.2f	8.2cd	65.0cd	18.7e	10.07a	1.49a
	150	250.0a	8.8e	9.1b	66.3cd	17.1g	9.37a	1.52a

*Values marked with the same letter(s) for each character are statistically similar using Revised LSD test at p = 0.05.

**D_0 = non-decapitation (control). D_1 = decapitation after 3 months of planting. D_2 = decapitation after 4 months of planting

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الملخص العربي

تأثير ميعاد إزالة القمة النامية (التطويش) و معدلات التسميد النيتروجيني على النمو و المحصول وصفات الجودة في الخرشوف

مصطفى نبوي فليفل
قسم الخضر ـ كلية الزراعة ـ جامعة الإسكندرية

أجريت تجربتان حقليت ان في المحطة التجريبية (أبيس) – بكلية الزراعة – جامعة الإسكندرية خلال الموسم الزراعي لعامي 2001/2000، و 2002/2001. لدراسة تأثير أربعة معدلات مختلفة من التسميد النيتروجيني (60، 90، 120، 150 كجم ن/فدان) تحت ثلاث معاملات لإزالة القمم النامية (التطويش) للساق الرئيسية للنبات (بدون تطويش ، التطويش بعد 3 أشهر، التطويش بعد 4 أشهر من الزراعة) على صفات النمو الخضري و المحصول و جودته بالإضافة إلى محاولة تعديل نظام توزيع إنتاج المحصول خلال موسم النمو لنباتات الخرش ـوف (صنف فرنساوي). أوضحت النتائج أن الإزالة المبكرة للقمم النامية (التطويش بعد 3 شهور من الزراعة) لنباتات الخرشوف أدت إلى زيادات معنوية في عدد الأفرع ، وعدد الأوراق،ومحتوى الأوراق من المادة الجافة ، بالإضافة إلى المحصول المبكر و الكلي للنبات من النورات معبراً عنه كوزن و عدد ، من ناحية أخرى أدت معاملات التطويش إلى نقص معنوي في ارتفاع النبات،و طول و قطر النورة، بالإضافة إلى وزن القرص الزهري للنورة ، أيضا أدت معاملة التطويش المبكر (بعد 3 أشهر من الزراعة) إلى تحوير نظام توزيع إنتاج المحصول خلال موسم النمو لنباتات الخرشوف حيث زادت أعداد النورات و نسبتها المئوية من المحصول الكلي للنبات خلال الأربعة الأشهر الأولى لموسم الحصاد. أظهرت النتائج أيضاً أن تسميد نباتات الخرشوف بمعدل 150كجم نيتروجين للفدان كان له تأثيرات معنوية إيجابية على عدد الفروع لكل نبات، و عدد الأوراق، و ارتفاع النبات والمحصول المبكر و الكلي للنبات (معبراً عنه كوزن، و عدد) . كما أدى إلى زيادات معنوية في محتوى النيتروجين و البوتاسيوم بالأوراق. و أشارت النتائج أيضاً إلى نقص محتوى القرص الزهري للنورة من المادة الجافة و المواد الصلبة الذائبة الكلية معنوياً مع إضافة السماد النيتروجيني.و عموما فأن إزالة القمم النامية لنباتات الخرشوف مع التسميد بمعدل 150 كجم للفدان أدى إلى زيادة المحصول المبكر و الكلي و تحسين صفات الجودة للنورات.