# EFFECT OF SOME GROWTH REGULATORS ON GROWTH, YIELD AND CHEMICAL CONSTITUENTS OF ARTICHOKE PLANTS *Cynara scolymus*, L.

BY

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## ABSTRACT

This experiment include 10 treatments gained from 3 levels of each of $GA_3$ (50, 100 and 200 ppm), CCC (500, 1000 and 2000 ppm) and NAA (100, 200 and 400 ppm) plus untreated control treatment. Growth regulators were sprayed on artichoke plants cv. Herious three times at 20 days intervals, starting 60 days after planting. Obtained results revealed that $GA_3$ foliar application within its three doses showed the most enhancing effect on both early and total yield of flower heads as compared with either CCC or NAA. For export purposes the application of 200 ppm $GA_3$ may be recommended as the most effective treatment improved flower head earliness and its quality. However, for improving the total yield, 50 ppm $GA_3$, 500 ppm CCC or 200 ppm NAA may be advisable.

## INTRODUCTION

Although the effect of $GA_3$ foliar application on artichoke plants had been studied by many investigators, few data are available regarding CCC and NAA. Bekhit *et al.* (1986), emphasized the enhancing effect of 50 ppm $GA_3$ on artichoke plant height. As for number of leaves per plant, Foury *et al.* (1977), pointed out that $GA_3$ at concentration of 5-10 mg/plant slightly increased it, whereas no significant effects could be detected due to spraying artichoke plants with 25, 50 or 75 ppm $GA_3$ compared to control (Aly, 1983). Regarding fresh and dry weight per plant, Abd El-Fattah (1978), reported favourable effects of $GA_3$ in this respect, whereby the maximum increase in dry matter percentage was obtained when artichoke plants were sprayed with 100 ppm $GA_3$.

Many investigators demonstrated the favourable effect of $GA_3$ application on flower bud development and consequently on yield earliness. Such stimulating effect was depending on the time of application (Casilli, 1969); number of sprays (Pochard, 1964; Radwan & Stino, 1973; El-Shal *et al.*, 1977;

Abd El-Fattah, 1978; Aly, 1983); concentration used; Ziv, 1960; Snyder et al., 1971; Radwan & Stino, 1973; Doel & Martinoli, 1976; El-Shal et al., 1977; Aly, 1983; Bekhit et al., 1986; El-Fadaly & Abou El-Hassan, 1986) and variety of artichoke (De-Angelis, 1970).

On the other hand, contradictive effects of $GA_3$ on the total yield of artichoke had been mentioned. Casilli (1969); De-Angelis (1970); Harboui et al., (1976); Harboui and Verlodt (1977,b); Bekhit et al., (1986) and El-Fadaly & Abo El-Hassan (1986), emphasized tremendous enhancing effects. While, Snyder et al., (1971); Radwan & Stino (1973) and El-Shal et al. (1977), proved little or insignificant effects. However, El-Baz et al., (1979) and Mangano & Signorelli (1981), demonstrated adversely bad effects.

As for the effect of CCC, it could be concluded that it had no considerable effect on the head yield of artichoke. The response was almost fluctuated (Hossny, 1974; El-Fadaly and Abou El-Hassan, 1986). Meanwhile, no available data were found concerning the effect of NAA application on artichoke plants.

Results on the effect of $GA_3$ on physical properties of the edible part of artichoke (capitulum) are contrasting. Foliar application of $GA_3$ at the range of 25-100 ppm is mostly found to reduce weight and diameter of capitulum leading to be less suitable for marketing (Pochard, 1964; De-Anglis, 1970; Radwan & Stino, 1973 and El-Shal et al., 1977). However, Harboui and Verlodt (1977a and 1977b) pointed out an improving effect on flower head quality and size. Meanwhile, no obvious effects could be detected regarding head weight, diameter or length (Abd El-Fattah, 1978 and Aly, 1983).

The aim of this work is to study the effect of some growth regulators on growth, yield and quality of artichoke plants.

## MATERIALS AND METHODS

This experiment was carried out to study the effect of foliar application of Gibberellic acid ($GA_3$) chlormequat chloride, 2-chloroethyl tri-methyl ammonium chloride (CCC) and B-Naphthalene acetic acid (NAA) on vegetative growth, chemical composition, flower head yield and quality of globe artichoke plants. Therefore, crown pieces and offshoots of globe artichoke (Cynara scolymus L.) cv. Herious were

planted in two successive field experiments in 1983/1984 and 1984/1985 seasons, at the Experimental Farm of the Faculty of Agric., Moshtohor, Zagazig Univ. All the ordinary agricultural practices were achieved.

This experiment included 10 treatments i.e. three different levels of each of $GA_3$ (50, 100 and 200 ppm), CCC (500, 1000 and 2000 ppm) and NAA (100, 200 and 400 ppm) plus the control treatment. Growth regulators were sprayed three times on plant foliage, at 20 days intervals starting two months after planting. A complete randomized block design with 4 replicates was adopted. The following data were recorded.

**Plant growth:**

At 120 days after planting, four plants from each plot were taken by random for growth measurements such as:

1- Plant height.
2- Number of leaves per plant.
3- Fresh weight, length and dry matter % of the 4th leaf.

**Chemical constituents:**

Chlorophyll a, b and carotene (A.O.A.C. 1970) content of leaves as well as total nitrogen (Pregl, 1945; Peach & Tracy, 1956); phosphorus (Murphy & Riely, 1962; John, 1970), potassium (Brown and Lilleland, 1946), reducing-, nonreducing and total-sugars (Forsee, 1938) in both leaves, 120 days after planting, as well as the edible part of artichoke, at the 5th picking.

**Flower head yield and its quality:**

Tender, mature, purplish green colour flower heads of 10 cm stalk length were picked at intervals of 10-15 days in winter and 4-6 days in spring, starting from 15th of December till the end of April. Harvested flower heads throughout the season were evaluated as total yield, while, the first five pickings (Dec.-Feb.) were considered as early yield. The yield was measured by weight (kg) and number.

At each picking time, flower head length and its diameter, as well as the weight, diameter and thickness of the edible part (receptacle) were taken into consideration.

Data recorded were subjected to the statistical analysis according to the randomized block design mentioned by Snedecor and Cochran (1962).

## RESULTS AND DISCUSSION

**1- Plant-growth characteristics:**

It is evident from data in Table (1) that plants sprayed with $GA_3$ were superior in plant height, number of leaves per plant, and length as well as fresh and dry weight of the fourth leaf, compared with plants sprayed with either CCC or NAA. The most stimulative effect was obtained by spraying plants with the range of 50-200 ppm $GA_3$, 1000 ppm CCC or 200 ppm NAA.

Obtained results on $GA_3$ are in agreement with those mentioned by Foury et al., (1977); Abd El-Fattah (1978) and Bekhit et al., (1986) on artichoke.

**2- Chemical composition:**

**a- Chlorophyll a, b and carotene in leaves:**

Results recorded in Table (2) show that growth regulators used not significantly affected either chlorophyll a or carotene in leaves. Contrasting to CCC treatments, chlorophyll b content was gradually increased as $GA_3$ or NAA levels increased. As for total chlorophyll content, using of 100 ppm $GA_3$ or 400 ppm NAA were of the most pronouncing effect.

The stimulative effect of $GA_3$ on chlorophyll content had been also reported by El-Assiouty (1983), on common bean.

**b- N, P, K in leaves:**

Results in Table (3) show clearly that $GA_3$ application mostly increased N, P and K percentages of leaves than control. However, CCC treatments showed no significant effect in this respect, except 500 ppm, which significantly increased N %. Meanwhile, NAA treatments mostly increased N and P percentages but no clear trend could be observed regarding to K % in leaves.

Obtained results on $GA_3$ coincided with those of Farrag (1971), whilst they contradicted those of El-Assiouty (1983).

**c- Reducing, non-reducing- and total-sugars in leaves:**

It is clear from data presented in Table (4) that the highest reducing sugars content in leaves was associated with the highest level of either $GA_3$ (200 ppm) or NAA (400 ppm), meanwhile a decreasing tendency could be noticed as CCC levels increased. Furthermore, a retarding effect of all growth regulators on non-reducing sugars was observed, except low level of $GA_3$ and medium level of both CCC and NAA.

Table (1) : Vegetative growth characteristics of artichoke plants as affected by foliar application of some growth regulators.

| Treatments | ppm. | 1983/1984 | | | | | 1984/1985 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 4 th leaf | | | | | 4th leaf | | |
| | | Plant height (cm) | No. of leaves/ plant | Fresh wt.(g) | Dry wt. % | Length (cm) | Plant height (cm) | No.of 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 |

Table (2): Chlorophyll and carbtene contents (mg/100 g fresh weight) of artichoke leaves as affected by foliar application of some growth regulators.

| Treatments | | 1983/1984 | | | | 1984/1985 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Chlorophyll | | | Carotene | Chlorophyll | | | Carotene |
| | ppm. | (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. |

Table ( 3 ): Total-N,P, and K content of artichoke leaves as affected by foliar application of some growth regulators.

| 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 |

Table (4) : Reducing, non-reducing and total sugras (mg/g dry weight) of artichoke leaves as affected by foliar application of some growth regulators.

| 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 |

Concerning the effect of various used growth regulators on total sugars content of artichoke leaves, data show clearly 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.

**3- Early yield of artichoke flower head:**

Data concerning the effect of growth regulators on flower head early yield are given in Table (5). It is clear that all used growth regulators, with the superiority of $GA_3$ treatments, enhanced flower heads early yield productivity. The most enhancing concentrations were 200 ppm $GA_3$, 200 ppm NAA and 2000 ppm CCC, since they increased the early yield by 220% 88% and 43% over the control, respectively.

The stimulative effect of $GA_3$ on artichoke flower head early yield production has been mentioned by Pochard (1964), Casilli, (1969); Ziv (1970); Synder et al., (1971); Radwan & Stino (1973); Doel & Martinoli (1976); El-Shal et al., (1977); Abd El-Fattah (1978) and Aly (1983). Furthermore, Bekhit et al., (1986) and El-Fadaly & Abou El-Hassan (1986), emphasized the favourable effect of 50-150 ppm $GA_3$ on flower head early yield production, comparing to either CCC or control.

Obtained results concerning the less stimulative effect of CCC on flower head early yield production is in harmony with the findings reported by Hossny (1974). In this connection, El-Fadaly and Abou El-Hassan (1986), reported that CCC within the range of 250-1000 ppm had no considerable effects on early yield.

**4- Total yield of artichoke flower heads:**

It is evident from data shown at table (6) that growth regulators i.e. $GA_3$, CCC and NAA significantly promoted flower heads total yield productivity by weight and number compared to the control. The super treatment of each growth substance was $GA_3$ at 50 ppm, CCC at 500 ppm and NAA at 200 ppm which produced 65%, 49% and 40% over the control, estimated as kg/plant during both seasons, respectively (Table 6).

Obtained results are in agreement with those reported by Casilli (1969), De-Angelis (1970); Harboui et al., (1976) and Harboui & Verlodt (1977b). Recently, Bekhit et al. (1986), emphasized the beneficial effect of 50 ppm $GA_3$ which was mainly due to the increase in number of heads per plant more than to the incraese in average head weight.

Table ( 5 ) : Early yield of artichoke flower heads as affected by foliar application of some growth regularors.

| 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 | |

Table ( 5): Total yield of artichoke flower heads by weight and number as affected by foliar application of some growth regulators.

| 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 |

El-Fadaly and Abou El-Hassan (1986), came to the same conclusion using 50-150 ppm $GA_3$.

However, obtained results are not in complete harmony with those obtained by Snyder et al., (1971); Radwan & Stino (1973); El-Shal et al. (1977); El-Baz et al. (1979) and Mangano & Signorelli (1981). This contradiction may be due to experiment location, cultivar, $GA_3$ concentration, number of sprays and/or time of application.

As for CCC application, results in this work did not agree with those found by Hossny (1974) and El-Fadaly and Abou El-Hassan (1986).

**5- Physical characteristics of flower heads:**

Data in Table (7) show that $GA_3$ treatments enhanced flower head length, CCC depressed it, whilst NAA showed no significant effect. With respect to flower head receptacle, all used growth regulators generally improved its studied physical parameters.

Regarding to the flower head diameter, obtained results are in harmony with El-Shal et al., (1977); Abd El-Fattah (1978) and Aly (1983), who found that $GA_3$ had no significant effect on flower head diameter.

The stimulative effect of $GA_3$ on the edible part of artichoke is in agreement with the results reported by Harboui and Verlodt (1977a and 1977b). However, obtained results did not agree with those of Radwan & Stino (1973) and El-Shal et al., (1977); Abd El-Fattah (1978) and Aly (1983), who found no or less effect of $GA_3$ on flower head weight and length.

**6- Chemical composition of edible part (receptacle):**

Dry matter content, as well as the percentages of N, P and K had been improved by using the different concentrations of all used growth regulators (Table 8).

As for reducing and total sugars content, $GA_3$ proved to be of a depressive effect, however, both CCC and NAA were of moderate stimulative effect. A retarding influence on non-reducing sugars could be detected as a result of $GA_3$ or CCC application. Meanwhile, the effect of NAA on non-reducing sugars during both seasons was fluctuated (Table 9).

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.

Table ( 7 ): 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 |

Table ( 8 ) : Dry matter, N, P and K contents of artichoke edible part as affected by foliar application of some growth regulators.

| 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 |

Table ( 9,): Reducing, non-reducing and total sugars (mg/g dry weight) of artichoke edible part as affected by foliar application of some growth regulators.

| 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 |

Abd El-Fattah (1978), found that $GA_3$ up to 50 ppm decreased reducing sugar content, meanwhile 100 ppm did not affect non-reducing sugar content compared to the control.

Obtained results on CCC are in agreement with those found by Hossny (1974), with regard to reducing and total sugars but contradict those of non-reducing sugars.

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# تأثير بعض منظمات النمو على النمو

# والمحصول والمحتوى الكيميائى لنبات الخرشوف

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تحتوى هذه التجربه على عشرة معاملات ناتجه عن ثلاثة مستويات من حمض الجبريليك ( ٥٠ ، ١٠٠ ، ٢٠٠ جزء فى المليون) ، السيكوسيل ( ٥٠٠ ، ١٠٠٠ ، ٢٠٠٠ جزء فى المليون) ونفتالين أسيتك أسيد ( ١٠٠ و ٢٠٠ و ٤٠٠ جزء فى المليون) بجانب معاملة المقارنه (الكنترول) .

رشت نباتات الخرشوف صنف Herious ثلاثة مرات بين كل رشه والاخرى عشرون يوما حيث بدأت الرشه الاولى بعد ستون يوما من الزراعه .

لوحظ أن حمض الجبريليك كان أكثر المنظمات المستخدمه تنشيطا لانتاج المحصول المبكر أو المحصول الكلى لنوارات الخرشوف وذلك بالمقارنه بالمعاملات الاخرى مثل ( السيكوسيل أو النفتالين أسيتك أسيد أو الكنترول .

وعليه فيمكن النصح برش نباتات الخرشوف بمحلول حمض الجبريليك بتركيز ٢٠٠ جزء/ المليون عند الرغبه فى انتاج أعلى محصول مبكر من النوارات خاص بالتصدير على حين يمكن استخدام أى من حمض الجبريليك ، السيكوسيل أو نفتالين أسيتك أسيد بتركيز ٥٠ ، ٥٠٠ ، ٢٠٠ جزء فى المليون على التوالى عند الرغبه فى زياده المحصول الكلى من النوارات وزنا وعددا .