*J. Agric. Sci. Mansoura Univ., 28 (3): 1645 - 1653, 2003*

# PHYSIOLOGICAL STUDIES OF SOME GROWTH REGULATORS ON THE GROWTH, YIELD AND CHEMICAL CONSTITUENTS OF ONION PLANTS (*Allium cepa* L.)

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## ABSTRACT

The present work was conducted during two successive seasons of 1999/2000 and 2000/2001 to study the effect of ethrel, cycocel and polyamine on growth, yield and chemical constituents on onion (Allium cepa L.).

The results suggested that, spraying onion plants twice with all growth regulators increased plant height, number of leaves and leaves weight. While, application of growth regulators with one or two sprays increased length, diameter as well as weight, of onion bulb. Moreover, spraying onion plants twice with growth regulators had a favourable effect on yield, especially with cycocel and polyamine.

Foliar spray of all growth regulators with one dose induced the highest increase in the soluble sugars. On the other hand, sprayed with two doses increased other chemical constituents. In most cases spraying ethryl and polymine at high level and cycocel at medium level may result in a promising chemical constituents.

## INTRODUCTION

For the importance of onion, trials were male to improve the efficiency of onion plant to grow and bulb formation. One of these trials is soaking the bulbs (before planting) or spraying plans (at different stages of growth) with growth regulators.

Ethephone (ethrel) application at higher rates suppressed vegetative growth and reduced both bulb diameter and yield. While caused bulb initiation in onion as observed by many investigators (Levy and Kedar, 1972; Lipe, 1975, and 1976 Tendaj, 1993, Lopez *et al*.., 2000, Starman, and Williams, 2000).

Cycocel (chlormequat) application resulted in deep green leaves and stout flower stalks. Spray applications of CCC at 1000 ppm and above promoted flowering and 3000 ppm caused virtually all the plants to flower (Sinnadurai *et al*., 1971). In this line, Foda *et al*. (1979) mentioned that, spraying the cloves with chlormequat once or twice resulted in the highest *yield of garlic compared with control, plants.*

Polyamine compounds (i.e. putrescine, spermidine, spermine and other polyamines) are found in all organisms, in a wide variety of capacities. They are essential for cell viability, and are correlated with,or required for, a variety of physiological events (Evans and Malmberg, 1989). Since polyamines involvement in various growth and development phases: cell division, embryogenesis, rooting, flowering and pollen tube growth. We cover various postulated links between polyamines and plant growth regulators (Heimer *et al*., 1979, Galston, 1983 and Davies, 1987). Exogenous application of polyamines retarded senescence in many species by exhibiting ethylene synthesis as observed in oat, apple, fruit, been and tobacco leaf

(Apelbaum *et al.*, 1981, Fuhrer *et al.*, 1982, Shih *et al.*, 1982 and Shiozaki *et al.*, 2001).

This work is an attempt to evaluate the importance of some growth regulators such as ethryl, cycocel and polyamine, sprayed at certain concentrations on vegetative growth, yield and bulb formation of onion (Allium cepa L.).

## MATERIALS AND METHODS

The present work was conducted in two successive seasons 1999/2000 and 2000/2001 at El-Salhia, Esmaillia governorate. Seeds of onion (Alium cepa L.) cv. Behairy were cultivated in bed during the first week of November in both seasons. After 70 days from sowing the seedlings were transplanted to the experiment field at 10 cm spacing. The plants were placed in plots (3.5 x 3.0 m area) with five rows 60 cm apart. Agriculture practices were followed for growing onion plants as it is recommended by the Egyptian Ministry of Agriculture.

The growth substances used in these experiments were Ethryl, (2-chloroethyl phosphonic acid) cycocel (CCC) (2-chloroethyl trimethyl ammonium chloride) and polyamine ($NH_2$ $(CH_2)_3$ $NH(CH_2)_4NH_2$). Three concentrations were individually used from each growth regulators (100, 200 and 300 ppm for ethryl; 250, 500 and 1000 ppm for cycocel and 50, 100 and 150 ppm for polyamine) in addition to untreated plants (control).

The experiment was divided into two parts, each of them included 11 treatments with four replicates. The plants in both parts sprayed after 50 days from transplanting by individually growth regulator. Whereas control were sprayed by tap water. The second part of the experiment, sprayed after 70 days from transplanting with the same abovementioned concentrations of growth regulators. After 90 days from transplanting, growth characters were recorded expressed as plant height, number of leaves/plant, fresh weights of leaves/plant, bulb length, bulb diameter and bulb weight.

At harvest time (120 days after transplanting), ten bulbs were chosen at random from every plot and the following data were recorded; bulb length, bulb diameter, bulb weight and total yield of onion. Moreover, samples of fresh bulb were chosen to determine soluble sugars (Dubois *et al.*., 1956), total soluble amino acids (Rosein, 1957), total soluble phenols (A.O.A.C., 1970) and total soluble indoles (Larson *et al.*, 1962).

The layout of he experiment was a complete randomized block design. Data obtained from the experiment were subjected to statistical analysis according to Snedecor and Cochran (1967). Least significant differences (L.S.D.) were calculated at 0.05 level for different treatments.

## RESULTS AND DISCUSSION

**1- Vegetative growth characters:**

Results in Table (1) showed that effect of growth regulators ethrel, cycocel and polyamine at different concentrations on vegetative growth

characters of onion plant. The data presented in Table (1) indicate that spraying plants twice with different concentrations of all growth regulators increased plant height in most cases. The highest mean value of plant height was obtained as a result of polyamine at 150 ppm in the twice prays.

Concerning the effect of growth regulators on number of leaves/plant, data in the same Table indicate that one spray of ethrel, CCC and polyamine resulted in insignificant effect of this characters. Whereas, the same growth regulators at two spray resulted in significant effect for leaves number. The maximum value of this character was observed as a result of polyamine at 150 ppm spraying growth regulators induced a highly significant increase in leaves weight/gm at one or two sprays compared with control. The same results were obtained on the bulb length in one spray. While in the two sprays indicated no significant effects for concentrations of growth regulators on bulb length.

Bulb diameter of onion plants increased with ethrel and polyamine at low and medium concentration for one spray. Whereas, the two sprays with cycocyl and polyamine at all concentrations resulted in the highest increase in blub diameter.

The maximum significant values for bulb weight were obtained as a result of ethrel and cyocel at medium concentration and polyamine at all concentrations, for one spray. On the other hand, cycocel at 250 ppm, 500 ppm and polyamine at 100 ppm resulted in the highest significant increase for bulb weight at the two sprays.

It may be concluded from the abovementioned results that, spraying onion plants twice with all treatments increased plant height, number of leaves/plant and leaves weight. While, application of growth regulators with one or two spray led to increase of bulb length and diameter as well as bulb weight. Therefore, we recommended the use of ethrel and cycocel at medium concentration and polyamine at medium or high concentration increase onion growth. Many investigators came to the same conclusion, Barakat and El-Araby (1991) and Tendaj (1993) found that, the highest yield of bunching onions was obtained when the seedlings were treated with ethryl at medium rate compared with lowes rate. Also sinnadurai *et al.*, (1971) and Singh *e al*, (1995), mentioned that spraying onion plant by cycocel at 500 ppm caused increases in the leaves number, leaves weight, bulb diameter and bulb weight. Furthermore, polyamine had the superior effect in various growth of onion plants (Heimer et al, 1979, Davies, 1987 and Phillip and Russell, 1989).

**Yield and quality:**

Data reported in Table (2) show that growth regulators (ethrel, cycocel and polyamine) had a significant effect on yield and quality of onion (Allium cepa L.).

Application of ethrel (200 ppm) and cycocel (500 or 1000 ppm), with one spray, induced a highly significant increase in bulb length, compared with control. While, spraying plants twice with cycocel (250 or 1000 ppm) and polyamine (150 ppm) significantly increased bulb length compared with control.

Regarding to response of bulb diameter to growth regulators

application in Table 2 indicate that ethrel at low concenration, as well as, cycocel and polyamine at high concentration resulted in the highest significant increase for bulb diameter, at one spray.On the other hand, spraying onion plants twice with ethrel and cycocel at low or high concentration and polyamine at medium or high concentration significantly increased bulb diameter compared with control.

It was evident from the data in same Table that bulb weight of onion plant significantly decreased with application of all growth regulators, in the one spray. On the other hand, spraying twice with all concentrations of growth regulators, except ethrel 100 ppm, significantly increased bulb weight compared with control.

It is evident from the data illustrated in Table (2) and Figure (1) that all used concentrations of ethrel, cycocel and polyamine, at one spray, led to significant decreases in total yield of onion. On the other hand, growth regulators at all concentrations, at two sprays, resulted in the highest significant increase for yield of onion. The most promising effect was noticed with polyamine 100 ppm treatment.

From the above data, it can be concluded that spraying onion plant twice with growth regulators had a favourable effect on yield, especially with cycocel and polyamine. These results could be in agreement with those obtained by Cantliffe (1981); Natlob and El-Habar (1983) and Tendaj (1990) on onion plant, also Mohamed *et al.* (1990) and Habba *et al.* (2001) on wheat, found that spraying plants twice with ethryl at favourable concentration had a positive effect in most cases on yield and quality. In this connection Foda *et al.* (1979) on garlic and Sinnadurai *et al.* (1971) and Abu-Grab and Ebrahim (2000) on onion. Mentioned that application of cycocel at medium concentration had significantly effect on growth and yield of garlic and onion plants. In addition, the positive correlation between spray twice with polyamine and yield. These results are in agreement with those obtained by Smith and Davies (1985). They mentioned that polyamines are important in cell division and a variety of physiological events.

**Chemical constituents:**

Data reported in Table 3 show that growth regulators (ethrel, cycocel and polyamine) had a significant effect on total soluble sugar, free amino acid, total phenols and total indols. For total soluble sugar, all concentrations of growth regulators, except ethrel 200 ppm, had a significant increase with one spray, compared with control. In this respect polyamine at 50 ppm was more effective than other treatments. On the other hand, spraying onion plant twice with all growth regulators, except ethrel 100 ppm, showed insignificant difference in total soluble sugar. It can be noticed that onion plants treated with growth regulators in one spray, gave the highes value of soluble sugars than plants treated with two spray.

One spray of ethryl and polyamine at high concentration and cycocel at all concentrations, enhanced free amino acid. The highest significant values in this respect were observed with 500 ppm of CCC and 150 ppm polyamine treatments. While, two sprays with ethryl at high concentration as well as CCC and polyamine at medium concentration, increased free amino

acid, compared with other treatments and control.

Concerning the effect of growth regulators on total phenols at one or two sprays. Generally, spraying with two doses resulted in highest increases than one spray. It is clear from Table 3 that all concentrations of growth regulators, at one and two sprays, significantly increased total phenols.

Application of cycocel and polyamine, in one dose, at low or high level significantly increased total indols compared with other treatments and control. Whereas, sprayed with two doses of 200 ppm ethryl, all level of cycocel and low level of polyamine caused significant increase in total indols. Thus, it can be concluded from the obvious results that sprayed onion plants with one dose of all growth regulators gave the highest value of soluble sugars than two doses. On the other hand, sprayed with two doses increased other chemical constituents. These results are in agreement with those obtained by El-Kabbany (1988), Ostrzycka, Gorecki (1991) and Ebrahim, Abu-Grab, (1997) on onion and preety *et al.* (1999) on spearmint, found that treated plants compared with those control, revealed significant differences in chemical constituents.

**Table (1): Effect of ethrel, cycocel and polyamine on some growth characteristics of onion plants after 90 days from transplanting (Average of two seasons).**

| Treatments | Plant height (cm) | | No. of leaves/ plant | | Leaves weight (g) | | Bulb Length (cm) | | Bulb diameter (cm) | | Bulb weight (g) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | II | I | II | I | II | I | II | I | II | I | II |
| Control | 63.00 | 63.00 | 7.30 | 7.30 | 36.70 | 36.50 | 4.15 | 4.20 | 1.40 | 1.40 | 25.70 | 25.30 |
| Ethrel 100 ppm | 66.70 | 68.00 | 7.00 | 7.30 | 39.10 | 39.70 | 5.15 | 4.50 | 1.53 | 1.13 | 22.30 | 19.60 |
| Ethrel 200 ppm | 70.00 | 71.70 | 7.30 | 7.70 | 56.10 | 43.40 | 5.00 | 4.35 | 2.03 | 1.13 | 39.50 | 23.70 |
| Ethrel 300 ppm | 64.30 | 67.30 | 7.70 | 7.70 | 41.00 | 46.40 | 5.35 | 4.65 | 1.33 | 1.23 | 26.80 | 24.70 |
| CCC 250 ppm | 64.70 | 65.30 | 7.30 | 8.70 | 41.00 | 42.80 | 4.50 | 4.85 | 1.10 | 2.20 | 23.60 | 40.90 |
| CCC 500 ppm | 69.70 | 70.00 | 7.30 | 7.00 | 48.20 | 35.10 | 4.85 | 4.85 | 1.40 | 1.50 | 32.30 | 37.30 |
| CCC 1000 ppm | 65.30 | 74.70 | 8.00 | 8.00 | 46.50 | 50.40 | 4.65 | 4.85 | 1.23 | 2.03 | 26.30 | 30.70 |
| Polyamine 50 ppm | 64.30 | 72.00 | 8.00 | 8.00 | 42.40 | 53.80 | 4.65 | 4.50 | 1.63 | 1.47 | 30.70 | 31.40 |
| Polyamine 100 ppm | 68.00 | 67.70 | 8.00 | 8.00 | 49.20 | 48.30 | 4.85 | 4.85 | 2.10 | 2.47 | 39.80 | 48.60 |
| Polymine 150 ppm | 68.70 | 75.00 | 7.00 | 9.00 | 51.20 | 51.70 | 4.85 | 4.85 | 1.37 | 1.47 | 31.20 | 30.20 |
| L.S.D. 5% | 2.8 | 5.6 | N.S | 1.1 | 3.9 | 4.1 | 0.60 | N.S | 0.56 | 0.45 | 4.0 | 8.1 |

I One spray
II Two sprays

**Table (2): Effect of ethrel, cycocel and polyamine on yield and yield quality of onion plants after 120 days from transplanting (Average of two seasons).**

| Treatments | Bulb length (cm) | | Bulb diameter (cm) | | Bulb weight (g) | | Total yield Kg.fed. | |
|---|---|---|---|---|---|---|---|---|
| | I | II | I | II | I | II | I | II |
| Control | 6.60 | 6.60 | 4.47 | 4.27 | 101.52 | 102.89 | 12000 | 12208 |
| Ethrel 100 ppm | 6.35 | 6.89 | 4.65 | 4.81 | 72.40 | 101.20 | 8920 | 12764 |
| Ethrel 200 ppm | 7.00 | 6.50 | 4.59 | 4.34 | 84.10 | 117.80 | 10264 | 13978 |
| Ethrel 300 ppm | 6.89 | 6.59 | 4.40 | 4.47 | 78.40 | 119.70 | 9896 | 14168 |
| CCC 250 ppm | 6.75 | 7.00 | 4.44 | 4.75 | 66.70 | 121 80 | 7960 | 14712 |
| CCC 500 ppm | 7.11 | 6.70 | 4.62 | 4.31 | 79.70 | 126.80 | 9456 | 14888 |
| CCC 1000 ppm | 7.00 | 6.85 | 4.77 | 4.51 | 78.00 | 129.20 | 9256 | 15776 |
| Polyamine 50 ppm | 6.72 | 6.39 | 4.58 | 4.27 | 65.60 | 117.20 | 10272 | 13800 |
| Polyamine 100 ppm | 6.63 | 6.79 | 4.52 | 4 76 | 83.40 | 144 40 | 10128 | 16992 |
| Polymine 150 ppm | 6.40 | 7.09 | 4.79 | 4.80 | 99.40 | 134.30 | 9888 | 15520 |
| L.S.D. 5% | 0.27 | 0.24 | 0.15 | 0.10 | 10.60 | 8.30 | 102 | 862 |

I One spray
II Two spray

**Table (3): *Effect of ethrel, cycocel and* polyamine on chemical constituents (mg/100 g.fw.) of onion bulb (Average of two seasons).**

| Treatments | Total soluble sugar | | Free amino acid | | Total phenols | | Total indols | |
|---|---|---|---|---|---|---|---|---|
| | I | II | I | II | I | II | I | II |
| Control | 1296 | 1187 | 63.36 | 83.70 | 39.27 | 44.39 | 4.36 | 4.42 |
| Ethrel 100 ppm | 1614 | 1382 | 62.45 | 65.13 | 41.14 | 59.82 | 4.42 | 4.69 |
| Ethrel 200 ppm | 1557 | 1218 | 62.34 | 72.12 | 47.17 | 81.13 | 4.75 | 6.01 |
| Ethrel 300 ppm | 1780 | 1190 | 67.24 | 85.42 | 56.23 | 65.21 | 4.63 | 4.89 |
| CCC 250 ppm | 1623 | 1044 | 65.03 | 70.46 | 48.83 | 71.51 | 5.55 | 7.22 |
| CCC 500 ppm | 1830 | 1235 | 82.85 | 84.62 | 45.52 | 81.44 | 3.87 | 7.78 |
| CCC 1000 ppm | 1607 | 1175 | 64.70 | 74.93 | 65.09 | 79.36 | 6.30 | 9.35 |
| Polyamine 50 ppm | 2508 | 1176 | 60.51 | 83.66 | 45.97 | 79.90 | 5.59 | 6.11 |
| Polyamine 100 ppm | 1911 | 1064 | 51.48 | 89.47 | 54.15 | 46.45 | 4.73 | 3.91 |
| Polymine 150 ppm | 2109 | 1046 | 72.29 | 59.44 | 49.68 | 52.88 | 6.63 | 4.49 |
| L.S.D. 5% | 297 | 98 | 8.27 | 8.30 | 3.74 | 5.29 | 0.98 | 1.40 |

I One spray
II Two sprays

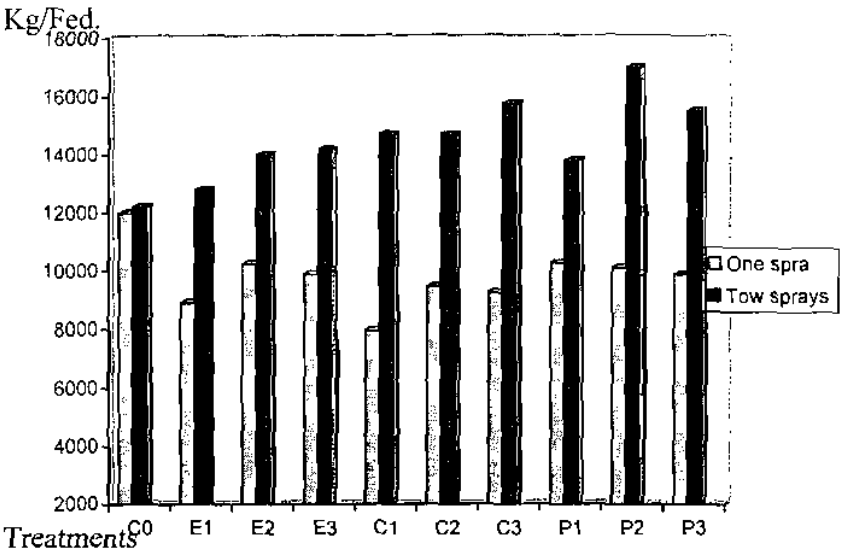


*Fig. (1):* Total yield of onion as affected by some growth regulators (combined analysis of two seasons)

***C 0= Control,***
**E = $E_1$ (Ethrel 100 ppm), $E_2$ (Ethrel 200 ppm), E3 (Ethrel 300 ppm)**
***C = $C_1$ (CCC 250 ppm), $C_2$ (CCC 500 ppm), , $C_3$ (CCC 100 ppm)***
**P = P1 (polyamine 50 ppm), P2 (polyamine 100 ppm), $P_3$ (polyamine 150 ppm).**

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## دراسات فسيولوجية لبعض منظمات النمو على النمـــو والمحصـــول والمكونـــات الكيماوية فى نبات البصل

**إبراهيم الأباصيرى حبه**
**قسم النبات – المركز القومى للبحوث – الدقى – القاهرة**

أجرى هذا العمل خلال موسمين ١٩٩٩-٢٠٠٠، ٢٠٠٠-٢٠٠١ لدراســة تأثير كل من الايثريل، السيكوسيل والبولى أمين على النمو والمحصول والمكونــات الكيماوية على نبات البصل.

أوضحت النتائج أن رش نباتات البصل مرتين بكل مـــن منظمـــات النمـــو أحدثت زيادة فى طول النبات وعدد الأوراق وكذلك وزن الأوراق، بينما أدى تـــأثير الرش بأى من منظمات النمو السابقة مرة ومرتين إلى زيادة طول البصلة وقطرها وكذلك وزنها. كذلك أعطى رش النباتات مرتين بأى من منظمـــات النمـــو تـــأثير مشجع للمحصول خاصة مع السيكوسيل والبولى أمين.

أدى الرش مرتين بتركيزات مرتفعة من الايثريل والبولى أمين والمتوسـطة من السيكوسيل إلى زيادة المحتوى الكيماوى