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EFFECT OF FOLIAR APPLICATIONS OF ASCORBIC ACID, ETHREL AND THEIR COMBINATIONS ON GROWTH, YIELD AND ENDOGENOUS HORMONES IN CUCUMBER PLANTS

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ABSTRACT

This study was carried out in two successive seasons of 1999 and 2000 at the Experimental Farm of Vegetable Research Department, Ministry of Agriculture. The effect of ascorbic acid, ethrel and their combinations on the vegetative growth, yield and endogenous hormones of the monoecious cucumber cv. Beit Alpha, were studied. Ethephon inhibited growth and induced earliness of producing female flowers. Ascorbic acid caused significant increase of stem length and fresh weight, but has no effect on the earliness of flowering, while the combinations of ascorbic acid with ethrel gave earliness of flowering and yield.

On the other hand, ascorbic acid has no effect on the early yield (number and weight of fruits), while the combined with ethrel gave increase in the early and total yield.

These results were accompanied with regular increase in the contents and levels of promoters [Auxins (IAA and IAN) and (GA-like substances)] and decrease in the contents and activity of inhibitors [abscisic acid (ABA)] leading to hormonal balance.

INTRODUCTION

Among the pathway for improving yield of cucumber, by increases the pistillate flowers can ultimately produce fruits and increasing yield. In addition, various exogenously applied growth regulators have been shown to affect increasing yield of cucumber. Ethrel tended to induce pistillate flowers on monoecious cultivars Karchi and Govers (1972) reported that the greatest number of female flowers were produced on the main stem when plants were sprayed with ethrel at 1-4 leaf stage. Ethrel caused inhibition of growth by stem stunting as a decrease in plant length, reflected by smaller weight and volume (Mishra *et al.*, 1976; Al-Juboory *et al.*, 1990 and Al-Masoum and Al-Masri 1999) on cucumber.

Ascorbic acid [Vitamine C (V.C)] is known as a growth regulator factor that influence many physiological processes such as the synthesis of enzymes, nucleic acids, proteins and act as co-enzymes (Reda *et al.*, 1977, Abdel-Halim, 1995 and Tarraf *et al.*, 1999) in different plants.

Spraying of tomato plants with ascorbic acid at 100 and 200 ppm gave the best plant growth (Montasser, 1990). Lemongrass plants increased in vegetative growth, oil yield and total carbohydrates by spraying ascorbic acid (Tarraf *et al.*, 1999). Abdel-Halim (1995) concluded that the application of 100 and 200 ppm of ascorbic acid as foliar spray on tomato plants caused significant increase on growth parameters, expressed as stem length number of branches, flowers and fruit set in comparison with control plants. Arisha (2000) found that spray of potato plants with ascorbic acid 100, 200 and 400

ppm gave significantly increase in total dry weight of plant, stem length and total yield with increasing ascorbic acid up to 400 ppm. El-Ghamring *et al.* (1999) found that spraying tomato plants with V.C. at 100 ppm significantly increased number of fruits, total yield/fed. Agwah (1990) concluded that ascorbic acid sprayed at 250 ppm enhanced lettuce fresh weight and yield.

The present work was carried out to study the possibility of using foliar application of different concentrations of ascorbic acid, ethrel and their combinations to improve flowering, growth, earliness and yield of cucumber plants.

MATERIALS AND METHODS

Two field experiments were performed in two successive years 1999 and 2000 in the Experimental Farm of Vegetable Research Department, Ministry of Agricultural and the chemical analysis was carried out in the Botany Laboratory, National Research Centre, Dokki, Cairo.

Seeds of *Cucumis sativus* L. cv. Beit Alpha, a monoecious type, were sown directly in open field in first March of both seasons.

The experiment included nine treatments, which were the combinations of the two growth regulators as follows :

1- Ascorbic acid (V.C.) at 200 ppm.
2- Ascorbic acid (V.C.) at 100 ppm
3- Ethre at 200 ppm.
4- Ethrel at 100 ppm.
5- Ascorbic acid (V.C.) at 200 ppm + Ethrel at 100 ppm.
6- Ascorbic acid (V.C.) at 200 ppm + Ethrel at 200 ppm.
7- Ascorbic acid (V.C.) at 100 ppm + Ethrel at 100 ppm.
8- Ascorbic acid (V.C.) at 100 ppm + Ethrel at 200 ppm.
9- Control (spraying with water only).

A complete randomized block design with four replicates consisted of nine treatments. Each treatment contained two rows of plants. Each row was 2 meter length, 1.2 meter width and consisted of eight plants, the space between plants was 25 cm. The recommended cultural practices for growing cucumber were performed.

Plants were sprayed two times with ethrel at concentrations of 0, 100 and 200 ppm in two stages, first when plants produced 2 true leaves and the second when plants reached fourth leaf stage. When initiation of flowering buds appearance, the plants sprayed twice with ascorbic acid at 100 and 200 ppm treatments at seven days intervals.

Collected data were as follows:

A. Vegetative growth measurements:

Such characteristics were recorded in one sample of 8 plants taken at random from each treatment at the end of growing season (95 days from sowing) in the two seasons of study. The following items were studied : Average fresh weight of plant (kg) and average length of main stem (cm).

B. Pistillate flowers :

Four plants in each replicate were chosen for each treatment to determine the days from germination to appearance of the first pistillate flower.

C. Endogenous hormones :

Endogenous hormones were recorded on the samples which taken after seven days from the last spray for every treatment. Auxins [Indole acetic acid (IAA), Indole acetonitrile (IAN)], Abscisic acid (ABA) and Gibberellins-like substances (GA-like substances).

The method of the preparation, extraction and bioassays were done as the method described by Badr *et al.* (1971). The biological determination of endogenous promoters and inhibitors was follows according to the method of [Linser, 1938 and 1940] and the biological activity of gibberellins was estimated by sorghum first leaf test adopted by Bently – Mowat (1966) and modified by Abd El-Wahab (1982).

D. Yield :

Early yield was estimated as number and weight of all harvest fruits per plant during the first two weeks of harvesting season. At the end of the growing season, total yield per plant was then calculated.

The obtained data was statistically analysed according to Steel and Torrie (1984). The treatments means compared by least significant differences (L.S.D.) at 1 % and 5 % level.

RESULTS AND DISCUSSION

Vegetative growth :

The effect of all treatments on main stem length of cucumber plants, the results in Table (1) reveal also that the dwarfing effect of ethrel which was evident by significantly short main stem for plants treated with these treatments compared with untreated control.

The ethrel alone recorded the minor lowest values of main stem length as compared with the control treatment. Plants treated with ascorbic acid alone or in combined with ethrel increased main stem length.

In this respect, the highest increment was detected significantly in case of using ascorbic acid at 200 ppm alone.

Similar results were obtained by Al-Masoum and Al-Masri (1999) on cucumber and El-Lithy and El-Greadly (2001) on melon.

Fresh weight :

Concerning the effect of ascorbic acid on plant fresh weight, data in Table (1) indicated that there was a promoting effect on the vegetative growth of all treatments included ascorbic acid alone or combined with ethrel. Such effect was significant increase in weight of plants treated with these treatments compared with untreated plants. The increase in plant weight showed variability between the treated with ascorbic acid 200 ppm alone or

combined with ethrel, while using ascorbic acid alone at 200 ppm recorded the maximum values in this respect which gave (0.894 kg) as compared with ethrel at 200 ppm treatment which gave the lowest value (0.357 kg) in comparison with the other treatments. Hewedy (1978) on cucumber indicated that high concentrations of ethrel (200 mg/L.) had a depressive effect on fresh weight, and he attributed this depressive effect to a toxic effect of high ethrel concentrations on plant growth and to the inhibition of cell elongation. Similar results were obtained by Arora *et al.* (1989), El-Lithy and Shosha (1993), Tarraf *et al.* (1999) and El-Lithy and El-Greadly (2001).

Table (1) : Growth measurements per plant as affected by Ascorbic acid, Ethrel and their combinations.

Treatments	1st season			2nd season		
	Plant length (cm)	Fresh weight (kg.)	No. of days before first pistillate opening	Plant length (cm)	Fresh weight (kg.)	No. of days before first pistillate opening
1. As. 200 ppm	185.4	0.894	59.2	205.5	0.931	57.1
2. As. 100 ppm	154.7	0.794	59.5	164.3	0.820	57.1
3. Ethrel 200 ppm	94.2	0.357	49.1	90.4	0.379	44.3
4. Ethrel 100 ppm	96.6	0.414	58.9	92.8	0.419	55.3
5. As.200 ppm + ethr. 100 ppm	121.5	0.553	50.8	133.5	0.649	46.1
6. As.200 ppm + ethr.200 ppm	104.3	0.431	34.3	107.7	0.472	32.6
7. As.100 ppm + ethr.100 ppm	116.8	0.511	55.2	127.2	0.545	55.3
8. As.100 ppm + ethr. 200 ppm	97.9	0.424	44.7	96.8	0.441	41.6
9. Control	147.5	0.771	59.8	159.4	0.797	57.7
L.S.D. at 0.05	15.5	0.042	3.7	12.2	0.047	2.1
0.01	21.1	0.057	5.0	16.7	0.066	2.7

Pistillate flowers:

Number of days from germination to appearance of the first female flower as affected by ethrel and ascorbic acid treatments shown in Table (1). Results show clearly that ethrel alone or in combinations with ascorbic acid treatments affect greatly on time of the appearance of the first female flowers Ethrel at 200 ppm plus ascorbic acid at 200 ppm was the most effective treatment in hastening the appearance of the first female flower, which was shown by decreasing the number of days before emanation of first female flower. Low effect was noticed in plants treated with ascorbic acid alone, while spraying cucumber plants with ethrel at 200 ppm plus ascorbic acid at 200 and 100 ppm were significantly affected the earliness in emanation of female flowers as compared with control treatment. This earliness in the appearance of the female flowers was early by 24.90 and 14.5 days in plants treated with 200 ppm V.C. + 200 ppm ethrel and in plants treated with 100 ppm V.C. and 200 ppm ethrel respectively in the first season and was 24.5 and 15.5 days in the second season.

These results are in harmony with those obtained by Patil *et al.* (1984), El-Lithy and Shosha (1993), Rahman and Ali (1996) and Al-Masoum and Al-Masri (1999) on cucumber plants.

Auxins and inhibitors contents :

It is clear from Figure (1) that the content and activity levels of growth promoting zones having auxin activity were progressively and markedly increased in the shoots of cucumber leaves with ascorbic acid and ethrel concentrations and such increases were proportional to the increases in ascorbic aid and ethrel combinations applied. Eight growth promoting zones having significant activity all of which contain indole compounds at R_{fs} values from 0.0 to 0.7 and 0.9 – 1.0 and one inhibition zone of R_f value (0.7 – 0.9) appeared in the extract of shoots of seedlings treated with 100 and 200 ppm ethrel. All ascorbic acid treatments and in combinations with ethrel gave a highly increase in the amount of auxins and disappeared the amount of abscisic acid (ABA) and the maximum activity of R_f values appeared in the extract of shoots of seedlings treated with ethrel at 200 ppm + Ascorbic acid at 200 ppm in comparison with control plants.

Gibberelline like substances :

Figure (2) shows that the biological activities given by the untreated plants and ethrel treatments, clearly showed one zone of inhibition activity and no inhibition activity was detected with ascorbic acid treatment alone.

The indogenous picture given by the acidic ethanol extract of cucumber shoots of untreated plants showed three zones of GA-like activity. The first zone corresponded to R_f values of (0.0 – 0.1), the second zone corresponded to R_f values of (0.2 – 0.5) and the third promotion was detected from R_f (0.9 – 1.0) and one inhibition zone was detected at R_f (0.1 – 0.2), while samples which treated with ethrel alone caused an increase in the inhibition activity of GA-like substances but these inhibition zones were decreased in the samples which treated with ethrel and ascorbic acid. Also, promotion zones were increased when plants treated with Ascorbic acid plus ethrel.

Plants treated with ascorbic acid gave the highest promotion activity of GA-like substances in comparison with the other treatments.

It may be suggested that the highly concentrations of ethrel caused an increase in inhibitors in the monoecious cucumbers. Similar findings has been obtained by Rudich *et al.* (1972). They found that application of ethrel induced a rise in abscisic acid and higher level of auxin inhibitors.

A number of effects in the past, attributed to high levels of auxin, are now considered to be a result of ethylene production under the influence of auxin. (Burg and Burg, 1966 a and b 1966 and Chadwick and Burg, 1970).

Furthermore, Rudich *et al.* (1972) indicated that ethrel treatments greatly increased ABA content of cucumber shoots, and that may support the assumption that ethephon induces also the formation of ABA.

A glimpse at the biological activities given by ethrel treatments clearly showed a decrease in endogenous levels of gibberelline-like substances and with a rise in abscisic acid level especially at high concentrations (Hayashi *et al.*, 1971).

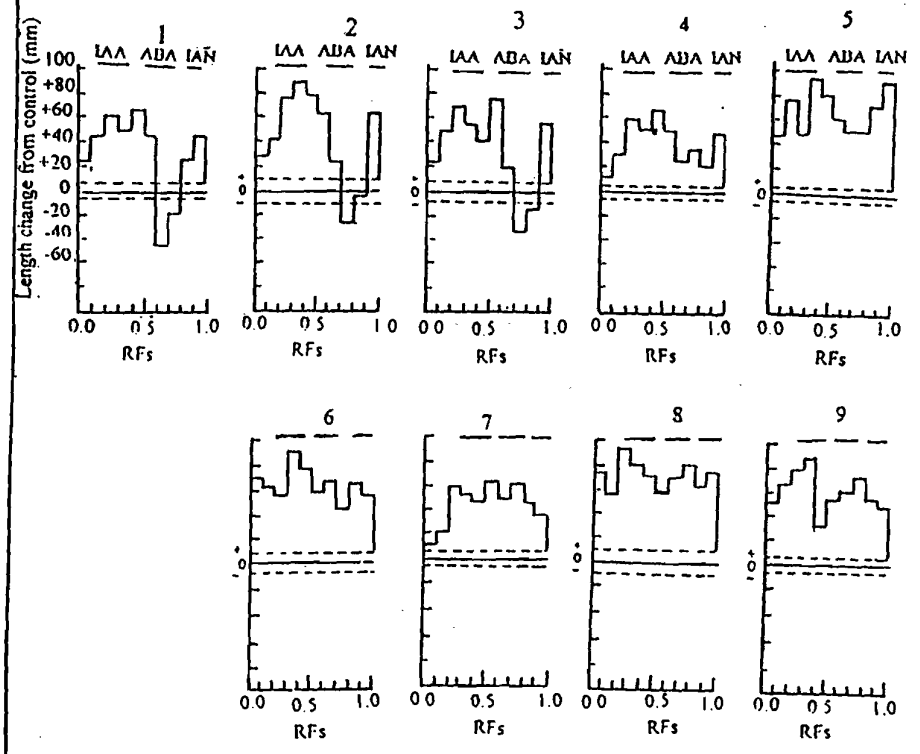

FIG.[1] :- biological activities of endogenous IAA , IAN and ABA in wheat coleoptile section test bioassay of purified extract of shoots of cucumber plants as affected by Ethhrel and ascorbic acid treatments.

1- untreated plants.
2- Plants treated with 100 ppm ethrel.
3- Plants treated with 200 ppm ethrel.
4- Plants treated with 100 ppm ascorbic acid .
5- Plants treated with 200 ppm ascorbic acid .
6- Plants treated with 100 ppm ascorbic acid + 100 ppm ethrel.
7- Plants treated with 100 ppm ascorbic acid + 200 ppm ethrel.
8- Plants treated with 200 ppm ascorbic acid + 100 ppm ethrel.
9- Plants treated with 200 ppm ascorbic acid + 200 ppm ethrel.

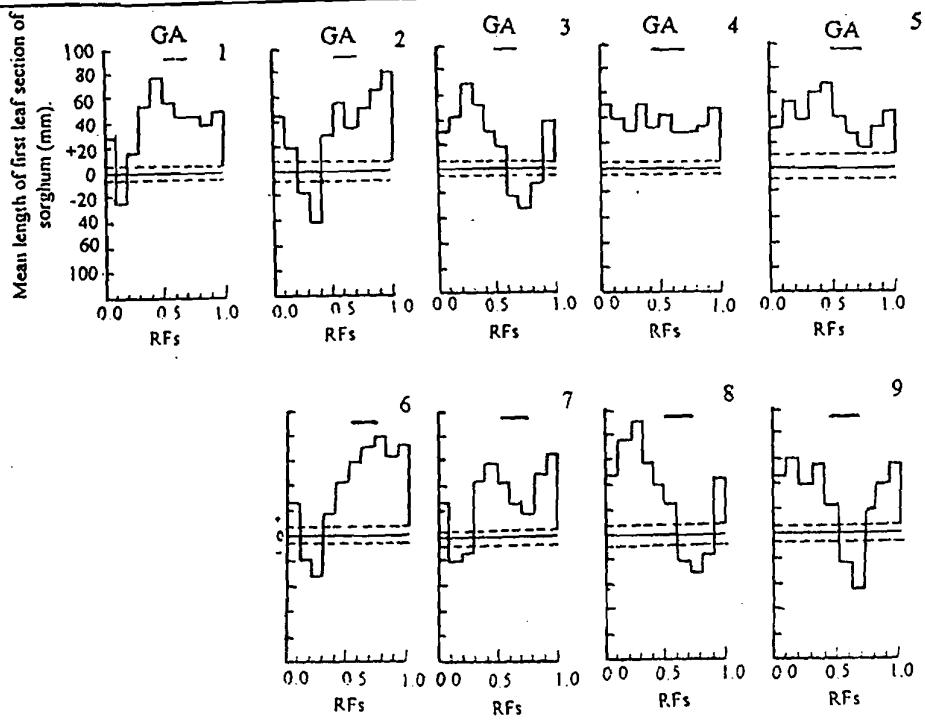

FIG.[2]:- biological activities of GA-like substances in sorghum first leaf sections bioassay test of purified extraction of shoots of cucumber plants as affected by ethrel and ascorbic acid treatments.

1-untreated plants.
2- plants treated with 100 ppm ethrel.
3- plants treated with 200 ppm ethrel.
4- plants treated with 100 ppm ascorbic acid.
5- plants treated with 200 ppm ascorbic acid.
6- plants treated with 100 ppm ascorbic acid + 100 ppm ethrel.
7- plants treated with 100 ppm ascorbic acid + 200 ppm ethrel.
8- plants treated with 200 ppm ascorbic acid + 100 ppm ethrel.
9- plants treated with 200 ppm ascorbic acid + 200 ppm ethrel

Also, Rudich *et al.* (1972), reported that the sex regulating activity of ABA might result from inhibiting GA activity by enhancing the formation of less active GA like hormones by promoting the binding of free GA and the formation of GA glycosides and other unidentified conjugates. Musgrave et al. (1972) and Hemphill and Tukay (1975) assumed that these conjugates have a physiological significance in GA movement in the plant as well as in the transformation of a biologically active GA into a less active one.

On the other hand, the content and activity levels of growth promoting zones having auxin and gibberellins activity were progressively and markedly increased in the shoots of cucumber leaves with ascorbic acid treatments and such increases were proportional to the increases in ascorbic acid alone or as a combination with ethrel concentrations applied. These stimulatory effects may be due to the role of ascorbic acid in increasing carbohydrates, synthesis of enzymes, proteins, RNA and DNA contents in plants (Reda *et al.* 1977 and Abdel-Halim 1995).

Yield:

The effect of ascorbic acid, ethrel and their combinations on number and weight of fruits per plant for early yield in both seasons is presented in Table (2). The highest early yield was obtained from plants treated with ascorbic acid at 200 ppm plus ethrel at 200 ppm, ascorbic acid at 100 ppm plus ethrel at 200 ppm and ethrel alone at 200 ppm which were (5.0 number = 0.53 kg weight), (3.9 number = 0.42 kg weight) and (2.3 number = 0.34 kg weight), respectively. While the lowest value from number and weight of early yield was obtained by ascorbic acid alone which was similar to control plants.

Table (2) : Effect of Ascorbic acid, Ethrel and their combinations on early yield per plant (after 15 days from the beginning of harvest).

Treatments	1st season			2nd season		
	No. of fruits	Wt. of fruits (kg.)	Earliness degree %	No. of fruits	Wt. of fruits (kg.)	Earliness degree %
1. As. 200 ppm	0.9	0.12	25.71	1.3	0.16	22.80
2. As. 100 ppm	0.8	0.13	19.51	1.4	0.12	25.92
3.Ethrel 200 ppm	2.3	0.34	20.72	2.4	0.38	18.75
4. Ethrel 100 ppm	1.4	0.17	33.33	1.9	0.19	31.14
5. As.200 ppm + ethr. 100 ppm	1.9	0.23	23.75	2.1	0.27	24.41
6. As.200 ppm + ethr.200 ppm	5.0	0.53	24.15	5.9	0.55	26.45
7. As.100 ppm + ethr.100 ppm	1.6	0.19	28.57	1.8	0.21	27.27
8. As.100 ppm + ethr. 200 ppm	3.9	0.42	25.00	4.7	0.50	26.25
9. Control	0.8	0.11	28.57	1.1	0.13	22.91
L.S.D. at 0.05	0.6	0.06	-	0.6	0.06	-
0.01	0.8	0.09	-	0.9	0.08	-

*Earliness degree % = $\frac{\text{Early yield (number or weight)}}{\text{Total yield (number or weight)}} \times 100$

Also, plants treated with ethrel combined with ascorbic acid gave an increase of weight and number of fruits. While, this increment was slightly noticed for plants treated with ascorbic acid alone.

This effect of ascorbic acid, ethrel and their combinations on early yield was clear indication for the previous effect of these growth substances on the earlier and more produced from pistillate flower.

In addition, spraying plants by ascorbic acid, ethrel and their combinations, resulted in an increase in earliness percentage compared to control treatment. However, these treatments were differed in weight of early yield. These results are in harmony with those reported by Sidhu *et al.* (1981), Al-Masoum and Al-Masri (1999) on cucumber and El-Lithy and El-Greadly (2001) on melon.

Concerning the effect of growth regulators and their combinations on average fruit weight, the results in Table (3) indicated that using some treatments increased average fruit weight. While spraying plants with ascorbic acid alone increased average fruit weight compared with control treatment.

Table (3): Effect of Ascorbic acid, Ethrel and their combinations on total yield per plant.

Treatments	Fruit number		Average fruit weight (gm.)		Total yield (kg.)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
1. As. 200 ppm	3.5	5.7	114.28	121.05	0.38	0.53
2. As. 100 ppm	4.1	5.4	107.32	133.33	0.31	0.51
3.Ethrel 200 ppm	11.1	12.8	99.09	96.09	1.04	1.17
4. Ethrel 100 ppm	4.2	6.1	100.00	91.80	0.51	0.66
5. As.200 ppm + ethr. 100 ppm	8.0	8.6	120.00	139.53	0.91	1.14
6. As.200 ppm + ethr.200 ppm	20.7	22.3	86.47	85.20	1.70	1.81
7. As.100 ppm + ethr.100 ppm	5.6	6.6	130.36	137.87	0.69	0.87
8. As.100 ppm + ethr. 200 ppm	15.6	17.9	88.46	96.64	1.31	1.65
9. Control	2.8	4.8	110.70	118.75	0.32	0.48
L.S.D. at 0.05	1.7	1.2	16.5	12.50	0.17	0.15
0.01	2.2	1.6	22.6	17.10	0.23	0.21

With regard to the total number and weight of fruits per plant, the results are presented in Table (3), indicated the effect of ascorbic acid and ethrel and their combinations on the total yield and fruits number followed the same trend of that obtained of early yield. These results gave a clear indication of the previous effects of these growth regulators and their combinations on the number of pistillate flowers. Similar results were obtained by Santos and Lopes (1981), El-Lithy and Shosha (1993) and Al-Masoum and Al-Masri (1999) on cucumber, Rahman and Ali (1996) on sweet ground and El-Lithy and El-Greadly (2001) on melon.

Table (4) : Effect of Ascorbic acid, Ethrel and their combinations on early and total yield per feddan in both seasons.

Treatments	Early yield per feddan (ton)		Total yield per feddan (ton)	
	1st season	2nd season	1st season	2nd season
1. As. 200 ppm	1.38	1.8	4.6	7.9
2. As. 100 ppm	1.50	1.4	5.1	8.3
3.Ethrel 200 ppm	3.91	4.4	12.7	14.2
4. Ethrel 100 ppm	2.00	2.2	4.8	6.4
5. As.200 ppm + ethr. 100 ppm	2.70	3.1	11.0	13.8
6. As.200 ppm + ethr.200 ppm	6.10	6.3	20.6	21.9
7. As.100 ppm + ethr.100 ppm	2.20	2.4	8.4	10.5
8. As.100 ppm + ethr. 200 ppm	4.80	5.8	15.9	19.9
9. Control	1.30	1.5	3.6	6.6

Data presented in Table (4) show that the outlook of early and total yield per feddan, which were calculated from the results obtained of the yield of plant. These results indicated that using Ethrel at 200 ppm alone or combined with ascorbic acid at 200 ppm gave maximum yield per feddan for early and total yield compared with control, while spraying with ascorbic acid alone slightly increased early and total yield. These results were in accordance with the results obtained of yield of the plant.

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تأثير الرش بحمض الاسكوربيك والايثريل ومخاليطهم على النمووالمحصول والهرمونات الداخلية فى نباتات الخيار

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أجرى هذا البحث خلال الموسم الصيفى ١٩٩٩ ، ٢٠٠٠ واشتملت دراسة تأثير الرش بحمض الاسكوربيك والايثريل بتركيز ١٠٠ ، ٢٠٠ جزء فى المليون بتركيز ١٠٠ ، ٢٠٠ جزء فى المليون ومخاليطهم على النمو الخضرى والمحصول والهرمونات الداخلية فى صنف الخيار بيتا –الفا (وقد اجريت التجربة فى مزرعة شعبة بحوث الخضر بالدقى) وتتلخص النتائج فيمايلى :

وجد ان الرش بالايثريل ادى الى التبكير فى التزهير المؤنث بالمقارنة بالنباتات المعاملة بحمض الاسكوربيك والكنترول حيث ادى الرش بالتركيز المرتفع من الايثريل الى انخفاض عدد الايام من الزراعة الى تاريخ تفتح اول زهرة مؤنثه –كما ادى الرش بالاثريل الى تقزم نمو النباتات وانخفاض الوزن الطازج .

وعلى العكس من ذلك ادى الرش بحمض الاسكوربيك الى زيادة معنوية فى طول السيقان والوزن الطازج بينما لم يكن لحمض الاسكوربيك تاثير على التبكير فى ظهور الازهار المؤنثة او المحصول المبكر والكلى بينما ظهر تأثيره عند استخدام مخاليط الرش مع تركيزات الايثريل حيث ظهر من النتائج ان اضافة حمض الاسكوربيك مع معاملات الايثريل قد حسنت من النمو الخضرى للنباتات بالاضافة الى التبكير فى ظهور الازهار المؤنثه مما انعكس ذلك على الحصول على محصول مبكر وزيادة المحصول الكلى للنباتات وذلك بالمقارنة بالنباتات الغير معاملة.

كما اوضحت النتائج ان حمض الاسكوربيك قد ادى الى زيادة فى متوسط وزن الثمرة خاصة فى التركيز المرتفع بينما الايثريل ادى الى خفض متوسط وزن الثمرة وفى الخليط بينهما ، ادى التركيز المنخفض من حمض الاسكوربيك مع التركيز المنخفض الايثريل الى زيادة فى متوسط وزن الثمرة بينما التركيز العالى من حمض الاسكوربيك مع التركيز العالى من الايثريل ادى الى خفض متوسط وزن الثمرة وذلك بالمقارنة بالكنترول .

جميع معاملات حمض الاسكوربيك سواء منفردة او مع الايثريل ادت الى زيادة المحصول المبكر والكلى بالنسبة للفدان .

ادت جميع معاملات الرش بحمض الاسكوربيك الى زيادة المحتوى الهرمونى من الاندولات والجبرلينات وقلة محتوى حمض الابسيسك وذلك على عكس معاملات الايثريل مما انعكس ذلك على زيادة طول النبات والوزن الطازج والمحصول وصفاته .