EFFECT OF GROWTH REGULATORS AND FLOWER CLUSTER VIBRATION ON YIELD AND FRUIT QUALITY OF TOMATO UNDER PLASTIC GREENHOUSE CONDITIONS.

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تأثير منظمات النمو وكذلك هز العنقود الزهرى على المحصول وجودة الثمار فى الطماطم تحت ظروف الصوب البلاستيكية

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ملخص البحث

الصنف

عوملت نباتات الطماطم للنصف مانى ميكر بكل من حمض الجبرليك وذلك بثلاثة تركيزات هى ٢٥ ، ٥٠ أو ١٠٠ جزء فى المليون وبالنفثالين استيك أسيد بتركيزات ٥ ، ٢٥ أو ٥٠ جزء فى المليون وكذلك بخليط من المادتين بالثلاثة تركيزات المستخدمة ، وقد أضيفت هذه المنظمات اما رشا على العنقود الزهرى فقط أو بالرش على النبات كله . بالاضافة الى هذا فقد أجريت عملية هز يدوى للأزهار (العنقود الزهرى) . ربيت النباتات على فرع واحد ، كما بدأت المعاملات مع تفتح أزهار أول عنقود .

أسفرت عملية رش منظمات النمو على العنقود الزهرى فقط الى اعطاء محصول كلى وتسويقى أكثر وذلك عن طريق زيادة اما فى عدد الثمار أو فى زيادة وزن الثمرة أو لكلاهما علاوة على ذلك فقد أدى الرش على العنقود الزهرى الى تحسين تكوين البذور بالثمار ولكنه أدى الى انخفاض محتوى الثمار من كل من المواد الصلبة الذائبة الكلية وكذلك فيتامين جـ . وذلك بالمقارنة مع رش هذه المنظمات على النبات كله .

بالرغم من أن جميع المعاملات بمنظمات النمو أدت الى زيادة فى العدد الكلى للثمار الا أن المعاملة بالنفثالين استيك أسيد (بجميع التركيزات) وكذلك بخليط من حمض الجبرليك والنفثالين استيك أسيد بالتركيز المنخفض (٢٥ + ٥ جزء فى المليون) هى المعاملات الوحيدة التى أدت الى زيادة فى المحصول

الكلى والتسويقى بالمقارنة بالكنترول النى لم يعامل · وقد أعطت المعاملة بالنفثالين استيك أسيد بتركيز ٥٠ جزء فى المليون أعلى محصول بين هذه المعاملات بينما أسفر استخدام التركيزات ٥ ، ٢٥ جزء فى المليون من هذه المادة الى اعطاء أعلى عدد من الثمار · وقد كان الرش على العنقود الزهرى فقط أكثر تأثيرا عن الرش على النبات كله فى زيادة هذه القياسات · وبصفة عامة فقد أعطى الرش بمادة النفثالين استيك أسيد ثمار ذات جودة عالية باستثناء أنه يعمل على زيادة التجوف فى الثمار · وعلى العكس من ذلك فقد أدى الرش بحمض الجبرليك وكذلك بالتركيزات العالية من الخليط من هذه المادة مع النفثالين استيك أسيد الى خفض المحصول الكلى والتسويقى بصورة واضحة · كذلك أدت هذه المعاملات الى تقليل التجوف وتكوين البذور وكذلك قطر الثمرة الا أنها أدت الى زيادة فى سمك لحم الثمرة والذى بدوره أدى الى زيادة فى صلابتها ·

لم تعط المعاملة بهز العنقود الزهرى أى تأثير ايجابى واضح بمقارنتها بمعاملة الكنترول ·

ABSTRACT

Tomato plants of Moneymaker cv. grown in unheated plastic greenhouse were treated by GA_3 at concentrations 25, 50 or 100 p.p.m., NAA at 5, 25 or 50 p.p.m. or their combinations at the three concentrations. Growth regulators were applied either on the flower cluster only or on the whole plant. In addition, handly shaking of inflorescences (vibration treatment) was also applied. The plants were pruned to 1 branch, and the treatments were initiated at the anthesis of the first cluster.

Application of growth substances on the flower cluster gave higher total and marketable yield, by increase number of fruits and/or average fruit weight. Moreover, flower cluster application improved fruit seed incidence rate, but decreased fruit T.S.S. and vitamin C content, compared with whole plant application.

Although, all growth regulators treatments increased total number of fruits, NAA (at all concentrations) and GA_3 + NAA at 25 + 5 p.p.m. only produced significantly higher total and marketable yield than the nontreated control. NAA at 50 p.p.m. in particular gave the highest yield, whereas NAA at 5 and 25 p.p.m. produced the highest number of fruits, and the effect was more pronounced by

flower cluster application. NAA treatments, in general produced fruits with good quality, but it increased puffiness in fruits. In contrast, GA_3 treatments and their combiantion with NAA at high concentrations reduced total and marketable yield dramatically. Furthermore, GA_3 reduced the percentage of marketable yield to total yield, fruit puffiness, seed incidence rate, and fruit diameter, however it increased fruit flesh thickness which in turn increased fruit firmness.

No considerable effect for vibration treatment was found compared with the control.

INTRODUCTION

Polyethylene-covered tunnels and greenhouses are now used in Egypt for winter-grown tomatoes, usually without additional heating. Under these conditions the night temperature may fall below 10°C, approximately equalling the outside temperature. Day temperature, vary considerably throughout the winter growing season as a result of prevailing temperature, levels of radiation, type of covering, rate of ventilation, and other factors. In addition, low light intensity (specially in winter season) and relatively high humidity, are often expected under plastic.

Lack of tomato fruit set, which is common under these particular conditions, can be overcome by the use of growth regulators. This has been investigated in Egypt under unprotected conditions of winter season (Malash and Midan, 1985), but there are insufficient work on improving fruit set and yield by using growth regulators under plastic greenhouses conditions.

It had been found, that IAA and GA_3 improved tomato fruit set (Nair et al., 1975). Fruit size also was enhanced by growth substances application especially those belong to auxins, (Perez and Ramirez, 1980 and Kassler et al., 1981). Tomato total yield was also

found to increase as a result of IAA, NOA (Lipari, 1982), tomato set (Martinez and Gonzalez, 1979) and ujotin (Kassler et al.,1981) application on tomato plants grown under greenhouses, conditions. Furthermore, GA_3 as foliar application increased tomato fruit dry matter, sugar, organic acids and vitamin C, (Emmerikh, 1974). Simiraly, NAA was mentioned also to increase both T.S.S. and vitamin C content in tomato fruit (Pandita et al., 1976).

Likewise, vibration of the inflorescences was also found to improve fruit production considerably and also seed content in tomato (Maisonneuve, and Philouze, 1982).

The present experiment was carried out to study the effect of some growth substances at different concentrations, beside handly vibration of the inflorescences on the productivity and quality of tomato grown under polyethylene greenhouse conditions.

MATERIALS AND METHODS

This study was conducted during the winter seasons of 1985/86 and 1986/1987 under unheated plastic greenhouse (60 m. long, 8 m. wide and 3.15 m. height) at the Agricultural Experimental Station of Faculty of Agriculture, Minufiya University, Shebin El-Kom.

In both growing seasons, tomato (Lycopersicum esculentum, Mill) seeds of cv. Moneymaker (indeterminate) were sown in seed beds at 1st of October and transplanted 4 weeks later. Transplants were set at distances to allow to be 6.7 plants/m^2. i.e. 25 cm between plants and 60 cm. between rows. Cultural practices such as fertilization, irrigation and etc. were applied as commonly practiced under greenhouses conditions. Fertilization rate was 250 kg ammonium sulphate, 300 kg super-phosphate and 150 kg potassium sulphate/faddan. The plants were pruned to 1 branch; the usual practice in greenhouses.

At anthesis of the first cluster i.e. after about 40 days from transplanting, treatments of growth regulators application were started. Growth substances were applied either directly to flower cluster only, or to whole plant. Such treatments were applied for 5 times with 10-day intervals. Growth regulators treatments were as follows:-

1- Gibberelic acid; GA_3 (Berlex, Plant Protection Ltd., England) at concentrations of 25, 50 and 100 p.p.m.
2- Naphthaleneacetic acid; NAA (Eastman Organic Chemicals) at concentrations of 5, 25 and 50 p.p.m.
3- Combinations between gA_3 and NAA at three concentrations i.e. GA_3 + NAA at 25 + 5, GA_3 + NAA at 50 + 25 and GA_3 + NAA at 100 + 50 p.p.m.

In addition, other plants were sprayed with water on either flower clusters or whole plant and used as control.

Furthermore, hand shaking of the inflorescences (vibration) as a treatment was also involved in this study to form 11 treatments. Vibration process was carried out twice a week, beginning at the same time with growth regulators treatments.

A split-plot design with 3 replicates was used. Methods of application, (application on flower cluster or whole plants) and treatments were assigned, respectively, to the main and sub-plots. Each sub-plot occupied 4.50 m^2.

The following determinations were made:-

1- Total yield.
2- Total number of fruits.
3- Marketable yield: Unless those of small weight (cherry fruits) all other fruits harvested were free from disorders commonly found

in tomatos. So marketable yield was the weight of all fruits which weigh more than 25 g.

4- Number of fruits of marketable yield.

5- Average weight of marketable fruit.

6- Fruit diameter: In this character and the following characters 5-8 first grade, firm red fruits per experimental unit were used in studying each character.

7- Flesh thickness.

8- Fruit firmness as determined by the fruit and vegetable tester (John Chatillon and Sons Inc., U.S.A.) using gauge 516-500 MRPFR with a plunger diameter of 0.026 in. Each fruit was tested at 3 positions i.e. near the blossom end, at the shoulder and in the middle. Then, average values were claculated for each fruit.

9- Seed incidnece: was rated on a 1-9 scale; where 1 means that all seeds were aborted, and 9 means that all seeds were normally formed.

10- Puffiness: was calculated by measure the width (in cm.) of seperation between the pericarp from the endocarp, in about 3 positions, then average values were calculated for each fruit.

11- Total Soluble Solids (T.S.S.) content: using Abbe hand refractometer.

12- Vitamin C contnet: Determination was made using the 2,6 dichlorophenolindophenol dye (A.O.A.C., 1965) using oxalic acid as extractor.

13- Titratable acidity: Determination was made using 0.1 N NaOH solution and phenolphthalein as indicator (A.O.A.C., 1965).

RESULTS AND DISCUSSION

I. Yield and its components:

I.1. Total yield:

Results presented in Tables 1 and 3 show that application of growth regulators directly to the flower cluster increased total

Table (1): Effect of vibration and growth regulators treatments and methods of application on yield and its component in 1985/1986 season.

Characters / Variables	Total yield in Kg./m^2	Total No. of fruits/m^2	Marketable yield Kg./m^2	No of Marketable fruits/ m^2	Average Weight of Marketable fruit /g	% of Market. yield/ total yield	% of Market. fruit No./ total No. of fruits
GA 25	7.742	168.8	6.217	107.8	57.10	80.30	63.86
GA 50	8.440	158.3	6.974	99.9	70.25	82.60	63.11
GA 100	9.200	182.6	7.513	115.3	64.95	81.67	63.14
NAA 5	14.082	229.7	13.114	190.4	68.65	93.13	83.00
NAA 25	14.551	233.7	13.413	188.2	73.00	92.18	80.53
NAA 50	14.965	218.9	13.767	170.9	80.60	92.00	78.07
GA+NAA(25+5)	11.670	227.2	10.057	162.2	62.10	86.18	71.39
GA+NAA(50+25)	10.380	190.0	8.684	122.1	70.85	83.66	64.26
GA+NAA(100+50)	9.387	165.0	7.521	107.5	75.90	80.12	65.15
Vibration	10.109	143.4	9.539	120.7	79.40	94.36	84.17
Control Water	11.349	162.7	10.612	133.2	79.90	93.51	81.87
L.S.D. Values. at P.0.05	0.698	14.14	0.620	8.71	4.56	4.63	3.62
Spray on cluster	11.919	200.73	10.375	145.05	71.39	88.06	72.26
Spray on whole plant	10.11	169.31	9.154	127.4	70.91	89.54	75.07
L.S.D. Values at p.0.05	0.871	13.57	0.773	10.85	N.S.	N.S.	N.S.

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Table 3 : Effect of vibration and growth regulators treatments, and method of applications on yield and its component in 1986/1987 season.

Characters / Variables	Total yield in Kg./m ^{2}	Total No. of fruits/ m ^{2}	Marketable yield Kg./ m ^{2}	No of Marketable fruits/ m^2	Average weight of marketable fruit/g	% of Market. yield/ total yield	% of Market. fruit No./ total No. of fruits
GA 25	6.632	149.5	5.169	91.0	56.0	77.9	60.9
GA 50	7.301	139.4	5.942	90.4	66.5	81.4	64.8
GA 100	8.175	158.1	6.768	101.8	66.5	82.8	64.4
NAA 5	11.971	187.0	11.075	151.2	75.2	92.5	80.9
NAA 25	11.946	175.0	11.123	142.1	80.9	93.1	81.2
NAA 50	12.383	177.7	11.546	144.2	80.9	93.2	81.1
GA+NAA(25+5)	10.372	191.3	9.164	142.9	64.8	88.3	74.6
GA+NAA(50+25)	8.871	151.8	7.590	100.6	76.3	85.6	66.1
GA+NAA(100+50)	8.294	139.1	7.099	91.3	78.3	85.6	65.3
Vibration	9.962	134.9	9.371	110.2	58.0	94.1	81.7
Control water	9.700	136.8	9.105	113.0	80.5	93.9	82.6
L.S.D. values P.0.05	0.369	9.92	0.540	7.37	3.29	4.33	3.31
Spray on cluster	10.151	161.7	9.053	117.6	78.3	89.5	73.4
Spray on whole plant	9.040	154.8	8.028	114.9	69.2	89.1	74.7
L.S.D. values at P.0.05	0.444	N.S.	0.673	N.S.	6.00	N.S.	N.S.

Table 4 : Effect of the interaction between growth regulators treatments and methods of application, beside vibration treatment of yield and its components in 1986/1987 season.

Characters / Methods of applications (A) / Treatments (B)	.Total yield in Kg. / m^2		Total No. of fruits/m^2		Marketable yield in Kg. / m^2		No.of Market fruits/m^2		Average weight of margetable fruit/g	
	cluster only	whole plant	cluster only	whole plant	cluster only	whole plant	cluster only	whole plant	cluster only	whole plant
GA 25	7.866	5.398	144.3	154.8	6.648	3.690	95.6	86.4	70.67	41.4
GA 50	7.938	6.665	130.0	148.7	6.899	4.984	88.4	92.5	79.28	53.8
GA 100	8.549	7.801	161.7	154.5	7.075	6.461	102.7	100.9	69.4	63.5
NAA 5	12.331	11.610	184.5	189.6	11.388	10.762	146.7	155.7	81.2	69.3
NAA 25	12.505	11.387	189.8	160.3	11.640	10.606	155.2	129.1	78.9	83.0
NAA 50	13.021	11.746	183.6	171.9	11.983	11.110	142.0	146.5	86.1	75.7
GA+NAA(25+5)	10.445	10.299	184.9	197.6	9.139	9.189	132.7	153.2	69.6	60.1
GA+NAA(50+25)	9.899	7.843	173.7	129.9	8.308	6.871	110.1	91.1	76.4	76.3
GA+NAA(100+50)	9.102	7.487	149.4	128.9	7.723	6.476	94.2	88.4	83.6	73.1
Vibration	9.911	10.014	137.8	132.0	9.320	9.422	112.1	108.3	83.1	86.9
Control(Water)	10.104	9.296	139.9	134.2	9.468	8.743	113.9	112.1	83.1	78.0

	T.yield	T.No. fruits	Mark. yield	No. of Mark. fruits	Av. weight of Mark. fruit
L.S.D. values to compare two values of A at one or more level of B at P.0.05 :	0.542	14.74	0.801	10.92	5.5
L.S.D. values to compare two values of B at one level of A at P.0.05 :	0.522	14.07	0.764	10.38	4.6

yield of tomato significantly than application on whole plant, in both years of study.

The striking effect of growth substances applied on flower clusters in increase yield was due to increase number of fruits in part and/or to increase average fruit weight in the other, (Tables 1 and 3). These findings are in agreement with those reported by Lipari (1982) who stated that IAA and NOA (naphtoxyacetic acid) applied on flowers at anthesis gave the best yield when compared with treatment of whole plants.

Regardless, the effect of method of application, NAA at 50 p.p.m. gave significantly the highest yield (Tables 1 and 3). This treatment increased yield by about 31% and 27% than the un-treated control in the first and second seasons respectively.

General speaking, NAA treatments with all concentrations (5, 25 or 50 p.p.m.) gave the highest, yield. However, GA_3 treatments with all concentrations, in addition, to the combinations of GA_3 and NAA at 50 + 25 and 100 + 50 p.p.m. all reduced total yield compared with the nontreated control (Tables 1 and 3). Regarding vibration process, no pronounced differences between this treatment and the control was found in both years of study.

These results agreed with former reports (Kepcka, 1966; Martinez and Gonzalez, 1979; Kassler et al., 1981 and Lipari, 1982) regarding the favour effect of auxinic substances on tomato production under the greenhouse conditions. Similarly it had been also found that GA_3 application (at 20, 40 or 100 p.p.m.) on inflorescences of tomato in the glasshouse, reduced total yield compared with the control (Lilov and Donchev, 1984).

Tables 2 and 4 show clearly that applied each treatment of growth regulators directly to flower clusters increased yield than

when applied to whole plant, and the effect was more prnounced with NAA treatments.

It should be also emphasized that increasing IAA or GA_3 concentrations (applied individual) led to increase yields of tomato, whenever applied on clusters or whole plants. In contrast, medium and high concentrations of the combinations of GA_3 + NAA (i.e. 50 + 25 and 100 + 50 p.p.m.) reduced yield significantly not only than the low concentration (25 + 5 p.p.m.) but also than the nontreated control. That reduction was aggravated when treatments were applied on the whole plant (Tables 2 and 4).

Vibration process, in this study had no favour effect on tomato production. So this result was not in agreement of that of Maisonneuve and Philouze (1982) who reported that vibration of the inflorescences improved tomato fruit production considerably. In our opinion, the reduction in the efficacy of vibration process, in this study, could counteract by increase frequency of the process i.e. to carry out daily and not twice a weak as done here.

I.2. Total number of fruits:

Total number of fruits, which is an approximate determination of number fruit set, as influenced by growth regulators treatments and method of application are shown in Tables 1, 2, 3 and 4.

According to the data given in Tables 1 and 3, direct application of growth regulators on flower clusters resulted in produce higher number of fruits/m^2, than application on whole plant. However differences were significant only in the first season. In 1985/1986 season, the growth regulators were most effective in increasing fruit number (by improving fruit set) specially when applied to flower cluster than in 1986/1987 season. Besides, number of fruits set in the first season (as indicated by total number of fruits)

were generally higher than in the second season, this suggested that the effectiveness of growth regulators depend on the prevailing climatic factors in the greenhouse in addition to nutritional status and health of the growing plant, which are excepected to vary between seasons.

Data illustrated in Tables 1 and 3 show that both growth regulators at all concentrations and combinations (except GA_3 at 50 p.p.m. in the first season) increased total number of fruits/m^2 compared with the control, and regardless the effect of method of application. These findings are in agreement with those reported by Nair et al. (1975) who found that, IAA and GA_3 at different concentrations improved fruit set of 5 tomato cvs.

The NAA 25 p.p.m. treated plants produced the highest number of fruits in the first planting, followed by NAA at 5 p.p.m. and GA_3 + NAA at 25 + 5 p.p.m. In the second planting, treatment by GA_3 + NAA at 25 + 5 p.p.m. gave the highest number of fruits and followed by treatment with NAA at 5 p.p.m. (Tables 1 and 3).

With few exceptions, in the second season in particular, all treatments applied to the flower cluster were most effective in increasing total number of fruits than when applied to whole plant, (Tables 2 and 4).

Results presented in Tables 2 and 4 also show that, in both years of study, treatment with NAA at 25 p.p.m. produced the highest number of fruits/m^2 among those treatments which applied to the flower cluster. Corresponding value of whole plant treatment was obtained when GA_3 + NAA at 25 + 5 p.p.m. was used. These results suggested that auxinic substances at concentration of 25 p.p.m. directly added to flowers would be most effective in improving fruit set. GA_3 at concentrations used in this study had little effect on

fruit set than NAA. However, GA_3 at low concentration seems to take a part in fruit set process beside auxinic substances.

I.3. Marketable yield:

Harvested fruits in this experiment were actually free from common disorders and diseases of tomato fruits. Producing seedless small fruits (cherry size) was the only uncommercial character observed, so marketable fruit was that of more than 25 g. in weight. Data illustrated in Tables 1 and 3 show that applied growth substances to the flower cluster produced higher marketable yield than when applied to the whole plant. However, the percentages of marketable yield to total yield of both methods of applications were not significantly different, (Table 1 and 3). This result suggested that most fruits produced by flower cluster application were marketable.

Regardless the effect of methods of applications, NAA treatments at all concentrations particulary that at 50 p.p.m. gave the highest marketable yields, in both seasons. In general, GA_3 applied alone (at the three concentrations) or with NAA at the intermediate and high concentrations decreased the marketable yield significantly compared with the control, or vibration treatment. In virtually, the proportion of marketable yield to total yield decreased by growth regulators treatments especially those of GA_3. This proportion strikingly varied by the treatments, it was 93.9% (average of vibration + control), 92.4% (average of NAA treatments), 83.3% (average of the combinations) and 81.5% (average of GA_3 treatments) in the first year. Corresponding values, in the second year were 94.0%, 92.9%, 86.5% and 80.7%.

Results presented in Tables 2 and 4 show that NAA at 50 p.p.m. applied to the flower cluster gave the highest marketable yield, while GA_3 at 25 p.p.m. applied to the whole plant in contrast gave the lowest marketable yield among all treatments studied.

I.4. Number of Marketable fruits:

Higher number of marketable fruits was obtained as a result of growth regulators treatments to the flower cluster rather than treatments to the whole plant, however, differences were not significant in the second year (Table 1 and 3).

Regardless, the effect of method of application, the low concentration of NAA, i.e. 5 p.p.m. produced the highest number of marketable fruits, in both years of study. It should be emphasized that concentrations which produced the highest total number of fruits (as previously mentioned) were somewhat higher than those found to produce the highest number of marketable fruits, (Tables 1 and 3).

In general, only treatments with NAA at all concentrations beside GA_3 + NAA at 25 + 5 p.p.m. produced significantly higher number of marketable fruits than the nontreated control.

The ratio of marketable fruits to total number of fruits % as influenced by growth regulators and method of applications are shown in Tables 1 and 3. These results indicated that vibration treatment gave the lowest percentage of cull fruits i.e. 17.0% (as the average of the two seasons) followed by the control (17.8%). NAA treatments (average of the three concentrations) in addition, show a slight increase in cull fruit percentage to total number of fruits i.e. 19.2% (average of the two seasons). On the other hand, GA_3 treatments (average of the three concentrations) produced the highest percentage of cull fruits/total number of fruits i.e. 36.7% (average of the two seasons).

The effect of methods of application and treatments (interaction) on number of marketable fruits are given in Tables 2 and 4. The results show that NAA at 25 p.p.m. sprayed on flower cluster gave the highest number of marketable fruits among all treatments under study. In

contrast, GA_3 at 50 p.p.m. applied on whole plant gave the least number of marketable fruits.

I.5. Average weight of marketable fruit:

Data on average weight of marketable fruit as affected by growth regulators and vibration treatments were presented in Tables 1 and 3. The results show that NAA at 50 p.p.m., in the first season, and vibration treatments followed by NAA treatment at 50 p.p.m. in the second season, gave the highest weight of marketable tomato fruit.

GA_3 treatments (regardless concentrations) particulary those applied alone (not in combination with NAA) reduced fruit weight significantly comparing with the control. These results agreed with former report of Choudhury and Faruque (1973) regarding the reducing effect of GA_3 treatments on tomato fruit weight.

These results, suggest that growth substances treatments (even applied to flower cluster) could modify the distribution pattern of the assimilates within the plant.

Except with GA_3 treatments, it could be observed that weight of marketable fruit was negatively related to number of marketable fruits (Tables 1 and 3).

Applied, growth regulators on the inflorescence resulted in increase fruit weight rather than application on whole plant, but differences between the two methods of application regarding this character were not significant in the first season. The lack of significance in that season may return to the relatively high number of fruits produced (in this season in particular) by growth regulators application on the flower cluster than on whole plant (Tables 1 and 3).

Data on average weight of marketable fruit as influnced by both methods of application and treatments (interaction) are presented in Tables 2 and 4. Results indicated that increasing concentration of both growth regulators, and their combinations (with few expetions) increased fruit weight, when applied to flower cluster. A similar but more pronounced trend occurred when treatments were applied on whole plant.

2. Physical properties of fruits:

2.1. Flesh thickness:

Data illustrated in Table 5 show that flesh thickness of tomato fruit was not affected by both methods of application of growth regulators i.e. application on inflorescences or on whole plant.

Growth regulators treatments were most effective in altering fruit thickness. In both seasons of study, treatments by GA_3 at 100 p.p.m. followed by GA_3 + NAA at 50 + 25 p.p.m. gave fruits with significantly thickest flesh. It could be also observed (Table 5) that all growth regulators treatments increased (not in consistant trend) flesh thickness of fruits than those of vibration or control. These results suggested that growth regulators applied on inflorescences stimulated growth of ovary walls which in turn produced fruits with thick pericarp (fruit flesh).

Although differences in flesh thickness were not significant regarding the effect of method of application (Table 5), yet the tendency to produce fruits with thick flesh from treatments applied on flower cluster was more pronounced than that fruit produced from treatments applied on whole plant (Tables 6 and 7). This observation might support the pervious discussion of the stimulating effect of growth regulator on growth of ovary walls. So, GA_3 at 100 p.p.m., which is an effective growth promoters, when applied to the flower cluster gave the highest value of flesh thickness (Tables 6 and 7).

Table 5 : Effect of vibration and growth regulators treatments and methods of application on some physical properaties of fruit.

Characters / Variables	Flesh thickness cm		Fruit firmness (g/0.17 cm2)		Fruit puffiness cm		seed incidence rate		fruit diameter cm	
	1986	1987	1986	1987	1986	1987	1986	1987	1986	1987
GA 25	0.79	0.70	210.3	211.4	0.24	0.15	5.95	6.40	4.62	4.46
GA 50	0.68	0.75	202.8	234.9	0.35	0.24	5.60	5.90	4.65	4.72
GA 100	0.87	0.84	288.9	267.3	0.07	0.21	5.35	6.15	4.65	5.11
NAA 5	0.72	0.73	166.8	208.2	0.15	0.30	7.50	7.62	5.31	5.36
NAA 25	0.77	0.74	167.9	170.5	0.28	0.31	7.00	7.05	5.33	5.20
NAA 50	0.79	0.71	153.4	181.9	0.48	0.49	6.85	7.33	5.61	5.30
GA+NAA(25+5)	0.83	0.78	190.0	213.6	0.20	0.14	7.95	7.48	5.38	4.86
GA+NAA(50+25)	0.87	0.80	230.5	248.8	0.53	0.43	7.40	6.35	5.40	5.13
GA+NAA(100+50)	0.73	0.74	198.1	211.7	0.19	0.23	4.25	5.03	4.97	4.88
Vibration	0.66	0.66	143.6	186.7	0.24	0.21	8.65	8.67	5.20	5.13
Control (water)	0.67	0.67	143.3	188.2	0.25	0.22	8.80	8.40	5.15	4.95
L.S.D. at P.0.05	0.06	0.05	12.34	13.53	0.016	0.017	0.47	0.46	0.31	0.32
Spray on cluster	0.78	0.75	193.9	206.8	0.28	0.26	7.38	6.95	5.27	5.15
Spray on whole plant	0.74	0.72	187.0	215.6	0.27	0.27	6.30	6.67	4.96	4.87
L.S.D.at P.0.05	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	0.60	N.S.	N.S.	N.S.

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Table 6 : Effect of the interaction between growth regulators treatments and methods of application, beside vibration treatment on some physical propereties of fruit in 1985/1986 season.

Characters / Methods of application (A) / Treatments (B)	Flesh thickness cm		Fruit firmness (g/ 0.17 cm²)		Fruit puffiness cm		seed incidence rate		Fruit diameter cm	
	cluster only	whole plant	cluster only	whole plant	cluster only	whole plant	cluster only	whole plant	cluster only	whole plant
GA 25	0.79	0.80	218.7	202.0	0.28	0.20	5.6	6.3	5.31	3.94
GA 50	0.73	0.64	173.7	232.0	0.47	0.23	7.9	3.3	5.04	4.25
GA 100	1.00	0.75	289.8	288.0	0.10	0.05	6.7	4.0	4.64	4.66
NAA 5	0.73	0.72	200.6	133.0	0.13	0.18	7.7	7.3	5.39	5.24
NAA 25	0.79	0.75	174.8	161.0	0.27	0.30	8.2	5.7	5.48	5.18
NAA 50	0.80	0.77	159.8	152.0	0.46	0.50	8.4	5.3	5.71	5.50
GA+NAA(25+ 5)	0.84	0.82	208.4	171.7	0.20	0.20	8.2	7.7	5.50	5.26
GA+NAA(50+25)	0.87	0.87	234.4	226.7	0.44	0.63	6.3	8.5	5.61	5.20
GA+NAA(100+50)	0.74	0.72	192.0	204.2	0.23	0.15	4.8	3.7	4.97	4.97
Vibration	0.65	0.67	146.3	141.0	0.24	0.24	8.6	8.7	5.19	5.21
Control(Water)	0.67	0.67	140.6	146.0	0.26	0.24	8.8	8.8	5.14	5.17

	Thick.	Firm.	Puff.	Seed incid.	Diam.
L.S.D. values to compare two values of A at one or more level of B at P. 0.05 :	0.05	18.32	0.024	0.69	0.46
L.S.D. values to compare two values of B at one level of P. 0.05 :	0.047	17.47	0.023	0.67	0.44

Table 7 : Effect of interaction between growth regulators treatments and methods of application, beside vibration treatment on some physical properties of fruit, in 1986/1987 season.

Characters / Methods of applications (A) / Treatments (B)	Flesh thickness cm		Fruit firmness (g/0.17 cm 2)		Fruit puffiness cm		Seed incidence rate		Fruit diameter cm	
	cluster only	whole plant	cluster only	whole plant	cluster only	whole plant	cluster only	whole plant	cluster only	whole plant
GA 25	0.76	0.64	232.1	190.7	0.16	0.14	6.53	6.27	5.12	3.80
GA 50	0.81	0.69	198.6	271.2	0.40	0.08	6.30	5.40	5.12	4.32
GA 100	0.87	0.81	256.8	277.9	0.12	0.29	6.13	6.17	5.08	5.13
NAA 5	0.73	0.73	194.2	222.1	0.24	0.36	7.47	7.77	5.44	5.29
NAA 25	0.76	0.72	170.7	170.3	0.37	0.25	7.87	6.23	5.35	5.05
NAA 50	0.72	0.70	185.3	178.4	0.37	0.61	6.70	5.10	5.40	5.20
GA+NAA(25+5)	0.78	0.78	225.5	201.7	0.17	0.10	7.40	7.57	4.97	4.75
GA+NAA(50+25)	0.81	0.80	239.6	257.9	0.35	0.52	6.20	6.5	5.33	4.94
GA+NAA(100+50)	0.72	0.76	199.7	223.7	0.22	0.24	5.5	4.57	4.88	4.88
Vibeation	0.65	0.67	186.4	187.0	0.22	0.20	8.43	8.90	5.12	5.14
Control(Water)	0.68	0.67	186.1	190.3	0.22	0.21	7.93	8.87	4.84	5.06

	Thickness	Firm.	Puff.	Seed incid.	Diam.
L.S.D. values to compare two values of A at one or more level of B at P. 0.05 :	0.063	20.10	0.025	0.68	0.47
L.S.D. values to compare two values of B at one level of A at P. 0.05 :	0.060	19.16	0.024	0.65	0.45

2.2. Fruit firmness:

According to the data given in Table (5), fruit firmness did not respond to methods of growth regulators application. In other words, differences in firmness between fruits produced by growth regulators applied on flower cluster or whole plant were not significant.

On the other hand, growth regulators treatments with their concentrations and combinations in both seasons (with two exceptions) resulted in produce firm fruits comparing with those produced by non-growth regulator treated plants (vibration and control). The only exceptions were the treatments of NAA at 25 and 50 p.p.m. in the second season (Table 5).

In general, GA_3 treatments either alone or in combinations with NAA gave firmer fruits comparing with other treatments. So, GA_3 treatments at 100 p.p.m. gave the highest value of fruit firmness in both seasons (Table 5).

A similar situation was observed regarding the effect of growth substances on flesh thickness (Table 5). This suggests that the increase of fruit firmness by growth regulators treatments, in general, and by GA_3 at 100 p.p.m. in particular was due to the stimulation effect of these treatments on flesh thickness. The correlation coefficient between fruit firmness and flesh thickness as affected by growth regulators (regardless method of application) was significant ($r = 0.723$) in the first season and ($r = 0.614$) in the second. Similarly the correlation between fruit firmness and flesh thickness was also found eleswhere (Videki and Vukovits, 1969).

2.3. Fruit Puffiness:

The effect of growth regulators treatments and method of application on fruit puffiness (as determined by measuring the width of

the separation of the pericarp from the endicarp in cm.) is shown in Table (5). The results indicated that no significant differences were found in fruit puffiness between methods of application of the growth regulators.

Growth regulators treatments (regardless method of application) were more effective in alteration this character in tomato fruit. Treatments with NAA at 50 p.p.m. and GA_3 + NAA at 50 + 25 p.p.m. gave the most puffy fruits, in the two seasons of study (Table 5). No consistant trend was detected with other treatments and in the two seasons. Similar results were obtained by Kassler et al. (1981) who reported that using of Ujotin (a growth substance, based on napthoxy-acetic acid) resulted in produce some hollow fruits in tomato.

It should be emphasized, that the treatments which increase fruit diameter (Table 5) were the same treatments which gave the most inhanced fruit growth (increase fruit diameter) predisposed puffiness in fruits. Significant positive correlation was then expected between fruit diameter and fruit puffiness; r were 0.567 and 0.628 in the first and second seasons, respectively.

Results of this study revealed no correlation (correlation coefficient was not significant) between fruit puffiness and seed incidence r were 0.189 and 0.029 in first and second seasons respectively. This result was not in agreement with that of Rylski (1979) who reported that fruit puffiness was particularly related to lack of fertilization in tomato fruit.

Results of interactions obtained in Tables 6 and 7 show that the most puffy fruits were produced by whole plant application of GA_3 + NAA at 50 + 25 p.p.m. and by NAA at 50 p.p.m. in the first and second seasons respectively. These both particular treatments increased also fruit puffiness when applied on flower cluster, but

their effectiveness were more pronounced when applied on whole plant. Furthermore, treatment with GA_3 at 50 p.p.m. in both seasons gave the most puffy fruits among all other treatments applied to the flower cluster (Tables 6 and 7).

2.4. Seed incidence rate in fruit:

Table (5) represents the effect of growth regulators treatments and methods of application on seed incidence rate which was determined by the degree of seed formation. The rating was from 1 to 9, where 1 means that all seeds were aborted, where 9 means that all seeds were normally formed. The results indicated that growth regulators applied to the flower cluster improved seed incidence rate than when applied to the whole plant. However, differences between the two methods of applications, regarding this character, were not significant in the second season. These results may suggest that direct application of growth regulators on the inflorescences increase the opportunity for fertilization.

In general, all growth regulators treatments reduced seed incidence rate in fruits compared with control and vibration treatment. The most reduction, in this character, occurred with GA_3 treatments at all concentrations and when combined with NAA particularly at high concentrations. Somewhat similar results are obtained by Monteiro (1982) who reported that auxin treatment produced fruits with aborted seeds. Moreover, Choudhury and Faruque (1973) indicated that the percentage of seedless fruits rose with increasing concentration of parachlorophenoxyacetic acid or GA_3, treatments (concentration were 50-100 p.p.m. for both substances).

Results of this character indicated that treatments resulted in reduced seed incidence rate were the same treatment which increased flesh thickness in fruit (Table 5). A negative significant correlation was then found ($r = -0.563$ and -0.661 in the first and second

seasons respectively) between seed incidence rate and flesh thickness (regardless method of application).

The effect of growth regulators (treatments applied either to the flower cluster or whole plant (interaction) is shown in Tables 6 and 7. These results indicate that treatments with growth regulators reduced seed incidence in fruit and the effect was more pronounced when applied to the whole plant. So, whole plant application of both GA_3 at 50 p.p.m. and GA_3 + NAA at 100 + 50 p.p.m. gave the lowest seed incidence rate in the first and second seasons, respectively. On the other hand, NAA treatments at 50 and 25 p.p.m., in the first season, and NAA at 25 p.p.m., in the second season, applied on flower cluster, produced high rate of seed incidence which were not significantly different from those of control or vibration treatments.

2.5. Fruit diameter:

Although there are some tendency to produce fruits with larger diameter by applying growth regulator on flower cluster than whole plant application, the differences between the two methods were not significant, in the both years of study (Table 5).

NAA treatments, in general, produced the larger fruit diameter. In contrast, GA_3 treatments, besides its combination with NAA at highest concentration reduced fruit diameter, comparing with the control in both seasons. Similarly, Monteiro (1982) found that auxin treatment produced mainly big fruits.

Results shown in Tables 6 and 7 indicated that the highest value of fruit diameter was obtained by NAA treatments at 50 p.p.m., in the first season, and at 25 p.p.m., in the second one but the effect of both treatments was more pronounced when applied to flower cluster

than when applied to the whole plant. On the other hand, GA_3 treatment at 25 p.p.m. on whole plant produced the smallest fruit diameter in both years of study.

3. Chemical properties of fruits:

3.1. Total soluble solids (T.S.S.) content:

Although differences between the two methods of application, regarding T.S.S. content, were significant only in the second season, (Table 8), the favour effect of whole plant application on content of T.S.S. was expected. The reason of this finding would return, in part, to the stimulation effect of these growth regulators in increasing assimilation area, when applied to the whole plant, which in turn increase the amount of the assimilates moved to fruits. In addition, highest number of fruits produced by flower cluster application (as mentioned before) increased the competition of fruits on the assimilates and then decreased nutrient substances devoted to each fruit.

Generally, all growth regulators treatments (with very few exceptions) increased fruit T.S.S. than that of control and vibration treatment. Somewhat, similar results were obtained by Kepcka (1966) who reported that fruit set by artificial pollination (vibration) had a lower dry matter content than set by auxin sprays.

Data in Table (8) show that GA_3 treatments (regardless concentrations and methods of applications) produced fruits with higher T.S.S. content than those produced by NAA treatments. However, the highest value of T.S.S. content was produced by treatment with GA_3 + NAA at 50 + 25 p.p.m., in both seasons of study. The favoured effect of GA_3 treatments on T.S.S. content was also found elsewhere (Sinnadurai and Amuti, 1973).

Table 8 : Effect of vibration and growth regulators treatments and methods of application on some chemical properties of fruit .

Character	T.S.S. Content %		Titra. Acidity content %		Vit. C content (mg/100 g. fruit)	
Variables	1986	1987	1986	1987	1986	1987
GA 25	4.25	5.19	0.94	1.15	17.91	21.87
GA 50	4.35	5.53	0,96	1.17	17.57	21.35
GA 100	4.45	4.76	1.10	1.20	18.56	20.31
NAA 5	4.20	5.37	1.38	1.67	16.30	20.84
NAA 25	4.40	5.07	1.20	1.32	15.87	17.93
NAA 50	4.03	5.18	1.23	1.61	20.36	25.04
GA + NAA 25 + 5	4.05	5.30	1.46	1.87	16.18	21.17
GA + NAA 50 + 25	4.45	5.73	1.05	1.45	17.81	23.89
GA + NAA 100 + 50	4.40	5.31	1.37	1.56	21.99	25.55
Vibration	4.10	4.78	1.22	1.37	15.65	18.39
Control (Water)	4.00	4.84	1.19	1.37	16.13	19.52
L.S.D. at 0.05	0.32	0.33	0.06	0.07	2.02	2.04
Spray on cluster	4.25	4.97	1.19	1.43	15.07	18.30
Spray on whole plant	4.31	5.41	1.20	1.43	20.27	24.58
L.S.D. at 0.05	N.S.	0.42	N.S.	N.S.	2.11	2.13

Tables 9 and 10 represent the effect of growth regulators applied either to flower cluster or whole plant on fruit T.S.S. Again, growth regulators treatments produce fruits with high T.S.S. content than the non-growth regulators treatments i.e. control and vibration. The effect of these growth regulators treatments was more pronounced when applied to whole plant. The reason of this result was previously explained. So the reason of increase T.S.S. content by growth regulator applied directly on the inflorescence (in most treatments) could be explained by findings of Kinet et al. (1978) who reported that benzyl-adenine and GA_3 applied to flower cluster modified the distribution pattern of the assimilates within the plant; the inflorescence being favoured at the expense of young leaves above.

The highest value of T.S.S. content obtained in this study was when GA_3 at 50 p.p.m. applied to whole plant (Tables 9 and 10).

3.2. Titratable acidity content:

No significant differences, in titratable acidity, were found, due to method of growth regulators application (Table 8).

The highest and next highest fruit acidity (in both seasons) was observed in plants treated with GA_3 + NAA at 25 + 5 p.p.m. and NAA at 25 p.p.m., respectively (Table 8). Data in the same Table clearly show that GA_3 treatments (alone) particularly at 25 p.p.m. reduced fruit acidity dramatically comparing with control. Somewhat similar results were found by Pandita et al. (1976) who stated that GA_3 treatment at 50 p.p.m. reduced tomato fruit acidity whereas NAA at 100 p.p.m. gave the highest content.

Among treatments applied to flower cluster NAA at 5 p.p.m. produced the highest fruit acidity. Meanwhile, treatment with GA_3 + NAA at 25 + 5 p.p.m. gave the most acid fruit among those applied on whole plant, in both seasons of study (Tables 9 and 10).

Table 9 : Effect of the interaction between growth regulators treatments and methods of application, beside vibration treatment on some chemical propereties of fruit, in 1985 / 1986 season.

Character / Methods of applic.(A) / Treatments (B)	T.S.S. content %		Titra. Acidity content %		Vit. C content (mg/100 g. fruit)	
	Cluster only	Whole plant	Cluster only	Whole plant	Cluster only	Whole plant
GA 25	4.30	4.00	0.90	0.99	13.90	21.92
GA 50	4.30	5.40	0.93	1.00	14.98	20.16
GA 100	4.30	4.60	1.02	1.18	14.29	22.83
NAA 5	4.20	4.20	1.55	1.22	15.26	17.34
NAA 25	4.40	4.40	1.19	1.21	13.95	17.79
NAA 50	4.07	4.00	1.22	1.24	13.64	27.09
GA + NAA 25 + 5	4.10	4.00	1.42	1.51	15.24	17.12
GA + NAA 50 + 25	4.30	4.60	1.08	1.02	14.70	20.92
GA + NAA 100 + 50	4.60	4.20	1.39	1.35	17.99	26.00
Vibration	4.20	4.00	1.22	1.23	15.65	15.65
Control (Water)	4.00	4.00	1.17	1.21	16.13	16.13

	T.S.S.	acidity	Vit.C
L.S.D. values to compare two values of A at one or more level of B at p. 0.05	0.34	0.08	3.46
L.S.D. values to compare two values of B at one level of A at p. 0.05 :	0.32	0.07	3.25

Table 10 : Effect of the interaction between growth regulators treatments and methods of application, beside vibration treatment on some chemical properties of fruit, in 1986 / 1987 season.

Character / Methods of applic.(A) / Treatments (B)	T.S.S. content %		Titra. Acidity content %		Vit. C content (mg/100 g. fruit)	
	Clester only	Whole plant	Clester only	Whole plant	Cluster only	Whole plant
GA 25	4.79	5.60	1.10	1.21	16.97	26.77
GA 50	4.72	6.33	1.13	1.22	18.20	24.50
GA 100	4.59	4.93	1.11	1.29	15.64	24.98
NAA 5	5.35	5.40	1.87	1.48	19.51	22.17
NAA 25	4.87	5.27	1.31	1.33	15.76	20.10
NAA 50	4.89	5.47	1.60	1.62	16.77	33.32
GA + NAA 25 + 5	5.33	5.27	1.82	1.93	19.94	22.40
GA + NAA 50 + 25	5.47	6.00	1.49	1.41	19.72	28.06
GA + NAA 100 + 50	5.09	5.55	1.58	1.54	20.90	30.21
Vibration	4.73	4.84	1.37	1.38	18.39	18.39
Control (Water)	4.89	4.80	1.38	1.37	19.52	19.52

	T.S.S.	Acidity	Vit. C
L.S.D. values to compare two values of A at one or more level of B at p. 0.05	0.49	0.09	3.68
L.S.D. values to compare two values of B at one level of A at p. 0.05	0.47	0.08	3.50

3.3. Vitamin C content:

Results in Table (8) indicate that applied growth regulators on whole plant increased vitamin C content in fruit than when applied on flower cluster.

Moreover, regardless the effect of method of application all growth regulators treatments (except one in both seasons of study) increased vitamin C content comparing with the non-growth regulators treatments i.e. control and vibration. Treatments with GA_3 + NAA at 100 + 50 p.p.m. followed by NAA at 50 p.p.m. gave the highest vitamin C content in the two seasons (Table 8). These results were in agreement with those of Emmerikh (1974) and Pandita et al. (1976) who reported, respectively, that GA_3 at 0.005% and NAA at 50 p.p.m. increased vitamin C content in tomato fruit.

Data illustrated in Tables 10 and 11 show the effect of growth regulators applied either on whole plant or on flower cluster. The highest vitamin C content obtained in this study was in fruits from plants treated with NAA at 50 p.p.m. as whole plant application.

Since, vitamin C is build up (in the fruit) by the monosaccharides particularly glucose, so increasing amount of assimilates (which are mainly monosaccharides) devoted to fruits would increase vitamin C content. The growth regulators used in this study are well known as growth promoters, which would aggravate assimilation area (especially when applied to whole plant) which in turn provide fruits with more assimilates. This discussion could explain how growth regulators increase vitamin C content particularly when applied on whole plant.

REFERENCES

Association of Official Agricultural Chemists (1965). Official methods of analysis, 10th A.O.A.C., Washington; D.C.

Choudhury, S.H.; and A.H.M. Faruque (1973). Effect of PCA and GA3 on seedlessness of tomato. Bangladesh Horticulture 1(1): 13-16. (C.F. Hort. Abstr. Vol. 44:6785, 1974).

Emmerikh, F.D. (1974). Treatment of tomato transplants with gibberellin. Agrokhimiya No. 1, 122-126. (C.F. Hort. Abstr. Vol. 45:7512, 1975).

Kassler, D.; J. Lanckow; and G. Baars (1981). Yield increases of greenhouse tomatoes with the use of Ujotin. Gartenbau 28(11):324-326. (C.F. Hort. Abstr. Vol. 52:3014, 1982).

Kepcka, A.K. (1966). The use of auxin sprays or artificial pollination in order to improve fruit-setting of tomatoes grown under glass. Acta Hort., Int. Soc. Hort. Sci. No. 4, pp 55-62. (C.F. Hort. Abstr. Vol. 37:5182, 1967).

Kinet, J.M.; D. Hurdebise; A. Parmentier and R. Stainier (1978). Promotion of inflorescence development by growth substance treatments on tomato plants grown in insufficient light conditions. J. Amer. Soc. Hort. Sci. 103(6):724-729.

Lilov, D. and T. Donchev (1984). Effect of a Bulgarian gibberellin preparatiion on tomato fruting. Gardinarska i Lozarska Nauka 21(2):49-55. (C.F. Hort. Abstr. Vol. 54:6265,1984).

Lipari, V. (1982). Results of studies on methods of applying fruit-setting growth regulators to tomatoes in protected cultivation. Rivista della Ortoflorofrutticoltura Italiana 66(1):59-73. (C.F. Hort. Abstr. Vol. 53:387, 1983).

Maisonneuve, B; and J. Philouze (1982). Effect of low night temperatures on a varietal collection of tomato (Lycopersicon esculentum). I- Study of fruit production and pollen fertility. Agronomie 2(5):443-452. (C.F. Hort. Abstr. Vol. 52:6136, 1982).

Malash; N.M.; and A.A. Midan (1985). Effects of some growth regulators on behaviour of tomato plants grown under cold conditions. Zagazig Jour. Agric. Res. 12(1):61-92.

Martinez, P.F. and A. Gonzalez (1979). Study on ways of improving fruit set in greenhouse tomatoes. Anales del Instituto Nacional de Investigaciones Agrarias, Produccion Vegetal No. 11, 159-170. (C.F. Hort. Abstr. Vol. 51: 4676, 1981).

Monteiro, A.A. (1982). The fruit growth in the tomato (Lycopersicon esculentum Mill.) in relation to methods of improving fruit-setting. XXI 1st Inter. Hort. Cong. Hamburg, German Fedral Republic; Inter. Soc. Hort. Sci. Vol. 1 Abst. No. 1506. (C.F. Hort. Abstr. Vol. 52:8044, 1982).

Nair, P.M.; N. Mohanakumaran and V.R. Nair (1975). Effect of growth regulators on the yield of tomatoes. Agric. Res. Jour. of Kerala 12(1):78-79. (C.F. Hort. Abstr. Vol. 46: 8508, 1976).

Pandita, M.L.; S.K. Arora; and K. Singh (1976). Effect of plant regulators on the chemical composition of tomato (Lycopersicon esculentum Mill.) var. HS-101. Haryana Jour. Hort. Sci. 5(1/2):65-72. (C.F. Hort. Abstr. Vol. 48:2466, 1978).

Perez, Z.M.; and G.O. Ramirez (1980). Effect of season and growth regulators on flowering, fruit set and development of the tomato. Jour. Agric. Univer. of Puerto Rico 64(4): 360-374. (C.F. Hort. Abstr. Vol. 51:4677, 1981).

Rylski, I. (1979). Fruit set and development of seeded and seedless tomato fruits under diverse regimes of temperature and pollination. J. Amer. Soc. Hort. Sci. 104(6):835-838.

Sinnadurai, S. and K. Amuti (1973). The effect of CCC and gibberellic acid on total soluble solids content and reducing sugar of tomato fruit. Ghana Jour. Agric. Sci. 6(1): 63-65. (C.F. Hort. Abstr. Vol. 44:3326, 1974).

Videki, L.; and L. Vukovits (1969). Studies on factors affecting firmness in tomatoes. Zoldsegtermesztes, 3:3-19. (C.F. Hort. Abstr. Vol. 40:8630, 1970).