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STUDIES ON SOME MATERIALS FOR IMPROVING FRUIT SET AND QUALITY OF SWEET PEPPER GROWN UNDER HIGH TEMPERATURE

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ABSTRACT

This investigation was carried out during the two successive summer seasons of 2005 and 2006 on sweet pepper cv. Marconi, to study the effect of spraying with some growth regulators (10 ppm GA_3 and 10 ppm NAA) and 200 ppm Zn as well as different combination treatments among them at flowers initiation on growth, fruit physical characters, yield and some chemical constituents of fruits.

Spraying plants grown under high temperature with 10 ppm GA_3, 10 ppm NAA, 200 ppm Zn or different combination treatments between them led to improving plant growth (plant height, number of branches and leaves/plant, fresh and dry weight/plant and leaf area), fruit length and diameter, number and weight of fruits/plant, early and total yield and chemical constituents (NPK, total chlorophyll, vitamin C, total soluble solids and zinc) as compared to control (water spray).

In general, the best treatment for increased vegetative growth, fruit physical characters, yield and chemical constituents in fruits was sprayed plant at flowers initiation with 10 ppm GA_3 + 10 ppm NAA+ 200 ppm Zn as compared to other treatments.

INTRODUCTION

Sweet pepper (*Capsicum annuum* L.) is cultivated both in summer and winter seasons in ‘‘partially climate control’’ glasshouses. But unsuitable environmental conditions (temperature, light, humidity and nutrition) resulted in unacceptable fruit and may cause decreasing in both fruit set and quality, especially hot months.

Under high temperature conditions, pepper plants produced small and unacceptable fruit, and also increasing drop flowers and new setting. Which reflect in productivity and marketable yield, so the price of yield is very high in this days.

Spraying plants at flower bud initiation with NAA reduced flowers drop, improved growth, fruit setting, increased fruit size, high fruit yields and promoted the accumulation of ascorbic acid in fruits (Singh *et al.*, 1994; Singh and Lal, 1995, Belakbir *et al.*, 1998 and Sharma *et al.*, 1999) on pepper.

The effects of GA_3 on growth, yield and chemical constituents were studied by many investigators. It was reported that the number of flowers and fruits/plant were reduced by increasing GA_3 concentration. Fruit set was greatest at 15 ppm and the fruit weight/plant was greatest at 5 ppm (El-Asdoudi, 1993).

Zinc foliar application improved plant growth and dry weight (Agwah and Mahmoud, 1994; Bose and Tripathi, 1996 on tomato) and increased leaves contents of chlorophyll and NPK (Gabal, 1984). In addition, Agwah and Mahmoud (1994), on tomato plants, found that spraying plants with Zn

solution significantly increased fruit setting and early and total yield. Gabal (1984) reported that Vit. C and TSS were increased by spraying tomato plants with Zn.

In general, treating pepper plants with NAA and GA_3 showed encouraging effects on the retention of flowers, fruit setting and increased fruit weight (Barai and Sarkar, 1999) and Sharma *et al.*, (1992)on eggplant, found that yield significantly increased with whole plant sprayed of 50 ppm NAA or seed treatment with 10 ppm GA3.

This work aimed to study the effect of some materials which will be considered improving fruit set and quality in high temperature months (June, July and august), to useful the high price of yield in this days and reach the best benefit of sowing pepper.

MATERIALS AND METHODS

Two field experiments were carried out during the two successive seasons of 2005 and 2006 at the Experimental Farm of Qaha Station, Qalubia Governorate, to study the response of sweet pepper cv. Marconi growth, yield and its components, fruit characters and fruit chemical constituents to some growth regulators (GA_3 and NAA), Zn and different combination treatments among them. The experimental soil was clay in texture with 7.5 pH, 1.23 % organic matter, 115 ppm N, 52 ppm P and 103 ppm K.

Meteorological data of the area were recorded during the growth seasons (Table 1).

Table 1: Local meteorological data at Qaha region.

Season Characters Month	2005				2006			
	Air tem. max. (°C)	Air temp. min. (°C)	RH max. (%)	RH min. (%)	Air tem. max. (°C)	Air temp. min. (°C)	RH max. (%)	RH min. (%)
May	32.91	15.61	81.94	24.36	31.59	14.81	83.13	21.67
June	33.45	20.51	81.73	28.55	33.33	19.99	83.47	23.73
July	34.62	23.82	81.58	30.80	35.99	20.79	84.06	26.14
Aug.	34.79	25.27	82.10	34.04	36.86	17.52	83.68	25.16

*** Meteorological Central Laboratory, Ministry of Agriculture**

This experiment included 8 treatments as follows:

1- Control (sprayed with water)
2- GA_3
3- NAA
4- Zn
5- GA_3 + NAA
6- GA_3+ Zn
7- NAA+ Zn
8- GA_3 + NAA +Zn

Plants were sprayed three times with aqueous solutions of GA_3 at 10 ppm, NAA at 10 ppm, Zn at 200 ppm or different combination treatments among them. The first spray was conducted at flowers initiation (40 days after transplanting), whereas the second and third spray were preformed later 15 days intervals.

These treatments were arranged in a complete randomized block design with three replications. The experimental unit area was 21 m^2 (4.2 x 5 m) and each unit contained six rows with 5 m length for each and 70 cm width of them, four inner rows were possessed for yield determination, whereas the two outer rows were for determination of plant growth characters. Seeds were sown in speedling trays on March 27th and 25th of and transplanted on May 1st and 3rd in 2005 and 2006 seasons, respectively.

Data recorded

A. Plant Growth

A random sample of six plants from each plot was taken at flowering stage and the following data were recorded: plant height (cm), number of leaves/plant, number of branches/plant, leaf area (cm^2),

Fresh and dry weight of whole plant (gm):

A random sample of other six plants from each plot was taken and the fresh weight of whole plant was determined, then dried at 70^0 C till constant weight and the dry weight of whole plant was determined.

B. Fruit Yield and Quality:

Mature fruits were continuously harvested when reached suitable maturity stages. The following data were recorded:

1- Fruit physical quality; i.e., fruit length (cm), fruit diameter (cm) and wall thickness (mm)

2- Number of fruits/plant = $\frac{\text{Total number of fruits /plot}}{\text{Number of plants/plot}}$

3-Fruit yield/plant (gm) = $\frac{\text{Total weight of fruits /plot}}{\text{Number of plants/plot}}$

2- Early yield (ton/fed) (the sum of first and second pickings)

3- Total yield (ton/fed)

Total fruit yield (tons/fed) was calculated on the base of total yield along harvesting stages by summing (the sum of all harvests).

C. Chemical Constituents

1- Photosynthetic pigments

Total chlorophyll content was determined in sample taken randomly from the fourth upper leaf according to methods of Wettstein (1957)

2- Minerals contents (NPK)

Dried fruits were finely ground separately and digested with sulfuric acid and percholoric acid (3:1) and nitrogen, phosphorus and potassium were determined according to the method described by Bremner and Mulvaney (1982), Olsen and Sommers (1982) and Jackson (1970), respectively.

3-Total soluble solids

A random sample of six fruits from the third picking were blended, filtrated throughout muslin cloth and then throughout filter paper No. 1, the

total soluble solids (TSS) were finally determined in filtrated by Carlzies refractometer.

4-Vitamin C content was assayed in fruits using 2,6-dichlorophenol indophenol dye (A.O.A.C.,1980).

5- Zn content was determined in dried fruits according to method (A.O.A.C.,1980).

Statistical analysis

The obtained data were subjected to statistical analysis according to the method described by Steel and Torrie (1980)

RESULTS AND DISCUSSION

1- Vegetative Growth

Results given in Table 2 show the effect of spraying plants with 10 ppm GA_3, 10 ppm NAA, 200 ppm Zn and different combination treatments among them as well as water spray (control) on growth aspects (plant height, number of branches and leaves/plant and fresh and dry weight/plant). It is obvious that vegetative growth was promoted with all spraying materials as compared to control.

Table 2: Effect of some growth regulators and Zn on vegetative growth of sweet pepper

Characters / Treatments	Plant height (cm)	No. of branches /plant	No. of leaves /plant	Fresh weight /plant (gm)	Dry weight /plant (gm)	Leaf area (cm^2)
2005						
Control	45.80	8.67	69.67	168.33	25.03	42.68
GA_3	57.60	15.33	137.67	288.00	51.17	45.71
NAA	56.18	13.33	102.67	246.33	45.77	54.24
Zn	53.80	13.00	105.00	282.33	50.80	42.93
GA_3+ NAA	60.40	15.67	155.00	370.00	54.90	53.31
GA_3+ Zn	58.87	15.00	145.33	356.33	56.53	51.48
NAA+ Zn	57.67	15.33	110.33	266.67	48.27	56.29
GA_3 + NAA +Zn	62.48	16.00	244.33	389.00	50.60	62.18
$LSD_{0.05}$	2.32	1.64	21.10	28.08	4.47	7.71
2006						
Control	46.64	9.67	74.67	175.67	24.40	45.34
GA_3	60.27	15.33	108.67	289.33	50.43	49.71
NAA	56.61	13.67	95.33	269.67	46.53	57.49
Zn	51.33	13.67	96.67	294.67	50.27	47.14
GA_3+ NAA	64.26	16.33	152.67	391.33	55.10	55.18
GA_3+ Zn	59.20	16.00	135.33	378.00	50.73	56.49
NAA+ Zn	58.80	16.33	110.33	273.33	46.00	60.40
GA_3 + NAA +Zn	64.39	17.33	186.67	405.33	54.73	62.25
$LSD_{0.05}$	2.74	2.11	14.09	17.48	2.62	5.31

Spraying plants with GA_3 recorded the uppermost values of plant height and number of branches and leaves/plant than NAA or Zn effect. But spraying with NAA gave the highest additive on leaf area as compared to GA_3 or Zn effect. This may be due to GA_3 increased cells elongation, which

reflected on plant height and vegetative growth, moreover, NAA may be increased cell division, which also reflected on plant growth, but the effect of GA_3 was more than the effect of NAA on vegetative growth of pepper plants.

Spraying with zinc had a positive effect on vegetative growth, this may be due to that Zn deficiency was a significant decrease in ^{14}C fixed in the primary photosynthetic process (Srivastava *et al.*, 1997), so spraying plants with Zn increased photosynthetic efficiency, which reflected a simulative effect on vegetative growth of pepper plant, and also zinc is a component of a variety of enzymes such as dehydrogenase, proteinase, peptidase and phosphohydrases (metabolism of carbohydrates, protein and phosphate), and Zn is known to stimulate plant resistance to dry and hot weather(Kabat and Pendias, 1992; Srivastava and Gupta). So spraying plants with all used substances (GA_3, NAA and Zn) gave the highest values of vegetative growth as compared to unsprayed one (control).

The best treatment for increasing vegetative growth was spraying plants with 10 ppm GA_3 + 10 ppm NAA + 200 ppm Zn as compared to other treatmnts.

The obtained results are in accordance with those reported by El-Asdoudi (1993); Belakbir *et al.*(1998) and Sharma *et al.*(1999) on pepper and Agwah and Mahmoud (1994) and Bose and Tripathi (1996) on tomato.

2- Fruit Physical Characters and Yield

It is obvious from the data in Table 3 that the effect of spray plants with 10 ppm GA_3, 10 ppm NAA, 200 ppm Zn and different combination treatments among them had a significant effect on fruit physical characters and yield, except wall thickness in both seasons under study. All spraying materials increased fruit length, fruit diameter, number and weight of fruits/plant and early and total yield as compared to unsprayed one (water spray).

Table 3: Effect of some growth regulators and Zn on fruit physical characters and yield of sweet pepper

Characters / Treatments	Fruit length (cm)	Fruit diameter (cm)	Wall thickness (mm)	No of fruits /plant	Fruit yield/plant (gm)	Early yield (ton/fed)	Total yield (ton/fed)
First season (2005)							
Control	7.53	2.70	0.30	10.12	363.19	1.983	8.333
GA_3	10.31	4.09	0.41	19.26	529.31	2.913	15.717
NAA	8.44	4.02	0.34	20.62	546.21	2.233	16.283
Zn	10.39	4.07	0.30	16.21	489.24	2.300	14.333
GA_3+ NAA	9.66	4.54	0.33	23.19	667.25	3.367	18.133
GA_3+ Zn	9.52	4.73	0.34	22.63	659.63	3.283	18.363
NAA+ Zn	9.95	4.53	0.34	20.54	632.82	3.617	17.050
GA_3+NAA+Zn	10.05	4.93	0.39	26.36	712.19	3.500	18.633
$LSD_{0.05}$	2.43	0.93	N.S	2.14	37.19	0.500	1.186
Second season (2006)							
Control	7.97	2.70	0.30	9.10	326.92	2.203	9.620
GA_3	10.43	4.93	0.39	18.36	511.54	3.567	15.883
NAA	8.30	5.00	0.34	19.74	571.36	3.600	16.783
Zn	8.10	4.40	0.31	17.44	510.36	3.350	13.600
GA_3+ NAA	9.57	4.93	0.34	24.87	679.23	4.717	17.817
GA_3+ Zn	9.47	4.87	0.37	23.15	652.79	4.497	18.067
NAA+ Zn	10.03	4.20	0.33	24.41	661.25	4.417	17.683
GA_3+NAA+Zn	11.37	5.60	0.38	28.92	730.18	4.533	19.150
$LSD_{0.05}$	1.17	0.42	N.S	3.26	42.28	0.690	0.690

Data in Table 3 also show that GA_3 caused a higher increase of fruit length and early yield than NAA and Zn, while NAA caused a higher increase of number and weight of fruits/plant and total yield than GA_3 and Zn. So, spraying plants with 10 ppm GA_3 + 10 ppm NAA + 200 ppm Zn recorded the highest values of fruit length, fruit diameter, number and weight of fruits/plant and early and total yield as compared to other treatments. These results are in good line with those obtained from the data of vegetative growth in Table 2 in this study.

These results agree with those obtained by El-Asdoudi (1993), Singh *et al.*, (1994), Singh and Lal (1995) and Barai and Sarkar (1999) on pepper and Agwah and Mahmoud (1994) on tomato.

3- Mineral (NPK) Contents

The effect of spraying plants with 10 ppm GA_3, 10 ppm NAA, 200 ppm Zn and different combination treatments among them as well as water spray (control) on NPK contents in fruits are shown in Table 4. It is clear that mineral (NPK) contents were significantly affected with all treatments, and all sprayed materials increased mineral (NPK) contents as compared to control.

This may be attributed to plants were health (Table 2) and fruits were good (Table 3) when plants were sprayed with 10 ppm GA_3, 10 ppm NAA, 200 ppm Zn or different combination treatments among them, which reflected on enhancing minerals uptake by plants to maximum values, and resulting in maximum accumulation of minerals in fruits.

The best treatment for increasing NPK contents was spraying with 10 ppm GA_3 + 10 ppm NAA + 200 ppm Zn as compared to other treatments.

The obtained results are in accordance with those reported by Gabal (1984).

Table 4: Effect of some growth regulators and Zn on mineral (NPK) contents (%) in sweet pepper fruits

Season	2005			2006		
Characters / Treatments	N	P	K	N	P	K
Control	3.433	0.417	2.267	3.333	0.403	2.633
GA_3	4.433	0.447	2.933	4.567	0.453	2.767
NAA	4.467	0.457	2.800	4.533	0.453	2.967
Zn	4.700	0.443	2.700	4.367	0.447	2.767
GA_3+ NAA	5.067	0.437	3.433	4.933	0.507	3.367
GA_3+ Zn	4.933	0.500	3.333	4.833	0.533	3.433
NAA+ Zn	4.933	0.533	3.367	4.900	0.547	3.400
GA_3 + NAA +Zn	5.333	0.537	3.467	5.167	0.557	3.533
$LSD_{0.05}$	0.318	0.018	0.266	0.399	0.055	0.372

4- Total Chlorophyll, Vitamin C, Total Soluble Solids and Zn Contents

It is clear from the data in Table 5 that spraying plants grown under high temperature at flowers initiation with 10 ppm GA_3, 10 ppm NAA, 200 ppm Zn or different combination treatments among them significantly increased total chlorophyll, vitamin C, total soluble solids and zinc contents as compared to water spray (control).

The best treatment for increasing total chlorophyll, vitamin C, total soluble solid and zinc contents was spray plants with 10 ppm GA_3 + 10 ppm NAA + 200 ppm Zn as compared to other treatments.

These results were in agreement with those obtained by Gabal (1984); Singh and Lal (1995); Belakbir *et al.* (1998) and Sharma *et al.* (1999).

Thus, it could be concluded that spraying pepper plants grown under high temperature with the combination among 10 ppm GA_3 + 10 ppm NAA + 200 ppm Zn was the superior treatment for improving fruit set and quality.

Table 5: Effect of some growth regulators and Zn on total chlorophyll (mg/m^2) in leaves and vitamin C (mg/100 gm fresh weight), total soluble solids (%) and Zn contents (ppm) in sweet pepper fruits

Season / Characters / Treatments	2005				2006			
	Total chlo.	Vit. C	TSS	Zn	Total chlo.	Vit. C	TSS	Zn
Control	521.14	83.87	3.95	25.10	513.75	82.19	3.49	27.83
GA_3	609.60	96.97	4.11	36.63	559.71	94.55	4.01	35.53
NAA	631.14	94.77	4.31	34.63	625.17	94.24	3.85	37.97
Zn	575.13	97.37	4.15	47.70	598.49	92.54	3.69	56.10
GA_3+ NAA	588.88	99.71	4.48	28.80	582.51	98.30	4.50	30.63
GA_3+ Zn	566.73	99.02	4.40	44.53	564.56	99.07	4.33	45.03
NAA+ Zn	610.94	105.14	4.61	41.40	605.34	104.06	4.09	42.47
GA_3 + NAA +Zn	675.30	108.02	5.21	38.43	676.71	104.34	4.76	39.47
$LSD_{0.05}$	36.32	3.52	0.89	5.53	27.88	4.44	0.18	4.20

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دراسات على بعض المواد المحفزة للعقد وجودة ثمار الفلفل الحلو النامي تحت درجات الحرارة المرتفعة

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أجرى هذا البحث في الموسم الصيفي لعامي ٢٠٠٥ ، ٢٠٠٦ على الفلفل الحلو صنف ماركونى لدراسة تأثير الرش ببعض منظمات النمو (١٠ جزء في المليون جبريلين، ١٠ جزء في المليون نفثالين حامض الخليك)، و ٢٠٠ جزء في المليون زنك ومختلف معاملات التوافيق بينهم في مرحلة نشأة الأزهار على النمو، والصفات الطبيعية للثمرة، والمحصول، وبعض الصفات الكيميائية للثمار.

أدى رش النباتات النامية تحت درجات الحرارة العالية بمعدل ١٠ جزء في المليون جبريلين أو ١٠ جزء في المليون نفثالين حامض الخليك أو ٢٠٠ جزء في المليون زنك أو مختلف معاملات التوافيق بينهم في مرحلة نشأة الأزهار إلى تحسين النمو الخضري (ارتفاع النبات، وعدد الأفرع والأوراق/نبات ، والوزن الطازج والجاف/نبات، ومساحة الورقة)، وطول وقطر الثمرة، وعدد ووزن الثمار/نبات، والمحصول المبكر والكلى، والمحتوى الكيماوي (نيتروجين، فوسفور، بوتاسيوم، والكلورفيل الكلى، وفيتامين ج، والمواد الصلبة الذائبة الكلية) عند مقارنتها بالكنترول (الرش بالماء).

وعموما، كانت أفضل معاملة لزيادة النمو الخضري، والصفات الطبيعية للثمرة، والمحصول، والمحتوى الكيماوي للثمار هي رش النباتات في مرحلة نشأة الأزهار بمعدل١٠ جزء في المليون جبريلين + ١٠ جزء في المليون نفثالين حامض الخليك + ٢٠٠ جزء في المليون زنك مقارنة بباقي المعاملات.