J. Agric. Sci. Mansoura Univ., 32 (2): 913 - 949, 2007

EFFECT OF BIOMAGIC®, YEAST, ACADIAN SEAPLANTS®, FOLIAFEED D®, TRIAL COMPOUND FERTILIZER, PUTRESCINE AND SILICON TREATMENTS ON GROWTH, YIELD AND CHEMICAL COMPOSITION OF TOMATO PLANTS GROWN UNDER EARLY AND LATE SUMMER SEASONS

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ABSTRACT

Two field experiments were conducted during the two successive early and late summer seasons of 2002 and 2003 at Kaha Vegetable Research Station (Qalubia Governorate) on tomato plants (*Lycopersicon esculentum*, Mill.) cv. Super Strain B to study the effects of Biomagic® (7.5 g/l), Baker's Yeast solution – Yeast (foliar), Yeast (soil) and Yeast (foliar+soil) - (10×10^9 cells /l), Acadian Seaplants® (1 l/ feddan), Foliafeed (D)® (0.625 g/ l), the trial (experimental) compound fertilizer (5 g/ l), putrescine (1 mg/l), silicon's powder, unadulterated sand (1 g/l) as well as sodium meta silicate (1 g/l) under two different periods of early and late summer seasons (heat stress conditions) on the different vegetative growth characters, flowering as well as yield and its components. This work aimed to rise the ability of this cultivar to tolerate the hard conditions of heat stress, prevailing in this period of year (May, June and July), which causes a severe drop in the productivity.

The obtained results indicated that, all applied treatments significantly increased the most of the studied vegetative growth characters. The greatest values of the two successive early summer seasons were obtained by treating plants with Yeast (foliar+soil) as well as Biomagic®. Foliar application of Biomagic®, silicon's powder as well as compound fertilizer resulted significant decreases in the number of days required for flowering 50 % of plants in the first season. In addition, the highest value in the early tomato yield (ton/ feddan) were recorded by using Biomagic® followed by silicon's powder treatments. Also, the applied treatments significantly decreased the values of the non-marketable tomato yield. All different treatments showed significant increases in the average fruit weights, total sugars in leaves and fruits, essential amino acids, non-essential amino acids, total amino acids and total proteins % of tomato leaves with some exceptions when compared to the control untreated plants.

Under the heat stress conditions (two late summer seasons), all applied treatments recorded higher values of different vegetative growth characters (plant height, number of branches and leaves) as compared to the two early summer seasons. No significant decrease on the number of days required for flowering of 50 % of plants under conditions of heat stress were recorded. Number of clusters/ plant were increased specially at 70 days after transplanting (D. A. T.). On the other hand, fruit set percentage as well as early, marketable and total tomato yield were decreased whereas, non-marketable yield increased as a result of heat stress conditions. The best treatments under this condition were application of putrescine, Foliafeed (D)®, Biomagic® as well as Yeast (foliar+soil) which increased most of these parameters. All different treatments showed significant increases in the average of fruit weights, total sugars, essential amino acids, non-essential amino acids, total amino acids as well as total protein % of tomato leaves with some exceptions as compared with the early summer season and when compared to the control (untreated plants).

INTRODUCTION

Tomato is the most popular and important vegetable fruit crop in Egypt for local fresh consumption, industry processing and exportation. Increasing the production of tomato fruits with high quality is very important objective to meet the increment in human population that may be achieved horizontally by increasing the cultivated area and/or vertically by increasing the total yield in the area. The increase in total yield per feddan can be achieved by application of different natural compounds as well as certain chemical substances. Much attention has been focused on the possibility of using natural and safety compounds, i.e. Biomagic® (Ismail, 2002) working on pea, Baker's Yeast solution (Abedel-Aziz, 1997) working on tomato and Acadian Seaplants® (Igbokwe *et al.,* 1990) working on tomato. Furthermore, putrescine plays an important regulatory role in plant growth, development and flowering owing to its effect on cell division and differentiation (Cohen *et al.,* 1982) working on tomato and Gharibe and Hanafy Ahmed (2005) working on pea. Additionally, macronutrients and micro nutrients are considered very important factors for enhancing plant growth and productivity of tomato plants (Kolota and Osinska, 2000) consequently improve plant nutrition to protect the plants against adverse environmental conditions (El-Sweify *et al.,* 2002). Moreover, many workers mentioned that silicon can stimulate growth and yield of different crops under normal and different stress conditions by several indirect actions (Marschner, 1995).

Furthermore, it is well known that, a serious drop in tomato production was occurred as a result of unfavorable high temperature prevailing during the period of late summer season (May, June, July and August). Generally, such depression occurs when day and night temperatures exceed 25 and 18ºC, respectively, although no visible injury to tomato vegetative growth characters could be observed in some cases (Aung, 1976 and Kuo *et al.,* 1979).

Thus, the objective of the present study was to investigate the effects of such treatments for improving tomato plant growth and productivity especially under the hard conditions of heat stress, which prevailing in the late summer season in Egypt every year.

MATERIAL AND METHODS

Field experiments were carried out during two successive early and late summer seasons of 2002 and 2003 at Kaha Vegetable Research Station (Qalubia Governorate), Horticulture Research Institute, Agriculture Research Center (A. R. C.), Giza, Egypt. The physical analysis of soil under study was % 61.2 clay, % 21.3 silt, % 17.5 sand and the soil type was clay loam. Chemical analysis of soil was pH 8.4, 87.9 (ppm) available N, 26.2 (ppm) available P as well as 85.2 (ppm) available K. Seeds of tomato (*Lycopersicon esculentum*, Mill.) cv. Super Strain B in the two early summer seasons were

sown on 2nd and 6th of January in 2002 and 2003, respectively. Whereas, the seeds of the same cultivar of the two late summer seasons were sown on 7th and 31st of April and March in 2002 and 2003, respectively in plant seedling trays (84 cell) filled with mixture of peat-moss and vermiculite (1:1) by volume in the unheated greenhouse conditions. Thereafter, tomato seedlings of the early summer seasons were transplanted on 17th and 23rd of February, in the 1st and 2nd season, respectively. The tomato seedlings of the two late summer seasons were transplanted on 15th and 5th May in the 1st and 2nd season, respectively. Each plot measured 16 m^2 (the plot consists of four rows each row was 1m wide and 4 m long). The two rows in the middle were used for growth data collection and the other two rows were sampled for fruit yield harvest, with a spacing of 30 cm between plants. Common cultural practices concerning tomato production such as surface irrigation, fertilization as well as pest management were conducted whenever were necessary as recommended by the Egyptian Ministry of Agriculture and Land Reclamation.
The meteorological data during the two growing seasons of this work are shown in Table (1).

Table 1: Meteorological data of Qalubia governorate region during the early and late summer seasons, 2002 and 2003.

Month	First season 2002				Second season 2003			
	Temperature ºC		Relative Humidity (%)		Temperature ºC		Relative Humidity (%)	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
Jan.	١٩	٩	٨١	39	٢١	١٠	٨٥	٣٩
Fab.	١٦	٤	٧٩	٣٩	٢٢	١٠	٨٤	٤٠
Mar.	٢١	٩	٨٧	٤٩	٢٤	١١	٨٨	٤٨
Apr.	٣٠	١٥	٨٤	٣٦	٣١	١٦	٨٦	٣٦
May	٣٣	١٦	٨٢	٣١	٣٤	١٨	٨٤	٣١
June	٣٤	١٨	٧٨	٣٧	٣٥	٢١	٨٥	٣٣
July	٣٥	٢١	٨٦	٣١	٣٦	٢٢	٨٧	٣٢

Tomato plants were sprayed with Biomagic® starting from 15 days after transplanting (D. A. T.) in the two early summer seasons and periodically each 15 days intervals eight times, while was started from 10 D. A. T. in the two late summer seasons, each 10 days intervals for until the end of the season seven times. The composition of Biomagic® was as follow: amino acids (1.907 %), vitamins (0.038 %), macro and micro-elements and pH 5.5 according to El- Sibaie (1995). Biomagic® was used at the rate of 7.5 g/l. Yeast (Foliar), Yeast (Soil) and Yeast (Foliar + Soil) treatments were started with Baker's Yeast solution after 15 D. A. T. in the two early summer seasons and periodically each 15 days intervals for four times, whereas started after 10 D. A. T. in the two late summer seasons, 10 days intervals for four times. The composition of Baker's Yeast solution (*Saccharomyces cerevisiae*) was as follow: protein 47%, carbohydrates 33%, nucleic acid 8%, lipids 4%, minerals 8% and vitamins according to Nagodawithana (1991). Baker's Yeast solution was used at the concentration of 10×10^9 cells /l. Acadian Seaplants® (liquid Seaweed concentrate) was used for eight and seven times in the two early and late summer seasons, respectively. Acadian is derived from fresh *Ascophyllum nodosum* Seaweed harvested from the North Atlantic coastal waters of Nova Scotia, Canada. It contains a natural storehouse of major and minor nutrients, carbohydrates, amino acids and naturally plant growth promoting substances. The first foliar application began when the plant reached 15-20 cm height, second foliar application was applied at first pre–bloom, third foliar application was applied at first fruit set and the last four foliar applications were applied each 48 hours of each picking. Acadian Seaplants® was used at the rate of 1 l/ feddan. The Foliafeed fertilizer (D)® contained Fe 3.00%, Mn 5.00%, Zn 7.00%, Cu 0.5%, B 0.5%, Mo 0.02% and Mg 0.5% (16.52 % trace elements). Foliafeed (D)® was used at the rate of 0.625 g/ l. The composition of compound fertilizer was N 25%, K_2O 17%, P_2O_5 3%, Mg 1.5%, Zn 0.03%, Cu 0.001% and Mn 0.001 %. Compound fertilizer was used at the rate of 5 g/ l. Diamine putrescine was applied at the rate of 1 mg/l. Silicon's powder [a raw silicon (unadulterated sand)] washed by a dilute hydrochloric acid at the concentration of 5%, followed by washing with a distilled water, then dried, crushed and sifted through a sieve (hole diameter = 56 µm). The fine sand was used at the rate of 1 g/l. Sodium meta silicate ($Na_2SiO_35H_2O$) was applied at the rate of 1 g/l only at the 2nd season.

Regarding, Foliafeed (D)®, compound fertilizer, putrescine, raw silicon and sodium meta silicate were applied for three times, from 15 D. A. T. and then after each 30 days in the two early summer seasons, while spraying was started after 10 D. A. T. and then after each 20 days, for two times in the two late summer seasons. The control treatment was sprayed with water. All chemicals were delivered in fine mist using hand pressure sprayer equipped with a fine nozzle.

The treatments of the experiments were arranged in a randomized complete block design and three replicates for each treatment were randomly distributed. Each replicate was represented by two plants which were taken randomly in early and late summer seasons at two vegetative growth periods, i.e. 60 and 90 D. A. T. in the two early summer seasons and at 40 and 70 D. A. T. in the two late summer seasons. For each sample, the following growth characters were measured: Plant height (cm), number of branches, number of leaves, dry weights of leaves, stems and roots (g).

The flowering characters were recorded: number of days required for flowering of 50 % of tomato plants from transplanting, number of clusters (were counted after 60 and 90 D. A. T. in the two early summer seasons and at 40 and 70 D. A. T. in the two late summer seasons) as well as fruit set percentage of the first three clusters after 90 D. A. T. in the two early summer seasons and 70 D. A. T. in the two late summer seasons using the following equation.

$$\text{Fruit set \%} = \frac{\text{No. of fruit set / cluster}}{\text{Total No. of flowers / cluster}} \times 100$$

Yield and its components were recorded: as follows early yield of fruits expressed as sum of weight for the first three harvesting in the early summer seasons and sum of the first two harvesting in the two late summer seasons (ton/feddan), marketable yield of fruits (included only good fruits, ton/feddan), non-marketable yield of fruit (included fruits having blossom-end rot as a physiological disorder disease, ton/feddan) as well as total yield (fruits of all harvesting, ton/feddan).

For average fruit weight (g), ten fruits were randomly sampled at the red ripe stage of fresh fruits for each replicate at the 3rd harvest in the two early summer seasons. Meanwhile, five fruits for each replicate were sampled at the 2nd harvest in the two late summer seasons. Total sugars composition was determined in leaves and fruit calorimetrically, using Sequoia- turner Model 340 Spectrophotometer at 490 n. m. using phenols sulphuric acid method according to Dubois *et al.* (1956). The content of total sugar calculated and expressed as mg/ g dry weight. Determination of total amino acids composition of tomato plants leaves (g /100 g dry weight sample) using HPLC-Pico-Tag method as described by Cohen *et al.* (1989) in the 2nd sample of the 2nd season of the early and late summer seasons. All data were subjected to the statistical analysis of variance and treatment means were compared according to the Least Significant Differences (L. S. D. 0.05) test method as described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

1- Vegetative growth characters:

Results of the two early summer seasons:

Data in Tables 2 and 3 revealed that, all applied treatments [Biomagic®, Yeast (foliar), Yeast (soil), Yeast (foliar+soil), Acadian Seaplants®, Foliafeed D®, the trial (experimental) compound fertilizer, putrescine, silicon's powder as well as sodium meta silicate] used in the two successive early summer seasons as well as various ages of samples, i.e. 60 and 90 D. A. T. recorded significant increases on the most of the studied different vegetative growth characters, i.e. plant height, number of branches and leaves, dry weights of leaves, stems and roots with some exceptions.

These results are in agreement with those obtained by Abedel-Aziz (1997) working on tomato and spraying with Baker's Yeast solution as well as Ismail (2002) working on pea and spraying with Biomagic®. Many investigators reported that Biomagic®, Baker's Yeast solution as well as Acadian Seaplants®, played an important regulatory role in plant growth, development as well as yield and its components. The promotive effects of Yeast may be due to their ability to secrete amino acids and cytokinins as well as vitamin B-complex and released CO_2 which improved net photosynthesis (Larson *et al.,* 1962 and Idso *et al.,* 1995). Additionally it contains IAA, GAs and cytokinins (Fletcher and Mcullagh, 1986). The positive stimulatory effects of using Baker's Yeast solution might be due to that Yeast as a source of cytokinins (Skoog and Miller, 1957) delaying the degradation of chlorophyll *via* the inhibition of chlorophyllase (Ben, 1986). Additionally, Yeast which a natural source of cytokinins might enhance cell division, cell enlargement, the extension of leaf surface area as well as the accumulation of soluble metabolites as mentioned by Muller and Leopoled (1966).

Table (٢) : Effect of different treatments on plant height (cm), number of branches and leaves of tomato plants during 2002 and 2003 seasons.

Treatments	First season 2002				Second season 2003			
	Early		Late		Early		Late	
	Days after transplanting							
	٦٠	٩٠	40	٧٠	٦٠	٩٠	٤٠	٧٠
	Plant height (cm)							
Control	٣٢,٨	٤٤,٨	٣١,٨	61.3	35.7	46.2	٣٣,٠	59.5
Biomagic®	٣٩,٠	٥٢,٠	٤٠,٠	٢.٥٩	43.2	55.0	٣.٣٩	60.8
Yeast (Foliar)	٣٥,٥	٤٨,٠	٣٦,٥	٥٧,٧	38.0	48.8	٣٤,٠	58.5
Yeast (Soil)	٣٧,٧	٤٩,٥	٣٥,٧	٦٠,٨	38.3	50.7	٣٦,٠	60.3
Yeast (Foliar + Soil)	٢.٤٠	٥١,٧	٠.٣٨	٥٨,٠	40.7	53.8	٣٩,٠	59.3
Acadian®	٢.٣٦	٥٠,٨	٣٧,٨	٦٦,٧	41.0	52.5	٣٦,٥	63.5
Foliafeed (D)®	٢.٣٨	٥٠,٥	٨.٣٦	٦١,٧	40.0	50.8	٣.٤١	65.5
Comp. fertilizer	٣٦,٣	٤8٣.	٣٥,٨	٥٧,٠	38.2	51.7	٣٧,٥	60.5
Putrescine	٧.٣٤	٤٦,٧	٣٥,٨	٦٠,٢	38.3	51.0	٣٦,٥	61.5
Silicon	٣٥,٠	٤٨,٣	٣٦,٥	٥٨,٣	37.3	50.3	٣٥,٠	59.0
Sodium meta silicate	-----	-----	-----	-----	36.5	48.5	٣١,٥	60.0
L. S. D. (0.0 5)	٢,٩٥	٤,٣٠	**N.S.**	**N.S.**	**3.10**	**4.30**	**3.67**	**N.S.**
	Number of branches							
Control	٢.٥	٥.٦	٤,٨	٢.٨	6.0	7.5	٦,٥	9.5
Biomagic®	٠.٧	٩,٣	٢.٧	٩,٧	8.3	10.3	٣.٨	11.0
Yeast (Foliar)	٢.٦	٧,٥	٦,٧	٨,٧	6.8	9.0	٧,٠	9.8
Yeast (Soil)	٦,٧	٨,٠	٦,٧	٩,٣	7.0	9.3	٧,٥	10.8
Yeast (Foliar + Soil)	٣.٦	٨,٧	٦,٧	٩,٠	7.5	9.6	٧,٨	10.3
Acadian®	٣.٦	٨,٥	٦,٨	٨,٧	7.5	9.2	٨.٦	10.0
Foliafeed (D)®	٦,٠	٧,٨	٧,٠	٢.٩	7.0	9.2	٨,٠	11.0
Comp. Fertilizer	٥,٧	٧,٨	٢.٦	٢.٩	7.3	9.5	٧,٠	10.0
Putrescine	٥,٨	٨,٣	٦,٠	٨,٨	7.0	9.3	٥.٧	10.0
Silicon	٥,٥	٧,٠	٦,٣	٧,٥	6.5	8.5	٦,٥	9.0
Sodium meta silicate	-----	-----	-----	-----	6.8	8.3	٦,٥	9.0
L. S. D. (0.0 5)	٨٤.٠	٠,٩٩	**1.30**	**N.S.**	**N.S.**	**1.35**	**0.91**	**1.32**
	Number of leaves							
Control	٣٢,٣	٢.٤٧	٢.٢٧	83.0	39.7	51.8	٣.٣٠	83.0
Biomagic®	٢.٤٣	٢.٦٩	٣٩,٠	٩٠,٣	54.0	75.7	٣.٣٨	111.0
Yeast (Foliar)	٣٥,٣	٥٥,٠	٢٨,٣	٨٥,٠	42.5	58.7	٨.٢٧	89.0
Yeast (Soil)	٣٨,٨	٥٩,٧	٣٢,٨	١٠٢,٨	47.2	62.3	٣٥,٥	114.0
Yeast (Foliar + Soil)	٤٠,٥	٦١,٥	٣١,٣	١٠٤,٣	44.8	68.8	٣٥,٠	120.3
Acadian®	٧.٣٨	٥٧,٣	٢.٣٦	٨٣,٣	50.0	65.0	٠.٣٣	92.0
Foliafeed (D)®	٣5٨.	٥2٨.	٢.٣٤	٧٠,٨	46.3	61.0	٤١,٠	101.0
Comp. Fertilizer	٣٧,٣	٥٦,٠	٢٩,٥	٧٩,٥	48.7	63.8	٣٣,٥	91.5
Putrescine	٢.٣٤	٥٥,٣	٢٧,٣	٧٧,٨	44.7	59.8	٣٥,٥	106.0
Silicon	٧.٣٣	٢.٥١	٧.٣١	٧١,٨	43.3	57.2	٣٢,٠	85.3
Sodium meta silicate	-----	-----	-----	-----	41.7	55.5	٣.٣١	89.0
L. S. D. (0.0 5)	٣,٩٠	٦,٢٨	**6.68**	**N.S.**	**5.22**	**7.71**	**4.42**	**22.70**

Furthermore, the effects of cytokinin, gibberellins and indole acetic acid as main components of Biomagic®, Baker's Yeast solution as well as Acadian Seaplants® on growth characters, are in accordance with those reported by Shehata (1990) working on tomato. In this connection, Evenari (1984) proved that cytokinins may influence the movement of metabolites in plant. Moreover, the favorable effects of vitamins as a main content of Biomagic® and Baker's Yeast solution on enhancing different vegetative growth characters, Radzevicius and Bluzmanas (1975) were reported similar results on tomato sprayed with thiamine or nicotinic acid as well as Bhardwaj and Rai (1987) working on cucumber sprayed with vitamin B complex. In this connection, Kodandaramaiah and Rao (1985) suggested that vitamins B complex participated indirectly in plant growth and development by enhancing the endogenous levels of various growth factors such as cytokinins and gibberellin. No doubt that all these components of Baker's Yeast led together to this stimulative effect on different vegetative growth characters of tomato plant, because they are essential for plant growth. In this respect, Zodape (2001) mentioned that seaweed extracts enhanced plant nutrients uptake, increase plant resistance against frost and fungal diseases, effective for ripening of fruits, increase shelf-life of the product and are an excellent soil conditioner. In addition, it is worth here to mention that Biomagic®, Baker's Yeast solution and Acadian Seaplants® are safe for environment to get lower chemical pollution effects. Also, these natural compounds reduced soil salinity *via* decrease using of mineral fertilization.

Table (3): Effect of different treatments on the dry weight of leaves, stems and roots (g) of tomato plants during 2002 and 2003 seasons.

Treatments	First season 2002				Second season 2003			
	Early	Late	Early	Late	Early	Late	Early	Late
	Days after transplanting							
	٦٠	٩٠	٤٠	٧٠	٦٠	٩٠	٤٠	٧٠
	Dry weight of leaves							
Control	١٦,٢	٣٩,٧	٦,٧	٣٧,٨	22.7	47.8	١٠,٠	43.8
Biomagic®	١.٢٧	٦٢,١	٤.١١	٤٦,٨	32.7	75.1	١٦,٥	56.4
Yeast (Foliar)	٢٣,٠	49.3	٩,٥	٤٠,٧	27.0	61.0	١٠,٧	49.8
Yeast (Soil)	٤.٢٣	53.8	١٠,٩	٥٠,٩	30.1	67.8	٩.١٢	56.0
Yeast (Foliar + Soil)	٢٦,٤	64.3	١٠,٥	٤٦,٩	35.9	79.1	١٤,٨	59.6
Acadian®	٤.٢٥	58.8	٩.١٠	٤٤,٤	33.5	71.8	١٣,٠	55.5
Foliafeed (D)®	٤.٢٢	48.8	١١,٤	٣٦,١	29.3	64.6	١٩,٠	60.5
Comp. fertilizer	٢٥,٧	٥٢,٤	٧,٧	٨.٣٨	31.0	68.3	١٥,٣	54.0
Putrescine	٣.١٨	50.8	١٠,٨	٣٨,٩	26.1	66.7	١٤,٦	56.2
Silicon	٣.١٧	46.5	١٠,٠	٣١,٢	24.6	58.7	١١,١	41.7
Sodium meta silicate	-----	-----	-----	-----	25.5	54.4	٢.١١	44.7
L. S. D. (0.0 5)	٢,٩١	١٤.٥	**N.S.**	**N.S.**	3.60	**6.90**	**3.41**	**N.S.**
	Dry weight of stems							
Control	٥.٥	13.0	٣,٠	٢٨,٢	7.3	16.2	٣.٤	27.8
Biomagic®	٩,٣	21.9	٥,١	٣٥,٨	12.3	29.6	٩.٦	33.8
Yeast (Foliar)	٦.٦	15.6	٢.٤	٣.٣٢	8.8	23.2	٨.٤	28.4
Yeast (Soil)	٢.٨	18.0	٥,٤	٣٤,٧	11.4	26.6	١.٦	35.3
Yeast (Foliar + Soil)	٩.٨	20.7	١.٤	٣٢,١	11.7	27.8	٣.٦	34.5
Acadian®	٨,٠	18.1	١.٥	٣٥,٣	11.5	29.0	٧.٥	32.2
Foliafeed (D)®	٧,٢	15.3	٨.٤	٢٧,٠	9.7	24.9	٧.٦	33.2
Comp. Fertilizer	٨.٨	16.9	٢.٤	٢٢,٨	10.7	27.6	٨.٥	29.9
Putrescine	٣.٦	16.5	٢.٤	٢٩,٠	9.4	25.4	٦,٢	32.0
Silicon	٢.٦	15.7	٤,٥	٢٥,١	8.5	21.5	٥,١	28.6
Sodium meta silicate	-----	-----	-----	-----	8.8	19.3	٦.٥	28.8
L. S. D. (0.0 5)	١,٠٦	**2.15**	**1.07**	**N.S.**	**1.80**	**2.85**	**1.1٣**	**3.88**
	Dry weight of roots							
Control	٢,٣	٥,٣	٦.١	6.0	3.0	6.1	٢,٠	6.1
Biomagic®	٣,٩	٧,٢	٢.٢	7.3	4.6	8.1	٦.٢	7.6
Yeast (Foliar)	٣,٠	5.٦	١,٨	6.3	3.8	6.5	٢,٢	6.7
Yeast (Soil)	٩.٣	6.6	٢,١	7.8	4.6	7.4	٢,٥	7.8
Yeast (Foliar + Soil)	٣,٧	٧,٢	١,٨	7.0	4.0	8.5	٣,٠	7.4
Acadian®	٣,٥	٦,٥	٢,٢	6.8	4.3	7.7	٣.٢	7.1
Foliafeed (D)®	١.٣	٥,٧	٠.٢	7.0	3.9	7.4	٢,٩	7.5
Comp. fertilizer	٣,٤	٥,٨	١,٧	6.6	4.6	7.7	٤.٢	7.0
Putrescine	٢,٨	٦,٢	١,٩	7.2	3.9	7.5	٧.٢	7.8
Silicon	٢,٨	٦,٠	١,٩	6.0	3.5	7.2	٢.٢	6.7
Sodium meta silicate	-----	-----	-----	-----	3.7	6.9	٢,٠	6.6
L. S. D. (0.0 5)	٦١.٠	٠,٦٢	**N.S.**	**N.S.**	**0.59**	**0.74**	**0.٤٤**	**N.S.**

Furthermore, the promoting effects of Foliafeed (D)® (as micro-elements fertilizer) and compound fertilizer treatments (as macro and micro-elements fertilizer) on vegetative growth characters were similar to that obtained by Hamsaveni *et al.* (2003) working on tomato as well as Gharibe and Hanafy Ahmed (2005) working on pea plants. In this regard, it can be suggested that the positive effect of different micro nutrients on growth and yield of tomato plants may be relevant to the enzymatic system catalayzing numerous metabolic reactions as well as through the improvement of the nutritive status of treated plants.

The stimulutive effects induced by putrescine foliar application on most of the studied vegetative growth characters, were similar to that obtained by Talaat (2003) working on sweet pepper and Gharibe and Hanafy Ahmed (2005) working on pea. In this respect, Tiburcio *et al.* (1993) postulated that putrescine and polyamines (Spermidine and Spermine) are essential for cell growth and may serve as intermediates in cellular to the growth factors. Moreover, they described polyamines as plant growth substances with a wide range of actions. Their mechanism of actions is related to bindings with nucleic acids and probably with membranes.

The favorable effects of silicon foliar application treatments (silicon's powder and sodium meta silicate) on vegetative growth characters, were in agreement with those finding by Miyake and Takahashi (1978) working on tomato as well as Lee *et al.* (2000) working on cucumber. In this concern, Aleshine *et al.* (1989) working on rice, mentioned that silicon stabilized metabolic processes in chloroplasts and participated in regulation of all 3 types of phosphorylation. Moreover, Agrie *et al.* (1992) working on rice reported that silicon reduced transpiration and increased water use efficiency in leaves, which in turn reduced the decline in photosynthesis and chlorophyll detraction in older leaves. Also, it was postulated that silicon decreased the mutual shading by improving leaf erectness, decreasing susceptibility to lodging, decreasing the incidence of infections with root parasites and pathogens, leaf pathogens and preventing manganese or iron toxicity or both. Other beneficial effects of silicon application were found by reducing water loss by stomatal transpiration as well as decreased the nonstomatal transpiration (Marschner, 1995). Liang *et al.* (1996) pointed out that silicon treatment increased CO_2 assimilation of barley leaves.

Results of the two late summer seasons:

Under the heat stress conditions, the data in Tables 2 and 3 revealed that all applied treatments during the two late summer season as well as through both samples ages, i.e. 40 and 70 D. A. T. recorded significant increases on the most of the studied different vegetative growth characters, (plant height, number of branches and leaves, dry weights of leaves, stems and roots), with some exceptions. Similar results were obtained by Titov *et al.* (1986) working on tomato. In this regard, heat stress severely affects photosynthesis, carbohydrates through depletion in respiration, protein breakdown and denaturation, nutritional and hormonal imbalances, enzyme inactivation, disturbances in membrane structure and function and restriction of stomatal function (Dubey, 1984). On the other hand, Biomagic®, Yeast as well as

Acadian Seaplants® as natural organic-biofertilizer have useful stimulatory and protective functions especially when its are applied on vegetative growth during stressful condition and this could be due to their contents from hormones (cytokinins, auxins and gibberellins), sugars, amino acids, nucleic acids, protein, phospholipids, vitamins and minerals, thereby it can accelerate cell division and enlargement. Also, it enhances nucleic acids, proteins and chlorophyll synthesis, promotes the formation of flower primordia and improves fruit setting percent. It can induce thermotolerance due to its content of heat shock proteins (HSPs) (Weiderrecht *et al.,* 1988). Exogenous application of benzyladenine (cytokinin) could overcome the effects of heat stress and enhanced photosynthesis and chlorophyll production. In the case of heat stressed green plants, cytokinin level becomes limiting and this was associated with reductions in photosynthetic activity, chlorophyll production and chloroplast development. The ability to reverse these processes in both green and etiolated tissues by applied cytokinins suggests an important role for cytokinins in chloroplast morphogenesis which is thermally controlled (Cheikh and Jones, 1994).

Moreover, Norrie and Hiltz (1999) reported that the beneficial effects of Seaweed extract derived from *Ascophyllum nodosum,* are attributed to the presence of natural plant growth regulators (cytokinins and auxins) as well as other plant biostimulants (betaines, polyamines, oligosaccharides) which can improve plant resistance and tolerance to environmental stresses, disease and insect. In addition, Fathy and Farid (2000) pointed out that spraying tomato plants with Yeast preparation at concentration of (50 ml/l) at 15, 30 and 45 days after transplanting, increased total dry weights (g) and leaf area (cm^2) per plant under heat stress conditions when compared to the control (untreated plants).

Furthermore, the results revealed that, vegetative growth characters of tomato plants treated with foliar fertilizer of Foliafeed D® was the superior treatment recorded under the conditions of the heat stress. Similar results concerning the favorable effects of macro and micro elements under heat stress on vegetative growth characters were obtained with Fathy and Farid (2000) working on tomato as well as Wei *et al.* (2004) working on maize.

Concerning the favorable effects of putrescine treatment under the conditions of heat stress on vegetative growth characters of tomato plants, Galston and Kaur–Sawhney (1990) mentioned that in cereals the main precursor of polyamines biosynthesis is the amino acid arginine and polyamines biosynthesis is rapidly increased under a range of environmental stresses, i.e. drought, heat and salinity in particular. Murkowski (2001) cited that exogenous application of 4 mM spermidine of two tomato cultivars, Robin (heat – tolerant) and Roma (heat – sensitive) improved the plant heat – resistance in both cultivars and especially in Roma.

Concerning the favorable effects of silicon foliar application on the most of the studied different vegetative growth characters under heat stress, Hattori *et al.* (2005) suggested that silicon application may be useful to drought tolerance of *Sorghum* [*Sorghum biocolor*, (L.) Moench] *via* the enhancement of water uptake ability.

2- Flowering characters:

Results of the two early summer seasons:

The results of flowering characters presented in Table (4) indicated that, in all examined samples the treatments of Biomagic®, silicon's powder as well as compound fertilizer resulted in significant decreases in the number of days required for flowering of 50 % of tomato plants in the first early season but in the second one, all the examined treatments showed non-significant effect on this character.

Table (4): Effect of different treatments on 50 % flowering, number of clusters/ plant and fruit set percentage (%) of tomato plants during 2002 and 2003 seasons.

Treatments	Flowering 50 %		Number of clusters/plant				Fruit set Percentage (%)	
	Early	Late	Early		Late		Early	Late
			Days after transplanting					
			60	90	40	70	90	70
First season 2002								
Control	34.3	19.0	٦,٨	٣.١٧	٤,٣	39.0	70.4	17.4
Biomagic®	30.0	18.7	9.7	٢٣,٧	٧,٣	50.8	85.3	21.8
Yeast (Foliar)	33.7	19.3	٢.٨	٢.٢٠	٢.٦	40.8	74.8	16.7
Yeast (Soil)	33.3	19.0	٩,٥	٢١,٠	٦,٧	42.4	82.9	19.7
Yeast (Foliar + Soil)	33.3	20.0	٠.٩	٢٢,٥	٢.٦	43.8	86.8	19.0
Acadian®	33.3	21.7	9.2	٢١,٠	٢.٧	40.5	84.7	18.5
Foliafeed (D)®	33.0	19.0	٩,٣	٢٠,٨	٦,٧	40.8	81.3	21.7
Compound fertilizer	32.7	21.3	٩,٠	٢٠,٠	٥,٨	40.7	81.8	18.5
Putrescine	33.7	19.0	٨,٧	٢.١٩	٦,٣	42.0	77.5	22.3
Silicon	32.3	22.0	٨,٠	١٩,٨	٢.٦	33.3	84.3	14.6
Sodium meta silicate	-----	-----	-----	-----	-----	-----	-----	-----
L. S. D. (0.0 5)	٤.١	**N.S.**	١,١	٢,٨	**1.8**	**8.1**	**5.7**	**3.9**
Second season 2003								
Control	29.8	22.3	٨,٥	١9٨.	٣.٦	42.5	74.4	20.7
Biomagic®	26.3	21.0	٢.١٢	٢.٢٧	٨.٨	48.8	86.3	28.2
Yeast (Foliar)	29.0	24.0	١٠,٣	٢٢,٨	٦,٥	40.8	78.7	20.7
Yeast (Soil)	28.0	22.3	١١,٥	٢٥,٠	٨.٧	44.5	83.4	25.0
Yeast (Foliar + Soil)	28.7	٢٣,٠	٧.١١	٢.٢٦	٨,٥	46.٠	88.3	26.3
Acadian®	27.7	22.0	١١,٨	٢.٢٥	٣.٧	45.8	84.6	25.8
Foliafeed (D)®	28.3	21.7	١٢,٣	٢٤,٨	٣.٩	47.0	83.5	29.0
Compound fertilizer	27.7	23.7	١١,٧	٠.٢٣	٧,٠	45.5	82.6	24.4
Putrescine	29.3	22.0	١١,٠	٨.٢٣	٨,٥	48.5	80.0	30.8
Silicon	28.0	25.0	٢.١٠	٢.٢٢	٨.٦	40.5	85.2	23.9
Sodium meta silicate	29.7	25.0	١٠,٧	٢٢,٠	٣.٧	41.5	79.3	22.5
L. S. D. (0.0 5)	**N.S.**	**N.S.**	٢,٠	3.2	**1.2**	**3.9**	**3.7**	**4.1**

As shown in the same Table, there is a gradual increase in the average number of clusters/ plant from 60 to 90 D. A. T. The superior treatments in induction higher number of clusters were achieved by treating tomato plants with Yeast (foliar+soil) as well as Biomagic® treatments. Most of the treatments also, showed significantly increased in the number of clusters/ plant with some exculpations. Concerning the fruit set (%), the results revealed that significant increases were recorded by tomato plant treated with all studied treatments, with the exception of Yeast (foliar) treatment in the 1st early summer season. The most active treatments on fruit set percentage were recorded by Yeast (foliar+soil) followed by foliar application of Biomagic® as compared to the control (untreated plants).

The favorable effects of Yeast, Biomagic® as well as Acadian Seaplants® treatments on flowering characters may be due to the enhancing effect of these compounds on hormones and vitamins productions, which indirectly improve flowering. Similar results were reported by Abedel-Aziz (1997) as well as El-Ghamriny *et al.* (1999) working on tomato. They mentioned that spraying Baker's Yeast solution significantly increased fruit set (%). In this connection, Bisaria and Rastogi (1988) reported that kinetin enhanced flowering in tomato plants. Mashev *et al.* (1980) and Kinet and Leonard (1983) pointed out that cytokinin improved the inflorescence and early flowers of tomato. Mapelli *et al.* (1979) recorded that GA_3 application promotes anther development and increase the amount of viable pollen of tomato. Poincelot (1994) used a 1% solution of ROOT PLUS (a commercial product containing seaweed (*Ascophyllum nodosum*) extract) increased number of flowers in *Cosmos* sp. cv. Sunny Red by 201% and flowering occurred 7 days earlier as compared with the control untreated plants. Helal *et al.* (2005) working on pea mentioned that foliar spray with vitamin B_1 showed the earliest flowering when compared with untreated control.

In this respect, Hanafy Ahmed *et al.* (1995) mentioned that high values of reducing sugars and free GA_3 may play a role in enhancing early flowering initiation of globe artichoke plants.

The favorable effects of Foliafeed (D)® and compound fertilizer treatments on flowering characters, were strongly confirmed by Agwah and Mahmoud (1994) working on tomato. In this connection, Hanafy Ahmed *et al.* (1996) working on *Vicia faba* recorded that, boron and manganese foliar applications resulted in an early flowering and increased the percentage of an accumulative flowers/ plant. Boron also, affected fertilization by increasing the pollen producing capacity of the anthers and pollen grain viability (Agarwala *et al.*, 1981). Indirect effects might also, be considered such as increase in amount and composition of sugar in the nectar, whereby the flowers that rely on pollinating insects become more attractive to insects (Eriksson, 1979). Moreover, Hanafy Ahmed *et al.* (1995) postulated that early flowering and heading of globe artichoke might be attributed to many metabolic and physiological processes, among which minerals uptake and phytohormones balance. Gharibe and Hanafy Ahmed (2005) reported that pea was sprayed with Foliafeed D® caused significant decrease in the number of days for anthesis comparing with the control untreated plants.

The favorable effects of putrescine treatment on flowering characters, are in agreement with those reported by Cohen *et al.* (1982) working on tomato. In this concern, Crisosto *et al.* (1988) working on "Comice" pears recorded that putrescine at 10^{-3} M improve pear fruit set, by delaying senescence of the ovules and enhancing pollen germination and fertilization by two days as well as increase floral cluster numbers. Moreover, Raina *et al.* (1983) pointed that polyamine levels are high during the onset of fruit development, as compared with other stages of fruit development, or even with other actively dividing plant structures. For instance, total polyamine levels found in tomato fruits at fruit set are close to 10^4 nmol/ g fresh weight (free and conjugated). High polyamine levels at full anthesis have been reported in apples. Furthermore, Orazi and Bangni (1987) postulated that putrescine increased nitrogen levels in the flowers but not in leaves of pears. They reported that the application of nitrogen to apples before anthesis improves fruits set.

In this respect, Bagni and Bellini (1982) suggested that the effect of exogenous polyamines on fruit set might be nonspecific and might merely serve as an exogenous nitrogen source. N and B levels can increase after putrescine application in flower tissue, 12 days after anthesis and may increase the rate of pollen tube growth in the styles of pear ovaries

In this regard, Galston *et al.* (1994) proved that increase in putrescine immediately preceded the activation of cell division in meristems passing from the vegetative to the floral stage. Moreover, Lui *et al.* (2003) suggested that fruit set increased by pre – bloom putrescine spray in *litchi* which associated with the decrease of ethylene release in the ovaries and extended pistil receptivity.

The effects of silicon on improving flowering characters are in agreement with those reported by Miyake and Takahashi (1978) working on tomato as well as Lu and Cao (2001) working on melon. In this concern, tomato plants raised in a silicon-free culture hardly born any fruit. In addition, about 10 % of the flowers investigated were found to have a part of the anther degenerated. The fertility of the pollen of a silicon-free cultured plant was markedly lower than that of a silicon-supplied plant. Abnormal pollen was observed in flowers of silicon-free cultured plants (Miyake and Takahashi, 1978). Miyake and Takahashi (1983) working on cucumber, mentioned that pollen fertility of silicon-free plants was lower than that of silicon supplied. In addition, Gharibe and Hanafy Ahmed (2005) working on pea assumed that the application of silicon meta silicate plays some important roles at the first bud flowering stage therefore it has some important effects on reproduction.

Results of the two late summer seasons:

Data in Table 4 revealed that, different studied treatments did not show any significant decreases in the number of days required for flowering of 50 % of tomato plants when compared to the control (untreated plants) in the two late summer seasons. Moreover, the number of clusters/ plant significantly increased at 40 D. A. T. as a result of Biomagic®, Yeast (soil), Yeast (foliar+soil), Foliafeed (D)® or putrescine application in both late summer seasons. Application of Acadian Seaplants® or Yeast (foliar) treatments produced significant increases in the number of clusters in the 1st sample (40 D. A. T.) of the first season.

Moreover, it could be noticed from the same Table that, a dramatic increase in the average number of clusters at 70 D. A. T. under the conditions of the heat stress were recorded, specially when compared with the two early summer seasons, by Biomagic® treatment in both late summer seasons.

Foliafeed (D)® as well as putrescine treatments recorded significant increases in the average number of clusters/ tomato plant at 70 D. A. T. of the 2nd season.

In addition, significant increases in fruit set percentage were recorded by the plants treated with Biomagic®, Foliafeed (D)® as well as putrescine treatments at 70 D. A. T. in both late summer seasons. Whereas, tomato treated plants with Yeast (soil), Yeast (foliar+soil) as well as Acadian Seaplants® significantly increased fruit set percentage in the 2nd season when compared to the control (untreated plants).

On the other hand, the inhibiting effect induces by heat stress conditions on flower characters and fruit set (%) under late summer season was reported by many workers. Sato *et al.* (2000) and Pressman *et al.* (2002) they reported that high temperature has been shown to cause a reducing of pollen viability, abortion of floral buds, flowers and fruit set in tomato fruits.

In this connection, Stevens and Rick (1979) working on tomato mentioned that temperatures greater than 34/20ºC (day/night) or a period of four hours at 40ºC will cause blossom drop in most of plants. In addition, another factor limiting fruit set at high temperatures is style elongation, which results in stigma exsertion through the antheridial cone. When stigma exsertion occurs, normal fertilization is prevented and flower usually drops. Song *et al.* (1999) working on tomato recorded that pollen germination *in vitro* are significantly inhibited at 33ºC and 35ºC but not at 25ºC. In this context, reduced fruit set at high temperature has been associated with decreased concentrations of proline accumulated in pollen grains which is necessary for pollen development during microsporogenesis (Mutters *et al.,* 1989) and reducing sugars in flower buds and flowers of pepper, (Aloni *et al.,* 1991) and increased ethylene production (Aloni *et al.,* 1994). Moreover, Ami and Markhart (2001) pointed out that carbon assimilation may play an important role in flower bud and flower abscission. They suggested that inhibition of fruit set at high temperature is most likely to a direct effect of high temperature on flower development and perhaps fertilization.

Furthermore, Pressman *et al.* (2002) assumed that continuous exposure of tomato 'Trust' to high temperatures (day /night temperature of 32/26ºC) markedly reduced the number of pollen grains per flower and decreased pollen viability. The effect of heat stress on pollen viability was associated with alterations in carbohydrate metabolism in various parts of the anther during its development.

The enhancing effects of Biomagic®, Yeast as well as Acadian Seaplants® treatments on flowering characters under heat stress conditions may be due to the enhancing effects of these compounds on hormones and vitamins productions in plant, which indirectly implicating on improving flowering and fruit set percentage. (Satti and Oebker, 1986 working on tomato). In this context, high temperatures reduce auxin content in developing tomato fruit (Iwahori, 1967) and increase absicisic acid levels in tomato shoots (Daie and Campbell, 1981). Furthermore, Rao and Narayanan (1997) suggested that high temperatures caused reductions in tomato fruit set and it has been demonstrated that exogenous applications of IAA can improve fruit set under high-temperature stress. Also, high auxin levels may prevent the abscission of newly set fruit at high temperatures and thus, may be an important component of heat tolerance.

Concerning the enhancement effects of Foliafeed D® and compound fertilizer treatments on flower characters under conditions of heat stress, Fathy and Farid (2000) working on tomato plants pointed out that spraying chelated micro-elements compound fertilizer increased fruit set (%) of the plants grown under heat stress conditions when compared to the control untreated plants.

Moreover, Sharma *et al.,* 1990 working on maize mentioned that in zinc deficiency prior to microsporogenesis did not significantly affect vegetative growth and ovule fertility but decreased pollen viability and cob dry weight by about 75 % in Zn-deficient plant, anther development is delayed and fewer and smaller pollen grains are produced with very low germination rates.

The enhancement effects of putrescine foliar application at concentration of 1 mg /l. under the adverse conditions of heat stress prevailing in the two late summer seasons on flower characters and fruit set (%) are in agreement with those reported by Song *et al.* (1999) working on tomato. They pointed out that polyamines ameliorating the adverse effects of high temperature on pollen. Pollen germination and tube growth *in vitro* were significantly inhibited at 33°C and 35°C than those at 25°C. The inhibition was reversed by the addition of spermidine or spermine to the germination medium. Also, they mentioned that polyamines can counteract the inhibitory effects of high temperature on pollen germination. They also, suggested that the endogenous concentration of polyamines in germinating pollen grains is an important factor for pollen germinability at high temperature. Moreover, Miao and Cao (2002) postulated that putrescine, spermidine and spermine contents were decreased and proline content increased when cucumber pollen germinated under high temperature (35°C). This might indicate that polyamine and proline might play a key role in cucumber anther development and pollen germination.

Regarding the favorable effects of silicon foliar application on flower characters under the adverse conditions of heat stress, Pershin *et al.* (1995) mentioned that during the reproductive stage, silicon is perennially transported into the flag leaves of rice and interruption of silicon supply at this stage is detrimental for spikelet fertility.

3-Yield and its components:

Results of the two early summer seasons:

Data presented in Table 5, revealed that all applied treatments significantly increased the early tomato yield, with the exception of Yeast (foliar) and putrescine treatments in both early summer seasons. The best treatments for production of higher tomato yield were recorded by Biomagic® followed by silicon's powder application.

It was evident from the Table 5 that, all the studied treatments significantly produced higher marketable and total tomato yield as compared with the control (untreated plants). The most effective treatments were obtained by Yeast (foliar+soil) and Biomagic®. Putrescine showed non-significant increase on marketable and total tomato yield of the 1st season as well as sodium meta silicate treatment in the 2nd one. However, Yeast (foliar) treatment showed non-significant increase on marketable and total tomato yield in both early summer seasons. However, all applied treatments significantly decreased the values of the non-marketable tomato yield in which tomato fruits were infected with blossom-end rot disease in both early summer seasons, while treated tomato plants with silicon's powder recorded significant and non-significant decrease in the non-marketable tomato yield, in the two successive seasons, respectively. Data presented in the same Table recorded that, all different treatments showed significant increases in the average of fruit weights (g) with some exceptions when compared to the control (untreated plants).

Table(5):Effect of some different treatments on yield and its components [early, marketable, non-marketable, total yield (ton/fed.) and fruit weight (g)] of tomato plants during 2002 and 2003 seasons.

	First season 2002									
	Early					**Late**				
Treatments	Early yield (ton/fed.)	**Marketable yield (ton/fed.)**	**Non-Marketable yield (ton/fed)**	**Total yield (ton/fed)**	**Fruit weight (g)**	Early yield (ton/fed.)	**Marketable yield (ton/fed.)**	**Non-Marketable yield (ton/fed)**	**Total yield (ton/fed)**	**Fruit weight (g)**
Control	٣,٤٦	١٥,٤٠	٠,٥٦	١٥,٩٦	74.12	0.81	٢,٦١	٠,٢٨	٢,٨٨	69.72
Biomagic®	٤,٨٩	١٩,٧٣	٣٠.٠	20.02	95.73	0.40	٣,٠١	٠,١٣	٣,١٤	72.54
Yeast (Foliar)	٣,٧١	١٦,٥١	٠,٣٥	16.86	82.43	0.62	٢,١٣	٠,٢٨	٢,٤١	70.62
Yeast (Soil)	٤,٣٢	٩٤.١٨	٠,٢٠	19.14	92.53	0.91	٢,٩٨	٠,٣٩	٣,٣٨	76.35
Yeast (Foliar + Soil)	٤,١٥	٢٠,٧٩	٤٠.٠	21.19	90.11	0.89	٢,٨٣	٠,٣٥	٣,١٨	74.48
Acadian®	٤,٢٧	١٩,١٢	٠,٢١	19.34	91.38	0.84	٢,٩٠	٠,٣٠	٣,٢٠	74.39
Foliafeed (D)®	4.00	١٨,٠١	٠,١٨	18.19	87.80	1.06	3.30	٠,٥١	٣,٨١	72.90
Compound fertilizer	٤,٣١	١٧,٥١	٠,٤٢	17.92	86.50	0.77	٢,٤٥	٠,٥٠	٢,٩٥	63.65
Putrescine	.٣61	١٦,٧٥	٠,٢٧	17.02	81.20	1.17	٣,٤٣	٠,٣٠	٣,٧٢	73.18
Silicon	٥,٠٣	18.72	٠,٤٨	19.19	89.60	0.67	٢,٢٥	٠,٤١	٢,٦٦	70.60
Sodium meta silicate	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
L. S. D. (0.0 5)	**٠,٤٧**	**.١40**	**0.07**	**1.34**	**8.76**	**0.18**	**٠,٥١**	**0.10**	**0.55**	**N.S.**
	Second season 2003									
Control	٣,٨٦	١٧,٤٣	٠,٦٣	١٨,٠٦	87.85	٠,٩١	٣,٣٢	٠,٢٦	٣,٥٧	72.86
Biomagic®	٥,٩٧	٢٢,٩٦	0.39	23.35	110.1	١,٤٧	٤,٩٢	٠,٢٠	٥,١٢	82.10
Yeast (Foliar)	٤,١٥	١٩,١٢	0.42	19.53	90.70	٠,٨٤	٣,٠٣	٠,٢٥	٣,٢٨	77.25
Yeast (Soil)	٤,٧٧	٢٠,٩١	0.30	21.20	95.11	١,٢١	٤,٠٦	٠,٣٧	٤,٤٣	80.96
Yeast (Foliar + Soil)	٤,٦٥	٢٣,٥١	0.48	23.98	105.18	١,٣٠	٤,٣٨	٠,٤٥	٤,٨٣	79.61
Acadian®	٤,٦٢	٢١,٧٩	0.27	22.05	106.80	١,٢٣	٤,٢٢	٠,٥٢	٤,٧٣	81.57
Foliafeed (D)®	٤,٥١	٢٠,٨٠	0.33	21.14	95.40	١,٩٢	٥,١٧	٠,٥٠	٥,٦٧	83.82
Compound fertilizer	٤,٩٦	٢٠,١٩	0.51	20.70	95.77	١,١٨	٣,٩٢	٠,٥٣	٤,٤٥	78.68
Putrescine	٤,٣٢	٥٥.١٩	0.49	20.04	92.93	١,٧١	٥,١٨	٠,٢٤	٥,٤٢	84.15
Silicon	٥,٦١	٢١,٢١	٠,٥٧	21.78	97.63	١,١٢	٣,٦٦	٠,٤٦	٤,١٢	76.07
Sodium meta silicate	٤,٦١	١٦.١٩	٠,٤٩	19.65	95.90	٠,٩٥	٣,٤٧	٠,٣٥	٣,٨٢	77.74
L. S. D. (0.0 5)	٠,٦٠	٢,٠٦	**0.07**	**1.88**	**7.15**	٠,٣٠	٠,٧١	**0.13**	**0.68**	**5.63**

In this respect, the favorable effects of Yeast, Biomagic® as well as Acadian Seaplants® treatments on yield and its components may be due to their enhancing effect on hormones and vitamins produced by plants, which indirectly could improve yield productivity. These results are in harmony with those reported by Auerswald (1991) as well as Abedel–Aziz (1997) working on tomato plants and using Baker's Yeast solution. Igbokwe *et al.* (1990), Poincelot (1994) and Csizinszky (1995) working on tomato and using seaweed extract, as well as Ismail (2002) working on pea plants cv. Victory Freezer and using Biomagic®.

Moreover, the results of Foliafeed D® and compound fertilizer treatments (Table 5) on yield and its components are in harmony with that previously obtained by Hamsaveni *et al.* (2003) and Paithankar *et al.* (2004) working on tomato as well as Gharibe and Hanafy Ahmed (2005) working on pea. In this respect, it might be suggested that the beneficial effects of foliar spraying of macronutrients and micro nutrients on yield and its components might be attributed to their effect on many metabolic and physiological processes, mineral uptake, phytohormones balance and enzymes activity as well as through improvement of nutritive status.

In addition, the favorable effects of putrescine foliar application on tomato yield and its components were similar to that reported by Cohen *et al.* (1982) working on tomato and Talaat (2003) working on sweet pepper under both non- saline or saline soil conditions. In this regard, Crisosto *et al.* (1988) reported that putrescine was found to improve pears fruit set, delay senescence of the ovules and enhance pollen germination and fertilization by two days. Kaur-Sawhney *et al.* (1990) demonstrated that polyamines seem to play a regulatory role in morphogenetic processes preceding fruit set; that is, in the formation of the flowers. Iannotta *et al.* (1996) postulated that putrescine foliar application at 10^{-4} M on olive trees reduced ovary abortion and improved fruit set.

Concerning the enhancing effects of both silicon forms treatments on yield and its components, there is a perfect agreement with Chillemi *et al.* (1999) working on tomato. Lu and Cao (2001) working on melon as well as Gharibe and Hanafy Ahmed (2005) working on pea plants. In this respect, Miyake and Takahashi (1986) postulated that withholding silicon supply not only reduced fruit yield drastically but also, caused malformation of newly developed leaves, wilting, premature senescence, impaired pollen viability and in several cases failure of fruit set. Correspondingly all of the pervious factors increased the yield of tomato fruits.

Results of the two late summer seasons:

Under the heat stress conditions, it is clear from Table (5) that, yield and its components were dramatically decreased when compared with the results in the two early summer seasons. Meanwhile, the incidence by blossom-end rot of tomato fruit disease was increased. Application of putrescine, Foliafeed (D)® as well as Biomagic® treatments were successed to increase significantly the early tomato yield in both seasons. However, Yeast (soil), Yeast (foliar+soil) as well as Acadian Seaplants® significantly increased early tomato yield but only in the 2nd season. Moreover, application of putrescine or Foliafeed (D)® treatment significantly enhanced marketable and total tomato yield in both seasons. The remaining treatments significantly increased marketable and total tomato yield only the 2nd season with some exceptions. Moreover, it could be noticed from the Table (5) that, compound fertilizer treatment showed significantly an increase on marketable tomato yield. Also, inoculation of Yeast (in the first season), Yeast (foliar+soil) as well as Acadian Seaplants® treatments (in the second one) significantly increased the incidence by blossom-end rot disease of the non-marketable tomato yield. Treating tomato plants with all considered treatments showed significant increase in the average of fruit weights of the 2nd season with some exceptions as compared to the control (untreated plants).

Concerning the effects of heat stress under the conditions of both late summer seasons on yield and its components of tomato plants, high temperatures have been reported to limit or prevent production of tomatoes during the summer in many regions of the world and can depress yields in principal production areas wherever, days are warmer than 32ºC, or nights are warmer than 21ºC (Moor and Thomas, 1952). Because of this high temperature sensitivity, poor fruit set is an important limitation to tomato production in the tropics (Villareal, 1980). Similar results obtained with Fujishige *et al.* (1991) working on tomato. In this concern, this failure might be attributed to elevated levels of ABA in the reproductive organs (Zeng and King, 1986).

In addition, it is obviously noticed that plants grown under the conditions of the late summer season were revealed physiological disorder on the fruits known as blossom-end rot which has been attributed to several factors among which high temperature. In this respect, Chong and Ito (1982) pointed out that at higher solution temperatures (30ºC) the incidence of blossom-end rot was greater in tomato plants. Also, Wui and Takano (1995) mentioned that the incidence of blossom-end rot increased with increasing temperature from 20 to 30ºC, especially in the case of air temperature. The blossom-end rot incidence was correlated with rapid early stages of fruit development at high temperatures.

In the present work, with regard to the favorable effects of Biomagic®, Baker's Yeast solution as well as Acadian Seaplants® under heat stress conditions prevailing at late summer season may be due to the enhancing effects of these compounds on hormones and vitamins productions, which indirectly improve flowering and yield productivity. The results are going in the same line with those obtained by Satti and Oebker (1986) and Auerswald (1991) working on tomato. In this respect, Cheikh and Jones (1994) reported that high ABA and low cytokinin levels as a result of heat stress were proposed to cause increased seed abortion and lower yields in corn. ABA increases under extremes in temperature, several characteristics of plants were affected by ABA, reduce growth, increase senescence, inhibit photosynthesis and subsequently, reduce yield. In this connection, El-Habbasha *et al.* (1999) studied that response of tomato plants to foliar spray with GA_3 and IAA at the rates of 0, 25 and 50 ppm of each other and obtained on increase in the early and the total tomato yield under the conditions of late summer season.

Therefore, it can be concluded that in such instances certain biogrowth regulators (Biomagic®, Baker's Yeast solution and Acadian Seaplants®) which contain cytokinin, indole acetic acid and gibberellins applied to the flowers may supplement the deficiency of endogenous hormones in tomato plants leading to stimulate the fruit set of tomatoes fruits which is considered an important parameter for production of the yield.

In this connection, Fathy and Farid (2000) pointed out that spraying Yeast preparation at concentration of 50 ml/l at 15, 30 and 45 days after transplanting, increased yield / plant and number of tomato fruits/ plant under heat stress conditions when compared to the control untreated plants.

The results of Foliafeed D® and compound fertilizer treatments on yield and its components under the heat stress conditions are in harmony with Dube and Chatterjee (1999) working on tomato. Meanwhile, beneficial effects of foliar fertilizer application of Foliafeed D® and compound fertilizer treatments on fruiting and yield of tomato under the heat stress conditions might be due to the stimulatory effect of such macronutrients and micro nutrients on enzymatic systems responsible for biosynthesis of amino acids, protein, chlorophyll, photosynthesis as well as many physiological and metabolical processes involved on reproductive organs (Marschner, 1995).

In addition, Fathy and Farid (2000) proposed that spraying chelated micro-elements compound fertilizer, increase yield / plant and number of tomato fruits/ plant as well as increase fruit fresh weights when compared to the control untreated plants. In this respect, it is important here to mention that the favorable effects of foliar fertilizer application of Foliafeed D® and compound fertilizer treatments on yield and its component of tomato fruit cv. Super Strain B might be due to stimulating effects of its main contents of macro and micro nutrients on many of metabolic processes in the tomato plants which consequently improved vegetative growth characters such as plant height, number of branches and leaves and subsequently increase assimilate production in the vegetative organs translocated into fruits (source-sink relationship).

The favorable effects induced by putrescine application under heat stress conditions on yield and its components in both late summer seasons were agree with that reported by Cohen *et al.* (1982) working on tomato as well as Manivel *et al.* (1998) working on young and mature tea. They pointed out that putrescine foliar application brought about a considerable alleviation of stress harmful induced by heat treatments. In this respect, the diamine putrescine and the polyamines, spermidine and spermine, are involved in an important biological processes, e.g., ionic balance (Willadino *et al.,* 1996) and DNA, RNA and protein stabilization (Bestford *et al.,* 1991).

Moreover, it may be suggested that the increase in fruit growth, yield and its components which detected by heat-stressed plants in the presence of putrescine application might be due to anti-senescence property of putrescine as it was demonstrated in many plants that putrescine inhibit senescence which induced by heat or water stress. In this respect, Rudulier and Goas (1980) mentioned that polyamines may retard senescence *via* their interaction with membranes. In addition, increased membrane fluidity is known to be associated with senescence and polyamines may thus, retard senescence by reducing this tendency (Friedman *et al.,* 1983).

Furthermore, it might be assumed that the improvement of yield under heat stress conditions by putrescine treatment could be due to increase endogenous polyamines concentration which is required for the normal development of reproductive structures (Prakash and Prathapasenan, 1988) or to inhibit the production of a senescence-promoting hormone (ethylene) which accelerates fruit ripening (Yang, 1987). Free polyamines inhibited ethylene production in tomato pericarp (Saftner, 1989).

Therefore, the results indicated that diamine putrescine is useful treatment in increasing yield and its components as well as significantly decreased non-marketable tomato yield grown in May under the heat stress conditions in the late summer season. Thus, it worth to mention that foliar application of putrescine at concentration of 1 mg /l. overcome, to some extent, the harmful effects induced by the adverse conditions of heat stress which prevailing during this period of year.

Concerning the effects of silicon treatments on yield and its components under the heat stress conditions, it is clear from the results that foliar application of silicon's powder as well as sodium meta silicate treatments especially in the 2nd season of the late summer season tended to increase yield and its components but this increase did not reach to a significant level. Similar results were obtained by Yadav and Pandey (1997) working on wheat.

4-Chemical composition of tomato fruit:

Results of the two early summer seasons:

Data in Table 6 indicate that, all applied treatments [Biomagic®, Yeast (foliar), Yeast (soil), Yeast (foliar+soil), Acadian Seaplants®, Foliafeed D®, the trial (experimental) compound fertilizer, putrescine, silicon's powder as well as sodium meta silicate] showed significant and non significant increases on total sugars concentration of tomato fruits in the two successive early summer seasons when compared to the control untreated plants.

Similar results were reported by many workers concerning the effects of Biomagic®, Baker's Yeast solution and Acadian Seaplants® on total sugars concentration like, El – Asdoudi (1993), Abedel–Aziz (1997) and Gupta and Gupta (2004) working on tomato fruits and Ismail (2002) working on pea plants and Biomagic as well as Igbokwe *et al.* (1990) working on tomato and spraying the seaweed extract fertilizer.

Furthermore, the favorable effects of Foliafeed (D)® and compound fertilizer treatments on total sugars concentration of tomato fruit, are in agreement with those reported by Dube and Chatterjee (1999), Kolota and Osinska (2000) as well as Chapagain and Wiesman (2004) working on tomato fruit.

The favorable effects of putrescine foliar application treatment on total sugars concentration of tomato fruit were in harmony with those obtained by Malik *et al.* (2003) working on mango fruits as well as Zheng and Zhang (2004) working on *mandarin* fruits.

The enhancement effect of silicon's powder as well as sodium meta silicate foliar application on total sugars concentration of tomato fruit were in agreement with those obtained by Kim *et al.* (2003) and Lee *et al.* (2004) working on tomato.

Results of the two late summer seasons:

Data in Table (6) reveal that under the heat stress conditions all applied treatments [Biomagic®, Yeast (foliar), Yeast (soil), Yeast (foliar+soil), Acadian Seaplants®, Foliafeed D®, the trial (experimental) compound fertilizer, putrescine, siliconوs powder as well as sodium meta silicate] showed non-significant increases on total sugars concentration of tomato fruit during the two late summer seasons as compared to the control untreated plants.

Table (٦): Effect of different treatments on total sugar concentrations (mg/ g dry weight) of tomato leaves and fruits during 2002 and 2003 seasons.

Treatments	First season ٢٠٠٢						Second season 2003					
	Early		Late		Total sugar in fruits		Early		Late		Total sugar in fruits	
	Days after transplanting											
	60	90	40	70	Early	Late	60	90	40	70	Early	Late
Control	28.2	30.1	47.2	38.5	232.7	290.9	33.2	36.1	45.1	37.1	246.1	280.9
®Biomagic	32.2	33.7	44.5	50.6	305.3	333.0	39.3	42.4	46.1	48.8	307.6	318.0
Yeast (Foliar)	28.5	28.2	32.1	29.1	240.7	312.9	32.9	30.5	37.8	33.9	255.5	292.9
Yeast (Soil)	31.3	37.3	48.8	49.8	288.9	331.0	34.2	38.8	39.9	43.3	3.13.0	317.0
Yeast (Foliar + Soil)	27.8	34.3	37.9	39.3	264.8	325.0	29.7	40.0	40.7	44.1	283.5	307.0
Acadian®`	32.0	35.6	43.5	34.5	315.6	315.0	36.4	42.8	41.7	35.7	300.9	290.9
Foliafeed (D)®	34.6	37.9	43.1	43.9	260.8	327.0	38.4	41.8	38.2	43.7	298.3	304.9
Comp. fertilizer	31.6	41.1	41.5	48.9	310.2	317.0	34.1	47.0	43.1	48.2	353.1	298.9
Putrescine	29.3	32.2	54.4	46.3	270.1	323.0	35.4	41.2	52.6	49.6	284.9	316.9
Silicon	28.6	34.1	45.7	43.5	279.5	307.0	32.8	43.6	42.1	42.1	295.3	294.9
Sodium meta silicate	-----	-----	-----	-----	-----	-----	33.3	40.3	37.9	39.7	278.2	286.9
D. S. L. (٠,٠٥)	**N. S.**	٥,٣٧	٦,٢٠	٤,٩٨	٤٤,٤٤	**290.9**	**N. S.**	٤,٨٧	٤,٨١	٥,١٦	٥١,١٩	**N.S.**

The favorable of effects of foliar application with Biomagic®, Baker's Yeast solution and Acadian Seaplants® on total sugars concentration of tomato fruit under heat stress conditions which contain cytokinin, indole acetic acid and gibberellins applied to the flowers may supplement the deficiency of endogenous hormones in tomato plants leading to stimulate total sugars concentration of tomato fruit which is considered an important parameter for production. Similar results that obtained with El-Habbasha *et al.* (1999) working on tomato.

Moreover, the favorable effects of Foliafeed (D)® and compound fertilizer treatments on total sugars concentration of tomato fruit were similar to that obtained by Dube and Chatterjee (1999) working on tomato as well as Hanafy Ahmed *et al.* (2005) working on flax and Foliafeed C®.

Concerning the enhancement effects of foliar application of putrescine on total sugars concentration of tomato fruit under heat stress conditions, are in harmony with those obtained by Botella *et al.* (2000) working on tomato and Talaat (2003) working on sweet pepper fruits under both non- saline or saline soil conditions.

The favorable effects of silicon treatments on total sugars concentration of tomato fruit under heat stress conditions were similar to that result obtained by Stamatakis *et al.* (2003) working on tomato fruits.

5- Chemical composition of tomato plants:

5-1- Total sugars composition in tomato leaves:

Results of the two early summer seasons:

Data in Table 6 indicate that, total sugars concentration in tomato leaves showed non-significant difference as a result of all applied treatments at 60 D. A. T. during the two early summer seasons. However, the total sugars concentration showed significant increase in tomato leaves in the 2nd sample as resulted of treated tomato plants with Yeast (soil) application of the 1st season. Application of Biomagic®, putrescine as well as silicon׳s powder treatments showed significant increases on total sugars concentration in the 2nd sample of the 2nd season. Also, Acadian Seaplants®, Foliafeed D® as well as compound fertilizer showed significant increases on the total sugars concentration in the 2nd samples of the two early summer seasons when compared to the control untreated plants.

Similar results obtained with Biomagic®, Yeast and Acadian Seaplants® on total sugars concentration in tomato leaves were similar to that obtained by Ismail (2002) working on pea.

Furthermore, the favorable effects induce by Foliafeed D® and compound fertilizer treatments on the total sugars concentration in tomato leaves, are in agreement with those reported by Gharibe and Hanafy Ahmed (2005) working on pea. In this concern, Mengel and Viro (1974) postulated that tomato plants supplied with higher potassium assimilated higher amounts of labeled CO_2. Moreover, they mentioned that higher levels of K nutrition increased the translocation rate of photosynthates. Mengel and Kirkby (1987) postulated that Mn is involved in the oxidation-reduction processes in the photosynthetic electron transport system. Also, they mentioned that boron play an essential role in sugar transport and in pentose phosphate pathway. Moreover, Achilea *et al.* (1999) working on tomato plants noticed that the most important function of potassium in plant metabolism is enzyme activation. Accumulation of carbohydrates and organic acids is highly depended on optimal photosynthesis the intensity of which is related to K status in the plant. The results of foliar application of putrescine at the rate of 1mg /l. on the total sugars concentration in tomato leaves are similar to that reported by Gharibe and Hanafy Ahmed (2005) working on pea.

Concerning the enhancement effects of silicon׳s powder and sodium meta silicate foliar application, on the total sugars concentration in tomato leaves were similar to that obtained by Gharibe and Hanafy Ahmed (2005) working on pea.

Results of the two late summer seasons:

It was evident from the results in the Table 6 that, application of Biomagic®, Yeast (soil), Foliafeed D®, compound fertilizer as well as putrescine (also, putrescine in the 1st two sample of the two late summer seasons) treatments showed significant increases on total sugars concentration in tomato leaves in the 2nd two samples of the two late summer seasons as compared to the control untreated treatment.

In this respect, it might be suggested that the favorable effects by using Biomagic®, Yeast as well as Acadian Seaplants® on total sugars concentration in tomato leaves under heat stress conditions may be induce indirectly due to enhancing plant hormones and vitamins productions, which indirectly implicating in improving total sugars concentration. In this respect, the favorable effects of beta-naphthoxyacetic acid (NOA) + GA_3 or NOA + GA_3 + zeatin under heat stress condition on carbohydrate formation and translocation of tomato plants were reported by Starck *et al.* (1989).

The enhancing effects of Foliafeed D® and compound fertilizer treatments on the total sugars concentration in tomato leaves under heat stress conditions were similar to that obtained by Dube and Chatterjee (1999) working on tomato leaves.

In this concern, Sherchand and Paulsen (1985) working on wheat under heat stress conditions suggested that foliar applications of KH_2PO_4 at the rates of 1 to 4 kg ha^{-1} increased cell sugar content and protected membranes. Moreover, Bergmann (1992) defined that soluble lower carbohydrate concentrations were generally lower in copper-deficient plants only during the initial stages of development and later when the plants ripening rose to levels above those of plants with an adequate copper status. Khurana and Chatterjee (2000) working on wheat (*Triticum aestivum*, L.) plants var. Sonalika defined that the deficiency of Mn (0.0055 mg/l.) decreased the concentration of sugars, starch and Hill-reaction activity.

Furthermore, the effect of heat stress conditions and putrescine foliar application on the total sugars concentration in tomato leaves were similar to that obtained by Hanafy Ahmed *et al.* (2002 a) working on *Myrtus communis*. Talaat and El-Din (2005) working on *Nigella sativa* L. plants under a pot experiment was carried out to study the effects of presowing heat stress in the presence and absence of the foliar application of putrescine (0, 1, or 5 mM) on the vegetative growth and chemical constituents of *N. sativa*. Putrescine at 5 mM combined with heat stress (50 degrees C) for 15 minutes significantly increased the total sugar contents of seeds.

The favorable effects of silicon's powder and sodium meta silicate foliar application, on the total sugars concentration in tomato leaves under heat stress conditions, were similar to that obtained by Carpita *et al.* (1990) pointed out that when cells exposed to osmotic stress they are directed to accumulate amino acids, sugars and other metabolically protective osmolites. Baker (1991) working on *Sorghum* plants reported that about 30.9 % or more of the observed osmotic adjustment could be attributed to sugars accumulation (glucose, fructose and sucrose). Amaregouda *et al*. (1994) working on groundnuts plants cv. Dh-3-30 were sprayed with 6 % silica powder at 45 day after sowing then withheld irrigation for 17 day. Content of reducing sugars was highest.

5-2- Amino acids composition

Results of the early summer season:

Data presented in Table 7 indicate that, all applied treatments [Biomagic®, Yeast (foliar), Yeast (soil), Yeast (foliar+soil), Acadian Seaplants®, Foliafeed D®, the trial (experimental) compound fertilizer, putrescine, silicon's powder as well as sodium meta silicate] increased essential, non-essential and total amino acids as well as total protein concentration in the leaves of tomato plants of the early summer season in the 2nd sample of the 2nd season.

T7

In this respect, Biomagic® treatment increased the concentration of individual essential amino acids (methionine, isoluecine, luecine and therionine) and non-essential amino acids (aspartic, glutamic, glycine, alanine, histidine and arginine), while, Yeast (foliar) application increased the individual essential amino acids (isoluecine) and non-essential amino acids (aspartic, serine, glutamic, glycine, histidine and arginine), Yeast (soil) increased individual essential amino acids (tyrosine) and non-essential amino acids (serine, glutamic proline, glycine, histidine and arginine), Yeast (foliar+soil) increased individual essential amino acids (methionine, valine, isoluecine, therionine, lysine and phenylalanine) and non-essential amino acids (serine, glutamic, glycine and arginine) as well as Acadian Seaplants® increased individual essential amino acids (cystine, isoluecine, luecine, threonine, lysine and phenylalanine) and non-essential amino acids (proline and histidine). In this connection, the concentration of amino acids of tomato leaves were increased in the following descending order by: foliar application of Biomagic®, Yeast (foliar+soil), Yeast (soil), Acadian Seaplants® as well as Yeast (foliar) when compared to the control untreated plants. Similar trends were obtained with Ismail (2002) working on pea and Biomagic®. The favorable effects by using Biomagic®, Yeast as well as Acadian Seaplants® may be induce indirectly due to enhancing plant hormones and vitamins productions, which indirectly implicating in improving amino acids concentration in tomato leaves. In this respect, Ramadan (2005) working on *Vicia faba* plants revealed that foliar spraying with GA_3 at 100 ppm induce a marked increase in all amino acids either essential (threonine, valine, luecine, iso-luecine, lysine, phenylalanine and tyrosine) and non-essential amino acids (aspartic, serine, proline, glycine, alanine, histidine and arginine) except for sulphur amino acids (cystine and methonine), which improved the quality of seeds also, the protein content in seeds.

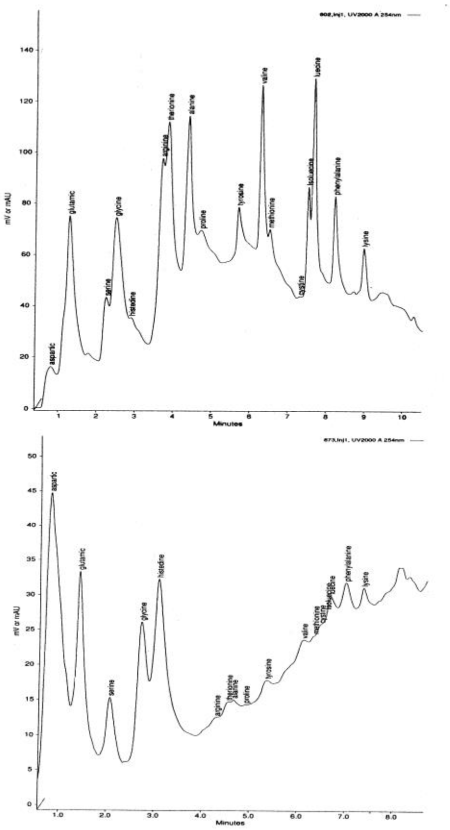
Moreover, the results reveal that Foliafeed D® increased individual essential amino acids (cystine, isoluecine, luecine, lysine and phenylalanine) and non-essential amino acids (glutamic, glycine and histidine). Furthermore, the treatment of compound fertilizer increased individual essential amino acids (isoluecine, luecine and lysine) and non-essential amino acids (glutamic, glycine, histidine and arginine). The data reveal the value on the total amino acids of the plants treated with Foliafeed D® was equal the trial (experimental) compound fertilizer treatment when compared to the control untreated plants. These results are in agreement with Hanafy Ahmed *et al.* (2002 b) working on *Sorghum* cultivars as well as Hanafy Ahmed *et al.* (2005) working on flax and Foliafeed C®.

Concerning the effects of putrescine application on the amino acids composition of tomato leaves the results indicate that putrescine increased individual essential amino acids (cystine, luecine, and lysine) and non-essential amino acids (aspartic, serine, glutamic, proline, glycine, histidine and arginine). Similar results were obtained with Özturk and Demir (2003) working on spinach leaves as well as Gharibe and Hanafy Ahmed (2005) working on pea cv. Master B. In this connection, Hanafy Ahmed *et al.* (2002 a) working on *Myrtus communis* found that polyamines application brought about a clear enhancement of free amino acids concentration in both shoots and roots. Also, the same authors mentioned that polyamines application enhancements proline concentration in both shoots and roots. In this respect, the authors suggested that putrescine as a diamine is involved in many important biological processes, such as ionic balance and DNA, RNA and protein stabilization, hence, leading to the enhancement of free amino acids and protein synthesis.

In addition, the results reveal that the treatment of siliconꞌs powder increased individual essential amino acids (methionine, valine, luecine, and therionine) and non-essential amino acids (aspartic, serine, glutamic, glycine, histidine and arginine) in tomato leaves, while the treatment of sodium meta silicate increased individual essential amino acids (isoluecine and lysine) and non-essential amino acids (aspartic, serine, glycine, histidine and arginine). Moreover, it is clear from the results that higher values of amino acids were recorded by the plant treated with siliconꞌs powder as compared with those treated with sodium meta silicate. Similar results were obtained with Hanafy Ahmed *et al.* (2002 c) working on wheat and Gharibe and Hanafy Ahmed (2005) working on pea.

Results of the late summer season:

As regard to the effect of heat stress conditions on the concentration of amino acids in tomato leaves, it is clear from the results that, all applied treatments [Biomagic®, Yeast (foliar), Yeast (soil), Yeast (foliar+soil), Acadian Seaplants®, Foliafeed D®, the trial (experimental) compound fertilizer, putrescine, siliconꞌs powder as well as sodium meta silicate] increased essential, non-essential and total amino acids as well as total protein concentration in the leaves of tomato plants of the late summer season at the 2nd sample of the 2nd season. Moreover, the results indicate that the treatment of Biomagic® (Table 7 and Fig. 1) increased individual essential amino acids (methionine, isoluecine, luecine, tyrosine, therionine and phenylalanine) and non-essential amino acids (proline, alanine and arginine), Yeast (foliar) increased individual essential amino acids (methionine, cystine, isoluecine and luecine) and non-essential amino acids (alanine), Yeast (soil) increased individual essential amino acids (methionine, cystine, isoluecine, luecine, lysine and phenylalanine) and non-essential amino acids (proline, glycine, alanine and arginine), Yeast (foliar+soil) increased individual essential amino acids (methionine, cystine, isoluecine, luecine, lysine and phenylalanine) and non-essential amino acids (proline, alanine and arginine) as well as Acadian Seaplants® increased individual essential amino acids (methionine, valine, luecine, tyrosine, lysine and phenylalanine) and non-essential amino acids (proline and alanine). The treatments were increased the concentration of amino acids in the following descending order by: foliar application of Acadian Seaplants®, Biomagic®, Yeast (soil), Yeast (foliar+soil), as well as Yeast (foliar) when compared to the untreated control (Table 7 and Fig. 1) plants. Similar results were obtained by Singh *et al.* (2000) working on *Senna* and total free amino acid.



Effect of control and Biomagic® on amino acids under heat stress conditions (Table 7 and Fig.1).

Concerning the enhancement effects of Foliafeed D® and compound fertilizer treatments under heat stress conditions on the concentration of amino acids in tomato leaves, the results indicated that Foliafeed D® treatment increased individual essential amino acids (methionine, cystine, isoluecine, tyrosine, therionine and lysine) and non-essential amino acids (aspartic and proline), while the trial (experimental) compound fertilizer treatment increased individual essential amino acids (methionine, isoluecine, luecine, tyrosine, therionine and phenylalanine) and non-essential amino acids (proline and alanine). In this respect, the values recorded by the foliar fertilizer application of Foliafeed D® treatment were more than the trial (experimental) compound fertilizer treatment. Similar finding were obtained by Eppendorfer and Bille (1996) working on beans, kale, spinach, cauliflower and potatoes as well as Liao *et al.* (2000) working on chicory and tomato.

Hanafy Ahmed *et al.* (2005) working on flax plant pointed out that Foliafeed C® decreases the main values of essential, non essential and total amino acids as well as crude protein in the shoot. However, there were increases in some amino acids like methionine, isoluecine, serine and therionine under saline soil when compared to the untreated plants.

As regard to the favorable effects induce by putrescine under heat stress conditions on the concentration of amino acids in tomato leaves, the data in Table 7 indicate that putrescine treatment increased individual essential amino acids (methionine, cystine, isoluecine, luecine, therionine, lysine and phenylalanine) and non-essential amino acids (proline and alanine). The value for putrescine treatment on total amino acids under heat stress increased to 1.93 folds as compared to the early summer season conditions. These results are in agreement with those obtained by Flores (1991) and Krishnamurthy (1991) working on rice plants. In this respect, Hanafy Ahmed *et al.* (2002 a) working on *Myrtus communis* mentioned that putrescine is a diamine involved in DNA, RNA and protein stabilization, hence, leading to the enhancement of free amino acids synthesis and accumulation under salinity stress conditions. In this connection many investigators pointed out that, higher plants accumulate free proline in response to external stress conditions. In this respect, Rabe (1990) indicate that nitrogenous compounds can accumulate in higher plants as a result of stress. Talaat (2003) working on sweet pepper plants mentioned that spraying putrescine at two levels, i.e., 1 or 2 ppm increased total free amino acids concentrations under both non-saline or saline soil conditions.

Additionally, Talaat and El-Din (2005) working on *Nigella sativa* L. plants under a pot experiment was carried out to study the effects of presowing heat stress in the presence and absence of the foliar application of putrescine (0, 1, or 5 mM) on the vegetative growth and chemical constituents of *N. sativa*. Putrescine at 5 mM combined with heat stress (50 degrees C) for 15 minutes significantly increased the total nitrogen and total protein contents of seeds.

Concerning the favorable effects of silicon under heat stress conditions on the concentration of amino acids in tomato leaves, it is clear from the results that silicon's powder treatment increased individual essential amino acids (methionine, isoluecine, luecine, lysine and phenylalanine) and non-essential amino acids (alanine and arginine). However, sodium meta silicate treatment increased individual essential amino acids (methionine, cystine, isoluecine, luecine and lysine) and non-essential amino acids (proline and alanine). In this respect, higher values of amino acids were detected by the plants treated with sodium meta silicate than those treated with silicon's powder. Similar trend, especially for proline obtained by Amaregouda *et al.* (1994) working on groundnuts plants cv. Dh-3-30 sprayed with 6 % silica powder. Mathur and Wattal (1995) recorded that proline indicate the degree of stress – induced injury and was not related to drought tolerance.

All applied treatments under heat stress increased some principal amino acids to overcome the adverse effects of heat stress conditions on tomato plants, in this respect, the plants subjected to most stressful environments show an increased level of total free amino acid. Proline seems to be the amino acid accumulated in the largest amounts in response to temperature stress. Proline, together with the other soluble nitrogenous compounds, serves as an osmoregulator in plants. The functional role of proline accumulation appears to be as a cytoplasmic osmoticum to lower cell water potential, provide hydration to biopolymer and sever as an energy and N source under adverse environmental conditions. In addition, to proline, other amino acids that accumulate under water stress are arginine, glycine, serine, alanine, leucine and valine. Water-stressed plants accumulate proline, alanine, arginine and phenylalanine which have a distinct correlation with the stress tolerance mechanism. Barley and radish plants exposed plants to high temperatures accumulated substantial amounts of proline. Various environmental stresses induced the accumulation of soluble nitrogenous compounds. The extent and nature of the compounds accumulated depend on the type of stress and the plant species. The levels of some of these compounds (i.e., amino acids and betaine) are associated with stress sensitivity or tolerance of the plant species (Pessaraki, 2002).

CONCLUSION

Concerning the favorable effects of the all different treatments generally, enhancing vegetative growth characters, fruit set (%), yield and its components (ton/ feddan), also the organic components i.e., total sugars, essential amino acids (isoluecine and lysine) and non-essential amino acids (serine, glutamic, glycine, histidine and arginine) and total amino acids as well as total proteins of tomato leaves. The greatest values of the two successive early summer seasons were obtained by treating tomato plants with application of Yeast (foliar+soil) as well as Biomagic® under the conditions of the two early summer seasons and when compared to control un-treated plants.

Furthermore, under the heat stress conditions, most of the treatments obtained similar trend as in the early summer season. However, the distinct increment achieved by using putrescine, Foliafeed (D)®, Biomagic® as well as Yeast (foliar+soil) in total sugars, essential amino acids (methionine, cystine, isoluecine, luecine and lysine), non-essential amino acids (proline and alanine) and total amino acids as well as total protein of tomato leaves were increased. Treating tomato plants with the previous treatments under heat stress conditions able to accumulate these compounds of amino acids which serve as osmoregulators, protect biomolecules, decrease the water potential of the cytoplasm and moisture uptake. Consequent Theses accumulation of amino acids increased the ability of tomato plants cv. Super Strain B of higher levels of tolerance under these hard conditions of heat stress also, the accumulating of these compounds is greater in tolerant plants than in sensitive ones.

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تـأثير المعاملـة بالبيوماجيـك والخميـرة والأعشـاب البحريـة والفوليافيـد والسـماد المركـب التجريبـى والبيتروسـين والسـليكون علـى النمـو والمحصـول والتركيـب الكيماوى لنبات الطماطم النامىى تحت ظروف العروة الصيفية المبكرة والمتأخرة

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أجريت تجربتين حقليتين بمحطة بحوث الخضر بمنطقة قها- محافظة القليوبية على نبات الطماطم صنف سوبر أسترين بى خلال العروة الصيفية المبكرة والعروة الصيفية المتأخرة لموسمى الزراعة ٢٠٠٢ و٢٠٠٣ بهدف دراسة تأثير الرش بالمنشط الحيوى البيوماجيك (٧,٥ جم/لتر) ومحلول خميرة الخباز: *Saccharomyces cerevisiae* (١٠ سم٣/لتر) - سواء بالرش على المجموع الخضرى أو بالتلقيح بجوار المجموع الجذرى أو بالرش على المجموع الخضرى والتلقيح بجوار المجموع الجذرى معاً أو الرش بمستخلص الأعشاب البحرية (الأكادين) *Ascophyllum nodosum* (لتر/فدان) أو بسماد العناصر الصغرى الفوليافيد - د (٠,٦٢٥ جم/لتر) أو الرش بالسماد المركب (٥ جم/لتر) أو الرش بمادة البيتروسين (١ ملجم/لتر) أو بمسحوق الرمل الخام (١ جم/لتر) أو بمادة الصوديوم ميتا سليكا (١ جم/لتر). بهدف دراسة تأثير هذه المواد على بعض صفات النمو الخضرى والتبكير فى إزهار ٥٠ ٪ وعدد العناقيد ونسبة العقد ٪ كذلك دراسة تأثيرها على المحصول ومكوناته مثل المحصول المبكر والتسويقى والغير تسويقى والكلى (طن/ فدان) وتقدير السكريات الكلية والأحماض الأمينية الأساسية والغير أساسية والكلية والبروتين الكلى كما تم تقييم دور كل من هذه المعاملات مرة أخرى خلال العروة الصيفية المتأخرة فى شهر مايو (تحت ظروف الحرارة المرتفعة) لزيادة القدرة الأنتاجية لهذا الصنف. هذا وقد تم أخذ عينتين للنمو الخضرى عند عمر ٦٠ و٩٠ يوم للعروة الصيفية المبكرة وعند ٤٠ و٧٠ يوم للعروة الصيفية المتأخرة من زراعة شتلات الطماطم. ولقد أكدت النتائج المتحصل عليها فى العروة الصيفية المبكرة أن معظم المعاملات أدت الى زيادة معنوية وغير معنوية فى معظم الصفات المأخوذة. وكانت أفضل المعاملات المعاملة بمحلول خميرة الخباز (رشاً على المجموع الخضرى مع التلقيح بجوار المجموع الجذرى) والمنشط الحيوى البيوماجيك. بينما أدت المعاملات بكل من البيوماجيك والرش بمسحوق الرمل الخام والسماد المركب الى التبكير فى إزهار ٥٠ ٪ فى الموسم الأول. بينما أدت المعاملة بكل من البيوماجيك ومسحوق الرمل الى أعلى زيادة فى المحصول المبكر. كما أدت جميع المعاملات الى زيادة معنوية فى صفة متوسط وزن الثمار فيما عدا معاملة البيتروسين أومحلول خميرة الخباز. كذلك أدت معظم المعاملات الى زيادة السكريات وزيادة تركيز الأحماض الأمينية الكلية ومنها الأساسية (الأيزوليوسين والليوسين) والغير أساسية (السرين والجلوتاميك والجليسين والهيستدين والأرجنين) الى جانب البروتين الكلى ٪.

أما بالنسبة العروة الصيفية المتأخرة غقد تحسنت معظم صفات النمو الخضرى المدروسة مثل أرتفاع النبات وعدد الأفرع الجانبية والأ وراق مقارنةً بالعروة الصيفية المبكرة بينما لم تؤدى أى من المعاملات المختلفة الى حدوث أى فرق معنوى فى تبكير إزهار ٥٠٪ بينما أزداد عدد العناقيد مع أنخفضت نسبة العقد ٪ والمحصول ومكوناته (المحصول المبكر والتسويقى والكلى) بينما أزدادت معدلات الأصابة بمرض عفن الطرف الزهرى كمحصول غير تسويقى نتيجة أرتفاع درجة الحرارة فى هذا الوقت من السنة وكانت أفضل المعاملات هى الرش بالبيتروسين وسماد العناصر الصغرى الفوليافيد (د) والمنشط الحيوى البيوماجيك وأيضاً محلول خميرة الخباز بالرش على المجموع الخضرى والتلقيح بجوار المجموع الجذرى معا. كما أدت جميع المعاملات تحت ظروف الحرارة العالية الى زيادة معنوية فى متوسط وزن الثمرة ما عدا المعاملة بالرش بمحلول خميرة الخباز أومسحوق السليكون أوالصوديوم ميتا سليكات مقارنة بوزن ثمار نباتات الكنترول فى الموسم الثانى. زد تركيز السكريات الكلية فى الأوراق وكانت أفضل المعاملات هى الرش بالبيتروسين بمعدل ١ملجم/لتر والأحماض الأمينية الكلية ومنها الأساسية (الميثونين والسيستين والأيزوليوسين والليوسين واليسين) والغير أساسية (البرولين والألنين) والبروتين الكلى ٪ حيث أزدادت بدرجة ملحوظة مقارنة بالعروة الصيفية المبكرة وبنباتات الكنترول.

Table (7): Effect of different treatments on essential, non-essential and total amino acids (g/ 100 g dry weight sample) as well as total protein % of tomato leaves in the 2nd season of early and late 2003 season at 90 and 70 days after transplanting.

Treatments	Periods	Essential amino acids										Non-essential amino acids										
		Methionine	Cystine	Valine	Isoluecine	Luecine	Tyrosine	Therionine	Lysine	Phenylalanine	Total essentia A. A.	Aspartic	Serine	Glutamic	Proline	Glycine	Alanine	Histedineene	Arginine	Total non-essential A. A	Total amino acids	Total protein
Control	Early	0.102	0.037	0.065	0.037	0.040	0.122	0.039	0.032	0.087	0.561	0.032	0.008	0.012	0.018	0.000	0.282	0.000	0.047	0.399	0.960	**12.2**
	Late	0.040	0.041	0.168	0.047	0.060	0.132	0.048	0.058	0.164	0.758	0.300	0.081	0.168	0.012	0.061	0.117	0.237	0.083	١,٠٥٩	1.288	**18.3**
	Mean	0.080	0.039	0.117	0.042	0.050	0.127	0.044	0.045	0.126		0.216	0.045	0.09٠	0.015	0.031	0.200	0.169	0.065			
Biomagic®	Early	0.126	0.029	0.031	0.082	0.070	0.028	0.069	0.012	0.045	0.490	0.090	0.018	0.076	0.020	0.056	0.392	0.048	0.098	0.798	1.440	**14.8**
	Late	0.225	0.030	0.129	0.085	0.148	0.305	0.150	0.050	0.200	1.322	0.053	0.044	0.176	0.118	0.085	0.408	0.117	0.117	1.118	2.4400	**21.9**
	Mean	0.176	0.030	0.105	0.084	0.109	0.167	0.110	0.031	0.123		0.072	0.031	0.126	0.069	0.071	0.400	0.083	0.108			
Yeast (Foliar)	Early	0.027	0.016	0.029	0.087	0.022	0.042	0.019	0.042	0.042	0.326	0.139	0.019	0.023	0.018	0.049	0.229	0.021	0.075	0.573	0.899	**16.5**
	Late	0.164	0.087	0.151	0.125	0.092	0.151	0.061	0.038	0.090	0.959	0.251	0.015	0.095	0.015	0.026	0.394	0.049	0.072	0.917	1.876	**20.1**
	Mean	0.096	0.052	0.090	0.106	0.057	0.097	0.040	0.040	0.066		0.195	0.017	0.059	0.017	0.038	0.312	0.035	0.074			
Yeast (Soil)	Early	0.085	0.032	0.062	0.033	0.040	0.153	0.053	0.035	0.042	0.535	0.023	0.026	0.124	0.061	0.049	0.233	0.063	0.090	0.669	1.204	**14.3**
	Late	0.099	0.095	0.088	0.153	0.102	0.124	0.062	0.084	0.208	1.015	0.197	0.073	0.091	0.080	0.095	0.431	0.073	0.237	1.277	2.292	**18.8**
	Mean	0.092	0.064	0.075	0.093	0.071	0.139	0.058	0.060	0.125		0.110	0.050	0.108	0.071	0.072	0.332	0.068	0.164			
Yeast (Foliar + Soil)	Early	٠,٠٥٩	٠,٠٣٢	0.108	٠,٢٢١	٠,٠٠٥	٠,٠٥٤	٠,١٦٧	٠,٠٦٥	٠,١٢٩	0.840	٠,٠٢٧	٠,٠٢٢	0.038	٠,٠١٦	٠,٠١١	٠,٢٥٣	٠,٠٠٥	٠,٠٧٠	0.442	1.282	**12.4**
	Late	0.096	0.122	0.077	0.218	0.102	0.134	0.058	0.090	0.230	1.127	0.032	0.064	0.083	0.083	0.064	0.384	0.070	0.262	1.042	2.169	**18.6**
	Mean	0.078	0.077	0.093	0.220	0.054	0.094	0.113	0.078	0.180		0.030	0.043	0.061	0.050	0.038	0.319	0.038	0.166			
Acadian®	Early	0.113	0.091	0.084	0.166	0.081	0.043	0.072	0.066	0.178	0.894	0.004	0.005	0.004	0.112	0.005	0.102	0.020	0.052	0.304	1.198	**15.4**
	Late	0.067	0.053	0.358	0.068	0.171	0.240	0.051	0.083	0.238	1.329	0.233	0.030	0.149	0.054	0.038	0.508	0.034	0.098	1.144	2.473	**22.2**
	Mean	0.090	0.072	0.221	0.117	0.126	0.142	0.062	0.075	0.208		0.119	0.018	0.077	0.083	0.022	0.305	0.027	0.075			
Foliafeed (D)®	Early	0.041	0.077	0.065	0.125	0.065	0.120	0.026	0.065	0.132	0.716	0.031	0.010	0.036	0.024	0.017	0.082	0.024	0.062	0.286	1.002	**13.0**
	Late	0.064	0.072	0.109	0.125	0.078	0.185	0.098	0.089	0.176	0.996	0.726	0.098	0.154	0.051	0.036	0.129	0.016	0.066	1.276	2.272	**22.1**
	Mean	0.053	0.075	0.087	0.125	0.072	0.153	0.062	0.077	0.154		0.379	0.054	0.095	0.038	0.027	0.106	0.020	0.064			
Comp. fertilizer	Early	0.044	0.021	0.037	0.105	0.043	0.055	0.013	0.057	0.064	0.439	0.106	0.012	0.036	0.026	0.055	0.230	0.020	0.085	0.570	1.0099	**13.1**
	Late	0.228	0.033	0.116	0.077	0.138	0.249	0.133	0.050	0.120	1.144	0.094	0.036	0.204	0.106	0.084	0.360	0.063	0.125	1.072	2.216	**21.3**

	Mean	0.136	0.027	0.077	0.091	0.091	0.152	0.073	0.054	0.092		0.100	0.024	0.120	0.066	0.070	0.295	0.042	0.105			
	Early	0.035	0.120	0.041	0.044	0.090	0.037	0.050	0.057	0.094	0.568	0.122	0.015	0.065	0.044	0.026	0.176	0.041	0.137	0.626	1.194	**14.6**
Putrescine	**Late**	0.197	0.037	0.127	0.092	0.095	0.141	0.086	0.099	0.219	1.093	0.207	0.049	0.032	0.066	0.055	0.644	0.072	0.083	1.208	2.301	**23.2**
	Mean	0.116	0.079	0.084	0.068	0.093	0.089	0.068	0.078	0.157		0.165	0.032	0.049	0.055	0.041	0.410	0.057	0.110			
	Early	0.143	0.008	0.096	0.054	0.066	0.032	0.066	0.006	0.010	.٠481	0.121	0.030	0.065	0.012*	0.029	0.264	0.098	0.121	0.740	.١221	**١٥,٠**
Silicon	**Late**	0.224	0.065	0.115	0.085	0.175	0.151	0.068	0.093	0.209	1.185	0.075	0.018	0.072	0.019	0.025	0.336	0.025	0.171	0.741	1.926	**18.9**
	Mean	0.184	0.037	0.106	0.070	0.121	0.092	0.067	0.050	0.110		0.098	0.024	0.069	0.016	0.027	0.300	0.062	0.1466			
	Early	0.023	0.023	0.040	0.127	0.048	0.038	0.017	0.110	0.085	0.511	0.097	0.015	0.007	0.020	0.050	0.261	0.015	0.107	0.572	1.083	**14.3**
Sodium meta silicate	**Late**	0.103	0.161	0.082	0.235	0.128	0.151	0.066	0.095	0.168	1.189	0.012	0.021	0.016	0.202	0.037	0.486	0.018	0.091	0.883	2.072	**19.6**
	Mean	**0.063**	**0.092**	**0.061**	**0.181**	**0.088**	**0.095**	**0.042**	**0.103**	**0.127**		**0.055**	**0.018**	**0.012**	**0.111**	**0.044**	**0.374**	**0.017**	**0.099**			

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