Effect of some natural materials and nutrients on vegetative growth of tomato (*lycopersicon esculentum mill*) plants under high temperature conditions

By

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ABSTRACT

Two field experiments were conducted at the experimental farm station of the Faculty of Agriculture, Benha University, during late summer seasons of 2006 and 2007. Tomato plants cv. super strain B were sprayed with yeast extract at 15 and 30 ml/L; marjoram extract at 15 and 30 ml/L and amino acids at 1.5 and 3 ml/L; vitamin E at 100 mg/L + selenium at 400μ/L; vitamin E at 200μ/L + selenium at 800μ/L; citric acid at 2.5 and 5 g/L; vitamin E at 100 mg/L + selenium at 400μ/L + citric acid at 2.5 g/L.; vitamin at 200 mg/L + selenium at 800μ/L+ citric acid at 5g/L; Boron at 25 and 50 mg/L; Zn at 50 and 100 mg/L after 15 days from transplanting. Treatments were done separately,. spraying was repeated 5 times with intervals of 15 days after the first one. This study aimed to investigate the effect of these treatments on vegetative growth after 50 days from transplanting during the two seasons.

The results showed that, significant increase was existed in many growth aspects as stem length and diameter, number of formed branches and leaves/plant, fresh and dry weight of both stems and leaves, total leaf area/plant and specific leaf weight as well with all applied treatments at 50 days after transplanting during the two seasons. The yeast extract 30 ml/L, amino acids 3 ml/L ,Boron 25ml/L and Zinc 50ml/L.were the most effective compared with other treatments in this respect. Also, it increased the number of branches/plant more than two times of the control value.

INTRODUCTION

The tomato (*Lycopersicon esculentum Mill*) is one of the most popular vegetables as well as one of the most important. It is known as a favorite vegetable crop, rich in antioxidants, vitamins and minerals for human diet. In Egypt, the late summer market tomato crop yielded from transplants raised from open field during May upon July. During this period, temperatures can exceed 35°C under field conditions (heat stress). This heat stress due to increased temperature is an agricultural problem in many areas in the world. Transitory or constantly high temperatures cause an array of morphological, physiological and biochemical changes in plants, resulting in either non-uniform growth and poor fruit yield or even completely failure of tomato cropping in a great part of the cultivated area. **El-Desouky, *et al.*, (2000); Pressman *et al.*, (2002); Adil *et al.*, (2004); Vollenweider and Gunthardt-Goerg (2005) and Wahid *et al.*, (2007)**. Recently it was demonstrated that all environmental stresses, heat, cold, light, salt and etc. can induce additional serious internal physiological stress. This internally inducible stress known as oxidative one, the internally generated reactive oxygen species (ROS) (Toxic oxygen free radicals), those were the main factor beyond all the heat and other stresses related disturbances. Also, it was stated that oxygen stress tolerance considered as an important factor for all stresses tolerance.

High temperature stress either accelerates the formation of toxic ROS levels with in plant tissues or impairs the normal defense mechanisms that protect tissues from ROS toxic effect. Such stress induce higher O_2 photo-reduction within chloroplasts, or electron transport disturbance, and donation of electron to O_2 within mitochondria all led to generation of toxic ROS **Van Breusegem *et al.*, (2001); Stepein and Grazyna (2005) and Xu *et al.*, (2006)**.

Those ROS (H_2O_2, OH, O_2, ……..) damaged chloroplasts, reduced carbohydrate synthesis and exportation and hastened oxygen senescence **Sairam and Tyagi (2004) and Wahid *et al.*, (2007)**, attack cell membranes lead to their degradation and leakage of cell solutes, denaturation of proteins and enzymes, damage of nucleic acids, degradation of chlorophyll and suppression of all metabolic process, finally senescence and death of cells and tissues **Howarth (2005) and Guo *et al.*, (2006).**

Recently, also, it was known that plants can be defense against such oxidative effects via groups of naturally occurring or exogenously applied substances known as antioxidants or oxygen free radicals scavengers.

Antioxidants, i.e. vitamins A, C and E, carotenoids, phenols, glutathione, citric acid, selenium, Zn, Cu and etc… due to their molecules auto (ox-redox) properties acts as cofactors for some specific enzymes, i.e., dismutases, catalases, peroxidases, those catalyzed breakdown of the toxic (H_2O_2), (OH), (O_2) radicals **(Lascaris and Deacon, 1991; Romheld and Marschner, 1991; Bowler *et al.*, 1992; Elad, 1992; Aono *et al.*,(1993); Fathy *et al.*, 2003 and Wahid *et al.*, 2007).**

The main aim of this work to alleviate the adverse effects of high temperature and its probable accompanied oxidative stress on tomato plant towards improving their morphological and metabolical performances by using some antioxidants as boron, zinc, vitamin E, citric, yeast extract, marjoram extract and amino acids also to focus and study interrelationship between them to know more about the mechanism by which tomato plant tolerate such conditions.

MATERIALS AND METHODS

Two field experiments were conducted at the experimental farm station of the Faculty of Agriculture, Benha University, during late hot summer seasons of 2006 and 2007. In order to study effect of some mineral nutrients, natural and organic safe agents (some antioxidants or oxygen free radicals scavengers) on the morphological characteristics of tomato (*Lycopersicon esculentum* Mill. cv. Super strain B) plants towards maximizing its growth during the hot late summer season. Also to focus and study the interrelationship between them to know more about the mechanism by which tomato plant tolerate such condition.

At the beginning of May during the two seasons, tomato transplants 45 day after sowing were transplanted in open field at 30cm apart on one side of ridge 3.5m long and 1m wide, experimental unit area was $10.5m^2$. Randomized complete block design in three replicates was adopted herein.

Plants were treated (sprayed) 5 times with any of different treatments, the first one was 15 days after transplanting and again each 15 days intervals. All cultural practices were performed as recommended. Treatments were as follows:

1. Yeast extract at 15 and 30 ml/L
2. Marjoram extract at 15 and 30 ml/L
3. Amino acids at1.5 and 3 ml/L
4. Vitamin E at 100 mg/L + Selenium at 400µg/L
5. Vitamin E at 200 mg/L + Selenium at 800µg/L
6. Citric acid at 2.5 and 5g/L
7. Vitamin E at100 mg/L + Selenium at 400µg/L + Citric acid at 2.5 g/L

8. Vitamin E at 200 mg/L + Selenium at 800µg/L + Citric acid 5g/L

9. Boron at 25 and 50 mg/L in form of Boric acid (16%B).

10. Zinc at 50 and 100 mg/L in form of Zinc citrate (12% Zn).

11. Control (untreated).

Amino acids composition:

Spanish compound known as delfan was used as a source for amino acids mixture which:

Technical characteristics

- Free amino acids: (34.5% w/w).
- Organic nitrogen: (3% w/w).
- Organic matter: (20% w/w).
- Colour: Brown.
- Total nitrogen: (4.3% w/w).
- Organic carbon: (9% w/w).
- Presentation: Soluble liquid (SL).

Its amino acids content (g. amino acids/ 100 g muestra) as follows:

Aspartic	2.3	Glutamic	4.2	Serine	2.8
Glycine	4.6	Histidine	0.3	Argnine	2.6
Threionine	1.2	Alanine	2.5	Proline	2.8
Tyrosine	0.9	Cystine	0.2	Valine	1.8
Methionine	0.2	Iso-Leucine	1.1	Leucine	2.1
Phenyl-alanine	1.1	Hidroxiproline	2.7	Lysine	1.1

The compound were obtained from Techno green group Cairo, Egypt.

Climatological data:

Maximum and minimum air temperature were recorded monthly after Shebeen El-Kanater weather station and indicated in Table (1).

Table (1): Monthly air temperature mean in Shebeen El-Kanater during summer seasons of 2006 and 2007.

Months	Air temperature °C			
	2006		2007	
	Max.	Min.	Max.	Min.
May	31.5	18.7	31.1	18.9
June	35.0	20.8	36.9	21.7
July	36.6	22.5	38.4	23.5
August	37.9	23.7	37.3	23.1
September	35.8	22.0	35.0	24.4

Sampling and collecting data:

I- Morphological characteristics:

Different morphological characteristics of tomato plants at 50 days after transplanting (i.e. the time of start flowering) were measured and calculated. Nine plants from each treatment were randomly taken for measurements.

The following characteristics were inspected:

- Plant height (cm).
- Stem diameter (cm) at the first internode.
- Number of branches / plant.
- Number of leaves / plant.
- Total fresh and dry weight of main stem and branches (g) / plant.
- Total" fresh and dry weight of leaves (g) / plant.
- Total fresh and dry weight of shoots (g) / plant.
- Total leaf area (cm^2) / plant using the disk method according to ***Derieux et al.*, (1973).**

Statistical analysis: Data of morphological characteristics were statistically analyzed and the means were compared using the least significant difference test (L.S.D) at 5% and 1% levels according to **Snedecor and Cochran (1989)**.

RESULTS AND DISCUSSION

I. Vegetative growth characteristics (morphological performance) at 50 days after transplanting:

I.I. plant height, stem diameter and fresh weight of stems and leaves:

Data in Table (2) clearly indicate that all applied treatments were significantly increased different estimated characteristics (i.e., plant height, stem diameter and the fresh weight of each of stems and leaves) of tomato compared with those of the control during late summer season which heat stress occur. In case of all treatments were increased to reach the highest level of significance in the two seasons. The exceptions were only that insignificant increase of plant height in case of citric acid (5g/L.) and stem fresh weight in case of marjoram extract (30 ml/L.), citric acid (2.5&5 g/L.) and Boron (25 mg/L) during the two seasons.

The most superior treatments were the yeast extract (30 ml/L.), amino acids (3 ml/L.), Zn (50 mg/L.) respectively at the two seasons. These results are of great interest, because at this early stage of growth great simulative positive differences existed with various applied treatments. Since, that could be prolonged to the advanced growth stages including each of flowering and the final fruit yield as well as the high quality of yielded fruits. Also, of interest to note that increase existed in stem diameter and that being preceded with basic anatomical modification in different stem tissues. Moreover, that could be accompanied with great variations in the nature of tomato branching. Furthermore, some of the estimated growth characteristics in case of yeast extract (30 m/L.) reached more than three times of the control. In this respect, in few other studies, some natural extracts have been applied to some economic plants as new trends for enhancing the plant growth, increasing the final yield and improving its quality as well as diminishing the amount of applied fertilizers of these studies are **Fathy *et al.*, (2000), Wanas (2002) and El-Tohamy and El-Greadly (2007).**

It was obvious from the same data that control plants were strongly stressed, they were morphologically suppressed as they were physiologically stressed. They were developed no mechanism by which they protected against the prevailing higher temperature stress and its probable inducible oxidative one **(Cakmak & Marschner, 1992 and Elestner & Osswald, 1994).**

Table (2): Effect of different applied treatments on some morphological characteristics of tomato (*Lycopesicon esculentum*, Mill.) Plants at 50 days after transplanting during 2006 and 2007 seasons.

Characters / Treatments	Plant height (cm)		Stem diameter (cm)		Stems fresh weight (g/plant)		Leaves fresh weight (g/plant)		Shoots fresh weight (g/plant)	
	Seasons									
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
1. Yeast extract at 15 ml/L.	42.80	43.93	1.13	1.10	36.33	36.97	107.23	106.97	143.57	143.93
2. Yeast extract at 30 ml/L.	63.77	66.47	1.33	1.33	114.60	130.23	253.97	220.80	368.57	351.03
3. Marjoram extract at 15 ml/L.	50.57	51.63	1.17	1.17	45.70	46.63	108.57	111.40	154.27	158.03
4. Marjoram extract at 30 ml/L.	45.93	51.40	1.07	1.17	32.33	33.70	98.27	90.27	130.60	123.97
5. Amino acids at 1.5 ml/L.	52.87	54.33	1.20	1.27	60.30	58.60	157.80	145.73	218.10	204.33
6. Amino acids at 3 ml/L.	50.50	45.60	1.33	1.37	56.63	60.27	172.30	162.33	228.93	222.60
7. Vit. E at 100 mg/L. + Sel. at 400µg/L.	43.30	43.70	1.20	1.23	49.67	50.97	117.33	119.67	167.00	170.67
8. Vit. E at 200 mg/L. + Sel. at 800µg/L.	50.37	51.83	1.10	1.13	39.40	43.57	124.83	126.57	164.23	170.13
9. Citric acid at 2.5g/L.	47.30	47.20	1.07	1.10	29.73	31.47	72.97	75.03	102.70	106.50
10. Citric acid at 5 g/L.	39.50	39.80	0.97	1.03	27.07	25.90	71.07	69.23	98.13	95.13
11. Vit. E at 100 mg/L. + Sel. at 400µg/L. + Citric acid at 2.5 g/L.	42.80	43.73	1.03	1.13	36.37	37.03	93.30	95.33	129.67	132.37
12. Vit. E at 200 mg/L. + Sel. at 800µg/L. + Citric acid at 5 g/L.	51.97	52.43	1.17	1.10	46.43	45.70	118.83	121.07	165.27	166.77
13. B at 25 mg/L.	41.30	45.97	1.07	1.13	27.10	29.27	91.77	101.07	118.87	130.33
14. B at 50 mg/L.	43.23	42.27	1.23	1.23	43.90	48.60	145.70	150.87	189.60	199.47
15. Zn at 50 mg/L.	51.37	51.47	1.17	1.27	50.67	62.90	150.77	142.47	201.43	205.40
16. Zn at 100 mg/L.	46.77	43.73	1.03	1.07	44.17	43.77	108.10	118.73	152.27	162.50
17. Control	37.27	38.23	0.73	0.77	20.37	22.53	47.03	55.97	67.40	78.50
L.S.D. 0.05	2.71	2.25	0.14	0.15	13.12	9.56	5.77	15.38	13.98	18.95

I.2. Branches and leaves characteristics:

As shown in Table (3) different estimated growth characters such as number of branches and leaves and leaf area per plant were increased to reach the high level of significance with different applied treatments. The exception was only that insignificant increase of leaf area / plant with the two concentration of citric acid during the two seasons and leaf area ratio /plant in case of amino acids (1.5 ml/L.) during 2007 season.

Also, it could be noticed that each of yeast extract (30 ml/L.), amino acids (3 ml/L.), Boron (50 mg/L.) and zinc (50 mg/L.) as well increased number of branches more than two times of the control. Here the treatment yeast extract gave the highest number those reached to 12.67 and 14.00 branch per plant during 2006 and 2007 seasons, respectively, meanwhile were 3.67 and 4.33 branches per plant in case of control plants. In this respect, increasing of formed branches on growing plant could be reversed upon many other characters such as number of leaves, leaf area, leaves dry weight. With regard to number of leaves it could be also noticed that nearly behaved as the same as the number of branches. Since, the yeast extract (30 ml/L.) gave the highest values, since increase in leaves number reached more than three times of control values in two assigned seasons .

Regarding, the total leaf area per plant it behaved as the same as the above mentioned characteristics. Since, all applied treatments showed its high significant increase. The exception was only that insignificant increase in case of citric acid with the two concentrations during the two seasons but its maximum was also obtained with the yeast extract (30 ml/l.) treatment. Increment of leaf area is of great interest because that could be reflected upon the efficiency of photosynthesis by accumulating more assimilates and high rates of their translocation specially toward formed fruits. Also, it could be noticed that increment of this area was preceded with high number of branches and leaves as well . Regarding the effect of different applied treatments upon vegetative characteristics were studied by **Davis *etal*., (2003), Khedr *etal.,* (2004), Wanas (2007)** for boron; **Aono *etal*., (1993), Bakardjieva and colleagues (2000), Khedr *et al*., (2004)** for zinc; **Alscher and Heath (2002), El-Bassiouny *et al*.,(2005) and Dorman (2007)** for Vit. E; **Fathy *et al*., (2003)** for citric acid; **El-Mogy *et al*., (1998), El-Tohamy and El-Greadly (2007)** for Yeast **and Foyer *et al*., (1995), Abou Dahab and AbdEl-Aziz (2006)** for amino acids.

Yeast treatments suggested to participate a beneficial role during stress due to its auxins, Gibberellins and cytokinins content **(Roberts, 1976 and Barnett *et al.,* 1990),** improve the formation of flower initiation due to its effect on carbohydrates accumulation **(Winkler *et al.,* 1962).** Also, it was reported about its stimulatory effects on cell division and enlargement, protein and nucleic acid synthesis and chlorophyll formation **Spencer *et al.,* 1983; Castelfranco and Beale, 1983 and Fathy and Farid, 1996).** Add to its contents of protective agent, i.e., sugars, proteins and amino acids and also several vitamins **(Shady, 1978).** Improving growth and fruiting of horticultural plants by yeast application was reported by **Fathy and Farid (1996) and El-Mogy *et al.* (1998).**

For Amino acids, alternative routes of IAA synthesis exist in plants, all starting from Tryptophan **Phillips (1971)** . **Hass (1975)** the biosyntheses of cinamic acids (which are the starting materials for the synthesis of phenols) are derived from phenylalanine and tyrosine. Tyrosine is hydroxy phenyl amino acid that is used to build neurotransmitters and hormones. organic nitrogenous compounds are the building blocks in the synthesis of proteins, which are formed by a process in which ribosomes catalyze the polymerization of amino acids **Russell (1982).** Amino acids are particularly important for stimulation cell growth. they remove the ammonia from the cell. This function is associated with amide formation, so they protect the plants from ammonia toxicity. They can serve as a source of carbon and energy, as well as protect the plants against stress. Amino acids also function in the synthesis of other organic compounds, such as protein, amines, purines and pyrimidines, alkaloids, vitamins, enzymes, terpeniods and others **Attoa *et al.*, (2002) .**

Table (3): Effect of different applied treatments on number of branches and leaf characteristics of tomato (*Lycopersicon esculentum*, Mill.) plants at 50 days after transplanting during 2006 and 2007 seasons.

Characters / Treatments	No. of branches /plant		No. of leaves/plant		Leaf area /plant (cm^2)		Leaf area ratio /plant (L.A.R) (Cm^2/g)		Specific leaf weight/plant (mg/cm^2)	
	Seasons									
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
1. Yeast extract at 15 ml/L.	7.67	7.33	41.33	44.33	1733.83	1764.53	84.53	79.40	8.17	8.53
2. Yeast extract at 30 ml/L.	12.67	14.00	71.60	81.33	3469.60	3419.83	64.70	56.53	10.93	11.50
3. Marjoram extract at 15 ml/L.	7.33	8.00	41.67	44.67	1530.47	1672.87	65.57	67.40	11.07	11.50
4. Marjoram extract at 30 ml/L.	8.33	9.00	38.33	40.67	1634.53	1784.30	81.07	80.70	9.23	9.57
5. Amino acids at 1.5 ml/L.	7.67	8.33	48.33	55.33	2899.57	3158.53	94.03	98.33	8.10	7.93
6. Amino acids at 3 ml/L.	9.33	9.00	50.67	56.67	2591.47	2709.50	77.60	77.50	9.83	10.33
7. Vit. E at 100 mg/L. + Sel. at 400µg/L.	8.00	9.33	46.00	42.67	1955.83	2329.33	76.33	88.40	9.90	8.57
8. Vit. E at 200 mg/L. + Sel. at 800µg/L.	8.33	8.67	48.67	51.00	2279.37	2061.30	83.07	68.97	8.50	10.47
9. Citric acid at 2.5g/L.	7.67	7.33	34.33	37.33	1259.40	1233.43	67.40	61.67	9.53	10.20
10. Citric acid at 5 g/L.	7.00	6.67	35.00	30.67	1094.87	1290.67	69.33	73.10	9.30	9.30
11. Vit. E at 100 mg/L. + Sel. at 400µg/L. + Citric acid at 2.5 g/L.	7.67	8.33	38.67	40.67	1710.87	1728.67	85.87	79.17	8.13	8.70
12. Vit. E at 200 mg/L. + Sel. at 800µg/L. + Citric acid at 5 g/L.	7.33	8.33	40.67	43.33	1822.97	1931.50	66.47	67.17	11.00	11.03
13. B at 25 mg/L.	7.33	7.33	38.33	42.33	1746.77	1782.40	75.70	74.33	9.50	9.57
14. B at 50 mg/L.	9.33	9.00	50.00	52.67	2288.97	2198.97	71.60	69.30	10.03	10.30
15. Zn at 50 mg/L.	8.33	9.67	51.00	52.67	2964.20	2492.60	88.97	78.23	8.37	9.17
16. Zn at 100 mg/L.	7.33	8.33	46.67	49.00	1833.17	1782.07	75.97	75.27	9.30	9.63
17. Control	3.67	4.33	19.00	20.67	998.17	970.30	114.63	102.47	6.77	7.43
L.S.D. 0.05	1.30	1.61	4.21	4.71	326.21	292.36	8.40	6.00	0.64	0.48

On the other hand, accordingly to beneficial effects of Zn known to enhance cell division and differentiation, viability and repeatability of the reproductive organs **(Suge *et al.,* 1986 and Domingo *et al.,* 1990)** induce an active and balanced hormonal status of higher IAA and GA's content vs. low ABA and ethylene within such reproductive and other plant organs .

Also, it plays a defensive protective role against adverse effects of higher temperature via it's antioxidant and gene regulatory functions **(Cakmak and Marschner, 1988 and Chesters, 1992).**

Moreover, it was reported that zinc **(Cakmak and Marschner, 1988)** enhances translocation of bioassimilates and nutrients within plant tissues as they activate the membrane transporter enzymes.

In addition, it was reported that foliar application of zinc **(Balakrishnan, 1999 and Dongre *et al.,* 2000)** improved growth and productivity of sweet pepper crop .

Also, boron is important in energy storage or structural integrity functions including sugar transport, cell wall synthesis, signification and cell wall structure; carbohydrate, IAA and phenol metabolism and respiration **(Loomis and Durst, 1992; Shelp, 1993 and Bondok, 1996)** .

This proved the efficiency of the anti-oxidants in protection the plants against higher temperature inducible toxic oxygen free radicals.

As for tocopherol it was also reported that Tocopherol ,can alleviate the harm full effect of ROS may be through several ways such as: (1) Inhibit the lipid photoperoxidation (2) involved in both electron transport of PS II and antioxidizing system of chloroplasts. (3)as membrane stabilizers and multifaceted antioxidants, that scavenge oxygen free radicals, lipid peroxyradicals, and singlet oxygen (4) react with peroxyl radicals formed in the bilayer as they diffuse to the aqueous phase. (5) It scavenges cytotoxic H_2O_2, and reacts non-enzymatically with other ROS: singlet oxygen, superoxide radical and hydroxyl radical (6)regenerate anther powerful water-soluble antioxidant, ascorbic acid, via the ascorbate glutathione cycle . (7)stabilize membrane structures
(8)modulate membrane fluidity in a similar manner to cholesterol, and also membrane permeability to small ions and molecnles decrease the permeability of digalactosyldiacylglycerol vesicles for glucose and protons **Blokhina, *et al*.,(2002)**

1.3 Branches and leaves Dry matter:

Data in Table (4) illustrated that all applied treatments increased dry weight of branches and leaves at this early stage of growth. As regards leaves dry weight, of interest to note that all applied treatments increased it to reach the high level of significance. Also, increment of this weight with yeast extract (30 ml/L)reached more than five times of the control value. These data go will with the above mentioned possibility for increasing yielded fruits. Since, vigorous growth of tomato plant with different applied treatments was the permanent result during this early stage of growth.

Also, these data will interpret those data about flowering and will answer many questions specially why tomato plant grown with yeast extract (30 ml/L) spray flowered earliest than the control.

Moreover, the calculated data of each of leaf area ratio and special leaf weight as shown in Table (3) could be support the above mentioned date about vigorous growth of tomato plants grown with assigned treatments specially the yeas extract (30 ml/L) .

With regard to dry weight of branches at this early stag of growth it could be also noticed that nearly behaved as the same as the leaves dry weight

Since, the yeast extract (30 ml/L) gave the highest values, since increase in branches dry weight reached more than eight times of control values in two assigned seasons. Same data also evidently confirmed the stimulatory and significantly effects of different applied treatments upon dry matter production and accumulation in leaves and branches

In general, data in Table (4) not only being a direct results for the vigorous growth obtained in Tables (2 & 3) but also could be considered an indicator for expectable high yield of fruits.

Table (4): Effect of different applied treatments on dry matter distribution in different organs of tomato (*Lycopersicon esculentum*, Mill.) plants at 50 days after transplanting during 2006 and 2007 seasons.

Characters / Treatments	Branches (including main stem) dry weight				Leaves dry weight				Total dry weight			
	g/plant		% relative to the control		g/plant		% relative to the control		g/plant		% relative to the control	
	Seasons											
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
1. Yeast extract at 15 ml/L.	6.47	7.17	335.79	317.90	14.00	15.00	207.43	209.13	20.47	22.17	235.47	234.73
2. Yeast extract at 30 ml/L.	15.80	21.20	814.65	936.91	37.97	39.23	564.33	546.37	53.77	60.43	619.57	638.40
3. Marjoram extract at 15 ml/L.	6.33	5.63	328.65	250.46	17.00	19.20	252.23	266.80	23.33	24.83	268.43	262.30
4. Marjoram extract at 30 ml/L.	5.40	5.03	263.64	224.58	15.07	17.07	223.00	237.63	20.13	22.100	231.63	233.67
5. Amino acids at 1.5 ml/L.	7.47	7.20	387.64	319.33	23.37	24.97	346.80	347.40	30.83	32.17	354.97	339.97
6. Amino acids at 3ml/L.	7.93	8.53	411.29	379.96	25.43	28.00	376.40	389.47	33.37	36.53	383.77	386.23
7. Vit. E at 100 mg/L. + Sel.at 400µg/L.	6.20	6.47	322.82	289.20	19.40	19.83	287.20	276.40	25.63	26.30	295.00	278.53
8. Vit. E at 200 mg/L. + Sel. at 800µg/L.	8.00	8.37	415.98	372.28	19.23	21.53	284.03	298.67	27.23	29.90	312.60	315.47
9. Citric acid at 2.5g/L.	6.70	7.47	348.19	332.83	11.97	12.53	177.10	174.30	18.67	20.00	214.70	211.50
10. Citric acid at 5 g/L.	5.60	5.63	290.09	251.71	10.20	11.97	151.83	167.13	15.80	17.60	192.07	186.27
11. Vit. E at 100mg/L. + Sel. at 400µg/L. + Citric acid at 2.5 g/L.	6.00	6.83	311.08	304.57	13.93	15.00	206.53	208.43	19.93	21.83	229.47	230.77
12. Vit. E at 200mg/L. + Sel. at 800µg/L. + Citric acid at 5 g/L.	7.43	7.47	385.25	330.70	19.97	21.30	295.93	296.63	27.40	28.77	315.13	304.27
13. B at 25 mg/L.	6.47	6.93	335.34	308.23	16.60	17.07	245.40	237.97	23.07	24.00	365.03	253.90
14. B at 50 mg/L.	8.97	9.07	465.01	404.77	23.00	22.57	340.40	313.70	31.97	31.63	367.53	334.63
15. Zn at 50mg/L.	8.57	9.00	444.05	401.42	24.67	22.80	362.00	317.07	33.23	31.80	382.33	336.53
16. Zn at 100mg/L.	7.13	7.20	369.53	320.72	17.00	17.13	252.50	238.73	24.13	23.67	277.97	250.40
17. Control	1.93	2.27	100.00	100.00	6.77	7.20	100.00	100.00	8.70	9.47	100.00	100.00
L.S.D. 0.05	1.13	1.04	44.22	35.24	2.39	2.60	40.14	36.94	2.91	3.26	37.12	33.13

Finally, it could be concluded with spraying tomato plant (under late summer/heat stress conditions), 5 times with yeast extract 30ml/L., hence this positively affected all the morphological characteristics within growing plants.

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الملخص العربى

تأثير بعض العناصر والمواد الطبيعية علي النمو الخضري لنباتات الطماطم تحت ظروف الحرارة المرتفعة.

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أجريت تجربتان حقليتان على نبات الطماطم فى العروه الصيفية المتأخره (موسمي ٢٠٠٦/٢٠٠٧) بمحطة البحوث التابعة لكلية الزراعة – جامعة بنها. وذلك برش نباتات الطماطم صنف سوبر سترين بي بمستخلص الخميرة ومستخلص البردقوش بتركيزي ١٥ ، ٣٠ مل/لتر لكل منها و الأحماض الأمينية بتركيزي ١.٥ ، ٣ مل لتر وفيتامين هـ ١٠٠مجم/لتر + السيلينيوم ٤٠٠ ميكروجرام/لتر وفيتامين هـ ٢٠٠ مجم/لتر + السيلينيوم ٨٠٠ ميكروجرام/لتر وحمض الستريك بتركيزي ٢.٥ ، ٥جم/لتر وفيتامين هـ ١٠٠ مجم/لتر + السيلينيوم ٤٠٠ ميكروجرام/لتر + حمض الستريك ٢.٥جم/لتر وفيتامين هـ٢٠٠ مجم/لتر + السيلينيوم٨٠٠ ميكروجرام/لتر + حمض الستريك ٥جم/لتر وعنصر البورون بتركيزي ٢٥ ، ٥٠ جزء في المليون والزنك بتركيزي ٥٠ ، ١٠٠ جزء في المليون وقد رشت النباتات ٥ مرات بعد ١٥يوم من الشتل ثم كل ١٥يوم. وذلك بهدف دراسة تأثير هذه المعاملات علي النمو الخضري لنباتات الطماطم. وقد أحدثت المعاملات زيادة معنوية في العديد من قياسات النموالخضرى مثل طول وقطر الساق ، عدد الأوراق والأفرع/ بنات ، الأوزان الطازجة والجافة لكل من السوق والأوراق ، ومساحة الأوراق الكلية/نبات وكذلك الوزن النوعي للأوراق بعد ٥٠ يوم من الشتل خلال موسمي الدراسة.

وكانت معاملة مستخلص الخميرة بتركيز ٣٠ مل/لتروالأحماض الأمينية بتركيز٣مل/لتر والبورن بتركيز٢٥مجم/لتروالزنك بتركيز٥٠مجم/لتر هي الأكثر تأثيراً مقارنة بالمعاملات الأخرى.