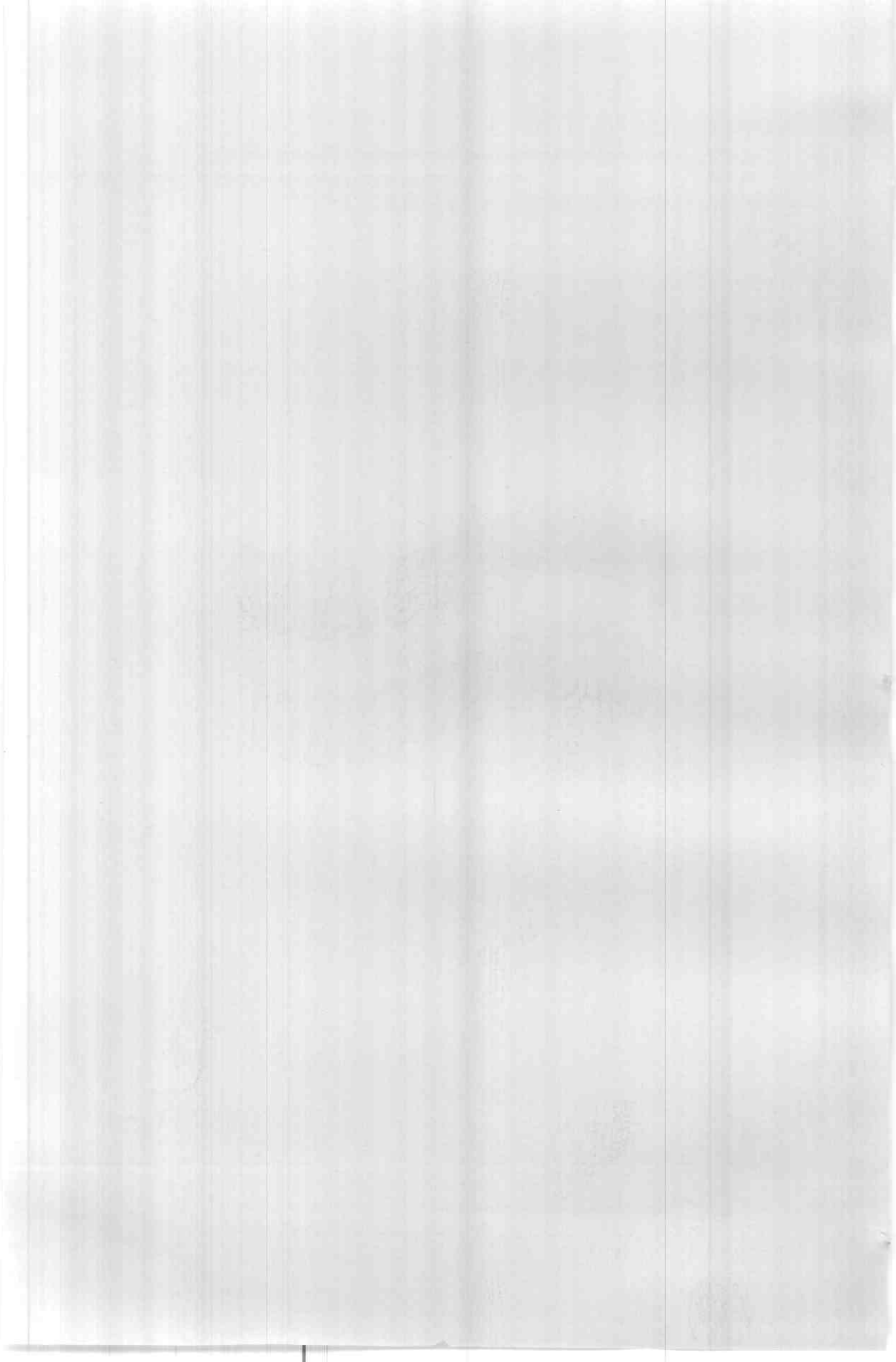
RESULTS AND DISCUSSION



IV. RESULTS AND DISCUSSION

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, anatomical, physiological and bio chemical changes in plants, which affected plant growth and development **(El-Desouky *et al.*, 2000 and Wahid *et al.*, 2007).**

In tomato, reproductive processes were adversely affected by high temperature, which included meiosis in both male and female organs, pollen germination and pollen tube growth, ovule viability, stigmatic and style positions, number of pollen grains retained by the stigma, fertilization and post-fertilization processes and growth of the fertilized embryo **(Foolad, 2005).** Also heat stress has been reported as one of the most important causes of reduction in yield and dry matter production in many crops **(Giaveno and Ferrero, 2003)**.

In this respect, the following obtained results clearly show the effects of different used treatments (as antioxidants) on alleviating adverse effects of high temperature stress conditions on tomato plants during late summer season.

1.Vegetative growth characteristics at 50 and 70 days after transplanting :

1.1. Plant height, stem diameter and fresh weight of branches and leaves:

Data in **Tables (2&3)** clearly indicate that all applied treatments significantly increased plant height, stem diameter and

fresh weight of each of both stems and leaves of tomato compared with those of the control under heat stress conditions at 50 & 70 days after transplanting during 2006 and 2007 late summer season.

The exception was that insignificant increases that existed in plant height with of citric acid at 5 g/L and stem fresh weight with marjoram extract at 30 ml/L, citric acid at 2.5 and 5 g/L and Boron at 25 mg/L during both seasons .

The most superior treatment was the yeast extract at 30 ml/L followed by amino acids at 3 ml/L then Zn at 50 mg/L respectively at the two seasons. These results are of great interest, because at this early stage of growth great simulative effects existed with various applied treatments. Hence, that could be prolonged to the advanced growth stages including each of flowering and the final fruit yield as well as quality of yielded fruits. Also, of interest to note that increase of stem diameter was accompanied with basic anatomical modification in different stem tissues especially phloem and xylem as mentioned later **(Table, 21)**. Therefore, that could be accompanied with great variations in the nature of tomato branching. Besides, increasing of stem diameter accompanied with increasing of plant height means that applied treatments lead to vigorous growth and more healthy tomato plant under high temperature conditions.

In addition, increment of shoots (stems & leaves) fresh weight due to increases of number of both branches and leaves and the total leaf area as mentioned later. Increment of leaf characteristics (number and area) as well as their content of photosynthetic could be a basic for increasing the photosynthetic efficiency. Furthermore, some of estimated growth characteristics

Table (2): Effect of different applied treatments on some morphological characteristics of tomato (*Lycopersicon esculentum*, Mill.) plants at 50 days after transplanting during 2006 and 2007 late summer 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		Seasons		Seasons		Seasons		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 400 µg/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 800 µg/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 400 µg/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 800 µg/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
	0.01	3.65	3.03	0.18	0.20	17.67	12.87	7.78	20.71	18.83	25.52

Table (3): Effect of different applied treatments on some morphological characteristics of tomato (*Lycopersicon esculentum*, Mill.) Plants at 70 days after transplanting during 2006 and 2007 late summer 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		Seasons		Seasons		Seasons		Seasons	
		2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
1. Yeast extract at 15 ml/L.		73.70	78.13	1.43	1.40	113.23	110.63	311.33	311.40	424.57	222.03
2. Yeast extract at 30 ml/L.		77.67	82.43	1.73	1.63	153.67	159.63	352.97	374.60	506.63	534.13
3. Marjoram extract at 15 ml/L.		52.97	58.57	1.27	1.33	63.67	64.73	141.30	151.70	204.97	216.43
4. Marjoram extract at 30 ml/L.		48.50	50.93	1.43	1.50	58.13	60.87	133.87	139.73	192.00	200.60
5. Amino acids at 1.5 ml/L.		70.43	72.57	1.50	1.53	97.27	97.33	259.93	263.47	357.20	360.80
6. Amino acids at 3 ml/L.		68.50	70.17	1.53	1.63	129.20	135.73	291.03	293.70	420.23	429.43
7. Vit. E at 100 mg/L. + Sel. at 400 µg/L.		52.50	55.17	1.33	1.27	59.63	56.90	194.10	198.07	253.73	254.97
8. Vit. E at 200 mg/L. + Sel. at 800 µg/L.		50.80	52.67	1.27	1.33	68.27	72.93	221.07	224.93	289.33	297.87
9. Citric acid at 2.5g/L.		53.73	58.03	1.33	1.40	87.27	89.37	252.70	260.40	339.97	349.77
10. Citric acid at 5 g/L.		50.63	54.93	1.23	1.30	50.13	56.07	158.17	161.53	208.30	217.60
11. Vit. E at 100 mg/L. + Sel. at 400 µg/L. + Citric acid at 2.5 g/L.		55.30	60.60	1.37	1.47	79.93	83.10	204.03	209.43	283.97	292.53
12. Vit. E at 200 mg/L. + Sel. at 800 µg/L. + Citric acid at 5 g/L.		71.73	70.43	1.47	1.47	112.90	111.40	326.77	326.37	439.67	437.77
13. B at 25 mg/L.		48.43	52.73	1.33	1.40	56.07	61.07	191.83	197.50	247.90	358.57
14. B at 50 mg/L		54.10	56.27	1.47	1.40	68.27	66.40	246.60	253.70	314.87	320.10
15. Zn at 50 mg/L.		58.93	58.60	1.60	1.63	96.53	100.07	269.73	272.03	366.27	372.10
16. Zn at 100 mg/L.		51.80	53.60	1.33	1.40	65.77	69.17	177.87	180.30	243.63	249.47
17. Control		42.50	45.97	0.97	1.10	36.07	39.17	94.73	108.97	130.80	148.13
L.S.D.	0.05	4.95	6.05	0.15	0.16	9.09	10.31	12.52	13.60	14.72	17.37
	0.01	6.67	8.14	0.20	0.22	12.25	13.89	16.86	18.31	19.83	2340

in case of yeast extract at 30 m/L reached more than three times of the control values. These results are in agreement with those reported by **El-Mogy *et al.*, (1998), El-Tohamy and El-Greadly (2007)** for Yeast ; **Foyer *et al.*, (1995), Abou Dahab and Abd - El-Aziz (2006)** for amino acids ; **Alscher and Heath (2002), El-Bassiouny *et al.*,(2005) and Dormann (2007)** for vitamin E; **Fathy *et al.*, (2003 a)** for citric acid; **Davis *et al.*, (2003), Khedr *et al.*, (2004), Ismaeil (2005) and Wanas (2007)** for Boron and **Aono *et al.*, (1993), Bakardjieva *et al.*, (2000) and Khedr *et al.*, (2004)** for Zinc.

It was obvious that control plants were negatively affected, as they were physiologically stressed. That might be due to they were developed no mechanism by which they protected against the prevailing higher temperature stress **(Fig. 1)** and its probable inducible oxidative one **(Cakmak and Marschner, 1992 and Elestner and Osswald, 1994) (Fig. 2).**

Vollenweider and Gunthart-Goerg (2005) and Wahid *et al.*, (2007) they reported that in tropical climates, excess of radiation and high temperatures are often the most limiting factors affecting plant growth and final crop yield. High temperatures can cause considerable pre- and post-harvest damages, including scorching of leaves and twigs, sunburns on leaves, branches and stems, leaf senescence and abscission, shoot and root growth inhibition, fruit discoloration & damage, and reduced yield .

1.2. Branches and leaves characteristics:

As shown in **Tables (4&5)** different estimated growth characters such as number of branches and leaves and leaf area per plant were increased to reach the 5% level of significance with

different applied treatments at 50 & 70 days after transplanting during the two growing seasons. The exception was that insignificant increase of leaf area / plant with the two applied concentrations of citric acid during the two seasons and leaf area ratio /plant in case of marjoram extract at 30 ml/L during 2007 season. Also, it could be noticed that each of yeast extract at 30 ml/L, amino acids at 3 ml/L, Boron at 50 mg/L and Zinc at 50 mg/L as well increased number of branches more than two times of the control values. Here the yeast extract 30 ml /L treatment gave the highest branches number reached to 12.67 and 14.00 / 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, flowering and finally the yielded fruits . 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 at 30 ml/L gave the highest values, since increase in leaves number reached more than three times of control values in the two assigned seasons.

Regarding, the total leaf area per plant it also 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 two applied concentrations during the two seasons but its maximum value obtained with the yeast extract at 30 ml/L treatment. Increment of leaf area is of great interest because that could be reflected upon the efficiency of photosynthesis by accumulating

Table (4): 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 late summer seasons.

Characters / Treatments		No. of branches /plant		No. of leaves/plant		Total Leaf area /plant (cm^2)		Leaf area ratio /plant (L.A.R) (cm^2/g)		Specific leaf weight/plant (mg/cm^2)	
		Seasons		Seasons		Seasons		Seasons		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 400 µg/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 800 µg/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 400 µg/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 800 µg/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
	0.01	1.75	2.17	5.67	6.34	439.32	393.73	11.31	8.08	0.86	0.65

Table (5): Effect of different applied treatments on number of branches and leaf characteristics of tomato (*Lycopersicon esculentum*, Mill.) plants at 70 days after transplanting during 2006 and 2007 late summer 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		Seasons		Seasons		Seasons		Seasons	
		2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
1. Yeast extract at 15 ml/L.		14.67	14.33	88.33	93.33	5332.33	4690.00	74.63	64.50	9.73	11.20
2. Yeast extract at 30 ml/L.		19.67	20.33	97.33	102.33	5443.33	6307.33	63.00	70.13	10.97	9.87
3. Marjoram extract at 15 ml/L.		11.67	11.67	58.33	63.00	2526.67	2577.33	79.33	78.03	8.90	9.03
4. Marjoram extract at 30 ml/L.		10.00	11.00	53.67	61.67	2496.67	2561.00	80.37	81.47	8.93	8.97
5. Amino acids at 1.5 ml/L.		12.00	12.33	73.33	78.33	4756.33	4713.67	80.07	78.57	8.67	8.70
6. Amino acids at 3 ml/L.		20.00	20.33	95.67	100.67	4922.33	4958.33	69.57	68.37	10.03	10.20
7. Vit. E at 100 mg/L. + Sel. at 400 µg/L.		10.33	11.00	71.00	73.67	3275.00	3451.00	68.53	69.37	10.43	10.23
8. Vit. E at 200 mg/L. + Sel. at 800 µg/L.		11.33	11.67	77.00	78.00	3898.33	4024.67	76.00	76.07	9.50	9.57
9. Citric acid at 2.5g/L.		11.67	12.33	75.67	78.33	4326.33	4559.33	79.97	79.90	9.33	9.27
10. Citric acid at 5 g/L.		9.67	10.67	63.00	68.67	2939.33	2940.67	82.73	79.10	8.90	8.93
11. Vit. E at 100 mg/L. + Sel. at 400 µg/L. + Citric acid at 2.5 g/L.		12.67	13.00	81.67	83.33	3835.33	4043.00	82.70	82.43	8.67	8.70
12. Vit. E at 200 mg/L. + Sel. at 800 µg/L. + Citric acid at 5 g/L.		13.33	13.00	84.67	87.67	5817.33	5670.33	84.20	78.17	8.47	9.07
13. B at 25 mg/L.		10.33	11.00	62.00	64.33	3481.33	3493.33	75.60	72.27	9.90	10.07
14. B at 50 mg/L		11.67	12.33	78.67	80.00	4071.00	4025.67	76.87	73.60	9.70	10.03
15. Zn at 50 mg/L.		12.67	13.00	81.67	83.33	4233.33	4196.33	68.83	65.73	10.10	10.40
16. Zn at 100 mg/L.		11.33	11.67	71.33	72.33	3216.67	3406.67	65.73	66.53	10.50	10.30
17. Control		7.33	8.33	40.67	44.33	2026.33	2368.00	102.37	108.17	6.67	6.67
L.S.D.	0.05	1.33	1.29	5.34	5.87	233.00	281.69	6.03	4.70	0.43	0.38
	0.01	1.79	1.74	7.19	7.91	313.79	379.36	8.12	6.33	0.58	0.51

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.

Yeast treatments suggested to participate a beneficial role during stress due to its cytokinin content **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 **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 marjoram extract its content of polyphenols, a phenylpropanoid and flavonoids have an antioxidant effect against the free radicals that can damage important cellular molecules or other parts of the cell under stress **Wolski *et al.*, (2007)** and **Matkowski *et al.*, (2008)**.

For Amino acids, alternative routes of IAA synthesis exist in plants, all starting from Tryptophan .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. 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).**

On the other hand, accordingly to beneficial effects of Zn known to enhance cell division and differentiation, viability and repeatability of the reproductive organs **(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 **(Chesters, 1992).**

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.

For Tocopherol, it was also reported that Tocopherol can alleviate the harmfull effect of ROS may be through several ways such as: (1) inhibit the lipid photoperoxidation (2) involved in both electron transport of PSII and antioxidizing system of chlorplasts. (3) as membrane stabilizers and multifaceted antioxidants, that scavenge oxygen free radicals, lipid peroxyradicals, and singlet oxgen (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 another powerful water-soluble antioxidant, ascorbic acid, via the ascorbate glutathione cyle. (7) stabilize membrane structures. (8) modulate membrane fluidity in a similar manner to cholesterol, and also membrane permeability to small ions and molecules decrease the permeability of digalactosyldiacylglycerol vesicles for glucose and protons **Alscher and Heath (2002)**

1.3 Branches and leaves Dry matter:

Data in **Tables (6&7)** illustrated that all applied treatments increased dry weight of branches and leaves at 50 and 70 days after transplanting during the two growing seasons. As regards leaves dry weight, of interest to note that all applied treatments increased it to reach the 5% level of significance. Also, increment of this parameter with yeast extract at 30 ml/L reached more than five times of the control value. These data go will with the previously mentioned possibility for increasing yielded fruits. Since, vigorous growth of tomato plant as affected by different applied treatments was the perment 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 treated with yeast extract at 30 ml/L flowered earliest than the control.

Moreover, the calculated data of each of leaf area ratio and specific leaf weight as shown in **Tables (4&5)** could be support the above mentioned date about vigorous growth of tomato plants as affected by the assigned treatments specially the yeast extract at 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

Table (6): Effect of different applied treatments on dry matter distribution in stems and leaves organs of tomato (*Lycopersicon esculentum*, Mill.) plants at 50 days after transplanting during 2006 and 2007 late summer 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		Seasons		Seasons		Seasons		Seasons		Seasons	
	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006
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 3 ml/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 400 µg/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 800 µg/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 100 mg/L. + Sel. at 400 µg/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 200 mg/L. + Sel. at 800 µg/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 50 mg/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 100 mg/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
L.S.D. 0.01	1.52	1.40	59.55	47.45	3.22	3.50	54.06	49.75	3.92	4.39	50.00	44.62

Table (7): Effect of different applied treatments on dry matter distribution in stem and leaves organs of tomato (*Lycopersicon esculentum*, Mill.) plants at 70 days after transplanting during 2006 and 2007 late summer 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		Seasons		Seasons		Seasons		Seasons		Seasons	
		2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
1. Yeast extract at 15 ml/L.		19.63	20.20	345.30	329.80	51.80	52.50	383.13	333.80	71.43	72.70	371.63	332.63
2. Yeast extract at 30 ml/L.		26.63	27.77	469.03	453.80	59.80	62.17	442.53	395.37	86.43	89.93	449.43	411.63
3. Marjoram extract at 15 ml/L.		9.37	9.73	164.50	159.23	22.47	23.30	166.33	148.33	31.83	33.03	165.70	151.23
4. Marjoram extract at 30 ml/L.		8.73	8.50	154.07	138.43	22.37	22.93	165.37	145.63	31.10	31.43	161.70	143.73
5. Amino acids at 1.5 ml/L.		18.30	19.10	321.57	311.97	41.10	40.90	303.77	260.43	59.40	60.00	308.97	275.00
6. Amino acids at 3 ml/L.		21.43	21.93	378.03	358.97	49.37	50.60	365.13	322.07	70.80	72.53	368.20	332.13
7. Vit. E at 100 mg/L. + Sel. at 400 µg/L.		13.70	14.50	241.57	237.50	34.13	35.27	252.47	224.47	47.83	49.77	248.73	227.93
8. Vit. E at 200 mg/L. + Sel. at 800 µg/L.		14.27	14.53	250.87	237.83	37.03	38.37	273.90	244.00	51.30	52.90	266.83	242.10
9. Citric acid at 2.5g/L.		13.87	14.80	244.20	242.13	40.23	42.27	297.70	268.87	54.10	57.07	281.37	261.20
10. Citric acid at 5 g/L.		9.43	10.87	166.17	177.60	26.10	26.27	193.17	167.13	35.53	37.13	184.70	169.97
11. Vit. E at 100 mg/L. + Sel. at 400 µg/L. + Citric acid at 2.5 g/L.		13.20	13.80	232.47	225.90	33.17	35.27	245.27	224.53	46.37	49.07	241.13	224.77
12. Vit. E at 200 mg/L. + Sel. at 800 µg/L. + Citric acid at 5 g/L.		19.87	21.13	350.37	344.27	49.30	51.40	364.60	326.90	69.17	72.53	360.23	331.83
13. B at 25 mg/L.		11.70	13.13	206.40	214.43	34.33	35.20	254.07	224.03	46.03	48.33	239.40	221.27
14. B at 50 mg/L		13.47	14.33	236.93	233.87	39.50	40.37	292.43	256.77	53.03	54.70	275.70	250.33
15. Zn at 50 mg/L.		18.83	20.27	331.27	330.73	42.70	43.57	315.93	277.10	61.53	63.83	320.17	292.10
16. Zn at 100 mg/L.		15.17	16.03	266.90	261.80	33.77	35.17	249.80	223.70	48.93	51.20	254.57	234.30
17. Control		5.70	6.13	100.00	100.00	13.53	15.73	100.00	100.00	19.23	21.87	100.00	100.00
L.S.D.	0.05	2.39	1.42	44.08	24.31	1.49	1.90	12.71	12.71	2.84	2.22	15.63	11.63
	0.01	3.21	1.91	59.36	32.74	2.00	2.56	17.57	17.12	3.82	2.99	21.05	15.66

the leaves dry weight. Since, the yeast extract at 30 ml/L gave the highest values, since increase in branches dry weight reached more than eight times of the 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 **Tables (6&7)** not only being a direct results for that vigorous growth obtained in **Tables (3&5)** but also could be considered an indicator for expectable high yield of fruits. These results are in agreement with those obtained by **Lascaris and Deacon (1991) Rūmheld and Marschner (1991), Blokhina *et al.*, (2002), Ismaeil (2005) and Kruk *et al.*, (2005).**

They reported that recently groups of substances known as antioxidants or oxygen free radical scavengers were applied to protect against adverse effects of environment oxidative stress. Those such as citrate /citric acid, zinc, vitamins, cacogenics, selenium and phenols. The stimulator effects of different applied treatments might be due to their antioxidant and scavenging effects to protect plant against degradation by the toxic reaction oxygen radicals which internally generated high temperature stress, which resulted in enhancing the morphological and metabolical performances of treated tomato plant during last summer season compared with control.

In general, shoots fresh weight was significantly increased with various treatments. It was obvious from the same data the stimulatory and significantly effects of applied treatments which greatly improved the vegetative growth characteristics and alleviate the adverse effects of high temperature stressfull conditions and its

probable accompanied oxidative stress on treated tomato plants (might be due to their anti-oxidantal scavenging effects in protecting plant form degradation by the toxic reactive oxygen radicals (ROS) which internally generated during stress) **Mckerise *et al.*, (1996), Cakmak (2000), Conklin (2001), Fathy and Kheder (2005) and Dormann (2007)**

2. Chemical composition:

2.1. Photosynthetic pigments:

Data presented in **Tables (8&9)** clearly indicate the effect of different applied treatments in increasing each of chlorophyll a, b and carotenoids concentrations compared with the control at 50 and 70 days after transplanting during both seasons. Also, treatment of yeast extract at 30 mg/L was more efficient in this respect followed by Zinc at 50 mg/L, vitamin E at 200 mg/L + Sel. at 400 µg/L, citric acid at 5 g/L and Boron at 50 mg/L in descending order. These results are of great interest, because they are lightly considered direct reason for the more dry matter production and distribution in shoots of tomato plants as affected by different applied treatments. It was obvious that control plants were greatly stressed. This might be due to either poor synthetic capacity or due to degradation of chlorophyll as result of heat /oxidative stress effects **Cakmak and Marschner (1992); Van Breusegem *et al.*,(2001) and Guo *et al.*, (2006).**They reported that under high temperatures, degradation of chlorophyll a and b was more pronounced in developing leaves. Such effects on chlorophyll or photosynthetic apparatus were suggested to be associated with the production of reactive oxygen species **Larkindale and Knight (2002) and Camejo *et al.*, (2005).**

Table (8): Effect of different applied treatments on photosynthetic pigments concentration in tomato (*Lycopersicon esculentum*, Mill.) leaves at 50 days after transplanting during 2006 and 2007 late summer seasons.

Characters / Treatments	Chlorophyll (a)		Chlorophyll (b)		Chlorophyll (a+b)		Carotenoids		Chl. (a+b)/ Carot.	
	Seasons		Seasons		Seasons		Seasons		Seasons	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
1. Yeast extract at 15 ml/L.	0.97	1.07	0.72	0.82	1.68	1.89	0.71	0.78	2.38	2.42
2. Yeast extract at 30 ml/L.	1.04	1.12	0.86	0.88	1.90	2.00	0.71	0.82	2.68	2.44
3. Marjoram extract at 15 ml/L.	0.81	0.85	0.61	0.59	1.43	1.44	0.60	0.66	2.37	2.19
4. Marjoram extract at 30 ml/L.	0.71	0.72	0.53	0.56	1.23	1.27	0.50	0.54	2.48	2.37
5. Amino acids at 1.5 ml/L.	0.81	0.87	0.56	0.60	1.37	1.47	0.62	0.66	2.21	2.23
6. Amino acids at 3 ml/L.	0.85	0.93	0.67	0.72	1.51	1.64	0.55	0.69	2.76	2.39
7. Vit. E at 100 mg/L. + Sel. at 400 µg/L.	0.78	0.82	0.59	0.57	1.36	1.38	0.58	0.56	2.36	2.48
8. Vit. E at 200 mg/L. + Sel. at 800 µg/L.	0.97	0.93	0.75	0.73	1.72	1.66	0.71	0.68	2.42	2.44
9. Citric acid at 2.5g/L.	0.87	0.82	0.59	0.55	1.46	1.37	0.65	0.59	2.25	2.32
10. Citric acid at 5 g/L.	0.71	0.78	0.55	0.62	1.26	1.39	0.54	0.57	2.33	2.46
11. Vit. E at 100 mg/L. + Sel. at 400 µg/L. + Citric acid at 2.5 g/L.	0.73	0.72	0.59	0.56	1.32	1.27	0.56	0.54	2.36	2.37
12. Vit. E at 200 mg/L. + Sel. at 800 µg/L. + Citric acid at 5 g/L.	1.01	1.00	0.74	0.71	1.76	1.71	0.70	0.71	2.50	2.41
13. B at 25 mg/L.	0.82	0.86	0.56	0.59	1.38	1.45	0.57	0.66	2.42	2.20
14. B at 50 mg/L	1.00	1.02	0.71	0.75	1.70	1.77	0.71	0.74	2.41	2.39
15. Zn at 50 mg/L.	1.11	1.09	0.85	0.84	1.96	1.92	0.80	0.79	2.45	2.44
16. Zn at 100 mg/L.	0.82	0.92	0.57	0.71	1.39	1.63	0.57	0.69	2.44	2.36
17. Control	0.68	0.70	0.49	0.52	1.38	1.22	0.51	0.50	2.29	2.44

Table (9): Effect of different applied treatments on photosynthetic pigments concentration in tomato (*Lycopersicon esculentum*, Mill.) leaves at 70 days after transplanting during 2006 and 2007 late summer seasons.

Characters / Treatments	Chlorophyll (a)		Chlorophyll (b)		Chlorophyll (a+b)		Carotenoids		Chl. (a+b)/ Carot.	
	Seasons		Seasons		Seasons		Seasons		Seasons	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
1. Yeast extract at 15 ml/L.	1.14	1.19	0.67	0.73	1.81	1.92	0.63	0.75	2.87	2.56
2. Yeast extract at 30 ml/L.	1.45	1.52	0.85	0.91	2.30	2.43	0.82	0.86	2.80	2.83
3. Marjoram extract at 15 ml/L.	1.06	1.07	0.45	0.64	1.51	1.71	0.62	0.63	2.44	2.71
4. Marjoram extract at 30 ml/L.	0.97	1.01	0.43	0.52	1.40	1.53	0.54	0.59	2.59	2.59
5. Amino acids at 1.5 ml/L.	1.03	1.12	0.54	0.70	1.57	1.82	0.60	0.64	2.62	2.84
6. Amino acids at 3 ml/L.	1.17	1.12	0.60	0.70	1.77	1.82	0.62	0.64	2.85	2.84
7. Vit. E at 100 mg/L. + Sel. at 400 µg/L.	1.02	1.12	0.63	0.68	1.65	1.80	0.58	0.66	2.84	2.73
8. Vit. E at 200 mg/L. + Sel. at 800 µg/L.	1.13	1.14	0.70	0.67	1.83	1.81	0.63	0.64	2.90	2.83
9. Citric acid at 2.5g/L.	1.15	1.19	0.60	0.61	1.75	1.79	0.65	0.66	2.69	2.71
10. Citric acid at 5 g/L.	0.93	1.05	0.46	0.52	1.39	1.57	0.57	0.66	2.44	2.38
11. Vit. E at 100 mg/L. + Sel. at 400 µg/L. + Citric acid at 2.5 g/L.	0.95	1.00	0.52	0.56	1.47	1.56	0.56	0.58	2.63	2.69
12. Vit. E at 200 mg/L. + Sel. at 800 µg/L. + Citric acid at 5 g/L.	1.18	1.22	0.67	0.67	1.85	1.89	0.68	0.72	2.72	2.63
13. B at 25 mg/L.	1.06	1.10	0.52	0.67	1.58	1.77	0.66	0.65	2.39	2.72
14. B at 50 mg/L	1.15	1.25	0.72	0.78	1.87	2.03	0.66	0.69	2.83	2.94
15. Zn at 50 mg/L.	1.49	1.54	0.87	0.90	2.36	2.44	0.78	0.79	3.03	3.09
16. Zn at 100 mg/L.	1.08	1.13	0.65	0.48	1.73	1.61	0.63	0.67	2.75	2.40
17. Control	0.89	0.93	0.67	0.45	1.56	1.38	0.49	0.58	3.18	2.38

The simulative effect of different applied treatments might be due to their anti–oxidantal scavenging effect to be protected chloroplasts and prevented chlorophyll degradation by the toxic reactive oxygen radicals which internally generated during high temperature stress. **Aono *et al.*, (1993), Bowler *et al.*, (1992) Garnczarska *et al.*, (2004) and Fathy and Khedr (2005)** reported that antioxdants, 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, peroxdases, those catalyzed breakdown of the toxic (H_2O_2), (OH) and (O_2) radicals.

2.2. Minerals concentrations at 50 and 70 days after transplanting :

Data in **Tables (10 and 11)** illustrated that all applied in leaves treatments were effectively increased N, P, K, Ca and Mg concentrations of treated plants compared with those of the untreated plants .Again, at the two periods during both seasons, most effective treatments was yeast extract at 30 ml/L followed by Boron with its two used concentrations, citric acid at 5 g/L and vitamin E at 200 mg/L + Sel. at 800 µg/L + citric acid at 5 g/L, respectively. The simulative effect of these treatments might be due to the higher mineral metabolic requirements to face the higher obtained vigorous growth and yield potentialities there by more minerals uptake and translocation .Notice data of growth and yield.

Additionally, the main function of anti-oxidants is their protective effect of cell membranes and their binding transporter proteins (H^+-ATP-ase membrane pump), maintained their structure and function against the toxic and destructive effects of ROS during

stress, in turn, more absorption and translocation of minerals. Here, it could be concluded that increase of leaf area and photosynthetic pigments as well as increment of dry matter accumulation in leaves reverse the stimulatory effects of these elements on the efficiency of photosynthesis process, hence more photosynthates being created as well as enhancement of minerals translocation from roots to leaves .In this connection the highest value were obtained when plants treated with zinc. As regard to the advantageous of yeast preparation could be due to it's essential bionconstituents, i.e. carbohydrate, protein, GAs, IAA, cytokinins and vitamins as well as mineral content **El-Tohamy and El-Greadly (2007).** For the increase obtained with Zn treatments might be attributed to its role in prevent the formation of free radicals (i.e., O_2, H_2O_2, OH ....etc.), thereby, the membrane leakage chlorosis and necroses of leaves. Besides, it may prevent the oxidative degeneration of IAA and consequently increases the level of IAA in plants. Such increase causes an enhancement of plant growth and mineral nutrients uptake and translocation or partially due to that sugar acts as an osmoregulator in plant cell; the process that participates in enhancing mineral uptake and translocation in plants and consequently the higher concentration of mineral in plant tissues **Brown *et al.*, (1993), Marschner (1995) .**

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).**

Table (10): Effect of different applied treatments on some minerals (mg/g D.W.) concentrations in tomato (*Lycopersicon esculentum*, Mill.) plant leaves at 50 days after transplanting during 2007 late summer season.

Characters / Treatments	N mg/g dry weight	P mg/g dry weight	K mg/g dry weight	Ca mg/g dry weight	Mg mg/g dry weight	Total determined elements mg/g dry weight
1. Yeast extract at 15 ml/L.	44.30	5.86	23.69	38.78	6.46	119.09
2. Yeast extract at 30 ml/L.	51.70	5.21	24.72	42.13	5.10	128.86
3. Marjoram extract at 15 ml/L.	41.80	5.49	22.66	42.05	5.03	117.03
4. Marjoram extract at 30 ml/L.	39.40	5.25	18.54	44.56	4.70	112.45
5. Amino acids at 1.5 ml/L.	34.40	4.59	16.48	38.43	5.83	99.73
6. Amino acids at 3 ml/L.	39.40	5.95	22.66	31.16	5.80	104.97
7. Vit. E at 100 mg/L. + Sel. at 400 µg/L.	39.40	7.38	30.9	36.21	6.06	119.95
8. Vit. E at 200 mg/L. + Sel. at 800 µg/L.	46.70	5.58	24.72	36.63	6.53	120.16
9. Citric acid at 2.5g/L.	44.30	5.13	22.66	39.07	6.36	117.52
10. Citric acid at 5 g/L.	44.00	7.18	26.78	41.81	4.60	124.37
11. Vit. E at 100 mg/L. + Sel. at 400 µg/L. + Citric acid at 2.5 g/L.	41.80	6.44	25.75	38.35	5.53	117.87
12. Vit. E at 200 mg/L. + Sel. at 800 µg/L. + Citric acid at 5 g/L.	46.70	5.99	24.72	35.44	6.06	118.91
13. B at 25 mg/L.	41.80	6.15	30.9	38.59	4.83	122.27
14. B at 50 mg/L	44.30	6.60	24.72	40.07	6.53	122.22
15. Zn at 50 mg/L.	51.70	6.52	28.84	40.23	5.73	133.03
16. Zn at 100 mg/L.	41.80	5.29	28.84	39.12	4.53	119.58
17. Control	22.10	4.31	18.54	29.38	4.55	78.88

Table (11): Effect of different applied treatments on some minerals (mg/g D.W.) concentrations in tomato (*Lycopersicon esculentum*, Mill.) plant leaves at 70 days after transplanting during 2007 late summer season.

Characters / Treatments	N mg/g dry weight	P mg/g dry weight	K mg/g dry weight	Ca mg/g dry weight	Mg mg/g dry weight	Total determined elements mg/g dry weight
1. Yeast extract at 15 ml/L.	46.80	3.61	18.54	41.58	5.80	116.33
2. Yeast extract at 30 ml/L.	51.70	3.36	29.57	28.79	6.26	119.68
3. Marjoram extract at 15 ml/L.	47.70	6.77	16.48	35.05	6.06	112.06
4. Marjoram extract at 30 ml/L.	46.70	4.88	23.69	37.28	5.81	118.36
5. Amino acids at 1.5 ml/L.	32.00	3.57	16.48	38.59	4.26	94.9
6. Amino acids at 3 ml/L.	44.30	2.79	16.48	38.63	4.86	107.06
7. Vit. E at 100 mg/L. + Sel. at 400 µg/L.	34.40	5.62	20.6	28.79	5.06	94.47
8. Vit. E at 200 mg/L. + Sel. at 800 µg/L.	39.40	4.55	22.66	40.23	5.13	111.97
9. Citric acid at 2.5g/L.	46.60	4.14	18.54	39.58	6.33	115.19
10. Citric acid at 5 g/L.	41.80	3.32	27.51	38.93	6.30	117.86
11. Vit. E at 100 mg/L. + Sel. at 400 µg/L. + Citric acid at 2.5 g/L.	44.30	4.18	18.54	37.65	5.91	110.58
12. Vit. E at 200 mg/L. + Sel. at 800 µg/L. + Citric acid at 5 g/L.	46.70	4.02	26.78	38.47	5.67	121.64
13. B at 25 mg/L.	39.50	3.32	24.72	35.83	5.34	108.71
14. B at 50 mg/L	39.40	2.87	27.51	39.57	4.48	113.03
15. Zn at 50 mg/L.	49.20	3.85	28.54	37.43	6.60	125.62
16. Zn at 100 mg/L.	34.40	3.85	16.48	34.25	6.16	95.14
17. Control	27.10	2.42	16.48	34.07	3.60	83.67

As for protein concentration, it could be noticed that it behaved the same as in case of elements since the different applied treatments increased this concentration compared with the control These results are in agreement with those reported by **Marschner (1995), Cakmak (2000), Foyer and Noctor (2003) and Velikova *et al.*, (2005)**

On the other hand, in **Tables (12 and 13)** clearly indicate that different applied treatments increased the concentrations induced higher content of microelements (iron, zinc and manganese) in tomato leaves at the two times of determination (50 and 70 days after transplanting) during the 2007 season.

The only exception was the decrease of Fe, Zn and Mn concentrations existed with vitamin E at 200 mg/L + Sel. at 800 µg/L (Fe); vitamin E at100 mg/L + Sel. at 400 µg/L + citric acid at 2.5 g/L(Zn) and yeast extract at 30 ml/L

The same data cleared that the most effective treatment which led to maintained the highest concentrations of determined microelements was Zinc at 50 mg/L followed by citric acid at 2.5 and 5 g/L, amino acids at 1.5 and 3 ml/L and Boron with the two concentrations, respectively. That could be mainly attributed to the fact that these elements being distributed into more plant materials production. It could be suggested that, foliar applied treatments optimized the elemental composition of tomato leaves of Zn and others (i.e., N, P, K, Ca, Mg and Fe), avoided the excessive accumulation of Mn and the inadequate concentration of other elements; i.e., Zn and Fe (the case of control plants). Accordingly, it optimized the growth and agronomical performances of tomato plants. The applied Zn improves its concentration within leaves of

Table (12): Effect of different applied treatments on iron, zinc and manganese concentration in tomato (*Lycopersicon esculentum*, Mill.) plants at 50 days after transplanting during 2007 late summer season.

Characters / Treatments	Iron (Fe)		Zinc (Zn)		Managanese (Mn)	
	ppm	% relative to the control	ppm	% relative to the control	ppm	% relative to the control
1. Yeast extract at 15 ml/L.	334.60	141.18	146.80	207.34	152.30	121.65
2. Yeast extract at 30 ml/L.	324.50	136.92	102.50	144.77	193.00	154.15
3. Marjoram extract at 15 ml/L.	347.80	146.75	110.40	155.93	198.40	158.47
4. Marjoram extract at 30 ml/L.	313.00	132.07	130.00	183.62	147.50	117.8
5. Amino acids at 1.5 ml/L.	427.10	180.21	190.70	269.35	138.30	110.46
6. Amino acids at 3 ml/L.	405.70	171.18	110.30	155.79	245.40	196.01
7. Vit. E at 100 mg/L. + Sel. at 400 µg/L.	345.00	145.56	133.30	188.28	187.40	149.68
8. Vit. E at 200 mg/L. + Sel. at 800 µg/L.	337.10	142.23	143.20	202.26	256.30	204.71
9. Citric acid at 2.5g/L.	440.70	185.95	191.00	269.77	234.80	187.54
10. Citric acid at 5 g/L.	437.20	184.47	161.20	227.68	195.20	155.91
11. Vit. E at 100 mg/L. + Sel. at 400 µg/L. + Citric acid at 2.5 g/L.	306.40	129.28	90.80	128.25	158.40	126.52
12. Vit. E at 200 mg/L. + Sel. at 800 µg/L. + Citric acid at 5 g/L.	358.20	151.14	142.50	201.27	183.70	146.73
13. B at 25 mg/L.	389.50	164.35	131.00	185.03	201.30	160.78
14. B at 50 mg/L	395.00	166.67	160.00	225.99	205.20	163.90
15. Zn at 50 mg/L.	460.00	151.90	193.00	272.60	251.00	200.48
16. Zn at 100 mg/L.	384.50	162.24	180.00	254.24	243.50	194.49
17. Control	237.00	100.00	70.80	100.00	125.20	100.00

Table (13): Effect of different applied treatments on iron, zinc and manganese concentration in tomato (*Lycopersicon esculentum*, Mill.) plants at 70 days after transplanting during 2007 late summer season.

Characters / Treatments	Iron (Fe)		Zinc (Zn)		Manganese (Mn)	
	ppm	% relative to the control	ppm	% relative to the control	ppm	% relative to the control
1. Yeast extract at 15 ml/L.	235.10	148.52	134.20	143.07	133.40	103.57
2. Yeast extract at 30 ml/L.	265.20	167.53	155.70	165.99	121.30	94.18
3. Marjoram extract at 15 ml/L.	240.30	151.80	143.40	152.88	156.70	121.66
4. Marjoram extract at 30 ml/L.	220.70	139.42	97.30	103.73	143.80	111.65
5. Amino acids at 1.5 ml/L.	285.50	180.35	185.80	198.08	185.50	144.02
6. Amino acids at 3 ml/L.	282.00	178.14	146.00	155.65	177.00	137.42
7. Vit. E at 100 mg/L. + Sel. at 400 µg/L.	203.40	128.49	133.30	142.11	143.30	111.26
8. Vit. E at 200 mg/L. + Sel. at 800 µg/L.	151.90	95.95	155.50	165.99	165.10	128.11
9. Citric acid at 2.5g/L.	283.50	179.09	165.00	175.91	213.80	165.99
10. Citric acid at 5 g/L.	287.30	181.49	173.80	185.29	193.20	150.00
11. Vit. E at 100 mg/L. + Sel. at 400 µg/L. + Citric acid at 2.5 g/L.	176.80	111.69	90.70	96.70	143.50	111.41
12. Vit. E at 200 mg/L. + Sel. at 800 µg/L. + Citric acid at 5 g/L.	185.40	117.12	115.00	122.60	165.00	128.11
13. B at 25 mg/L.	283.30	178.96	158.00	168.44	163.00	126.55
14. B at 50 mg/L	281.20	177.64	143.40	152.88	155.40	120.65
15. Zn at 50 mg/L.	295.80	186.86	193.10	205.86	243.20	188.82
16. Zn at 100 mg/L.	282.50	178.46	115.20	122.8	155.00	120.34
17. Control	158.30	100.00	93.80	100.00	128.80	100.00

the treated plants. In turn, it might protect plasma membrane and its linked transporter enzymes against the harmful effects of higher temperature / oxidative stresses.

Thereby, improves its transportation functions for other elements and solutes. As discussed before, Zn involved in both the detoxification of ROS and the inhibition of ROS production, thus an important factor in an organism's defense against these destructive ROS. Super oxide dismutases, in particular, are known to play a critical role in the oxidative defense systems of all biological tissue **(Bowler *et al.*, 1992).** Improvement of the Zn status in plants may therefore be of great importance for their survival under oxidative stress condition **(Cakmak, 2000).**

2.3. Sugars, total carbohydrates and crude protein concentrations at 50 and 70 days after transplanting:

Data in **Tables (14 & 15)** clearly indicate that total carbohydrates in tomato leaves were highly increased with different applied treatments during 2007 season at the two time of determination (50 and 70 days after transplanting) compared with those of control.

The same data cleared that the most effective treatments which maintained the highest carbohydrates was amino acids at 1.5 ml/L followed by yeast extract at 30 ml/L, Zn at 50 mg/L, Boron at 50 mg/L, Citric acid at 2.5 g/L, Boron at 25 g/L, Zn at 100 mg/L and vitamin E + Sel. with the two concentrations, respectively.

In this respect, increasing of total carbohydrate with different applied treatments consider as a direct result of increasing both photosynthesis rate and efficiency. Also, that was preceded with large photosynthetic area **Tables (4&5)** and high

Table (14): Effect of different applied treatments on sugars, carbohydrates and crude protein concentrations in tomato (*Lycopersicon esculentum*, Mill.) leaves at 50 days after transplanting during 2007 late summer season

Characters / Treatments	Total carbohydrates		Reducing sugars mg/g dry weight	Non reducing sugars mg/g dry weight	Total sugars		Crude protein	
	mg/g dry weight	% relative the control			mg/g dry weight	% relative the control	mg/g dry weight	% relative to the control
1. Yeast extract at 15 ml/L.	462.40	143.47	25.10	9.40	34.50	193.28	276.88	200.45
2. Yeast extract at 30 ml/L.	523.50	162.43	28.00	11.33	39.33	220.34	323.13	233.93
3. Marjoram extract at 15 ml/L.	453.30	140.65	18.93	7.45	26.38	147.79	261.25	189.13
4. Marjoram extract at 30 ml/L.	448.70	139.22	15.83	9.47	25.30	141.74	246.25	178.27
5. Amino acids at 1.5 ml/L.	546.90	169.69	24.53	3.57	28.10	157.42	215.00	155.65
6. Amino acids at 3 ml/L.	446.50	138.54	22.70	6.70	29.40	164.71	246.25	178.27
7. Vit. E at 100 mg/L. + Sel. at 400 µg/L.	475.00	147.38	19.04	11.48	30.52	170.98	246.25	178.27
8. Vit. E at 200 mg/L. + Sel. at 800 µg/L.	475.20	147.44	18.66	11.53	30.19	169.13	291.88	211.31
9. Citric acid at 2.5g/L.	491.90	152.62	19.25	9.15	28.40	159.10	276.88	200.45
10. Citric acid at 5 g/L.	466.00	125.97	19.41	8.00	27.41	153.56	275.00	199.09
11. Vit. E at 100 mg/L. + Sel. at 400 µg/L. + Citric acid at 2.5 g/L.	467.00	144.90	21.96	4.39	26.35	147.62	261.25	189.13
12. Vit. E at 200 mg/L. + Sel. at 800 µg/L. + Citric acid at 5 g/L.	463.90	143.93	16.71	10.89	27.60	154.62	291.88	211.31
13. B at 25 mg/L.	482.00	149.55	26.67	7.95	34.62	193.95	261.25	189.13
14. B at 50 mg/L	497.20	154.27	26.23	7.26	33.49	187.62	276.88	193.93
15. Zn at 50 mg/L.	513.70	159.39	21.33	13.79	35.12	196.75	323.13	233.93
16. Zn at 100 mg/L.	477.40	148.12	27.12	5.49	32.61	182.70	261.25	189.13
17. Control	322.30	100.00	13.03	4.82	17.85	100.00	138.13	100.00

Table (15): Effect of different applied treatments on sugars, carbohydrates and crude protein concentrations in tomato (*Lycopersicon esculentum*, Mill.) leaves at 70 days after transplanting during 2007 late summer season

Characters / Treatments	Total carbohydrates		Reducing sugars mg/g dry weight	Non reducing sugars mg/g dry weight	Total sugars		Crude protein	
	mg/g dry weight	% relative the control			mg/g dry weight	% relative the control	mg/g dry weight	% relative to the control
1. Yeast extract at 15 ml/L.	482.30	143.76	29.31	12.99	42.30	183.04	292.5	172.69
2. Yeast extract at 30 ml/L.	553.00	164.83	32.23	11.89	44.12	190.91	323.13	190.77
3. Marjoram extract at 15 ml/L.	470.70	140.30	22.85	10.27	33.12	143.31	298.13	176.01
4. Marjoram extract at 30 ml/L.	465.30	138.69	27.66	4.19	31.85	137.82	291.88	172.32
5. Amino acids at 1.5 ml/L.	452.00	134.72	28.02	4.18	32.20	139.33	200.00	118.08
6. Amino acids at 3 ml/L.	463.50	138.15	25.54	8.83	34.37	148.72	276.88	163.47
7.Vit. E at 100 mg/L. + Sel. at 400 µg/L.	500.50	149.18	24.60	14.86	39.46	170.75	215.00	126.93
8. Vit. E at 200 mg/L. + Sel. at 800 µg/L.	498.00	148.44	20.54	19.13	39.67	171.66	246.25	145.38
9. Citric acid at 2.5g/L.	507.10	151.15	29.02	9.93	38.95	168.54	291.25	171.95
10.Citric acid at 5 g/L.	498.80	148.67	28.40	8.76	37.16	160.80	261.25	154.24
11.Vit. E at 100 mg/L. + Sel. at 400 µg/L. + Citric acid at 2.5 g/L.	463.20	138.06	20.97	19.63	40.60	175.68	276.88	163.47
12.Vit. E at 200 mg/L. + Sel. at 800 µg/L. + Citric acid at 5 g/L.	479.100	142.80	26.30	4.94	31.24	135.18	291.88	172.32
13.B at 25 mg/L.	495.20	147.60	28.57	3.25	31.82	137.69	246.88	145.76
14. at 50 mg/L	505.50	150.67	29.06	3.49	32.55	140.85	246.25	145.38
15. Zn at 50 mg/L.	529.60	157.85	30.30	7.1	37.40	161.83	307.50	181.54
16.Zn at 100 mg/L.	484.90	144.53	28.27	7.1	35.37	153.05	215.00	126.93
17. Control	335.50	100.00	15.19	7.92	23.11	100.00	169.38	100.00

concentration of photosynthetic pigments **Tables (6&7)** as well under the treatment of various treatments but reached its maximum with yeast extract at 30 ml/L. Such promotional effect of applied anti-oxidant on carbohydrates concentrations could be due to their similar effect on photosynthetic pigments, and number of leaves, surfaces of photo-assimilation. Thereby the capacity of Co_2 fixation and carbohydrates synthesis **(Dicknson *et al.*, (1991),** also citric acid might be involved in ATP synthesis and decreased the destruction of carbohydrates **(Fathy *et al.*, 2003).**

The simulative effect of the yeast extract, Zn, B, citric acid and tocopherol + Selenium might be due to their anti-oxidantal scavenging effect to protect chloroplasts and prevent chlorophyll degradation by the toxic reactive oxygen radicals which internally generated during high temperature stress **(Fig.1 and 2). Lu and Huang (2003)** suggested that plant stress tolerance will depend on the intrinsic anti-oxidation system in leaf cells.

As for the total sugars and their fraction, data in **Tables (14 and 15)** exhibited their dominant increases with all applied treatments at the two assigned times of determination. Also, yeast extract at 30 and 15 ml/L treatments gave the highest values of their concentrations. Yet, it was followed by Zn at 50mg/L, Boron at 25 mg/L, Zn at 100 mg/L, Boron at 50 mg/L, amino acids at 3 ml/L and vitamin E + Sel. With its two concentrations, respectively. That was true during the two times of determination during 2007 season.

In addition, increment of sugars in tomato leaves with different applied treatments considered a direct result of the obtained vigorous growth that being accompanied with high photosynthesis efficiency. Thereby, plants with this case of

vigorous growth and entire feeding system under these adverse conditions (heat stress) could be give high yield with high quality.

Once again, treated plants of these treatments were of the higher carbohydrates and sugars concentrations might be exported sufficient sugars at early stages. Those essentially required for fruit setting activities, specially under stress condition. Moreover, carbohydrates and sugars link to the case of heat tolerance via their roles as cellular cry protective or osmoregulators agent, they protected proteins and enzymes against denaturation induced by heat stress, as well as basic substrate for ATP synthesis. These result are in agreement with those reported by **Hare *et al.*, (1998); Conklin, (2001); Lu and Huang, (2003) and A¯non *et al.*, (2004)** they reported that a key adaptive mechanism in many plants grown under abiotic stresses, extreme temperatures, is accumulation of certain organic compounds of low molecular mass, generally referred to as compatible osmolytes under stress, different plant species may accumulate a variety of osmolytes such as sugars and sugar alcohols (polyols), proline tertiary and quaternary ammonium compounds, and tertiary sulphonium compounds. Accumulation of such solutes may contribute to enhanced stress tolerance of plants.

As for protein concentration, it behaved as the same as in case of elements, since the different applied treatments increased this concentration compared with the control. These results are in agreement with those reported by **Marschner (1995), Cakmak (2000), Foyer and Noctor (2003) and Velikova *et al.*, (2005)**

It was obvious from the same data that control plants were greatly stressed, they have poorest carbohydrates and sugars concentrations as a direct result for high temperature stress which

developed without mechanism by which they protected against the prevailing high temperature stress **(Fig.2)** and its probable inducible oxidative one **(Fig.1).** This might be due to either poor synthetic efficiency or due to degradation of chlorophyll as result of heat/oxidative stress effects **Cakmak and Marschner (1992); Crafts-Brander and Salvucci (2002) and Guo *et al.*, (2006)** they reported that high temperature stress associate with the production of active oxygen radicals ROS, these ROS (i.e., H_2O, OH, O_2, ...etc.) damaged chloroplast, reduced carbohydrate synthesis and exportation and hastened oxygen senescence, 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 processes, finally senescence and death of cell and tissues.

2.4. Total phenols and total amino acids concentrations at 50 and 70 days after transplanting:

In similar trend, total phenols and total amino acids were affected as other mentioned bioconstituents. **Tables (16 & 17)** clearly indicate that total phenols and total amino acids in tomato leaves were highly increased with different applied treatments compared with those of control plants during 2007 season at the two times of determination,(50 and 70 days after transplanting).

Same data revealed that the highest amino acids concentrations was with yeast extract at 30 and 15 ml/L followed by vitamin E at 200 mg/L + Sel. at 800 µg/L, marjoram extract at 15 ml/L, vitamin E at 100 mg/L + Sel. at 400 µg/L and Zinc at 50 mg/L, respectively. While the highest total phenols concentration was with yeast extract at 30 ml/L, marjoram extract at 15 ml/L,

Table (16): Effect of different applied treatments on amino acids and phenols concentrations of tomato (*Lycopersicon esculentum*, Mill.) plant leaves at 50 days after transplanting during 2007 late summer season.

Characters / Treatments	Total amino acids		Total phenols	
	mg/g dry weight	% relative to the control	mg/g dry weight	% relative to the control
1. Yeast extract at 15 ml/L.	16.12	214.10	3.08	270.00
2. Yeast extract at 30 ml/L.	17.85	237.10	3.44	301.90
3. Marjoram extract at 15 ml/L.	14.68	195.00	3.24	284.60
4. Marjoram extract at 30 ml/L.	12.72	168.90	2.96	259.40
5. Amino acids at 1.5 ml/L.	12.96	172.10	3.00	263.00
6. Amino acids at 3 ml/L.	11.50	152.70	2.67	234.20
7. Vit. E at 100 mg/L. + Sel. at 400 µg/L.	14.23	189.00	2.36	206.80
8. Vit. E at 200 mg/L. + Sel. at 800 µg/L.	14.92	198.10	3.17	278.10
9. Citric acid at 2.5g/L.	15.12	200.80	2.28	200.20
10. Citric acid at 5 g/L.	11.14	147.90	3.14	275.50
11. Vit. E at 100 mg/L. + Sel. at 400 µg/L. + Citric acid at 2.5 g/L.	12.34	163.90	2.89	253.40
12. Vit. E at 200 mg/L. + Sel. at 800 µg/L. + Citric acid at 5 g/L.	15.18	201.60	2.96	260.20
13. B at 25 mg/L.	9.33	123.90	2.59	227.10
14. B at 50 mg/L	10.53	139.80	2.61	229.40
15. Zn at 50 mg/L.	12.86	170.80	3.05	268.00
16. Zn at 100 mg/L.	12.03	159.80	2.47	217.00
17. Control	7.53	100.00	1.14	100.00

Table (17): Effect of different applied treatments on amino acids and phenols concentrations in tomato (*Lycopersicon esculentum*, Mill.) plant leaves at 70 days after transplanting during 2007 late summer season.

Characters / Treatments	Total amino acids		Total phenols	
	mg/g dry weight	% relative to the control	mg/g dry weight	% relative to the control
1. Yeast extract at 15 ml/L.	15.79	178.40	3.88	357.10
2. Yeast extract at 30 ml/L.	16.43	185.60	4.49	413.40
3. Marjoram extract at 15 ml/L.	15.18	171.50	3.57	329.30
4. Marjoram extract at 30 ml/L.	12.74	144.00	2.82	259.40
5. Amino acids at 1.5 ml/L.	12.34	139.40	2.90	267.50
6. Amino acids at 3 ml/L.	10.82	122.30	2.82	259.60
7. Vit. E at 100 mg/L. + Sel. at 400 µg/L.	13.09	147.90	3.65	336.70
8. Vit. E at 200 mg/L. + Sel. at 800 µg/L.	13.65	154.20	2.94	271.20
9. Citric acid at 2.5g/L.	11.51	130.10	2.76	254.70
10. Citric acid at 5 g/L.	10.29	116.30	3.12	287.70
11. Vit. E at 100 mg/L. + Sel. at 400 µg/L. + Citric acid at 2.5 g/L.	12.38	139.90	3.32	305.60
12. Vit. E at 200 mg/L. + Sel. at 800 µg/L. + Citric acid at 5 g/L.	10.35	116.90	3.53	325.70
13. B at 25 mg/L.	11.56	130.60	2.44	224.40
14. B at 50 mg/L	12.74	144.00	2.50	230.20
15. Zn at 50 mg/L.	14.17	160.10	2.71	250.00
16. Zn at 100 mg/L.	12.86	145.30	2.81	258.70
17. Control	8.85	100.00	1.09	100.00

vitamin E at 200 mg/L + Sel. at 800 µg/L, yeast extract at 15 mg/L and Zinc at 50 mg/L, respectively at the two time of determination with the superiority of yeast extract at 30 ml/L in both cases.

Herein, it was clear that the applied anti-oxidants induced the synthesis of phenols, amino acids (other anti-oxidants) as a defensive system **(Fig. 2).** Generally, it could be concluded that different applied treatments were mostly effective, which induced an active metabolical case and the most effective internal defensive anti-oxidantal mechanism (i.e., carotenoids, phenols, sugars, protein, ….etc.). At the same time, this was accompanied with good morphological, minerals status and agronomical performances.

Once again, the simulative effect of these treatments might be due to their anti-oxidantal scavenging effect against the prevailing higher temperature stress or due to enhance the internal metabolical defensive machine of tomato plant against the higher temperature adverse effects (the internal synthesized protective anti-oxidant bioconstituents) **Lu and Huang (2003)**.

In this respect, **Wahid and Ghazanfar (2006)** reported that phenolics, including flavonoids, anthocyanin, lignins,…..etc, are the most important class of secondary metabolites in plants and play a variety of roles including tolerance to a biotic stresses. On the other hand the role of amino acids in a biotic stress resistance was reported by **Singh(1999)** he reported that this class of molecules includes certain amino acids (notably proline), quaternary ammonium compounds (e.g., glycinebetaine, prolinebetaine, β -alaninebetaine, and choline-O-sulfate), and the tertiary sulfonium compound 3-dimethyl-sulfoniopropionate (DMSP). These compounds are thought to play a pivotal role in

plant cytoplasmic osmotic adjustment in response to osmotic stresses.

The synthesis of quaternary ammonium and tertiary sulfonium compounds requires participation of the "activated methyl cycle" to provide methyl groups for the onion moieties of these compounds.

Therefore, attention is given to the role of sulfur amino acid metabolism, and in particular, the role of methionine and S-adenosylmethionine (SAM) in the biosynthesis of these methylated onium compounds. The central position of SAM in stress metabolism in plants is further illustrated by briefly considering its role as a precursor of the hormone ethylene and of the polyamines spermine and spermidine. The role of sulfur amino acid metabolism in plant stress-resistance mechanisms is further explored in relation to the participation of cysteine as a precursor of peptides (glutathione and phytochelatins) facilitate detoxification active oxygen species **(Foyer *et al.*, 1995).**

Also, the above mentioned results which obtained results clearly indicate that amino acids treatment effectively enhanced the internal metabolically protective status by their direct scavenging functions against the toxic free radicals (induced by heat stress) and / or their promotional effect on synthesis of natural protective antioxidants (i.e., total phenols, carotentoids, sugars, proteins...ect) as well as they induced an potent biosynthesis case due to the higher photosynthetic pigments concentrations (protection of chlorophyll's and chloroplasts against stress degradable/ senescence effects), thereby higher carbohydrates and minerals accumulation.

The strong positive correlations of such constituents v.s. growth confirmed and coincided such functions and roles of antioxidants.

3. Endogenous phytohormones:

Data in **Table (18)** show the changes in endogenous phytohoromones, indole acetic acid (IAA), abscisic acid (ABA), gibberellic acids (GA_3) and cytokinins of tomato plant sprayed with yeast extract at 30 and 15 ml/L; Zn at 50 and 100 mg/L; Boron at 50 mg/L; amino acids at 3 ml/L; citric acid at 2.5 g/L; vitamin E at 200 mg/L + Sel. at 800 µg/L + Citric acid at 5 g/L and marjoram extract at 15 ml/L (the most effective treatments, which greatly improved the morphological, metabolical performances of tomato plant as obvious from the previously mentioned and discussed results obtained in the present study) and the control at 70 days after transplanting during 2007 season. As for auxin level, it was highly increased in tomato leaves with different assigned treatments compared with that of untreated plants. Again, yeast extract at 30 ml/L. was the most effective followed by amino acids at 3 ml/L, vitamin E at 200 mg/L + Sel. at 800 µg/L + citric acid at 5 g/L and Zinc at 50 mg/L. With regard to, gibberellin level, data in **Table (18)** also clearly show that the level of gibberellin like-substances, its level in tomato leaves was behaved as the same as auxins.

Furthermore, **Table (18)** clearly indicates that the level of cytokinines positively responded to the different assigned treatments. Since, the activity was the lowest in case of the control.

With regard to, gibberellins level in tomato leaves, it was behaved as the same as auxins level **(Table 18).**

Table (18): Effect of different determined treatments on endogenous phytohormones in tomato (*Lycopersicon esculentum*, Mill.) leaves at 70 days after transplanting during 2007 late summer season.

Plant hormones / Treatments	Promoters					Inhibitors		Promoters/ inhibitors	% relative to the control
	Gibberellins (GA_3) µg/g F.wt.	Auxins (IAA) µg/g F.wt.	Cytokinins µg/g F.wt.	Total µg/g F.wt.	% relative to the control	Abscisic acid (ABA) µg/g F.wt.	% relative to the control		
1. Yeast extract at 15 ml/L.	68.74	52.32	97.32	218.38	255.00	1.56	31.90	139.99	499.49
2. Yeast extract at 30 ml/L.	81.53	63.59	101.79	246.91	288.31	1.48	30.27	166.83	952.77
3. Marjoram extract at 15 ml/L.	48.17	19.92	89.35	157.44	183.84	3.48	71.17	45.24	258.37
4. Amino acids at 3 ml/L.	51.67	30.32	76.26	158.25	184.79	3.22	65.85	49.15	280.70
5. Citric acid at 2.5g/L.	62.51	26.43	82.71	171.65	200.43	3.15	64.42	54.49	311.19
6. Vit. E at 200 mg/L. + Sel. at 800 µg/L. + citric acid at 5 g/L	53.86	23.87	63.65	141.38	165.09	2.98	60.94	47.44	270.93
7. B at 50 mg/L.	61.32	39.28	74.21	147.81	172.59	3.06	62.58	48.30	275.84
8. Zn at 50 mg/L.	63.54	44.35	85.83	193.72	226.20	2.23	45.60	86.87	496.12
9. Zn at 100 mg/L.	58.72	42.98	76.52	178.22	208.10	2.97	60.74	60.01	342.72
10. Control	33.84	16.67	35.13	85.64	100.00	4.89	100.00	17.51	100.00

Generally, these phytohormones those promote growth aspects (i.e., growth promoters, auxins, gibberellin and cytokinin) were highly increased with different assigned treatments. Here the treatment of yeast extract at 30 ml/L gave the highest value activity of promoting phytohormones level, where the increment reached more than three times of control value. Also, increment of endogenous hormones in tomato plants obtained in the present study could be interpret both of the obtained modifications in different studied histological features **(Tables,21&22)** and the improvement of growth **(Tables,1-9)** and yield **(Tables,25-27)**. For example, increasing cytokinins could be in favor of increasing the number of formed branches and that could also increase transverse growth on the account of longitudinal one as well as increasing of sink organs (i.e., fruits) ability to accumulate and storage more assimilates. Once again, yeast treatments showed the highest value of cytokinins, IAA and GA_s in tomato leaves. Yeast is a natural source of cytokinins and has stimulatory effects on plants **(Barnett *et al.*, 1990).** Yeast has also higher contents of different nutrients, higher percentage of proteins and higher value of vitamins as reported by **Fathy and Farid, (1996) and El-Mogy *et al.*, (1998).** This may explain the increase of cytokinins and other promoting hormones in response to yeast application.

For higher levels of promoting hormones obtained with vitamin E treatment may be attributed to its promoting effects on growth and yield of tomato plants. **El-Bassiouny *et al.*, (2005)** attributed these promoting effects of Vitamin E on growth and yield to the fact that it is a low molecular weight lipophilic antioxidant which protect membrane from oxidative stress. Also, **(Blokhina *et***

al., **2002)** indicated that vitamin is highly effective antioxidant at the membrane site.

On the other hand, **Marschner (1995) and Cakmak *et al.,* (1997)** indicated the positive effects of Zn application on promoting hormone contents which may be due to the fact that zinc has an effect on the metabolism of natural auxin (IAA) and consequently activating cell division and enlargement. As well as being an important factor in plant's defense against (ROS) which proliferate under various stress, including heat stress.

Here, the present data indicates the effectiveness of using yeast, Zn, Vitamin E, citric acid and amino acids as foliar spray on promoting growth and yield of tomato plants grown under heat temperature stress conditions during the late summer season.

With regard to, the growth inhibitor, (abscises acid) its level was reduced with various assigned treatments compared with the control, but the reduction acid was more obvious with yeast extract at 30 ml/L.

In this respect, **Maestri *et al.,* (2002) and Larkindalr and Haung, (2005)** reported that abscisic acid (ABA) and ethylene (C_2H_4), as stress hormones, are involved in the regulation of many physiological properties by acting as signal molecules. Different environmental stresses, including high temperature, result in increased levels of ABA. For example, recently it was determined that in creeping bent grass (Agrostis palustris), ABA level did not rise during heat stress, but it accumulated upon recovery from stress suggesting a role during the latter period. However, the action of ABA in response to stress involves modification of gene expression.

Moreover, the proportions of total promoters to the inhibitor abscisic acid **Table (18)** was increased with the different assigned treatments compared with the control and reached its maximum value with yeast extract at 30 ml/L. In this respect, these results being of great interest for interpreting each of the obtained vigorous growth and the great fruit yield of tomato plant attained in the present study.

It was obvious from the same data the simulative effects of these treatments to enhance the internal metabolical defensive mechanism (such as promoting hormones) of tomato plant against the high temperature adverse effects towards maximizing its growth and productivity during hot summer season.

4. Enzymatic antioxdants activity:

Plants posses antioxidant system in the form of enzymes such as superoxide dismutase (SOD), catalase, (CAT) peroxidase (PX) and metabolites, as ascorbic acid,glutathione, and α-tocopherol, carotenoid, flavanoids.....ect, these antioxidant enzymes and metabolites are reported to increase under various environmental stress **price *et al.*,(1994) and Noctor and Foyer (1998).**

In this respect, data in **Table (19)** clearly show that different applied treatments induced reductions in the peroxidase, catalase and superoxide dismutase actives as compared with those of the untreated plants in tomato leave at 70 days after transplanting during the lat summer season of 2007. These reductions in determined enzymatic antioxidants activity with different applied treatments compared with control one might be due to their direct scavenging function against the toxic free radicals (induced by heat

stress) and / or their promotional effects on synthesis of internal protective antioxidants, i.e., total sugars, total phenols, total amino acids and carotenoids as well as they induce an potent biosynthesis case due to the higher photosynthetic pigments content (protection of chlorophyll's and chloroplasts against stress degradable/ senescence effects), thereby higher carbohydrates accumulation and higher minerals (N, P, K, Ca, Mg, Fe, Zn and Mn) constituents vs. growth as mentioned before. Hence, the obtained results in the present study confirmed and coincided such functions and roles of antioxidants. **Noctor and Foyer (1998) and Xu *et al.*, (2006)** reported that in addition to tissue dehydration, heat stress may induce oxidative stress which reactive oxygen species (ROS), such as the superoxide anion radical (O_2), hydrogen peroxide (H_2O_2) and the hydroxyl radical (OH), are by-products of normal cell metabolism that can damage many cellular components, including lipids, proteins and nucleic acids. The conditions leading to damage caused by ROS are referred to as oxidative stress, which can lead to an inhibition of photosynthesis and respiration, and there for, plant growth. Plants have evolved well-developed defense mechanisms against these ROS, involving enzymatic and non-enzymatic scavenging systems, Under unstressed conditions, however, including heat stress, the defense system can be overwhelmed, and is then unable to remove the additional **ROS** with increased enzymatic or non-enzymatic antioxidant processes. While superoxide dismutase (SOD), ascorbate peroxidase (APX), catalase (CAT)and glutathione reductase (GR)are key enzymatic antioxidants. SOD catalyses the first step in the scavenging system of ROS by the dismutation of O_2 by CAT or APX.GR can also remove H_2O_2 via the ascorbate-glutathione cycly.

Table (19): Effect of different applied treatments on antioxidant enzymatic activity (/g fresh w./h) in tomato (*Lycopersicon esculentum*, Mill.) plant leaves at 70 days after transplanting during 2007 late summer season

Characters / Treatments	Peroxidase		Catalase		Superoxide dismutase	
	Activity	% relative to the control	Activity	% relative to the control	Activity	% relative to the control
1. Yeast extract at 15 ml/L.	187.00	63.39	65.00	57.52	213.00	83.86
2. Yeast extract at 30 ml/L.	163.00	55.25	33.00	29.20	198.00	77.95
3. Marjoram extract at 15 ml/L.	209.00	70.85	23.00	20.35	165.00	64.96
4. Marjoram extract at 30 ml/L.	185.00	62.71	87.00	76.99	208.00	81.89
5. Amino acids at 1.5 ml/L.	193.00	65.42	104.00	92.04	197.00	77.56
6. Amino acids at 3 ml/L.	183.00	62.03	83.00	73.45	266.00	104.72
7. Vit. E at 100 mg/L. + Sel. at 400 µg/L.	208.00	70.51	63.00	55.75	241.00	94.88
8. Vit. E at 200 mg/L. + Sel. at 800 µg/L.	195.00	66.10	104.00	92.04	175.00	68.90
9. Citric acid at 2.5g/L.	22.00	75.59	112.00	99.12	203.00	79.92
10. Citric acid at 5 g/L.	211.00	71.53	55.00	48.67	217.00	85.43
11. Vit. E at 100 mg/L. + Sel. at 400 µg/L. + Citric acid at 2.5 g/L.	245.00	83.05	76.00	67.26	221.00	87.01
12. Vit. E at 200 mg/L. + Sel. at 800 µg/L. + Citric acid at 5 g/L.	196.00	66.44	105.00	92.92	197.00	77.56
13. B at 25 mg/L.	201.00	68.14	110.00	97.35	201.00	79.13
14. B at 50 mg/L	191.00	64.75	103.00	91.15	245.00	96.46
15. Zn at 50 mg/L.	175.00	59.32	45.00	39.82	233.00	91.73
16. Zn at 100 mg/L.	213.00	72.20	73.00	64.60	193.00	75.98
17. Control	295.00	100.00	113.00	100.00	254.00	100.00

5. Heat shock proteins response (HSP):

In this respect, **Iba (2002)** discussed that immediately after exposure to high temperatures and perception of signals, changes occur at the molecular level altering the expression of genes and cumulation of transcripts, thereby leading to the synthesis of stress-related proteins as a stress tolerance strategy expression of heat shock proteins (HSPs) is known to be an important adaptive strategy in this regard. The HSPs, ranging in molecular mass from about 10 to 200 kD(Kilo Dalton), have chaperone like functions and are involved in signal transduction during heat stress. Also, **Ahn and Zimmerman (2006)** have shown that the tolerance conferred by HSPs results in improved physiological phenomena such as photosynthesis, assimilate partitioning, water and nutrient use efficiency, and membrane stability such improvements make plant growth and development possible under heat stress .

As shown in **(Table, 20)** (scanned gel resulting from SD-PAGE using the gel Doc2000 Bio-Rad system and analyze with quantity one soft ware package supplied by the manufacturer) and **Fig. (3)**, all different applied treatments induced the appearance of new proteins of M.Wts 261.76-235.29, 217.66-183.76, 159.95-140.05, 128.97-118.18, 114.87-109.68, 105.03-98.34, 86.96-78.42, 70.63-64.31, 62.83-61.83, 40.00-35.84, 31.89-28.80, 28.06-27.28, 27.04-26.85, 26.79-26.60, 25.63-22.90 and 17.41-16.11 KD as compared with the pattern of the untreated tomato plants. Exposure of tomato plants to high temperature stress during late summer season under the field conditions induced the appearance of 16 protein bands with all different applied treatments compared with

Table (20): Effect of different applied treatments on protein electrophoretic pattern of tomato (*Lycopersicon esculentum*, Mill.) leaves at 70 days after transplanting during 2007 late summer season.

Number of bands	M.W.Kd	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	C
1	261.76-235.29	-	-	+	-	-	+	-	-	-	-	-	+	-	-	-	-	-
2	217.665-183.76	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	159.95-140.05	+	+	+	+	+	+	+	+	+	-	+	-	-	-	-	-	-
4	128.97-118.18	-	+	+	-	+	-	-	-	+	+	-	-	-	-	-	-	-
5	114.87-109.68	-	-	+	-	+	-	-	-	+	+	-	-	-	-	-	-	-
6	105.03-98.34	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	-
7	86.96-78.42	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-
8	70.63-64.31	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	-
9	62.83-61.83	-	-	+	+	+	+	+	+	+	-	+	-	+	+	+	+	-
10	59.77-56.76	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
11	51.22-44.29	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
12	40.00-35.84	-	-	+	-	+	-	+	+	-	-	+	-	-	+	+	+	-
13	31.89-28.80	-	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	-
14	28.06-27.28	-	-	+	-	+	+	+	+	+	-	-	-	-	-	+	+	-
15	27.04-26.85	+	+	+	+	-	-	-	+	+	+	-	+	+	-	+	-	-
16	26.79-26.60	-	+	-	-	+	-	+	-	-	-	-	-	-	-	-	+	-
17	26.50-25.83	+	+	+	+	+	-	+	+	+	+	-	-	+	+	-	+	+
18	25.63-22.90	-	-	+	-	+	+	+	-	+	-	+	+	-	-	+	+	-
19	21.07-18.15	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
20	17.41-16.11	-	+	+	-	+	+	+	+	+	+	-	-	-	-	+	-	-

1. Yeast extract at 15 ml/L
2. Yeast extract at 30 ml/L
3. Marjoram extract at 15 ml/L
4. Marjoram extract at 30 ml/L
5. Amino acids at 1.5 ml/L
6. Amino acids at 3 ml/L
7. vitamin E at 100 mg/L + Sel. at 400 µg/L
8. vitamin E at 200 mg/L + Sel. at 800 µg/L
9. Citric acid at 2.5 g/L
10. Citric acid at 5 g/L
11. vitamin E at 100 mg/L + Sel. at 400 µg/L + Citric acid at 2.5 g/L
12. vitamin E at 200 mg/L + Sel. at 800 µg/L + Citric acid at 5 g/L
13. B at 25 mg/L
14. B at 50 mg/L
15. Zn at 50 mg/L
16. Zn at 100 mg/L
(C) : Control

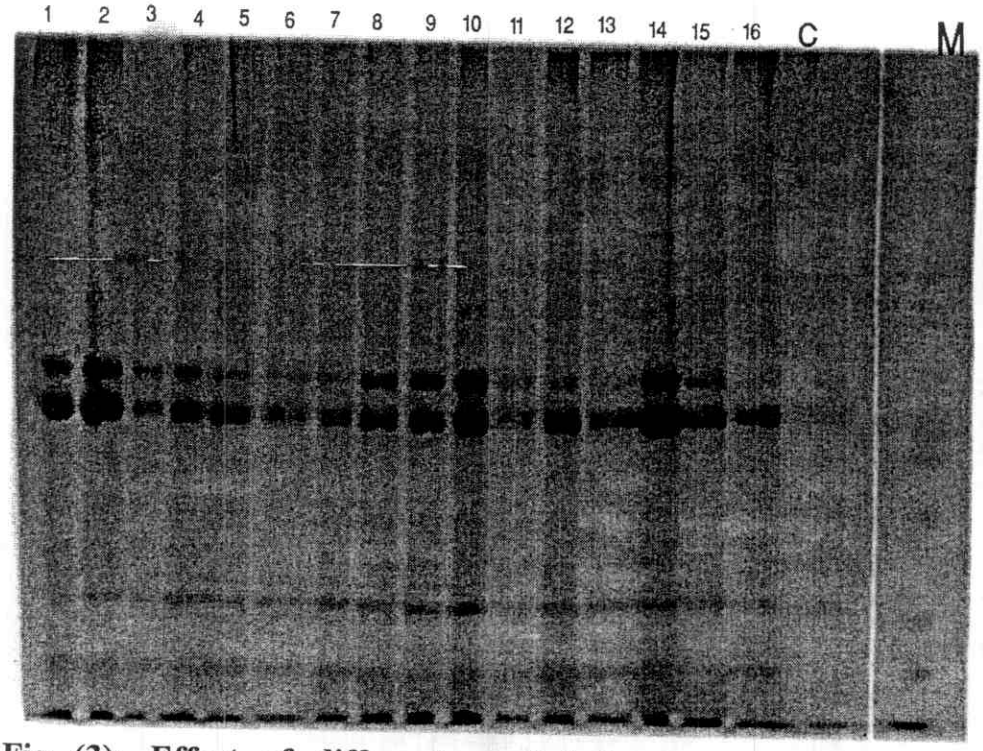


Fig (3): Effect of different applied treatments on protein electrophoretic pattern of tomato (*Lycopesicon esculentum*, Mill.) leaves at 70 days after transplanting during 2007 season

Where:

1. Yeast extract at 15 ml/L
2. Yeast extract at 30 ml/L
3. Marjoram extract at 15 ml/L
4. Marjoram extract at 30 ml/L
5. Amino acids at 1.5 ml/L
6. Amino acids at 3ml/L
7. vitamin E at 100 mg/L + Sel. at 400 µg/L
8. vitamin E at 200 mg/L + Sel. at 800 µg/L
9. Citric acid at 2.5 g/L
10. Citric acid at 5 g/L
11. vitamin E at 100 mg/L + Sel. at 400 µg/L + Citric acid at 2.5 g/L
12. vitamin E at 200 mg/L + Sel. at 800 µg/L + Citric acid at 5 g/L
13. B at 25 mg/L
14. B at 50 mg/L
15. Zn at 50 mg/L
16. Zn at 100 mg/L
C: Control
M: Protein marker

the untreated control. The new protein bands were the band number 1, 2, 3, 4, 5, 6, 7, 8, 9, 12, 13, 14, 15, 16, 18, and 20.

On the other, hand the bands number 10,11,17 and 19 were common nearly between all applied treatments and the control.

It is obvious from the same data that appearance of new protein bands with different applied treatments is one of different plant mechanisms for surfing under elevated temperatures. Whereas, the control plants strongly stressed since, they developed with out no mechanism by which they protected them self a against the prevailing high temperature stress. Also, appearance of new protein bands with used treatments clear up the simulative effect of these treatments on enhancing the internal metabolical defensive mechanism of tomato plant a against the adverse effects of heat stress towards maximizing its growth and productivity. The strong positive correlation of such constituents vs. growth roles of antioxidants.

The obtained results were in agreement with those reported by **Khalil *et al.*, (2008)**.

Furthermore, **Neumann *et al.*, (1993); Feussner *et al.*, (1997); Liu *et al.*, (2006) and Wahid and Close (2007)** concluded that expression of stress proteins is an important adaptation to cope with environmental stresses. Most of the stress proteins are soluble in water and therefore contribute to stress tolerance presumably via hydration of cellular structures. Although heat shock proteins (HSPs) are exclusively implicated in heat-stress response, certain other proteins are also involved.

Three classes of proteins, as distinguished by molecular weight, account for most HSPs, viz., HSP90, HSP70 and low

molecular weight proteins of 15-30 kDa. The special importance of small HSPs in plants is suggested by their unusual abundance and diversity. The proportions of these three classes differ among plant species. HSP70 and HSP90 mRNAs can increase ten-fold, while low molecular weight (LMW) HSPs can increase as much as 200-fold. Other proteins, such as 110 kDa polypeptides and ubiquitin, though less important, are also considered

In response to high temperatures, specific HSPs have been identified in different plant species. For example, HSP68, which is localized in mitochondria and normally constitutively expressed, was determined to have increased expression under heat stress in cells of potato, maize, tomato, soybean and barley. The gene for a nuclear-encoded HSP, HSA32, encoding a 32 kDa protein, has been cloned in tomato.

6. Anatomical study:

Data in **Tables (21&22)** show the effect of all applied treatments on the mean counts and measurements in microns of certain histological features of the main stem and leaves of tomato plant (*Lycopersicon esculentum* Mill.) cv. Super Strain B grown in the field under heat stress conditions at 70 days after transplanting.

6.1. Effect of different applied treatments on the stem anatomy:

Table (21) and **Figs. (4, 5 and 6)** show that different applied treatments increased the stem diameter compared with control. This increase reached its maximum values with yeast extract at 30 ml/L , Vit. E at 100 mg/L. + Sel. at 400 µg/L. + citric acid at 2.5 g/L. and Zn at 50 mg/L. gave 7248.60, 7188.60 and 7137.00µ, respectively compared with the stem diameter was 6977.25 µ of the control .

Table (21): Effect of different applied treatments on the mean counts and measurements of certain histological features of main tomato (*Lycopersicon esculentum*, Mill.) stem at 70 days after transplanting as affected by different applied treatments.

Histological characteristics (micron) / Treatments	Stem diameter	Cuticle layer thickness	Epidermal thickness	Palisade like tissue hickness	Thickness of collenchyma layers	Number of Collenchyma layers	Mean thickness of Collenchyma layer	Thickness of parenchyma layers	Number of parenchyma layers	Mean thickness of parenchyma layer	outer phloem thickness	Cambium al region thickness
1. Yeast extract at 15 ml/L.	6090.30	15.30	43.20	76.50	147.60	7.00	21.08	105.30	4.00	26.32	136.35	64.80
2. Yeast extract at 30 ml/L.	7248.60	17.10	40.95	0.00	214.65	5.00	42.93	155.25	4.00	38.81	103.95	75.60
3. Marjoram extract at 15 ml/L.	5971.95	14.40	34.65	79.65	122.85	6.00	20.47	90.90	4.00	22.72	130.05	42.30
4. Marjoram extract at 30 ml/L.	4084.65	18.00	35.33	0.00	147.60	5.50	26.84	99.00	4.00	24.75	82.35	64.35
5. Amino acids at 1.5 ml/L.	5274.00	20.25	41.40	67.95	97.20	6.00	16.20	80.55	4.00	20.14	61.65	51.75
6. Amino acids at 3 ml/L.	5583.60	17.10	39.15	0.00	142.20	7.00	20.31	81.90	3.00	27.30	111.15	47.25
7. Vit. E at 100 mg/L. + Sel. at 400 µg/L.	4555.80	12.60	31.50	76.50	128.70	6.00	21.45	120.60	6.00	20.10	83.70	59.40
8. Vit. E at 200 mg/L. + Sel. at 800 µg/L.	5525.30	13.50	34.65	0.00	165.15	7.00	23.59	105.75	4.00	26.44	109.80	97.20
9. Citric acid at 2.5g/L.	6869.70	16.20	31.50	0.00	165.15	7.00	23.59	88.65	3.00	29.55	113.40	84.60
10. Citric acid at 5 g/L.	5494.50	11.70	39.15	63.00	115.65	6.00	19.27	99.00	4.00	24.75	68.40	63.00
11. Vit. E at 100 mg/L. + Sel. at 400 µg/L. + Citric acid at 2.5 g/L.	7188.60	14.40	29.25	64.26	281.25	7.00	40.18	142.20	4.00	35.55	189.00	103.50
12. Vit. E at 200 mg/L. + Sel. at 800 µg/L. + Citric acid at 5 g/L.	5353.20	15.30	28.35	75.15	117.00	6.00	19.50	123.75	4.00	30.94	69.75	58.95
13. B at 25 mg/L.	3692.24	14.40	34.65	0.00	146.70	7.00	20.96	147.15	6.00	24.52	50.85	65.25
14. B at 50 mg/L	4179.60	12.60	29.25	90.00	102.60	7.00	14.66	108.00	4.00	27.00	78.30	42.30
15. Zn at 50 mg/L.	7137.00	17.10	42.30	108.00	211.50	7.00	30.21	96.30	6.00	16.05	157.50	98.10
16. Zn at 100 mg/L.	5661.08	15.75	36.90	100.80	200.25	7.00	28.61	108.00	4.00	27.00	131.85	55.80
17. Control	6977.25	16.65	48.60	158.40	189.00	6.00	31.50	180.45	4.00	45.11	154.80	78.30

Continue of Table (21): Effect of different applied treatments on the mean counts and measurements of certain histological features of main tomato (*Lycopersicon esculentum*, Mill.) stem at 70 days after transplanting as affected by different applied treatments.

Histological characteristics (micron) / Treatments	Xylem thickness	Number of xylem rows/Vascular cylinder	No. of xylem vessels / row	diameter of the widest xylem vessel in V. cylinder	Thickness of inner phloem	Parenchymatous pith thickness	Number of parenchymatousp ith layers	Mean thickness of Parenchymatous pith / layer	Trichome length in the epidermal layer
1. Yeast extract at 15 ml/L.	808.65	88.00	8.80	113.29	189.45	3069.00	37.00	82.94	201.15
2. Yeast extract at 30 ml/L.	761.40	86.00	18.00	105.00	185.40	4140.00	36.00	115.00	175.50
3. Marjoram extract at 15 ml/L.	747.00	82.00	12.50	119.85	157.50	3291.75	43.00	76.55	295.20
4. Marjoram extract at 30 ml/L.	714.15	74.00	9.75	88.05	130.05	1503.00	17.00	88.41	204.30
5. Amino acids at 1.5 ml/L.	652.50	89.00	6.50	108.00	137.25	2988.90	36.00	83.03	223.65
6. Amino acids at 3 ml/L.	783.00	76.00	11.00	109.20	190.80	2758.50	32.00	86.20	214.65
7. Vit. E at 100 mg/L. + Sel. at 400 µg/L.	469.35	88.00	14.33	122.40	122.85	2498.40	29.00	86.15	203.40
8. Vit. E at 200 mg/L. + Sel. at 800 µg/L.	781.20	87.00	9.28	105.30	177.75	2555.30	29.00	88.11	281.25
9. Citric acid at 2.5g/L.	1003.05	111.00	11.83	128.70	186.30	3492.00	39.00	89.54	205.65
10. Citric acid at 5 g/L.	887.85	103.00	11.75	106.43	157.50	2640.00	30.00	87.00	213.53
11. Vit. E at 100 mg/L. + Sel. at 400 µg/L. + Citric acid at 2.5 g/L.	1197.00	108.00	13.80	113.85	216.00	2843.40	33.00	86.16	162.04
12. Vit. E at 200 mg/L. + Sel. at 800 µg/L. + Citric acid at 5 g/L.	783.00	89.00	12.20	85.80	166.50	2628.00	34.00	77.29	207.90
13. B at 25 mg/L.	362.02	52.00	9.50	131.40	97.65	1854.90	15.00	123.66	151.20
14. B at 50 mg/L	293.40	72.00	7.25	103.50	120.60	2605.50	29.00	89.84	213.30
15. Zn at 50 mg/L.	1094.40	102.00	12.40	130.05	214.20	3274.20	30.00	109.14	214.20
16. Zn at 100 mg/L.	755.10	76.00	8.00	124.20	176.85	2700.00	33.00	81.82	190.80
17. Control	956.70	70.00	8.80	153.82	216.90	3294.45	27.00	122.02	290.70

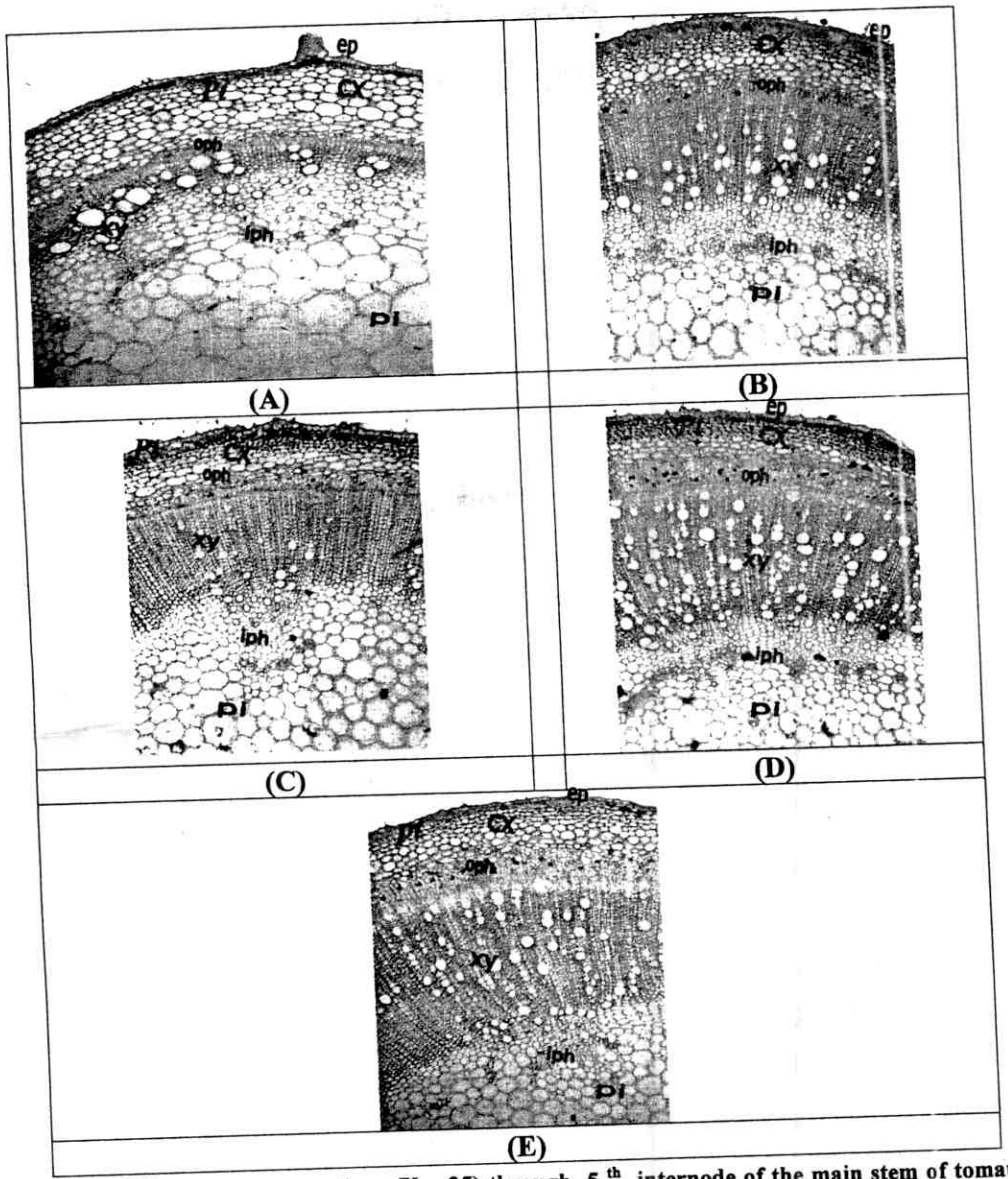


Fig. (6): Transverse sections (X = 25) through 5 th internode of the main stem of tomato plants at 70 days after transplanting as affected by different applied treatments.

Where: (A): Control (B): B at 25 mg/L, (C): B at 50 mg/L, (D): Zn at 50 mg/L and (E): Zn at 100 mg/L .

ep= Epidermis cx= Cortex pi= pith
oph= outer phloem tissue ilph=inner phloem tissue
xy= Xylem tissue pt= Palisade like tissue

Also, it could be noticed that increase of the stem diameter of stem were reversed upon different tissues comprising the whole section . Since, thickness of each cuticle layer, epidermis, cortex (palisade like, collenchyma and parenchyma tissues) and pith parenchyma layers, as well as the dimensions of vascular bundles. Moreover, thickness of outer & inner phloem tissues, of cambial region and of xylem tissue, number of xylem vessels /vascular bundle and diameter of the widest xylem vessel were greatly increased compared with the control. Also, Zn at 50 mg/L. followed by yeast extract at 30 ml/L. and amino acids at 1.5 ml/L. treatments were more pronounced in this respect.

In this respect, other studies reported nearly similar findings of these are **Wanas *et al.*, (1998)**, using yeast extract on squash **Ismaeil (2005)** using boron on squash and **Wanas (2007)** using Zn and B on tomato.

In general, the stimulatory effects of applied treatments upon the anatomy features of treated plants could be attributed to the effect upon cambium activity. Increment of cambium activity could mainly attributed to the increase of endogenous hormones level especially cytokinins and auxins, **(Sotiropoulos *et al.*, 2002 and Ismaeil, 2005)** as well as the findings of the present study.

Of interest to note that most applied treatments induced the appearance of palisade like tissue at stem anatomy below the epidermis layer (resulted to the higher temperature stress, **Wahid, 2007**) i.e., Zn at 100 mg/L., Yeast extract at 30 ml/L. and Marjoram extract .The appearance of palisade tissue during stem anatomy with some treatments , clearly indicate the effect of applied treatments upon alleviating such adverse effects of the

higher temperature stress by inducing best anatomical performances (due to their ability to develop an internal protective mechanisms against such stress adverse effects).

6.2. Effect of different applied treatments on tomato leaf anatomy:

Data in **Table (22)** and **Figs. (7, 8 and 9)** clearly indicate the effect of different applied treatments upon alleviating the adverse effects of the high temperature stress on different anatomical features of tomato leaves. In this respect, most of the studied features of leaf anatomy were increased with different applied treatments. Among these anatomical features were the most important ones, i.e., thickness of midrib, length & width of vascular bundle, phloem & xylem tissues and number of xylem vessels in vascular bundle as well as the leaf blade thickness.

With regard to the blade thickness, it was increased with different used treatments to reach its maximum value (602.55µ) with B 50 mg/L. and (440.05µ) with citric acid at 2.5 g/L. and (393.30µ) with yeast extract at 30 ml/L treatment. That represent of the control value (322.20µ). Also the thickness of each of upper and lower epidermis, were also increased with all applied treatments. Also it could be noticed that increase ratio was higher of upper epidermis than that of the lower one.

With regard to cuticle layer thickness **Antonio *et al.*, (2005)** reported that most epidermal cells of the aerial parts of higher plants (such as leaves, fruits, and non woody stems), as well as some bryophytes, are covered by a continuous extra cellular membrane of soluble and polymerized lipids called the cuticle or cuticular membrane (CM). The structure and composition of the

CM varies among plants, organs, and growth stages. A suite of physical, chemical, mechanical, and morphological properties gives the plant CM the characteristics of a unique and complex biopolymer. Since vascular plants managed to establish themselves on dry land a physiological point of view, the main function ascribed to the CM is to minimize water loss. However, from a more general point of view, this role in the regulation of plant water loss is accompanied by other important functions: the CM limits the loss of substances from plant internal tissues, protects the plant against physical, chemical, and biological attacks and protects the plant against the external environment stress. The cuticular membrane in association with the epidermis is the morphological structure that confers the main mechanical strength to plant organs.

For mesophyll tissue, thickness of both spongy and palisade tissues were increased with different applied treatments. Here, spongy tissue thickness was 137.25 micron in the control but increased to reach 333.90, 235.80, 223.87, 218.02 and 198.00 micron with B at 50 mg/L, Vit. E at 200 mg/L. + Sel. at 800µg/L., citric acid at 5 g/L., Zn at 100 mg/L. and Vit. E at 200 mg/L. + Sel. at 800 µg/L. + citric acid at 5 g/L. respectively, which were the more effective treatments in the same order. Also, palisade tissue thickness was 109.80 micron of control but increased to reach 218.70, 164.25, 158.40, 156.60 and 155.70 micron with Vit. E at 200 mg/L. + Sel. at 800 µg/L., B at 50 mg/L , citric acid at 2.5g/L., yeast extract at 30 ml/L. and Marjoram extract at 30 ml/L. respectively, which were the more effective treatments in the same order.

Table (22): Effect of different applied treatments on the mean counts and measurements of certain histological features of tomato (*Lycopersicon esculentum*, Mill.) leaf at 70 days after transplanting as affected by different applied treatments.

Histological characteristics (micron) / Treatments	Thickness of upper epidermis cuticle layer	Thickness of Lower epidermis cuticle layer	Upper epidermis thickness	Lower epidermis thickness	Palisade tissue thickness	Spongy tissue thickness	Number of spongy tissue layers	Mean of spongy layer thickness	Thickness of blade	Thickness of collenchyma layers below the upper epidermis at midrib	No. of collenchyma layers below the upper epidermis at midrib	Thickness of collenchyma layers above the lower epidermis at midrib
1. Yeast extract at 15 ml/L.	15.75	9.90	32.17	21.60	127.80	162.45	6.00	27.07	369.67	232.20	4.50	156.60
2. Yeast extract at 30 ml/L.	9.90	8.10	33.30	19.80	156.60	165.60	6.00	27.60	393.30	236.25	4.50	132.30
3. Marjoram extract at 15 ml/L.	15.75	9.90	41.40	23.40	96.30	188.10	7.00	26.87	374.85	218.70	5.50	133.20
4. Marjoram extract at 30 ml/L.	14.85	11.70	30.60	22.50	155.70	155.70	5.00	31.14	319.30	268.20	6.00	131.40
5. Amino acids at 1.5 ml/L.	13.50	11.25	27.90	19.35	120.60	133.20	5.00	26.64	325.80	226.35	4.00	175.50
6. Amino acids at 3 ml/L.	14.40	11.70	34.20	24.30	151.92	144.45	5.00	28.89	380.97	251.55	4.50	102.60
7. Vit. E at 100 mg/L. + Sel. at 400 µg/L.	16.20	9.00	33.75	22.50	153.00	190.35	6.50	29.28	424.80	129.60	4.00	148.50
8. Vit. E at 200 mg/L. + Sel. at 800 µg/L.	18.00	16.65	32.40	29.70	218.70	235.80	7.00	33.68	551.25	166.50	4.00	154.80
9. Citric acid at 2.5g/L.	14.85	11.70	32.85	27.85	158.40	197.40	6.00	32.40	440.05	196.20	4.00	144.00
10. Citric acid at 5 g/L.	13.50	10.35	45.00	37.80	100.35	223.87	5.50	40.70	430.87	261.00	3.00	86.40
11. Vit. E at 100 mg/L. + Sel. at 400 µg/L. + Citric acid at 2.5 g/L.	10.80	9.00	34.65	18.00	117.90	176.17	5.50	32.03	366.52	217.80	5.00	142.20
12. Vit. E at 200 mg/L. + Sel. at 800 µg/L. + Citric acid at 5 g/L.	16.65	11.70	36.90	28.80	140.85	198.00	6.00	33.00	432.90	157.50	4.00	108.00
13. B at 25 mg/L.	11.70	9.90	23.40	18.00	133.20	134.10	5.00	26.82	330.30	126.00	4.00	115.20
14. B at 50 mg/L	12.60	9.90	42.30	39.60	164.25	333.90	6.00	55.65	602.55	256.05	5.50	117.00
15. Zn at 50 mg/L.	9.00	7.20	25.20	18.00	81.90	101.70	5.00	20.34	243.00	116.10	4.00	143.55
16. Zn at 100 mg/L.	9.00	6.75	33.75	22.65	146.70	218.02	6.00	36.34	436.27	162.00	4.00	154.80
17. Control	13.95	10.80	29.70	20.70	109.80	137.25	5.00	27.55	322.20	210.60	5.00	129.30

Continue of Table (22): Effect of different applied treatments on the mean counts and measurements of certain histological features of tomato (*Lycopersicon esculentum*, Mill.) leaf at 70 days after transplanting as affected by different applied treatments.

Histological characteristics (micron) / Treatments	No. of collenchyma layers above the lower epidermis at midrib	Thickness of upper most phloem in the vascular bundle	Thickness of lower most phloem in the vascular bundle	Thickness of xylem tissue	Number of xylem rows in the vascular bundle	Number of vessels in the xylem row	thickness of widest xylem vessel in the vascular bundle	Length of midrib vascular bundle	Width of midrib vascular bundle	Thickness of leaf midrib	Length of Trichome in the epidermal layer
1. Yeast extract at 15 ml/L.	2.00	135.00	137.70	211.95	16.00	8.00	37.80	572.40	822.15	1708.20	231.75
2. Yeast extract at 30 ml/L.	2.50	124.20	165.15	218.25	15.00	8.33	41.85	508.50	781.20	1760.85	174.60
3. Marjoram extract at 15 ml/L.	3.00	113.40	90.00	210.60	20.00	8.00	43.88	470.70	831.60	1487.70	164.70
4. Marjoram extract at 30 ml/L.	2.00	170.55	100.35	212.85	17.00	9.67	40.73	383.85	806.85	1432.35	324.00
5. Amino acids at 1.5 ml/L.	3.50	72.00	81.00	171.45	14.00	6.33	37.35	356.85	648.00	1197.00	288.00
6. Amino acids at 3 ml/L.	2.50	166.50	96.75	249.30	23.00	8.67	43.20	487.35	980.55	1687.95	228.15
7. Vit. E at 100 mg/L. + Sel. at 400 µg/L.	2.00	47.70	88.20	242.10	22.00	6.50	42.75	454.50	1174.00	1824.30	217.35
8. Vit. E at 200 mg/L. + Sel. at 800 µg/L.	3.00	52.65	63.00	173.70	23.00	8.00	37.80	383.85	1134.00	1477.80	375.30
9. Citric acid at 2.5g/L.	2.00	71.10	101.70	178.20	16.00	5.50	29.25	373.95	1309.50	816.30	285.75
10. Citric acid at 5 g/L.	2.00	121.50	104.85	264.70	24.00	8.00	37.20	515.70	1120.50	1917.00	228.90
11. Vit. E at 100 mg/L. + Sel. at 400 µg/L. + Citric acid at 2.5 g/L.	2.00	83.02	122.40	225.00	19.00	6.50	36.00	527.40	1047.60	1824.30	266.40
12. Vit. E at 200 mg/L. + Sel. at 800 µg/L. + Citric acid at 5 g/L.	2.00	76.50	108.90	201.15	13.00	7.50	38.93	444.60	887.85	1663.20	307.35
13. B at 25 mg/L.	3.00	52.20	78.30	153.00	14.00	2.25	32.85	316.80	522.90	1285.20	171.00
14. B at 50 mg/L	3.00	86.85	124.20	256.95	29.00	9.33	43.80	612.00	1683.00	2629.80	396.00
15. Zn at 50 mg/L.	3.00	40.50	56.70	141.30	21.00	5.00	30.60	371.25	1150.20	1750.50	303.30
16. Zn at 100 mg/L.	2.50	45.90	83.70	232.20	14.00	8.25	36.90	432.00	793.80	1684.80	238.50
17. Control	2.50	167.40	83.25	203.85	19.00	7.00	34.43	356.40	834.30	1310.85	169.20

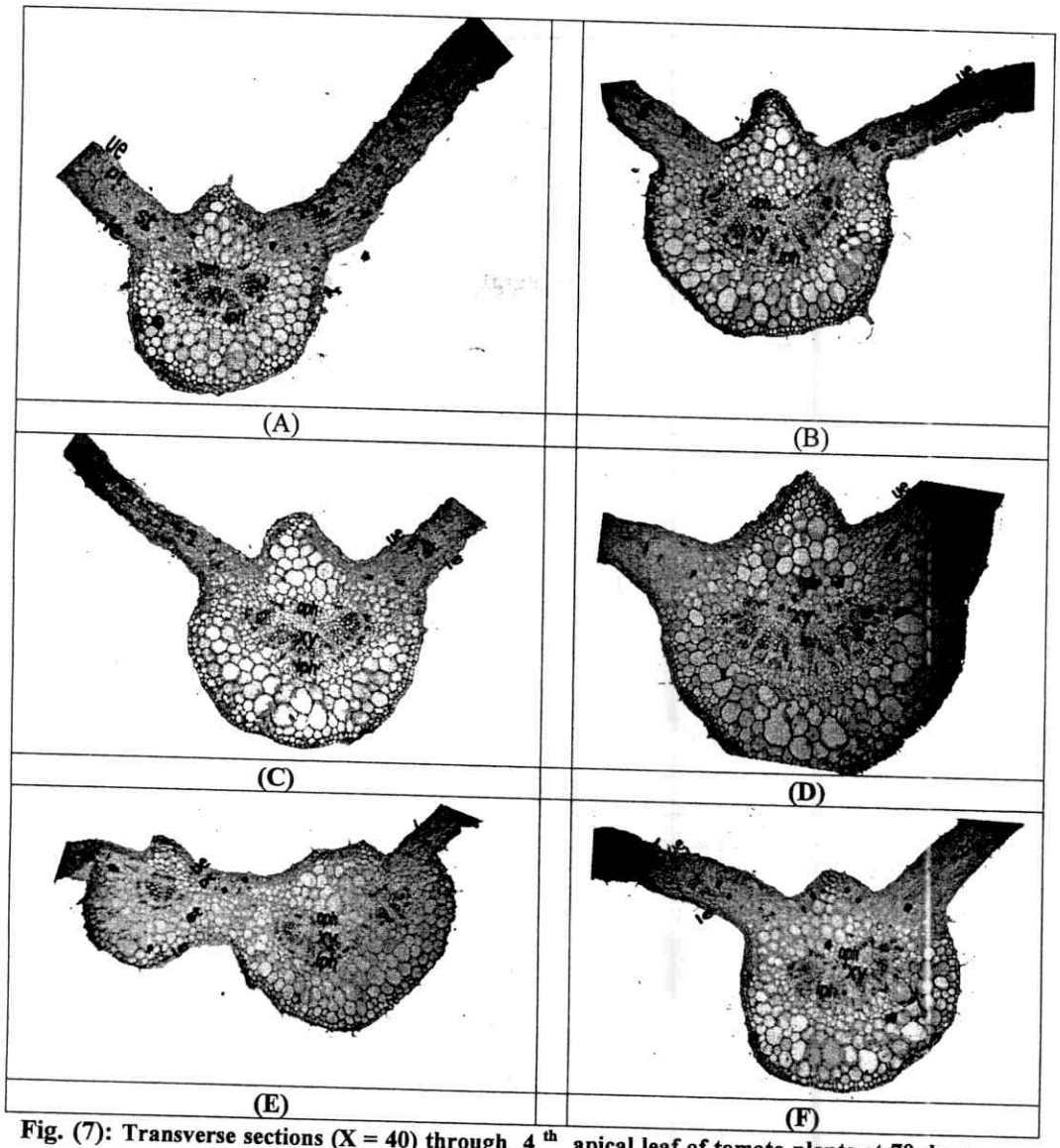


Fig. (7): Transverse sections (X = 40) through 4 th apical leaf of tomato plants at 70 days after transplanting as affected by different applied treatments.

Where: (A): Control (B): Yeast extract at 15 ml/L, (C): Yeast extract at 30 ml/L, (D): Marjoram extract at 15 ml/L, (E): Amino acids at 1.5 ml/L and (F): Amino acids at 3ml/L .

ouph= outer phloem tissue
iph=inner phloem tissue
pt= Palisade tissue
le= Lower epidermis
xy= Xylem tissue
ue= Upper epidermis
st= Spongy tissue

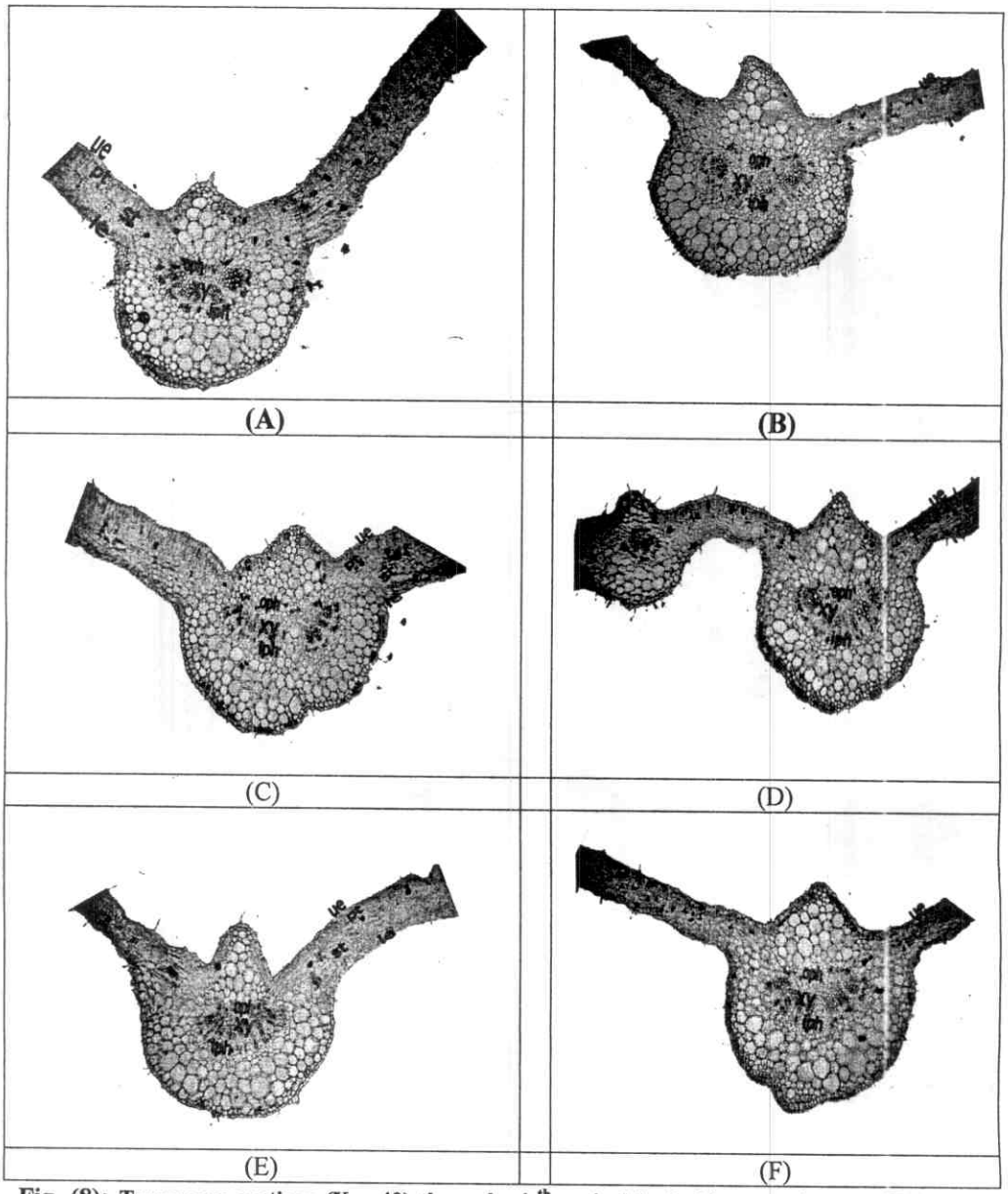


Fig. (8): Transverse sections (X = 40) through 4 th apical leaf of tomato plants at 70 days after transplanting as affected by different applied treatments.

Where: (A): Control (B): vitamin E at 100 mg/L + Sel. at 400 µg/L, (C): vitamin E at 200 mg/L + Sel. at 800µg/L, (D): Citric acid at 2.5g/L, (E): Citric acid at 5 g/L and (F): vitamin E at 100mg/L + Sel. at 400µg/L + Citric acid at 2.5 g/L and .

oph= outer phloem tissue xy= Xylem tissue
iph=inner phloem tissue ue= Upper epidermis
pt= Palisade tissue st= Spongy tissue le= Lower epidermis

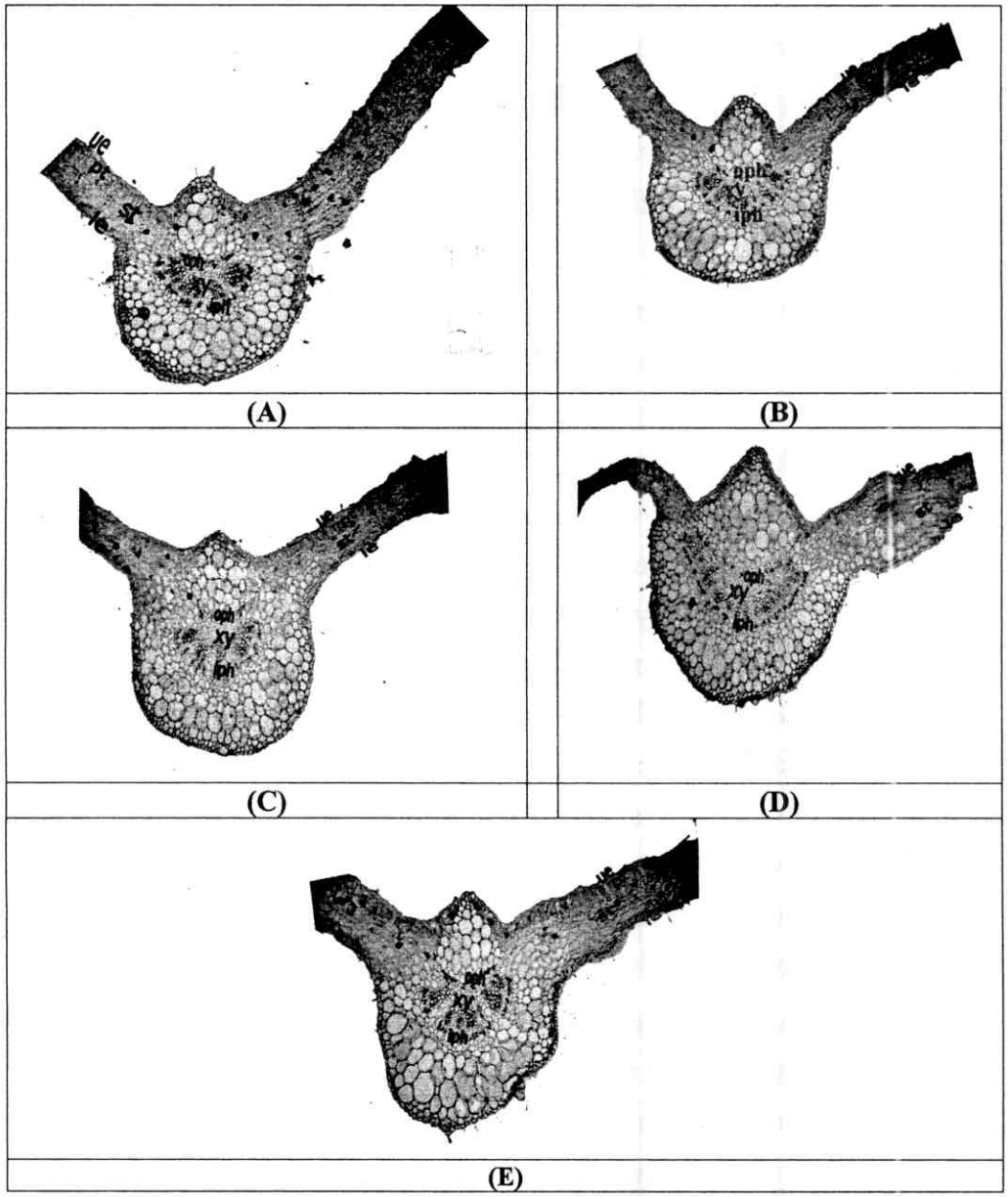


Fig. (9): Transverse sections (X = 40) through 4 th apical leaf of tomato plants at 70 days after transplanting as affected by different applied treatments.

Where: (A): Control (B): B at 25 mg/L, (C): B at 50 mg/L, (D): Zn at 50mg/L and (E): Zn at 100mg/L .

oph= outer phloem tissue	xy= Xylem tissue
iph=inner phloem tissue	ue= Upper epidermis
pt= Palisade tissue	st= Spongy tissue le= Lower epidermis

of interest, to note that mesophyll increase belong to that increase of each of palisade and spongy tissue thickness. Since, the two components were increased with all applied treatments but reached their maximum as other traits with yeast extract at 30 ml/L treatment.

With regard to midrib anatomical features, could be noticed that increment in the midrib thickness with different applied treatments attributed to the increase in many of its histological features such as thickness of both uppermost and lower most collenchyma tissues, lower most parenchyma tissue and dimensions of main vascular bundle as well as thickness of upper most & lower most phloem tissues, xylem tissue and also number and diameter of xylem vessels in the main vascular bundle. This increases were more obvious with the yeast extract at 30ml/L. The above mentioned results specially increment of the conductive tissues (xylem & phloem) are also of great importance because they could be also involved in the interpretation about why vigorous growth and high yielded fruits were existed with different applied treatments specially with yeast extract at 30 ml/L.

In general, these positive alterations in leaf anatomy of tomato plants treated with applied treatments led to vigorous growth and enhancement of flowering and fruit setting of treated plants. That as well mentioned afterwards reversed upon high increases in the final fruit yield. Besides, yield increases with different applied treatments through doing alterations in the anatomical features of treated plants was also reported by **Wanas *et al.*, (1998), Ismaeil (2005) and Wanas (2007).**

Also, the previously mentioned and discussed results of tomato leaf anatomy of treated plants, reveal that increasing of leaf anatomy features compared with control confirmed by vigorous growth of tomato was positively correlated with mineral content (N, P and K), photosynthesis pigments, carbohydrates and total phenols content. This confirmed the previously discussed results of anatomy growth, proved that the best morphological behavior of tomato plant under heat accompanied oxidatative stress condition as affected by the applied antioxidant treatments was mainly due to their induceable best physiological and anatomical performances, also due to their ability to develop an internal protective mechanism against such stress adverse effects.

Of interest to note that these positive responses of different anatomical aspects to treatments were completely reversed upon vegetative and reproductive growth of treated plants. So, present study revealed those increases of xylem tissue, i.e., the route of mineral nutrients and water translocation from roots to leaves and the phloem tissue i.e., the pathway of different assimilates from leaves to fruits and other plant sinks. Thereby, improvement of translocation events directly could be considered a direct reason for increment the final fruit yield.

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, anatomical changes in plants, which affect plant growth and development and may lead to drastic reduction in economic yield, **Wahid *et al.*, (2007)**. Also, **A˜non *et al.*, (2004)** reported that although limited details are available, anatomical changes under high ambient temperatures are

generally similar to those under drought stress. At the whole plant level, there is a general tendency of reduced cell size, curtailed water loss and increased trichomatous densities and greater xylem vessels of both root and shoot.

7. Reproductive characteristics:

7.1.Flowering characteristic:

As shown in **Table (23) and Figs. (10,11 and 12)** all applied treatments significantly decreased number of days required for starting of flower anthesis of treated plants, hence induced them to flower earlier than untreated ones. The most effective treatment in this respect were marjoram extract at 15 ml/L followed by Zn at 50 mg/L, B at 50 mg/L, marjoram extract at 30 ml/L and Vitamin E at 200 mg/L+ Sel. at 800 µg/L Here, days of earliness were 26.95, 19.44, 17.75, 17.30 and 17.22%, respectively during 2006 season. Also it could be noticed that these days of earliness existed with different used treatments reached to the level of significance 5% during the two seasons. These days of earliness could be followed by rapid development and growth of setted fruits thereby, earliness in repined tomato fruits being expected .Earliness of yielded fruits in tomato plant consider of great interest, because that will suit early marketing of such fruits. With respect to the number of flowers/plant, it was significantly increased with most applied treatments during the two grown seasons. The exception was that insignificant increase existed with each of B at 25 mg/L, vitamin E at 100 mg/L + Sel. at 400 µg/L during 2006 season, Zn at 100 mg/L, vitamin E at100 mg/L+Sel. at 400 µg/L., vitamin E at 200 mg/L+ Sel. at 800 µg/L+ citric acid at 5 g/L, marjoram extract at 30 ml/L and amino acids at 1.5 ml/L during 2007 season. Increment

Table (23): Effect of different applied treatments on flowering, fruit setting and flower abscission of tomato (*Lycopersicon esculentum*, Mill.) plants during 2006 and 2007 late summer seasons.

Characters / Treatments	Start of flower anthesis (days)		Earliness of flower anthesis (days)		Earliness of flower anthesis % relative to the control		No. of flowers / plant		Total fruits (No./plant)		Fruit setting (%)		Abscission (%)	
	Seasons		Seasons		Seasons		Seasons		Seasons		Seasons		Seasons	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
1. Yeast extract at 15 ml/L.	68.00	69.33	11.33	13.33	14.28	16.18	67.67	74.67	23.33	19.00	34.53	25.54	65.47	74.46
2. Yeast extract at 30 ml/L.	69.33	70.00	10.00	12.67	12.70	15.39	87.67	79.33	27.67	26.67	31.58	33.74	68.43	66.26
3. Marjoram extract at 15 ml/L.	58.00	61.67	21.33	21.00	26.95	25.39	82.67	81.67	21.00	19.67	25.45	24.45	74.55	75.55
4. Marjoram extract at 30 ml/L.	65.67	69.33	13.67	13.33	17.30	16.13	66.00	60.00	23.33	20.67	35.51	34.41	64.49	65.59
5. Amino acids at 1.5 ml/L.	66.33	69.67	13.00	13.00	16.46	15.70	80.00	64.33	23.33	20.00	29.18	31.59	70.82	68.41
6. Amino acids at 3 ml/L.	69.00	70.67	10.33	12.00	13.11	14.62	66.33	74.33	21.33	23.00	32.22	30.97	67.78	69.03
7. Vit. E at 100 mg/L. + Sel. at 400 µg/L.	68.00	69.67	11.33	13.00	14.32	15.81	63.67	64.67	23.67	22.00	37.30	34.08	62.70	65.92
8. Vit. E at 200 mg/L. + Sel. at 800 µg/L.	65.67	68.33	13.67	14.33	17.22	17.30	60.33	66.67	21.33	19.67	35.41	29.80	64.59	70.20
9. Citric acid at 2.5g/L.	69.33	69.00	10.00	13.67	12.54	16.59	73.33	79.00	21.67	22.33	29.59	28.39	70.41	71.61
10. Citric acid at 5 g/L.	67.33	70.00	12.00	12.67	15.06	15.43	74.33	79.67	21.33	22.67	28.74	28.58	71.26	71.42
11. Vit. E at 100 mg/L. + Sel. at 400 µg/L. + Citric acid at 2.5 g/L.	69.67	71.33	9.67	11.33	12.18	13.80	82.67	77.33	21.00	18.67	25.47	24.01	74.53	75.99
12. Vit. E at 200 mg/L. + Sel. at 800 µg/L. + Citric acid at 5 g/L.	67.33	70.67	12.00	12.00	15.07	14.51	73.67	69.00	21.00	20.33	28.64	29.51	71.36	70.49
13. B at 25 mg/L.	68.67	69.00	10.00	13.67	12.66	16.60	60.00	67.67	18.67	17.67	31.16	26.55	68.84	73.45
14. B at 50 mg/L	65.33	65.00	14.00	17.67	17.75	21.42	68.00	74.67	20.67	20.67	30.45	28.48	69.55	71.52
15. Zn at 50 mg/L.	65.00	66.67	14.33	16.00	19.44	19.34	73.00	77.67	20.67	21.00	28.39	27.16	71.61	72.84
16. Zn at 100 mg/L.	68.67	70.33	10.67	12.33	13.42	14.95	76.00	63.00	19.00	20.00	25.07	31.68	74.93	68.32
17. Control	79.33	82.67	0.00	0.00	0.00	0.00	56.33	59.67	12.00	11.00	21.61	18.99	78.39	81.01
L.S.D. 0.05	2.65	3.28	2.46	3.28	3.43	3.92	6.30	10.46	1.77	2.49	3.82	5.57	3.82	5.57
L.S.D. 0.01	3.57	4.42	3.32	4.42	4.62	5.28	8.48	14.08	2.38	3.36	5.14	7.50	5.14	7.50

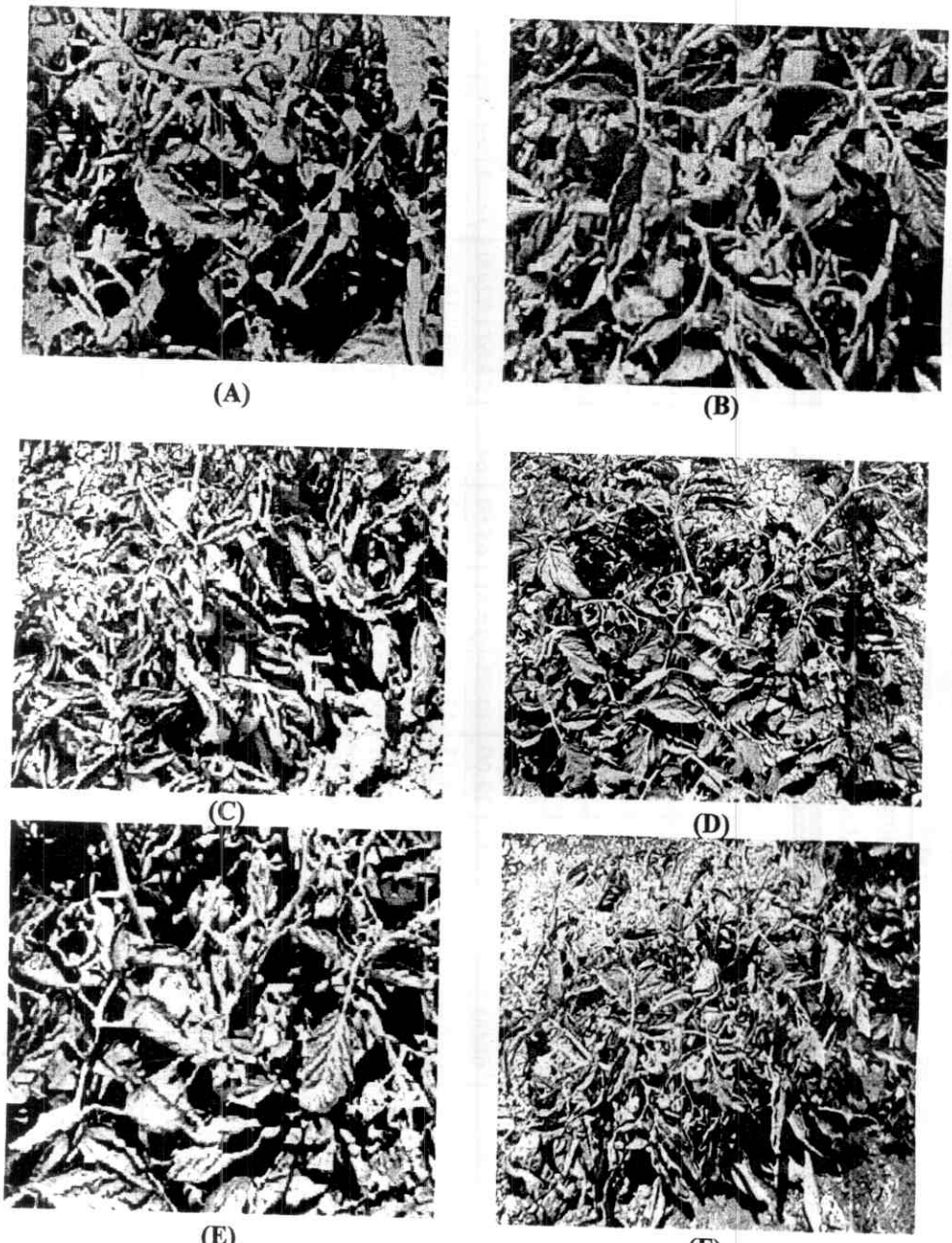


Fig.(10):Showing effect of treatments on reproductive characteristics of tomato plants (A): Yeast extract at 15 ml/L, (B): Yeast extract at 30 ml/L, (C): Marjoram extract at 15 ml/L, (D): Marjoram extract at 30 ml/L, (E): Amino acids at 1.5 ml/L and (F): Amino acids at 3 ml/L.

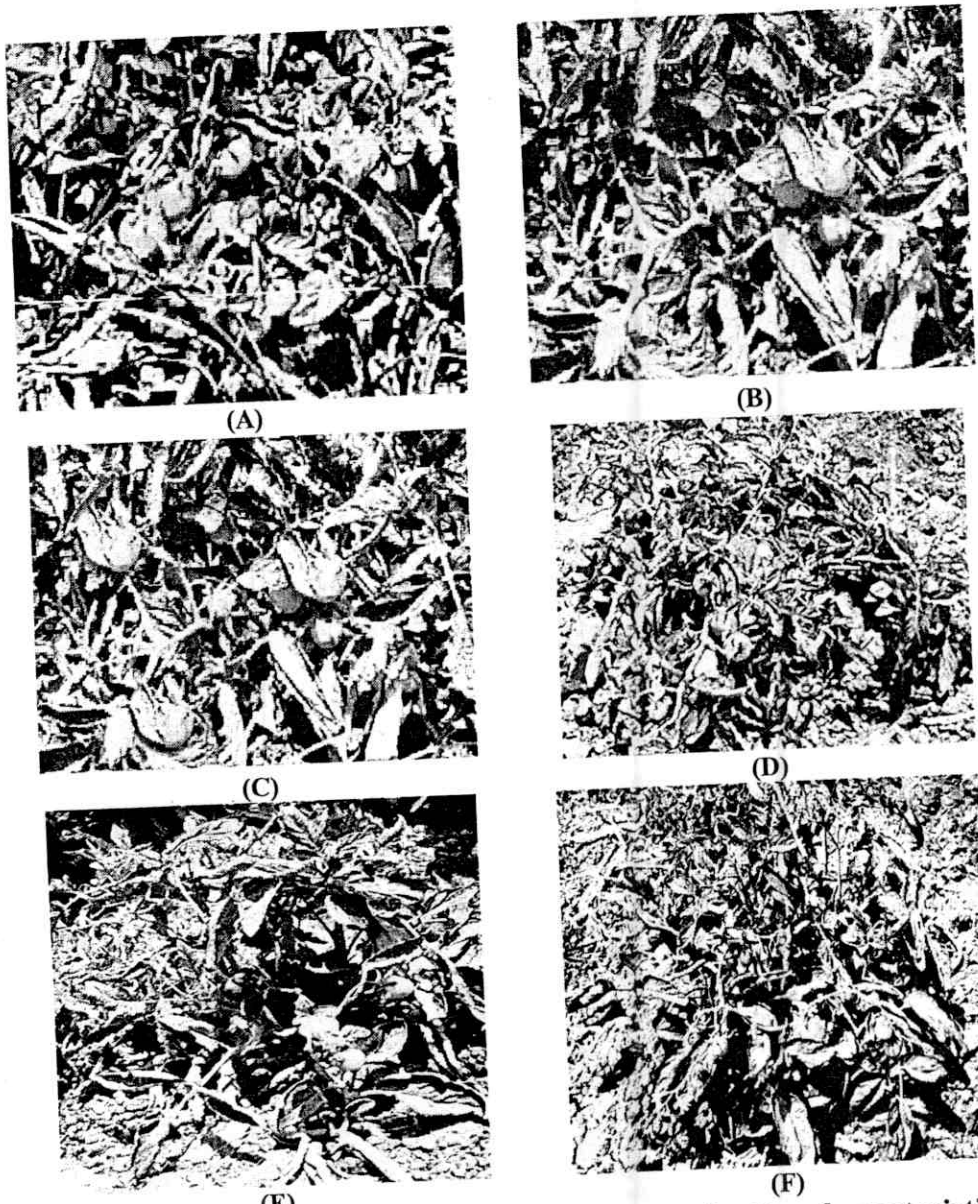


Fig.(11):Showing effect of treatments on reproductive characteristics of tomato plants (A): vitamin E at 100 mg/L + Sel. at 400 µg/L, (B): vitamin E at 200 mg/L + Sel. at 800 µg/L, (C): Citric acid at 2.5 g/L, (D): Citric acid at 5 g/L, (E): vitamin E at 100 mg/L + Sel. at 400 µg/L + Citric acid at 2.5 g/L and (F): vitamin E at 200 mg/L + Sel. at 800 µg/L + Citric acid at 5 g/L.

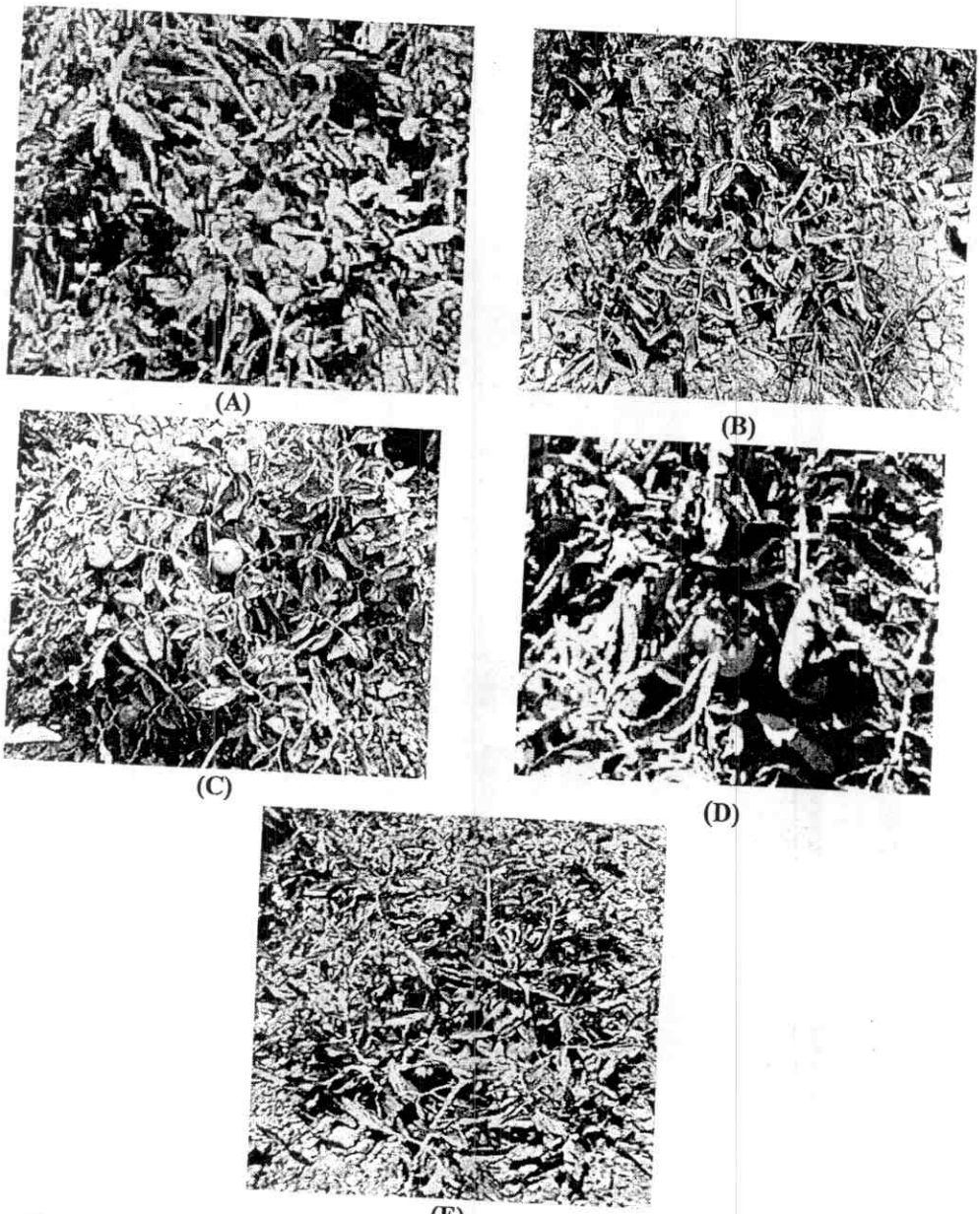


Fig.(12):Showing effect of treatments on reproductive characteristics of tomato plants. (A): B at 25 mg/L, (B): B at 50 mg/L, (C): Zn at 50 mg/L, (D): Zn at 100 mg/L and (E): Control

the numbers of flowers with most applied treatments were followed also by increasing of total fruits number. That means that was preceded with high percentages in setted fruits. That was the case, since as shown in **Table (24)** yeast extract at 30 ml/L. gave the highest values of total fruits number / plant and the percentages of fruit setting as well when compared different treatments.

On the other hand, abortion of flowers was decreased. Since, percentage of flower abscission was decreased to reach the 5% level of significance with different applied treatments except that insignificant decrease with Zn at 100 mg/L during 2006 and vitamin E at 100 mg/L + Sel. at 400 µg/L + citric acid at 2.5 g/L and marjoram extract at 15 ml/L during 2007 season. Again, it could be concluded that reduction in flowers abscission percentages of in turn enhancement of fruit setting obtained with yeast extract at 30 ml/L treatment may be due to increase of total carbohydrates, protein and mineral concentrations in the leaves (source) as well as the endogenous auxins, especially at full blooming and setting stages.

7. 2. Pollen grains fertility:

Data in **Table (24)** clearly indicate that, different applied treatments highly increased the fertility of pollen grains in treated plants compared with control. Also it could be noticed that the yeast extract and Zn at 50 mg/L gave the highest fertility. These data being more evident when calculated on the control basis, since, e.g. yeast extract at 30 ml/L treatment gave increase value of 233.39% relative to the control. The above mentioned results could be directly reversed upon the high percentages of fruit setting as previously mentioned **(Table 23).** Since yeast extract treatment,

Table (24): Effect of different applied treatments on pollen grains fertility of tomato (*Lycopersicon esculentum*, Mill.) plants during 2007 late summer season.

Characters / Treatments	Fertility		Sterility	
	%	% relative to the control	%	% relative to the control
1. Yeast extract at 15 ml/L.	38.71	201.30	61.29	75.88
2. Yeast extract at 30 ml/L.	44.88	233.39	55.12	68.24
3. Marjoram extract at 15 ml/L.	35.84	186.38	64.16	79.44
4. Marjoram extract at 30 ml/L.	33.78	175.66	66.22	81.99
5. Amino acids at 1.5 ml/L.	34.62	180.03	65.38	80.95
6. Amino acids at 3 ml/L.	36.45	189.55	63.55	78.68
7. Vit. E at 100 mg/L. + Sel. at 400 µg/L.	34.87	181.33	65.13	80.64
8. Vit. E at 200 mg/L. + Sel. at 800 µg/L.	37.53	195.16	62.47	77.34
9. Citric acid at 2.5g/L.	33.24	172.85	66.76	82.27
10. Citric acid at 5 g/L.	30.84	160.37	69.16	85.63
11. Vit. E at 100 mg/L. + Sel. at 400 µg/L. + Citric acid at 2.5 g/L.	31.53	163.96	68.47	84.77
12. Vit. E at 200 mg/L. + Sel. at 800 µg/L. + Citric acid at 5 g/L.	36.67	190.69	63.33	78.41
13. B at 25 mg/L.	33.22	172.75	66.78	82.68
14. B at 50 mg/L	35.83	186.32	64.17	79.45
15. Zn at 50 mg/L.	39.44	205.10	60.56	74.98
16. Zn at 100 mg/L.	34.68	180.34	65.32	80.87
17. Control	19.23	100.00	80.77	100.00

also gave the lowest percentage of sterile pollen grains. Moreover, the above mentioned results are of great interest, since fruits setting, number, as well as early and total fruit yields are completely depending on them. It was obvious from the same data that control plants were strongly stressed. In contrary the different applied treatments increased pollen grains fertility as a direct result for the simulative effect of these treatments that actively enhanced the internal metabolically protective status by their direct scavenging functions against the toxic free radicals (induced by heat stress) or due to their promotional effect on synthesis of natural protective antioxidants, (i.e., phenols, amino acids, sugars, hormones, carotenoids .....ect.) as well as they induce an potent biosynthesis case due to the higher photosynthetic pigments content (protection of chlorophyll's and chloroplasts against stress degradable / senescence effects), there by higher carbohydrates accumulation and content as well as higher minerals (N, P and K) content which finally resulting in increasing pollen grains fertility. The strong positive correlations of such constituent vs. pollen grains fertility and fruit yield confirmed and coincided such functions and roles of antioxidants under high temperature stress during late summer season.

In this respect, **Saini (1997); Sato *et al.*, (2000); Pressman *et al.*, (2002) and Foolad, (2005)** reported that continuous exposure of tomato to high temperatures (day/night temperatures of 32/26°C) markedly reduced the number of pollen grains per flower and decreased 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. Under control,

favourable temperature conditions (28/22°C), starch accumulated in the pollen grains, where it reached a maximum value 3 d before anthesis; it then diminished towards anthesis. During anther development, the concentration of total soluble sugars gradually increased in the anther walls and in the pollen grains (but not in the locular fluid), reaching a maximum at anthesis. Continuous exposure of the plant to high temperatures (32/26°C) prevented the transient increase in starch concentration and led to decreases in the concentrations of soluble sugars in the anther walls and the pollen grains. In the locular fluid, however, a higher soluble sugar concentration was detected under the high-temperature regime throughout anther development. These a deficiency in carbohydrate metabolism in the tomato anther leads to abnormal pollen development. Stress-induced arrest of male gametophyte development is preceded by disturbances in carbohydrate metabolism and distribution within anthers. The affected pollen grains failed to accumulate starch, which is a major constituent of fertile grass pollen. In tomato, the failure of viable pollen grain production under high temperature conditions may also be associated with hindered sugar metabolism. The heat stress-related biochemical events that diminish pollen grain viability are not known.

7.3. Early fruits and early yield:

Data in **Table (25)** clearly show that in the two seasons, early fruits (fruit No./plant) and early yield (g/ plant) were significantly increased with different applied treatments. Here, yeast extract at 30 ml/L and marjoram extract at 30 ml/L treatments showed the highest increases in the early yield. Also, the view will

Table (25): Effect of different applied treatments on early fruits yield of tomato (*Lycopersicon esculentum*, Mill.) plant during 2006 and 2007 late summer seasons.

Characters / Treatments		Early fruit				Early yield			
		No. / plant		% relative to the control		g/plant		% relative to the control	
		Seasons		Seasons		Seasons		Seasons	
		2006	2007	2006	2007	2006	2007	2006	2007
1. Yeast extract at 15 ml/L.		5.33	4.67	350.00	233.33	356.33	345.33	430.68	383.54
2. Yeast extract at 30 ml/L.		6.67	7.67	450.00	383.33	461.67	506.00	551.62	571.30
3. Marjoram extract at 15 ml/L.		5.67	5.33	383.33	266.67	349.00	283.00	415.48	317.13
4. Marjoram extract at 30 ml/L.		6.67	6.00	450.00	300.00	395.67	321.00	471.53	358.49
5. Amino acids at 1.5 ml/L.		5.67	5.00	383.33	250.00	350.33	322.33	421.42	360.93
6. Amino acids at 3 ml/L.		5.00	5.33	350.00	266.67	308.00	354.33	372.86	403.66
7. Vit. E at 100 mg/L. + Sel. at 400 µg/L.		5.33	4.67	366.67	233.33	326.33	336.67	395.45	380.37
8. Vit. E at 200 mg/L. + Sel. at 800 µg/L.		5.33	4.67	366.67	233.33	320.00	315.67	391.68	361.69
9. Citric acid at 2.5g/L.		5.00	4.67	350.00	233.33	271.67	352.33	367.84	398.90
10. Citric acid at 5 g/L.		5.67	5.33	383.33	266.67	374.00	382.67	444.99	431.36
11. Vit. E at 100 mg/L. + Sel. at 400 µg/L. + Citric acid at 2.5 g/L.		4.67	5.33	300.00	266.67	341.33	277.00	402.48	307.00
12. Vit. E at 200 mg/L. + Sel. at 800 µg/L. + Citric acid at 5 g/L.		4.33	5.00	283.33	250.00	332.67	364.00	395.42	406.06
13. B at 25 mg/L.		3.33	3.33	233.33	166.67	191.00	196.00	228.59	220.12
14. B at 50 mg/L		4.67	4.33	316.67	216.67	295.33	283.00	353.83	320.30
15. Zn at 50 mg/L.		4.67	4.67	300.00	233.33	304.00	305.67	360.32	344.65
16. Zn at 100 mg/L.		4.33	4.00	283.33	200.00	272.33	290.00	323.07	326.16
17. Control		1.67	1.67	100.00	100.00	86.53	89.60	100.00	100.00
L.S.D.	0.05	1.07	1.12	109.93	54.91	49.13	68.85	75.88	85.49
	0.01	1.44	1.51	148.05	73.95	66.16	92.73	102.19	115.14

be more evident when these values related to the control one. Since, e.g. values reached to or even more than four times of the control value with these two efficient treatments. The finding of great interest because it enables farmers to sell big part of tomato fruits earlier with high prices. Enhancing effect of such treatments on tomato plant on early yield was mainly due to their promotional effect on fruit setting and number of fruits/plant rather than fruit weight. This also could be due to the pronounced enhancable effect of the same treatments on growth behavior, metabolic activity (chlorophyll and carbohydrates content), mineral content and the antioxidant bioconstituents, i.e. corotenoids and phenols content. All of them positively correlated with early fruit yield.

Once again, plants of these treatments were of the highest carbohydrates content might be exported sufficient sugars at early stages, those which essentially required for fruit setting activities, specially under stress condition **Yang *et al.*, (2002).** Moreover, the induceable effect of antioxidants on early fruit setting under stress conditions might be also due to their protective effect on the most sensitive reproductive organs (pollen grains and ovules) and their viability and, in turn, the efficiency of fertilization process and their associated hormonal stimulation **(Fathy *et al.*, 2003 a).**

7.4. Fruit yield and yield components:

Data presented in **Tables (26 & 27)** clearly show that fruit yield and its components of tomato were highly increased as affected by different applied treatments in relatively similar fashion as previously mentioned. All applied treatments significantly increased fruit setting, No. of fruits / plant and fresh and dry weight

Table (26): Effect of different applied treatments on total yield of tomato (*Lycopersicon esculentum*, Mill.) plants during 2006 and 2007 late summer seasons.

Characters / Treatments		Total fruits				Total yield (kg/plant)		Relative total yield (%)		Early yield (kg/plant)		Early yield (%)	
		No. / plant		% relative to the control									
		Seasons		Seasons		Seasons		Seasons		Seasons		Seasons	
		2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
1. Yeast extract at 15 ml/L.		23.33	19.00	195.34	177.43	1.55	1.45	234.97	225.27	0.36	0.345	22.93	23.92
2. Yeast extract at 30 ml/L.		27.67	26.67	231.39	254.44	1.82	1.82	276.27	284.81	0.46	0.506	25.31	27.83
3. Marjoram extract at 15 ml/L.		21.00	19.67	175.31	183.98	1.47	1.33	222.15	207.20	0.35	0.283	23.81	21.35
4. Marjoram extract at 30 ml/L.		23.33	20.67	195.59	195.35	1.64	1.46	247.72	227.24	0.40	0.321	24.19	22.03
5. Amino acids at 1.5 ml/L.		23.33	20.00	195.13	188.15	1.59	1.43	240.37	223.43	0.35	0.322	22.05	22.55
6. Amino acids at 3 ml/L.		21.33	23.00	178.85	219.16	1.46	1.64	221.33	258.15	0.31	0.354	21.05	21.48
7. Vit. E at 100 mg/L. + Sel. at 400 µg/L.		23.67	22.00	197.90	208.44	1.54	1.59	232.71	249.67	0.33	0.337	21.19	21.16
8. Vit. E at 200 mg/L. + Sel. at 800 µg/L.		21.33	19.67	178.85	188.53	1.55	1.72	234.18	268.87	0.32	0.316	20.59	22.45
9. Citric acid at 2.5g/L.		21.67	22.33	181.16	211.47	1.63	1.58	246.11	247.22	0.31	0.352	18.75	22.33
10. Citric acid at 5 g/L.		21.33	22.67	178.85	217.92	1.61	1.36	243.43	210.67	0.37	0.383	23.27	22.31
11. Vit. E at 100 mg/L. + Sel. at 400 µg/L. + Citric acid at 2.5 g/L.		21.00	18.67	175.56	174.40	1.53	1.57	231.88	245.10	0.34	0.277	22.29	20.38
12. Vit. E at 200 mg/L. + Sel. at 800 µg/L. + Citric acid at 5 g/L.		21.00	20.33	175.31	191.18	1.49	1.40	225.81	220.21	0.33	0.364	22.35	23.20
13. B at 25 mg/L.		18.67	17.67	156.04	165.96	1.14	1.07	172.70	167.67	0.19	0.196	16.74	18.29
14. B at 50 mg/L		20.67	20.67	173.04	194.70	1.42	1.44	215.46	225.63	0.30	0.306	20.75	20.17
15. Zn at 50 mg/L.		20.67	21.00	172.28	197.73	1.50	1.52	226.90	237.31	0.30	0.283	20.29	19.65
16. Zn at 100 mg/L.		19.00	20.00	159.32	188.00	1.31	1.40	197.70	219.20	0.27	0.290	20.87	20.71
17. Control		12.00	11.03	100.00	100.00	0.66	0.64	100.00	100.00	0.09	0.090	13.09	13.97
L.S.D.	0.05	1.77	2.49	16.15	33.91	0.14	0.21	20.94	36.32	0.05	0.07	2.21	2.73
	0.01	2.38	3.35	21.75	45.67	0.19	0.29	28.20	48.92	0.06	0.09	2.97	3.68

Table (27): Effect of different applied treatments on fruits characteristics of tomato (*Lycopersicon esculentum*, Mill.) plants during 2006 and 2007 late summer seasons.

Characters / Treatments		Fruit fresh weight (g)/fruit		Fruit dry weight (g)/fruit		Fruit diameters				Fruit shape index (L/D)	
						Length (cm)		Diameters (cm)			
		Seasons		Seasons		Seasons		Seasons		Seasons	
		2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
1. Yeast extract at 15 ml/L.		69.55	76.35	4.09	4.06	5.75	6.24	5.22	5.16	1.10	1.21
2. Yeast extract at 30 ml/L.		66.00	68.23	4.60	4.76	6.28	6.23	5.52	5.27	1.14	1.18
3. Marjoram extract at 15 ml/L.		70.10	68.35	3.91	3.78	6.13	6.18	5.44	5.35	1.13	1.15
4. Marjoram extract at 30 ml/L.		70.08	70.87	3.48	3.68	6.09	6.15	5.51	5.49	1.10	1.12
5. Amino acids at 1.5 ml/L.		68.04	72.23	3.56	3.54	6.27	6.54	5.31	5.64	1.18	1.16
6. Amino acids at 3 ml/L.		68.49	71.70	3.90	3.84	6.12	6.52	5.32	5.28	1.15	1.23
7. Vit. E at 100 mg/L. + Sel. at 400 µg/L.		65.00	72.92	3.84	4.02	6.24	6.37	5.27	5.17	1.19	1.23
8. Vit. E at 200 mg/L. + Sel. at 800 µg/L.		72.37	70.90	4.00	4.01	6.18	6.17	5.30	5.53	1.17	1.12
9. Citric acid at 2.5g/L.		75.06	71.20	4.18	4.18	6.50	6.50	5.45	5.34	1.19	1.22
10. Citric acid at 5 g/L.		75.37	75.69	4.35	3.91	6.50	7.10	5.30	5.15	1.23	1.38
11. Vit. E at 100 mg/L. + Sel. at 400 µg/L. + Citric acid at 2.5 g/L.		72.88	72.70	3.50	3.62	6.41	6.47	5.43	5.27	1.18	1.23
12. Vit. E at 200 mg/L. + Sel. at 800 µg/L. + Citric acid at 5 g/L.		71.04	77.62	3.67	3.58	5.57	6.38	5.18	4.77	1.08	1.34
13. B at 25 mg/L.		61.14	61.33	3.97	3.83	6.69	6.16	5.17	5.31	1.29	1.16
14. B at 50 mg/L		68.87	70.37	4.01	4.49	6.36	6.56	5.65	5.27	1.13	1.25
15. Zn at 50 mg/L.		73.07	73.02	4.53	4.58	6.88	6.42	5.38	5.12	1.28	1.26
16. Zn at 100 mg/L.		68.73	70.94	3.86	3.89	6.96	7.04	5.30	5.26	1.31	1.34
17. Control		55.26	60.39	3.00	2.84	5.60	5.94	5.00	5.00	1.12	1.19
L.S.D.	0.05	5.62	6.87	0.40	0.51	0.64	0.59	0.38	0.38	0.13	0.14
	0.01	7.57	9.25	0.54	0.68	0.86	0.80	0.51	0.51	0.17	0.19

(g) / fruit and in turn,greatly improved the total fruit yield (kg / plant) compared with the control during the two growing seasons.

Some data revealed that the highest total fruits No./ plant and total yield Kg/ plant were obtained with yeast extract at 30 ml/L. treatment. Also, it could be noticed that these increment of total yield and its component values related to the control reached to or even more than two times of control values with the applied treatments. Regarding to characters of fruit quality, the same data in **Table (27)** indicate that all treatments were significantly improved dry matter content of fruit compared with control one. The highest content was obtained with yeast extract at 30 ml/L treatment during the two seasons.

Also, fruit length (cm) and diameter (cm) were greatly differed among most of treatments and control especially at 5% level of significance. Herein, it was observed that the stimulative effect of such treatment on tomato fruit yield was mainly due to their promotional effect on fruit setting and number of fruits/plant rather than fruit weight. This also could be due to the pronounced enhanceable effect of the same treatments on growth behavior, N, P and K content, metabolie activity (chlorophyll and carbohydrate content), and the anti-oxidant bioconstituents, i.e. carotenoids and phenols content. All of them positively correlated with fruit yield. Once again, plants of these treatments were of the highest carbohydrates content might be exported sufficient sugars at early stages, those which essentially required for fruit setting activities, especially under stress condition **(Fathy *et al.*, 2003).**

Moreover, the induecable effect of anti-oxidant combinations on fruit setting and fruit number under stress

condition might be also due to their protective effect on the most sensitive reproductive organs (pollen grains and ovules) and their viability and, in turn, the efficiency of fertilization process and their associated hormonal stimulation.

7.5. Economical and Biological yield:

As shown in **Table (28)** different applied treatments significantly increased the economical yield of tomato plant (i.e., dry weight of yielded fruits) and the Biological yield as well during the two growing seasons of this study. Also, it could be noticed that yeast extract at 30 ml/L gave the highest weights of economic yield that reached more than three times during first season and four times in second season comparing with the control value.

Here, of interest to note that different treatments increased that part of assimilates being allocated to the economic part of tomato plant, i.e., fruits. On the other hand, the biological yield of tomato plants, i.e., total dry matter produced (including dry matter of shoots + fruits) were also exhibited high significant increase with different used treatments in the two seasons. Also yeast extract at 30 ml/L was the most superior treatment in this respect. These results are of great interest because they mean that used treatments not only increased dry matter accumulation in fruits but also that existed in shoots. That in other meaning strictly proved that the applied treatments obviously increased the efficiency of photosynthesis in plants treated with them. In addition, this stimulation of dry matter production considered as a direct result of that vigorous growth including the photosynthetic area and photosynthetic pigments in leaves of tomato plants during different stages of growth.

Table (28): Effect of different applied treatments on biological and economical yield as well as harvest index of tomato (*Lycopersicon esculentum*, Mill.) plants during 2006 and 2007 late summer seasons.

Characters / Treatments		Economical yield (g)/plant		% relative to the control		Biological yield (g)/plant		% relative to the control		Harvest index (%)	
		Seasons		Seasons		Seasons		Seasons		Seasons	
		2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
1. Yeast extract at 15 ml/L.		95.56	78.06	266.36	256.43	166.16	172.82	167.79	181.08	57.66	45.59
2. Yeast extract at 30 ml/L.		127.38	136.99	354.35	442.19	185.31	190.82	187.12	199.97	68.87	66.57
3. Marjoram extract at 15 ml/L.		82.05	74.16	227.86	243.38	147.84	164.90	149.62	172.59	55.68	45.17
4. Marjoram extract at 30 ml/L.		81.26	75.72	226.35	254.13	152.57	158.95	153.92	166.79	53.37	47.78
5. Amino acids at 1.5 ml/L.		83.18	70.64	231.10	234.62	162.82	169.09	164.31	176.27	51.23	41.70
6. Amino acids at 3 ml/L.		83.24	88.32	232.42	296.27	143.59	157.58	145.31	165.30	58.07	56.14
7. Vit. E at 100 mg/L. + Sel. at 400 µg/L.		90.79	88.43	253.02	295.89	159.47	167.84	160.97	175.37	57.01	52.73
8. Vit. E at 200 mg/L. + Sel. at 800 µg/L.		85.31	78.87	237.38	266.02	157.82	162.17	159.69	169.70	51.60	48.63
9. Citric acid at 2.5g/L.		90.44	93.10	251.37	313.54	165.33	170.73	167.22	178.88	54.61	54.75
10. Citric acid at 5 g/L.		93.00	88.64	259.94	299.99	168.70	174.25	170.76	182.39	55.32	50.89
11. Vit. E at 100 mg/L. + Sel. at 400 µg/L. + Citric acid at 2.5 g/L.		73.43	67.11	204.62	218.46	136.67	142.41	137.94	148.94	53.76	47.29
12. Vit. E at 200 mg/L. + Sel. at 800µ g/L. + Citric acid at 5 g/L.		76.85	72.60	213.22	238.35	144.59	146.09	146.33	151.75	53.13	49.79
13. B at 25 mg/L.		73.96	68.06	206.06	226.93	136.69	151.55	137.99	158.50	54.12	44.87
14. B at 50 mg/L		82.77	92.05	230.78	308.36	149.33	159.13	150.81	166.55	55.44	57.88
15. Zn at 50 mg/L.		93.67	96.59	260.20	317.72	158.13	163.21	159.73	171.05	59.25	59.49
16. Zn at 100 mg/L.		73.42	78.12	203.74	255.29	150.07	156.99	151.57	164.36	48.91	49.91
17. Control		35.98	30.98	100.00	100.00	99.16	97.01	100.00	100.00	36.44	31.94
L.S.D.	0.05	11.14	15.47	31.57	64.19	11.77	12.36	12.35	15.87	8.39	10.62
	0.01	15.00	20.83	42.51	86.45	15.85	16.65	16.63	21.38	11.30	14.31

With regard to the harvest index, i.e., the dry matter of economic yield divided by the dry matter of biological yield it is clearly that different applied treatments significantly increased this index, except that insignificant increase obtained with amino acids at 1.5 ml/L during the second season.

Same data revealed that the highest yield and its components was positively corralled with the previously mentioned and discussed relations and parameters under heat stress conditions. Also, proved that the agronomical performance of plants was greatly depend on their metabolical performances and internal protective mechanism against such stress adverse effects.

7. 6. Minerals content in tomato fruits:

With regard to the minerals concentrations in tomato fruits data in **Table (29 and 30)** clearly indicate that most of applied treatments highly increased total determined minerals (i.e. N, P, K, Ca, Mg), Fe, Zn and Mn concentrations in the marketable tomato fruits. In this respect, the most effective treatment was Vitamin E at100 mg/L + Sel. at 800 µg/L followed by Boron at 50 mg/L, yeast extract at 15 ml/L, marjoram extract at 15 ml/L, Zinc at 50 mg/L and vitamin E at 100 mg/L + Sel at 400 µg/L + citric at 2.5 g/L. The exception was only in case of marjoram extract at 15 ml/L for Fe and vitamin E + Sel. with its two concentrations for Zn.

As for crude protein content, applied treatments increased its concentration in ripened tomato fruits during 2007 season except that reduction obtained with Vitamin E at 100 mg/L + Sel. at 400 µg/L.

In this respect, the most effective treatments which gave the highest concentration was Vitamin E at 200 mg/L+ Sel. at 800 µg/L

followed by Boron at 50 mg/L, vitamin E at 100 mg/L + Sel. at 400 µg/L + citric acid at 2.5 g/L and yeast extract at 15 ml/L, respectively.

The above mentioned results evidently indicated that the applied treatments were greatly increased the ability of tomato fruits as sink organs. So, absorption of these elements, their translocation into fruits being highly stimulated under such treatment. That is also true for the crude protein concentration as one of the essential bioconstituents compared with control which greatly stressed. In this respect, **Taiz and Zeiger (2006)** concluded that under low to moderate heat stress, a reduction in source and sink activities may occur leading to severe reductions in growth, economic yield and harvest index. Assimilate partitioning, taking place via apoplastic and symplastic pathways under high temperatures, has significant effects on transport and transfer processes in plants.

Here, it must mentioned that applied treatments made tomato fruits with high nutritive value, i.e. it increased their validity for human consumption.

Also, the same data clearly indicate that increasing the minerals content in tomato fruit was positively and greatly correlated with minerals and bioconstituents composition of vegetative organs (i.e., leaves), which induce the most active metabolical case and the most effective internal defensive anti-oxidantal mechanism (carotenoids and phenols). At the same time, accompanied those with the best morphological, minerals status. Such results indicate the stimulative effect of the applied treatments to enhance internal metabolical defensive mechanism of tomato

plant against the higher temperature adverse effects during the late summer season towards maximizing its growth and productivity.

Also, it was obvious from the same data that control plants were physiologically stressed. They developed with no or weakly mechanism by which they protected against the prevailing higher temperature stress and its probable inducible oxidative one **Elestner and Osswald (1994).**

7.7. Effect of treatments on some bioconstituents of tomato fruits:

Data in **Tables (31 and 32)** obviously indicate that positive and stimulative effects of applied treatments specially that yeast extract at 30 ml/L upon many bioconstituents production including each of total carbohydrates, total sugars, crude protein, total amino acids and total phenols.

Since, different applied treatments, obviously increased such bioconstituents compared with those of the control at the late summer of 2007 season. The obtained positive bioconstituents responses are the result of increasing leaf area and its reversion upon increasing the net photosynthesis per unit of leaf area. Also, such promotional effect of these antioxidants on carbohydrates and sugars concentrations in tomato fruits, could be due to their similar effect on chlorophyll content, number of leaves and total leaf area (surfaces of photo-assimilation), as well as their capacity of CO_2 fixation and carbohydrates synthesis compared with photosynthesis efficiency of control plants which greatly stressed by high temperature. In this concern **Wise *et al.*, (2004)** reported that alterations in various photosynthetic attributes under heat stress are good indicators of thermotolerance of the plant as they show

correlations with growth. Any constraint in photosynthesis can limit plant growth at high temperatures. Photochemical reactions in thylakoid lamellae and carbon metabolism in the stroma of chloroplast have been suggested as the primary sites of injury at high temperatures.

In similar trend, total phenol and total amino acids as shown in **(Table, 32)** were affected as other mentioned bioconstituents. Here, it was clear that the applied antioxidants induced the synthesis of phenols (other anti-oxidants) which act as an internal a defensive system.

That confirmed the previously discussed results proved that the best morphological behavior of tomato plant under heat stress accompanied with oxidative stress conditions as affected by the applied antioxidant treatments. This simulative effect of the applied treatment was mainly due to they induce best physiological and metabolical performances, also due to their ability to develop an internal protective mechanism against such stress adverse effects **Velikova, *et al.*, (2005) and Wahid and Ghazanfar (2006)**. They concluded that when plants are exposed to potentially harmful environmental conditions, such as strong light and/or elevated temperatures. Some secondary metabolites such as phenolic compounds and sugars are synthesized in response to thermal stress, which is considered to trigger the acclimation to heat stress.

Such results are connected with those reported by **El-Mogy *et al.*, (1998), El-Tohamy and El-Greadly (2007)** for Yeast ; **Foyer *et al.*, (1995), Abou Dahab and Abd -El-Aziz (2006)** for amino acids ; **Alscher and Heath (2002), El-Bassiouny *et al.*,(2005) and Dormann (2007)** for vitamin E ; **Fathy *et al.*,**

(2003 a) for citric acid ; **Davis *et al.*, (2003), Khedr *et al.*, (2004) and Wanas (2007)** for Boron and **Aono *et al.*, (1993), Bakardjieva *et al.*, (2000) and Khedr *et al.*, (2004)** for Zinc.

On the other hand, such data in **Table (33)** indicate that organic constituents (total acidity, Vitamin C and total soluble solids) concentrations were greatly increased with most applied treatments during the late summer of 2007 season compared with the control. Increasing such constituents in tomato fruits consider very important since, tomato is one of the highly important foods in human nutrition for its highly nutritive value. It is rich in vitamins A and C, in addition to its value to human healthy, contributed to tomato acidity. Hence, the applied treatments improved the quality of tomato fruits by increasing their concentrations of total soluble solids, Vitamin C and the titratable acidity. Also, increasing such bioconstituents reveal the stimulative effect of these treatments to enhance, the internal metabolically protective status by their direct scavenging functions against the toxic free radicals (induced by heat stress) under their promotional effect on synthesis of natural protective antioxidants, i.e. total phenols and carotenoids as well as they induce an potent biosynthesis case due to the higher photosynthetic pigments content (protection of chlorophyll's and chloroplasts against stress degradable/ senescence effects). Thereby, higher carbohydrates accumulation and content as well as higher minerals (N, P and K) content. The strong positive correlations of such constituents vs. growth and fruit yield confirmed and coincided such functions and roles of antioxidants **Fathy *et al.*, (2003 a).**

Table (33): Effect of different applied treatments on some chemical constituents of tomato (*Lycopersicon esculentum*, Mill.) fruits during 2007 late summer season.

Treatments \ Fruit quality	Vitamin C (mg/100 cm^3 juice)	Total soluble solids (%)	Total acidity (%)
1. Yeast extract at 15 ml/L.	20.03	4.47	0.48
2. Yeast extract at 30 ml/L.	21.95	4.55	0.40
3. Marjoram extract at 15 ml/L.	22.48	4.20	0.38
4. Marjoram extract at 30 ml/L.	19.35	3.71	0.48
5. Amino acids at 1.5 ml/L.	19.72	4.03	0.45
6. Amino acids at 3 ml/L.	20.67	3.45	0.46
7. Vit. E at 100 mg/L. + Sel. at 400 µg/L.	20.53	3.93	0.47
8. Vit. E at 200 mg/L. + Sel. at 800 µg/L.	21.08	3.26	0.44
9. Citric acid at 2.5g/L.	20.76	3.74	0.49
10. Citric acid at 5 g/L.	21.54	3.36	0.49
11. Vit. E at 100 mg/L. + Sel. at 400 µg/L. + Citric acid at 2.5 g/L.	19.83	4.02	0.42
12. Vit. E at 200 mg/L. + Sel. at 800 µg/L. + Citric acid at 5 g/L.	21.33	3.82	0.45
13. B at 25 mg/L.	19.64	3.49	0.38
14. B at 50 mg/L	21.22	4.40	0.42
15. Zn at 50 mg/L.	22.38	4.60	0.43
16. Zn at 100 mg/L.	21.42	3.25	0.41
17. Control	17.43	3.35	0.38