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EFFECT OF SOME CHEMICAL TREATMENTS, YEAST PREPARATION AND ROYAL JELLY ON SOME VEGETABLE CROPS GROWN IN LATE SUMMER SEASON TO INDUCE THEIR ABILITY TOWARDS BETTER THERMAL TOLERANCE.

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ABSTRACT

Four field experiments were conducted in late summer seasons of 1998 and 1999 to study different responses of some vegetable crops, i.e. tomato cv. Castel Rock (first exp.), sweet pepper cv. California Wander (second exp.), snap bean cv. Bronco (third exp.) and cowpea cv. Creem-7 (fourth exp.) grown in late summer season to induce thermotolerance responses (improvement of fruiting and yield) by using yeast preparation (Y_1 & Y_2) (25 ml/L & 50 ml/L), chelated micronutrients (CME) (1 ml / L), iodo-benzoic-salicylic acid (IBS) (0.2 gm/L) and royal jelly (RJ) (10 ppm) three times spraying on tomato. Also, Y_1, Y_2, IBS and ATP (50 ppm), three times spraying on pepper, snap bean and cowpea in other experiments.

The results could be summarized as follows:-

- Different vegetable crops differed in their morphological and nutritional behavior as well as fruiting and yield as a result of application the same treatments under the same stress condition.
- In first exp., with tomato, IBS and RJ were the best treatments for improving nutrients content, fruiting and yield. RJ gave rise to the best vegetative growth. IBS increased yield by 142.3% and RJ by 125.0% (mean of two season) above control. Also, tomato relative to other crops was of the highest response to the same treatment based on RY value.
- Sweet pepper (second exp.) followed snap bean in its response for the same treatment (based on RY value). ATP treatment was the best for growth, nutritional case, fruiting and yield (161.2% of control).
- Snap bean followed tomato in its responses. Yeast preparation (Y_2) 50 ml/L was the best treatment for growth, most chemical contents and yield (186.0% of control).
- Cowpea was relatively the least thermosensitive crop (at the same basis). ATP was the best treatment for growth, whereas IBS was the best for nutrients content, fruiting and dry seed yield, it increased seed yield by 30.0% above control.
- Present work allowed to own new specific techniques and promising growth and fruiting substances as yeast preparation (a natural growth stimulator rich in auxins, GA_3, cytokinins and several essential bioconstituents), IBS as a new synthetic growth inhibitor of great benefits specially during stress condition and new balanced chelated microelements combination (CME) with new specialized technique.

Successfully application of such new substances on different vegetable crops in critical season to induce thermotolerability and considerably increase their fruiting and yield.

INTRODUCTION

In recent years unfavourable higher temperature prevails during late summer season could severely depress growth, fruiting and yield of important vegetable crops, i.e. tomato, sweet pepper, snap bean and cowpea. Generally, such depression occurs when day and night temperature exceeds 25 and 18°C, respectively, although no visible injury to vegetative growth is observed in some cases (Asahira, 1976 and Kuo *et al*., 1978 on tomatoes; Rylski and Spigelman, 1982 and Wein, 1990 in sweet pepper; Halterlein *et al*., 1980; Nikolova and Poryazov, 1990; Keeler *et al*., 1996 and Kleiner and Frett, 1996).

Meanwhile, and at the physiological and metabolic level, heat stress severely affects photosynthesis, carbohydrates depleted in respiration, protein breakdown and denaturation, nutritional and hormonal imbalances, enzyme inactivation, disturbances in membrane structure and function and restriction of stomatal function (Leopold and Scott, 1952; Emmett and Wolker, 1973; Berry and Björkman, 1980 and Dubey, 1994). Hewitt and Curtis (1948) attributed abortion of flower buds in tomato to a depletion of the carbohydrates by increased respiration during heat stress. Pollen development, pollen tube growth, ovaries development and fruit set are also severely influenced (Leopold and Scott, 1952 and Marre and Murneek, 1953). Fruit set and fruit development are usually associated with endogenous plant hormones, those, which are dramatically affected by high temperature stress (Iwahori, 1967 and Abd El-Rhman, 1977).

Once again, abscission of ovaries and poor fruit set and yield, poor pollen development and lack of pollination as well as carbohydrates and minerals competition all are serious modifications occurred during high temperature stress (Aung, 1978). In addition, thermotolerance known to be related with tissue minerals and ions level, i.e. K and Ca as well as with the function of H^+-ATP-ase membrane ions pump via its role in creating certain balance between H^+, K^+ and Ca^{++} ions, also via (Ca^{++} / calmodulin-activated kinase) altered gene expression and induce synthesis of hsps (Nover *et al*., 1983; Burke and Orzech, 1988 and Landry *et al*., 1988).

Various attempts have been made and more attention is paid to use chemical and natural substances to alleviate the above mentioned adverse effects of heat stress on growth and yield of vegetable crops with varying degree of success or failure. Menary and Vanstaden (1976) indicated that P and cytokinin have an beneficial effect on number of flowers, fruit set and yield of tomato under higher temperature condition. Also, sucrose and cytokinin improved fruit set under the same stress condition (Marre and Murneek, 1953). Other growth regulators as BA and CPA (Iwahori, 1967 and

Abdalla and Verkerk, 1968) and CPA, CCC and pix (Mahmoud, 1991) all were used during exposure to heat stress.

Based on the above mentioned information present work aimed to investigate new promising natural and chemical agent of hormonal and nutritional nature as ATP, yeast, IBS (Iodo-benzoic-salicylic acids), royal jelly and CME (Chelated micro-elements) on vegetable crops (tomato, sweet pepper, snap bean and cowpea) to induce thermotolerance and improve their growth, mineral composition, fruiting and yield under higher temperature stress of late summer season.

Herein, its of value to cited the relevant information and effects about such new promising treatments. Micro-elements (Fe, Mn, Zn, Cu, B and Mo) specially in chelated form known to be of essential beneficial role in all key physiological and biochemical processes as enzyme activation, electron transport system of photosynthesis and respiration, nucleic acid metabolism, protein and sugar synthesis, free radical (oxygen and superoxide detoxification), differentiation and meristematic growth and pollen viability, germination and growth (Bussler, 1981; Hewitt, 1983 & 1984, Bumell, 1988; Mortvedt *et al*., 1991; Römheld and Marschner, 1991 and Welch, 1995).

Royal jelly is a biosubstance produced by newly emerged workers of honey bee, it is rich in essential amino acids as arginie (4.75), cystine (2.3%), histidine (1.7%) and lysine (4.4%), as well as tryptophan and tyrosine (Appler, 1922 and Ammon and Zoch, 1957). Also, it is rich in sugar, protein, lipids and vitamins (Snodgrass, 1956). Gade (1998) used it as natural stimulator in comparison with IAA on Bougainvilla Buttiana, it significantly increased root length and dry weight. IBS (performed as iodo-benzoic, salicylic acid) derivative, its like TIBA (the known benzoic acid synthetic growth inhibitor derivative). Such synthetic growth inhibitor family known to be restrict auxin polar transport, inhibit ethylene biosynthesis, increase content of some nutrient elements within tissues (Ca and Fe), and inhibite growth and stimulate reproductive functions (Bukovac and Witter; 1959; Thompson *et al*., 1973 and Rubery, 1978). Salicylic acid can also improve flowering and reproduction processes of plant via its role in signal transduction pathway and gene expression ulteration during stresses (Malamy *et al*., 1990 and Samac and Shah, 1991).

ATP suggested to be of several roles that potentially implicated in establishing thermotolerance case due to it's functional role, to energized all active metabolical-ATP dependent process (Ito *et al*., 1991 and Thomas *et al*., 1999), regulatory role, ATP hydrolytic derivative AMP serve as one of main precursor of cytokinin of known stimulatory effects, and in certain pathway AMP shifted to CAMP (cyclic AMP), this which act as secondary messenger in stress signal transduction and gene expression regulation and ulteration to stress tolerable state (McClure *et al*., 1989 and Jameson, 1994), structural involvement in DNA (gene) struction (Dashek, 1997), its role in ion retention, osmoregulation and stress recovery via its function in ATP/H^+-ATP-ase membrane pump system (Palta, 1990 and Poovaiah and Reddy 1987 & 1993), and recently its involvement in thermotolerance system via the role of ATP-ase enzyme/ protein as a member of the 70 Dka family of heat shock proteins (Kirsch and Beevers, 1993). Little information about the exogenous application of ATP were relevant and most of them were as *in vivo* treatments (Kubik and Michalczuk, 1987; Ito *et al*., 1991; Reymond *et al*., 1992; Younis *et al*., 1992; Njaroge *et al*., 1998 and Thomas *et al*., 1999).

Additionally, yeast a natural biosubstance suggested to be of useful stimulatory, nutritional and protective functions when it is applied onto vegetable plants during stressful condition. Due to its hormones, sugars, amino acids, nucleic acids, protein, phospholipids, vitamins and minerals content; thereby it can accelerate cell division and enlargement; enhances nucleic acids, proteins and chlorophyll synthesis, promotes the formation of flower initiations and improves fruit setting percent. it can induce thermotolerance due to its content of heat shock proteins (hsps) (Nover *et al*., 1983; Kurtz *et al*., 1986 and Weiderrecht *et al*., 1988) and the cryoprotective and osmoregulator organic solutes (Winkler, 1962; Roberts, 1976; Kraig and Haber, 1980; Castelfranco and Beale, 1983; Spencer *et al*., 1983 and Fathy and Farid, 1996). Also, using yeast to improve growth and fruiting of horticultural crops was reported in narrow scale by Bow *et al*. (1989); Fathy and Farid (1996) and El-Mogy *et al*. (1998).

The goal of this work is to use new promising natural and chemical treatments to counteract and improve the internal nutritional and physiological state of tomato, sweet pepper, snap bean and cowpea plants, ultering the case of higher temperature associated nutritional and metabolical disorders to an inducable thermotolerance one. Thereby improving their growth, fruiting and yield during late summer unconducive higher temperature stress condition.

MATERIALS AND METHODS

Four field experiments were performed in Experimental Station of Mansoura during late summer seasons of 1998 and 1999 on some vegetable crops.

In the first experiment, treatments of yeast preparation (Y_1, Y_2), royal jelly (RJ), iodobenzoic-salicylic acid (IBS) and chelated micro-elements formulation (CME) were applied onto tomato crop, Y_1, Y_2, ATP and IBS were applied onto sweet pepper, snap bean and cowpea in second, third and fourth experiment, respectively.

First experiment (Tomato cv. Castel Rock):

At the beginning of May, tomato transplants 30-day age were transplanted to permanent field at 30 cm apart on one side ridge 5 m long and 1 m wide, experimental unit area was 15 m^2. Plants were sprayed with treatment solutions 15, 30 and 45 days after transplanting, treatments and procedures were as follow:-

Yeast preparation (Y_1 and Y_2 treatments): Using a technique allowed yeast cells (commercial soft yeast) to be grown and multiplied efficiently during conducive aerobic and nutritional conditions to produce denovo beneficial bioconstituents, i.e. carbohydrates, sugars, proteins, amino acids, fatty acids, hormones and etc., hence allowed such constituents to release out of yeast tissues. This technique based on:

* Nutritional medium of glucose and casein as a favorite sources of C and N, also presence of P, K, Ca, Mg, Fe, Mn, Zn, Cu, B, Mo as well as Na and Cl in suitable balance.
* Air enrichment (pumping), current control for incubation temperature.
* Freezing for disruption of yeast tissues and releasing their content (methyl acetate also could be applied for this purpose.

This Procedure was modified after Shady (1978), Spencer *et al*. (1983) and Abd El-Rahim *et al*. (1998). Analysis of prepared yeast stock solution was: as follows total protein (5.3%), total carbohydrates (4.7%), N (1.2%), P (0.130%), K (0.30%), Ca (0.02%), Mg (0.013%), Na (0.01%); micro-elements (ppm), Fe (0.13), Mn (0.07), Zn (0.04), Cu (0.04), B (0.016), Mo (0.0001), IAA (0.5 mg/ml) and GA (0.3 mg/ml). According to Cotton (1954) for mineral analysis; Nelson (1944) and A.O.A.C. (1965) for carbohydrate and protein, GLC method (Vogel, 1975) for IAA and GAs and Fletcher and Mcullagh (1986) for cytokinins bioassay (see Fig. 1a and 1b). Y1 was 25 ml/L and Y2 was 50 ml/L.

2. CME treatment: Chelated micro-elements formulation was performed using cation exchanger technique (Resin-H^+ form, sulfate form of each element (Fe, Mn, Zn and Cu) and EDTA chelator agent) according to Fathy *et al*. (1997). Besides addition of citric and tartaric acids. CME formulation composition was as follow: (Fe [2%], Mn [1.5], Zn [1.0%), Cu [0.25%] all in EDTA & organic acids forms, B [0.35%] boric acid form, Mo [0.001%] molybdic acid form and 2% citric and tartaric acid). CME applied at 1 ml/L.
3. RJ treatment: Natural royal jelly kept at freezing temperature until it used. Just at application time, it allowed to be dissolved in distilled water remain at 8°C and at once used . RJ applied at 10 ppm concentration.
4. IBS treatment:: Iodo-benzoic-salicylic acid combination prepared as a modified form of TIBA and as a new benzoic acid derivative (synthetic growth inhibitor). It is performed by mechanical reaction, mixing of metalic iodine, benzoic acid and salicylic acid at chemical basis (Rahway, 1983) and procedure for avoidance of volatilization. IBS combination finally was in fine brownish powdered form kept in strongly closed doubled layer pockets (plastic and foil). IBS applied at concentration of 0.2 gm/L.

Second experiment (sweet pepper):

At the beginning of May, pepper transplants 35 day age were transplanted in open field at 30 cm apart on one side ridge 3.5 m long and 0.6 m wide, experimental unit area was 6.3 m^2. Plants were sprayed with yeast preparation, ATP and IBS solutions 20, 40, 60 and 80 days after transplanting, treatments were as follow:-

1. Yeast treatments (Y_1 & Y_2) as in the first experiment.
2. ATP treatment: Chemical agent adenosine-tri-phosphate introduced from El-Gommhoria Co, Egypt in crystallized

powder form kept as it and as prepared stock solution at 4°C. It applied at 50 ppm concentration

3. IBS treatments was as in the first experiment.

Fig. 1a. Yeast preparation auxins (IAA) and gibberellins (GAs) content, as determined by the GLC according to Vogel (1975).

Fig. 1b. Yeast preparation cytokinins determined by bioassay test according to Fletcher and Mcullagh (1986).

Third and fourth experiment (Snap bean and cowpea):

Seeds of snap bean cv. Branco and cowpea cv. Creem-7 were directly sown in permanent field in mid April (snap bean) and at beginning of May (cowpea). Snap bean seeded 20 cm apart on two side of ridge 3m long and 0.6 m wide, in plot (3 ridges). Cowpea seeded 30 cm apart on one side ridge 3 m long, 0.6 m wide (3 ridges / plot). Plants were sprayed with Y_1 (25 ml/L), Y_2 (50 ml/L), ATP (50 ppm) and IBS (0.2 gm/L), 25, 35 and 45 day after sowing (snap bean), 35, 55 and 75 day after sowing (cowpea).

Experimental parameters:

Tomato and pepper:

At the middle of harvesting season, five plants from each plot were taken for estimation of total dry weight (gm/plant), leaf area (cm^2/plant) (tomato); number of leaves/plant, total dry weight (gm/plant) and leaf area (dcm^2/plant) (pepper). At full blooming, samples of leaves were taken for chemical analysis. N, P and K were determined according to Cotton (1954), whereas, Ca and Mg were analyzed by Atomic-absorption SP method. Also, five plants/plot were labelled, average number of flowers and fruits was determined during the whole season, fruit set % was calculated as follows:

$$\frac{\text{No. of fruits / plant x 100}}{\text{No. of flowers / plant}}$$

Yield as number and weight of fruits / plant was calculated from all harvested fruits / plot divided by number of plants / plot. Also relative yield (RY) was calculated as % of control treatment yield.

* Snap bean representative samples of 10 plants / plot in 3 replicates were taken 70 day after sowing. In each sample, plant height, number of leaves and shoots, total fresh and dry weight (gm), all / plant were determined. At time of bloom, newly expanded trifoliate leaves were taken at random. Samples were dried, ground and analyzed for N, P, K and Ca. Chlorophyll content was measured in field on similar leaves of cultivated plants by "Minolta Chlorophyll Meter SPAD-502". Dry matter content of pods was also determined. Green pods were weekly harvested (stage of horticultural maturity), total number and weight (gm) of pods were recorded in every plot. Those divided by number of plants / plot, then yield as number and weight (gm) / plant as well as (ton) / fed. were calculated. Also pod average weight (gm), relative yield (RY) % of control yield / plant were counted.
* Cowpea, also similar samples were taken 80 days after sowing for plant height (cm), number of leaves and shoots, total fresh and dry weight (gm) (all per plant) estimation. At time of bloom, fully expanded leaves from top were taken (10 plants / plot) for N, P, K and Ca analysis as above mentioned. Harvesting for dry seed yield was started when 25% of plot pods was in known suitable stage for dry

yield (turn to yellow colour and start to dry). Cumulative harvested pods of each plot were taken and allowed to be completely dried. Number of pods and weight of dry seeds per plant were recorded, then number of pods / plant, weight (gm) and dry seeds / plant, relative yield (RY) and yield of dry seeds / fed. were counted. Also, number and weight of dry seeds / pod were determined in samples of 200 pod for each plot.

Randomized complete block design in three replicates was adopted for each experiment. All the obtained data were subjected to computer statistical analysis.

Also, air temperature during the two seasons of this work (monthly means of max. and min.) were presented in Table (1) to detect the periods of non-conductive higher temperature (heat stress condition).

Table (1): Mean monthly air temperature in El-Mansoura during summer season of 1998 and 1999.

Time	Temperature (°C)					
	1998			1999		
	Max.	Min.	Mean	Max.	Min.	Mean
April	29.9	12.6	19.2	23.0	10.6	16.8
May	26.6	16.7	21.7	26.7	14.2	20.4
June	30.3	19.6	24.9	28.9	19.0	24.0
July	30.5	21.5	26.0	29.7	20.5	25.1
August	33.0	23.0	28.0	30.5	20.3	25.4
September	31.7	20.6	26.1	--	--	--
October	29.9	17.2	23.5	--	--	--

Source: Sakha Meteorological Station.

RESULTS AND DISCUSSION

I. Experiment (1) (Tomato plant):

I.1. Vegetative growth:

Data in Table (2) indicated that all treatments significantly differed among of them and increased total dry weight (gm) per plant and leaf area (cm^2) per plant of tomato plant relative to those of untreated one except total dry weight of yeast preparation at low concentration (25 ml/L) at two seasons. It is also evident that royal jelly treatment was rise to the highest dry weight and leaf area followed by IBS, and hence by yeast preparation at higher concentration (50 ml/L) and chelated micro elements formulation with pronounced similar effect among of them. The clearly lowest dry weight and leaf area were produced by untreated plants at two seasons.

The pronounced dramatic reduction of surfaces of bio-assimilation (leaf area) and dry matter synthesis (total dry weight) of untreated tomato plants as affected by unconducive higher temperature prevails in late summer season exceeds the critical, 25°C / 18°C day / night temperature (above it, heat stress adverse effects might be occurred) (Table 1), was similar to the results of Asahira (1976) and Kuo *et al*. (1978) on tomato.

Table 2: Vegetative growth of tomato plants as affected by yeast (Y_1 & Y_2), chelated micro-elements (CME), royal jelly (RJ) and iodo-benzoic-salicylic acid formulation (IBS) in late summer season of 1998 and 1999.

Treatments	1998		1999	
	Total dry weight (gm/plant)	Leaf area (cm^2/plant)	Total dry weight (gm/plant)	Leaf area (cm^2/plant)
Yeast prep. (25 m/l) (Y_1)	202.5 d	4018.0 d	200.0 d	4017.0 d
Yeast prep. (50 ml/L) (Y_2)	245.7 c	4630.0 c	246.7 c	4576.0 c
Chelated micro-element (CME)	244.6 c	4673.0 c	247.5 c	4696.0 c
Royal jelly (RY)	308.2 a	5698.0 a	324.2 a	5684.0 a
Iodo-benzoic-salicylic (IBS)	286.3 b	5147.0 b	282.5 b	5190.0 b
Control	186.2 d	3589.0 e	188.3 d	3656 e

Means within the same column having different superscripts significantly different.

Such pronounced depression in growth of tomato control plants could be attributed to the similar resultant decrease in their nitrogen (N), potassium (K)and calcium (Ca) content during the same stress condition (Table 3). Herein,it is beneficial to observe that such restrection in growth and reduction in mineral content of control plants was extended to fruiting and yield (Table 4).

As surface of assimilation and N, K and Ca content reduced under heat stress condition, a restiraction in carbohydrate, amino acids, and protein synthesis, as well as hormonal depression and disturbances might be the case and thereby reduced growth and development of such control tomato plants. Such interpretation is in consistence with the findings of Leopold and Scott (1952), Emmett and Walker (1973), Berry and Björkman (1980) and Duby (1994) about heat stress related physiological and metabolical disturbances as nutritional and hormonal imbalances, severely limit photosynthesis, protein denaturation, carbohydrate depletion in respiration and restriction in membrane structure and function. Moreover, the relatively low K and Ca content of control plants (Table 3), might be attributed with its thermosensitivity. Since, they are known to involve in thermotolerance processes via activation of H^+-ATP-ase the membrane ion pump that potentially associated with ion and osmotic regulation, stress recovery and heat shock proteins hsps synthesis as well as it as hsp enzyme / protein, all might be involved in thermo sensitivity or tolerability (Nover *et al*., 1983; Burke and Orzech, 1988 and Landry *et al*., 1988).

On the other hand, the clear superiority of royal jelly and IBS, iodo-benzoic salicylic acid) treatments and beneficial effect of CME (chelated micro-elements formulation) and yeast preparation (higher concentration, 50 ml/L) could be due to that the same treatments had the same effect on mineral content, i.e. N, K and Ca (Table 3), those that potentially involved in biochemical and metabolical processes, those that tightly related with internal thermotolerance processes as above discussed and reviewed.

Once again, superiority of royal jelly treatment might be due to its richness in content of essential amino acids, protein, soluble sugars and vitamins (Appler, 1922; Snodgrass, 1956 and Ammon and Zoch, 1957). Those that known to serve in cryoprotection and osmoregulation essential processes specially during stress condition (Hochaka and Somero, 1973). As well as might be to some extent substituted, the depleted sugar by the resultant higher respiration rate (Leopold and Scott, 1952) and the insufficient amino acids and protein those, which their metabolism dramatically restricted under higher temperature condition (Dubey, 1994). In addition, Gad (1998) used royal jelly as natural stimulator in comparison with IAA, which would improve growth and dry matter accumulation of Bougainvilla Butliana.

Table 3: Mineral composition of tomato plants as affected by yest (Y_1 & Y_2), chelated micro-elements (CME), royal jelly (RJ) and iodo-benzoic-salicylic acid formulation (IBS) in late summer season of 1998 and 1999.

Treat.	1998			1999		
	N (%)	K (%)	Ca (%)	N (%)	K (%)	Ca (%)
Y_1	2.47 d	2.62 c	1.69 c	2.51 d	2.68 c	1.68 c
Y_2	3.05 b	2.99 b	2.17 b	2.94 b	3.01 b	2.22 b
CME	2.75 c	2.93 b	2.14 b	2.72 c	2.93 b	2.15 b
RJ	3.11 ab	3.41 a	2.43 a	3.09 ab	3.34 a	2.40 a
IBS	3.20 a	3.55 a	2.37 a	3.23 a	3.47 a	2.37 a
Control	2.24 e	2.38 d	1.67 c	2.10 e	2.35 d	1.64

Regarding the pronounced beneficial effect of IBS, the modified synthetic growth inhibitor of TIBA family might be due to its known action in inhibition of both auxin polar transport and ethylene biosynthesis. Thereby restirected apical growth and promoted lateral growth (branching) those favorate leaf area extention and dry matter accumulation. Also, its clearly improved N, K and Ca content (Table 3). These might be implicated in thermotolerance processes via the role of Ca and K in counteracting internal ionic status, therefore inducing heat shock proteins (hsps) synthesis and in activation of H-ATP-ase enzyme hydrogen pump (Nover *et al*., 1983; Burke and Orzech, 1988 and Landry *et al*., 1988). Such interpretation was in consistent with the findings of Buleovac and Witter, 1959; Thompson *et al*., 1973 and Rubery, 1978).

Beneficial influence of yeast preparation: The suggested natural growth stimulator might be attributed to its richness in bioconstituents content (protein, carbohydrate, IAA, GA, CK, and ABA as well as minerals content, notice yeast analysis in previous part of this work). Such constituents known to be involved in cryoprotection, osmoregulation, cell division and enlargement, activation of carbohydrate and protein synthesis and promotion of lateral and apical meristematic growth. Besides, its involvement in thermotolerance processes (Nover *et al*., 1983 on tomato and corn) via its heat shock proteins content (hsps) as suggested by Kurtz *et al*. (1986) and Weiderrecht *et al*. (1988).

I.2. Mineral composition:

Data in Table (3) showed that all treatments considerably differed among and increased nitrogen (N), potassium (K) and calcium (Ca) content of tomato foliage relative to control treatment except Ca content of yeast preparation at low concentration (25 ml/L) at the two seasons.

Same data indicated that iodo-benzoic-salicylic acid (IBS) and royal jelly treatments were conducive to the highest and equal N, K and Ca content followed by yeast preparation (Y_2) of higher concentration (50 ml/L) and chelated micro-elements formulation (CME) treatments of similar mineral content except that of nitrogen (N) at both seasons. It is also evident that yeast preparation at low concentration (25 ml/L) was of low beneficial effect among treatments and the least mineral content was found in control treatment.

Similar results about nutritional disorded and deficiency during exposure of plants to heat stress condition were obtained by Aung (1978), Berry and Björkman (1980) and Bubey (1994) and about the elevated K and Ca content as associated with thermotolerance responses (Nover *et al*., 1983; Burke and Orzech (1988) and Landry *et al*. (1988). Also, about the effect of IBS-growth inhibitor family (Bukovac and Witter, 1959 and Rubery, 1978) and Welch (1995) about the beneficial effect of micro-element on mineral uptake and content.

In such case, beneficial effect of royal jelly, IBS, CME and yeast treatments on extension of leaf area (surfaces of assimilation) and the accumulation of dry matter (Table 2) besides the pronounced higher fruit set and yield (Table 4) relative to control plants under natural heat stress condition (Table 1), indicated that such treated plants could be in thermotolerance responses state. Ultering to or onset of thermotolerance as well as its response and metabolism known to need more and ample nutrient supply and content. Since, such ulteration include gene expression ulteration, protein metabolism, hormonal and nutritional balance, ionic and osmotic counteract and adjustment, heat shock proteins (hsps) synthesis and H-ATP-ase activation. All of these are largely dependent and required sufficient N, K and Ca supply and internal content (Nover *et al*., 1983; Burke and Orzech, 1988; Landry *et al*., 1988; Palta, 1990 and Poovaiah and Reddy, 1993).

So, it could be suggested that the resultant N, K and Ca content herein was considered as thermotolerance metabolical function and ulteration.

I.3. Fruiting and yield:

Data in Table (4) indicated that most treatments were significantly differed among in their effect. They induced significant higher number of fruits/ plant, fruit set % and yield (kg) / plant as compared with untreated tomato plants in two seasons.

Same data showed that both royal jelly and IBS were of considerable equal highest number of fruits, fruit set % and yield (kg) / plant at the two seasons with only one exception of significant increase in yield of IBS treatment above that of royal jelly one at the second season. It is also evident that plants treated with yeast preparation at higher concentration (50 ml/L) and chelated micro-element formation (CME) (1 ml/L) did not significantly differ in their yield (kg) / plant, but differed considerably in their number of fruits / plant and fruit set %. Yeast treated plants were higher values at both seasons. Yeast preparation treatment of low concentration (25 ml/L) was of significant low beneficial effect on all parameters relative to other treatments, but not to control one. It is also clear that the significant least fruiting and yield at two seasons were obtained by control plants.

Table 4. Fruiting and yield of tomato plants as affected by yest (Y_1 & Y_2), chelated micro-elements (CME), royal jelly (RJ) and iodo-benzoic-salicylic acid formulation (IBS) in late summer season of 1998 and 1999.

Treat.	1998			1999		
	No. of fruits/ plant	Fruit set(%)	Yield (kg/plant)	No. of fruits / plant	Fruit set(%)	Yield (kg/plant)
Y_1	23.50 d	37.63 d	1.62 c	23.25 d	36.64 d	1.63 d
Y_2	37.00 b	56.70 b	2.62 b	36.66 b	57.02 b	2.56 c
CME	34.55 c	52.43 c	2.57 b	34.75 c	51.50 c	2.42 c
RJ	44.01 a	69.35 a	3.16 a	43.88 a	69.40 a	2.89 b
IBS	44.23 a	69.95 a	3.28 a	45.00 a	70.02 a	3.21 a
Control	18.55 e	29.55 e	1.38 d	19.00 e	27.65 e	1.30 e

Similar findings about the adverse effect of heat stress condition on fruiting and yield of tomato were obtained by Asahira (1976); Aung (1978), Kuo *et al*. (1978) and Mohamed (1991). Also, the beneficial effect of royal jelly, IBS, yeast and CME treatment on tomato reproductive phase (fruiting and yield) was in agreement with the findings of Thomson *et* al. (1973), Rubery (1978); Bow *et* al. (1989); Malamy *et al.* (1990), Samac and Shah (1991); Welch (1995); Fathy and Farid (1996); El-Mogy *et al*. (1998) and Gade (1998).

Herein, the resultant severe reduction in fruiting and yield of untreated tomato plants as affected by non-conductive higher temperature prevail during late summer season (Table 1), could be due to the resultant depression in their leaf area and dry matter accumulation as well as N, K and Ca content (Tables 2 and 3). Otherwise, such plants should have poor own potentiality to tolerate heat stress adverse effects, therefore, they are underlaying heat-related physiological, nutritional and might be hormonal disturbances and in turn extended such case to their fruiting and yielding ability. Also, such plants might be undergoing heat stress related to disturbances i.e. carbohydrates depletion in respiration, protein breakdown and denaturation, nutritional and hormal imbalances, enzymes inactivation, membrane structure and function disturbance and stomatal function restriction (Leopold and Scott, 1952; Emmett and Walker, 1973; Berry and Björkman, 1980 and Dubey, 1994).

Additionally, it was reported that pollen and ovaries development are severely affected by heat stree (Leopold and Scott, 1952 and Marre and

Murneek, 1953), also, it was known that poor pollen development and poor fruit set were due to minerals and carbohydrates competition and then storage as well as to endogenous plant hormones imbalances (Hewitt and Curtis, 1948; Iwahori, 1967; Satio and Ito, 1967; Abdalla and Verkerk, 1968; Abd El-Rhman, 1977 and Aung, 1978).

On the other hand, the resultant improvement in fruiting and yield of treated tomato plants (IBS, royal jelly, yeast and CME treatments) could be logically true, since the same treatment under the same stressfull condition considerablly improved area of bioassimilation surface and the symthesis of dry matter (Table 2) as well as mineral content (N, K and Ca) (Table 3), those as above mentioned implicated in establishing an internal thermotolerance basis and status, this expressed in term of higher fruit setting and yield under higher temperature condition. Thermotolerance known to be related with the internal ion and mineral level, K^+ and Ca^{++} cations as well as N content, activation and function of H-ATP-ase membrane enzyme / pump, which links also to Ca and K content, Ca/ / calmodulin (protein) activated kinase system and gene expression ulteration and synthesis of specific heat shock protein (hsps) (Nover *et al*., 1983; Burke and Orzech, 1988 and Landry *et al*., 1988).

Furthermore, the beneficial effect of IBS treatment might be due to that this synthetic that growth inhibitor known to be inhibit auxin polar transport and ethylene bio-synthesis and stimulate reproductive functions added to the role of IBS-salicylic acid content in flowering and fruiting induction via its involvement in gene expression ulteration (Thompson *et al*., 1973; Rubery, 1978; Malamy *et al*., 1990 and Somac and Shah, 1991). Royal jelly as arich rich natural source of soluble sugars, essential amino acids and as a precursor for IAA might be compensate the depleted sugars, and the denaturated protein thereby stimulated fruit set and considerably improved yield of tomato plant.

Yeast preparation due to its hormonal and nutritional contents (analysis of yeast preparation in part of material and methods) as well as its hsps content (Kurtz *et al*., 1986 and Weiderrcht *et al*., 1988), it might be induce thermotolerance (Nover *et al*., 1983) and improved fruit set and yield (Winkler, 1962; Roberts, 1976; Kraig and Haber, 1980; Castelfranco and Beale, 1983 and Spencer *et al*., 1983).

Meanwhile, beneficial effect of CME treatment on fruiting and yield of tomato under heat stress condition might be due to the stimulatory effect of such micro-nutrient combination on all physiological and metabolical processes and functions as well as their specific effect on reproductive organs (Bussler, 1981; Hewitt, 1983 & 1984; Bumell, 1988; Mortvedt *et al*., 1991; Römheld and Marschner, 1991 and Welch, 1995).

It could be suggested that IBS and royal jelly were the best treatment to greatly improve tomato plant mineral content, fruiting and yield under heat stress condition in late summer season.

II. Experiment (2) (pepper plant):

II.1. Vegetative growth:

Data in Table (5) showed that different treatments, yeast preparation Y_1 (25 ml/L), Y_2 (50 ml/L), adenosine-tri-phosphate (ATP 50 ppm), iodo-benzoic-salicylic acid (IBS) and untreated control treatment significantly differed among them in their effect on vegetative growth parameters, number of leaves / plant, leaf area (dcm^2/plant) and total dry weight (gm/plant) at 1998 and 1999 late summer seasons. Such data also indicated that all treatments greatly increased all mentioned parameters above those of control plants.

Same data showed that ATP treated plants were of the highest growth parameters followed by yeast at higher concentration (50 ml/L) for leaf area and dry weight only and by IBS for number of leaves at the two seasons. Data also cleared that IBS treated plants were of pronounced favourable effect on leaf area and dry weight, yeast preparation (25 ml/L) was relatively of benefit effect whereas untreated plants were of the significant lowest growth characteristics at two seasons.

Table (5). Vegetative growth of pepper plants as affected by IBS, ATP and yeast during 1998 and 1999 seasons.

Treat.	1998			1999		
	No. of leaves / plant	Leaf area (dcm^2 / plant)	Total dry weight (gm/plant)	No. of leaves / plant	Leaf area (dcm^2 / plant)	Total dry weight (gm/plant)
Control	134.0 e	22.71 e	45.09 e	140.0 e	20.57 e	45.41e
IBS	212.3 b	40.48 c	72.07c	217.7 b	42.25 c	76.37 c
ATP	294.6 a	50.40 a	117.5 a	294.3 a	54.51 a	119.7 a
Y_1	184.0 d	33.28 d	55.98 d	184.3 d	36.10 d	58.23 d
Y_2	199.7 c	46.84 b	88.57 b	206.7	44.91 b	86.25 b

Similar effects and findings about IBS-inhibitor family were obtained by (Bukovac and Witter, 1959; Thomson *et al*., 1973 and Rubery, 1978), Bow *et al*. (1989), Fathy and Farid (1996), and El-Mogy *et al*. (1998) about yeast effects and results of Kubik and Michalczuk (1987), Ito *et al*. (1991), Remond *et al*. (1992), Younis *et al*. (1992), Njaroge *et al*. (1998) and Thomas *et al*. (1999) about ATP effects and results.

From climatical data presented in Table (1) and according to Rylski and Spigelman (1982) and Wein (1990), pepper plants were under heat stress condition. Untreated pepper plants could be as higher temperature sensitive plants as their growth progressivelly depressed. While, plants of other treatments showed different degrees of thermotolerance as their growth had been improved under the same stress condition.

Such result and suggestion could be expected herein, since the same control and other promosing treatments held the same effect on mineral content, i.e. P, K and Ca (Table 6). Those which known to be implicated in thermotolerance induction responses via their roles in activation of ATP/ATP-ase system therby in internal ionic balance and counteracting conducive for gene expression ulteration and hsps synthesis (Nover *et al*., 1983; Burker and Orzech, 1988 and Landry *et al*. (1988). Superiority of ATP treatment might be due to that it energized all active metabolical ATP-dependent processes (Ito *et al*., 1991 and Thomas *et al*., 1999). Such function might optimize respiration rate and reduce the depletion of photometabolites those which attributed to higher temperature (Dubey, 1994).

Also, it was known that ATP has a regulatory function during stress via its hydrolytic derivatives as a precursor of cytokinin (Jameson, 1994) or as an agent in signal transduction system for gene expression ulteration (McClure *et al*., 1989). Besides it interfers in gene struction (Dashek, 1997), in regulation and activation of mineral uptake, translocation and retention via ATP/H^+-ATP-ase pumps (Poovaiah, 1987; Palta, 1990 and Poovaiah and Reddy, 1993) and directly in thermotolerance responses via activation of ATP-ase enzyme as a member of 70 Dka hsps (Kirsch and Beevers, 1993). Meanwhile, yeast generally known to be accelerate cell division and enlargement, supplemented depleted bioconstituents and enhanced all metabolical processes, its bioconstituents content act as cryoprotective and osmoregulator agents (notice yeast preparation analysis in previous part of this work) (Winkler, 1962; Roberts, 1976; Kraig and Herber, 1980; Spencer *et al*., 1983 and Fathy and Farid, 1996). Also it directly involved in thermotolerance responses via its hsps content (Kurtz *et al*., 1986 and Weiderrecht *et al*., 1988).

II.2. Mineral composition:

Data in Table (6) indicated that IBS, yeast preparation (Y_1 and Y_2, 25 and 50 ml/L) and ATP treatments, all significantly improve mineral content (P, K and Ca) of pepper plant relative to control one at 1998 and 1999 late summer seasons. Same data revealed that ATP and IBS treated plants were of the highest P, K and Ca content, whereas, untreated pepper plants were of the lowest mineral content at two seasons. Yeast preparation treatments (Y_1 and Y_2) followed the previous superior treatments and were of beneficial effect, but treatment of higher concentration (Y_2) was better than that of lower concentration (Y_1).

ATP, IBS and yeast treatments as they largely improved fruiting and yield of pepper plants (Table 7) and at same basis might ulter such plants to be in thermotolerance case of higher metabolical minerals requirements (Menary and Vanstaden, 1976; Nover *et al*., 1983; Burke and Orzech, 1988 and Landry *et al*., 1988). Also, ATP via its involvement in ATP / H^+-ATPase membrane pump system might improve uptake and translocation of such minerals, IBS as it somewhat inhibited vegetative growth (Table 5). It improved mineral content at basis of dilution effect (Bukovac and Witter, 1959) and yeast could be due to its mineral content (analysis of yeast preparation, Material and Methods).

Table (6): Mineral composition of pepper plants as affected by IBS, ATP and yeast during 1998 and 1999 seasons.

Treat.	1998			1999		
	P (%)	K (%)	Ca (%)	P (%)	K (%)	Ca (%)

Control	0.203 d	3.18 c	2.51 c	0.190 d	3.20 c	2.48 d
IBS	0.263 b	3.73 ab	4.96 a	0.290 a	4.00 a	5.00 a
ATP	0.290 a	3.90 a	4.98 a	0.300 a	3.96 a	4.97 a
Y_1	0.226 c	3.57 b	3.47 b	0.233 c	3.67 b	3.45 c
Y_2	0.243 bc	3.60 b	4.49 a	0.250 b	3.90 ab	4.66 b

II.3. Fruiting and yield:

Data in Table (7) indicated that all treatments ATP, IBS yeast preparation (Y_2, 50 ml/L) and Y_1 (25 ml/L) were of pronounced promotional effect upon number of flowers and fruit / plant , fruit set % and yield (kg) / plant compared with the effect of control treatment at two seasons.

Same data showed that effect of these treatments was nearly in the same order, otherwise ATP was the most superior treatment followed by IBS and Y_2 (50 ml/L), hence Y_1 and at least control one. It is also evident that there was no considerable difference in yield due to IBS and Y_2 treatments although the first one was of significant effect on number of flowers and fruits at both seasons and higher fruit set % only at second season.

Similar results about the adverse flowering, fruiting and yield responses during higher temperature stress were of Rylski and Spigelman (1982) and Wien (1990) as well as about beneficial effects and responses of ATP, IBS and yeast treatments were of Kubik and Muchalczuk (1987), Ito *et al*. (1991), Remond *et al*. (1992), Younis *et al*. (1992), Njaroge *et al*. (1998) and Thomas *et al*. (1999) (ATP); Bukovac and Witter (1959), Thomson *et al*. (1973), Rubery (1978), Malamy *et al*. (1990) and Samac and Shah (1991) (IBS); Bow *et al*. (1989), Fathy and Farid (1996) and El-Mogy *et al*. (1998) (Yeast).

Table (7): Fruiting and yield of pepper plants as affected by IBS, ATP and yeast during 1998 and 1999 seasons.

Treat.	1998				1999			
	No. of flowers / plant	No. of fruits / plant	Fruit set (%)	Yield kg / plant	No. of flowers / plant	No. of fruits / plant	Fruit set (%)	Yield kg / plant
Control	28.53e	9.40 e	32.93d	0.717c	29.10e	9.00 e	34.00e	0.728d
IBS	47.03a	23.60b	50.34b	0.936b	46.17a	25.87a	56.07b	0.910b
ATP	42.53b	25.33	59.80a	1.145a	42.70b	26.67a	62.43a	1.185a
Y_1	30.27d	11.30d	37.37c	0.763c	30.07d	11.93c	39.70d	0.786c
Y_2	37.20c	18.53c	49.80b	0.880b	38.43c	19.73b	51.40c	0.915b

Under present work condition, the resultant reduction in fruiting and yield of untreated pepper plants could be due to that the same plants did not undergo any alteration in their internal nutritional status (Table 6) and the case was true for leaf surface area and dry matter accumulation (Table 5). Thereby, they were stressed by higher temperature and were not able to set their fruits normally.

In contrary, yeast treated plants sufficiently extended their leaf surface area and accumulated higher mass of dry matter as well as raised their mineral content to some extent (Tables 5 and 6).

In addition to yeast preparation bioconstituents and hormones (see analysis of yeast preparation), all could be ensure sufficient supply of bioconstituents, growth substances and minerals into fruits. Thus, increasing yield via increasing fruit weight has been induced.

On the other hand, IBS due to its depressive effect on vegetative growth and to its considerable benefit effect on minerals content (Tables 5 and 6), might be orinted more photomertabolities and minerals into flower buds and fruits in early stage, thus, increase fruit set and increasing yield via increasing fruit number. Meanwhile, it could be observed that ATP due to its superior effect on growth and mineral content (Tables 5 and 6) and due to its reviewed fundamental roles, increased yield of pepper plants via increasing both fruit number and weight.

Finally, it could be suggested that ATP, IBS and yeast treatments considerably ultered pepper plants to be physiologically and metabolically in thermotolerance case and to be efficiently set their fruit and increased their yield under higher temperature stress condition.

Herein, it should be concluded that ATP treatment was the best one that greatly increased growth, nutrient content, fruiting and yield of pepper plants even during higher temperature in late summer season.

III. Experiment (3) Snap bean plant:

III.1. Vegetative growth:

Data in Table (8) showed the effect of IBS, ATP, Y_1 (yeast preparation of low concentration, 25 ml/L) and Y_2 (high concentration, 50 ml/L) as well as control treatment on vegetative growth of snap bean plant under natural heat stress condition (Table 1) during late summer seasons of 1998 and 1999.

From climatical data illustrated in Table (1) and from findings of Halterlein *et al*. (1980), Nikolovo and Poryazov (1990), Keeler *et al*. (1996) and Kleiner and Frett (1996), it could be suggested that snap bean plants were actually under heat stress conditions.

The noticeable reduction in most estimated growth characteristics of untreated plants relative to other treatments during two seasons (same data in Table, 8) had been coincided such suggestion, Otherwise, such results indicated that such untreated plants were stressed by higher temperature (Table 1) and they relatively had less or no own potential to tolerate this stressfull adverse effect. Since they also could not conductivelly ulter their chemical composition (chlorophyll and mineral content) (Table 9). Those which known to be physiologically and biochemically implicated in induction and responses of thermotolerance state (Menary and Vastaden, 1976; Nover *et al*., 1983; Burke and Orzech, 1988 and Landry *et al*., 1988).

On the other hand, same data revealed that all treatments were of beneficial effect on most parameters compared with control one at two seasons.

It is also evident that Y_2 (50 ml/L) treatment was considerably of the best effect followed by ATP one with little or no differences among them particularly in fresh and dry weight at both seasons. Also, no differences were detected among ATP and IBS treatments as for most parameters, except significant increment in dry weight of ATP-treated plants in both seasons. Data cleared also that no considerable differences were observed among Y_1 (25 ml/L) treatment and control one. Herein, it could be suggested that such treatments especially yeast preparation (50 ml/L) and ATP (50 ppm) considerably altered a thermo-sensitive snap bean plants towards better thermotolerance and this responses have been based on their beneficial effect on the internal nutritional status and chlorophyll content (Table 9).

So, the yeast (50 ml/L) and ATP treated plants exhibited the best behaviour in their growth even under heat stress adverse conditions. Moreover, favourable effect of yeast treatment could be tightly attributed to its stimulatory effect on cell division and enlargement and on all metabolic processes as well as its involvement in induction of thermotolerance case via its carbohydrate, protein, minerals and hormones content (GAs, IAA and cytokinins) (analysis of yeast preparation, Figs. 1a & 1b). Similar finding about the beneficial effect of yeast were obtained by Winkler (1962), Roberts (1976), Kraig and Haber (1980); Spencer *et al*. (1983), Kurtz *et al*. (1986), Weiderrecht *et al*. (1988) and Fathy and Farid (1996). Meanwhile, the beneficial effect of ATP treatment might be due to its suggested several roles and involvement in thermotolerance responses (Poovaiah, 1987; McClure *et al*., 1989; Palta, 1990; Ito *et al*., 1991; Kirsch and Beevers, 1993; Poovalah and Reddy, 1993; Jameson, 1994; Dashek, 1997 and Thomas *et al*., 1999).

III.2. Chemical composition:

Data in Table (9) indicated that all treatments considerably improved most of the studied chemical composition parameters of snap bean plants, i.e. total chlorophyll, pod dry matter content, N%, P%, K% and Ca% relative to those of control treatment during the two seasons.

Same data showed that ATP treated plant was of the highest P, K and Ca content in their leaves and dry matter content in their pods followed by yeast (Y_2, 50 ml/L) and IBS for the same parameters. It is also obvious that IBS and Y_2 treatment were of the highest chlorophyll and nitrogen content followed by ATP treatment. The data also indicated that Y_1 (yeast preparation) of low concentration (25 ml/L) was followed the above mentioned treatments. It was somewhat of beneficial effect relative to control treatment. Whilst, control plants were of the lowest chemical composition values in two seasons.

In this connection, increasing mineral as well as chlorophyll and dry matter content of ATP, yeast and IBS treated snap bean plants might be herein characterized as an internal biochemical ulterations and functions by which such plants could be counteracting the higher temperature related adverse disturbances, i.e. (limit photosynthesis, carbohydrates depleted in respiration, protein breakdown and denaturation, enzyme inactivation, nutritional and hormonal imbalances and etc.) (Leopold and Scott, 1952; Emmett and Walker, 1973; Menary and Vanstaden, 1976; Aung, 1978; Berry and Björkman, 1980 and Dubey, 1994). Such ulterations and functions to induction thermotolerance onset and responses known to be basically required sufficient and blanced ionic supply and content as well as efficient and ample biomass and dry matter synthesis and accumulation (Aung, 1978; Nover *et al*., 1983; Burke and Orzech, 1988 and Landry *et al*., 1988) were the case of such treated plants under this work condition.

In addition, yeast preparation treatments beneficial effect could be directly due to bioconstituents and hormonal content (yeast preparation analysis, Figs. 1a & 1b). ATP treatment benifical effect might be due to its known structural and regulatory roles and to its involvement in activation of mineral absorption and translocation memberane machine (ATP / H^+-ATP-ase pumps), as above reviewed. IBS beneficial effect might be partly explained based on physiological dilution resulted by the somewhat reduced growth of this treatment relative to yeast and ATP treatments (Table 8), besides to the prior reviewed IBS effects.

It is beneficial to suggest that yeast preparation in higher level (50 ml/L) was the best application to be greatly increase growth, chemical contents, fruiting and yield of snap bean during exposure to higher temperature in late summer.

III.3. Yield and its components:

Data in Table (10) revealed that all treatments were significantly increased number of pods per plant, pod average weight (gm), pods yield (gm) per plant and (ton) per fed. compared with control treatment at both seasons.

Such data indicated also that yeast preparation (Y_2) treatment (50 ml/L) was of the significant highest yield of pods per plant and per fed., followed by IBS and ATP (with no significant differences among of the two later treatments). Y_1 treatment also significantly increased yield and its components relative to control treatment but not to other ones. The significant lowest values of yield and its component were of control treatment at the two seasons. Same data cleared that the superiority of Y_2 treatment in pods yield / plant or / feddan was due to the considerable increase in number of pods more than the effect of pod average weight whereas the reverse was true for IBS beneficial effect upon yield. It is also evident that ATP beneficial effect should be due to the resultant improvement of number and average weight of pods.

Under such work conditions, superiority of yeast preparation in number of pods, yield / plant and yield / fed. could be expected since the same treatment considerably improved branching and total dry matter accumulation (Table 8) as well as improved chlorophyll, N and Ca content (Table 9). Also, could be due to the effect of its hormonal (IAA, GAs and cytokinin) content besides to other constituents (yeast analysis, Figs. 1a & 1b). Additionally to the previously discussed implication of yeast in thermotolerance induction and response.

It could be also assumed that yeast preparation via its richness in hormonal content should be of specific important role in flowering and pod or fruit set and development specially during heat stress condition. Since, it was known that pollen and ovaries development are usually associated with endogenous plant hormones those which dramatically affected by high temperature, they also associated with minerals and carbohydrates content (Iwahori, 1967; Satio and Ito, 1967; Abdalla and Verkerk, 1968; Menary and Vanstaden, 1976; Abd El-Rhman, 1977, Aung, 1978; Mahmoud, 1991 and Dubey, 1994).

Meanwhile, the clear beneficial effect of IBS upon pod average weight and yield should be herein due to that IBS to some extent reduced growth (Table 8), increased chlorophyll, N and other minerals content and in turn orinted and accumulated more dry matter into pods (Table 9). ATP also due to its promotional effect on branching, accumulation of dry matter, chlorophyll and minerals content (Tables 8 and 9) besides to the above reviewed important roles, it could be also clearly improve yield of snap bean under higher temperature stress condition (Table 1).

Similar results were obtained by Halterlein *et al*. (1980), Nikolova and Poryazov (1990), Fathy and Farid (1996), Keeler *et al*. (1996), and Kleiner and Frett (1996), as well as Thomson *et al*. (1973); Rubery (1978); Malamy *et al*. (1990) and Samac and Shah (1992); Younis *et al*. (1992); Njaroge *et al*. (1998) and Thomas *et al*. (1999) (ATP effects) and Bow *et al*. (1989), Fathy and Farid (1996) and El-Mogy *et al*. (1998) (Yeast effect).

Table (10). Pod yield and its components of snap bean plants as affected by IBS, ATP and yeast during 1998 and 1999 seasons.

Treat.	1998				1999			
	Pods No. / Plant	Pod average weight(g)	Yield (kg) plant	Yield (Ton) plant	Pods No. / plant	Pod average weight (g)	Yield (kg) plant	Yield (Ton) fed
Control	10.70e	4.45 d	47.77d	2.86 d	10.00d	4.55 d	47.73d	2.76 d
IBS	15.70e	5.34 a	83.90b	5.03 b	15.66b	5.31 a	84.99b	5.07 b
ATP	16.60b	5.02 b	83.37b	5.00 b	15.62b	5.03 b	84.02b	4.98 b
Y_1	13.50d	4.89 c	65.92c	3.95 c	13.04c	4.91 c	66.20c	3.90 c
Y_2	18.00a	4.95bc	88.91a	5.32 a	17.83a	4.99 b	88.77a	5.21a

IV. Experiment (4) Cowpea plant:

IV.1. Vegetative growth:

Table (11) illustrated that same treatments, i.e. IBS, ATP, Y_1 and Y_2 used on pepper and snap bean were also applied to cowpea plant under the same higher temperature stress condition (presented in Table 1) in late summer season of 1998 and 1999. Same data indicated that all treatments were significantly increased all vegetative growth parameters, i.e. stem length, number of leaves and shoots / plant as well as total fresh and dry weight (gm) / plant compared with those of control treatment at two seasons. The unique exception was the significant decrease in stem length of IBS plants relative to control plants at first season.

The same data revealed that the best effect on vegetative growth of cowpea plant was due to ATP followed by IBS and Y_2 treatments. Among the two later treatments IBS was the best as for total fresh and dry weight as well as number of leaves, whereas Y_2 was the best for stem length and somewhat number of shoots. Also, Y_1 treatment was to some extent of beneficial effect and at least control plants of significant heat stressed vegetative growth.

Although, it was generally known that cowpea plant exhibited more higher temperature tolerability than other vegetable crops, cowpea ATP, IBS and Y_2 treated plants were exhibited best vegetative growth reactions and responses under the same stress condition. Beneficial effect of ATP and IBS on growth of cowpea plants could be attributed to the similar improvement in P, K and Ca content by the same treatment (Table 12) those which known to be sustaine and oriented metabolical processes toward thermotolerance induction and responses as previously reported and discussed. Also, such nutrient element in sufficient level as in Table (12) for these best treatments known to be potentially implicated in improving protein and carbohydrate metabolism as well as, balancing the interrelationship among photosynthesis

and carbohydrate production from one side and respiration and carbohydrate consumption or depeltion on the other side specially during prevailing of higher temperature (Table 1).

Added to that, ATP via its several suggested roles and being a precursor for cytokinins might activate shooting and leaves number thereby dry matter accumulation, also IBS as it inhibit the apical growth activity and induce the lateral growth activity thereby might be allowed more efficient accumulation and distribution of dry matter and biomasses in different plant parts. Meanwhile, beneficial effect of yeast treatment could be due to its similar effect on nitrogen and calcium content in Table (12) those that involved in beneficial ulteration in protein, enzymes metabolism and hsps metabolism and associated to thermotolerance induction added to the advantagous of yeast preparation bioconstituents and hormonal content as in (yeast preparation analysis and Figs. 1a & 1b).

Similar findings coincided with this interpretation and results were obtained by Leopold and Scott (1952), Aung (1978), Berry and Björkman (1980), Nover *et* al. (1983), Landry *et* al. (1988) and Dubey (1994), as well as Thomson *et al*. (1973), Rubery (1978), McClure *et al*. (1989), Kirsch and Beevers (1993), Jameson (1994), Fathy and Farid (1996) and Thomas *et al*. (1999).

4.2. Mineral composition:

Data in Table (12) showed that all treatments significantly increased N, P, K and Ca content of cowpea leaves relative to control plants in both seasons. It is also evident that the distinct highest K and Ca content was of IBS plants, highest P content was of ATP one and the highest N content was of yeast preparation Y_2 (50 m/L) at two seasons.

Also, IBS and ATP had a good balanced content of other minerals. It is obvious that Y_1 (yeast pre. 25 ml/L) was of low beneficial effect on minerals content, but it was better than control treatment.

Herein, the noticeable good and balanced mineral content of IBS treated plants might be as an metabolical ulteration and requirement for more thermotolerance (Nover *et al*., 1983; Burke and Orzech, 1988 and Landry *et al*., 1988), more dry mattrer and seed yield production (Table 11 and 13), also Bukovac and Witter (1959). ATP beneficial effect on mineral content might be mainly related to its role in activation of membrane pump system (ATP / H^+-ATP-ase) and as a metabolical increasingly minerals requirement for thermotolerance processes. The obvious increase in N content of yeast treated plants could be due to its protein and N content (Yeast analysis and shady, 1978).

IV.3. Seed yield and its components:

Table (13) indicated that all treatments significantly improved number and weight (gm) of seeds / pod, number of pods / plant and seed yield (gm) / plant, (ton) / fed. relative to control one and they significantly differed among of them in most cases at two seasons. Such data also showed that IBS treatment was the most superior one since it was of the significant highest

number and weight of dry seeds / pod, seed yield (gm) / plant and seed yield (kg) / fed., although it was of relatively low number of pods / plant.

Same data showed that ATP treatment followed IBS in its number of seeds / plant and seed yield / plant and / fed. It was of the highest number of pods / plant and of low weight of seeds / pod at two seasons.

Meanwhile, Y_2 treatment followed ATP treatment in its seed yield per plant and per fed., also it was of higher number of seeds / pod and of beneficial effect on number of pods / plant and weight of seeds / pod. Data revealed also that Y_1 treatment was of low beneficial effect, and that control treatment was of the significant values.

Herein, the superior effect of IBS on cowpea yield was as a result for the considerable increase in number and weight of seeds / pod. Such case required ample mineral content, balance and translocation as well as hormonal balance and sufficient translocation of bio-assimilates into reproductive organs. IBS considerably increase K and Ca content (Table 13), K might be implicated in the increase of seed weight via its role in activation of photosynthesis and translocation of carbohydrates from leaves into pod, or seeds. Ca content known to be associated with pollen germination and pollen tube elongation (Mascarenhas and Machlis, 1964) as well as the activity of cell division in merstematic tissues (links to the increase in number of seeds).

The resultant slight reduction in growth of IBS treated plants (Table 11) could allow sufficient accumulation and translocation of dry matter and metabolites into reproductive organs. Such results could be related to findings of Bukovac and Witter (1959), Thomson *et al*. (1973), Rubery (1978) and Beermann (1998), as well as Malamy *et al*. (1990) and Samac and Shah (1991) about the role of IBS contained salicylic acid in improving fruiting and yield via its effect on gene expression activity.

It is obvious that beneficial influence of ATP upon seed yield should be mainly due to its inducable effect on number of pods as well as number of seeds / pod, whereas yeast preparation (Y_2) improved yield due to the clear increase in number of seeds / pod and somewhat to the increase in weight of seeds / pod. Added to the conductive effect of ATP on P content (Table 12), on branching and dry matter accumulation (Table 11), also yeast (Y_2) increased branching and greatly raised N content (Tables 11 & 12).

Moreover, improving seed yield of cowpea plants due to the resultant increase in number of pods / plant and number of seeds / pod (ATP) and due to the increase in number of seeds / pod (Y_2) might be closely related to the involvement of ATP and yeast treatment in gene expression ulteration, flower initiations formation, pod and seed set via the hormonal (IAA, GAs and cytokinins) content of yeast preparation (yeast analysis, Figs. 1a & 1b), as well as the hydrolytic process of ATP to AMP and CMP those which involved in gene expression ulteration and cytokinins synthesis (McClure *et al*., 1989 and Jameson, 1994).

The results were in agreement with those of Hipp and Cowly (1969), Thomson *et al*. (1973), Rubery (1978), Malamy *et al*. (1990) and Samac and Shah (1991) about the beneficial effect of IBS; Kubik and Michalczuk (1987), Ito *et al*. (1991), Remond *et al*. (1992), Younis *et al*. (1992), Njaroge *et al*. (1998) and Thomas *et al*. (1999) about beneficial effect of ATP; Bow *et al*. (1989); Fathy and Farid (1996) and El-Mogy *et al*. (1998) about yeast application.

It should be concluded that the best treatment was IBS (0.2 gm/L), 3 times spraying on cowpea plants to improve their internal minerals content (ionic status), fruiting and dry seed yield during heat stress in late summer season.

V. Relative yield (RY) of tomato, sweet pepper, snap bean and cowpea:

After previous discussion and interpretation the effects and responses to the suggested promising new treatments, with greatly emphasised on consedring internal ionic / mineral status as well as leaf surface area and dry matter accumulation as an internal physiological / metabolical basis / tools for thermotolerability or sensitivity could be expressed in term of fruit or pod setting and yielding capabilities under higher temperature stress condition .

Data in Table (14) illustrated relative yield (the yield of different treatments (per plant) as % of untreated plant yield (values 1998, 1999 and the mean). By which it could be accuratly detected the best treatment, the case of thermosensitivity and the resultant (acquired) thermotolerability.

Such data indicated that Y_1, CME, Y_2, RJ and IBS treatments increased yield of tomato by 21.5, 86.1, 93.3, 125.6 and 142.3% compared with the yield of control treatment, respectively. The best treatments of the highest relative yield (HRY) (125.6%, 142.3%) were RJ and IBS, respectively.

Concerning sweet pepper, data showed that, Y_1, Y_2, IBS and ATP treatments increased yield by 7.2, 24.1, 27.7 and 61.2% relative to yield of control, respectively, the best treatment of the HRY (61.2%) was ATP one. Same data also revealed that Y_1, ATP, IBS and Y_2 treatment were increased snap bean yield by 38.3, 75.2, 76.8 and 86.0% compared with control yield, respectively, the best treatment of HRY (86.0%) was Y_2 treatment.

Regarding cowpea, data indicated that Y_1, Y_2, ATP and IBS increased yield by 17.6, 21.0, 27.2 and 30.0% relative to yield of control one, the best treatment of HRY (30.0%) was IBS treatment.

Meanwhile, under present work condition based on comparison of HRY of different crops. It could be suggested that thermosensitivity degree should be in this order: tomato, snap bean, sweet pepper and at least cowpea from higher to lower degree. Whilest, the acquired thermotolerability by the best treatment was in reversed order.

Herein, its important to observed that thermotolerance responses (based on RY of same treatment) of tomato and pepper not coincided the commonly known that pepper more thermosensitive than tomato. This might be relatively due to that cvs Castle Rock and California wander differed in their adaptation degree along time under local condition. Whereas, snap bean, pepper and cowpea were in normal sequence under the same thermo case as affected by the same treatment (ATP).

Also, based on effect or response to ATP treatment by snap bean, pepper and cowpea, important physiological suggestations should be present in mind:-

ATP exogenous application either induce a conducive balance / ulteration among respiration the ATP generative and C skelton depleted process and photosynthesis as C skelton and energy generative process, otherwise might to some extent reduce the inducable higher respiration rate or optamize the two critical processes during higher temperature stress.

Or in thermosensitive plants as snap bean and pepper, higher temperature might reduce ATP production (via impair respiratory sites / organell and activity or respiratory enzymes and pathways, thereby increase the need and response for ATP application. The case was not the same with cowpea, less thermosensitive crop.

Finally, it could be suggested and concluded that:-

The main approach of this work is to use new promising and safely materials in low concentration and cost with higher efficiency to counteract the internal nutritional / ionic case as well as conducive extension in area of bio-assimilation surfaces and accumulation of dry matter as a mechanisms / toot for acquiring thermotolerance responses and reduced thermosensitive one. Thereby improve fruit, pod and seed set as well as yield (Y) and relative yield (RY) all as indicator for thermotolerability or sensitivity.

Different vegetable crops tomato, pepper, snap bean and cowpea differed in their morphological and internal nutritional behaviour as they were influenced by the same treatment during the same condition / season.

Under present work condition tomato cv Castel Rock could be relatively the most thermosensitive crop and the best one in its thermotolerance responses. The best treatments that greatly improved growth, nutritional state, fruiting, yield and relative yield (RY) were IBS followed by royal jelly (RJ), they increased yield by 142.3 and 125.0% (highest relative yield) above control, respectively.

Snap bean cv Branko followed tomato in its sensitivity and responses. The best treatment in its effect on growth, most chemical contents, yield and RY was yeast preparation (Y_2) (50 ml/L) with the highest relative yield (HRY) of 86.0%.

Pepper cv. California Wander followed snap bean in its sensitivity and responses. The treatment of the best effect on growth, nutritional case, fruiting, yield and Y was ATP with HRY of 61.2%.

Cowpea cv. Creem-7 was relatively the least thermosensitive crop. ATP followed by IBS was the best treatment in its effect on growth, whereas IBS followed by ATP was the best in nutritional status, fruiting, seed yield and RY with HRY of 30.0 and 27.2% for IBS and ATP, respectively.

Present work gave the possibility to own new specific techniques for:

One)Preparation of new natural stimulator/nutritive substance as yeast preparation, the rich natural source for IAA, GAs and cytokinins as well as different essential bioconstituents.

Two)Performation of iodo-benzoic, salicylic acid (IBS) as a new synthetic growth inhibitor (member of benzoic acid derivatives family).

Three)Performation of new balanced chelated micro element combination (CME).

Four)Application of ATP exogenously as a new physiological technique for its stimulatory regulatory and energy supplying benefit during stressful condition.

Five)Preparation and application of natural royal jelly as a new promising growth nutritive and stimulator substance.

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تأثير بعض المعاملات الكيميائية وتجهيز الخميرة والغذاء الملكى على بعض محاصيل الخضر المنزرعة فى العروة الصيفية المتأخرة لحفز قدرتها على تحمل الحرارة0

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أقيمت تجارب حقلية فى العروة الصيفية المتأخرة فى عامى 1998 و 1999 لدراسة الإستجابات المختلفة لنباتات الخضر : الطماطم صنف كاستل روك (التجربة الأولى) والفلفل صنف كاليفورنيا وندر (التجربة الثانية) والفاصوليا صنف برونكو (التجربة الثالثة) واللوبيا صنف كريم - 7 (التجربة الرابعة) المنزرعة فى العروة الصيفية المتأخرة لحفز التحمل الحرارى وتحسين الإثمار والمحصول0 وذلك بإستخدام معاملات تجهيز الخميرة (25 ، 50 مل/لتر) وتركيبه العناصر الصغرى المخلبية (1 مل/لتر) وأيودو بنزويك - سلسيليك أسيد (0.2 جم/لتر) والغذاء الملكى (10 جزء فى المليون) 3 مرات رش على نباتات الطماطم0 وكذلك معاملات تجهيز الخميرة (25 ، 50 مل/لتر) وأيودو - بنزويك - سلسيليك أسيد (0.2 جم/لتر) وآتبى (50 جزء فى المليون) 3 مرات رش على نباتات الفلفل والفاصوليا واللوبيا فى التجارب الأخرى0

وقد أمكن تلخيص أهم النتائج فيما يلى:-

1. إختلفت محاصيل الخضر المختلفة فى سلوكها المورفولوجى والغذائى وكذلك فى إثمارها ومحصولها بتأثير نفس المعاملة وتحت نفس الظروف0
2. فى التجربة الأولى (الطماطم) كانت معاملتى أيودو - بنزويك - سلسيليك أسيد (أى بى أس) والغذاء الملكى أفضل المعاملات فى المحتوى من العناصر الغذائية والإثمار والمحصول وكانت معاملة الغذاء الملكى (آرجى) الأفضل فى النمو0 وقد زادت معاملة أى بى أس المحصول بمقدار (142.3%) والغذاء الملكى بمقدار (125.0%) عن معاملة المقارنة0 وعلى أساس المحصول النسبى كانت الطماطم أعلى المحاصيل إستجابة لنفس المعاملة وتحت نفس ظروف الإجهاد0
3. وفى التجربة الثانية (الفلفل) تبعت نباتات الفلفل نباتات الفاصوليا فى الإستجابة لنفس المعاملة (على أساس المحصول النسبى)0 وكانت المعاملة الأفضل فى النمو والحالة الغذائية (المحتوى المعدنى) وفى الإثمار والمحصول هى الـ آ تى بى (أدينوزين تراى فوسفات) وتلك المعاملة زادت المحصول بمقدار (61.2%) على معاملة المقارنة0

4. تبعت الفاصوليا (التجربة الثالثة) الطماطم فى إستجابتها وكانت معاملة تجهيز الخميرة (50 مل/لتر) هى الأفضل فى النمو والمحتوى المعدنى والمحصول وأحدثت زيادة فى المحصول مقدارها (86.0%) عن معاملة المقارنة0
5. وكانت اللوبيا (التجربة الرابعة) هى نسبياً المحصول الأقل فى الحساسية الحرارية (على نفس الأسس)0 وكانت معاملة الـ آ تى بى متبوعة بالـ آى بى أس هى الأفضل فى النمو بينما كانت الأخيرة متبوعة بالأولى هى الأفضل فى المحتوى من العناصر الغذائية والإثمار ومحصول البذور الجافة وأعطتا زيادة فى المحصول مقدارها (30.0%) ، (27.2%) على التوالى بالنسبة لمعاملة المقارنة0
6. يسمح البحث الحالى بإمتلاك تقنيات نوعية جديدة ومواد نمو وإثمار واعدة مثل تجهيز الخميرة الغنى فى محتواه من الأوكسينات والجبريللينات والسيتوكينينات وعديد من المكونات الحيوية الضرورية ، وآ ى بى أس كمثبط نمو تخليقى جديد له فوائد كبيرة خاصه أثناء ظروف الإجهاد وتركيبة جديدة متوازنة من العناصر الصغرى المخلوبة وتقنية متخصصة جديدة فى إنتاجها.
7. إستخدام مثل هذه المواد الجديدة بنجاح على محاصيل خضر مختلفة فى عروة حرجة لحفز القدرة على التحمل الحرارى ولزيادة الإثمار والمحصول بدرجة ملموسة0

Table (8). Vegetative growth of snap bean as affected by IBS, ATP and yeast during 1998 and 1999 seasons.

Treat.	1989					1999				
	Stem length (cm)	No. of leaves / plant	No. of shoots / plant	Total fresh weight (gm) / plant	Total dry weight (gm) / plant	Stem length (cm)	No. of leaves / plant	No. of shoots / plant	Total fresh weight (gm) / plant	Total dry weight (gm) / plant
Control	25.0 b	27.30 c	5.0 c	108.7 b	18.0 b	24.0 b	27.0 e	5.6 b	103.3 b	17.6 c
IBS	30.0 ab	34.0 bc	8.3 ab	132.0 ab	24.7 b	29.3 ab	34.3 c	7.3 ab	147.2 a	26.6 b
ATP	32.33 a	40.3 ab	8.0 ab	156.0 a	33.7 a	32.4 a	39.0 b	8.7 a	154.4 a	36.7 a
Y_1	31.0 a	29.0 c	7.5 b	118.0 b	23.6 b	31.0 a	31.0 d	8.3 a	121.3 b	20.0 c
Y_2	33.34 a	43.0 a	8.6 a	165.0 a	38.7 a	33.0 a	43.3 a	9.0 a	161.0 a	39.0 a

Means within the same column having different superscripts significantly different.

Table (9). Chemical composition of snap bean as affected by IBS, ATP and yeast during 1998 and 1999 seasons.

Treat.	1989						1999					
	Total Chlorophyll	D.M. content of pods (%)	N (%)	P (%)	K (%)	Ca (%)	Total chlorophyll	D.M. content of pods (%)	N (%)	P (%)	K (%)	Ca (%)
Control	31.90b	10.82c	2.80 d	0.132d	1.80 d	1.23 c	31.4 c	10.3 c	2.88 d	0.130d	1.75 d	1.41 c
IBS	46.97a	12.10b	4.80 a	0.300b	3.05 b	2.14ab	49.0 a	12.5 a	4.76 a	0.310b	3.13 a	2.20 b
ATP	42.10a	13.30a	4.34 b	0.350a	3.21 a	2.35 a	42.4 b	13.1 a	4.50 b	0.350a	3.21 a	2.40 a
Y_1	43.9 a	10.76c	3.70 c	0.257c	2.59 c	1.72bc	42.8 b	10.6bc	3.70 c	0.243c	2.53 c	2.10 b
Y_2	44.9 a	10.99c	4.65 a	0.310b	3.02 b	2.18 a	43.6 b	11.4 b	4.70ab	0.320b	3.02 b	2.20 b

Means within the same column having different superscripts significantly different.

Table (11). Vegetative growth of cowpea as affected by IBS, ATP and yeast during 1998 and 1999 seasons.

	1989					1999				
Treat.	**Stem length (cm)**	**No. of leaves / plant**	**No. of shoots / plant**	**Total fresh weight (gm) / plant**	**Total dry weight (gm) / plant**	**Stem length (cm)**	**No. of leaves / plant**	**No. of shoots / plant**	**Total fresh weight (gm) / plant**	**Total dry weight (gm) / plant**
Control	60.40 b	25.67 d	7.60 d	441.8 d	59.67 e	60.30 b	25.67 d	6.30 c	462.6 c	60.90 e
IBS	57.50 c	32.67 ab	11.00bc	610.4 ab	83.70 b	57.73 b	32.00 b	11.30 ab	632.7 a	83.20 b
ATP	76.50 a	34.33 a	13.00 a	623.7 a	87.87 a	73.43 a	34.00 a	13.00 a	642.0 a	87.60 a
Y_1	74.23 a	30.33 c	10.30 c	583.5 c	75.47 d	74.97 a	29.33 c	10.3 b	602.0 b	75.80 d
Y_2	74.57 a	31.33 bc	11.66 b	597.7 b	80.38 c	75.07 a	29.68 c	12.70 ab	610.2 b	81.30 c

Means within the same column having different superscripts significantly different.

Table (12). Mineral composition of cowpea as affected by IBS, ATP and yeast during 1998 and 1999 seasons.

Treat.	1989				1999			
	N (%)	**P (%)**	**K (%)**	**Ca (%)**	**N (%)**	**P (%)**	**K (%)**	**Ca (%)**
Control	3.65 c	0.264 d	2.80 d	1.62 c	3.63 c	0.262 d	3.48 c	1.68 c
IBS	4.18 b	0.454 b	4.41 a	2.32 a	4.12 b	0.450 b	4.47 a	2.32 a
ATP	4.07 b	0.497 a	4.18 b	2.02 b	3.95 b	0.500 a	4.23 ab	2.05 b
Y_1	3.75 c	0.387 c	3.76 c	1.99 b	3.53 c	0.398 c	3.80 bc	2.01 b
Y_2	4.62 a	0.404 c	3.88 c	2.05 b	4.53 a	0.403 c	3.87 abc	2.09 b

Means within the same column having different superscripts significantly different.

Table (13). Seed yield and its components of cowpea as affected by IBS, ATP and yeast during 1998 and 1999 seasons.

	1989					1999				
Treat.	Seeds No. / Pod	Seeds weight (gm) / pod	Pods No. / plant	Seed yield (gm) / plant	Seed yield (kg) / fed.	Seeds No. / pod	Seeds weight (gm) / pod	Pods No. / plant	Seed yield (gm) / plant	Seed yield (kg) / fed.
Control	10.73 c	1.21 e	39.7 d	48.20 d	1060 d	10.6 c	1.20 e	40.63 d	48.89 e	1076 e
IBS	13.03 a	1.45 a	44.0 b	63.97 a	1407 a	13.1 a	1.44 a	43.27 c	62.30 a	1371 a
ATP	11.77 b	1.36 c	45.8 a	62.50 b	1374 b	11.8 b	1.34 c	45.60 a	61.1 b	1344 b
Y_1	11.50 b	1.30 d	41.1 c	57.50 c	1266 c	11.3 b	1.31 d	40.90 d	56.70 d	1247 d
Y_2	12.80 a	1.40 b	44.5 b	58.70 c	1292 c	12.6 a	1.38 b	44.50 b	58.40 c	1285 c

Means within the same column having different superscripts significantly different.

Table (14). Relative yield (RY) of treatments as % of control treatment yield (yield / plant) for tomato, pepper, snap bean and cowpea plants under higher temperature natural stress condition (late summer season) of 1998 and 1999.

Treat.	Tomato			Pepper			Snap bean			Cowpea		
	1998	1999	Mean	1998	1999	Mean	1998	1999	Mean	1998	1999	Mean
Control	100	100	100	100	100	100	100	100	100	100	100	100
IBS	237.7	246.9	242.3	130.5	125.0	127.7	175.6	178.1	176.8	132.7	127.4	130.0
ATP	--	--	--	159.7	162.8	161.2	174.5	176.0	175.2	129.6	124.9	127.2
Y_1	117.4	125.7	121.5	106.4	108.0	107.2	138.0	138.7	138.3	119.3	115.9	117.6
Y_2	189.8	196.9	193.3	122.7	125.6	124.15	186.1	186.0	186.0	121.8	119.4	121.0
RJ	228.9	222.3	225.6	--	--	--	--	--	--	--	--	--
CME	186.2	186.1	186.1	--	--	--	--	--	--	--	--	--

Means within the same column having different superscripts significantly different.