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# Physiological Studies on Growth and Productivity of Tomato Grown in Sandy Soil under Low Temperature Conditions.

**Zakher, A. G. and M. A. M. Elashry.**
**Vegetables Res. Dept., Horticulture Res. Inst., Agricultural Res. Center, Giza, Egypt.**

## ABSTRACT

Two field experiments were carried out at private farm Amoun Agricultural Society, AL-tal El Kabier, Ismailia Governorate, Egypt during the two successive winter seasons of 2013/2014 and 2014/2015 to study effect of using some anti-cold stressors or anti-oxidants compounds on minimizing cold injury on tomato plants grown in sandy soil under drip irrigation system. The compounds used were Phosphor X, Pepton 85/16 , Amcoton, Calcium citrate, Zinc citrate , Potassium citrate , Potassin-F, Ascopen comparing with the untreated control. These compounds applied as foliar spray on the vegetative growth four times starting at the beginning of flowering stage and repeated every 10 days.The obtained results showed that, all compounds used in these study induced positive effect on reducing cold injury of the low temperature during the growing season, i,e October , November , December , January months comparing with the control . The superior treatments in this regard were the foliar spray with Phosphor X, Pepton 85/16, Amcoton while, the other treatments showed medium effects. Phosphor X, Pepton then Amcoton registered the high values in cold tolerance, i.e., induced higher degrees of minimizing chilling injury, while the lowest value of minimizing chilling injure was obtained from the control. In addition, the same favorable treatments i,.e : the foliar spray with Phosphor X, or Pepton then Amcoton showed excellent influence on the vegetative growth, fruit setting, fruit yield and its quality of tomato plants grown in winter season under sandy soil .So it can be recommend that spraying tomato plant during the winter months by some anti-cold stress treatments such as Phosphor X, or Pepton then Amcoton respectively for the purpose of minimizing chilling injury and enhancing the vegetative growth and giving high fruit yield with best quality.

**keywords:** Tomato, Foliar spray, cold stress compounds- cold tolaerance, fruit yield and its quality,

## INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is one of the most important vegetable crops in Egypt and the other world countries for fresh consumption, industry processing and exportation. Increasing the production and enhancing the quality of tomato fruits are very important objective to meet the higher human population demand. Furthermore, it is well known that, a serious reduction in tomato production, in Egypt, was occurring yearly as a result of the unfavorable low temperature prevailing during the periods of October, November, December and January. It is obvious that, the late autumn and winter tomato plantation, the plants expose to low temperature which, the cold stress led to obvious injury causing reduction on plant growth and its development, poor flowering, low fruit set, and substantial reduction in fruit yield. The injury degree depending on the intensity and duration of exposure to the chilling temperatures, in addition photosynthesis, respiration, membrane integrity, water relations and the hormone balance of the plants may be affected (Graham and Patterson, 1982). With the continuous of lowering the temperature to the lowest degree, the plants may die (Brüggeman et al., 1992 and Van Der Ploeg and Heuvelink, 2005). Sen Gupta et al. 1993 reported that cold stress in plants has been found to be associated with the increase in antioxidant enzyme expression. Abd El-Latif, 1995 and Hafez, 2001 on tomato plants reported that application of amino acids improved plant growth and production under cold stress conditions. Lopez and Satti, 1996 studied the effect of potassium fertilization as KNO3 on tomato plants grown under greenhouse conditions. They found that both leaf fresh weight and its number were increased with increasing K level. Hewedy, et al., 1998 on their studies of foliar spray effect by using some stimulators on tomato growing under plastic tunnel and open field in the winter season, found that Greenton (1.2% 1-Naphthyl acetamide and 0.45 % 1-Naphthyl acetic acid) or Tomaset (20% N mata – tolylphthalamic acid) increased plant growth, chlorophyll leaf content, fruit set% total yield, fruit weight and size. It was found that some simulative compounds used by Darwesh and Bhnan, 2012 showed obvious increment in early and total fruit yield as well as enhanced physical fruit quality and its contents. Mckersie et al., 1996 demonstrated that all environmental stresses such as heat, cold, light, salt and etc., can induce additional serious internal physiological stresses. This internally inducible stress known as oxidative one, the internally generated reactive oxygen species (ROS), those were the main factor beyond all the heat and other stresses related disturbances. Also, it was stated that oxygen stress tolerance considered as an important factor for stresses tolerance. Fathy et al., 2003 studied the effect of some antioxidants as foliar spray under temperature stresses and found that all applied antioxidants were actively enhanced the internal metabolically protective status by their direct scavenging functions against the toxic free radicals (induced by stress) or due to their promotional effect on synthesis of natural protective antioxidants, i.e., phenols and carotenoids as well as its induce potent biosynthesis case due to the higher photosynthetic pigments content (protection of chlorophyll's and chloroplasts against stress degradation and senescence effects), thereby higher carbohydrates are accumulated. Higher minerals (N, P, and K) content also are increased. The strong positive correlations of such constituents vs. growth and fruit yield confirmed and coincident such functions and the roles of antioxidants. The tolerance to biotic stresses is very complex at the whole plant and cellular levels (Foolad et al., 2003; Ashraf and Harris, 2004; and Grewal 2010). This is in part due to the complexity of interactions between stress factors and various molecular, biochemical and physiological phenomena affecting plant growth and development, (Zhu, J. K.

2002). Kowalczyk and Zielony, 2008 reported that the amino acids known as a superior bio-stimulant which has positive effects on plant growth yield and significantly mitigates on the injuries caused by biotic stress.

The aim of this study was to determine the effects of some nutrition materials, as well as some anti- cold stresses compounds and enhancing fruit setting compounds i.e., Phosphor X, Amcoton, Pepton 85/16, Calcium citrate, Zinc citrate, Potassium citrate, Ascopen and Potassin-F on reducing chilling injury on tomato and in addition the effect of such compounds were evaluated as plant growth, fruit setting , fruit yield and its quality of tomato plants grown in winter season under drip irrigation system in sandy soil.

## MATERIALS AND METHODS

Two field experiments were carried out at Amoun Agricultural Society (private farm) at Al-Tal El-Kabier (76 km from Cairo), Cairo-Ismailia desert road, Ismailia Governorate, Egypt during the two successive winter seasons of 2013/2014 and 2014/2015 to study the effect of some treatments acting as anti-stressors or anti-oxidants on vegetative growth, flowering, fruit quality and yield of tomato. Seeds of tomato cv. NSXTY9535F$_1$ hybrid (produced by Namdhary seeds co. India) were sown in the nursery on 5$^{th}$ and 10$^{th}$ of September, respectively and the seedlings were transplanted in the open field at 10$^{th}$ and 15$^{th}$ of October of 2013/2014 and 2014/2015, respectively based on 40 cm apart between the seedlings in one side of the ridges. Each experimental plot consisted of four ridges each was 1.25 m in width and 5.0 m in length with an area about 25.0 m$^2$, where three ridges were planted and the fourth one was left without planting as empty gap between the plots. Drip irrigation system was used for irrigate the plants with equal amount of water and fertigation system was used according to fertilizer recommended program of tomato plants under sandy soil. The horticultural practices were applied in tomato management as usual. The farm soil type was sandy soil and Table 1 shows the mechanical and chemical analyses of the experimental soil.

**Table 1. Some physical and chemical properties of the experimental soil profile of cultivated area before cultivation.**

| Physical properties | | | | | |
|---|---|---|---|---|---|
| Sand % | | Clay% | | Silt% | Texture |
| 88.92 | | 6.08 | | 5.00 | Sandy |
| **Chemical properties** | | | | | |
| **Ca** | **Mg** | **Na** | **K** | **HCO$_3$** | **Cl** |
| meq/l | | | | | |
| 1.0 | 0.4 | 0.76 | 0.31 | 1.01 | 0.51 |

**Field environmental conditions:**

The meteorological data for the experimental area obtained from Central Laboratory for Agricultural Climate (CLAC), Agricultural Research Center (ARC),the values were calculated and expressed as monthly interval means during the two growing seasons as shown in Table 2.

**Table 2. Meteorological data of Ismailia governorate region during the winter seasons of 2013-2014 and 2014-2015.**

| Months | Min temperature $^oC$ 2013/2014 Min. | 2014/2015 Min. |
|---|---|---|
| Oct. | 10.5 | 10.2 |
| Nov. | 8.5 | 9.8 |
| Dec. | 8.0 | 9.5 |
| Jan. | 5.5 | 5.4 |
| Feb. | 5.5 | 7.1 |

**The experimental treatments:**

The experiment included foliar applications of some anti-cold stress as well as some anti oxidant treatments, as shown in Table 3.The plants were sprayed 4 times with different assigned treatments per season. The first spray started at the beginning of flowering stage and repeated every 10 days to reach four times.

**Table 3. Composition and Concentrations of the anti-stressor treatments used in the study during winter seasons of 2013/2014 and 2014/2015.**

| The compounds name | Composition | The concentrations used in the exp. |
|---|---|---|
| Phosphor X | P$_2$o$_5$, 30% + N, 4.5% + Copper, 2.5% + polyethylene glycol, 5% | 0.75 cm$^3$/liter |
| Amcoton | Naphthyl acetic acid, 0.45% + Naphthyl acetamid, 1.25% + Other additives, 98.30%. | 0.6 g/ liter |
| Pepton 85/16 | Organic nitrogen, 12% + potassium oxide, 3.5% + Amino Acids Contained+ P$_2$O$_5$, 3% | 0.5 g/ liter |
| Calcium citrate | Calcium 20%. | 3.0 cm$^3$/L |
| Zinc citrate | Zinc, 12% | 3.0 cm$^3$/L |
| Potassium citrate | Potassium oxide, 30%. | 3.0 cm$^3$/L |
| Ascopen | Organic acids, 38% + incentive materials for growth of 62%. | 1g/L |
| Potassin-F | Potassium oxide, 30% + Pent oxide phosphorus, 8%. | 3.0 cm$^3$/L |
| Control | Tap water | Tap water |

**Data recorded:**

The following data were recorded during the two growing seasons:

**I-The degree of Chilling Injury (CI) Symptoms:**

In tomato plants, chilling injury manifested as intensity of leaf purpling, therefore, CI was scored according to external skin purpling as; minor damage effect (1-25% purpling lesion, PL); hard damage effect (>25% PL) and Healthy plants (no symptom). The severity of PL was calculated according to Mirdehghan and Ghotbi, 2014 by the following formula:

$$\textbf{CI index (\%)} = \frac{\textbf{No. of plants at the PL level/plot}}{\textbf{total No. of plants in the treatment/plot}} \times 100$$

**Vegetative growth characteristics**:

At the beginning of fruiting stage (65– 70 days) after transplanting, five plants were randomly chosen from each plot for recording the vegetative growth parameters (plant height (cm), number of branches and both number and weight (g) of leaves/plant).

**Chemical constitutes in tomato leaves:**

At the beginning of fruiting stage (65– 70 days) after transplanting, the leaves number 4, 5 from the top of the plants were collected and total chlorophyll was determined using portable chlorophyll reader SPAD-502 (Konica-Minolta, Osaka, Japan), measuring absorbance at 650 nm, as a non-destructive method. Three readings were taken on each leaf and the results were expressed in SPAD units (Monje and Bugbee, 1992). Potassium (K) % was measured in the leaves by using of flame photometer, Cari-Zeiss model, according to the method described by Horneck and Hanson (1998). Also, Phosphorus (P) % was photometrically determined using the molybdate-vanadate method according to Jackson (1973).

**Flowering parameters:**

1. **Flowering date:** Number of days from transplanting till 50% flowering per plot.
2. **Fruit setting percentage:** Four plants were chosen randomly from each plot and average fruit set of the clusters number 3 and 4 on the main stem was calculated according to the formula:

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

**Fruit yield parameters:**

In the suitable maturing and ripening stage i.e., marketing stage, fruits from the whole plants of each plot were harvested for recording the early yield (expressed as weight of the first three pickings ) and the total yield (weight of the all pickings) as kg/ plot, then were summated and calculated as ton/ fed. Average fruit fresh weight (g) was determined theoretically by dividing total fruits weight on the total fruits number.

**Fruits quality characteristics:**

A random sample of five fruits per plot was used for measuring fruit length and diameter, the measurements were recorded at the same stage from the harvesting in mid-season and the averages were calculated. Fruit firmness was measured using a needle type pocked penetro-meter. In fruit juice, the percentage of Total Soluble Solids (TSS) was determined by a hand refractometer according to the methods mentioned in the (A.O.A.C.1990).

**Statistical analysis:-**

Data for the analytical determinations were subjected to analysis of variance (ANOVA) as a simple experiment in a complete randomize block design. LSD method was used to compare between of treatment means according to Snedecor and Cochran (1989).

## RESULTS AND DISCUSSION

**I-The degree of Chilling Injury (CI) Symptoms:**

In tomato plants grown under winter season were affected by chilling injury which was manifested as purple color in the leaves with different percentage according to the cold degree and the applied treatments. The highest chilling injury was observed under the control followed by Zinc citrate and Calcium citrate treatments in descending order , on the contrary, the lowest effect (favorable effect) was obtained by using PhosphorX and Pepton 85/16 in the both studied seasons as shown in (Table 4).

**Table 4. Influence of using some anti-stress compounds on chilling injury percentage of tomato plants grown in winter season of 2013/2014 and 2014/2015.**

| Treatments | 1st Season | | | | 2nd Season | | | |
|---|---|---|---|---|---|---|---|---|
| | Healthy plants % | damage effect % | | | Healthy plants % | damage effect % | | |
| | | minor | hard | total | | minor | hard | total |
| 1-PhosphorX® | 90 | 10 | 0 | 10 | 90 | 5 | 5 | 10 |
| 2-Amcoton® | 85 | 10 | 5 | 15 | 85 | 10 | 5 | 15 |
| 3-Pepton 85/16® | 90 | 5 | 5 | 10 | 90 | 0 | 10 | 10 |
| 4-Calcium citrate | 45 | 20 | 35 | 55 | 40 | 25 | 35 | 55 |
| 5-Zinc citrate | 40 | 20 | 40 | 60 | 40 | 20 | 40 | 60 |
| 6-Potassium citrate | 70 | 15 | 15 | 30 | 75 | 15 | 10 | 25 |
| 7-Ascopen® | 55 | 20 | 25 | 45 | 55 | 15 | 30 | 45 |
| 8-Potassin-F® | 60 | 20 | 20 | 40 | 65 | 15 | 20 | 35 |
| 9-Control | 35 | 25 | 40 | 65 | 35 | 25 | 40 | 65 |

These results are in agreement with those of Ding *et. al.*(2001) they reported that this treatments reduced chilling injury. The effect of both PhosphorX and Pepton treatments on alleviating chilling injury during cold months may be attributed to its ability to induce the accumulation of heat shock protein and antioxidant systems (Wang *et. al.,* 2006 and Evans *et. al.,* 1991). The data also, show that the treated plants with Amcoton, Potassium citrate and Potassin-F showed significant lower percentage of chilling injury index compared with the control. These results are consider of great interests because at the primary and mid stages of vegetative growth, the applied treatments inducing great simulative effects and thus affect the chilling injury index. This would positively affect and prolong subsequent stages including flowering, fruit setting and finally on fruit yield as well as fruits quality (Abd El-Basir, 2013). This stimulation caused increment of leaves fresh weight as well as increases of number either branches or leaves as it will be mentioned later. Several researchers reported that, under different stresses, it can be using foliar application with anti-stressor to induce stimulation on vegetative growth and produce high yield with acceptable quality (Goss, 1973; Apel and Hirt, 2004; Abd El–Monem, 2007; Abdel Aziz *et al.*, 2010; Abo Sedera et al., 2010 and Boras et al., 2011). With regards to citric acid several investigators confirmed the activity of anti oxidant for cold injury relief (Noctor and Foyer, 1998; Fathy *et al.*, 2003). Again, a brief discussion for amino acids and polyethylene glycol as one of the main content in some anti-stressors; the positive effect of amino acids on growth was stated by Goss (1973) who indicated that amino acids can be served as a source of carbon and energy under the condition of carbohydrates deficiency in the plants releasing the ammonia and organic acid from which the amino acid was originally formed. The organic acids then enter Kerbs cycle, to be broken down to release energy through respiration. Thon *et al.*,1981 pointed out that amino acids provide plant cells with an immediately available source of nitrogen, which generally can be taken by the cells more rapidly than inorganic nitrogen. The ameliorative effect of amino acids might be linked to the observable increase in photosynthetic pigments as well as, leaf number. Consequently, the efficiency of the photosynthetic apparatus was increased due to amino acid treatments, which in turn considerably increased the biosynthesis of osmotic solutes. Therefore, Amino acids can directly or indirectly affect the physiological activities of the plant. The regulatory effect of amino acids on growth could be explained on the basic that some amino acids can affect plant growth and development through their influence on gibberellins biosynthesis (Walter and Nawacke, 1978). On the other hand, the protective role of Phosphor X on tomato plants can be related to the role of Polyethylene glycol (one of the main phosphor X components) in osmotic adjustment where it acts as non-toxic cytoplasm osmolyte. Polyethylene glycol is known to play role in process of osmotic adjustment in many crops. The main role is probably due to protect plant cells against stress by preserving the osmotic balance, stabilizing the structure of key protein such as Rubisco, protecting the photosynthetic apparatus and functioning as oxygen free radical scavenger agent (Heuer, 2003 and Abd El-Basir, 2013).

**Vegetative growth characteristics**:

Data in Table 5 show that all applied anti-stressors treatments induced significant superior effect than the control in their effect on the all studied growth parameters of tomato plants in the both winter seasons except of calcium citrate and zinc citrate on plant height and only zinc citrate also on number of leaves/plant in the 1st season. The most effective treatment was Phosphor X followed by Pepton for the all vegetative growth parameters in the two studied seasons. The least treatment was the control. Data also show that other treatments (Amcoton, Potassium citrate, Potassin-F, Ascopen, Calcium citrate and Zinc citrate) improved vegetative growth parameters of tomato plants in descending order towards the control without significant values among them, in some cases, but with significant differences compared with the control in both seasons. Similar results were recorded by Agwah and Mahmoud, 1994; Bose and Tripothi, 1996; Lopez and Satti (1996); Belakbir *et al*., 1998; Sharma *et al*., 1998; Hewedy, 2000; Darwesh *et al*., 2007 and Darwesh and Bhnan, 2012. Meanwhile these effects of PhosphorX and Pepton 85/16 could be expected, since it's had similar superior effect, which its increased photo-synthetic pigments; absorption and accumulation of macro- and micro-elements in plant tissues; high levels of phyto-hormones; high levels of bio-constituents content of leaves; in addition increase enzymes activity as mentioned by (Abd El-Basir, 2013). Accordingly, the all previous activities were reflected on tomato growth, fruit set, yield and fruits quality parameters.

**Table 5. Influence of using some anti- stress compounds on vegetative growth characteristics of tomato in winter seasons of 2013/2014 and 2014/2015.**

| Treatments | Plant height (cm) | | Number of branches /Plant | | leaves/Plant | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Number | | weight (gm) | |
| | 1st Season | 2nd Season | 1st Season | 2nd Season | 1st Season | 2nd Season | 1st Season | 2nd Season |
| 1-PhosphorX® | 73.33 | 64.00 | 11.00 | 10.00 | 78.00 | 66.67 | 200.33 | 172.00 |
| 2-Amcoton® | 70.00 | 59.33 | 8.67 | 7.67 | 54.33 | 47.33 | 105.00 | 93.33 |
| 3-Pepton 85/16® | 71.00 | 61.00 | 9.67 | 9.00 | 63.67 | 56.33 | 114.83 | 100.00 |
| 4-Calcium citrate | 52.00 | 50.33 | 6.00 | 5.33 | 31.67 | 34.00 | 65.63 | 70.33 |
| 5-Zinc citrate | 51.33 | 50.67 | 5.33 | 5.00 | 29.00 | 31.67 | 49.90 | 54.33 |
| 6-Potassium citrate | 63.33 | 56.33 | 7.33 | 6.67 | 44.00 | 45.00 | 99.33 | 102.00 |
| 7-Ascopen® | 54.67 | 50.67 | 6.33 | 5.67 | 34.00 | 35.67 | 72.63 | 76.33 |
| 8-Potassin-F® | 58.33 | 53.33 | 6.67 | 6.33 | 39.00 | 40.00 | 90.63 | 92.67 |
| 9-Control | 50.33 | 47.33 | 4.00 | 3.67 | 25.33 | 28.00 | 36.80 | 40.33 |
| L. S. D. at 0.05 | 3.387 | 2.75 | 1.154 | 0.881 | 3.977 | 2.411 | 8.512 | 9.067 |

**Chemical constitutes in tomato leaves:**

The effect of anti-stressor foliar applications on some mineral contents,. i.e $K_2O$, $P_2O_5$ and total chlorophyll are shown in Table 6.The results indicated that the all applied anti-stressors treatments led to greater effect on Phosphorus, Potassium and total Chlorophyll contents than the control treatment in both seasons. The most superior treatments were PhosphorX followed by Pepton (with non significant values between them in most cases) and the least one was the untreated plants at the both seasons. The illustrated data show that the other treatments showed beneficial effect as its improved growth, photosynthetic pigments content of tomato towards control with less or no significant differences among them in most cases but had significant values comparing with the control. These results are consider very important because it play an positive role on enhancing effect chlorophyll and mineral content as showing in table 6 corresponding with the production and distribution of dry mater in tomato plant organs. It obvious from the results that the control plants were greatly stressed. This might be due to either poor synthetic capacity or degradation of chlorophyll as a result of stress effects (Van Breusegem *et al*., 2001, Larkindale and Knight, 20012 and Abd El-Basir, 2013). This interpretation from the present results is confirmed by the findings of Belakbir *et al*., 1998; Hewedy *et al*., 1998; Hussein *et al*., 2000, Darwesh *et al*., 2007 and El-Zeiny, 2007. Abo Sedera *et al*., 2010, They revealed that spraying several vegetable plants with amino acids (Pepton) at 0.5 and 1.0 g l-1 significantly increased total nitrogen, phosphorus and potassium in plant foliage compared with the control treatment.

**Table 6. Influence of foliar spray with some anti-stressors compounds on Phosphorus (%), Potassium (%) and chlorophyll contents in tomato plants grown in winter seasons of 2013/2014 and 2014/2015**

| Treatments | Phosphorus(%) 1st Season | Phosphorus(%) 2nd Season | Potassium (%) 1st Season | Potassium (%) 2nd Season | Total Chlorophyll (SPAD unit) 1st Season | Total Chlorophyll (SPAD unit) 2nd Season |
|---|---|---|---|---|---|---|
| 1-PhosphorX® | 0.735 | 0.795 | 3.23 | 3.28 | 49.93 | 47.5 |
| 2-Amcoton® | 0.716 | 0.717 | 3.09 | 3.05 | 43.23 | 41.03 |
| 3-Pepton 85/16® | 0.733 | 0.753 | 3.12 | 3.17 | 47.87 | 45.57 |
| 4-Calcium citrate | 0.513 | 0.520 | 2.55 | 2.57 | 37.83 | 35.87 |
| 5-Zinc citrate | 0.513 | 0.523 | 2.53 | 2.55 | 36.9 | 35.1 |
| 6-Potassium citrate | 0.592 | 0.585 | 2.85 | 2.75 | 41.17 | 39.2 |
| 7-Ascopen® | 0.546 | 0.543 | 2.68 | 2.62 | 39.27 | 37.5 |
| 8-Potassin-F® | 0.622 | 0.630 | 2.77 | 2.78 | 38.67 | 37.03 |
| 9-Control | 0.450 | 0.457 | 2.40 | 2.38 | 34.4 | 32.4 |
| L. S. D. at 0.05 | 0.016 | 0.01 | 0.110 | 0.097 | 2.145 | 2.376 |

**Flowering parameters:**

The parameters used for measuring flowering behavior of tomato plants in this study included the number of days from transplanting till (25-50%) flowering and fruit setting percentage in the two seasons under cold stress conditions and the role of the used treatments. The results presented in Table 7, clearly revealed that using Phosphor X, Pepton and Ascopen treatments as foliar spray significantly decreased the number of days from transplanting until (25-50%) flowering than untreated ones in the both seasons, while applied Amcoton and Calcium citrate treatments significantly decreased number of days till (25-50%) flowering in the second season only. The most effective treatment in this respect was Phosphor X and Pepton (which gave the lowest period from transplanting to flowering); these days of earliness could be followed by rapid development of setted fruits thereby, and that is meaning producing earl yield. It is obvious also from table 7 that, spraying tomato plant, with Phosphor X, Pepton followed by Amcoton led to high significant values of fruit setting % that is mean highest fruit yield. Earliness of yielded fruits in tomato plant as well as highest fruit setting % consider great benefit, because that will suit early marketing of such fruits and increment in the total fruit yield (Abd El-Basir, 2013).

**Table 7. Influence of foliar spray with some anti-stressors compounds on flowering and fruit yield parameters of tomato in winter seasons of 2013/2014 and 2014/2015.**

| Treatments | Flowering date 1st Season | Flowering date 2nd Season | Fruit setting% 1st Season | Fruit setting% 2nd Season | Fruit weight(g) 1st Season | Fruit weight(g) 2nd Season | yield(tons/ Fed) Early 1st Season | yield(tons/ Fed) Early 2nd Season | yield(tons/ Fed) Total 1st Season | yield(tons/ Fed) Total 2nd Season |
|---|---|---|---|---|---|---|---|---|---|---|
| 1-PhosphorX® | 38.7 | 38.3 | 85.0 | 84.63 | 100.0 | 91.0 | 6.63 | 5.72 | 23.30 | 20.08 |
| 2-Amcoton® | 41.0 | 41.7 | 77.63 | 76.2 | 82.0 | 77.3 | 6.26 | 5.06 | 22.00 | 17.81 |
| 3-Pepton 85/16® | 38.3 | 38.3 | 85.0 | 80.1 | 100.0 | 90,0 | 6.43 | 5.41 | 22.63 | 19.09 |
| 4-Calcium citrate | 41.3 | 41.7 | 43.33 | 40 | 71.7 | 65.3 | 3.28 | 3.19 | 11.55 | 10.72 |
| 5-Zinc citrate | 43.3 | 48.3 | 40.0 | 38.67 | 67.7 | 61.0 | 2.92 | 2.65 | 10.17 | 9.12 |
| 6-Potassium citrate | 42.3 | 46.7 | 72.3 | 66.83 | 94.3 | 84.0 | 5.09 | 4.50 | 17.83 | 15.78 |
| 7-Ascopen® | 39.3 | 41.7 | 66.27 | 60.17 | 82.3 | 70.7 | 3.99 | 3.59 | 14.02 | 12.63 |
| 8-Potassin-F® | 43.0 | 46.7 | 67.3 | 64.7 | 82.3 | 73.7 | 4.33 | 4.18 | 15.30 | 14.83 |
| 9-Control | 42.0 | 48.7 | 34.63 | 30.53 | 62.3 | 56.0 | 2.51 | 2.12 | 8.90 | 7.49 |
| L.S. D. at 0.05 | 1.56 | 5.86 | 3.76 | 4.701 | 5.69 | 7.61 | 0.107 | 0.299 | 0.365 | 0.952 |

**Fruit yield parameters:**

The parameters used for measuring fruit yield of tomato plants in this study included average fruit weight, early yield and total yield. The data presented in Table 7 clearly show that all applied anti-stressors treatments significantly increased both early and total yield. On the other hand, the all applied anti-stressors treatments significantly increased fruit weight except zinc citrate treatment which gave insignificant values but shows increase compared with the control. It could be noticed that, Phosphor X gave the highest values of the all fruit yield parameters followed by Pepton with non significant differences between them under fruit weight character in both seasons. The other treatments (Amcoton, Potassium citrate, Potassin F, Ascopen, Calcium citrate and Zinc citrate) improve both early and total yield of tomato comparing with the control and the all of them showed significant differences with the control in the both seasons. Abo Sedera *et al.*, 2010 revealed that spraying strawberry plants with amino acids (Pepton) at 0.5 and 1.0 g l-1 significantly increased total yield, weight, TSS of fruits compared with control treatment. On the contrary, the control plants exhibited significant lowest values for the all studied traits, this is to far extent, proved that these plants were greatly affected in severe and harmful way during their reproductive stage by the prevailing temperature (Bita and Gerats, 2013) and its probable inducible oxidative stress. Similar results were obtained by Khayat *et al*., 1985; De Koning, 1989; Adams *et al*., 2001; Zhang *et al*., 2003; Awad and El-Ghamry, 2007, El-Zeiny, 2007 and Darwesh and Bhnan, 2012.

**Fruits quality characteristics:**

The results presented in Table 8 clearly indicated that the all foliar applications using anti-stressors treatments were superior for the all traits under this study comparing with the untreated plans (control). The data illustrated that the most effective treatment which maintained the highest values of the studied parameters were Phosphor X followed by both of Amcoton and Pepton with non significant differences between them, also, data showed that, the treatments ,i.e.: Calcium citrate, Potassium citrate, Potassin-F, Ascopen and Zinc citrate, respectively had beneficial effects on both fruit length and fruit diameter of tomato in descending order towards the control with less values or non significant differences among them in the most cases. On the other hand, such data indicate that total soluble solids (TSS) was greatly increased with adding Phosphor X, Amcoton and Pepton in both seasons as well as most applied anti-stressors treatments during only the winter season of 2014/2015 compared with the control. Increasing such constituent in tomato fruits had been very important and revealed the simulative effect of these treatments to enhance the internal metabolically protective status by their direct scavenging functions against the toxic free radicals (Galal, 1984; Buchner *et al*., 1998; Hewedy *et al*., 1998; Kovtun *et al*., 2000 and Abd El-Basir, 2013).

**Table 8. Influence of foliar spray with some anti-stressors compounds on fruits quality characteristics of tomato in winter seasons of 2013/2014 and 2014/2015**

| Treatments | Fruit Length (cm) | | Fruit Diameter (cm) | | Fruit firmness ($Kg/cm^2$) | | T.S.S % | |
|---|---|---|---|---|---|---|---|---|
| | 1st Season | 2nd Season | 1st Season | 2nd Season | 1st Season | 2nd Season | 1st Season | 2nd Season |
| 1-PhosphorX® | 4.73 | 4.67 | 5.17 | 4.97 | 2.67 | 2.68 | 5.67 | 5.81 |
| 2-Amcoton® | 4.53 | 4.47 | 5.00 | 4.80 | 2.50 | 2.48 | 5.33 | 5.3 |
| 3-Pepton 85/16® | 4.43 | 4.33 | 4.80 | 4.77 | 2.47 | 2.48 | 5.17 | 5.1 |
| 4-Calcium citrate | 4.40 | 4.30 | 4.73 | 4.67 | 2.28 | 2.25 | 4.73 | 4.83 |
| 5-Zinc citrate | 3.80 | 3.87 | 4.17 | 4.07 | 2.23 | 2.18 | 4.7 | 4.47 |
| 6-Potassium citrate | 4.27 | 4.17 | 4.57 | 4.50 | 2.33 | 2.25 | 4.47 | 4.6 |
| 7-Ascopen® | 3.97 | 4.00 | 4.37 | 4.33 | 2.32 | 2.32 | 4.47 | 4.4 |
| 8-Potassin-F® | 4.07 | 4.10 | 4.50 | 4.43 | 2.42 | 2.35 | 4.47 | 4.3 |
| 9-Control | 3.83 | 3.77 | 4.10 | 4.00 | 2.15 | 2.07 | 4.47 | 4.17 |
| L. S. D. at 0.05 | 0.144 | 0.127 | 0.125 | 0.139 | 0.085 | 0.072 | 0.267 | 0.216 |

## CONCLUSION

It is obvious from the obtained data and discussing the results, that spraying tomato plants "NSXTY9535 $F_1$ hybrid" grown in sandy soil during the winter season under drip irrigation system with Phosphor X (0.75 $cm^3/L$), Pepton (0.5 gm/L) and Amcoton (0.6 gm/L) 4 times during the growth season starting at the beginning of flowering stage and repeated its every 10 days gave high cold tolerant against the low temperature with (90%),(90%) and (85%) respectively comparing with the control (35%) and balanced vegetative growth and produced high total yield21.7, 20.9 and 19.9 ton/Fed respectively comparing with control which gave 8.1 ton/ Fed., the values were average of the tow seasons with acceptable quality under the unfavorable low temperature prevailing during the period (October, November, December and January) in AL-tal El Kabier, Ismailia Governorate .

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## دراسات فسيولوجيه على نمو وانتاجية الطماطم المنزرعه فى الاراضى الرمليه تحت ظروف درجة الحراره المنخفضه .

**الفونس جريس زاخر و مشهور على العشرى**
**اقسام بحوث الخضر – معهد بحوث البساتين – مركز البحوث الزراعيه – مصر**

أجريت تجربه حقلية في مزرعة خاصة بجمعية امون الزراعية في التل الكبير - محافظة الإسماعيلية-مصر بالعروه الشتويه لموسمى ٢٠١٤/٢٠١٣ و ٢٠١٥/٢٠١٤ لدراسه تأثير استخدام بعض المركبات التى تعمل كمضادات للاكسده والاجهادات الحراريه على تقليل(او خفض ) اضرار البروده والحراره المنخفضه على نباتات الطماطم المنزرعه بالاراضى الرمليه تحت ظروف +الرى بالتنقيط . وهذه المركبات هى فسفور اكس ،وماده البيتون ١٦/٨٥ ، امكوتون ، سترات الكالسيوم، سترات الزنك ،سترات البوتاسيوم ،بوتاسين ف و الاسكوبين بالاضافه الى الكنترول (بدون معامله) واستخدمت هذه المركبات رشا على المجموع الخضرى ٤ مرات بالموسم مع بداية مرحلة التزهير وتكرار ذلك كل ١٠ ايام .واظهرت النتائج ان المعاملات المستخدمه لها تأثير كبير فى خفض الضرر الناتج عن انخفاض درجات الحراره على نباتات الطماطم وسجلت معاملتى الرش بمركب فسفور اكس و البيبتون اعلى القيم فى نقص الضرر الناتج عن الحراره المنخفضه وكانت اقل القيم هى معاملة الكنترول –كما اعطت نفس المعاملات نمو خضرى متزن وانتاج محصول مرتفع من الثمار بجوده ومواصفات جيده تحت ظروف الحراره المنخفضه والتى تكون غالبا سائده خلال اشهر الشتاء ( اكتوبر و نوفمبر وديسمبر وينـاير ). وعليه يمكن تحت ظروف زراعة الطماطم بالعروه الشتوى واحتمال تأثرها الشديد بانخفاض درجة الحراره اجراء الرش الورقى ببعض المركبات الهامه التى تقلل هذا الضرر بدرجه معنويه مع الحصول على نمو متزن ومحصول مرتفع بمواصفات جيده وكان افضل هذه المركبات مركب الفسفور اكس و مركب البيبتون كذلك منظم النمو ومحسن العقد امكوتون .