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# Induced Resistance for Controlling Tomato Fruit Rots by using Safe Chemicals

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**Different** pre-harvest treatments of tomato fruits, *i.e.* Ethiphon, Bion, potasium phosphate monobasic, potasium phosphate dibasic and indole butyric acid (IBA), were evaluated for their capability to control tomato fruit rots under naturally infection and/or artificially inoculation with *Alternaria alternata*, *Botrytis cinerea* during storage for 6 weeks throughout the two successive seasons of 2010 and 2011. All pre-harvest treatments protect tomato fruits during cold storage 10$^{o}$C for 6 weeks during the two seasons. Ethiphon treatment at their three concentrations showed the higher efficacy in reducing tomatoes fruits rot which inoculated under artificial infection with *B. cinerea, A. alternata* and naturally infection followed by Bion treatments. There was positive relationship between increasing the concentration of pre-harvest treatments and their effect on reducing of tomatoes fruits rots during cold storage periods whether under artificial inoculated or under naturally infected during the two seasons 2010 and 2011. All treatments stimulate enzymes activities (chitinase and *B*-1.3-gluconase). The highest enzymes activities were obtained with Ethiphon followed by Bion compared to other treatments. Data also clearly show that, all treatment performance to enhancing the quality of tomato fruits during cold storage periods by enhancing fruits colour, increase of vitamin C contents and decrease the percentage of losses in tomato fruits fresh weight whether under artificial inoculated or under naturally infection during the two seasons 2010 and 2011.

**Keywords**: *Alternaria alternata*, Bion, *Botrytis cinerea*, Ethiphon, fruit rots, IBA, $K_2HPO_4$, $KH_2PO_4$, pre-harvest and tomato.

Tomato (*Lycopersicon esculentum* Mill.) is one of the most economic vegetable crops in Egypt for local consumption and exportation purposes. Fruit rots are important post-harvest diseases of tomato that occur during harvesting and/or improper storage and marketing conditions. Under inappropriate conditions fruits are subjected to be attacked by several microorganisms such as *Alternaria alternata*, *Botrytis cinerea*, *Aspergillus niger* and *Fusarium* spp. that have been found associated with tomato fruit rots. (Ragab *et al.,* 2001 and Zhao *et al*., 2007).

Fungicidal applications cause hazards to human health and increase environmental pollution. Therefore, alternatives, eco-friendly approaches for control of plant diseases are needed such as induced resistance (Abd-El-Kareem, 2007; Rojo *et al.,* 2007 and Mandal *et al.,* 2009).

Various chemicals have been discovered that seem to act at various points of the defence. Some compounds, *e.g.* benzo 1,2,3-thiodiazole-7-carbothioic–methlye ester (Bion), Ethylene (ET), indole butyric acid (IBA), $K_2HPO_4$ and $KH_2PO_4$ have been shown to induce resistance in plants (Mosa, 2002; Chowdhury, 2003; Mahmoud *et al.,* 2006 and Hussien, 2011). Inducer of systemic resistance sensitizes the plant to respond rapid after infection. These responses include phytoalexin accumulation, phenols, lignifications and activation of many enzymes such as peroxidase, polyphenoloxidase and chitinase (Kuc, 1982; Metraux and Boller, 1986; Boller, 1991; Meena *et al.*, 2001; Mahmoud *et al.,* 2006 and Hussien, 2011).

In this respect, Bion (BTH) enhanced activities of the defence related enzymes chitinase, $\beta$-1,3-gluconase and peroxidase moreover it associated with increases in activities of many classes of pathogenesis-related protein (Abou-Taleb, 2001 and Mosa, 2002).While, many investigations stated that mono and di-basic potassium phosphate ($KH_2PO_4$ and $K_2HPO_4$ have been shown to induce resistance in plants by increase synthesis of host metabolites such as phytoalexins and their production could be induced by many chemicals and increase of enzymes activities and total phenols (Nighat *et al.,* 2011).

Auxins such as IAA (indole acetic acid), IBA (indole butyric acid) and NAA (1-naphthaleneacetic acid) is a potential antifungal that have strongly inhibited mycelium growth, sporulation, and spore germination and sclerotial formation of *Fusarium* spp., *M. phaseolina* and *Sclerotium rolfsii* moreover it showed appreciable increase in the total phenol, calcium and increase the activity of chatechol oxidase compared to untreated plants. The activity of pectolytic enzyme was significantly reduced (Khalil, 2002; Chowdhury, 2003; Khalifa, 2003 and Hussien, 2011).

The gaseous plant hormone ethylene regulates developmental processes and is involved in interactions between the plant and its environment for example; ethylene is involved in seed germination, growth of roots and shoots, xylem differentiation, formation of storage organs such as tubers and bulbs, flower development, fruits ripening, and senescence. Ethylene production is increased upon exposure to abiotic and biotic stresses, including extreme temperatures, drought, anaerobic conditions, wounding, herbivory, and infection by viral, bacterial, and fungal pathogens (Abeles *et al.,* 1992 and Bart *et al.,* 2002).

The present studies have been conducted to investigate the effectiveness of such environmentally safe chemicals for control of tested tomato fruit rots.

## Materials and Methods

*1. Fungal pathogen:*

Pathogenic isolates of *A. alternata* and *B. cinerea* were isolated early from infected tomato fruits and used for all experiments in this study.

*2. Pre-harvest treatments:*

Different concentrations of Ethiphon (2-chloro-ethyl-phosphate), *i.e.* 0.1, 0.2 and 0.4%, as well as Bion (benzo 1,2,3-thiodiazole-7-carbothioic–methlye ester), potasium phosphate monobasic ($K_2HPO_4$) and potasium phosphate dibasic

($KH_2PO_4$) at concentration of 2, 4, and 8 mM as well as indole butyric acid (IBA) at concentration of 25, 50 and 100 ppm, were evaluated for their antifungal effects under field conditions, throughout the two successive seasons 2010 and 2011. Seedlings were dipped in each tested concentration for 3-5 min before planting then sprayed two times for 15 days interval after planting. This experiment was carried out at Sears Elli an in Minofiya Governorate.

*3. Post harvest treatments and inoculation with A. alternata and B. Cinerea:*

Fresh tomato fruits cv. Casel rook apparently free of physical damage and diseases were used in this experiment. Fruits were surface sterilized with sodium hypochlorite (3%) and washed several times with sterilized water. The effect tomato fruits in the naturally decayed (uninoculated) fruits as well as the artificially inoculated fruits with *A. alternata* and *B. cinerea*.

The inoculation was carried out by fungal growth disks (3mm), inserted onto fruits injured. After 24 hours, the inoculated fruits were treated in the given treatments.

Each treatment contained three replicates, each of ten fruits. Then, packed in carton bags, inoculated and non-inoculated (natural infection) tomato fruits incubated at $10^{O}$C and 90-95% RH for 6 weeks

All treated fruits as well as the untreated (uninoculated and inoculated by the fungus) were stored for 6 weeks at $10^{O}$C and 90-95% RH. The stored tomato fruits were examined weekly for detection of decay symptoms of the fungal pathogen.

*4. Diseases assessment:*

Percentage of infection (%) and disease severity for symptoms of *A. alternata* and *B. cinerea* were determined after 6 weeks. Disease severity was calculated using formula adopted by Hanounik (1986).

*5. Determination of enzyme activities:*

Samples were taken after 15 days of treatment, one gram of fruits tissue was homogenized with 0.2M Tris HCL buffer (pH 7.8) containing 14 mM of $\beta$-mercaptoethanol at the rate of 1/3 (w/v). The homogenate was centrifuged at 300 rpm for 15 min, the supernatant was used to determine enzyme activities (Tuzun *et al.,* 1989).

The method of Abeles and Forrence (1970) was used to determine *B*-1.3-glucanase and assayed using a spectrophotometer at 500 nm $\beta$-1.3-glucanase activity expressed as mM glucose equivalent released/gram fresh weight/ 60 min. While, chitinase activity was determined according to Monreal and Reese, 1969 assayed using a spectrophotometer at 540 nm. Chitinase activity expressed as mM N-acetyl glucose amine equivalent released/gram fresh weight/ 60 min.

*6. Tomato fruits quality measurements:*

The tomato fruits quality parameters, *i.e.* LW, Vitamin C and colour, were determined 5 weeks storage for inoculated and no inoculated fruits.

*6.1. Loss in weight (LW):*

Losses in tomato fruits fresh weight (%) were estimated in the inoculated and non inoculated tomato fruits for all treatments (average weight of 40 fruits for each treatment) according to the following formula:

$$LW (\%) = \frac{\text{Initial weight - weight of tomato at sampling date}}{\text{Initial weight of tomato fruits.}} \times 100$$

*6.2. Vitamin C (ascorbic acid):*

Extracts from tomato fruits were obtained by blending tissues in blender for 5 minutes containing oxalic acid 6% equivalent to the tissues (v/w). The tissues were strained through several layers of cheesecloth. The liquid fraction was then centrifuged for 5 min and the filtrate was used to determine ascorbic acid. Twenty ml of filtrate was brought to volume 100 ml of oxalic acid 3% and titrated with stain (10 mg of vitamin C in 250 ml of oxalic acid 3%) until pink colour. Amount of ascorbic acid was calculated according to the following formula, (Anonymous, 1951).

$$\text{Ascorbic acid with milligrams} = \frac{V \times C \times D}{\text{Weight of sample with gram}} \times 100$$

Whereas: V= volume of stain, C= concentration of stain and D= dilutions of sample.

*6.3. Colour:*

Fruits colour was scored as follows: + = Green, ++ = Green trace with red and +++ = Red.

*7. Statistical analysis:*

The data were statistically analyzed by analysis of variance (ANOVA) using the Statistical Analysis System (SAS Institute, inc, 1996). Means were separation by least significant difference (L.S.D.) Test at $P \leq 0.05$ level.

## Results

*1. Effect of certain pre-harvest treatments on tomato fruit rots during storage period:*

These experiments were carried out to evaluate the efficiency of some pre-harvest treatments, Ethiphon, Bion, $K_2HPO_4$, $KH_2PO_4$ and IBA against tomatoes fruits rots under artificial and natural inoculation.

*1.1. Under artificial inoculation:*

Data presented in Tables (1 and 2) show that, there was a significant effect of all pre-harvest treatments at their tested concentrations in reducing of tomatoes rots disease severity during seasons 2010 and 2011. Ethiphon treatments followed by Bion were the most effective treatments in reducing disease severity and recorded the highest efficacy compared to other treatments during the two seasons. in this respect Ethiphon at 0.4% was the best treatment in reducing of tomatoes fruits rots which inoculated under artificial infection with *B. cinerea* or *A. alternata* while, treatment with $KH_2PO_4$ at 2 mM followed by $K_2HPO_4$ at 2 mM recorded the highest disease severity during seasons 2010 and 2011 compared to other treatments.

**Table 1. Disease severity (D.S %) and efficacy (Eff %) of certain pre-harvest treatments for controlling tomato rots caused by *A. alternata* and *B. cinerea* during cold storage at 10°C and 90% R.H. for 6 weeks (season 2010)**

| Treatment | Conc. | *A. alternata* | | *B. cinerea* | |
|---|---|---|---|---|---|
| | | D.S | Eff | D.S | Eff |
| Ethiphon | 0.1% | 0.0 | 100 | 5.55 | 94.01 |
| | 0.2% | 0.0 | 100 | 0.0 | 100 |
| | 0.4% | 0.0 | 100 | 0.0 | 100 |
| Bion | 2 mM | 2.77 | 96.60 | 12.04 | 86.99 |
| | 4 mM | 1.85 | 97.73 | 10.18 | 89.01 |
| | 8 mM | 0.93 | 98.86 | 4.63 | 94.99 |
| IBA | 25 ppm | 9.25 | 88.65 | 22.22 | 76.00 |
| | 50 ppm | 5.55 | 93.19 | 11.11 | 88.00 |
| | 100 ppm | 3.70 | 95.46 | 5.55 | 94.01 |
| $K_2HPO_4$ | 2 mM | 14.81 | 81.82 | 33.33 | 64.00 |
| | 4 mM | 12.04 | 85.22 | 20.31 | 77.99 |
| | 8mM | 10.18 | 87.51 | 9.25 | 90.01 |
| $KH_2PO_4$ | 2 mM | 16.66 | 79.48 | 40.74 | 55.99 |
| | 4 mM | 13.88 | 82.89 | 32.40 | 65.01 |
| | 8 mM | 11.11 | 86.35 | 28.70 | 69.00 |
| Control | | 81.48 | 0.0 | 92.59 | 0.0 |
| L.S.D. at 05% for: Treatments (T) | | 1.118 | 0.008 | 1.372 | 0.038 |
| Concentrations (C) | | 0.732 | 0.005 | 0.898 | 0.025 |
| T x C | | 1.939 | 0.014 | 2.378 | 0.066 |

Data also showed relationship between increasing the concentration of treatments and their effect on reducing of disease severity during seasons 2010 and 2011.

*1.2. Under natural infection:*

Data presented in Table (3) show that all pre harvest treatments significantly decreased decay development on naturally infected tomato fruits during cold storage. Ethiphon at the three concentrations were the most effective treatments to control tomato fruits rots on naturally infection. While $KH_2PO_4$ at the three concentrations give the lowest effect in reducing tomato fruits rots during seasons 2010 and 2011.

**Table 2. Disease severity (D.S %) and efficacy (Eff %) of certain pre-harvest treatments for controlling tomato rots caused by *A. alternata* and *B. cinerea* during cold storage at 10$^{o}$C and 90% R.H. for 6 weeks (season 2011)**

| Treatment | Conc. | *A. alternata* | | *B. cinerea* | |
|---|---|---|---|---|---|
| | | D.S | Eff | D.S | Eff |
| Ethiphon | 0.1% | 3.70 | 95.55 | 6.79 | 92.89 |
| | 0.2% | 0.0 | 100 | 1.85 | 98.05 |
| | 0.4% | 0.0 | 100 | 0.0 | 100 |
| Bion | 2 mM | 3.70 | 95.55 | 13.88 | 85.39 |
| | 4 mM | 2.77 | 96.68 | 11.11 | 88.31 |
| | 8 mM | 1.85 | 97.77 | 5.55 | 94.16 |
| IBA | 25 ppm | 10.18 | 87.78 | 19.44 | 79.54 |
| | 50 ppm | 5.55 | 93.33 | 12.04 | 87.32 |
| | 100 ppm | 4.63 | 94.44 | 8.31 | 91.25 |
| $K_2HPO_4$ | 2 mM | 13.88 | 83.34 | 32.40 | 65.89 |
| | 4 mM | 12.96 | 84.44 | 18.52 | 80.51 |
| | 8mM | 11.11 | 86.66 | 11.11 | 88.31 |
| $KH_2PO_4$ | 2 mM | 18.05 | 78.34 | 43.52 | 54.19 |
| | 4 mM | 15.27 | 81.67 | 41.53 | 56.26 |
| | 8 mM | 12.50 | 84.99 | 30.50 | 67.89 |
| Control | | 83.32 | 0.0 | 95.0 | 0.0 |
| L.S.D. at 05% for: | | | | | |
| Treatments (T) | | 0.594 | 0.001 | 0.737 | 0.018 |
| Concentrations ( C ) | | 0.389 | 0.001 | 0.482 | 0.016 |
| T x C | | 1.030 | 0.002 | 1.278 | 0.036 |

Data also indicated that there were positive relationship between increasing the concentration of pre harvest treatments and their effect on reducing of tomato fruits rots on naturally infection during cold storage.

2. *Effect of certain pre-harvest treatments on the activity of chitinase and $\beta$-1.3-gluconase enzymes:*

Results in Table (4) indicate that, all treatment stimulated enzymes activity. The highest activity was obtained with Ethiphon followed by Bion and $K_2HPO_4$ compared to other treatments.

**Table 3. Disease infection (In%) and Efficacy (Eff %) of certain pre-harvest treatments for controlling tomato rots on natural infection during cold storage at 10$^{o}$C and 90% R.H. for 6 weeks (seasons 2010 and 2011)**

| Treatment | Conc. | Season2010 | | Season2011 | |
|---|---|---|---|---|---|
| | | In % | Eff | In % | Eff |
| Ethiphon | 0.1% | 3.7 | 96.81 | 2.70 | 97.3 |
| | 0.2% | 0.0 | 100 | 0.0 | 100 |
| | 0.4% | 0.0 | 100 | 0.0 | 100 |
| Bion | 2 mM | 7.40 | 92.31 | 11.11 | 88.89 |
| | 4 mM | 7.40 | 92.31 | 5.55 | 94.95 |
| | 8 mM | 3.7 | 96.81 | 3.70 | 96.3 |
| IBA | 25 ppm | 11.11 | 88.46 | 13.88 | 86.12 |
| | 50 ppm | 7.4 | 92.31 | 9.25 | 90.75 |
| | 100 ppm | 3.7 | 96.81 | 5.55 | 94.45 |
| $K_2HPO_4$ | 2 mM | 16.66 | 82.70 | 13.88 | 86.12 |
| | 4 mM | 11.11 | 88.46 | 12.96 | 87.04 |
| | 8mM | 3.7 | 96.81 | 4.63 | 95.37 |
| $KH_2PO_4$ | 2 mM | 18.51 | 80.78 | 17.59 | 82.41 |
| | 4 mM | 14.81 | 84.62 | 12.04 | 87.96 |
| | 8 mM | 11.11 | 88.46 | 10.18 | 89.82 |
| Control | | 96.29 | 0.0 | 100 | 0.0 |
| L.S.D. at 05% for: | | | | | |
| | Treatments (T) | 0.682 | 0.017 | 0.708 | 0.021 |
| | Concentrations ( C ) | 0.447 | 0.013 | 0.464 | 0.019 |
| | T x C | 1.183 | 0.033 | 1.228 | 0.044 |

**Table 4. Chitinase and *B*-1.3-glucanase activities in tomato fruits as affected by different pre-harvest treatments during the two seasons 2010 and 2011**

| Treatment | Conc. | Chitinase | | $\beta$-1.3-glucanase | |
|---|---|---|---|---|---|
| | | 2010 | 2011 | 2010 | 2011 |
| Ethiphon | 0.1% | 1.3 | 1.1 | 3.9 | 3.5 |
| | 0.2% | 1.7 | 1.5 | 4.6 | 4.1 |
| | 0.4% | 2.0 | 1.8 | 5.4 | 4.8 |
| Bion | 2 mM | 1.4 | 1.1 | 3.8 | 3.4 |
| | 4 mM | 1.9 | 1.3 | 4.4 | 3.9 |
| | 8 mM | 2.2 | 1.6 | 4.8 | 4.3 |
| IBA | 25 ppm | 1.1 | 0.9 | 2.3 | 2.0 |
| | 50 ppm | 1.3 | 1.1 | 2.7 | 2.4 |
| | 100 ppm | 1.7 | 1.4 | 2.8 | 2.5 |
| $K_2HPO_4$ | 2 mM | 1.2 | 1.0 | 3.6 | 3.2 |
| | 4 mM | 1.5 | 1.1 | 3.9 | 3.5 |
| | 8mM | 1.9 | 1.6 | 4.6 | 4.1 |
| $KH_2PO_4$ | 2 mM | 1.0 | 0.4 | 2.2 | 1.9 |
| | 4 mM | 1.3 | 0.9 | 2.6 | 2.3 |
| | 8 mM | 1.6 | 1.1 | 2.8 | 2.5 |
| Control | | 0.8 | 0.6 | 2.1 | 1.9 |

* Chitinase activity expressed as mM N-acetyl glucose amine equivalent released/gram fresh weight/ 60 min.

** $\beta$-1.3-glucanase activity expressed as mM glucose equivalent released/gram fresh weight/ 60 min.

Meanwhile, $KH_2PO_4$ treatments give the lowest activity. All treatments stimulate $\beta$-1.3-gluconase activity than chitinase and their ability to increase activity of enzymes increasing with increase their concentrations during seasons 2010 and 2011.

*2. Effect of some pre-harvest treatments on the quality of tomatoes fruits:*

*2.1. Colour and content of vitamin C:*

Data in Tables (5 and 6) state that, pre harvest treatments led to enhancing of fruits colour during storage periods Ethiphon treatment recorded the highest effect in fruits colour followed by Bion treatment during seasons 2010 and 2011. Increase of treatment concentrations led to increase of their effect on fruits colour. Data also show that, all treatment performance to increase of vitamin C content in tomatoes fruits which increase with increasing of their concentration. In this respect Ethiphon treatment recorded the highest vitamin C content followed by Bion treatment during seasons 2010 and 2011.

**Table 5. Effect of certain pre-harvest treatments on colour and content of vitamin C for tomatoes fruits infected with *A. alternata*, (A), *B. cinerea* (B) and naturally infected (N) during season 2010**

| Treatment | Conc. | Colour * | | | V.C. | | |
|---|---|---|---|---|---|---|---|
| | | A | B | N | A | B | N |
| Ethiphon | 0.1% | +++ | +++ | +++ | 0.4 | 0.6 | 0.5 |
| | 0.2% | +++ | +++ | +++ | 0.5 | 0.7 | 0.5 |
| | 0.4% | +++ | +++ | +++ | 0.7 | 0.7 | 0.6 |
| Bion | 2 mM | +++ | ++ | +++ | 0.5 | 0.5 | 0.3 |
| | 4 mM | +++ | +++ | +++ | 0.6 | 0.6 | 0.4 |
| | 8 mM | +++ | +++ | +++ | 0.6 | 0.7 | 0.5 |
| IBA | 25 ppm | ++ | ++ | +++ | 0.5 | 0.3 | 0.1 |
| | 50 ppm | ++ | +++ | +++ | 0.6 | 0.5 | 0.1 |
| | 100 ppm | +++ | +++ | +++ | 0.6 | 0.6 | 0.1 |
| $K_2HPO_4$ | 2 mM | + | ++ | +++ | 0.2 | 3.0 | 0.2 |
| | 4 mM | ++ | +++ | +++ | 0.3 | 5.0 | 0.4 |
| | 8mM | ++ | +++ | +++ | 0.5 | 7.0 | 0.4 |
| $KH_2PO_4$ | 2 mM | ++ | ++ | +++ | 0.4 | 2.0 | 0.2 |
| | 4 mM | ++ | +++ | +++ | 0.4 | 3.0 | 0.2 |
| | 8 mM | ++ | +++ | +++ | 0.5 | 5.0 | 0.4 |
| Control | | + | ++ | ++ | 0.3 | 0.2 | 0.1 |

* (+)= Green, (++)= Green trace with red and (+++)= Red.

**Table 6. Effect of certain pre-harvest treatments on colour and content of vitamin C for tomatoes fruits infected with *A. alternata*, (A), *B. cinerea* (B) and naturally infected (N) during season 2011**

| Treatment | Conc. | Colour * | | | V.C. | | |
|---|---|---|---|---|---|---|---|
| | | A | B | N | A | B | N |
| Ethiphon | 0.1% | ++ | ++ | +++ | 0.3 | 0.5 | 0.4 |
| | 0.2% | +++ | +++ | +++ | 0.4 | 0.5 | 0.4 |
| | 0.4% | +++ | +++ | +++ | 0.5 | 0.5 | 0.5 |
| Bion | 2 mM | ++ | ++ | ++ | 0.4 | 0.5 | 0.4 |
| | 4 mM | ++ | ++ | +++ | 0.3 | 0.4 | 0.3 |
| | 8 mM | +++ | +++ | +++ | 0.3 | 0.4 | 0.2 |
| IBA | 25 ppm | ++ | ++ | ++ | 0.4 | 0.5 | 0.2 |
| | 50 ppm | ++ | ++ | +++ | 0.4 | 0.4 | 0.1 |
| | 100 ppm | ++ | +++ | +++ | 0.3 | 0.2 | 0.1 |
| $K_2HPO_4$ | 2 mM | + | ++ | ++ | 0.2 | 2.3 | 0.2 |
| | 4 mM | ++ | ++ | +++ | 0.2 | 3.9 | 0.3 |
| | 8mM | ++ | +++ | +++ | 0.3 | 5.5 | 0.3 |
| $KH_2PO_4$ | 2 mM | ++ | ++ | ++ | 0.3 | 1.6 | 0.2 |
| | 4 mM | ++ | +++ | +++ | 0.3 | 2.3 | 0.2 |
| | 8 mM | +++ | +++ | +++ | 0.4 | 3.9 | 0.3 |
| Control | | + | + | ++ | 0.2 | 0.2 | 0.1 |

* As described in footnote of Table (5).

*2.2. Percentage of losses in tomato fruits fresh weight:*

Results in Tables (7 and 8) illustrated that, all treatments showed decrease of the percentage of losses in tomato fruits fresh weight during storage periods whether under artificial inoculated or under natural infection. In this respect IBA treatments followed by $K_2HPO_4$ treatments were the most effect. Data also indicate that, there were positive relationship between increasing the concentration of pre harvest treatments and their effect on reducing of losses in tomato fruits fresh weight during seasons 2010 and 2011.

**Table 7. Effect of certain pre-harvest treatments on percentage of losses in fresh weight of tomato fruits infected with *A. alternata*, *B. cinerea* and naturally infection during season 2010**

| Treatment | Conc. | Fruits weight lossess (%) | | | | | |
|---|---|---|---|---|---|---|---|
| | | *A. alternata* | | *B. cinerea* | | naturally infection | |
| | | Storage (weeks) | | | | | |
| | | 3 | 6 | 3 | 6 | 3 | 6 |
| Ethiphon | 0.1% | 4.3 | 6.4 | 6.0 | 8.5 | 3.0 | 5.0 |
| | 0.2% | 3.3 | 5.2 | 4.1 | 6.2 | 2.0 | 4.0 |
| | 0.4% | 2.1 | 4.0 | 3.0 | 5.1 | 1.0 | 2.0 |
| Bion | 2 mM | 4.9 | 5.9 | 5.7 | 7.0 | 4.0 | 8.0 |
| | 4 mM | 1.6 | 3.0 | 3.2 | 4.9 | 2.0 | 6.0 |
| | 8 mM | 1.5 | 2.9 | 2.4 | 3.7 | 1.0 | 4.0 |
| IBA | 25 ppm | 3.4 | 5.3 | 4.8 | 7.2 | 2.0 | 4.0 |
| | 50 ppm | 2.0 | 4.0 | 3.1 | 5.0 | 0.9 | 3.0 |
| | 100 ppm | 1.5 | 3.0 | 2.7 | 4.0 | 0.8 | 2.0 |
| $K_2HPO_4$ | 2 mM | 6.6 | 8.5 | 7.2 | 9.3 | 5.0 | 7.0 |
| | 4 mM | 2.7 | 4.9 | 3.5 | 5.1 | 1.0 | 3.0 |
| | 8mM | 1.6 | 3.5 | 2.4 | 4.4 | 0.5 | 1.0 |
| $KH_2PO_4$ | 2 mM | 5.5 | 7.0 | 6.4 | 8.1 | 4.0 | 6.0 |
| | 4 mM | 3.9 | 5.6 | 4.2 | 6.1 | 2.0 | 4.0 |
| | 8 mM | 1.8 | 3.6 | 2.9 | 4.9 | 1.0 | 2.0 |
| Control | | 22.7 | 27.5 | 23.4 | 28.2 | 16.5 | 32.9 |

**Table 8. Effect of certain pre-harvest treatments on percentage of losses in fresh weight of tomato fruits infected with *A. alternata*, *B. cinerea* and naturally infection during season 2011**

| Treatment | Conc. | Fruits weight lossess (%) | | | | | |
|---|---|---|---|---|---|---|---|
| | | *A. alternata* | | *B. cinerea* | | naturally infection | |
| | | Storage (weeks) | | | | | |
| | | 3 | 6 | 3 | 6 | 3 | 6 |
| Ethiphon | 0.1% | 4.9 | 7.3 | 6.8 | 9.7 | 3.4 | 5.7 |
| | 0.2% | 3.8 | 5.9 | 4.7 | 7.0 | 2.3 | 4.5 |
| | 0.4% | 2.4 | 4.5 | 3.4 | 5.8 | 1.1 | 2.3 |
| Bion | 2 mM | 5.6 | 6.7 | 6.5 | 8.0 | 4.5 | 9.1 |
| | 4 mM | 1.7 | 3.4 | 3.6 | 5.6 | 2.3 | 6.8 |
| | 8 mM | 1.5 | 3.3 | 2.7 | 4.2 | 1.1 | 4.5 |
| IBA | 25 ppm | 3.9 | 6.0 | 5.5 | 8.2 | 2.3 | 4.5 |
| | 50 ppm | 2.3 | 4.5 | 3.5 | 5.7 | 1.0 | 3.4 |
| | 100 ppm | 1.7 | 3.4 | 3.1 | 4.5 | 0.9 | 2.3 |
| $K_2HPO_4$ | 2 mM | 7.5 | 9.7 | 8.2 | 10.6 | 5.7 | 8.0 |
| | 4 mM | 3.1 | 5.6 | 4.0 | 5.8 | 1.1 | 3.4 |
| | 8mM | 1.8 | 4.0 | 2.7 | 5.0 | 0.6 | 1.1 |
| $KH_2PO_4$ | 2 mM | 6.3 | 8.0 | 7.3 | 9.2 | 4.5 | 6.8 |
| | 4 mM | 4.4 | 6.4 | 4.8 | 6.9 | 2.3 | 4.5 |
| | 8 mM | 2.0 | 4.1 | 3.3 | 5.6 | 1.1 | 2.3 |
| Control | | 25.8 | 31.3 | 26.6 | 32.0 | 18.8 | 37.4 |

## Discussion

Regarding to the effect of pre-harvest treatments on diseases severity of tomato fruit rots, results showed that, there was a significant effect of all treatments at their tested concentrations in reducing of studied diseases and consequently increasing the quality of tomato fruits. Ethiphon treatments followed by Bion were the most effective, increasing the concentration of treatments result in higher disease reduction. In this respect, several reports have been published on use of ethylene releasing compound Ethiphon for inductions of resistance in plants (Abeles *et al.,* 1992, Abd-El-Kareem *et al.,* 2001, Bart *et al.,* 2002 and Hussien, 2011). In this research, Ethiphon treatments showed the higher efficacy in reducing tomato fruit rots which are artificially inoculated with *B. cinerea* and *A. alternata* or naturally infected The effect of ethylene in reducing disease incidence due to its effect in synthesis of pathogenesis-related proteins (PR-proteins), lignification and papilla formation and activity of $\beta$-1,3-glucanase and chitinase which realized in this study by increasing the activity of both enzymes due to Ethiphon treatments (Booler *et al.,* 1983, Matsumoto and Asada, 1990, Okuno *et al.,* 1991 and Abd-El-Kareem *et al.,* 2001).While Bion treatment led to reducing of tomato fruit rots by enhanced activities of the defence related enzymes chitinase and $\beta$-(1,3)-gluconase moreover it is associated with increases in activities of many classes of PR-proteins (Abou-Taleb, 2001 and Mosa, 2002).

Efficacy of $KH_2PO_4$ and $K_2HPO_4$ against plant infection to trigger plant defence through a process involving the consequent of calcium from host tissue, elicits the release of signal triggers of plant response and makes the plant more resistance and makes the plant more responsive after subsequent infection.(Gottstein and Kuc, 1989 and Mucharromah and Kuc, 1991).Moreover $KH_2PO_4$ and $K_2HPO_4$ led to increase synthesis of host metabolites such as phytoalexins and their production could be induced by many chemicals and increase of enzymes activities and total phenols (Nighat *et al.,* 2011). While IBA showed appreciable increase in the total phenol, calcium and increase the activity of many enzymes that led to decrease the activity of pectolytic enzyme (Khalil, 2002 and Khalifa, 2003, and Chowdhury, 2003) and that explain the role of the both treatment (Potassium and IBA) in decrease of the percentage of losses in tomato fruits fresh weight during storage periods whether under artificial inoculated or under natural infection and increase the quality of tomato fruits.

In the present study, it was found that Ethiphon, Bion and $K_2HPO_4$ treatments increased the activity of chitinase and β-1,3-gluconase and their activity increasing with the increase of treatments concentration that may be due to the role of chitinase and β-1,3-gluconase that affect the capability of pathogen to secrete macerating enzymes and to elicit phytoalexin formation also markedly reduced the production of polygalacturonase by pathogenic fungi and their ability to decay the cell wall of pathogenic fungi which chitin is the major cell wall component (Mauch *et al*., 1984, Kendra et al.,1989, El- Ghaouth *et al*.,1991, Abd-EL-Kareem *et al*., 2001 and Ragab *et al*., 2001).

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# المكافحة المستحثّة لأمراض أعفان ثمارِ الطماطم باستخدام مواد كيماوية آمنة

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تم معاملة ثمار الطماطم قبل الحصاد بكل من الأثيفون و البيون وحامض الأندول بيوتيريك وفوسفات بوتاسيوم ثنائي وأحادي الهيدروجين لمقاومة أعفان ثمار الطماطم تحت ظروف العدوي الصناعية بـ *Alternaria alternata*, *Botrytis cinerea* والعدوي الطبيعية خلال التخزين لمدة ٦ أسابيع في موسمي ٢٠١٠ و ٢٠١١ (العروة الصيفية). أعطت كل المعاملات المختبرة وقاية لثمار الطماطم المخزنة تحت درجة حرارة ١٠ درجة مئوية لمدة ٦ أسابيع خلال موسمي الدراسة ٢٠١٠ و ٢٠١١ (العروة الصيفية). اظهرت معاملة الأثيفون تحت الثلاث تركيزات المختبرة اعلي كفاءة في خفض الإصابة بأعفان ثمار الطماطم سواء تحت ظروف العدوي الصناعية أو الطبيعية تلاها معاملة البيون. أوضحت الدراسة وجود علاقة إيجابية بين زيادة تركيز المعاملة و زيادة قدرتها علي خفض الإصابة بأعفان الثمار سواء تحت العدوي الصناعية أو الطبيعية خلال موسمي الدراسة. أدت كل المعاملات لزيادة نشاط انزيم الشيتينيز وأنزيم ٣,١ بيتا جلوكونيز وسجل معاملة الأثيفون و البيون أعلي نشاط للإنزيمين بالمقارنة بباقي المعاملات. ادت المعاملات إلي تحسين مواصفات الثمار المخزنة بالتبريد سواء تحت ظروف العدوى الصناعية أو العدوى الطبيعية عن طريق تحسين لون الثمار وزيادة محتواها من فيتامين سي وكذلك خفض نسبة الفقد في الوزن الطازج للثمار.