*J. of Plant Production, Vol. 1 (1): 11 - 25, 2010*

# ALLEVIATING THE HARMFUL EFFECT OF SOME SOILBORNE FUNGI IN WHEAT PLANT GROWN UNDER INFECTED SOIL WITH *Fusarium graminearum* OR *Bipolaris sorokiniana*

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## ABSTRACT

A pot experiments was carried out to investigate the role of some antioxidant materials (presoaking and foliar spray ) in alleviation the harmful effect of biotic stress *Fusarium graminearum* or *Bipolaris sorokiniana* on wheat plant. Applied antioxidants decreased pre and post-emergence damping off, leaf infected percentage and leaf disease severity, fungi transmission from root, stem and grains of wheat plants growing under infected soil with *Fusarium graminearum* or *Bipolaris sorokiniana* in comparing with untreated plants growing in the same soil. However, grown infected soil enhanced survived seedlings percentage , emergence percentage of wheat plants with *Fusarium graminearum* or *Bipolaris sorokiniana* compared with untreated plants grown under same condition . SWE and Zn were more effective comparing with other antioxidants in both *Fusarium graminearum* or *Bipolaris sorokiniana*.

Applied antioxidants in high concentration were more effective than other concentrations in this respect.

**Keywords**: Antioxydants, pathogens, *Fusarium graminearum*, *Bipolaris sorokiniana*, wheat.

## INTODUCTION

Several soilborne pathogens of wheat (*Triticum aestivum* L.; poaceae) cause common root rot, with necrosis of basal stems, crowns, subcrown internodes, and roots (Mathre, *et al.*, 2003). Fusarium head blight (FHB), caused by *Fusarium graminearum* , is a major disease of wheat and has resulted in heavy yield losses in many areas of the World (Parry, *et al.*,1995).

*Bipolaris sorokiniana* is a severe fungal pathogen causing common root rot and leaf spot diseases in wheat, barley, oats and rice, as well as in many other plants. The pathogen occurs throughout the world (Sivanesan, 1987). Plants with common root rot produce fewer tillers and fewer kernels per ear. Grain yield losses due to common root rot and seedling blight for Canada, Scotland (Murray, *et al.*, 1998).

Edgar, *et al.*, (2006), found that *Fusarium oxysporum* is a soilborne fungal pathogen that causes major economic losses by inducing necrosis and wilting symptoms in many crop plants. The interaction between *F. oxysporum* and the model plant *Arabidopsis thaliana* has been investigated to better understand the nature of host defences that are effective against the Fusarium wilt pathogen.

Exogenous salicylic acid treatment prior to inoculation, however, activated defence gene expression in leaves and provided increased *F. oxysporum* resistance as evidenced by reduced foliar necrosis and plant death. Exogenous salicylic acid treatment of the foliar tissue did not activate defence gene expression in the roots of plants. There results suggest that salicylate-dependent defences may function in foliar tissue to reduce the development of pathogen-induced wilting and necrosis.

According to Hammond-Kosack and Jones, (1996), microbes produce a number of cutinases and cell wall hydrolyzing enzymes, such as pectinases, cellulases, xylanases, and polygalacturonases (PGs), that attack the various cell wall polymers. Mechanical pressure may also facilitate microbial entry (Agrios, 1988). Although individually none of the above-mentioned enzymes is crucial for particular modes of pathogenesis (Knogge, 1996), these activities produce cell wall fragments, particularly oligomers of galacturonic acid, that might elicit additional defense responses or amplify the original ones ( Levine, *et al.,* 1994).

The toxicity of AOS compounds may contribute to host cell death during the HR as well. Moreover Lipid peroxidation and generation of lipid free radicals after elicitor or pathogen exposure has been extensively documented (Adam, *et al.*, 1989). Grant, and Loake, (2000), reported that one of the most rapid defense responses engaged following pathogen recognition is the so-called oxidative burst, which constitutes the production of reactive oxygen intermediates (ROIs), primarily superoxide ($O_2$) and $H_2O_2$, at the site of attempted invasion (Apostol, *et al.*, 1989).

Severa1 other roles for SA and/or benzel adenine (BA) in plant defense have been proposed (Klessig and Malamy, 1994). Furthermore, exogenous SA application induces the coordinated expression of a subset of PR genes in numerous plant species (Ryals, *et al.,* 1996).

SA also inhibits ascorbate peroxidase (APX), the other key enzyme for scavenging $H_2O_2$. Furthermore, the ability of SA analogues to block APX activity correlated with their ability to induce defense-related genes in tobacco and enhance resistance to tobacco mosaic virus.

Glutathione, a major low-molecular weight thiol in plant cells, is increased after pathogen infection (Edwards, *et al.,* 1991). In carrot inhibition of glutathione synthesis, triggers phytoalexin accumulation, whereas the addition of $H_2O_2$ mimics this response (Guo, *et al.,* 1993).

Ascorbate is a substrate for cell wall peroxidases, it may play a role in the regulation of cell wall lignification, particularly during the HR, through its capacity to inhibit the oxidation of phenolic compounds by peroxidases (Mehlhorn, *et al.,* 1996). The pathogen-induced increase in the peroxidase activity of the cell wall would be effective only in the absence of AA.

Huckelhoven, *et al .,*(1999), found that $H_2O_2$ may play a substantial role in plant defense against the powdery mildew fungus. It did not detect any accumulation of salicylic acid in primary leaves after inoculation of the different barley genotypes, indicating that these defense responses neither relied on nor provoked salicylic acid accumulation in barley. The role of $H_2O_2$ and SA in the defense responses of plants against parasites is controversial. (Chen, *et al .,* 1993) has argued that SA acts *via* inhibition of a catalase that subsequently results in accumulation of $H_2O_2$ , which may involve cross-linking reactions leading to cell wall toughening (Brisson, *et al* ., 1994) and/or signaling that results in defense gene activation (Chamnongpol, *et al* ., 1998).

Shao, *et al.* (2008), reported that, antioxidants in plant cells mainly include glutathione, ascorbate, tocopherol, proline, betaine and others, which are also information-rich redox buffers and important redox signaling components that interact with cellular compartments. They added that,as an unfortunate consequence of aerobic life for higher plants, reactive oxygen species (ROS) are formed by partial reduction of molecular oxygen. The above enzymatic and non-enzymatic antioxidants in higher plant cells can protect their cells from oxidative damage by scavenging ROS. According to Chen, *et al.,* (2007), increasing the foliar GSH/GSSG ratio induced *Triticum aestivum* was enhanced resistance to powdery mildew and induced transcript accumulation of other pathogenesis-related genes.

Haffez, (2005), stated that antioxidants are substances that delay or inhibit oxidative to target molecules such as lipids, proteins, nucleic acid and carbohydrates. He added that antioxidants might protect a target by scavenging oxygen-derived species or minimizing the formation of oxygen-derived species.Various antioxidants ascorbic acid and its derivatives, glutathione, proline, trehalose, polyols, tocopherols, as well as pigments such as carotenoids and melanins—are present in fungal cells.

Mohammadi, and Kazemi, (2002), observed a significant increase in POX specific activity in heads of wheat cultivars following the inoculation with *F. graminearum* conidia.

## MATERIALS AND METHODS

A pot experiments was carried out to investigate the role of some antioxidant materials (presoaking and foliar) in alleviation the harmful effect of biotic stress of *Fusarium graminearum* or *Bipolaris sorokiniana* on wheat plant. All pot were placed in a greenhouse under natural ambient conditions during winter season.

The sterilized seeds were soaked for 6 hours in any of applied antioxidant before sowing. The plants of each biotic stress of *Fusarium graminearum* or *Bipolaris sorokiniana* were sprayed with any of antioxidant used (the same antioxidant used in seed soaking) at three physiological stages ( 30, 60 and 90 days after sowing) using a hand atomizer.

Antioxidants used were: Ascorbic acid ,(ASA in,100 – 200 - 300 mg/L)., Salicylic acid (SA in, 100 – 200 - 300 mg/L)., Citric acid( 100 – 200 - 300 mg/L)., Reduced Glutathione (GSH in,100 – 200 - 300 mg/L)., Seaweed extract (SWE in,1000 – 2000 - 3000 mg/L)., Humic acid (HA, in 1000 – 2000 - 3000 mg/L)., α –Tocopherol ( 50 – 100 – 150 L).,Putrescince(10 - 20- 30 mg/L)., Zinc sulphate (Zn,in 5 -10 - 15 mM)., Calcium chloride (Ca,in 200 - 300 - 400 mM)., Hydrogen peroxide (H2O2, in 400 - 600 - 800 mg/L)., Distilled water (control).

Seed sowing was carried out on November $20^{th}$ in pots (30 cm inner diameter) containing 10 Kg of air dried loamy soil at the rate of 15 grains/pot.

The pots were supplied with limit amounts of 15% $P_2O_5$ in the form of calcium super phosphate (with range of 130 Kg/fed), N 46% in the form of urea (in range of 75 Kg/fed) and $K_2O$ in the form of potassium sulphate 48% . Thirty cm diameter of plastic pots were fill with soil and inoculated with 2% (w /w ) of the inocula . The pots inoculated with *Fusarium graminearum* or *Bipolaris sorokiniana* watered and left for 3 days to ensure the distribution of inoculated fungi.

This experiment contained three factors, the first factor was infection fungi and included three treatments (*Fusarium graminearum* and *Bipolaris sorokiniana* and (control) without infection). The second factor was twelve antioxidant treatments in addition to the control .The third factor was antioxidants concentrations which were three concentrations for each treatment of antioxidants solutions except for distilled water treatment which was a control in the present study. Each treatment was carried out in three replicates.

Pre and post-emergence damping off ,survived seedlings , emergence percentage, severity disease and infected leaves percentage and fungi transmission were calculated.

Transmission of both pathogenic fungus from various plant parts (Root, lower first stem and middle stem node , upper stem node and grains) by planting them on sterile moist blotters and incubated for 7-10 days at 20 ± 2 °C . Fungi recorded from each treatment were identified and the transmission percentage was recorded according to the follow formula :
Mean of incidence % = Number of tissue infected / total number of tissue sections examined × 100 , (Abou-Table, 2006).

## RESULTS

**1- Pre-emergence damping off :**

Data in the table (1) show the effect of applied antioxidants on pre-emergence damping off of wheat seedlings grown under infected soil with *Fusarium graminearum* or *Bipolaris sorokiniana.*

Data show that applied antioxidants decreased pre-emergence damping off of wheat seedlings growing in infected soil with *Fusarium graminearum* or *Bipolaris sorokiniana* in comparing with untreated seedlings growing in infected soil. SWE and Zn were the most effective in decreasing pre-emergence damping off in both infected soil with *Fusarium graminearum* or *Bipolaris sorokiniana.*

Higher concentration of ASA, GSH, SWE, HA, Toco, $H_2O_2$ while moderate concentration of SA, Zn were more effective in the case of *Fusarium graminearum* and *Bipolaris sorokiniana.*

**2- Post-emergence damping off :**

Data in the table (1) show the effect of applied antioxidants on post-emergence damping off of wheat seedlings growing under infected soil with *Fusarium graminearum* or *Bipolaris sorokiniana* fungi .

Data show that applied antioxidants slightely decreased post-emergence damping off of wheat seedlings grown under infected soil with *Fusarium graminearum* or *Bipolaris sorokiniana* when compared with untreated seedlings grown under same condition . SWE and Zn were mos effective in decreasing post-emergence damping off of wheat seedlings in both case of *Fusarium graminearum* or *Bipolaris sorokiniana.*

Applied antioxidants in high concentration were more effective than other concentrations in this respect.

**Table (1): Effect of antioxidants concentrations on Pre and post- emergence damping off, Survived seedling (S.S) and emergence percentage (E.P) of wheat plant grown under infection soil by *Fusarium graminearum* or *Bipolaris sorokiniana.***

| Treatments | Pre - emergence damping off | | post- emergence damping off | | Survived seedling percentage | | Emergence percentage | |
|---|---|---|---|---|---|---|---|---|
| | F.g | B.s | F.g | B.s | F.g | B.s | F.g | B.s |
| Control | 5.9 | 5.9 | - | - | 94.1 | 94.1 | 94.1 | 94.1 |
| Inf. Soil + water | 25.1 | 26.7 | 9.7 | 8.9 | 65.1 | 64.4 | 74.8 | 73.3 |
| Inf. Soil + ASA | 12.6 | 15.5 | 8.2 | 7.4 | 78.5 | 77.0 | 86.7 | 84.5 |
| Inf. Soil + SA | 14.8 | 15.5 | 7.4 | 6.7 | 77.7 | 77.8 | 85.2 | 84.5 |
| Inf. Soil + Citric | 14.1 | 19.3 | 8.2 | 8.9 | 76.2 | 71.8 | 84.4 | 80.7 |
| Inf. Soil + GSH | 17.7 | 15.5 | 7.4 | 11.1 | 74.5 | 73.3 | 81.9 | 84.4 |
| Inf. Soil + SWE | 8.2 | 8.2 | 5.2 | 6.7 | 86.6 | 85.1 | 91.8 | 91.8 |
| Inf. Soil + HA | 12.6 | 15.5 | 6.7 | 7.4 | 80.7 | 77.0 | 87.4 | 84.5 |
| Inf. Soil + Put | 15.5 | 13.3 | 7.4 | 11.8 | 77.8 | 74.0 | 85.2 | 85.9 |
| Inf. Soil + Toco | 18.5 | 15.5 | 9.6 | 10.4 | 71.8 | 73.3 | 81.5 | 83.7 |
| Inf. Soil + Zn $so_4$ | 8.9 | 8.2 | 6.7 | 6.7 | 84.4 | 85.1 | 91.1 | 91.8 |
| Inf. Soil + $CaCl_2$ | 14.0 | 16.3 | 6.7 | 8.9 | 78.5 | 74.0 | 85.1 | 82.9 |
| Inf. Soil + H2O2 | 18.5 | 17.0 | 8.2 | 10.4 | 73.3 | 71.8 | 81.4 | 82.2 |
| Mean | 14.3 | 14.8 | 7.0 | 8.1 | 78.4 | 76.8 | 85.4 | 84.9 |
| LSD at 5% | 3.41 | 3.49 | 1.0 | 1.05 | 2.33 | 2.30 | 3.79 | 3.60 |

ASA : Ascorbic acid
SA : Salicylic acid
GSH : Glutathione
Citric : Citri acid
Put : Putrescine
Toco : α- Tocopherol
Zn $so_4$ : Zinc sulfite
$CaCl_2$ : Calcium chloride
F.g : *Fusarium graminearum*
B.s : *Bipolaris sorokiniana.*
SWE : seaweeds extract
HA : Humic acid
$H2O_2$ : Hydrogen peroxide
Inf. Soil : Infected soil with Conc.

**3- Survived seedlings :**

Data in the table (1) show the effect of applied antioxidants on survived seedlings percentage of wheat plants grown under infected soil with *Fusarium graminearum* or *Bipolaris sorokiniana.*

Applied antioxidants enhanced survived seedlings percentage of wheat plants grown under infected soil with *Fusarium graminearum* or *Bipolaris sorokiniana.* compared with untreated plants grown under same condition . SWE , HA , and Zn were most effective in this respect.

Higher concentration of SWE , ASA , HA , Put , Toco and $H_2O_2$ while the moderate concentration of SA , Zn and Ca were mor effective than other concentrations in the case of *Fusarium graminearum.*

Moreover higher concentrations of ASA , Citric , GSH , Put , Toco , Ca , $H_2O_2$ while moderate concentrations of SA and Zn were more effective in *Bipolaris sorokiniana* case.

**4- Emergence seedlings percentage :**

Data in the table (1) show that applied antioxidants slightely increased emergence percentage of wheat seedlings grown under infected soil with *Fusarium graminearum* or *Bipolaris sorokiniana* compared with untreated seedlings grown under same condition .

SWE and Zn were most effective in this respect. In most cases the higher concentration of applied antioxidants were more effective comparing with other concentrations.

**5- Leaves infection and leaves disease severity percentage :**

Data in the tables (2) show that applied antioxidants markedly decreased both infection leaves percentage and leaves disease severity of wheat plants grown under infected soil with *Fusarium graminearum* or *Bipolaris sorokiniana* , when compared with untreated plants grown under the same conditions . SWE and Zn were most effective antioxidants in decreasing both leaves infection or leaves disease severity percentage.

**Table (2): Effect of antioxidants concentrations on leaves infection , disease severity, transmission percentage of fungi from root and stem of wheat plant grown under infection soil by *Fusarium graminearum* or *Bipolaris sorokiniana*.**

| Treatments | Leaves infection. | | disease severity | | Transmission percentage of fungi from root. | | Transmission percentage of fungi from lower first stem node | |
|---|---|---|---|---|---|---|---|---|
| | F.g | B.s | F.g | B.s | F.g | B.s | F.g | B.s |
| Control | 00.0 | 00.0 | 1.0 | 1.0 | 0.0% | 0.0% | 0.0% | 0.0% |
| Inf. Soil + water | 70.0 | 75.0 | 4.0 | 4.0 | 100% | 100% | 100% | 80.0% |
| Inf. Soil + ASA | 44.0 | 45.7 | 3.0 | 3.3 | 60.0% | 60.0% | 60.0% | 46.7% |
| Inf. Soil + SA | 53.3 | 42.3 | 3.7 | 3.3 | 73.3% | 66.7% | 73.3% | 53.3% |
| Inf. Soil + Citric | 60.0 | 44.0 | 4.0 | 3.0 | 86.7% | 73.3% | 86.7% | 66.7% |
| Inf. Soil + GSH | 61.3 | 44.7 | 4.0 | 3.3 | 86.7% | 86.7% | 86.7% | 66.7% |
| Inf. Soil + SWE | 28.0 | 31.0 | 2.7 | 2.7 | 40.0% | 46.7% | 40.0% | 40.0% |
| Inf. Soil + HA | 47.0 | 48.3 | 3.3 | 3.3 | 66.7% | 80.0% | 66.7% | 66.7% |
| Inf. Soil + Put | 56.0 | 58.3 | 4.0 | 4.0 | 86.7% | 86.7% | 86.7% | 66.7% |
| Inf. Soil + Toco | 64.3 | 59.7 | 4.0 | 4.0 | 93.3% | 93.3% | 93.3% | 73.3% |
| Inf. Soil + Zn $so_4$ | 31.7 | 25.7 | 3.0 | 2.3 | 60.0% | 53.3% | 60.0% | 46.7% |
| Inf. Soil + $CaCl_2$ | 54.0 | 62.0 | 3.7 | 4.0 | 86.7% | 93.3% | 86.7% | 66.7% |
| Inf. Soil + H2O2 | 50.3 | 53.7 | 3.7 | 3.7 | 80.0% | 80.0% | 80.0% | 66.7% |
| Mean | 47.7 | 45.4 | 3.38 | 3.23 | 70.8% | 70.8% | 70.8% | 56.9% |
| LSD at 5% | 6.5 | 6.1 | - | - | 12.6 | 12.0 | 13.0 | 7.9 |

ASA : Ascorbic acid
SA : Salicylic acid
GSH : Glutathione
Citric : Citri acid
Put : Putrescine
Toco : α- Tocopherol
Zn $so_4$ : Zinc sulfite
$CaCl_2$ : Calcium chloride
F.g : *Fusarium graminearum*
B.s : *Bipolaris sorokiniana.*
SWE : seaweeds extract
HA : Humic acid
$H2O_2$ : Hydrogen peroxide
Inf. Soil : Infected soil with Conc.

**6- Transmission percentage :**

Data in the tables (3) show the effect of applied antioxidants on fungi transmission percentage from roots , lower first stem node, middle stem node, upper stem node and grains of wheat plants grown under infected soil with *Fusarium graminearum* or *Bipolaris sorokiniana.*

Data show that applied antioxidants slightely decreased fungi transmission from root, stem and grains compared with untreated plants grown under the same condition.

SWE and Zn were most effective in this respect. High concentration of applied antioxidants was more effect compared with other of concentrations

High concentration of ASA , SWE , HA , Toco , $H_2O_2$ were mor effect than the other concentrations in the case of decreasing both leaves infection percentage or leaves disease severity of wheat plants grown under infected soil with *Fusarium graminearum* or *Bipolaris sorokiniana*.

**Table (3): Effect of antioxidant concentrations on Transmission percentage of fungi from stem and grainsof wheat plant grown under infection soil by *Fusarium graminearum* or *Bipolaris sorokiniana*.**

| Treatments | Transmission percentage of fungi from middle stem node | | Transmission percentage of fungi from upper stem node | | Transmission percentage of fungi from wheat grains | |
|---|---|---|---|---|---|---|
| | F.g | B.s | F.g | B.s | F.g | B.s |
| Control | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Inf. Soil + water | 80.0% | 60.0% | 80.0% | 60.0% | 9.6% | 4.8% |
| Inf. Soil + ASA | 46.7% | 40.0% | 40.0% | 33.3% | 5.6% | 3.0% |
| Inf. Soil + SA | 53.3% | 46.7% | 46.7% | 40.0% | 7.1% | 3.2% |
| Inf. Soil + Citric | 66.7% | 53.3% | 53.3% | 46.7% | 7.9% | 3.3% |
| Inf. Soil + GSH | 66.7% | 53.3% | 53.3% | 46.7% | 8.1% | 3.6% |
| Inf. Soil + SWE | 33.3% | 33.3% | 26.7% | 26.7% | 4.5% | 2.7% |
| Inf. Soil + HA | 53.3% | 46.7% | 46.7% | 46.7% | 5.7% | 3.7% |
| Inf. Soil + Put | 66.7% | 53.3% | 60.0% | 60.0% | 7.8% | 3.8% |
| Inf. Soil + Toco | 73.3% | 60.0% | 73.3% | 60.0% | 8.7% | 4.3% |
| Inf. Soil + Zn $so_4$ | 40.0% | 33.3% | 33.3% | 26.7% | 4.9% | 2.5% |
| Inf. Soil + $CaCl_2$ | 60.0% | 60.0% | 60.0% | 53.3% | 6.6% | 4.0% |
| Inf. Soil + H2O2 | 60.0% | 53.3% | 53.3% | 53.3% | 6.3% | 3.8% |
| Mean | 53.8% | 45.6% | 48.2% | 42.6% | 6.4% | 3.4% |
| LSD at 5% | 16.7 | 14.2 | 14.0 | 11.0 | 0.8 | 0.6 |

**ASA : Ascorbic acid** **Toco : α- Tocopherol** **SWE : seaweeds extract**
**SA : Salicylic acid** **Zn $so_4$ : Zinc sulfite** **HA : Humic acid**
**GSH : Glutathione** **$CaCl_2$ : Calcium chloride** **$H2O_2$ : Hydrogen peroxide**
**Citric : Citri acid** **F.g : *Fusarium graminearum*** **Inf. Soil : Infected soil with Conc.**
**Put : Putrescine** **B.s : *Bipolaris sorokiniana*.**

## DISCUSSION

Applied antioxidants decreased pre and post -emergence damping off , infected leaves percentage and leaves disease severity, fungi transmission from root, stem and grains of wheat seedlings growing under infected soil with *Fusarium graminearum* or *Bipolaris sorokiniana* in comparing with untreated seedlings growing in the same soil. While enhanced survived seedlings percentage , emergence percentage of wheat plants grown under infected soil with *Fusarium graminearum* or *Bipolaris sorokiniana* compared with untreated plants grown under same condition . SWE and Zn were more effective comparing with other antioxidants in both case of *Fusarium graminearum* or *Bipolaris sorokiniana*.

Exogenous salicylic acid treatment prior to inoculation, however, activated defence gene expression in leaves and provided increased *F. oxysporum* resistance as evidenced by reduced foliar necrosis and plant death. This suggests that salicylate-dependent defences may function in foliar tissue to reduce the development of pathogen-induced wilting and necrosis. (Edgar, *et al.,* 2006).

Durner and Klessig, (1995), reported that salicylic acid (SA) plays an important role in plant defense responses to pathogen attack. One of SA's mechanisms of action is the inhibition, of catalase, resulting in elevated levels of $H_2O_2$, which activate defense-related genes. SA also inhibits ascorbate peroxidase (APX), the other key enzyme for scavenging $H_2O_2$.

Glutathione, a major low-molecular weight thiol in plant cells, is increased after pathogen infection (Edwards, *et al.,* 1991). Because ascorbate is a substrate for cell wall peroxidases, it may play a role in the regulation of cell wall lignification, particularly during the HR, through its capacity to inhibit the oxidation of phenolic compounds by peroxidases (Mehlhorn, *et al.,* 1996). The pathogen-induced increase in the peroxidase activity of the cell wall would be effective only in the absence of AA.

The role of $H_2O_2$ and SA in the defense responses of plants against parasites is controversial. (Chen, *et al* ., 1993) has argued that SA acts *via* inhibition of a catalase that subsequently results in accumulation of $H_2O_2$ , which may involve cross-linking reactions leading to cell wall toughening (Brisson, *et al* ., 1994) and/or signaling that results in defense gene activation (Chamnongpol, *et al* ., 1998).

It induces the expression of pathogenesis related proteins and initiate the development of systemic acquired resistance and hypersensitivity (Metwally *et al.*, 2003). Moreover, White, (1979) demonstrated that application of exogenous salicylic acid or its derivatives induces synthesis of pathogenesis related proteins and partial resistance to pathogens. On the other side, citric acid decrease growth of *Macrophomina phasolaina* and *Rhizoctonia solani* consequently decrease damping-off as well as charcoal rot disease percentage. These findings are in agreement with the finding of Elwakil and El-Metwally, (2000), who shows that the most potent antioxidant on the linear growth of *Cephalosporium* sp., *F. moniliforme*, *F. oxysporum*, *F. solani*, *Rhizoctonia solani*, *Sclerotium bataticola* and *Verticillium* sp. was hydroquinone. Galal, *et al.*, (2000) the investigated sensitivity of *Alternaria radicina* and *A. tenuissima in vitro* against five antioxidants (ascorbic acid, benzoic acid, hydroquinone, salicylic acid and tannic acid), they found that the mycelial dry weights of both tested fungi were completely inhibited at 10 mM benzoic acid and salicylic acid.

Evaluation under artificial infection in greenhouse conditions indicated that all natural compounds (mannitol, oxalic acid, citric acid and ascorbic acid), lmM polyamines spermine, omithine and 1% antitranspirants were effective against both pathogens., *Phytophthora infestans* (*Alternaria solani*) Haggag, and EL-Khair, (2007).

The present study demonstrated that these natural compounds not only inhibit the blight pathogens but also have an effect in improving the growth and tuber yield of potato plants.Addition of exogenous ascorbic acid lowered lipid peroxidation in fungal cells and inhibited sclerotial differentiation. GSH plays an important antioxidant role in cells by decreasing ROS level (Lee, *et al.,* 2001).

HA enhanced natural resistance against plant diseases (Scheuerell & Mahaffee, 2004 and 2006), stimulation plant growth through increased cell division, as well as optimized uptake of nutrients and water, (Chen *et al.*, 2004). Moreover, HA stimulated the soil microorganisms (Atiyeh *et al.*, 2002). Several reports indicated the efficiency of HA in reducing some plant diseases(Bush, 1993).

The role of HA in overcoming the harmful effects of chocolate spot and rust diseases in faba bean plant may be due to the increase in chitinase activity (Abd-El- Kareem, 2007) and stimulation plant growth through increased cell division, as well as optimized uptake of nutrients and water (Atiyeh *et al.*, 2002 and Chen *et al.*, 2004), regulate hormone level, improve plant growth and enhance stress tolerance (Piccolo *et al.*, 1992). Foliar application of HA enhanced antioxidants such as á-tocopherol, â-carotene, superoxide dismutases, and ascorbic acid concentrations in turfgrass species (Zhang, 1997).

El-Ghamry, *et al.,* (2009) stated that growth and yield components and chlorophyll content significantly increased by the application of HA (2000 ppm) interacted with AA (2000 ppm). The maximum reduction of disease severity of chocolate spot was recorded with the interaction between HA at1000 ppm + AA at 1000 ppm .

The results in the present investigation show that antioxidant zinc caused significant reductions in linear growth of both pathogenic fungi . The role of antioxidants on overcoming the injurious effects of both may be attributed to the regulation of plant development and chilling of disease resistance (Achuo, *et al.*, 2004). In addition, antioxidants may neutralize the harmful oxygen radicals released during the infections (Shahda, 2002). Also, zinc has a marked effect on the level of auxins due to its important for the synthesis of intermediates in the metabolic pathway, through tryptophan to auxin, which encourage the meristemic activity ( Devlin and Witham, 1983). In this investigation, all tested antioxidants and Zn increased photosynthetic pigments in turn, it will increases carbohydrate content in plant tissues. Carbohydrates are the main substances of photosynthetic energy, they comprise structurally polysaccharides of plant cell walls, principally cellulose, hemicelluloses and pectin that consider a barrier against plant pathogens invasion and phenolic compounds are associated with structural carbohydrates, which play a major and important role in plant defense (Hahlbrock and Scheel, 1989).

Zinc is co-factors of Super Oxide Dismutase (SOD), which considered enzymatic antioxidant, hence alleviate the harmful effect of Reactive Oxygen Species (ROS free radicals) caused by fungal stress. ( Kostas and Christos, 2006), who found that, the foliar application of microelements (zinc) can be used to reduce the severity of tan spot disease on durum wheat . The positive effect of zinc on increasing the vegetative growth which lead to an increase in plant tolerance and yield components may be due to the role of zinc as essential constituent of three enzymes (Carbonic anhydrase, Alcohol dehydrogenase and superoxide dismutase).). In addition, the enhancement in chlorophyll content by Zn is resulting from stimulating pigment formation and increasing the efficiency of photosynthetic apparatus with a better potential for resistance as well as decreasing phtotophosphorylation rate, which occurred after infection (Amaresh and Bhatt, 1988).

The results in the present investigation demonstrate that calcium salts directly suppress the bitter rot pathogens ,suppressive effects include reduced germ tube growth, reduced mycelial growth *in vitro*, and reduced severity of infection of host tissues pretreated with calcium. Calcium salts also have been shown to reduce mycelial growth *in vitro* and reduce incidence and severity of infection of peach fruits and shoots by *Monilinia fructicola* and *Leucostoma persoonii*, respectively (Biggs, *et al.,* 1997; Biggs, and Peterson, 1990). The mechanisms by which calcium salts inhibit germ tube and mycelial growth are not known. One hypothesis is that high external concentrations of Ca2+ may lead to increased concentration of Ca2+ in the cytosol (Droby, *et al.,* (1997) . Since maintenance of low basal concentrations of internal Ca2+ is essential for normal cell functions, organisms with the inability to regulate intracellular Ca2+ may exhibit compromised growth and development. Calcium ions may reduce the incidence of fungal infection by directly inhibiting fungal growth and by inhibiting cell wall–degrading enzymes produced by the pathogens (Conway, and Sams, 1984 ,Droby, *et al.,* 1997 and Biggs, *et al.* (1997) .

Seaweed extracts have been shown to enhance plant defense against pest and diseases (Allen, *et al.,* 2001). Besides influencing the physiology and metabolism of plants, seaweed products promote plant health by affecting the rhizosphere microbial community. Fungal and bacterial pathogens SWE can serve as an important source of plant defense elicitors (Cluzet, *et al.,* 2004 Khan, *et al.,* 2009). Plants protect themselves against pathogen invasion by the perception of signal molecules called elicitors which include a wide variety of molecules such as oligo and polysaccharides, peptides, proteins, and lipids, often found in the cell wall of attacking pathogens (Boller, 1995). A variety of polysaccharides present in algal extracts include effective elicitors of plant defense against plant diseases (Kloareg and Quatrano, 1988). Although red algae typically(SWE) contain agars and carrageenans in their cell walls, extracts of brown algae contain alginates, laminarans, sulfated fucans, and other complex mucilages, and green algae . contain mucilages composed of units such as rhamnose, uronic acid, and xylose (Cluzet, *et al.,* 2004). Laminaran, a linear b-(1,3)-glucan, and sulfated fucans from brown algae elicit multiple defense responses in alfalfa and tobacco (Kobayashi, *et al.,* 1993; Klarzynski, *et al.,* 2000, 2003). Simailarly, carrageenans, a family of sulfated linear galactans, are effective elicitors of defense in tobacco plants (Mercier, *et al.,* 2001). Foliar sprays of SWE reduced Phytophthora capsici infection in Capsicum and Plasmopara viticola in grape (Lizzy, *et al.,* 1998).

Seaweeds are a rich source of antioxidant polyphenols with bactericidal properties (Zhang, *et al.,* 2006). Who added that the application of A. nodosum extract and humic acid to bentgrass (*Agrostis stolonifera*) increased SOD activity, which in turn significantly decreased dollar spot disease caused by *Sclerotinia homoeocarpa*. Treatment of alfalfa with the algal extracts prior to pathogen challenge resulted in an increased resistance to *Colletotrichum*..

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## التغلب على الآثار الضارة لبعض فطريات التربة على نبات القمح النامى تحت ظروف التربة المعدية بفطر الفيوزاريوم أو البايبولارس.

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أجريت تجربة أصص لدراسة دور بعض مضادات الأكسدة ( نقعا ورشا) للتغلب على الاثار الضارة الناجمة عن العدوى بفطرى الفيوزاريوم و البايبولارس لنبات القمح.

أتضح أن المعاملة بمضادات الأكسدة أدت الى نقص واضح فى كل من البادرات الميتة قبل و بعد انبثاقها فوق سطح التربة، نسبة إصابة الأوراق، شدة إصابة أوراق نبات القمح ، نسبة انتقال الفطر من الجذر والساق والحبوب لنباتات القمح النامية تحت ظروف التربة المعدية بأى من الفطرين تحت الدراسة بينما أدت المعاملة بمضادات الأكسدة المستخدمة إلى زيادة كل من نسبة انبثاق البادرات وكذلك النسبة النهائية للبادرات التى استمرت فى النمو لنباتات القمح مقارنة بالنباتات النامية تحت نفس الظروف والغير معاملة بمضادات الأكسدة كما أتضح أيضا أن التركيز الأعلى لمضادات الأكسدة فى معظم الأحوال كان هو الأكثر فعالية مقارنة بالتركيزات الأقل.

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