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RESPONSE OF STRAWBERRY PLANTS TO SOME ABIOTIC INDUCERS UNDER STRESS OF SOME ROOT ROT PATHOGENS

BY

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ABSTRACT

Chemical inducers from different groups were tested, as solution for dipping the roots of strawberry plant before transplanting in the soil infested with *Rhizoctonia solani, R. fragariae* and *Sclerotium rolfsii*, and foliar sprayed after 7 day to induction a systemic resistance. *In vitro*, mycelial growth of three tested fungi was mostly inhibited by SA, Rizolex-T and Ethephon, but not or little affected by another tested inducers. Under greenhouse conditions, $CuSO_4$ completely prevented disease incidence (as % of dead plants) in the presence of *R. fragariae* and *R. solani* either after 21 or 45 days from infestation. The same effect was achieved by BA against *R. fragariae*. After 21 days $MgSO_4$, Bion 50%, and Ethephon were almost equal with Rizolex-T 50%, but lowest effect was recorded by using Ascorbic acid after 21 and 45 days. Under field conditions, all abiotic inducers were declined the dead strawberry plants (%) than untreated control after 21 and 45 days in both seasons (2004 -2005). However, abiotic were more effective in the second season than the first, especially SA, $CuSO_4$ then BA, AA and Bion 50%. Clear increase in the shoot and root lengths of strawberry plants as response to treatment with all tested abiotic inducers than untreated plants was observed. Ethephon exceeded the others for the induction of the resistance against root-rot pathogens, and enhanced the growth parameters of strawberry plants under greenhouse conditions. KH_2PO_4 and SA inducers increased the enzyme activities of peroxidase, polyphenoloxidase, chitinase and β,1-3-glucanase than other abiotics, while little activities were recorded with other treatments. Lignin content was increased in the treated plants in response to all inducers than untreated.

Key words: Strawberry, abiotic inducers, root-rot, Rhizoctonia, Sclerotium, plant growth parameters, enzyme activities.

INTRODUCTION

Strawberry (*Fragaria x ananassa* Duch.) is an important high-value culturable crop. Root-rot caused by some soil borne fungi is important disease responsible for dramatic yield losses in commercial strawberry production (Maas, 1998). For a plant surviving, a pathogen attack depends on both performed barriers, such as constructed mechanical barriers, and on induced active defense mechanisms (Nandakumar *et al.* 2001). In the latter case, biotic and abiotic elicitors induce a plant's defence mechanisms against various pathogens (Baker *et al.* 1997). These elicitors can induce a plant's defense mechanisms by activating genes that invoke

systemic induced resistance (SIR) which can be a specific defense response or a complex unspecific response. The origin of abiotic elicitor derived from a pathogen may be exogenous (*e.g.*, fungal cell wall elements such as β-1,3-glucan or chitin) or endogenous if released from the plant cell wall during infection (Ebel and Scheel 1997 and Hutcheson 1998). Resistance induced by these agents (resistance elicitors) is broad spectrum and long lasting, but rarely provides complete control of infection, with many resistance elicitors providing between 20 and 85% disease control (Walters et al., 2005). The indiscriminate use of synthetic pesticides in production system of fruits and vegetables is of great concern for health and environment safety. Research and Development strategies are presently diverted in search of suitable biological alternatives to replace the pesticide use (Naqvi and Naqvi, 2004).

The objective of this study was to determine if some tested abiotic chemicals, from different groups, induce systemic resistance against root-rot pathogens of strawberry plants.

MATERIALS AND METHODS

Source of fungal inocula:

Six fungal isolates (*i.e., Sclerotium rolfsii, Rhizoctonia solani, Rhizoctonia fragariae, Macrophomi phasealina, Fusarium solani* and *Pythium ultimum*) were most frequently isolated from strawberry roots (Sweet Charli and Camarosa cvs.) naturally infected with root-rot disease collected from Qalyubia, Ismailia, Sharqia and Beheira Governorates at various times during the 2003 through 2005 seasons. According to the pathogenicity and *in vitro* studies, only three isolates (*i.e., Sclerotium rolfsii, Rhizoctonia solani* and *Rhizoctonia fragariae*) were found to be the most virulent, so another experiments restricted on them (Abdel-Ghany, 2008).

Abiotic inducers:

- Salicylic acid (SA), boric acid (BA), ascorbic acid (AA), CuSO4, $MgSO_4$, KH_2PO_4 (Sigma-Aldrich Co., St. Louis, MO, USA) all at 20 mM.
- Rizolex-T50 WP: a mixture of Tolclofosmethyl (20%) + thiram (30%) (Bayer, Egypt) at 1500 ppm.
- Acibenzolar-S-methyl (Bion 50 WG) is a plant activator belonging to a new group of compounds known as benzothiadiazoles (produced by Syngenta, Egypt) at 800 ppm.
- 2-chloroethylphosphonic acid (Ethephon®): is a commercial organic phosphorus compound as a plant growth regulator (Amchem Products Inc., Ambler, Pa., USA) at 800 ppm.

The effect of these abiotic inducers, with showed concentrations, on the six fungal growth were studied *in vitro*. The suitable amount of the above abiotic concentrations were placed into the sterilized bottom of Petri dishes (Ø 9 cm) immediately before pouring the warmed sterilized PDA medium. After solidification, the plates were inoculated at the center with a disc (Ø 5 mm) taken from the peripheral active mycelial growth of 4 day-old cultures of a six tested fungi then incubated at 27°C. PDA plates with only tested pathogens were served as control. Three plates were used for each treatment as replicates. Averages of linear growth were determined in all plates as described by Orober *et al.* (1988).

$$\text{Reduction \%} = G_1\text{-}G_2/G_1 \times 100$$

where:

G_1= Average linear growth of the control plates (pathogen inoculated alone),

G_2= Average linear growth of the pathogen in the presence of abiotic inducers.

Disease incidence:

Under greenhouse and filed conditions, the most susceptible strawberry cv. Camarosa roots soaked for 10 min before transplanting and foliar sprayed with suspensions of above mentioned abiotic inducers and concentrations. Two groups of strawberry transplants were left without treatment or dipped in Rizolex-T 50% suspension (at the rate 3 g/l water) served as control. Four transplants/pot (∅ 25 cm) containing sandy soil previously infested with inocula (grown for 2 weeks in 1:1 w/w corn meal/sand medium) of 3 tested fungi at the rate of 1%. Disease incidence express as % dead plants after 21 and 45 days from transplanting were calculated according to the following formula:

$$\text{Disease percentage} = \frac{\text{Number of dead plants}}{\text{Total number of plants}} \times 100$$

Plant growth parameters

Plant growth parameters under greenhouse conditions (*i.e.* shoot and root lengths) were determined after 15 days post transplanting as described by El-Kolaly, Ghada (2003).

Enzyme activity assays:

Samples (1g) were taken from roots of the treated and untreated strawberry plants (grown under greenhouse conditions) after 8 days post treatments, homogenized individually using mortar and pestle with 0.2 M Tris-HCl buffer (pH 7.8) containing 14 mM β-mercaptoethanol at rate of 1:3 (w/v) then filtered through four layers of cheesecloth. The filtrate was centrifuged at 3000 rpm for 15 minutes at 6°C. The resultant supernatants were kept in the refrigerator at –20°C (Tuzun *et al.*, 1989) until used. Polyphenoloxidase, peroxidase, chitinase enzymes were assayed in the supernatants using Spectrophotometer (Spectronic-601) as follow:

Peroxidase activity (PO) was assayed spectrophotometrically by measuring oxidation of pyrogallol to pyrogallin, in the presence of H_2O_2 at 425 nm/g fresh weight/15 min (Kar and Mishra, 1976).

Polyphenoloxidase activity (PPO) was determined spectrophotometrically as the increase in absorbance at 495 nm/g fresh weight/30 min (Maxwell and Bateman (1967).

Chitinase activity was expressed as mM N-acetyl glucose amine equivalent released/gram fresh weight tissue/60 min at 540 nm (Boller and Mauch, 1988).

β-1,3-glucanase activity was measured at 500 nm optical density as mM glucose equivalent released gram fresh weight tissues/60 minutes (Bradford, 1976).

In addition, Lignin content in strawberry roots was determined after 15 days of challenge according to the method of Bjorkman (1956).

EXPERIMENTAL RESULTS

Effect on fungal growth:

Data in Table (1) indicate that salicylic acid (SA) and Rizolex-T were the superior in the reduction of mycelial growth of all tested fungi (94.4%), followed by ethephon then Boric acid (BA) and Ascorbic acid (AA). Growth of all tested fungi was not affected by $MgSO_4$ and KH_2PO_4. Other tested abiotic inducers came in between in this concern.

Table (1): Effect of some abiotic inducers on growth reduction (%) of some strawberry root-rot fungi *in vitro*.

Abiotic inducers	Cons.	% of growth reduction		
		S. rolfsii	*R. solani*	*R. fragariae*
Control		0.0	0.0	0.0
Salicylic acid (SA)	20 mM	94.4	94.4	94.4
Boric acid (BA)	20 mM	94.4	87.0	78.8
Ascorbic acid (AA)	20 mM	75.9	79.6	74.0
$CuSO_4$	20 mM	79.6	78.5	81.5
$MgSO_4$	20 mM	0.0	0.0	0.0
KH_2PO_4	20 mM	0.0	0.0	0.0
Bion 50%	800 ppm	0.0	77.7	64.8
Ethephon	800 ppm	70.3	94.4	94.4
Rizolex T 50%	1500 ppm	94.4	94.4	94.4

Disease incidence:

Under greenhouse conditions, data in Table (2) indicate that all tested abiotic inducers were somewhat better than the fungicide Rizolex-T, with some exceptions, in deceasing the percentage of dead plants caused by any of the 3 tested root rot pathogens with slightly differences between recorded data after 21 and 45 days compared with untreated control. $CuSO_4$ completely prevent the harmful effect of *R. fragariae* and *R. solani* either after 21 or 45 days from infestation. The same effect was achieved by BA against *R. fragariae* after 21 and 45 days. In this concern, after 21 days $MgSO_4$, Bion 50%, and Ethephon were almost equal with Rizolex-T 50%, but lowest effect was recorded by using Ascorbic acid after 21 and 45 days.

Under field conditions, data in Table (3) indicate that, % dead strawberry plants determined after 21 or 45 days from planting were decreased by all tested abiotic inducers during seasons 2004 and 2005 comparing with the untreated control. In 2004 season, the fungicide Rizolex-T and Ethephon were the best of all (after 21 and 45 days), followed by BA, SA, AA and $MgSO_4$ (after 21 days) and SA, AA and $MgSO_4$ (after 45 days). However, lowest effect recorded by using Bion 50% after 45 day (2004). In 2005 season, $CuSO_4$ and ascorbic acid was the most effective followed by Rizolex-T, whereas BA, AA and Bion 50% were came in the next in this concern. The lowest effect was recorded by using $MgSO_4$ (after 21 or 45 days) followed by KH_2PO_4 and Bion 50% specially after 45 days.

Effect of abiotic inducers on some Shoot and root lengths of strawberry plants:

Under greenhouse conditions, data in Table (4) reveal that length of shoots and roots of strawberry plants, grown in infested soil with the tested pathogens, were increased by all the tested abiotic inducers compared to the untreated controls.

Ethephon recorded the highest increase in shoot and root lengths, followed by $CuSO_4$, meanwhile the least increase was recorded by using Bion compared to the control. Treatment with abiotic inducers increased the root length in the soil infested with *R. solani* than those infested with *S. rolfsii* or *R. fragariae*.

Table (2): Effect of some abiotic inducers on % dead strawberry plants 21 and 45 days after sowing in a pathogen-infested soil.

Abiotic Inducers	Cons.	% Dead plants after					
		21 days			45 days		
		S. rolfsii	*R. fragariae*	*R. solani*	*S. rolfsii*	*R. fragariae*	*R. solani*
Control		66.66	58.33	58.33	100.00	83.33	75.00
Salicylic acid (SA)	20 mM	0.00	8.33	8.33	8.33	8.33	8.33
Boric acid (BA)	20 mM	8.33	0.00	8.33	16.67	0.00	8.33
Ascorbic acid (AA)	20 mM	16.67	8.33	16.67	16.67	8.33	25.0
$CuSO_4$	20 mM	8.33	0.00	0.00	8.33	0.00	0.00
$MgSO_4$	20 mM	16.67	8.33	8.33	16.67	8.33	8.33
KH_2PO_4	20 mM	8.33	8.33	8.33	8.33	8.33	8.33
Bion 50%	800 ppm	16.67	8.33	8.33	16.67	8.33	8.33
Ethephon	800 ppm	8.33	16.67	8.33	8.33	16.67	8.33
Rizolex T 50%	1500 ppm	8.33	8.33	16.67	16.67	16.67	16.67

Table (3): Effect of application methods of some abiotic inducers on the percentage of dead strawberry plants after 21 and 45 days of planting under field conditions in seasons 2004 & 2005.

Abiotic inducers	Cons.	% of dead plants after 21 & 45 days			
		2004		2005	
		21	45	21	45
Control		22.50	24.17	19.17	22.50
Salicylic acid	20 mM	1.67	2.50	0.00	0.00
Boric acid	20 mM	0.83	3.33	0.83	3.33
Ascorbic acid	20 mM	1.67	2.50	0.83	1.67
$CuSO_4$	20 mM	2.50	3.33	0.00	0.00
$MgSO_4$	20 mM	1.67	2.50	1.67	2.50
KH_2PO_4	20 mM	2.50	3.33	0.83	1.67
Bion	800 ppm	2.50	4.17	0.83	1.67
Ethephon	800 ppm	0.83	1.67	0.83	1.67
Rizolex-T	1500 ppm	0.83	1.67	0.00	0.83

Effect of abiotic inducers on oxidative enzymes activities:

Data in Table (5) show that maximum peroxidase (PO) activity was observed with 20 mM of AA then $CuSO_4$ and $MgSO_4$ in the soil infested with all three tested fungi. Meanwhile, the lowest activity was observed with 800 ppm Bion 50% then 20 mM SA. Activities in other treatments were inbetween. Most of abiotic inducers increased the PO activity in the strawberry roots infected with *R. fragariae*, followed by *S. rolfsii* then *R. solani*. Polyphenoleoxidase (PPO) activity peaked in roots of strawberry sown in soil infested with *S. rolfsii* and treated with 20mM $MgSO_4$, followed by 20mM SA, BA and 800 ppm Bion 50% in the soil infected with *R. fragariae*. PPO activity in the treated plants with 20 mM BA, AA, $CuSO_4$ 800 ppm Ethephon and 1500 ppm Rizolex-T was lower than control in roots grown in soil

infested with *S. rolfsii* and *R. solani*. Chitinase activity in the roots of strawberry plants grown in infested soil with three tested fungi was recorded two peaks with 20 mM SA and KH_2PO_4. Generally, all tested inducers were increased chitinase activity in the treated than untreated control. Lowest chitinase activity was recorded with 1500 pp Rizolex-T, followed by 20 mM of BA, AA, $CuSO_4$ and $MgSO_4$ under the stress of almost three tested fungi. β,1-3-glucanase activity was nearly of those of chitinase with few exceptions.

Table (4): Effect of some abiotic inducers on shoot and root length of strawberry plants (15 days) after sowing in a pathogen-infested soil.

Abiotic inducers	Cons.	Shoot length (cm)			Root length (cm)		
		S. rolfsii	*R. fragariae*	*R. solani*	*S. rolfsii*	*R. fragariae*	*R. solani*
Control		2.43	2.63	2.57	8.73	8.20	8.93
Salicylic acid (SA)	20 mM	4.80	4.40	4.80	15.20	13.50	15.90
Boric acid (BA)	20 mM	4.40	4.10	4.87	14.73	12.33	15.67
Ascorbic acid (AA)	20 mM	4.83	4.43	4.50	15.20	13.07	16.10
$CuSO_4$	20 mM	5.40	5.17	4.93	15.67	14.10	15.67
$MgSO_4$	20 mM	4.50	4.13	4.20	13.67	12.20	14.77
KH_2PO_4	20 mM	4.47	4.37	4.57	14.53	12.23	15.62
Bion 50%	800 ppm	4.10	4.07	3.90	12.77	11.27	13.43
Ethephon	800ppm	5.93	6.17	6.50	17.27	15.17	17.23
Rizolex-T 50%	1500ppm	4.67	4.77	4.60	15.27	13.57	15.47

Effect on lignin content in roots of strawberry plants:

Data in Table (6) show that all tested abiotic inducers; regardless root rot pathogens, greatly increased lignin content in roots in comparison with the untreated controls. Using SA against any tested root rot pathogen (*S. rolfsii*, *R. fragariae* and *R. solani*) induced the highest lignin content followed by Rizolex-T, AA, BA, KH_2PO_4, $MgSO_4$, $CuSO_4$, Bion and ethephon, respectively.

DISCUSSION

Among tested chemical inducers, Rizolex-T used at 800ppm and salicylic acid (SA) used at 20mM caused the highest inhibition of growth of the tested root-rot pathogens followed by ethephon, ascorbic acid (AA) and boric acid (BA), $CuSO_4$, Bion, KH_2PO_4 and $MgSO_4$ (all used at 20mM except Bion and ethephon which used at 800ppm). Singh and Dwivedi (1987) reported that salicylic acid, picric acid and 2,4- dinitrophenol caused significant reduction in radial growth of *S. rolfsii*. Kataria *et al.* (1997) found that the antioxidants ascorbic acid, benzoic acid, gluconic acid lactone and thiourea inhibited *Rhizoctonia solani* growth *in vitro*. Shaat (1998) recorded that all the tested antioxidants including ascorbic acid and salicylic acid reduced linear growth of the tested pathogenic fungi (*Helminthosporium tetramera*, *Cochliobolus spicifer* and *Fusarium oxysporum*) on Czapek's agar medium at concentrations of 10 mM. Shalaby *et al.* (2001) recorded that, potassium salicylate (PS), oxalic acid and salicylic acid inhibited the *in vitro* growth of *M. phaseolina*. El-Ganaieny *et al.* (2002) evaluated some antioxidants [aminobutyric acid (ABA), potassium salicylate (PS), oxalic acid (OA), salicylic acid (SA) or ascorbic acid (AA)] at different concentrations [2 - 10 mM] for their effect on growth of *Fusarium*

oxysporum, F. solani and *F. moniliforme*. The antioxidants were more effective against Fusarium species when applied as seed and transplant treatment than as soil treatment under greenhouse conditions.

Table (5): Effect of abiotic inducers on Peroxidase, Polyphenoloxidase, Chitinase and β,1-3-Glucanase activities* in roots of strawberry plants after 8 days from planting in a pathogen-infested soil.

Abiotic inducers	Peroxidase			Polyphenoloxidase			Chitinase			β,1-3-Glucanase		
	S. rolfsii	*R. fragariae*	*R. solani*	*S. rolfsii*	*R. fragariae*	*R. solani*	*S. rolfsii*	*R. fragariae*	*R. solani*	*S. rolfsii*	*R. fragariae*	*R. solani*
Control	0.152	0.260	0.261	1.698	1.580	1.681	3.78	3.85	3.81	4.3	4.4	4.4
Salicylic acid	1.636	3.760	3.180	1.962	1.980	1.936	12.78	10.58	12.38	13.9	11.7	14.4
Boric acid	4.198	4.217	2.881	1.133	1.881	0.921	5.13	6.46	7.29	5.7	7.3	6.5
Ascorbic acid	6.748	7.143	5.633	1.276	1.563	0.921	5.35	6.55	7.26	6.9	6.5	5.7
$CuSO_4$	6.521	6.826	5.701	0.811	0.685	0.966	5.72	8.25	7.06	7.3	8.7	7.3
$MgSO_4$	6.630	6.443	4.432	3.721	1.853	1.890	7.43	10.35	5.96	6.4	9.5	5.4
KH_2PO_4	4.362	4.750	3.915	1.921	1.710	1.692	11.47	12.79	9.32	13.2	13.9	7.3
Bion	0.678	2.433	2.748	1.470	1.831	1.078	8.70	8.60	7.48	6.6	7.4	5.4
Ethephon	4.188	5.126	2.801	0.973	0.951	1.545	7.15	7.19	7.34	7.2	8.7	7.3
Rizolex-T	4.471	4.412	4.644	1.381	1.369	1.372	4.78	5.13	7.02	10.2	8.2	10.4

* Optical densities for peroxidase, polyphenoloxidase, chitinase and β,1-3-glucanase were recorded at 425nm/g FW/15min, 495nm/g FW/30min, 540nm/g FW/60min and 500nm/g FW/60min., respectively.

Table (6): Effect of some abiotic inducers as pre-sowing treatment on lignin content (mg/g dry weight) in roots of strawberry plants (15 days) after planting in a pathogen-infested soil.

Abiotic inducers		Lignin content (mg/g dry weight)		
		S. rolfsii	*R. fragariae*	*R. solani*
Control		120	132	127
Salicylic acid (SA)	20 mM	398	411	421
Boric acid (BA)	20 mM	352	361	382
Ascorbic acid (AA)	20 mM	379	391	392
$CuSO_4$	20 mM	256	291	289
$MgSO_4$	20 mM	291	295	321
KH_2PO_4	20 mM	316	345	366
Bion 50%	800 ppm	256	276	295
Ethephon	800 ppm	256	262	275
Rizolex-T 50%	1500 ppm	398	390	379

Under greenhouse conditions, $CuSO_4$ caused the highest decrease in dead plants incited by tested root rot pathogens followed by BA and SA, KH_2PO_4, $MgSO_4$, Bion, ethephon and Rizolex-T compared to the untreated control. This positively correlated with the inhibition effect of these inducers on tested root-rot pathogens and the role of these chemicals in the induction systemic resistance in the treated plants. Sallem *et al.* (1992) showed that ethephon treatment was efficient in inducing resistance of faba bean to both chocolate spot (*Botryits fabae* and *B. cinerea*) and rust

disease *(Uromyces fabae)*. Soaking seeds in 800 ppm ethephon resulted in a significant reduction in the severity of both disease and a noticeable increase in seeds/plant. Nofal *et al.* (1996) controlled the pepper root-rot infection caused by *Pythium* sp., *Rhizoctonia solani, Fusarium solani, Sclerotinia* sp. by using pre-sowing treatment with 1200 ppm solution of ethephon. They found that Ethephon treatment had a depression effect on fungal infection during the different periods of pepper growth. Mazen (2004) mentioned that salicylic acid (SA) and ethephon gave a significant protection against *Rhizoctonia solani* infection with low percentage of pre- and post-emergence damping off and high percentage of survival plants. Shenoudy (2004) found that after 10 days of treatment the least disease severity resulted on plants treated with Ethephon, Rubigan, Bion and salicylic acid. He and Wolyn (2005) noticed that SA-treated plants exhibited enhanced systemic resistance, with a significant reduction in disease severity of the asparagus roots inoculated with *F. oxysporum* f.sp. *asparagi*, compared with untreated plants. Durrant and Dong (2004) mentioned that, systemic acquired resistance (SAR) is a mechanism of induced defense that confers long-lasting protection against a broad spectrum of microorganisms. SAR requires the signal molecule salicylic acid (SA) and is associated with accumulation of pathogenesis-related proteins, which are thought to contribute to resistance.

Enzyme activities (peroxidase, polyphenoloxidase, chitinase and β,1-3-glucanase) in the roots of strawberry plants grown in the soil infested with each of three tested root-rot fungi were increased as response to treating with KH_2PO_4 and SA inducers at 20mM than other abiotics. Also, lignin content was increased in the treated plants in response to all inducers than untreated.

Induced systemic response (ISR) defined as the process of active resistance dependent on the host plant's physical and chemical barriers, activated by biotic and abiotic agents (Leeman *et al.*, 1996). This response involves production of many pathogenesis related proteins (PR-proteins) which mainly include (a) phenol oxidases, peroxidases and polyphenoloxidases (Nicholson and Hammerschmidt, 1992; Wojtaszek, 1997) and (b) enzymes like β-1,3 glucanases, chitinases, β-1,4 glucosidases and N-acetlyglucosaminidases (Heil and Bostock, 2002). Changes that have been observed in plant roots exhibiting induced system resistance include: (1) strengthening of epidermal and cortical cell walls and deposition of newly formed barriers beyond infection sites including callose, lignin and phenolics (Yedida *et al.*, 1999); (2) increased levels of enzymes such as chitinases, peroxidase polyphenol oxidase, and phenylalanine ammonia lyase (Nicholson and Hammerschmidt, 1992; Wojtaszek, 1997); (3) enhanced phytoalexin production (Marley and Hillocks, 1993); and (4) enhanced expression of stress-related genes (Zhang, *et al.*, 2002).

CONCLUSIONS

Its clear from all mentioned results that abiotic inducers gave fast similar efficacy of the tested fungicide Rizolex-T. Thus, we could recommend using of these abiotic inducers in stead of many used fungicides for managing root-rot diseases of strawberry, as well as saving the environment and human health.

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إستجابة نباتات الفراولة لبعض المحثات الكيماوية تحت ظروف تواجد بعض مسببات مرض عفن جذور الفراولة

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أختبر تأثير المعاملة ببعض الكيماويات التابعة لمجموعات مختلفة في استحثاث مقاومة نباتات الفراولة لبعض الفطريات المسببة لأعفان الجذور مثل ريزوكتونيا سولاني وريزوكتونيا فراجاريا وسكليروشيام رولفزياي. وتحت ظروف المعمل اختبر تأثير محاليل أحماض السلسيلك والبوريك والأسكوربيك وكبريتات النحاس وكبريتات المغنسيوم وفوسفات البوتاسيوم بتركيز ٢ ملليمول ، ومستحضر البيون والإثيفون التجاريين بتركيز ٨٠٠ جزء في المليون وأخيراً مبيد ريزوليكس-ت بتركيز ١٥٠٠ جزء في المليون (الموصى به) على النمو الميسليومي للثلاثة فطريات السابقة ، ووجد أن حمض السلسليك ومبيد الريزوليكس ومركب الأسيفون (بالتركيزات المذكورة) كانت أكثرهم تأثيرا على خفض معدل النمو الميسليومي عن غيرها من المحاليل. وتحت ظروف الصوبة أختبر تأثير نقع جذور شتلات الفراولة (لمدة ١٠ دقائق) ثم رش المجموع الخضري (بعد ٧ أيام) بمحاليل الكيماويات السابقة في استحثاث مقاومة النباتات المنزرعة في التربة المعداة بالفطريات المختبرة ، ووجد أن كبريتات النحاس قد حافظت على حياة معظم النباتات من الموت سواء بعد ٢١ أو ٤٥ من زراعتها في التربة المعداة بفطريات رايزوكتونيا فراجاريا وريزوكتونيا سولاني ، وحدث نفس التأثير باستخدام حمض البوريك ضد فطر رايزوكتونيا فراجاريا ، أما تأثير بقية المركبات على نسبة موت النباتات فقد كان متقاربا. أيضاً أدت المعاملة لزيادة واضحة في أطوال الجذور والمجموع الخضري وخاصة نتيجة المعاملة بمركب الأثيفون. وتحت ظروف الحقل تسببت المعاملة بتلك المركبات وبتركيزاتها خفض نسبة النباتات الميتة بعد ٢١ و ٤٥ يوم في موسمي الزراعة ٢٠٠٤ و ٢٠٠٥ إلا أن تأثيرها كان أقوى في الموسم الثاني عن الموسم الأول. وكانت أقوى المركبات تأثيراً حمض السلسليك وكبريتات النحاس يليها في ذلك أحماض البوريك والأسكوربيك ومركب البيون. أدت المعاملة بالمركبات المختبرة لزيادة في أطوال الجذور والمجموع الخضري أكثر من النباتات الغير معاملة. وبقياس نشاط بعض إنزيمات الأكسدة المرتبطة بالتفاعل بن الفطريات الممرضة والنباتات وجد أن نشاط إنزيمات البيروكسيداز والبولي فينول أوكسيداز والشيتيناز والجلوكوناز قد زاد بصورة ملحوظة في النباتات المعاملة عن الغير معاملة. وهذا النشاط أدى إلى زيادة اللجنين في النباتات المعاملة مما فسر تحسن نموها بجانب مقاومتها للفطريات الممرضة المختبرة.