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Performance of induced resistance chemicals (IRCs) on olive transplants root rot disease under greenhouse conditions

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ABSTRACT

Root rot of olive transplants is a severe disease caused by several soil borne fungi recording high loss in growth and transplants production in nurseries. Benzoic acid, Sorbic acid, Salicylic acid, Propionic acid, Potassium sorbate, Potassium silicate, and Hydroqunion as Induced Resistant Chemicals (IRCs) were tested against linear growth of pathogenic fungal isolates causing root rot of olive transplants *i.e., Macrophomina phaseolina, Botryodiplodia theobromae, Fusarium solani* and *Rhizoctonia solani*. The tested concentrations of Induced Resistance Chemicals (IRCs) significantly reduced the mycelium growth of tested fungi. Benzoic acid, Sorbic acid, Propionic acid and Salicylic acid with 25mM concentration recorded and 100% growth reduction of tested fungi.

All tested concentrations of Propionic acid completely inhibited the linear growth of all tested fungi. Also complete inhibition of linear growth was obtained with Benzoic acid, Sorbic acid, Salicylic acid at concentrations of 10, 15 and 25 mM with all tested fungi except that *B. theobromae* while other treatments showed moderate effects.

The efficiency of four Induced Resistance Chemicals (IRCs) on disease incidence and severity was carried, under greenhouse conditions during 2019 and 2020 seasons at faculty of agriculture farm, Fayoum. Results reveal that, for 2019 growing season, the most effective treatments are Sorbic acid, Propionic acid and Salicylic acid which suppressed the disease incidence by 80.45, 91.30 & 82.61 % and disease severity by 85.13, 86.57 & 83.98 % respectively. Meanwhile, Benzoic acid showed moderate effect. The same trend was observed during 2020 growing season. All tested chemicals significantly increase plant growth parameters i.e., plant height (cm), fresh and dry weights (gm) in transplants grown in infested soil with tested pathogenic fungi comparing with untreated transplants. Results of the present study could suggest that soil drench with Induced Resistance Chemicals (IRCs) can be used as a safe control measure of the disease on olive transplants and as a stimulant of vegetative growth parameters.

KEYWORDS: Olive transplants, root rot disease, soil borne fungi, induce resistance chemicals (IRCs), vegetative growth parameters

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1. INTRODUCTION

Olive (*Olea europaea* L.) is considered one of the most important economic fruit crops in the world as well as in Egypt. It is grown extensively in the Mediterranean Basin, the subtropical regions of Australia, Southern Africa, and North and South America (Barreto *et al*., 2003). Egypt is the world's second largest producer of table olives and produced around 450,000 tons in 2018/19 of which arou olives is one of the most important fruits in Egypt. The total quantity of it is about 178,000 feddans which is considered 12.3% of the total quantity of fruits in Egypt which is about 1450.7 thousand of feddans as average (in 2008-2013). Planting olives was developed greatly in the last two decades. It increased from 480.1 thousand tons in 2008 to 541.8 thousand tons in 2013. This means that its production increased by 12.9. This made Egypt the second world country in producing it by 19.8% from the total production of olives in the world from 2008 to 2013. And it is expected that this increase will go up (Anonymouss, 2018).

Olive transplants are subject to attack by several soil-borne pathogens, causing severe deterioration in nurseries and new orchards. Root rot and wilt diseases of olive transplants are primarily caused by several pathogens, *Fusarium. solani*, *Rhizoctonia solani*, *Macrophomina phaseolina, F. oxysporum, and* other fungi (Radwan *et. al.,* 1995, Sergeeva, *et. al.,* 2005, Mousa, *et. al.,* 2006, El-Morsi, *et. al.,* 2009 and Sanei and Razavi 2011). These pathogens are capable of surviving in the soil in the absence of their host plants, and might become destructive under favorable conditions.

Because of the hazards of pesticides in general and fungicides in specific, on public health and environmental balance (Elad, 1992) a relatively recent direction of pest control management was introduced. Inducing or acquiring the systemic resistance in the host plant became a good target for minimizing disease incidence or severity with the least cost and without environmental pollution. Organic acid and antioxidants which save to humans and the environment had been used successfully to control some plant diseases such as peanut root rot (Mahmoud *et al*., 2006), Fusarium wilt in tomatoes (El-Khallal, 2007; Mohamed *et al*., 2007), damping- off in pepper (Rajkumar, 2008), root rot and wilt diseases in pepper plants (Abd El-Monaim and Ismail, 2010 and wilt diseases of Roselle (Hassan *et al.,* 2014). At the same time, Abd EL-Hai *et al*. (2016) found that antioxidant i.e., benzoic, citric and salicylic acids were highly effective agents in the control of soil borne pathogens of soybean i.e., *Fusarium solani, Rhizoctonia solani* and *Macrophomina phaseolina*.

This work was carried out to study the effect of some antioxidant compounds i.e. Benzoic acid, Sorbic, Salicylic, Potassium sorbate, Potassium silicate, Hydroqunione, and Propionic acids on linear growth of *Macrophomina phaseolina, Botryodiplodia theobromae, Fusarium solani* and *R.solani in vitro* and their effect on root rot disease as well as growth parameters of olive transplants.

2. MATERIALS AND METHODS

2.1. Effect of Some Induce Resistance Chemicals (IRCs) on linear growth of olive transplants root rot fungi *in vitro*: -

Four organic acids i.e. Benzoic acid, Sorbic acid, Salicylic acid, Propionic acid and three antioxidants Potassium sorbate, Potassium silicate, and Hydroqunion as Induce resistance

chemicals (IRCs) were tested to study their effect on linear growth of olive root rot fungi i.e. *Macrophomina phaseolina, Botryodiplodia theobromae, Fusarium solani* and *R. solani in vitro.* Previous treatments were dissolved in sterilized distilled water to prepare 100 ml stock solutions. Calculated volumes from each stock solution were added to 100 ml of (PDA) medium to obtain the tested concentration, i.e., 5.0, 10.0, 15.0 and 25.0 mM just before pouring into the Petri dishes to evaluate their efficacy on the radial growth of the tested fungal isolates as described by Deans and Svoboda (1990). PDA plates free of organic acid or antioxidants concentration were served as control. For each treatment, as well as the control treatment, three petri dishes were used as replicates. All plates were incubated at 25°C until the control plate was completely covered by fungal mycelium development. The inhibitory effect was measured the linear growth (MG mm) of each isolate and the percentage of fungal growth reduction (GR %) was calculated according to the following formula:

Fungal growth reduction (GR %) = (C-P/C) *100.

Where C is the diameter of mycelial growth in untreated plate (control) and P is the diameter of mycelial growth in treated plate.

2.2. Effect of some Induced Resistance Chemicals (IRCs) on olive transplant root rot disease incidence under greenhouse condition:

The efficacy of IRCs on olive transplant root rot disease was carried out to evaluate their effect on disease incidence and severity during 2019 and 2020 seasons at Deomo farm of the Faculty of Agriculture, Fayoum University.

The efficacy of IRCs on root rot disease incidence and severity of olive transplants was carried out during 2019 and 2020 seasons at Deomo farm of the Faculty of Agriculture, Fayoum University.

The inoculum of tested fungi i.e., *Macrophomina phaseolina, Botryodiplodia theobromae, Fusarium solani, F.oxysporum*, and *Rhizoctonia solani* was prepared by inoculate autoclaved barley-sand medium in 500 ml bottles with homogeneous agar discs of 5 mm in diameter holding 7 days old growth of each isolate and incubating at 25°C for two weeks to get sufficient growth. For check treatments, uninoculated autoclaved barley medium were utilized.

According to the data obtained from previous laboratory experiment, four organic chemicals i.e., Benzoic, Sorbic, Propionic and Salicylic acids were applied. This experiment was carried out on apparently healthy olive transplants cv. Toffahi under greenhouse conditions during growing season 2019 and 2020. Natural soil of each planting black plastic bag which previously individually infested with *Macrophomina phaseolina, Botryodiplodia theobromae, Fusarium solani and R. solani* at the rate of 5% of soil weight. The IRCs at 25mM concentration were drenched with 250 ml of each of 7 days later soil infestation. One olive transplant (three-month-old) of cv. Toffahi was planted in each bag and five bags were used as a replicate for each treatment. Five uninoculated transplants served as control. The experiment treatments were irrigated regularly every 21 days. The percentage of disease incidence and severity were recorded after Three months of planting in a black plastic bag. Re-isolation was carried out from infected transplants showing disease symptoms and the isolated fungi were compared with the original fungal cultures used.

Disease assessments:

A- Disease incidence (DI %) = **Total number of infected plants/Total number of plants *100.**

B- Disease severity (DS %):

The disease severity was evaluated on a scale of 0-4 based on the percentage of the affected foliage where 0= transplants healthy, 1= from 0 to 25% (mailed symptoms), 2= from 26 to 50 % (intermediate symptoms), 3= from 51 to 75% (severe symptoms), 4= more than 76% diseased foliage (transplants nearly to dead and dead). The percentage of disease severity (DS %) was calculated according to **El-Morsi et al., 2009** as follows:

$$DS\% = \sum n \times v / N \times V \times 100.$$

Where: n = Number of plants in each category, v= Category number, N = Number of all plants nd Va = the highest category.

Vegetative growth parameters *i.e.* Length shoot (cm), Fresh weight root (g) and Dry weight root (g) were recorded according to **Ahmed and Morsy 1999**.

Statistical analysis

Analysis of variance (ANOVA) was used to perform statistical analysis of the data using SAS software (version 9.1). Duncan's multiple range tests were used to differentiate the means at a 5% level of probability **Snedecor and Cochran, 1982.**

RESULTS AND DISCUSSION

3.1. Effect of the some Inducer Resistance Chemicals (IRCs) on linear growth of root rot 3.2. fungal isolate *in vitro*.

Laboratory experiment was conducted to determine the inhibitory effects of seven organic acids and antioxidants as Inducer Resistant Chemicals (IRCs), i.e., Benzoic acid, Propionic acids Sorbic acid, Salicylic acid; Potassium sorbate, Potassium syllicate, and Hydroqunion on olive transplant root rot fungal isolates i.e., *Macrophomina phaseolina, Botryodiplodia theobromae, Fusarium solani* and *Rhioctona solani.* Five concentrations, i.e., 5, 10, 15 and 25 mM of each one were used.

The data presented in table (1) and illustrated in Fig. (1) show that all tested concentrations of Propionic acid completely inhibited the linear growth of all tested fungi. Also complete inhibition of linear growth was obtained with Benzoic acid, Sorbic acid, Salicylic acid at concentrations of 10, 15 and 25 mM with all tested fungi except that *B. theobromae*.

Meanwhile, the tested concentrations of potassium sorbate, potassium silicate, and Hydroqunion significantly reduced the average mycelium growth of tested fungi, ranging from 27.92 to 63.08 mm and the average percentage of growth reduction ranged from 29.90% to 68.52% with Potassium sorbate and Hydroqunion at 25mm concentration, respectively. Organic acids and antioxidants as IRCs had a significant antagonistic effect on growth reduction of *M. phaseolina* (68.09%), *B. theobromae* (89.38%), *F. solani* (76.38) and *R. solani* (83.87%).

The data also show the effect of IRCs on the linear growth and growth reduction of tested fungal isolates which significantly reduced. Linear growth and growth reduction (GR %) of *R. solani* were significantly reduced, recording 31cm and 83.87%, however, *B. theobromae* was recorded 58.76cm and 89.83%, respectively.

Statistical analysis cleared that there were significant differences in average linear growth values between the evaluated organic and antioxidant chemicals. Several investigators

reported that the IRCs may control seed and soil-borne fungal diseases, suggesting that these compounds have lethal or inhibition effect on fungal cells. These results are in agreement with results obtained by **Sholberg, 1998; Shahda, 2001; Hemeda, 2009; EL-Morsi et al., 2009; Abd El-Monaim and Ismail, 2010; Moataza and Ziedan, 2010; Saad et al., 2014, Khalil, 2017 and Saad et. al, 2019.**

Many investigations and studies stated the antibacterial and antifungal properties of organic acids and antioxidants which have been widely used in foodstuff industry and agriculture **De Muynck et al., 2004; Sathe et al., 2007; Pao et al., 2008; El-Saidy and Abd El-Hai, 2011.** Salicylic acid showed superior inhibitory effect against the growth of some pathogenic fungi **Saad et al., 2014**. The mechanisms of antioxidants alone or in combination with micronutrients may inhibit a number of enzymes by dissolving the membrane lipids and interfere with membrane functions, including transport of nutrients. Also interfere with the synthesis of protein, RNA and DNA, and destroy the membrane potential similar to other weak organic acids **Eklund, 1989** in addition, antioxidants alone or in combination with micronutrients reduced linear growth and sclerotia germination of *R. solani*, Scanning electron microscopic (SEM) observation showed germ hyphae alterations, includes, changes in measurements of hyphae, increased branches, reduce length of branches, retardation of the plasm lemma and collapse of cytoplasm and reduced damping-off and rotting of young seedlings **Yousef et al., 2013**. Furthermore, applied antioxidants and micronutrients mixture inhibit the activity of enzymes involved in the biosynthesis of melanin (1, 8dihydroxynaphthalene, DHN) in a wide range of plant pathogenic fungi **(Butler and Day, 1998 and Yousef et al., 2013.**

3.1. of Induced Resistance Chemicals (IRCs) on root rot disease incidence of olive transplant (cv.Toffahii), under greenhouse conditions, during 2019 and 2020 seasons.

Data presented in Table (2) and illustrated in Fig. (2 and 3) show that, soil drench treatments with Benzoic acid, Sorbic acid, Propionic acid, and Salicylic acids significantly reduced the average percentage of root-rot disease incidence and severity of olive transplants comparing with untreated once (control).

As for 2019 growing season, the most effective treatments are Sorbic acid, Propionic acid and Salicylic acid which suppressed the disease incidence by 87.3, 90.7 & 86.3 % and disease severity by 85.1, 86.5 & 84.0 % respectively. Meanwhile, Benzoic acid showed moderate effect. The same trend was observed during 2020 growing season.

Propionic acid was significantly reduced the average percentage of root rot diseases incidence and severity recording 6.67 and 12.06%, followed by Sorbic acid and Salicylic acid which recorded **Effect** (15.00 and 13.35%) and (13.33 and14.39%) respectively, comparing with untreated once (control)which recorded 76.67 and 89.80%, respectively. Meanwhile, Benzoic acid recorded promising values without significant differences (18.33 and 24.28%).

The data also showed that IRCs was affected the average percentage of diseases incidence and disease severity of tested fungal isolates. The average percentage of disease incidence and disease severity% caused by *M. phaseolina* and *B. theobromae* were recorded 35.00 and 25.33 % as DI%, and 32.91 and 30.19%, as DS%, respectively. However, *F. solani* and *R, solani* were recorded 22.67 % and 24.00%, as DI%, and 27.87 and 28.02%, as DS%, during 2019 season.

The same trend was observed during data obtained 2020 season. Propionic acid significantly reduced the average percentage

of disease incidence and severity recording (6.67 and 12.06 %), respectively, comparing with untreated once (control), which recorded 85.84%. Meanwhile, Benzoic acid recorded promising values without significant differences 16.67 and 26.13 %.

Table (1): *In vitro* inhibitory effect of some Induced Resistance Chemicals (IRCs) on the linear growth and growth reduction of pathogenic fungal isolates causing root rot of olive transplants.

IRCs	Conc. (mM)	Fungal isolate/Linear growth (mm)/Growth reduction (%)								Average		Average all	
		M. phaseolina		*B. theobromae*		*F. solani*		*R. solani*		L.G (mm)	G.R (%)	M.G (mm)	G.R .(%)
		L.G (mm)	G.R (%)	L.G (mm)	G.R (%)	L.G (mm)	G.R (%)	L.G (mm)	G.R (%)				
Benzoic acid	5.00	13.30	85.2	90.00	0.0	28.30	68.5	16.70	81.4	37.08	58.77	26.67	87.9
	10.00	0.00	100	8.33	90.74	0.00	100	13.33	85.2	5.42	93.99		
	15.00	0.00	100	3.33	96.30	0.00	100	0.00	100	0.83	99.08		
	25.00	0.00	100	0.00	100	0.00	100	0.00	100	0.00	100.00		
Sorbic acid	5.00	60.00	33.3	78.30	27.7	0.00	100	10.00	100	37.08	65.25	28.83	69.22
	10.00	0.00	100	55.00	38.8	0.00	100	0.00	100	13.75	84.70		
	15.00	0.00	100	13.33	85.2	0.00	100	0.00	100	3.33	96.30		
	25.00	0.00	100	0.00	100	0.00	100	0.00	100	0.00	100.00		
Propionic acid	5.00	0.00	100	0.00	100	0.00	100	0.00	100	0.00	100.00	0.00	1000.00
	10.00	0.00	100	0.00	100	0.00	100	0.00	100	0.00	100.00		
	15.00	0.00	100	0.00	100	0.00	100	0.00	100	0.00	100.00		
	25.00	0.00	100	0.00	100	0.00	100	0.00	100	0.00	100.00		
Salicylic acid	5.00	18.30	79.6	81.70	25.7	23.33	40.7	5.00	94.4	32.08	60.10	25.25	72.00
	10.00	0.00	100	16.67	81.5	0.00	100	0.00	100	4.17	95.37		
	15.00	0.00	100	0.00	100	0.00	100	0.00	100	0.00	100.00		
	25.00	0.00	100	0.00	100	0.00	100	0.00	100	0.00	100.00		
Potassium sorbate	5.00	90.00	0.0	90.00	0.0	30.00	66.6	83.30	7.40	73.33	18.50	71.20	20.69
	10.00	90.00	0.0	90.00	0.0	21.67	75.9	63.33	25.90	66.25	25.45		
	15.00	90.00	0.0	90.00	0.0	15.00	83.3	58.33	35.10	63.33	29.60		
	25.00	90.00	0.0	90.00	0.0	15.00	83.3	57.33	36.30	63.08	29.90		
Potassium silicate	5.00	90.00	0.0	90.00	0.0	58.33	70.4	90.00	0.00	82.08	17.60	73.72	14.84
	10.00	57.7	35.9	90.00	0.0	55.00	35.1	90.00	0.00	73.17	17.75		
	15.00	58.3	35.1	90.00	0.0	51.67	38.9	90.00	0.00	72.50	18.5		
	25.00	56.7	40.7	90.00	0.00	26.67	40.7	30.00	66.60	50.83	37.00		
Hydro quinone	5.00	31.7	64.8	90.00	0.0	51.67	40.7	30.00	66.6	50.83	43.025	47.32	47.15
	10.00	0.00	100	90.00	0.0	50.00	44.4	0.00	100	35.00	61.10		
	15.00	0.00	100	90.00	0.0	41.33	52.5	0.00	100	32.08	63.12		
	25.00	0.00	100	90.00	0.0	21.00	74.1	0.00	100	27.92	68.52		
Control	0.0	90.00	0.0	90.00	0.0	90.00	0.0	90.00	0.0	90.00	0.00		
Average		36.21c	68.09	58.76a	89.83	39.31b	76.38	31.99d	83.87				

L.G. (mm) = Linear growth. G.R. (%) =Growth reduction according to the control treatment

L.S.D at 0.05% for	M.G.(mm)	G.R. (%)
Induced Resistance Chemicals (IRCs)	2.64	3.00
Concentration (C)	2.23	2.54
Fungi (F)	1.99	2.27
(IRCs)* (C)	5.91	6.71
(IRCs)* (C) *(F)	11.82	13.44

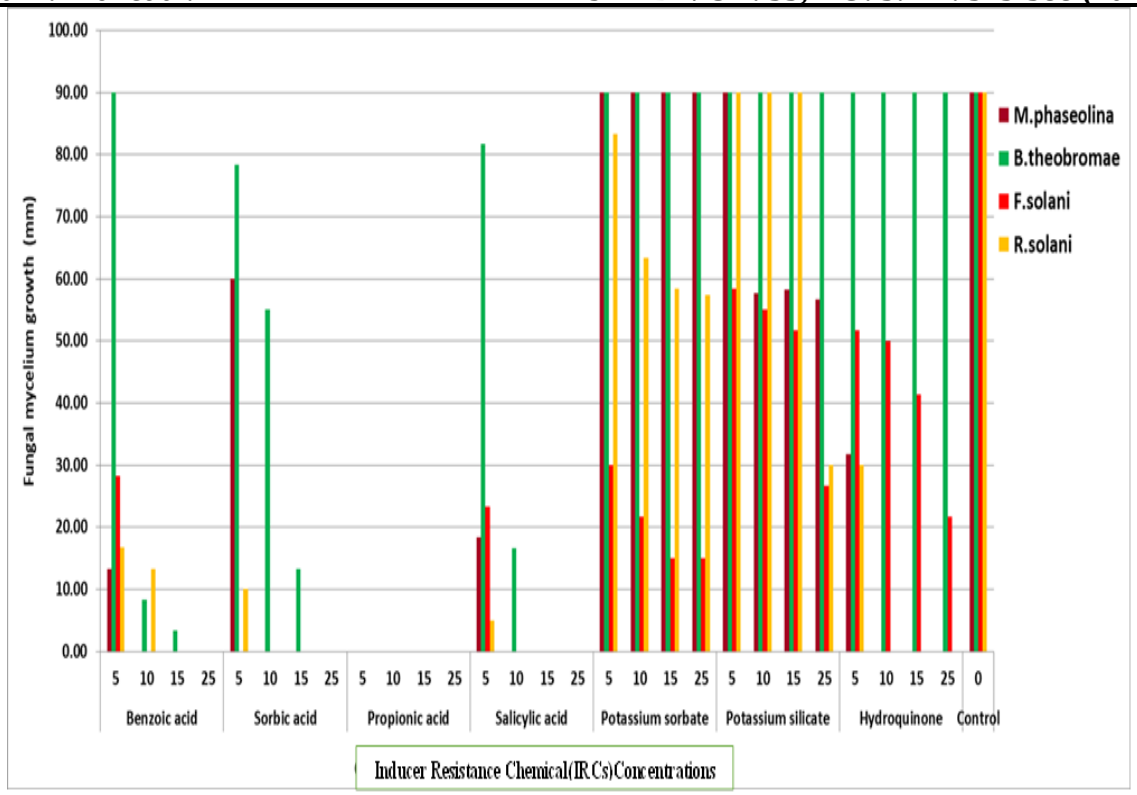

Fig. (1): *In vitro* inhibitory effect of some Induce Resistance Chemicals (IRCs) on the linear growth of root rot fungal isolates of olive transplants.

The data obtained during 2020 season also showed the effect of IRCs on the average percentage of disease incidence and disease severity % of tested fungal isolates, which was be in harmony with those obtained during 2019 season. *M. phaseolina* and *B. theobromae* were recorded 28.00 % and 32.00 %, as DI%, and 32.57and 29.15%, as DS%. However, *F. solani* and *R, solani* were recorded 26.67% and 25.34 %, as DI%, and 27.42%,as DS% for both, during 2020season.

hese results were in agreement with these obtained by **Mostafa 2006; Abdel - Monaim 2008; Nayaka et al., 2008, Abd El-Monaim and Ismail 2010 and El - Mohamedy and Abd-Alla 2013; Suprakashojha 2012; Abdel - Monaim 2013 and Ziedan et al., 2020.** They stated that tested induce resistant chemicals might stimulate some defense mechanisms such as phenolic compounds, oxidative enzymes and other metabolites **El-Khallal, 2007, Amel, et al., 2010 and EL-Mohamedy et al., 2015.** Also, they mentioned that some induce resistant chemicals may have a direct antimicrobial effect and thus, involved in crosslinking in cell walls, induction of gene expression, phytoalexin production and induction of systemic resistance **Abdel-Monaim, 2010.**

Table (2): Effect of some Induced Resistance Chemicals (IRCs) on root-rot disease incidence of olive transplants (Cv. Toffahii) artificially infected with pathogenic fungi under greenhouse conditions, during 2019 and 2020 seasons.

IRCS	Fungal isolate/ Disease incidence (DI %) /Disease severity (DS %) (2019)								Average	
	M. phaseolina		*B. theobromae*		*F. solani*		*R. solani*			
	D.I (%)	D.S (%)	D.I (%)	D.S (%)	D.I (%)	D.S (%)	D.I (%)	D.S (%)	D.I (%)	D.S (%)
Benzoic acid	26.67	33.17	20.00	23.03	13.33	24.60	13.33	16.31	18.33	24.28
Sorbic acid	20.00	14.43	20.00	11.32	6.67	13.18	13.33	14.45	15.00	13.35
Propionic acid	13.33	12.49	6.67	13.44	0.00	10.20	6.67	12.11	6.67	12.06
Salcyllic acid	13.33	16.16	6.67	11.10	13.33	15.50	20.00	14.82	13.33	14.39
Control	86.67	94.74	73.33	93.77	80.00	87.47	66.67	83.23	76.67	89.80
Average	**32.00**	**34.20**	**25.33**	**30.53**	**22.67**	**30.19**	**24.00**	**28.18**		
Fungal isolate / Disease incidence (DI%)/Disease severity (DS%)(2020)										
Benzoic acid	13.33	32.73	26.67	31.00	20.00	23.80	6.67	16.98	16.67	26.13
Sorbic acid	13.33	18.33	13.33	31.67	13.33	12.18	13.33	116.45	15.00	19.6
Propionic acid	13.33	13.57	13.33	13.44	6.67	10.83	6.67	13.11	10.00	12.74
Salcyllic acid	6.67	15.49	13.33	12.07	13.33	15.50	20.00	23.48	13.33	16.64
Control	93.33	93.41	86.77	92.33	80.00	87.10	80.03	80.12	85.01	88.24
Average	**28.00**	**34.71**	**32.00**	**36.10**	**26.67**	**29.88**	**25.34**	**30.03**		

L.S.D at 0.05% for (2019)	**D.I. (%)**	**D.S. (%)**
Induce Resistance Chemicals (IRCs)	10.18	0.37
Fungi (F)	9.11	0.34
(IRCs)*Fungi	20.37	0.75
L.S.D at 0.05% for (2020)	**D.I. (%)**	**D.S. (%)**
Induce Resistance Chemicals (IRCs)	9.78	3.02
Fungi	8.75	2.71
(IRCs)*Fungi	19.55	6.06

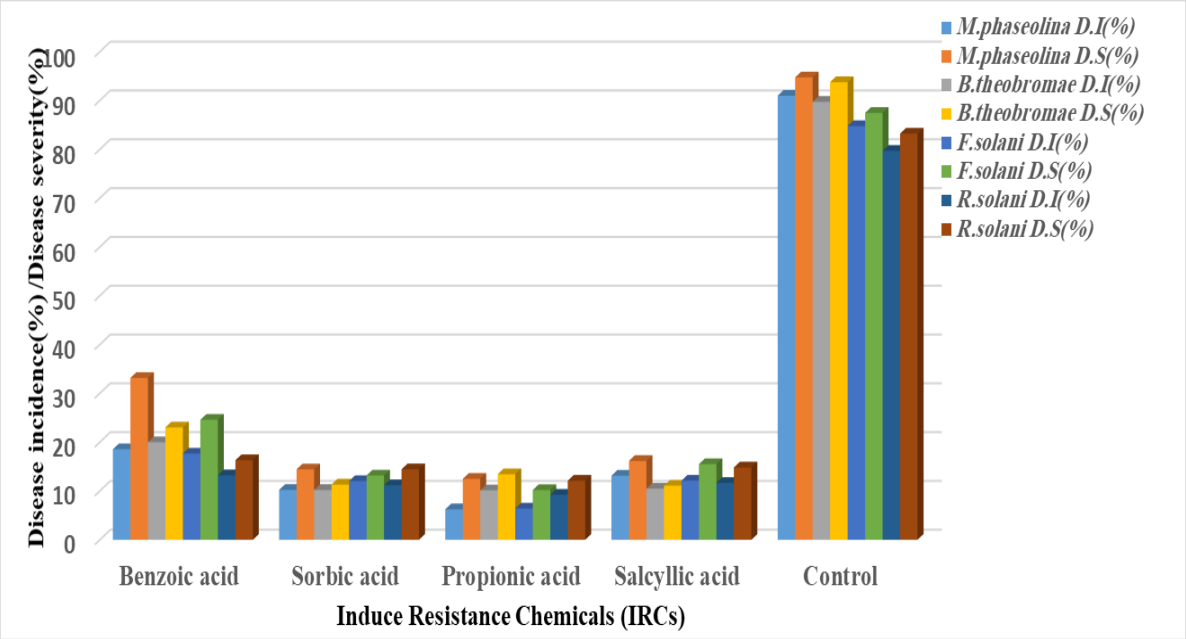

Fig (2): Effect of Inducer Resistance Chemicals (IRCs) on root-rot disease incidence of olive transplants (Cv. Toffahii) artificially infected with pathogenic fungi under greenhouse conditions, during 2019 season.

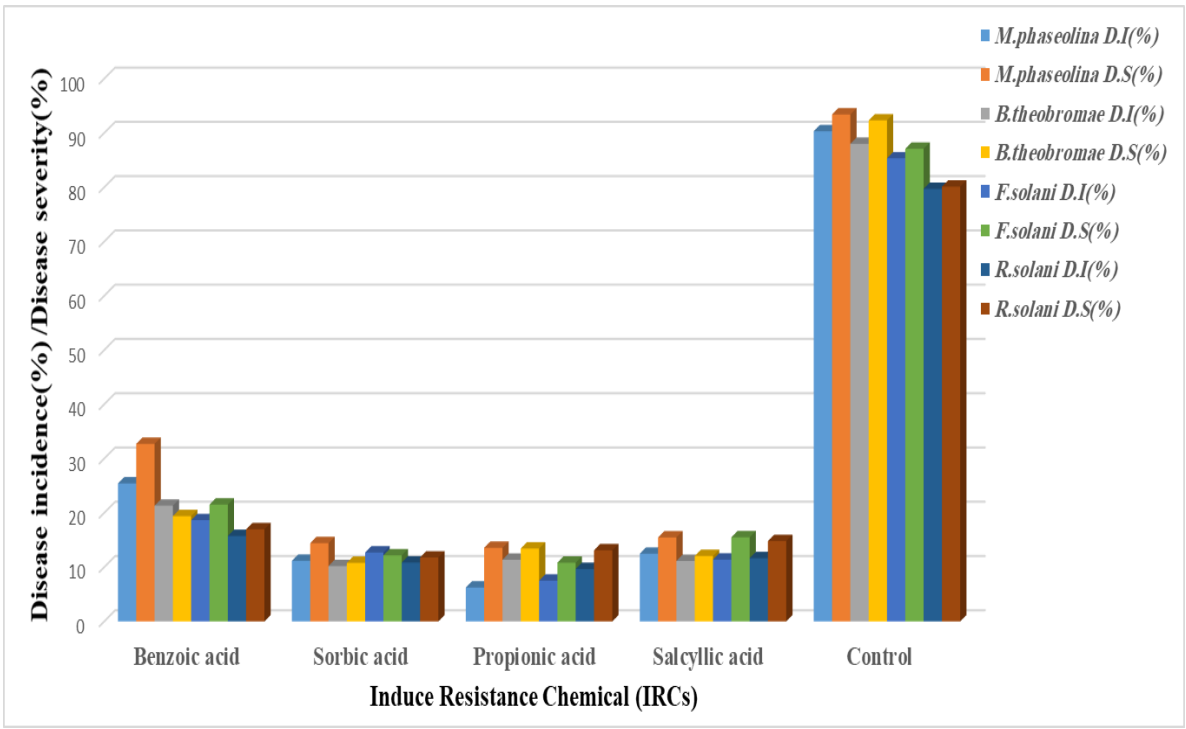

Fig. (3): Effect of Induce Resistance Chemicals (IRCs) on disease incidence of olive transplants (cv. Toffahi) artificially infected with pathogenic fungi under greenhouse condition, during 2020 season.

Table (3) Effect of Inducer Resistance Chemicals (IRCs) on growth parameter of olive transplant artificially infected with pathogenic fungi under greenhouse conditions, during 2019 and 2020 seasons.

IRCs	Fungal isolate/ growth parameter /2019												Average		
	M. phaseolina			*B. theobromae*			*F. solani*			*R. solani*					
	L.sh	F.W	D.W	L.sh	F.W	D.W	L.sh	F.W	D.W	L.sh	F.W	D.W	L.sh	F.W	D. w
Ben	65.00	6.01	4.00	79.00	14.57	7.70	68.67	10.21	5.76	68.00	12.48	6.34	70.17	10.80	5.95
SO	65.00	8.56	4.35	72.33	7.29	5.30	69.33	16.48	6.66	76.33	9.59	5.22	70.75	10.49	5.38
Prop	62.67	12.26	5.38	72.33	13.01	7.71	68.33	9.60	4.52	71.67	8.61	3.78	68.75	10.87	5.35
SA	61.67	13.88	6.50	66.33	13.50	7.80	66.33	12.68	5.56	82.67	8.61	4.35	69.25	12.17	6.05
Control	35.00	2.53	1.37	44.00	3.18	1.73	43.33	2.27	1.04	48.33	3.56	1.74	42.67	2.88	1.47
Average	58.22	8.32	4.14	65.72	9.46	5.54	63.06	10.29	4.86	68.33	8.62	4.29			
Fungal isolate/ growth parameter /2020															
Ben	64.67	6.18	4.16	72.33	13.33	6.02	73.00	9.67	5.13	76.50	10.17	5.50	71.13	9.74	4.91
SO	69.33	8.33	5.92	71.67	7.00	5.70	73.67	15.90	7.67	78.67	9.50	4.67	73.33	10.18	6.24
Prop	72.63	11.00	5.00	72.33	9.30	4.67	70.00	10.33	5.31	69.56	8.50	4.67	71.63	9.84	5.21
SA	67.00	11.17	6.13	78.00	10.33	5.40	69.33	12.00	6.46	80.67	9.00	4.67	73.75	10.63	5.67
Control	41.33	3.63	2.13	47.67	3.97	1.83	42.72	3.54	1.82	49.67	3.83	1.98	45.35	3.74	1.94
Average	62.16	7.94	4.57	67.11	8.38	4.44	65.34	10.24	5.34	69.73	8.22	4.47			

L.sh (cm) = Length shoot F.W (g) =Fresh weight root D.W (g) =Dry weight root
Ben = Benzoic acid, SO = Sorbic acid, Prop =Propionic acid, SA= Salcyllic acid

L.S.D at 0.05% for (2019)	**L.sh(cm)**	**F.W.(g)**	**D.W.(g)**
Induce Resistance Chemicals (IRCs)	5.70	2.19	47.00
Fungi	5.09	1.95	42.05
(IRCs)*Fungi	11.40	4.38	95.01
L.S.D at 0.05% for (2020)	**L.sh(cm)**	**F.W.(g)**	**D.W.(g)**
(IRCs)	4.41	1.37	0.64
Fungi	3.94	1.23	0.57
(IRCs)*Fungi	8.82	2.75	1.28

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الملخص العربى

كفاء بعض الكيماويات المستحثة للمقاومة على مرض عفن جذور شتلات الزيتون تحت ظروف الصوبة

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عفن الجذور شتلات الزيتون مرض يتسبب عن العديد من الفطريات الكامنة فى التربة ويحدث خسائر لإنتاجها في المشاتل. تم اختبار بعض المواد الكيميائية المحفزة للمقاومة (IRCs) وهى حمض البنزويك وحمض السوربيك وحمض الساليسيليك وحمض البروبيونيك وسوربات البوتاسيوم وسيليكات البوتاسيوم والهيدروكونيون ضد نمو العزلات الفطرية المسببة لعفن جذور الزيتون مثل *Macrophomina phaseolina* و *Botryodiplodia theobromae* و *Fusarium* و *Rhizoctonia solani* أدت غالبية التركيزات المختبرة للمواد الكيميائية المحفزة للمقاومة (IRCs) إلى خفض نمو الفطريات الممرضة بدرجة معنوية. أدت كل تركيزات حامض البروبيونيك المختبرة الي التثبيط الكامل لنمو كل الفطريات الممرضة . وكذلك أدي استخدام حامض البنزويك وحامض السوربيك وحامض الساليسيليك بتركيزات ١٠و ١٥ و ٢٥ ملليمول الي التثبيك الكامل لنمو كل الفطريات المختبرة عدا فطر بترورديبلوديا ثيوبروم .

تم دراسة فاعلية أربع مواد محفزة للمقاومة(IRCs) هى حامض البنزويك ، وحامض السوربيك ، وحامض الساليسيليك ، وحامض البروبيونيك كمعاملة للتربة وبالمقارنة بالشتلات غير المعاملة او قياسية (الكنترول) تحت ظروف العدوي الصناعية في تجربة الصوبة خلال موسمي النمو ٢٠١٩ و ٢٠٢٠. اختلفت في تقليل وخفض حدوث المرض وشدته فى المشتل تحت ظروف العدوى الصناعية . جميع المواد الكيميائية المحفزة للمقاومة بشكل ملحوظ في خفضت نسبة مرض عفن الجذور وشدة المرض فى شتلات الزيتون مقارنة بمعاملة الكتنرول.

وأوضحت النتائج أن خلال موسم نمو ٢٠١٩ أدت جميع المعاملات أدت الي انخفاض معنوي لنسبة حدوث وشدة مرض عفن الجذور في شتلات الزيتون . وأدت معاملات حامض السوربيك وحامض البروبيونيك وحامض الساليسيليك الي انخفاض النسبة المئوية لحدوث المرض بواقع ٨٠.٤٥ و ٩١.٣٠ و ٨٢.٦١ % ونسبة شدة المرض بواقع ٨٥.١٣ و ٨٦.٥٧ و ٨٣.٩٨ % علي الترتيب. بينما أدي حامض البنزويك الي نتئج متوسطة . تم ملاحظة نفس التماثل في النتائج خلال موسم نمو ٢٠٢٠.

وقد أظهرت الدراسة ان جميع المواد الكيميائية المختبرة المحفزة للمقاومة التى اضيفت للتربة ادت إلى زيادة معنوية في صفات النو الخضرى للنباتات مثل ارتفاع النبات (سم) والأوزان الرطبة والجافة لجذور الشتلات (جرام) المنزروعة في التربة المعدية بالفطريات الممرضة المختبرة مقارنة بالكنترول الغير معامل (تربة غير مغمورة بالمعاملات). وبذلك تشير نتائج الدراسة الحالية إلى أن غمر التربة بمواد كيميائية محفزة للمقاومة (الأحماض العضوية) يمكن استخدامها كطريقة آمنة لمكافحة المرض في مشاتل الزيتون وكمحفز لصفات النمو.