

**THE USE OF SALICYLIC ACID TO CONTROL ROOT ROT
-WILT COMPLEX AND TO ENHANCE YEILD AND
QUALITY OF FABA BEAN**

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ABSTRACT

Five fungal species were found to be associated with root rot and wilt of faba bean in three major regions for faba bean cultivation in El-Behera governorate, *Rhizoctonia solani*, *Fusarium oxysporum*, *Fusarium solani*, *Verticillium spp* and *Aspergillus niger*. *F.oxysporum* was the most prevalent over the surveyed regions and recovered in frequency of 67.51% followed by *R. solani* frequencies of 20.9% while the other fungal species were recovered in frequency lower than 10%. Treatment with salicylic acid to faba bean as seed soaking for 24 hours in 4mM solution before sowing has resulted in considerable reduction in disease severity developed by *R.solani* and *F.oxysporum*, 44.93 % and 36.47 % for the two fungal species, respectively. This reduction effect was found to be correlated with higher peroxidase ($r = 0.70$ and 0.71) and polyphenol ($r = 0.98$ and 0.97) activities due to the salicylic acid treatment. Meanwhile, salicylic acid treatment has resulted in enhancement of the vegetative growth of faba bean grown in the soil infested with *R. solani* and *F. oxysporum* compared to the untreated infested control. This was resulted in 24.58 and 22.25cm for shoot length, 36.08 and 29.76cm for root length, 15.12 and 10.13cm for shoot fresh weight and 10.06 and 8.93cm for the root fresh weight for treated plants grown in soil infested with *F. oxysporum* and *R. solani*, respectively. Also, total carbohydrates and

total proteins obviously improved being 54.19% and 53.16% and 15.9% and 18.75% compared to 51.04 and 50.37 and 14.25 and 13.24% for *F. oxysporum* and *R. solani*, respectively for the non-treated control. The salicylic acid control and enhancement effects were reflected in improved seed yield / plant as 25.45g and 24.33g compared 17.3 to 13.41, for *F. oxysporum* and *R. solani*, respectively. Also, number of seeds/ plant increased to 13.44 and 10.22 and 34, 28.89 compared to 25.4 and 24.2 in non-treated control. The obtained results showed that the effect of salicylic acid in controlling faba bean root rots and wilt. Control can be integrated with other control measures to have a sustainable management for faba bean disease control.

INTRODUCTION

Faba bean (*Vicia faba* L.) is an old leguminous food used on a large scale for human and animal feed in Egypt and many other countries in the world. In addition, faba bean adds about 20-30 nitrogen unit/feddan thus increases soil fertility (Ministry of Agric.2005). Unfortunately, faba bean is attacked by several diseases, which cause tremendous quantitative and qualitative losses in yield in the field (El-Garhy, 1994). Root rot diseases, and wilt ranked as the most important fungal diseases affecting faba bean production in Egypt. These are complex diseases involving several soil-borne fungi which cause yield losses and badly affect quality of faba bean (El-Gantiry *et al.*, 1994; Abou-Zeid *et al.*, 1997; Akem and Bellar, 1999 and Kurmut *et al.*, 2002). Several fungal species were reported to be associated with root rot and wilt of faba bean in Egypt and in several parts of the world these were *Rhizoctonia solani*, *Fusarium oxysporum*, *Sclerotium spp.*, *Helminthosporium spp.*, *Phytophthora spp.*, *Pythium.*, *Verticillium spp.*, *Fusarium solani* (Sepulveda 1991; Kurmut *et al.* 2002; Mazen 2004). Fungicides are an important disease management mean there ever-growing the public concern over the use of fungicides posed a pressure to seek non-fungicidal and safer materials to control root rot and wilt of faba bean. Salicylic acid (SA) has been reported to have potential to control several plant diseases as plant resistance inducers via inducing the systemic acquired resistance (SAR) against, bacterial wilt (Abdel-Said *et al.*, 1996) as well as the

fungal root rot and wilt diseases (Chen-Chunquan *et al.*,1999; El-Mougy,2004; Mahmoud,2004 ; Mazen, 2004 and Ragab *et al.*, 2009). Moreover, few records reported a direct inhibition effect of SA on growth of several phytopathogenic microorganisms (Matthew & Alexander,1999 and El-Mougy, 2002). Induction of systemic resistance sensitizes the plant to responded in the form of activation of peroxidase and polyphenol oxidase (Meena *et al.*, 2001 and Mahmoud, 2004). Peroxidase and polyphenol oxidase enzymes play a role in plant defense against pathogens. These enzymes were highest in the internal tissues of the resistant cultivars compared to the susceptible cultivars (Cui *et al.*, 2002; Campos *et al.*, 2004; Thipyapong *et al.*, 2004; Raj *et al.*, 2006 and Thipyapong *et al.*, 2007)

The present study therefore was conducted to investigate the potential of SA to control root rot and wilt of faba bean and its effect on plant growth, yield quantity, and yield quality.

MATERIALS AND METHODS

1-Isolation and identification of fungi associated with root rot and wilt of faba bean:

Plants of faba bean showed root rot and wilt symptoms were sampled from five different regions where faba bean was of effectively cultivated intensively in El-Behera governorate during the 2005-2006 growing season, These were Kafr El-Dawar, Etay El-Baroud, Shobrakhit, AboHomous and KomHamada

Diseased samples were washed with tap water, cut to 0.5 cm long, surface disinfected using sodium hypochlorite solution (2%) for 2 - 3 minutes, and washed with sterilized water. The sterilized parts were dried with sterilized filter paper and transferred into Petri dishes (9 cm diameter) containing water agar medium. Plates were incubated at 27°C for 5 days. Hyphal tip or single spore cultures of grown fungi were maintained on PDA medium identified according to Booth ,(1971), Ellis, (1971) and Barnett and Hunter, (1972). Frequency of the isolated fungi was recorded.

2 - Cultivar reaction and effect of salycilic acid treatment on root rot and wilt of faba bean.

Greenhouse experiment was conducted at Etay El-Baroud Agric. Res. Station during the 2006 / 2007 growing seasons. Fourty five days

after sowing , severity of root rot and wilt developed on faba bean plants grown in soil artificially infested with *F. oxysporum* and *R.solani* were assessed according to Hassan, (1992) and Muyolo *et al* , (1993) .

3:Chemical changes associated with salicylic acid treatments

Greenhouse experiments were conducted at Etay El-Baroud Agric. Res. Station during the 2006 / 2007 growing seasons. Seeds of faba bean cultivars , Sakha 1, Giza 3 and Giza 843 used in these experiments were obtained from the Department of Legume Crop Research , Field Crops Research Institute , Agricultural Research Center , Giza .

Faba bean seeds were soaked in the solution of salicylic acid (4Mm) for 24hrs as recommended by Mazen (2004)and Mahmoud *et al.*, (2006) then dried between two layers of filter papers while other faba bean seeds were soaked in tap water for the same period and used as control. Salicylic acid (99%) was obtained from EL-Nasr company.

The inoculum of the most pathogenic frequent fungi recovered from the surveyed regions were prepared by growing discs (5-mm in diameter) of 7days old cultures of each fungus on sand barley medium (25g sand + 75g barely and sufficient water) in 500ml conical flasks and incubated at 28°C for 15 days according to Heweidy *et al.*, (2000)

Clay soil was previously treated with 5 % formalin solution. Plastic pots (25 cm) were rinsed in the same solution and then filled with soil and covered with heavy cloth for 10 days after which they were left uncovered for a few days' before inoculation trials.

The barley inoculum of the pathogens was added to the prepared pots at the rate of 3% of soil weight and mixed thoroughly with the soil. The pots were watered for 7 days before planting to give a chance for the growing and establishment of the pathogens. Healthy faba bean seeds which were previously soaked with salicylic acid sown in pots (five seeds / pot) and 4 pots were used for each treatment. Untreated seeds were used as control treatment. Tow sets were prepared for both diseased and faba bean growth and yield assessments. All pots were left under greenhouse conditions and were irrigated when necessary.

After 45 days of sowing, shoot length (cm), root length (cm), shoot fresh weight (g), root fresh weight (g) and shoot dry weight (g) were recorded. This was conducted in both untreated and treated plants

with salicylic acid. Meantime, yield and yield components, i.e., yield of seeds/pot (g), number of pods/pot, and number of seeds/pot, were recorded 90 days after sowing.

3.a. Effect of salicylic acid on peroxidase and polyphenol oxidase activity of faba bean plants cultivated in soil infested with *Fusarium oxysporum* and *Rhizoctonia solani*.

Peroxidase and polyphenol oxidase were determined after 15 and 30 days from sowing (37 days and 52 days) from soil infestation with the tested fungi.

Extraction:

Plant tissue (roots) was homogenized in a mortar with 0.2 M Tris HCL buffer (pH 7.8) containing 14 Mm B- mercaptoethanol (1:3 W/V). The extracted tissues were strained through four layers of cheesecloth. The filtrate was centrifuged at 3000 rpm for 15 minutes at 6°C. The supernatant was saved in the refrigerator at -20°C till determination of enzymes (Tuzun *et al.*, 1989).

Peroxidase activity:

Peroxidase activity was determined spectrophotometrically, according to Allam and Hollis, (1972) by measuring the oxidation of pyrogallol to pyrogallin in the presence of H₂O₂ at 425 nm. The reaction mixture consists of 0.5 ml of 0.1M sodium phosphate buffer solution at pH 7.0, 0.5 ml enzyme extract, 0.3 pyrogallol, 0.1 ml 1.0% H₂O₂ brought to final volume of 3.0 ml with distilled water. The activity of peroxidase enzyme was expressed as change in absorbance/ min.

Polyphenol oxidase activity:

For polyphenol oxidase determination, a spectrophotometrically method proposed by Matta and Dimond, (1963) was used. The reaction mixture consists of 1.0 ml enzyme extract, 1.0 ml 0.2 M sodium phosphate buffer at PH 7.0 and 1.0 ml 10 M catechol brought to final volume of 6.0 ml with distilled water. The activity of polyphenol oxidase was expressed as the change in the absorbance of the mixture every 0.5 min period at 495 nm.

3.b. Protein and carbohydrates content of seeds.

Total protein determination:

Total nitrogen content was determined by a modified semi-micro keelhaul method according to Hassouna, (1962)and Rahhal, (1978).

The total nitrogen content (g) was calculated according to the equation:

$14 \times (0.01/1000) \times (100/5) \times (\text{titration value of sample} - \text{titration of blank})$

Determination of total soluble carbohydrates:

The procedure of Dubois *et al.*, (1956) was followed. The optical density of the mixture was measured at 490 nm by means of the spectrophotometer. The carbohydrate content was calculated by the following equation:

Carbohydrate % = $F \text{ (mg)} \times \text{extract volume (ml)} / (\text{aliquot (ml)} \times \text{sample wt (g)} \times 10)$

Where F = mg carbohydrate obtained from the graph.

4. Effect on growth and yield of faba bean.

Seeds of faba bean cultivars ; Sakha 1, Giza 3 and Giza 843 used in these experiments were obtained from the Department of Legume Crop Research , Field Crops Research Institute , Agricultural Research Center , Giza . Faba bean seeds were soaked in the solution of Salicylic acid (4Mm) for 24hrs then dried partially between two layers of filter papers while other faba bean seeds were soaked in tap water for the same period and used as control (Aly et al., 1988). The inoculum of each pathogenic fungus; *Fusarium oxysporum* and *Rhizoctonia solani* was prepared by growing discs (5-mm in diameter) of 7days old cultures of each fungus on sand barley medium (25g sand + 75g barely and sufficient water) in 500ml conical flasks incubated at 28°C for 15 days. Clay soil was previously treated with 5 % formalin solution. Plastic pots (25 cm) were rinsed in the same solution and then filled with soil and covered with heavy cloth for 10 days after which they were left uncovered for a few days before inoculation trials. The barley inoculum of the pathogens was added to the prepared pots at the rate of 3% of soil weight and mixed thoroughly with the soil. The pots were watered for 7 days before planting to give a chance for the growing, establishment and spreading of the microorganisms. Healthy faba bean seeds which were previously soaked with biotic inducers were sown in pots (five seed / pot) and 4 pots were used for each treatment. Untreated seeds were used as control treatment. All pots were left under greenhouse conditions and were irrigated when necessary (Heweidy et al., 2000). After 30 days and 45 days shoot length (cm), root length (cm), shoot fresh weight (g), root fresh weight

(g), shoot dry weight (g) were recorded.

5. Statistical Analysis:

Data obtained were statistically analyzed using randomized and factorial designs (Snedecor and Cochran, 1967). Averages were compared with LSD test at the 0.05 of probability.

EXPERIMENTAL RESULTS

1- Fungi associated with root rot and wilt of faba bean:

The faba bean root rot fungi were identified according to Booth,(1971)&Ellis,(1971) as *F.oxysporum*, *Fusarium solani*, *R. solani*, *Verticillium spp* and *Aspergillus niger* Data presented in Table (1) showed that five fungal species were recovered from the surveyed regions. The *F.oxysporum* isolates, however, were prevalent and constituted 67.51 % of the total isolates made, i.e., 129. This was followed by *R.solani* which constituted 20.9%. Meantime, the *Fusarium solani*, *Verticillium spp* and *Aspergillus niger* isolates were recovered in lower frequency of 11.22, 7.69 and 1.54, respectively. Both *R. solani* and *F.oxysporum* were recovered from the five surveyed regions while *F. solani* isolates were recovered from only three localities.

Meantime, the *Verticillum spp.* were recovered from only two regions, while the *A.niger* were isolated from only one region out of the five regions surveyed (Table 1).

2- Cultivar reaction and effect of salicylic acid treatment:

Data in Table (2) exhibited that all tested faba bean cultivars were susceptible to the tested soil-borne fungi. Severity of the disease developed with the tested fungi, i.e. *Rhizoctonia solani* and *Fusarium oxysporum* ranged between 73.5 and 90.7. However, treatment with salicylic acid substantially decreased severity of the disease incited by the tested soil-borne fungi. The reduction obtained ranged between 20.88% and 64.7%. The cv.Giza 843, however, was exhibited the highest tolerance to the infection in the salicylic acid treatment followed by Giza 3 cv.

Table (1): Frequency of fungal isolates recovered from rotted roots and wilted faba bean samples collected from five regions in El-Behera Governorate, during the 2005-2006 growing seasons.

Regions Fungi	Regions					Total isolates	Frequency
	Kafr El-Dawar	Abo-Homous	Etay El-Baroud	Kom Hamada	Shobrakheet		
<i>Rhizoctonia solani</i>	4	9	5	6	3	27	20.9
<i>Fusarium oxysporum</i>	24	24	16	7	8	79	67.51
<i>Fusarium solani</i>	1	9	7	–	–	17	11.22
<i>Verticillium spp</i>	–	–	–	3	2	5	7.69
<i>Aspergillus niger</i>	–	–	–	1	–	1	1.54
Total	29	42	28	17	13	129	

Values are number of isolates recovered.

Frequency (%) = [number of isolates of certain fungal species / total isolates recovered] x 100.

Table (2): Cultivar reaction and effect of treatment with salicylic acid on disease severity developed on faba bean grown in potted soil artificially infested with certain soil borne fungi, 45 days after sowing.

Fungi Cultivar	<i>Fusarium oxysporum</i>			<i>Rhizoctonia solani</i>		
	Untreated control	Treated	*R (%)	Untreated control	Treated	R(%)
Sakha 1	73.5	50.63	31.11	81.9	64.8	20.88
Giza 3	77.9	47.53	38.98	73.8	46.3	37.26
Giza 843	89.1	31.45	64.7	90.7	44.2	51.26
Mean	80.16	43.2	44.93	82.13	51.76	36.47

Values are disease severity(%)

*Reduction (%) = [(control- treatment) / control] x 100.

L.S.D 0.05

Cultivar (C): 18.9 13.3

Treatment (T): 1.16 1.21

3:Chemical changes associated with salicylic acid treatment:

3.a.Peroxidase and polyphenol oxidase activity:

Table (3): Effect of salicylic acid treatment on peroxidase and polyphenoloxidase activity in roots of faba bean cultivars sown in soil artificially infested with *F. oxysporum* and *R. solani*, 15 and 30 days after sowing.

Cultivars	Peroxidase activity (absorbance at 425 nm / g.f.w)				Polyphenol oxidase activity (absorbance at 495 nm / g.f.w)			
	<i>F.oxysporum</i>		<i>R.solani</i>		<i>F.oxysporum</i>		<i>R.solani</i>	
	Untreated control	Treated	Untreated control	Treated	Untreated control	Treated	Untreated control	Treated
	15 days							
Sakha 1	0.38	0.44	0.30	0.87	0.29	0.32	0.31	0.48
Giza 3	0.47	0.66	0.44	0.56	0.28	0.3	0.28	0.47
Giza 843	0.4	0.62	0.34	0.39	0.27	0.38	0.2	0.35
Mean	0.42	0.57	0.36	0.59	0.28	0.33	0.26	0.43
	30 days							
Sakha 1	0.4	5.47	1.12	1.49	0.56	0.62	0.42	0.45
Giza 3	3.2	5.2	1.16	1.48	0.61	0.68	0.47	0.6
Giza 843	2.8	3.5	1.19	1.55	0.37	0.73	0.41	0.54
Mean	3.33	4.5	1.15	1.50	0.51	0.67	0.43	0.53

* Data are average of 4 replicates.

Data illustrated in Table (3) indicated that salicylic acid treatment increased both the peroxidase and polyphenol oxidase activity assessed 15 and 30 days after sowing in the infested soil compared to the untreated control. This was consisted with the three tested faba bean cultivars and for the two tested soil-borne fungi, i.e., *R. solani* and *F. oxysporum*, in both of the two tested intervals of the assay (Figs.1,2,3,4).

3. b.Total protein and carbohydrate content:

Data in Table (4) indicated that salicylic treatment tended to increased percentage of both the carbohydrate and total protein in the faba bean seeds of plants grown in soil infested with the soil borne fungi compared to the untreated infested control. This was steady in the three cultivars tested and for the two tested fungi despite that it was not always significant. The cv.Giza 843 was the most positively responded and percentage of total protein significantly increased compared to untreated infested control.

Table (4): Effect of salicylic acid on carbohydrate content and total protein of faba bean seeds produced in soil infested with *F. oxysporum* and *R. solani*.

Cultivars	Carbohydrate of seeds %				Total protein of seeds %			
	<i>F.oxysporum</i>		<i>R.solani</i>		<i>F.oxysporum</i>		<i>R.solani</i>	
	Untreated control	Treated	Untreated control	Treated	Untreated control	Treated	Untreated control	Treated
Sakha 1	47.43	53.38	51.54	55.74	14.3	14.44	16.6	19.38
Giza 3	52.59	54.6	50.31	51.98	15.19	16.63	12.19	18.13
Giza 843	53.11	54.6	49.26	51.76	13.19	16.63	10.94	18.76
Mean	51.04a	54.19a	50.37a	53.16a	14.25	15.9	13.24	18.75

Data are average of 4 replicates.

LSD at 0.05 for cvs:	3.18	N.S	N.S	N.S
For treatment:	N.S	N.S	1.33	2.17

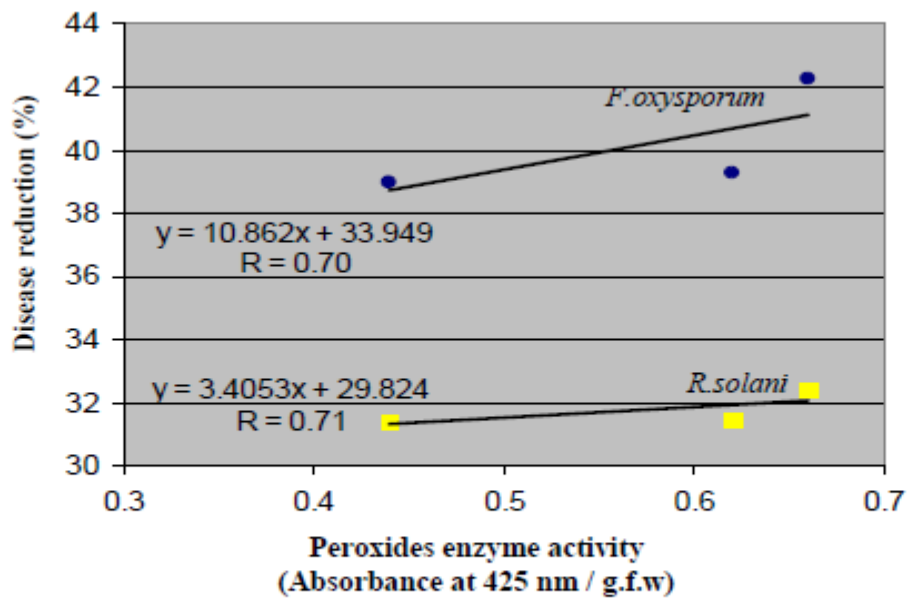


Figure (1) Correlation between peroxidase activity and disease reduction of faba bean seeds grown in infested soil with *F. oxysporum* and *R. solani* after 15 days of sowing

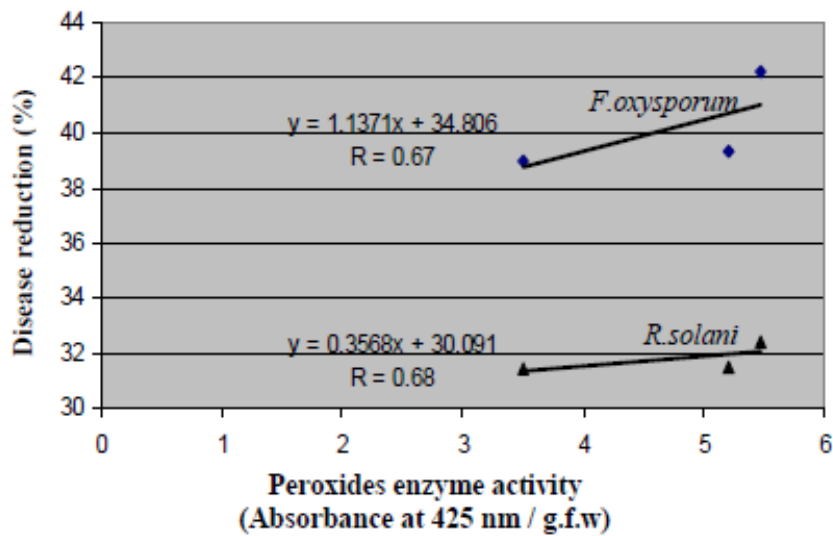


Figure (2) Correlation between peroxidase activity and disease reduction of faba bean seeds grown in infested soil with *F. oxysporum* and *R. solani* after 30 days of sowing

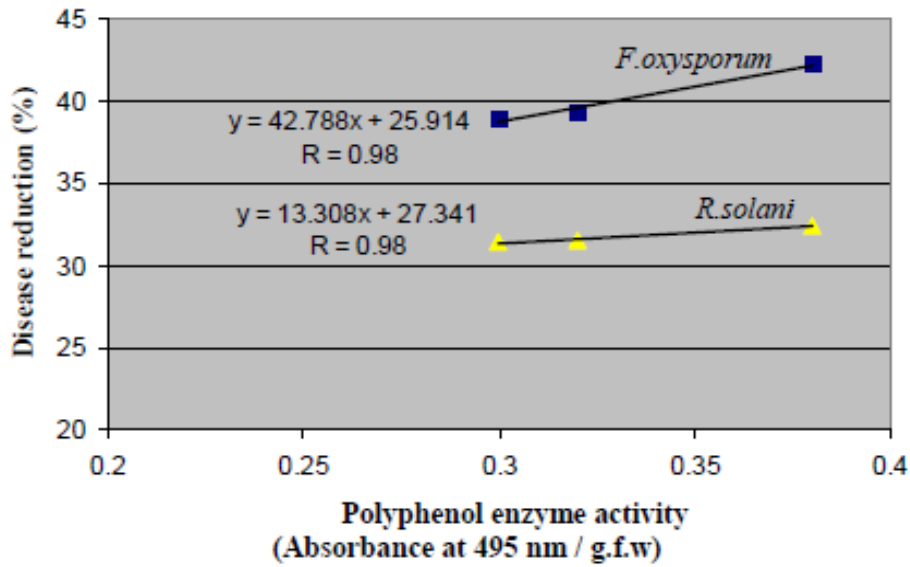


Figure (3) Correlation between polyphenol oxidase activity and disease reduction of faba bean seeds grown in infested soil with *F. oxysporum* and *R. solani* after 15 days of sowing

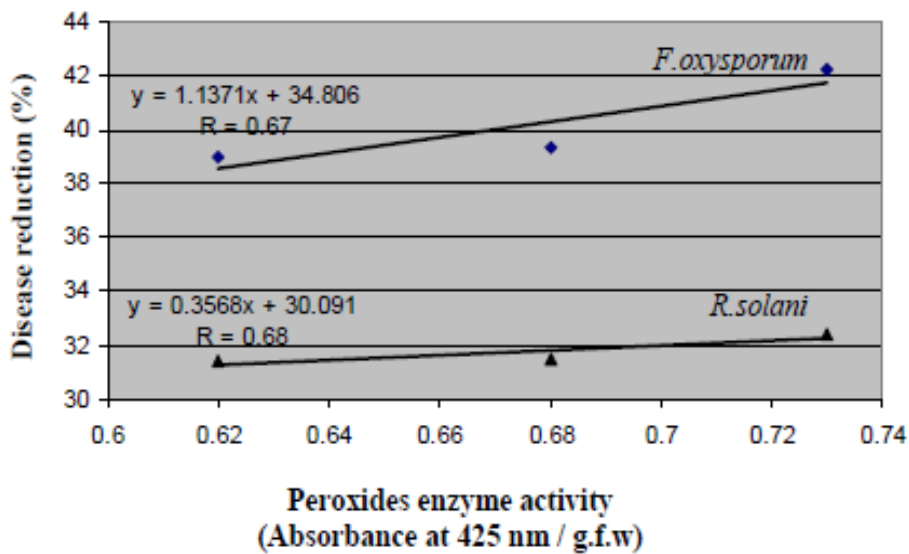


Figure (4) Correlation between polyphenol activity and disease reduction of faba bean seeds grown in infested soil with *F. oxysporum* and *R. solani* after 30 days of sowing

4. Effect of salicylic acid on growth and yield of faba bean:

4.1. Effect on vegetative growth:

Data presented in Table (5) indicated that salicylic acid treatment to faba bean significantly improved all the vegetative growth characteristics tested for the plants grown in soil infested with the two tested soil-borne fungi compared to the untreated infested control. This was true for all the tested faba bean cultivars, i.e., Sakha 1, Giza 3, and Giza 384, and for the two tested fungi, i.e., *R. solani* and *F. oxysporum*.

Table (5): Effect of salicylic acid treatment on vegetative growth of faba bean cultivars sown in soil artificially infested with *F. oxysporum* and *R. solani*, under greenhouse conditions.

Cultivars	Shoot length (cm)				Root length (cm)				Shoot fresh weight (g)				Root fresh weight (g)			
	<i>F.oxysporum</i>		<i>R.solani</i>		<i>F.oxysporum</i>		<i>R.solani</i>		<i>F.oxysporum</i>		<i>R.solani</i>		<i>F.oxysporum</i>		<i>R.solani</i>	
	Untreated control	Treated	Untreated control	Treated	Untreated control	Treated	Untreated control	Treated	Untreated control	Treated	Untreated control	Treated	Untreated control	Treated	Untreated control	Treated
Sakha 1	19.0	24.25	17.5	25.5	20.0	42.0	25.5	31.25	9.03	12.97	7.32	13.84	8.48	8.92	4.61	7.65
Giza 3	17.75	28.5	19.5	20.5	20.75	40.0	31.0	31.25	8.24	17.82	5.88	11.87	6.53	10.56	4.9	7.99
Giza 843	20.0	21.0	13.25	20.75	26.5	35.0	23.25	26.5	8.41	14.57	1.67	4.69	7.96	10.7	3.23	9.54
Mean	18.92	24.58	16.75	22.25	22.41	36.08	26.58	29.76	8.56	15.12	4.95	10.13	7.66	10.06	4.25	8.93

L.S.D. at: 0.05 Cvs	N.S	N.S	N.S	N.S	N.S	1.42	N.S	1.89
Treatment	2.30	3.06	3.25	4.33	N.S	1.14	N.S	1.52

4.2. Effect on yield and yield components:

It is evident from data of Table (6) that treatment with salicylic acid to faba bean grown in soil infested with *R. solani* and *F. oxysporum* significantly increased the seed yield per pot. This was 25.45 and 24.33 g/pot in treated pots compared to 13.41 and 17.3 g/pot for the untreated control for *F.oxysporum* and *R.solani* infested soil, respectively. Similar increase was

Table (6):Effect of salicylic acid treatment on yield and yield components of faba bean grown in soil infested with two tested soil-borne fungi

Cultivars	Yeild of seeds/plant (g)				Number of pods/plant				Number of seeds/plants			
	<i>F.oxysporum</i>		<i>R.solani</i>		<i>F.oxysporum</i>		<i>R.solani</i>		<i>F.oxysporum</i>		<i>R.solani</i>	
	Untreated control	Treated	Untreated control	Treated	Untreated control	Treated	Untreated control	Treated	Untreated control	Treated	Untreated control	Treated
Sakha 1	8.43	33.5	18.03	30.36	10.33	12.67	10	10.33	26	37	23.67	30.0
Giza 3	16.87	24.28	18.8	21.3	10.67	15	10	11	28.67	36	27.33	34.67
Giza 843	14.93	18.57	15.07	21.33	8.67	12.67	9	9.33	21.67	29	21.67	22.0
Mean	13.41	25.45	17.3	24.33	9.89	13.44	9.66	10.22	25.44	34	24.22	28.89

L.S.D. at 0.05 Cvs Treatment

5.06	3.51	N.S	N.S	4.19	2.95
3.03	2.74	N.S	N.S	3.63	2.19

recorded for the number of pods/pot and number of seeds/pod. However, the increase in the number of pods/pot was not significant

Discussion

Identification of the isolated fungi from rotten roots and wilted faba bean plants of different faba bean cultivars collected from five regions, in which faba bean was intensively cultivated in EL-Behera governorate during the 2005-2007 growing seasons, showed that the highest frequency recorded was for *Fusarium oxysporum* 67.51. This was followed by *F. solani*, *Rhizoctonia solani*, *Verticillium spp.* and *Aspergillus niger* with averages of 20.9, 11.82, 7.69 and 1.54 %, respectively. These results are in agreement with the findings of El-Gantiry *et al.*, (1994) and Mazen, (2004). This trend was closely similar to the trend shown by the results mentioned by El Gantiry *et al.*, (1994).

All the tested faba bean cultivars were susceptible to *Rhizoctonia solani* and *Fusarium oxysporum* which were the most frequent fungi in the conducted survey. However, treatment with salicylic acid substantially decreased severity of the developed disease incited by the tested fungi, i.e. *Rhizoctonia solani* and *Fusarium oxysporum*. The reduction in the disease severity obtained ranged between 20.88% and 64.7%. Meanwhile the cv. Giza 3, however, had the most tolerant reaction for the tested fungi and the most consistent response to salicylic acid treatment.

Induced resistance is a physiological state of enhanced defensive capacity elicited by specific environmental stimuli, whereby the plant's initiate defenses are potentiated against subsequent biotic challenges. Colson, (1998) and Mahmoud *et al.*, (2006) reported that some chemical inducers significantly reduced damping-off, wilt and root rot incidence. This was supported by findings of the present study. The reduction effect of salicylic acid on root rot and wilt diseases in our study, meantime, is in agreement with the findings of Gaffney *et al.*, (1993); Delaney *et al.*, (1994); Chen-Chunquan *et al.*, (1999) and Mandavia *et al.*, (2000) who reported that SA has been claimed to be essentially involved in systemic acquired resistance (SAR) against viral, fungal and bacterial pathogens.. On the other hand, El-Mougy, (2004) reported that acetylsalicylic acid (ASA) as lupine seed dressing or soil drench showed superior effect on root rot incidence followed by SA and Rizolex-T, respectively . This may sensitizes the plant to respond rapidly after infection. These responses include phytoalexin accumulation, phenols, lignifications and activation of

peroxidase and polyphenol oxidase. It was proposed that SA signaling leading to SAR is mediated by active oxygen species (AOS) derived from H_2O_2 , since SA specifically binds to catalase and inhibits it (Chen *et al.*, 1993).

Meantime, in the present study salicylic acid treatment increased both the peroxidase and polyphenol oxidase activity assessed 15 and 30 days after sowing compared to the untreated control. This was consistent with the three tested faba bean cultivars and for the two tested soil-borne fungi, i.e., *R. solani* and *F. oxysporum*, in both of the two intervals of the assay, with evident correlation ($r = 0.70, 0.71$) and polyphenol ($r = 0.98, 0.97$). This was in agreement in general with the findings of Meena *et al.*, (2001) and Mahmoud, (2004) who found that application of chemical inducers led to increased activities of both peroxidase and polyphenol oxidase. Agrios, (1988) indicated that the importance of polyphenol oxidase activity in disease resistance probably was due to its property in oxidizing phenolic compounds to quinones, which are often more toxic to microorganisms than the original phenols. It is reasonable to assume that an increased activity of polyphenol oxidase results in high concentrations of toxic products of oxidation.

Salicylic acid treatment also tended to increase percentage of both the carbohydrate and total protein in the faba bean seeds of plants grown in soil infested with root rot and wilt fungi compared to the untreated infested control. This was steady in the three cultivars tested and for the two tested fungi. This was in agreement with Ismail *et al.*, (2008), who reported that in faba bean (G40) foliar application of SA exhibited a high percentage of seed protein content which reached 23.62%.

Salicylic acid treatment to faba bean in the present study significantly improved all the vegetative growth characteristics tested for the plants grown in soil infested with the tested soil-borne fungi compared to the untreated infested control. This was true for all the tested faba bean cultivars i.e., Sakha 1, Giza 3, and Giza 384, and for the two tested fungi, i.e. *R. solani* and *F. oxysporum*.

This was reflected in a higher yield of 25.45 and 24.33 g/pot in treated pots compared to 13.41 and 17.3 g/pot for the untreated infested with *F. oxysporum* or *R. solani*, respectively. This was reflected in a better yield components, i.e. the number of pods and the number of seeds / pot. These results are in harmony with those findings of Mazen (2004) who reported

that the treatment with a biotic inducers showed remarkable increase in faba bean growth parameters (including length of plant, fresh weight, dry weight, weight of 100 seed and seed yield) compared with untreated control. Abd-El Kareem (1998) added that the increase in yield was not only due to the reduction in disease severity, but also due to a positive effect of the treatments themselves. Despite that the obtained effect of salicylic acid to control root rot and wilt of faba bean was not effective the fungicides, this, however, can be integrated with other control measures to achieve the sustainable management in which the use of fungicides will be the last resort.

The use of salicylic acid .may not control disease to a level which may replace the use of fungicides,however,this integration into current diseases management practices could reduce the fungicide use and the associated environmental problems. cultivars, i.e. Sakha 1, Giza 3, and Giza 384, and for the two tested fungi, i.e. *R. solani* and *F. oxysporum*.

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الملخص العربي

استخدام حمض السلسيليك في مكافحه عفن الجذور والذبول وتحسين محصول وجوده الفول البلدي

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وجد أن هناك خمسة أجناس فطرية مرتبطة بأمراض أعفان الجذور والذبول في الفول البلدي وذلك في ثلاثة مناطق لزراعته في محافظة البحيرة وهذه الأجناس كانت كالتالي:

Rhizoctonia solani, *Fusarium oxysporum*, *Fusarium solani*, *Verticillium spp*
Aspergillus niger. ألا أنه وجد ان الفطر *F.oxysporum* كانت أكثر تكرارا في كل المناطق التي تم حصرها وذلك بنسبه (67,51%) ويليه الفطر *R. solani* بنسبه (20,9%) بينما ظهرت باق الأجناس الفطرية بمعدلات تكرار اقل من (10%). كما وجد ان المعاملة بحمض السلسيليك مرتين في صورته محلول للذور وكتنليل للتربة وذلك بعد 15 يوم من الزراعة قد ادي إلي انخفاض ملحوظ في الشدة المرضية التي يظهرها الفطرين *R.solani* and *F.oxysporum* وذلك بنسب (44,93% و 36,47%) علي التوالي. وجد أن الانخفاض في الشدة المرضية كانت متوافقة مع الارتفاع في معدلات نشاط البيروكسيداز بمعدل ارتباط (ر = -0.70، 0,71) والبولي فينول او كسيداز (ر = 0,97-0,98) وأدت المعاملة بحمض السلسيليك إلي تشجيع النمو الخضري لنبات الفول البلدي المزروع في تربه معده بالفطرين *R. solani* *F. oxysporum* وكان النشاط التحفزي كالتالي (24,58 و 22,25 سم) بالنسبة لأطوال النباتات و (10,6 و 8,93 جرام) بالنسبه للوزن الطري للجذور وأيضا الكربوهيدرات الكلية والبروتين الكلي فقد زادت بنسبه ملحوظة (15,9-53,16 -54,19 -18,75%) علي التوالي.

وأدت المعاملة بحمض السلسيليك إلي تحسين مكونات المحصول وذلك عند العدوى بالفطرين *F. oxysporum* and *R. solani* وذلك مقارنة بالتربة غير المعاملة. ومن النتائج المتحصل عليها يمكن القول أن تأثير السلسيليك أسيد في مقاومه أعفان الجذور والذبول من الممكن دمج مع طرق المقاومة الاخرى وذلك للحصول علي مقاومه مستدامة لأمراض عفن الجذور والذبول في الفول البلدي.

