Identification And Control Of Strawberry Root And Stalk Rot In Iraq

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Abstract— *This study was conducted to identify, test the pathogenicity of strawberry root and stalk rot pathogens and evaluate the efficiency of some biocontrol agents and fungicides to control the disease. The isolation and identification of fungi associated with infected plant samples showed that Rhizoctonia solani was detected in all studied commercial strawberry lath houses at different location of Baghdad-Iraq. The frequency percentages ranged 25.5-63.5 % and 10.75 - 40 % for Rhizoctonia solani and Phymatotrichopsis omnivora respectively. Pathogenicity test revealed R. solani and P. omnivora isolates were highly pathogenic to strawberry plants. The disease severity percentages of R. solani and P. omnivora were 83.0-100% and 55.5-62.0 % respectively. The isolates HRs3 and KPh1 of R. solani and P. omnivora respectively, caused the highest disease were used during this study. The control agents Rizolex and Tachigarin fungicides, Azotobacter chroococcum and Pseudomonas fluorescens have shown high efficiency against R. solani and P. omnivora on culture media (PDA).*

The treatment of biocontrol agent's A. chroococcum and P. fluorescens and the fungicide Rizolex and Preserve Pro showed high efficiency in disease control and enhance plants growth under greenhouse conditions. Disease severities on foliar and root system in A. chroococcum , Rizolex , Preserve Pro and P. fluorescens were 6,66 and 0.00 %, 20.00 and 0.00 %,13.33 and 0.00 % and 13.33and 0.00 % respectively in plants infected with R. solani .Whereas they were 6.66 and 0.00%, 13.33 and 0.00 %,13.33 and 0.00 %,and 13.33 and 0.00 % respectively in plants infected with P. omnivora. This study is the first report of the occurrence of root and stalk rot disease caused by R. solani and P. omnivora on strawberry plants in Iraq.

Keywords— Biocontrol agents, Fungicides, Root and Stalk rot, Strawberry.

1. INTRODUCTION

Strawberry *(Fragariae ananassa* Duch.) is one of the most economically important crops worldwide. It is grown under a wide range of climatic conditions as wild and cultivated plants producing small fruits. Strawberries are appreciated worldwide for their unique flavor, importance as a source of macronutrients and beneficial dietary compounds (Bianco et al. 2009) with benefits on neurodegenerative and cardiovascular (Bombarely et al. 2010).

Strawberry plants reported to be infected by several soil borne pathogens causing root rot and crown rot (Fang et al., 2011a; Fang et al., 2012). Black root rot is a complex disease caused by one or more of fungal pathogens, including *Fusarium oxysporum* (Juber et al.,2014), *Macrophomina phaseolina* (Hutton et al. ,2013) , *Phymatotrichopsis omnivora* (Hu, 2012) , *Pythium* spp. (Abdel-Sattar et al.,2008), *Phytophthora* spp. (Mingzhu et al., 2011)and *Rhizoctonia* (Fang et al., 2013). These pathogens can cause crown rot and root rot disease to strawberry either individually or in combinations. *Rhizoctonia* spp. are soil-borne pathogens cause black root rot disease. These pathogens may be predominant in soils with high clay content. This complex disease is characterized by feeder rootlet killing, deterioration and blackening of the main root system, and a decline in vigor and productivity of the plant sand causing damage to the host and considerable reduction in the yield (Abdel-Sattar et al;2008, Fang et al.,2012b; Ceja-Torres et al., 2014) .

The infected plant are less vigorous and produce fewer runners black root rot will exhibit one or more symptoms on roots. Root system is smaller than in normal plants. Lesions on the main root are darker than other root parts. Feeder roots with dark zones or lesions. All or part (usually the tip) of main roots killed. A cross-section of a dead root shows it is blackened throughout (Ullio, 2004). Root rot of strawberry caused by binucleate fungus *Rhizoctonia fragariae* Husain and McKeen or *R. solani* Kühn is a serious threat to commercial strawberry production worldwide. It is associated with severe economic losses, like those have been reported in Japan, Italy and Australia (Matsumoto and Yoshida ;2006; Manici, Bonora 2007 ; Fang, et al, 2011) Disease caused by *Rhizoctonia spp.* is difficult to manage due to the soil-borne nature and wide host range of *Rhizoctonia spp*. (Ohkura et al, 2009) . *Phymatotrichopsis omnivora* is one of a devastating soil borne ascomycete .This pathogen infects the roots of over 2,000 different species of plants and resulting in a rapid plant wilting and death causing significant economic losses. It was reported to destroy crops grown in the southwestern United States and northern Mexico

(Gaxiola et al., 2010; Uppalapati et al., 2010; Ping Hu, 2012; Arif et al., 2014). Symptoms of root and crown rot are associated with wilting of some leaves manifested on some strawberry plants rots.

Fungicides commonly used, such as Rizolex and Tachigaren are highly specific against *R.solani* (Abd-El-Kareem et al., 2004 ; Hameed ,2008 ; Fayadh et al., 2008 ; El-Morsi , and Mahdy.2013) and *Fusarium oxysporum* f. *sp*. *fragariae* (Juber et al.,2014) respectively. Growth regulators, chemical fertilizers and pesticides have extensively been used to increase yield in agriculture. Plant-Growth-Promoting Rhizobacteria (PGPR) could be used to replace the chemical products (Kawahara et al., 2006 and Walters et al., 2013).

The use of such chemicals may cause environmental pollution problems, affect animal and human health, destruction of natural biological communities and modify natural nutrient recycling (Karuppiah and Rajaram, 2011).

PGPR represent a wide range of rhizosphere- inhabiting bacteria which stimulate the growth of host plant through different mechanisms of actions (Zaidi et al., 2009; Martínez-Viveros et al .,2010 ; Karthikeyan and Sakthivel 2011; Ahemad and Kibret, 2014; and Noumavo et al., 2015**).** These mechanisms can be active simultaneously or independently at different stages of plant growth. Among these, P-solubilization , biological nitrogen fixation, improvement of other plant nutrients uptake, and phytohormone production like, indole-3-acetic acid , gibberllins, and cytokines are some of the regulators that profoundly influence plant growth (Kloepper et al.,2007 ;Bhattacharyya and Jha,2012; Mohite, 2013; Noumavo et al., 2015). It was found to produce ammonia, vitamins and also shows biocontrol activities like HCN and siderophore production (Woyesa and Assefa 2011; Paul et al., 2014). Different PGPR including associative bacteria such as, Azotobacter, Bacillus, Pseudomonas, Enterobacter have been used for their beneficial effects on plant growth (Shoebitz et al., 2009; Ordookhani and Zare,2011; Sharafzadeh,2012;Matloob and Juber, 2013; Noumavo et al., al., 2015).

Systemic acquired resistance (SAR) is the activation of plants defense mechanism leading to induction of systemic resistance to subsequent pathogens infection .Ascorbic acid (Preserve Pro) has been known to have many biochemical functions in most organisms. The role of Ascorbic acid in tolerance of plants to environmental stress has established much consideration (Khan et al., 2011). This phenomenon, that resistance of plant to pathogens can be enhanced by the application of various biotic and a biotic agent, called induce systemic resistance in plants **(**Sarwar et al ,2005 ;Abd-El Kareem et al ,2006 ;bd-El-Kareem et al, 2007**)** Ascorbic acid is an essential cofactor for α-ketoglutarate-dependent dioxygenases (e.g. prolyl hydroxylase hydroxylases). It is important for formation of covalent adducts with electrophilic secondary metabolites in plants (Tarber& Stevens, 2011). The photolysis of ascorbic acid appears to be affected by the concentration of active ingredient, pH, and viscosity of the medium (Ahmad et al., 2011). So the study was aimed to isolate and identify the causal agents of strawberry root and stalk rot and test some chemicals and biological agents as well as some specific fungicides to manage the diseases**.**

2. MATERIALS AND METHODS

2.1 Isolation and identification of pathogen

Diseased strawberry plants showing root and crown rots (Black root rot) symptoms were collected from four commercial strawberry lath houses in Baghdad / Iraq, in April 2014. Twenty symptomatic plants from each lath house were used for isolation of pathogens. Samples were transferred to the laboratory in cold boxes and prepared for isolations immediately. Leaves were removed and the remaining materials were washed carefully under running tap water. The root and crown of each plant were cut into approximately 0.5 -1 cm, surface sterilized in 1% sodium hypochlorite, rinsed with sterile water and dried in a lamina flow cabinet. Four pieces were placed on Potato Dextrose Agar (PDA:200 g potatoes, 20 g dextrose, 15g ager in 1 L water) medium containing 50 mg/L of streptomycin sulfate in petri-dish of 9cm diam. The petri-dishes were incubated at 25°C for 72 hrs. Fungal hyphae from the margin of developing colony were transferred into PDA to have pure culture. Isolates were identified up to species level based on cultural and morphological features (Parameter and Whitney, 1970, Sneh et al., 1996 and Domsch et al., 2007).

The isolation frequency of the species was calculated as follow:

$$\text{Frequency (\%)} \frac{\text{No. of plant segments of species occrrence}}{\text{Total No. of plant segments used}} \times 100 \quad (1)$$

2.2 Pathogenicity of *Phymatotrichopsis omnivora* and *Rhizoctonia solani* isolates in a glass house

Pathogenicity of *R.solani* Kühn (HRs1 - HRs4) and *P. omnivora* (Duggar) Hennebert (KPh1- KPh2) isolates were tested using strawberry seedlings in a glass house experiment. About 1kg per pot of sterilized soil was added to pots of 14 cm

diameter. The four *R.solani* and two *P. omnivora* isolates grown on millet seeds**.** Millet seed-based inoculum of each isolate was prepared using a modified procedure of Fang et al.(2012). About 100 g millet seed (*Panicum miliaceum*) was soaked in100 mL DI water in a 1 L flask for 12 h. The excess water was drained and subsequently autoclaved at 121°C and 1.5 kg //cm2 on three consecutive days. Then, 5mm diameter discs from pure fungal culture grown on PDA were added to each flask containing sterilized millet seeds. Flasks were shaken every 2 days to ensure uniform colonization and incubated at 25 ±1 C° for 2weeks. Healthy strawberry seedlings, at five leaf stage were transplanted into 14 cm diameter plastic pots (containing 1 kg/ pot sterilized soil- peat moss l:1(v/v) mixture infested with millet seed-based inoculum of each isolate at a rate of 1% (w/w). Control treatments were inoculated with sterilized millet seeds**.** One seedlings per pot and 4 replicates pots for each treatment were used. Complete randomized design (CRD) was designed for the glasshouse experiment. . Plant samples were collected 4 weeks later and the severity of root rot was assessed on a 0 to 5 disease severity scale as described previously by Fang et al. (2013). Disease severity was calculated based on the formula below:

Disease severity (%) = {Σ (No. infected plants × their infected degree) / (total examined tested plants × upper infected degree)} × 100 (2)

2.3 Evaluation the activity of Biocontrol, Rizolex and Tachigarin against pathogenic fungi on PDA

One ml of *P. fluorescens* at 10^8 CFU/ml (provided by Organic Culture Plant Protection Office, Ministry of Agriculture), *A.chroococcum* at 10^9 CFU /ml (provided by Biocides Production Department, Agriculture research center, Ministry of Science and Technology), 0.5 g/L of fungicide Rizolex, and 1 ml/L fungicide Tachigarin were added separately to PDA before solidification and poured in 9 cm diameter petri-dishes. Each petri-dish was inoculated in the middle with a 5 mm disk excised from 5 days old culture of *R.solani (*HRs3) and *P. omnivora* (KPh1) isolates individually. The plates were incubated at 25 ±1 C° until the fungal growth in the control plates reach to the edge. Four plates for each treatment were used. The fungal growth diameters were measured and the percentage of inhibition was calculated by the following equation:

% inhibition = (Fungal growth diameter in control –fungal growth diameter in treatment /fungal growth diameter in control) ×100 (3)

2.4 Evaluation of biocontrol agents activity in reduction of Strawberry root and crown rot severity under green house conditions.

Pot experiments were conducted in green house at Plant Protection Department, College of Agriculture, University of Baghdad .The pathogenic fungi isolates *R.solani* (HRs3) and *P. omnivora* (KPh1) were grown on local sterile millet seeds. Mixed soil was autoclaved at 121°C and 1.5 kg /cm² for one hour twice in two successive days, added to 1 kg pots. The pots grouped to 4 groups. The first grouped pots were treated with *A. chroococcum* (Ac) inoculum grown on sterile peat moss at 10^9 CFU /g (2g/kg) . Second group were treated with *P. fluorescens* **(**Pf**),** at 2g/kg soil containing 10^8 CFU /g. The 3rd group were watered with Preserve Pro (PP) (Preserv Pro product was provided by Arysta life science 2% Ascorbic acid) at 1ml /L., while 4^{th} group was watered with Rhizolex solution at 1g/L . Each group of pots was divided in two subgroup; the first was contaminated with *R.solani* inoculum and the second with *P. omnivora* grown on millet seeds at 10g/kg soil, three days after the addition of the biocontrol and fungicides. Other pots related to biocontrol agent non – treated with pathogenic fungi were used as control. The pots were planting with strawberry plantlets, Ruby variety and CRD with 4 replicates was used for the pots in the glasshouse. Root and foliar disease was determined after 2 month of planting and a 0–5 disease severity scale was used for disease assessment as previously described by Fang et al. (2013). Scale scores for each plant on each raised bed were converted into % indices disease based on the method described by McKinney (1923).

3. RESULTS AND DISCUSSION

3.1 Isolation and Identification of the pathogenic fungi

The isolated and identified fungi occurred in the four samples of strawberry plants showing symptoms of root rot were included in Table 1. The isolation study revealed that *R. solani* was found in all studied commercial strawberry lath houses at different location in Baghdad / Iraq with frequency percentage ranged 25.5-63.5 %. Whereas, two *P. omnivora* isolate were obtained from the samples collected from Horticulture Office / Abu Ghraib and College of Agriculture/ Abu Ghraib at 10.75 and 40.50 % frequency respectively (Table 1).

These results agreed with Fang et al.(2013) which reported that *Rhizoctonia* spp. were the most frequently isolated pathogen from diseased strawberry roots in Western Australia**.** Similar results were previously reported that the main causal agents of

strawberry root rot and crown rot was *Rhizoctonia spp.* isolated from crown and root in Western Cape Provence of South Africa (Botha et al., 2003**).** Besides, many reports indicated that strawberry black root rot diseases caused by *R. solani* fungus and causes the significant economic losses in worldwide (Abdel-Sattar et al,2008 ; Fang et al.,2013 ; Ceja-Torres et al., 2014 ; Uz-Zaman et al., 2015).

Several other studies indicated that *P. omnivora* was among major causal agent of cotton root rot (Uppalapati et al., 2010; Chitrampalam and Olsen, 2014; Arif et al., 2014) . *P.omnivora* is an indigenous soil borne fungus that is found deeply in soils. *P.omnivora*. produces Mycelial strands that colonize the roots causing rot of the entire root system. A dense web of hyphae covers the root once the fungus has penetrated and caused decay. The strands grow through the soil and infect healthy roots nearby. The fungus also survives for long periods in the soil by producing hyphal structures called sclerotia (Gaxiola et al., 2010; Hu, 2012). One aspect that makes the disease particularly damaging to agriculture is that the pathogen infects a wide range of plants, including cotton, alfalfa, vegetable crops, (Marek et al., 2009; Uppalapati et al., 2010 ; Chitrampalam and Olsen .2014**).** This is thought to be the first report of root rot and crown rot disease caused by *P. omnivora* and the *R. solani* causing root rot and crown rot of strawberry in Iraq.

TABLE 1
FREQUENCY OF *RHIZOCTONIA SOLANI* AND *PHYMATOTRICHOPSIS OMNIVORA* IN STRAWBERRY SAMPLES.

Isolates	Frequency (%)	Location
Rhizoctonia solani	30.6	Zafrianyia
R. solani	53.5	Ministry of Agriculture / Horticulture Office /Abu Ghraib
Phymatotrichopsis omnivora	40.50	
R. solani	63.5	Al-Madain
R. solani	25.5	College of Agriculture/ University of Baghdad/ Abu Ghraib
P. omnivora	10.75	

3.2 Pathogenicity of *Rhizoctonia solani* and *Phymatotrichopsis omnivora* isolates under glass house condition

Results of pathogenicity test showed that all isolates were highly pathogenic to strawberry plants (Table2)**.** The disease severity percentage of *R. solani* and *P.omnivora* isolates ranged between 83.0 -100% and 55.5 -62.0 % respectively, as compared with zero in control treatment. The highest disease severity percentage showed by *R. solani* isolate HRs3 isolated from naturally infected strawberry roots at lath houses in Al-Madain province, 100 km Southeast Baghdad (Iraq). Wherease, the lowest disease severity percentage showed by P. *omnivora*. KPh2 isolate isolated from College of Agriculture/ University of Baghdad/ Abu Ghraib compared with zero in control treatment.

TABLE 2
EFFECT OF *RHIZOCTONIA SOLANI* AND *PHYMATOTRICHOPSIS OMNIVORA* ISOLATES ON STRAWBERRY PLANTS (CV. RUBY)

*Isolate	Disease severity**(%)**
HRs1	92.5
HRs2	83.75
HRs3	100.0
HRs4	89.00
KPh1	62.0
KPh2	55.5
Control	0.0
LSD Value (P≤0.05).	4.034

*** HRs1= Zafrianyia, HRs2 = Ministry of Agriculture / Horticulture office /Abu- Ghraib, HRs3= Al-Madain, HRs4= College of Agriculture/ University of Baghdad/ Abu- Ghraib, KPh1= Ministry of Agriculture / Horticulture Office /Abu- Ghraib and KPh2= College of Agriculture/ University of Baghdad/ Abu- Ghraib**

These results agree with Fang et al. (2013) who reported that 65 out of 96 isolates of *Rhizoctonia* spp. recovered from diseased strawberry were pathogenic to strawberry in Western Australia. It has been reported that *Rhizoctonia* spp. Isolates recovered from diseased strawberry are also pathogenic to strawberry in other countries, like the USA (Martin, 2000), South Africa (Botha et al., 2003), Italy (Manici and , Bonora ,2007), Western Australia,(Fang et al.,2011a) and Mexico (Ceja-Torres et al., 2014). Results agreed with that the root rot fungus *P. omnivora* had a wide host range which includes several

crop plants, such as alfalfa and cotton and causcausing significant economic losses (Uppalapati et al., 2010; Hu et al.,2011 ; Chitrampalam ;Olsen .2014) .

3.3 The inhibition activity of biocontrol agents and fungicides against *Rhizoctonia solani* and *Phymatotrichopsis omnivora* on PDA

High percentages of inhibition in radial growth of both *R. solani* **(**HRs3) and *P. omnivora* **(**KPh1) on PDA was exerted by the bacteria A. *chroococcum* (Ac) and *P. fluorescens* (Pf), with obvious supreme of Ac compared with Pf (Table 3). The inhibition percentages of (KPh1) attained to 100% with Ac compared to 70.30 and 57.50 % with Pf for the two fungi respectively. Also it was observed that Ac was more efficient than Rizolex and Tachigarin. The inhibition percentages of HRs3 growth were 72.5 and 50.50% for Rizolex and Tachigarin respectively, wherease, they were 93.80 and 70% inhibition of KPh1 growth for Rizolex and Tachigarin respectively. The activity of Ac and Pf on the fungi may be due to the secondary metabolites produced by the two bacteria (organic compounds, Lytic enzymes and antibiotic), as well as competition with the fungi for nutrients. Hillel (2005) and Panhwar et al., (2012) have reported the *A. chroococcum* and *P. fluoresces* produced organic compounds, indol acetic acid , enzymes, antibiotic and hydrogen cyanide on culture media. Nur et al. (2008) have reported *Pseudomonas* spp. exhibited the best antagonistic properties against *R. solani* among the other collected isolates from paddy location in Seberang Perai, Penang, Malaysia. Results also agreed with Panhwar et al., (2012) finding that *P. fluorescens* have a high antagonistic ability against *R. solani* on culture media. These results were agreed with Matloob and Juber (2013) who reported that *A. chroococcum*, isolated from wheat, bean and sesban, showed a high antagonistic activity against the higher pathogenic isolate of *R. solani* (RS-3) on PSA medium. Our current results agreed with several previous studies concerning the high activity of *A. chroococcum* against *R. solani* on culture media (El-Fiki et al., 2008; Fatima et al., 2009; Al-Azawy, 2010 ; Waheed et al., 2014).

The activities of *P. fluoresces* and *A. chroococcum* were explained by their abilities to produce several antibiotics such as catalase, siderophores Oomycine A, and pyrrolnitrin, the competition and competition for space and nutrients.(Hillel,.2005 ; Panhwar et al.,2012; Abdul-hussein,2013 ; Noumavo et al.,2015) . Results agreed with Hameed (2008) who showed that Rizolex strongly inhibited mycelial growth of *R. solani* (100%) at all concentrations (0.025, 0.05, 0.25 and 0.5 ppm). The results are agreed with those recorded by Juber et al. (2014) who reported that Tachigarin was highly effective on radial growth of *F. oxysporum* f. *sp. Fragariae*.

TABLE 3
EFFECT OF BIOCONTROL AGENTS AND FUNGICIDE AGAINST *RHIZOCTONIA SOLANI* AND *PHYMATOTRICHOPSIS OMNIVORA* ON PDA

Treatment	Inhibition (%)
R. solania(HRs3) + *Pseudomonas fluorescens* (Pf)	57.50*
HRs3+ Rizolex	72.5
HRs3+ Tachigarin	50.5
HRs3+ *Azotobacter chroococcum* (Ac)	100.0
Phymatotrichopsis omnivora (KPh1) +Pf	70.30
KPh1+ Rizolex	93.80
KPh1+ Tachigarin	70.0
KPh1+ Ac	100.0

***Each value in the table represent mean of 4 replications**

3.4 Effect of Biocontrol agents and fungicides on Strawberry root and crown rot under greenhouse conditions

Results showed that all the control agents tested exhibited significant reduction in disease severity of strawberry root and crown rot caused by *R. solani* and *P. omnivora* under green house conditions (Table 4, Fig.1)

A. chroococcum reduced disease severity on foliage and root systems to 6.6 , 0.00 % , Rhizolex to 20.00 , 0.00 % , Preserve Pro (PP) to 13.33 , 0.00% and *P. fluorescens* (Pf) to 13.33 , 0.00% compared with 100% disease severity in both root and foliage of strawberry plants grown in soil contaminated with *R. solani*. Similar results were obtained with plants infected with *P. omnivora* , *A.chroococcum*(Ac) , Rizolex , Preserve Pro(PP) and *P. fluorescens* (Pf) when significantly

reduced disease severity on foliage and root systems by 6.66 , 0.00% 13.33 , 0.00 % 13.33 , 0.00 % and 13.33 , 0.00 % respectively compared with 60.00 , 26.66 % in control treatments on foliage and root systems respectively.

Results of Table (4) showed that all the tested treatments of the control agents have enhanced plants growth parameters when shown increasing fresh and dry weights of treated plants compared with control treatment (HRs3 and KPh1 alone). The effect of the control agents on the plants infected with *Rhizoctonia solani* (HRs3), the foliage and root fresh weights were 9.20 and 10.30 g/ plant in *A.chroococcum*, 8.50 and 7.90 g/ plant in Rizolex(Rz) , 8.80 and 9.30 g/ plant in Preserve Pro (PP) and 7.33 and 7.93 in *P. fluoresscens* compared to untreated control. The dry weights of plants foliage and roots were found 2.20 , 2.40 g/ plant, 2.15 , 1.90 g/plant , 2.00, 2.20 g/ plant and 1.60 , 1.70 g/ plant in Ac + HRs3, Rz + HRs3, PP+ HRs3 and Pf + HRs3 treatments respectively compared to 0.00g / plant dry weights of plants foliage and 0.43g / plant dry root in control treatment.

The foliage weights were 9.96, 9.76, 9.70 and 8.00 g /plant, while the root fresh weights were 12.80, 9.33, 9.90 and 8.76 g / plant in treatments containing, Ac+ KPh1, Rz+ KPh1, PP+ KPh1 and Pf + KPh1 treatments respectively compared to 4.77 g / plant foliage and 4.23 g / plant root weight for control treatment. The dry weights of plant foliage and root were found 2.60, 2.46, 2.40 and 1.90 g/plant and 2.75, 2.21, 2.46 and 1.85g/ plant in the same previous treatments respectively compared with 1.10 g / plant foliage dry weight and 1.06 g / plant root dry weight in control treatment.

Many previous studies reported the activity of *A.chroococcum* against *R. solani* (Al-Mousawy and Juber,2012 ; Matloob and Juber,2013; Safiuddin et al .,2014; Waheed et al .,2014). Results also agreed with EL-Barugy et al. (2009) who found that *A.chroococcum* have high antagonistic ability against root rot pathogens under green house conditions. The ability of a large number of *Pseudomonas fluorescent* strains to suppress soil borne diseases(Juber, et al .,2014 ;Waheed et al .,2014 ; Noumavo et al .,2015). Similar results were obtained by Waheed et al .(2014) who reported that all the tested treatments of *A. chroococcum*, *Bacillus subtilis* and *P. fluorescence* decreased the disease incidence and severity of eggplants infected by *R. solani* under greenhouse conditions when compared to both negative and positive control treatments .

Plant growth promoting rhizobacteria (PGPR) are known to influence plant growth by direct and/or indirect mechanisms (Noumavo et al., 2015). These mechanisms can be active simultaneously or independently at different stages of plant growth. Among these, biological nitrogen fixation and make other nutrients available to plants, and phytohormone production like, indole-3-acetic acid, gebberillins,cytokinines and auxins that profoundly influence plant growth. It was found to produce ammonia, vitamins and suppress disease causing organisms. (Martínez-Viveros et al .,2010;Mohite ,2012; Woyesa and Assefa 2011; Panhwar et al .,2012; Ahemad and Kibret, 2014 ; Paul et al., 2014; Noumavo et al .,2015). The bacteria reported to produce catalase, lytic, ,phosphatase and phytase enzymes capable of decomposing organic compounds in the soil. (Panhwar et al., 2012; Noumavo et al .,2015). Some of them produce iron scavenging compounds to improve iron nutrition to the roots of plants, and release secondary antagonistic organic compounds to protect plants from root disease (Lucy et al., 2004). PGPR can also protect several plants from root disease caused by soil borne fungi through HCN and siderophore production. Hydrogen cyanide production by *Azotobacter* isolates were about 60% for the inhibition of phytopathogens in the soil (Hillel, 2005, Joseph et al., 2007 and Ahmad et al., 2008).

The effect of Preserve Pro in reducing disease severity may come from its content of ascorbic acid which act directly on the fungus through inhibiting pathogen biochemical activities that led to inhibit its growth and death (Ahmed ,2010; Khan et al ,2011 ;Abdel-Kader et al .,2012). The indirect action may be through activation genes of PR protein in plants (Ali et al, 2009; Dias et al .2011;Katay et al .2011). Ahmed et al. (1996) showed that foliar spray with ascorbic acid might increase the organic acids excreted from the roots into the soil. It consequently increased the solubility of most nutrients which release slowly into the rhizosphere zone where it may be utilized by the plants. Talaat (2003) who showed that the accumulation of nitrate by ascorbic acid foliar application may be due to the positive effect of ascorbic on root growth which consequently increased nitrate absorption. In this context, the increase in P concentration by ascorbic treatments may be attributed to the postulation. Results were agreed Mazher et al. (2011) who reported that the application of 100 or 200 ppm ascorbic acid a foliar application had a favorable effect on all growth parameters(number of leaves, stem diameter, number of branches, root length as well as fresh and dry weight) of *Codiaeum variegatum* L. plants during the two growing seasons. Dias et al. (2011) confirmed that Ascorbic acid is the main precursor of oxalic acid in susceptible and resistant cacao (*Theobroma cacao*L.) infected by the hemibiotrophic fungus *Moniliophthora perniciosa*. Plants have several L-AA biosynthetic pathways but the contribution of each one in the AA synthesis varies between different species, organs and developmental stages (Cruz-Rus et al.,2011).

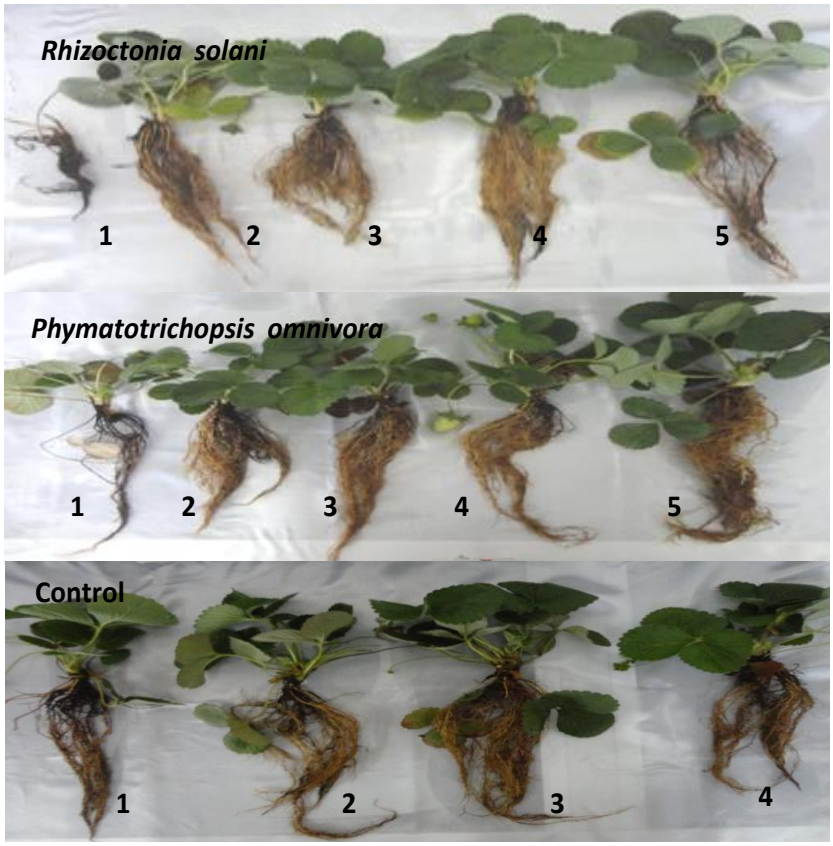

FIGURE1: ACTIVITY OF BIOAGENTS, RIZOLEX(RZ) AND PRESERVE PRO (PP) AGAINST RHIZOCTONIA SOLANI (HRS3): (1= HRS3;2= RZ +HRS3; 3= PP+ HRS3;4= AC + HRS3 ; AND 5= PF + HRS3) AND PHYMATOTRICHOPSIS OMNIVORA(KPH1) : 1= KPH1;2= RZ +KPH1; 3= PP+ KPH1;4= PF+KPH1;5=AC+ KPH1;CONTROL 1(1= CONTROL; 2=PRESERVE PRO(PP) ; 3= A. CHROOCOCCUM ;4= P. FLUORESCENCE)

TABLE 4
EFFECT OF BIOCIDE AND FUNGICIDE ON STRAWBERRY ROOT AND CROWN ROT UNDER GREENHOUSE CONDITIONS

	Disease severity		Fresh weight of plants (gm/plant)		Dry weight of plants (gm/plant)	
	Foliage	**Root**	**Foliage**	**Root**	**Foliage**	**Root**
Rhizoctonia solani (HRs3)	100.00*	100.00	0.00	2.33	0.00	0.43
HRs3+*Azotobacter chroococcum* (Ac)	6.66	0.00	9.20	10.30	2.20	2.40
HRs3+ Rizolex(Rz)	20.00	0.00	8.50	7.90	2.15	1.90
HRs3 + Preserve Pro(PP)	13.33	0.00	8.80	9.30	2.00	2.20
HRs3+*Pseudomonas fluorescens* (Pf)	13.33	0.00	7.33	7.93	1.60	1.70
phymatotrichopsis omnivora (KPh1)	26.66	60.00	4.77	4.23	1.10	1.06
KPh1+ Ac	6.66	0.00	9.96	12.80	2.60	2.75
KPh1+ Rz	13.33	0.00	9.76	9.33	2.46	2.21
KPh1 + PP	13.33	0.00	9.70	9.90	2.40	2.46
KPh1 + Pf	13.33	0.00	8.00	8.76	1.90	1.85
A. chroococcum	0.00	0.00	11.47	14.32	2.90	3.75
Preserve Pro	0.00	0.00	11.74	13.32	2.83	3.50
P. fluoresces	0.00	0.00	10.50	12.75	2.10	3.10
Control	0.00	0.00	10.30	11.70	2.10	2.95
LSD Value (P≤0.05).	8.64	12.64	2.71	3.56	1.15	0.60

***Each value in the table represent mean of 4 replications**

4. CONCLUSION

1. The main pathogen of strawberry root and stalk rot in the lath houses samples in Baghdad was *R. solani* .
2. All the used control agents showed efficiency against the root and stalk rot pathogens under laboratory and glass house conditions with the superiority of *A. chroococcum* treatments.

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