Zagazig J. Agric. Res., Vol. 46 No. (6A) 2019

Plant Protection and Pathology Research

http:/www.journals.zu.edu.eg/journalDisplay.aspx?Journalld=1&queryType=Master

EFFCIENCY OF SOME BIOLOGICAL AND CHEMICAL TREATMENTS AGAINST WHEAT ROOT AND CROWN ROT DISEASE

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Received: 22/07/2019; Accepted: 02/09/2019

ABSTRACT: *Fusarium culmorum* (W.G. Smith) Sacc., *Bipolaris sorokiniana* (Sacc.) Shoemaker, *Rhizoctonia oryzae* Kühn and *Fusarium* spp. were isolated from wheat plants exhibiting typical root and crown rot symptoms from different districts at Sharkia Governorate, Egypt during 2015/ 2016 growing season. Pathogenicity test revealed that *B. sorokiniana* was the most virulent one causing pre-emergence damping-off followed by *Fusarium culmorum*. In addition, *F. culmorum* was the most virulent one responsible for post-emergence damping-off incidence. *Rhizoctonia oryzae* showed the highest percentage of root rot, Moreover, *F. culmorum* and *B. sorokiniana* showed the highest percentage of disease incidence. In the same trend, *F. culmorum* induce the highest percentage of disease severity. *In vitro*, *Trichoderma* sp. bio-agent and its culture filtrate were the most effective treatment that reduced mycelial growth of the tested fungi. *In vivo*, it decreased pre and post-emergence damping off, root rot, disease incidence and disease severity compared with the control. In addition, the obtained results indicated a significant increase on healthy survival plants and significantly improved the plant growth parameters *i.e*. fresh and dry weights of shoots and roots, plant height, spike length and 1000 grain weight. *In vitro*, Score and Amistar-top fungicides were the most effective in inhibiting the mycelial growth of *R. oryzae* followed by Amistar-top on *B. sorokinana* and Score on *F. culmorum*. Score was the most effective treatment revealed the highest percentage of healthy survival plants followed by Amistar-top and gave the highest protection against root and crown rot disease as shown by disease incidence and severity percentages.

Key words: Wheat, root rot, crown rot, biological control, chemical control.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops grown worldwide and in Egypt. *Fusarium graminearum* and *F. culmorum* were the causal agent of root rot, crown rot and stem base disease in wheat **(Winter *et al*., 2019)**. *Fusarium* spp. caused the two major diseases, fusarium head blight (FHB) and fusarium crown rot (FCR) on wheat that reduce yield qualitative and quality damage in addition to, a major mycotoxin procedure such as deoxynivalenol, zearalenone and nivalenol **(Matny, 2015; Mahmoud, 2016)**. **Paulitz and Schroeder (2016)** reported that *Rhizoctonia oryzae* caused wheat and barley root rot, reduced emergence of wheat, moreover, reduced length and number of roots. *Bipolaris sorokiniana* is a pathogen of cereals including, seedling blight, root rot, black point on grains, foliar spot, blotch, leaf blight and head blight on barley and wheat. It considered as seed borne fungi transmitted with seed **(Burlakoti *et al.*, 2013; Raza *et al.*, 2014; Somani *et al*., 2019)**. Genus *Streptomyces* had high inhibition effect on *Fusarium* spp., *in vitro*, as well *in vivo*. It reduce root rot and crown colonization by *F. culmorum*, *F. pseudograminearum*. Results reported by **Winter *et al.* (2019)** significantly reduced fusarium crown rot symptoms on roots and fresh weight and plant biomass compared with soil enrichment by Streptomyces. *Streptomyces* spp. used as bio-fertilizers in several crops due to their ability to promote

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plant growth and biocontrol of various phytopathogenic fungi and bacteria as a reason of it is metabolizes, antibiotics and produce organic compounds in soil **(Vurukonda *et al.*, 2018).** Clearly significant effect of actinomycetes were detected on *F. culmorum*, seedling growth and seed germination of wheat compared with commercial fungicide tebuconazole **(Laid *et al.*, 2016).** *Trichoderma harzianum*, *T. viens* and *T. virdi* reduced mycelial growth of *Bipolaris sorokiniana* in dual culture method, as well as, significantly reduced disease severity, increased seed germination, plant height, dry fresh weight of root, shoot and increase 1000 grain weight **(El-Gremi *et al.*, 2017; Singh *et al.*, 2018).** *Trichoderma* spp. as a seed treatment reduced *F. graminearum* and *F. culmorum* root rot severity based on antagonistic activity against mycelium by mechanisms of mycoparasitism, antibiosis and chitinase encoding gene **(Matarese *et al.*, 2012; Xue *et al.*, 2017).** *Trichoderma harzianum* inhibited *R. solani* mycelium *in vitro* through dual culture technique **(Rajendraprasad *et al.*, 2017)**. Inoculate wheat plant with *Trichoderma* sp. as a seed and root treatments, reduced infection with *Rhizoctonia* sp., increased plant height and number of roots **(Barnett *et al.*, 2017).** Seed coating treatment by plant growth-promoting rhizobacteria (PGPR) like *Bacillus* sp. and *Pseudomonas* sp., controlled wheat root and crown rot and increased significantly root length, root fresh weight, dry weight and shoot length **(Moussa *et al.*, 2013). Zhao *et al.* (2014)** found that *Bacillus subtilis* isolated from wheat grains have antagonistic activity against *F. graminearum* mycelial growth, sporulation and toxin production as reason of destroying cell structure organelles and cytoplasm followed by cell death due to antifungal activity associated with production of chitinase and surfactins. **Balah *et al.* (2018)** reported that antifungal activity of some rhizobacterial isolates metabolites of *Bacillus cereus* and *Pseudomonas geniculata* were the most efficient isolates could be used as a good element to control *Bipolaris sorokiniana* in plant root rot disease. *Bacillus* sp. and *Pseudomonas* sp. were effective as biocontrol agent *in vitro* against *F. culmorum*, controlling fusarium head blight and reduced mycotoxin contamination on wheat **(Dal Bello *et al.*, 2002; Palazzini *et al.*, 2016; Dweba *et al.*, 2017; Mnasri *et al.*, 2017)**. *Pseudomonas* spp. isolated from soil were active against wheat root rot disease caused by *R. solani* and *R. oryzae*, it increased seedling root and shoot length **(Mavrodi *et al.*, 2012)**.

Triazoles group such as Teubeconazole and Prothioconazole was the most effective fungicide for management *Fusarium* spp., *F. culmorum*, *F. graminearum*, *F. cerealis* and fusarium head blight of wheat. These group influence on ergo-sterol biosynthesis and considered most effective fungicide **(Hellin *et al.*, 2017; Shah *et al.*, 2018).** Also, Azole group of fungicides tebuconazole, prothioconazole, propiconazole and strobin (azoxystrobin) fungicides treatment showed increasing grain germination, plant height and decreased disease severity (%) caused by *F. culmorum* and *Cochlibolus sativus* in addition, inhibiting their mycotoxin production **(Soováli *et al.*, 2017; Koycu, 2019).** Score fungicides (Difenoconazole) was the best performance to inhibit *Drechslera sorokiniana* mycelial growth in poisoned food technique and seed treatment followed by Amistar-top (Azoxystropin + Difenoconazole) as mentioned by **Mehboob *et al.* (2015)**.

Propiconazole as one of azole fungicides group used widely, its targets were the demethylase enzymes involved and inhibiting the biosynthesis of sterols which building blocks of fungal cell membranes. Propiconazole at 0.1 and 0.05% after 7 days was the most effective one for inhibition mycelial growth of *Cochliobolus sativus* and *B. sorokiniana* **(Kavita *et al.*, 2017; Somani *et al.*, 2019).** Tebuconazole and Difenoconazole as active ingredient were the most effective fungicide as seed treatment with a dose of 2.5 g and 1.0 ml/kg wheat grains, respectively and significantly increased the seedling emergence caused by *B. sorokiniana* and *Fusarium* sp., as compared with control. Moreover, reduced the number of rotted roots and healthy grains per spike and yield **(Shahbaz *et al.*, 2018).** Propiconazole inhibited mycelium growth of *R. solani* **(Rajput *et al.*, 2016).** Also, difenoconazole and azoxystrobin as new combination fungicide was effective against *R. solani* and *R. oryzae* **(Bhuvaneswari and Raju, 2012; Kucharska *et al.*, 2018).**

Thus, this work was designed to isolate the causal pathogens of wheat root and crown rot. In addition, pathogenicity test, biological and chemical control treatment of the isolated pathogens and its effect on plant growth parameters.

MATERIALS AND METHODS

Samples Collection

Naturally infected wheat plants with root samples exhibit typical symptoms doubted to be due to root rot disease were collected from different districts at Sharkia Governorate (Zagazig, Kafr El-Hamam, Ghazala and Abu-Kaber). Samples were transferred under cooling using ice box to Plant Pathology Lab. Plant Pathology Dept., Fac. Agric., Zagazig Univ., Egypt.

Isolation and Purification of the Pathogenic Fungi

The infected wheat roots were surface sterilized in 1% sodium hypochlorite solution for 2 minutes, rinsed twice in sterilized distilled water, dried between two sterilized filter papers. Then were cut into small pieces and transferred into water agar (WA) medium **(Parsons and Munkvold, 2012)** and incubated at 27±1ºC for 7 days.

The developed fungi were recorded as frequency percentage for all the isolates and purified using the hyphal tip and/or single spore techniques **(Skidmore and Dickinson, 1976; Dhingra and Sinclair, 1995)**. The purified fungi were transferred to potato dextrose agar (PDA) medium and kept slant at 5˚C for identification and further studies.

Detection of the Isolated Fungi

The isolated fungi from infected wheat samples were microscopically identified according to the morphological features of mycelia and asexual spores using the description of **Nelson *et al.* (1983)**, **Leslie and Summerell (2006)** for *Fusarium* sp. and **Manamgoda *et al.* (2014)** for *Bipolaris sorokiniana*. The selected three isolates were identified at Plant Pathology Lab. Plant Pathology Dept., Fac. Agric., Zagazig Univ., Egypt.

Pathogenicity Tests

Pathogenicity tests of four identified isolates of *Fusarium culmorum*, *Fusarium* spp., *Rhizoctonia oryzae* and *Bipolaris sorokiniana* were carried out under greenhouse conditions at Fac. Agric., Zagazig Univ.

Inoculum preparation

Inoculum of *Fusarium* spp., *F. culmorum*, *R. oryzae* and *B. sorokiniana* prepared using autoclaved wheat grains (200 g of wheat grains, 80 ml distilled water per flask 500 ml) singly inoculated by each pathogen and incubated at 27±1ºC for three weeks **(Chekali *et al.*, 2011)**.

Pots and soil disinfestation

Sterilized plastic pots (25 cm in diameter) with formalin 3% for 10 min. were filled with 6.6 kg sterilized autoclaved sandy clay soil (1:1).

Soil infestation

Soil infestation was carried out by adding the fungal inoculum (5 g/kg soil) to the sterilized autoclaved soil. The infested soil was watered as usual and left for 10–15 days before sowing to stimulate the fungal growth and ensure its distribution in the soil. Control pots were treated in the same way using pathogen free autoclaved wheat grains described by **El-Sayed (1999)**. Wheat grains Masr 1 cultivar were obtained from Filed Crop Research Institute, Agric. Res., Cent. (ARC). Grains were sterilized with 1% sodium hypochlorite solution for 2 minutes and sown at the rate of 10 grains /pot. Three replicates were used for each treatment. Inoculated fungi were re-isolated from the infected plants to confirm Kock's postulate.

Disease Assessment

Damping-off incidence was recorded as percentage of pre, post-emergence healthy survivals percentage at 15, 30 and 45 days after sowing, respectively. Crown and root rots severity was done on infected plants damping off mature plants. Infected plants were removed from pots, then washed and disease severity was rated on a 0 to 3 scale based on symptoms observed on the crown and roots, 0: no symptoms (healthy roots and crown); 1: browning on the crown; 2: extension of browning to roots and 3: dark brown color of the crown and all roots. Disease severity was averaged among the replicates according to **Chekali *et al.* (2011).** Disease severity was calculated using the scale values, as follows:

(∑ (number of plants in a disease scale category × disease scale category)/(total number of plants × maximum disease scale category)) × 100). The most virulent isolate was selected on the basis of disease severity averages.

Plant Growth Parameters

Growth parameters including plant height (cm), fresh and dry weights (gram) were estimated at the end of experiment. Root system was tapped out of the pot and washed with gentle stream of water, for obtaining fresh and dry weight, the roots were pressed gently between two pads of blotting paper then the fresh weight was recorded using electronic balance. Dry weight was recorded after drying the roots and shoots in oven under 70°C for several days until the constant weight. Spike length (cm), spike number and weight of the 1000 kernels (gram) were determined.

Biological Control

Plant growth promoting rhizobacteria (PGPR) isolates was obtained through isolation of bio-control microorganisms from wheat rhizosphere by the serial dilution agar plating method using different selective media according to **Jacobs and Gerstein (1960).** Identification of isolated Fungi, Streptomyces and bacteria was carried out at Plant Pathology Lab. Plant Pathology Dept., Fac. Agric., Zagazig Univ., Egypt using identification roles mentioned by **Shirling and Gottlieb (1966); Lelliott and Stead (1987) and Krishna *et al*. (2012).**

Laboratory Experiments

Evaluation the inhibitory effect of isolated bacteria on pathogenic fungi using dual culture technique

Antagonistic activities of identified *Streptomyces* sp., *Bacillus* sp., *Pseudomonas* sp. and *Trichoderma* sp. were done against wheat root rot pathogens were cultured for 7 days onto PDA medium, then 5 mm disc of the pathogenic fungi were re-cultured onto one side of 9 cm Petri dish and the opposite side was cultured with one disc *Trichoderma* sp. bio-agent and/ or streak in the case of bacteria and *Streptomyces* sp. at the same. Three plates were used as replicates for each treatment. Mycelial discs (5 mm) of diameter removed from the growing edge of *R. oryzae*, *F. culmorum* and *B. sorokiniana* grown onto PDA were used as control. The plates were incubated at 28 ± 2°C for 5 days in the dark. Linear growth of pathogenic fungi was measured, when the control dishes reached full growth and the growth diameter average, was calculated. The inhibition rate of tested bio-agent on mycelial growth pathogens was calculated using the following formula: growth inhibition rate (%) = (Rc–Rt)/RC×100, where Rc is the average linear growth of pathogen (control), and Rt is the average growth of the pathogen. Four Petri dishes for each antagonist were used **(Skidmore and Dickinson, 1976).**

Influence of antagonist bio agents culture filtrates on wheat root rot pathogen

Antagonist cultures were grown in flasks (250 ml) containing 100 ml potato dextrose broth (PDB) for one week at 25°C., nutrient agar (NA) used for bacteria and starch nitrate (SN) media for actinomycetes. *Pseudomonas* sp. and *Bacillus* sp. increased the turbidity (silkiness or cloudiness). The liquid cultures were filter sterilized using G3 filter to give sterile and cell free culture filtrate according to **Jacobs and Gerstein (1960)**. Culture filtrates were mixed with autoclaved PDA media before solidifying (at 1%) and poured in Petri plates. Then plats were inoculated with a disc (0.5 cm diameter) of the pathogens and incubated at 25°C for one week. Inhibition of mycelial growth of *F. culmorum*, *R. oryzae* and *B. sorokiniana* were calculated.

Biological control using isolated plant growth promoting microorganism's against wheat root rot and growth parameter under greenhouse conditions

In planta, healthy wheat grains cv. Masr 1 were surface sterilized in 1% NaOCl (Sodium hypochlorite) for 2 minutes and then rinsed three times in sterile water to get rid of surface seed secondary fungal pathogens as mentioned by **Parsons and Munkvold (2012)**. Then wheat grains cv. Masr-1 were soaked in 50 ml suspension of *Trichoderma* sp. at 1.50×10^{-6} spores/ml for 2 hr. Wherever, in case of bacterial bioagent (*Pseudomonas* sp., *Bacillus* sp. and *Streptomyces* sp.) wheat grains were dipped in 50 ml suspension at 6×10^{-8}cfu/ml for 2 hr. **(Ma *et al*., 2008).**

For control treatments, Grains were soaked individually with sterile water for 2 hr, in 50 ml according to **Xue *et al.* (2017).** Treated grains were air dried and ten grains were planted in pots (25 cm) containing infested and non-infested soils as control. Three pots were used for each particular treatment. Seed soaking in sterile distilled water were sown in infested and non-infested soil to serve as positive and negative control, respectively. Disease parameter and plant growth parameter were recorded as previously mentioned.

Chemical Control

Evaluation the inhibitory effect of some fungicides on the linear growth of pathogenic isolates *in vitro*

Three tested fungicides Score 250 EC (Difenoconazole 25%), Amistar-top 325 SC (Azoxystrobin 20% and Difenoconazole 12.5%) and Topas 100 EC (Penconazole 10%) as shown in Table 1 were obtained from Plant Pathology Lab. Plant Pathology Dept., Fac. Agric. Zagazig Univ., Egypt. Fungicides were used at different concentrations (0.00, 0.025, 0.05, 0.10, 0.15 and 0.20 ml) against *F. culmorum, R. oryzae* and *B. sorokiniana* using poison food technique according to **Kavita *et al.* (2017)** on potato dextrose agar (PDA) medium**.** Linear growth of each tested fungus was measured, when the pathogenic fungi completely covered the surface of the medium in control treatment. The radial growth of fungus in each treatment (percent growth inhibition) was calculated using the following formula. [PGI= C–T/C]×100, Where, PGI = Percent growth inhibition; C = Linear area of test fungus in control (mm) and T = Linear area of test fungus in respective treatment (mm) according to **Rajendraprasad *et al.* (2017)**.

Evaluation of some fungicides against *F. culmorum, R. oryzae* and *B. sorokiniana* as seed treatment under greenhouse conditions

Fungicides were applied at the recommended dose (0.025 ml/kg grains). Grains of wheat was surface sterilized as mentioned before then separately mixed with the recommended dose of each fungicide. Treated grains were left to dry. Ten grains of Masr 1 cultivar planted in pots (25 cm diameter) previously infested with the pathogenic fungi as previously mentioned and irrigated after planting. The recommended rate of fertilizers was applied. The experiment was conjunctly randomized block design (RBD) with three replicates.

Statistical Analysis

All experiments were conducted in a factorial (treatments× three fungal species) a completely randomized block design with three replicates per treatment. Analyzed was carried out according to the methods described by **Snedecor and Cochran (1980)** using Statistic Complete 9 Program for ANOVA and LSD analysis.

RESULTS AND DISCUSSION

Samples Collection

The samples exhibit typical disease symptoms of wheat root and crown rot were collected. The disease reduced weight of grains, Infection increased in high or semi high humidity **(Shah *et al.*, 2018; Winter *et al*., 2019)**.

Also, some of pathogenic fungi such as, *Rhizoctonia* spp., *R. oryzae* and *R. oryzae* AG-8 consider a necrotrophic pathogen that infect wheat and barley symptoms was chronic root rot, causing pre-emergence damping off, crown roots in seedlings, stunted plants, reduced plant growth length, reduced length and number of seminal roots and bare patch decreased losses in growth and yield as well as, number of grains on spike **(Paulitz and Schroeder, 2016)**.

Isolation, Identification and Frequency of Fungi Associated with Infected Wheat Grains

Identification the isolated fungi based on morphological characterization was used as it has been previously utilized in various other studies for *Fusarium* sp. and *Bipolaris sorokiniana* **(Nelson *et al.*, 1983; Leslie and Summerell, 2006; Manamgoda *et al.* 2014).**

The obtained results, diagnosed fungal isolates associated with wheat root rot, as *Fusarium culmorum* (W.G. Smith) Sacc., *Bipolaris sorokiniana* (Sacc.) Shoemaker, *Rhizoctonia oryzae* Kühn and *Fusarium equestii*.

Table 1. List of the tested fungicides, their active ingredients, manufacture and rate of use

Commercial fungicide	Active ingredient	Manufacture	Rate of used (cm/100 L)
Score 250 EC	Difenoconazole 25%	Syngenta	50
Amistar-top 325 SC	Azoxystrobin 20%	Syngenta	75
	Difenoconazole 12.5%		
Topas 100 EC	Penconazole 10%	Syngenta	25

Results presented in Fig. 1 show that the most frequently isolated fungi from infected wheat root and crown samples were *R. oryzae*, *F. culmorum* and *B. sorokiniana* (27.80, 27.40 and 21.56%, respectively).*R. oryzae* was the most frequently isolate one especially from Kafr El- Hamam (53.33%) followed by, *F. culmorum* in Zagazig (50.94%). and *B. sorokiniana* from Abu-Kabeer (31.15%).

Similar results were showed by **Tunali *et al.* (2008)** that frequency of the isolated fungi from crowns and roots of wheat in dryland was reported as *Rhizoctonia* species found in 22%, *F. culmorum* (14%), *B. sorokiniana* (10%) and *F. pseudograminearum* (2%). In addition, they isolated fungi from individual tillers which were *B. sorokiniana* (15%), *F. culmorum* (13%) and *F. pseudograminearum* (8%).

Also, **Abdallah-Nekache *et al.* (2019)** reported that frequency of isolated fungi from wheat crown was 68% to *F. culmorum* and 10% for *F. pseudograminearum.* While, isolation from head was 94.1% to *F. culmorum* and 5.9% to *F. pseudograminearum.*

Pathogenicity Tests

Results obtained from pathogenicity tests under greenhouse conditions in Fig. 2 reveal that significant differences were found between tested fungi. The highest percentage of pre-emergence damping-off was recorded with *B. sorokiniana* followed by *F. culmorum* and *R. oryzae*. Also, *Fusarium culmorum* produced the highest percentage of post-emergence damping-off. *R. oryzae* showed the highest percentage of root rot followed by *B. sorokiniana* and *F. culmorum* without significant differences among them. In addition, the highest percentage of disease incidence were found in both *F. culmorum*, *B. sorokiniana* and *R. oryzae*. While, *F. equestii* was the lowest one. Disease severity was in the highest level in case of *F. culmorum* followed by *B. sorokiniana* and *R. oryzae.* As well, *Fusarium equestii* showed the highest percentage for survival healthy plants.

Similar results were obtained by **Gebremariam *et al.* (2018)** and **Abdallah-Nekache *et al.* (2019)** where they reported that *Fusarium culmorum* was the most aggressive pathogen on wheat from seedling to heading. In addition, *Fusarium* species infected lower stems and crown. *F. culmorum*, *F. graminearum* and *F. pseudogramineaum* caused sever crown rot on wheat. They found also that, *Cochilibolus sativus*, *F. graminearum*, *F. culmorum* and *F. avenaceum* were virulent to wheat and barley.

Fusarium sp. produced micro-conidia in colossal amounts, which are known to transmit through air to large distances, finally infecting wheat roots and crown parts of plant as mentioned by **Leslie and Summerell, (2006)**. *B. sorokiniana* as a hemi-biotroph pathogen it caused symptoms *i.e*. seedling blight, brown to dark brown spot, foliar blotch, leaf blight, root rot and black point of wheat. It considered transmitted with seed as seed borne fungi. In addition, it affecting significantly on seed germination and head blight on barley and wheat, as well, *Bipolaris sorokiniana* caused rot at the sub crown internode **(Al-Sadi and Deadman, 2010; Raza *et al*., 2014; Somani *et al*., 2019)**.

Biological Control

In vitro effect of some bioagent using dual culture technique against *Fusarium culmorum*, *Bipolaris sorokiniana* and *Rhizoctonia oryzae*

Results presented in Figs. 3 and 4 indicate that, the bio-agents tested significantly reduced growth of the tested pathogenic fungi *i.e.*

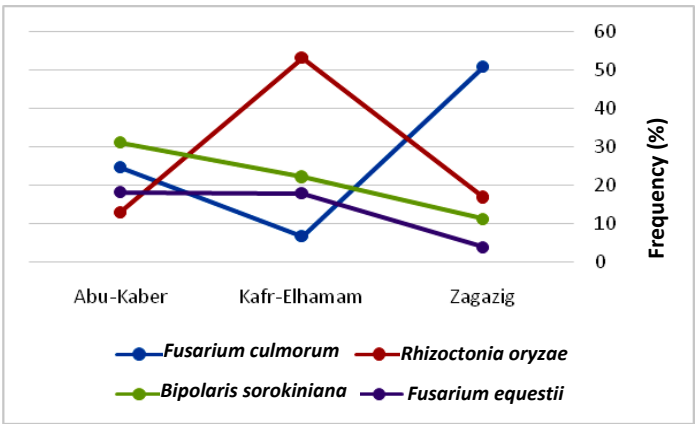


Fig. 1. Frequency of occurring isolated fungi from root and crown rot of wheat collected from different districts of El Sharkia Governorate during 2015/ 2016 growing seasons

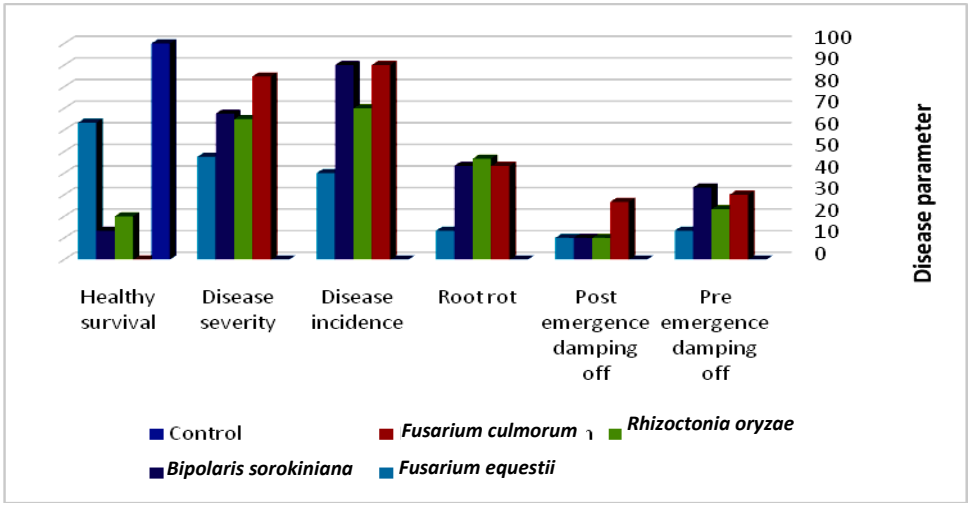
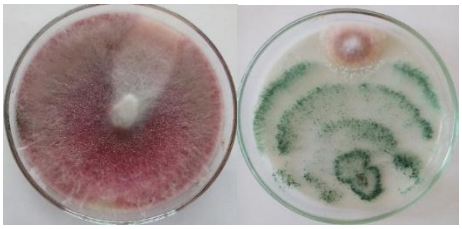
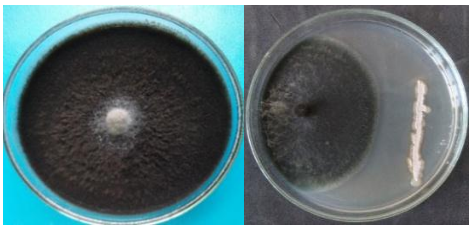


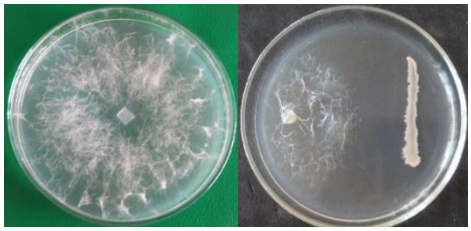
Fig. 2. Pathogenicity test for the isolated fungi that caused wheat root and crown rot disease of Masr 1 cultivar under greenhouse condition



A- *Trichoderma* sp. against *Fusarium culomrum*



B- *Streptomyces* sp. against *Bipolaris sorokinana*



C-*Bacillus* sp. against *Rhizoctonia oryzae*

Fig. 3. Biological control using dual culture technique

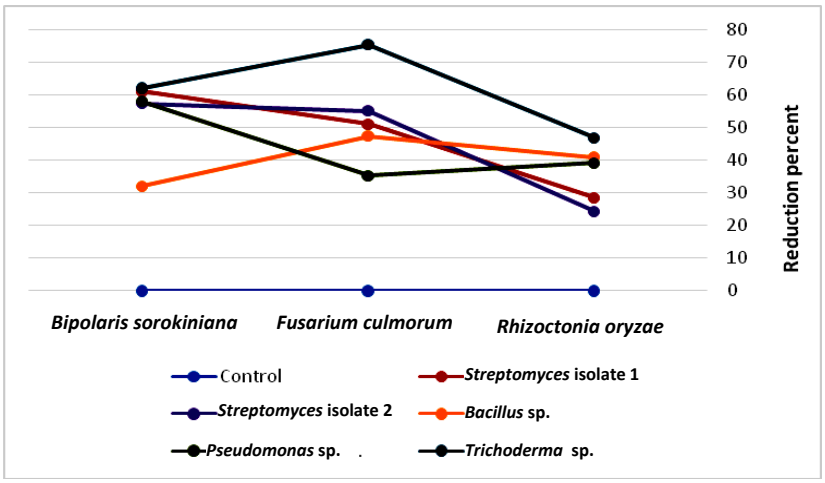


Fig. 4. Reduction percentage in the mycelial growth of the causal organisms of wheat root and crown rot disease using dual culture technique of the tested bio-agents

B. sorokiniana followed by *F. culmorum* and *R. oryzae*. *Trichoderma* sp. showed the highest reduction percentage of the mycelial growth of tested pathogenic fungi followed by *Streptomyces* isolate 1 and *Streptomyces* isolate 2. However, *Bacillus* sp. was the least effective one. In addition, *Trichoderma* sp. was the most effective on *R. oryzae* followed by *Bacillus* sp. Although, *Streptomyces* isolate 2 was less effective. As well, *Trichoderma* sp. showed the highest reduction percent followed by *Streptomyces* isolate 2. While, *Pseudomonas* sp. was the less effect one on *F. culmorum*. In case *B. sorokiniana*, *Trichoderma* sp. was the highest effective one followed by *Streptomyces* isolated 1. Also, *Bacillus* sp., was the lowest one.

In vitro effect of antagonist culture filtrates against the wheat root rot pathogen

Results in Fig. 5 show that *B. sorokiniana* was the highest sensitive fungus to culture filtrate followed by *F. culmorum*, while *R. oryzae* was the lowest one (50.41, 41.78 and 33.72%, respectively). *Trichoderma* sp. culture filtrate was the most effective on reducing fungal growth followed by *Bacillus* sp. and *Streptomyces* isolate 1 (72.85, 63.63 and 43.37%, respectively).

The effect of different bio-agent *Streptomyces* spp., *Pseudomonas* sp., *Bacillus* sp., and *Trichoderma* sp. on wheat root and crown rot disease and plant growth parameter under greenhouse conditions

Data in Table 2 indicate that results of both dual culture and culture filtrate were in harmony. *Trichoderma* sp. showed the highest percentage of healthy survival plants followed by *Streptomyces* isolate 1. While *Pseudomonas* sp. performed the lowest compared to control. There were significant differences between bio-agent on pre-emergence damping off whereas, *Trichoderma* sp. reduced pre-emergence, followed by *Streptomyces* isolate 2. While, *Pseudomonas* sp. showed the highest percentage of pre-emergence, *Trichoderma* sp. and *Streptomyces* isolate 1 showed the lowest percentage of post-emergence. *Trichoderma* sp. showed the lowest percentage of disease parameters (root rot, disease incidence and disease severity). Such results consequently followed by significant high values of plant growth parameter (Table 3). *Trichoderma* sp. showed the highest value of root fresh weight (3.92 g), shoot length (80.00 g) and 1000 kernel weight (48.73 g), followed by *Bacillus* sp. for shoot fresh weight (19.94 g) and spike length (11.18 cm) compared to control. Treatment of plant growth promoting rhizobacteria (PGPR) increased seed germination and shoot/ root growth might be due to IAA, gibberellins and cytokinin production. Other mechanism such as siderophores, hydrocyanic acid and induction of resistance may play a role in the mode of action of PGPR **(Singh *et al.*, 2015)**. Thus, rhizobacterial agents considered to be one of the most significant strategies for disease management **(Laid *et al.*, 2016)**. Antagonistic activity of *Streptomyces* against plant pathogens attained through different mechanisms, *i.e.*

production of secondary enzymatic activities metabolites including nutrient competition, chitinase, antibiosis, induced resistance, production of degradative enzymes, and nitrous oxide production **(Cohen and Mazzola, 2006; Mahmoudi *et al*., 2011; Boukaya *et al*., 2018; Winter *et al*., 2019).**

Streptomycetes was an active producer of volatile organic compounds and antibiotics both in soil and in planta, and this feature was helpful for antagonists of plant pathogens as biocontrol agents. Production of siderophores (iron-chelating compounds) and chitinolytic enzymes as mode of action for fungal growth inhibition by endophytic actinobacteria. In addition to produce enzymes that degrade fungal cell walls by the production of chitinases. Moreover, actinomycetes present 90% of chitinolytic microorganisms **(Vurukonda *et al*., 2018)**.

The biological inhibition ability of selected *Pseudomonas* spp. might be as reason of competition for space and nutrients, siderophore mediated competition for iron, induction of induced systemic resistance and antibiosis in the host plant **(Balah and Latif, 2013)**. Strains of some *Bacillus* sp. had the ability to produce chitinolytic enzymes and to induce systemic resistance in the host plant **(Tsai *et al*., 2002; Moussa *et al*., 2013)**. *Bacillus subtilis* have antagonistic activity against *F. graminearum* mycelial growth, sporulation, toxin production and reduced disease incidence by production of chitinase and surfactants and broad spectrum of antimicrobial compounds. Similar result was mentioned by **Cohen- Kupiec (1998) and Zhao *et al.* (2014)**.

Balah *et al*. (2018) found that the secondary metabolites in case of *Pseudomonas geniculata* were coumaric acid, aminobutyric acid, tryptophan amino acid, 1,4-benzoquinone, succinic acid, sinapic acid and ferulic acid. However, *B. cereus* produced 1,4-benzoquinone, aminobutyric acid, ferulic acid benzoic acid, coumaric acids and sinapic acid. Similar result was matched with **Singh *et al*. (2018)** who found that *Trichoderma harzianum, T. virdi* and *T. viens* on mycelial growth of *B. sorokiniana* which increased plant height, fresh and dry weights of shoots and roots of wheat seedlings compared with the control, Moreover, the hyphal interaction between test fungus and Antagonists revealed disorganization of protoplasmic content in addition, lysis of host hyphae. *Trichoderma harzianum* improved germination, seedling growth, length of roots, shoots, tillers and increase 1000 grain weight in wheat disease caused by *C. sativus* and *F. graminearum. T. harzianum* showed hyper-parasitism on the tested pathogens *i.e. F. graminearum, C. sativus* and *A. alternata* in dual culture assays **(El-Gremi *et al*., 2017)**. *Trichoderma* isolates reduced inoculum and growth of *F. culmorum* and *F. graminearum* by mechanisms of mycoparasitism, chitinase and encoding gene antibiosis. Furthermore, it coil around the pathogens hyphae, which is considered a sign of mycoparasitism **(Matarese *et al*., 2012).**

Chemical Control

Inhibitory effect of some fungicides of tested pathogenic fungus on linear growth

Results in Table 4 show that *R. oryzae* was the most sensitive to fungicide followed by *F. culmorum* and *B. sorokiniana*. Also, Results showed that Score highly reduced the mycelial growth of *F. culmorum* followed by Topaz while, Amistar-top was the less effective one. No significant differences were observed between tested concentrations (0.025, 0.05, 0.1, 0.15 and 0.2 ml) on *R. oryzae* with both Score and Amistar-top.

Evaluation of fungicides against *F. culmorum*, *R. oryzae* and *B. sorokiniana* under greenhouse conditions

Results in Tables 5 and Fig. 6 indicat that Score and Amistar-top fungicides showed the lowest percentage of pre and post-emergence without significant differences between them followed by Topaz compared to control. Score showed the lowest percentage of root rot and highest percentage of healthy plants followed by Amistar-top and Topaz. There were significant differences among treatment fungicides Score, Amistar-top and Topaz in disease incidence (20.00, 22.50 and 24.53%, respectively). Score showed the lowest percentage of disease severity (8.33%) followed by Amistar-top (14.99%). While, the highest percentage was observed with Topaz (16.57%).

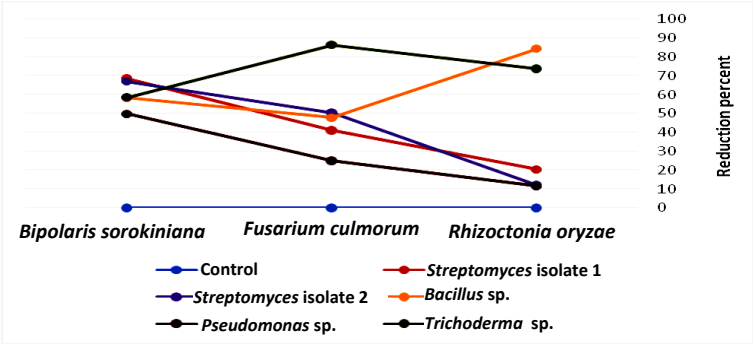


Fig. 5. Reduction percentage in the mycelial growth of the causal organisms of wheat root and crown rot disease due to culture filtrates of the tested bio-agents

Table 2. *In vivo* effect of some bio-agent treatments on wheat root and crown rot pathogens on pathogenic parameters wheat Masr1 cultivar

Treatment	Pathogenic parameters					
	Pre (%)	Post (%)	Root rot (%)	Disease incidence (%)	Disease severity (%)	Healthy (%)
Fusarium culmorum	26.67	30.00	43.33	90.00	85.20	0.00
Rhizoctonia oryzae	23.33	10.00	60.00	70.00	68.40	6.67
Bipolaris sorokinana	30.00	10.00	60.00	90.00	73.33	0.00
Control	0.00	0.00	0.00	0.00	0.00	100.0
Average	20.00	12.50	40.83	62.50	56.73	26.67
***Streptomyces isolate* 1**	0.00	0.00	0.00	0.00	0.00	100.0
Streptomyces isolate* 1+*Fusarium culmorum	16.67	0.00	33.33	55.00	20.56	50.00
Streptomyces isolate* 1+*Rhizoctonia oryzae	6.67	0.00	26.66	50.00	34.89	66.67
Streptomyces isolate* 1+*Bipolaris sorokinana	6.67	0.00	16.60	30.00	18.05	76.67
Average	7.50	0.00	19.16	33.75	18.38	73.34
***Streptomyces isolate* 2**	0.00	0.00	0.00	0.00	0.00	100.0
Streptomyces isolate* 2+*Fusarium culmorum	20.00	3.33	36.67	40.00	23.33	40.00
Streptomyces isolate* 2+*Rhizoctonia oryzae	3.33	0.00	36.67	40.00	23.33	60.00
Streptomyces isolate* 2+*Bipolaris sorokinana	3.33	3.33	26.67	40.00	33.33	66.67
Average	6.67	1.67	25.00	30.00	19.99	66.67
***Pseudomonas* sp.**	0.00	0.00	0.00	0.00	0.00	100.0
Pseudomonas* sp.+*Fusarium culmorum	23.33	3.33	33.33	60.00	23.33	40.00
Pseudomonas* sp.+*Rhizoctonia oryzae	13.33	0.00	13.33	20.00	16.66	73.33
Pseudomonas* sp.+*Bipolaris sorokinana	6.67	0.00	43.33	60.00	40.00	50.00
Average	10.83	0.83	22.50	35.00	19.99	65.83
***Bacillus* sp.**	0.00	0.00	0.00	0.00	0.00	100.0
Bacillus* sp.+*Fusarium culmorum	16.67	0.00	30.00	30.00	24.33	53.33
Bacillus* sp.+*Rhizoctonia oryzae	6.67	0.00	23.33	30.00	20.33	70.00
Bacillus* sp.+*Bipolaris sorokinana	13.33	3.33	33.33	40.00	30.00	50.00
Average	9.17	0.83	21.67	25.00	18.67	68.33
***Trichoderma* sp.**	0.00	0.00	0.00	0.00	0.00	100.0
Trichoderma* sp.+*Fusarium culmorum	13.33	0.00	13.33	20.00	10.50	73.33
Trichoderma* sp.+*Rhizoctonia oryzae	3.33	0.00	23.33	50.00	33.33	73.33
Trichoderma* sp.+*Bipolaris sorokinana	6.67	0.00	16.66	18.50	16.66	76.67
Average	5.83	0.00	13.33	22.13	15.12	80.83
LSD 0.05%						
A- Fungi	0.66	0.26	0.29			0.72
B-Bioagent	0.54	0.18	0.47			0.85
C- interaction	1.09	0.37	0.95			1.70

Table 3. ***In vivo*** **effect of some bio-agent treatments on wheat root and crown rot pathogens on plant growth parameters of wheat cultivar Masr1**

Treatment	Plant growth parameter									
	Root dry weight (g)	Shoot fresh weight (g)	Shoot dry weight (g)	Shoot length (cm)	Root length (cm)	Tiller (No.)	Spike length (cm)	Kernels number (No.)	1000 kernel weight (g)	Head blight (No.)
Fusarium culmorum	1.15	12.50	1.24	68.00	12.00	2.00	8.90	39.67	25.70	2.00
Rhizoctonia oryzae	1.65	15.27	4.13	73.00	14.00	2.00	9.40	35.33	37.80	0.00
Bipolaris sorokinana	1.18	13.22	2.29	70.00	14.00	2.00	10.10	42.33	39.50	0.00
Average	1.46	14.91	3.74	72.25	14.00	2.25	9.75	41.00	36.48	0.50
***Streptomyces isolate* 1**	2.43	18.30	7.03	79.00	18.00	3.00	10.87	59.67	48.10	0.00
Streptomyces isolate* 1+*Fusarium culmorum	2.07	17.18	5.95	76.00	16.00	3.00	10.50	49.00	45.70	0.00
Streptomyces isolate* 1+*Rhizoctonia oryzae	1.76	16.03	5.10	76.00	16.00	3.00	10.33	47.00	44.20	0.00
Streptomyces isolate* 1+*Bipolaris sorokinana	2.19	17.95	5.68	77.00	17.00	3.00	10.80	56.76	47.80	0.00
Average	2.11	17.37	6.19	77.00	16.75	3.00	10.63	53.17	46.45	0.00
***Streptomyces isolate* 2**	2.68	19.21	7.68	79.00	18.00	3.00	10.87	56.33	47.80	0.00
Streptomyces isolate* 2+*Fusarium culmorum	2.54	17.63	6.74	77.00	16.00	3.00	10.67	50.67	45.80	0.00
Streptomyces isolate* 2+*Rhizoctonia oryzae	1.61	15.57	5.11	76.00	15.00	3.00	10.27	44.67	41.10	0.00
Streptomyces isolate* 2+*Bipolaris sorokinana	2.62	18.00	6.94	78.00	17.00	3.00	10.67	53.33	46.60	0.00
Average	2.36	17.60	6.62	77.50	16.50	3.00	10.62	51.25	45.33	0.00
***Pseudomonas* sp.**	2.68	17.54	6.97	79.00	18.00	3.00	11.27	60.00	48.70	0.00
Pseudomonas* sp.+*Fusarium culmorum	2.51	17.16	6.50	78.00	17.00	2.00	11.23	54.67	47.20	0.00
Pseudomonas* sp.+*Rhizoctonia oryzae	2.57	17.29	6.64	78.00	17.00	3.00	11.10	57.33	47.90	0.00
Pseudomonas* sp.+*Bipolaris sorokinana	2.49	16.91	6.43	78.00	16.00	2.00	10.50	55.00	46.40	0.00
Average	2.56	17.23	6.64	78.25	17.00	2.50	11.03	56.75	47.55	0.00
***Bacillus* sp.**	3.21	20.74	9.65	80.00	18.00	2.00	11.33	57.33	50.10	0.00
Bacillus* sp.+*Fusarium culmorum	2.30	20.33	6.34	79.00	17.00	2.00	11.17	54.67	49.60	0.00
Bacillus* sp.+*Rhizoctonia oryzae	2.35	19.45	8.55	78.00	16.00	2.00	11.23	52.33	47.70	0.00
Bacillus* sp.+*Bipolaris sorokinana	2.41	19.24	8.32	78.00	17.00	2.00	10.97	49.33	46.20	0.00
Average	2.57	19.94	8.97	78.75	17.00	2.00	11.18	53.42	48.40	0.00
***Trichoderma* sp.**	3.03	20.83	9.53	81.00	18.00	3.00	11.33	58.33	51.40	0.00
Trichoderma* sp.+*Fusarium culmorum	2.95	20.17	8.90	80.00	18.00	3.00	11.27	52.33	49.50	0.00
Trichoderma* sp.+*Rhizoctonia oryzae	1.91	17.06	6.89	79.00	17.00	3.00	10.90	45.67	46.80	0.00
Trichoderma* sp.+*Bipolaris sorokinana	2.69	18.74	7.54	80.00	18.00	3.00	11.17	48.67	47.20	0.00
Average	2.65	19.20	8.22	80.00	17.75	3.00	11.17	51.25	48.73	0.00
Un treated	1.87	18.63	7.29	78.00	16.00	3.00	10.60	46.67	42.90	0.00
LSD 0.05%										
A- Fungi	0.38	0.60	0.49	0.49	0.55		0.31	3.12		
B-Bioagent	0.39	0.48	0.43	0.69	0.66		0.30	3.73		
C- interaction	0.78	0.96	0.87	1.38	1.32		0.60	7.47		

Table 4. ***In vitro*** **inhibitory evaluation of some fungicides on reduction percent of the treated pathogenic fungi**

Concentration (ml)	*Rhizoctonia oryzae*				*Fusarium culmorum*				*Bipolaris sorokiniana*			
	Score	**Amistar top**	**Topaz**	**Average**	**Score**	**Amistar top**	**Topaz**	**Average**	**Score**	**Amistar top**	**Topaz**	**Average**
0.0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	**0.00**
0.025	94.44	94.44	70.78	**86.55**	72.22	62.22	66.00	**66.81**	70.78	88.56	71.89	**77.08**
0.05	94.44	94.44	94.44	**94.44**	77.78	72.22	82.78	**77.59**	74.11	94.44	94.44	**87.66**
0.1	94.44	94.44	94.44	**94.44**	88.33	75.56	84.78	**82.89**	87.44	94.44	94.44	**92.11**
0.15	94.44	94.44	94.44	**94.44**	88.89	79.44	87.00	**85.11**	92.78	94.44	94.44	**93.89**
0.2	94.44	94.44	94.44	**94.44**	94.44	85.22	88.56	**89.41**	93.89	94.44	94.44	**94.26**
Average	**78.70**	**78.70**	**74.76**		**70.28**	**62.44**	**68.19**		**69.83**	**77.72**	**74.94**	

LSD 0.05% A- Concentration 0.15 B-Fungi 0.10 C-Fungicides 0.10

Table 5. Effect of fungicidal treatments on disease parameters of wheat root rot pathogens under greenhouse condition

Treatment	Pre emergence damping off (%)					Post emergence damping off (%)					Root rot (%)					Healthy survival plants (%)				
	Fusarium culmorum	*Rhizoctonia oryzae*	*Bipolaris sorokiniana*	Control	Average	*Fusarium culmorum*	*Rhizoctonia oryzae*	*Bipolaris sorokiniana*	control	Average	*Fusarium culmorum*	*Rhizoctonia oryzae*	*Bipolaris sorokiniana*	control	Average	*Fusarium culmorum*	*Rhizoctonia oryzae*	*Bipolaris sorokiniana*	control	Average
Without	**26.67**	**23.33**	**30.00**	**0.00**	**20.00**	**30.00**	**10.00**	**10.00**	**0.00**	**12.50**	**43.33**	**60.00**	**60.00**	**0.00**	**40.83**	**0.00**	**6.67**	**0.00**	**100.0**	**26.67**
Score	**3.33**	**00.00**	**6.67**	**00.00**	**2.50**	**00.00**	**00.00**	**00.00**	**00.00**	**00.00**	**16.66**	**6.67**	**6.66**	**0.00**	**7.50**	**80.00**	**93.33**	**86.67**	**100.0**	**90.00**
Amistar- top	**00.00**	**3.33**	**6.67**	**00.00**	**2.50**	**00.00**	**00.00**	**00.00**	**00.00**	**00.00**	**23.33**	**10.00**	**10.00**	**0.00**	**10.83**	**76.67**	**86.67**	**83.33**	**100.0**	**86.67**
Topaz	**3.33**	**3.33**	**6.67**	**0.00**	**3.33**	**3.33**	**00.00**	**3.33**	**0.00**	**1.67**	**33.33**	**33.33**	**26.67**	**0.00**	**20.83**	**60.00**	**73.33**	**63.33**	**100.0**	**74.17**
Average	**8.33**	**7.50**	**12.50**	**0.00**		**8.33**	**2.50**	**3.33**	**0.00**		**29.16**	**25.00**	**25.83**	**0.00**		**54.17**	**65.00**	**58.33**	**100.0**	
L.S.D. 0.05%																				
A- Fungi		0.14					0.36					0.39					0.39			
B-Fungicide		0.41					0.43				.	0.63					0.67			
C-Interaction		0.83					0.87					1.26					1.35			

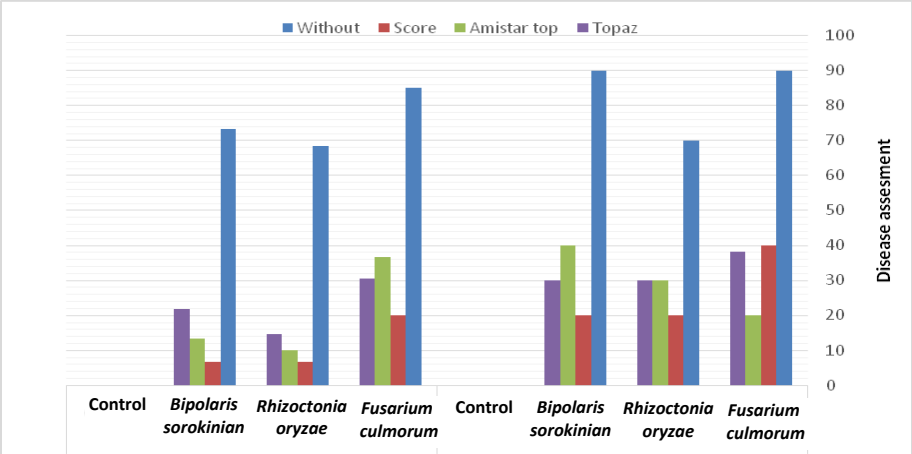


Fig. 6. Effect of fungicidal treatments on disease incidence and severity percentage of wheat root rot pathogens under greenhouse condition

Table 6. Evaluation of fungicides against *F. culmorum*, *R. oryzae* and *B. sorokiniana* under greenhouse conditions on plant growth parameters on Masr 1 cultivar

Fungicide	Treatment	Plant growth parameter									
		Root dry weight(g)	Shoot fresh weight(g)	Shoot dry weight(g)	Shoot Length(cm)	Root length (cm)	Tiller (No)	Spike length (cm)	Kernels number (No)	1000 kernels weight (g)	Head blight (No)
Score	**Control**	2.83	19.91	8.88	81.00	19.00	3.00	11.00	61.33	47.70	0.00
	Fusarium culmorum	2.58	19.10	8.08	79.00	17.00	3.00	10.90	51.33	46.20	0.00
	Rhizoctonia oryzae	2.64	19.64	8.64	79.00	18.00	3.00	11.10	54.33	46.70	0.00
	Bipolaris sorokinana	2.71	19.65	8.56	80.00	18.00	3.00	11.23	57.00	47.09	0.00
	Average	2.69	19.58	8.54	79.75	18.00	3.00	11.08	55.10	46.92	0.00
Amistar top	**Control**	2.92	19.87	7.21	80.00	18.00	3.00	11.23	61.33	47.40	0.00
	Fusarium culmorum	2.34	17.86	6.89	78.00	16.00	2.00	10.90	49.33	45.30	0.00
	Rhizoctonia oryzae	2.65	19.16	8.47	78.00	17.00	3.00	11.03	56.33	46.50	0.00
	Bipolaris sorokinana	2.72	19.38	8.56	79.00	17.00	3.00	11.10	55.67	46.90	0.00
	Average	2.66	19.07	7.78	78.75	17.00	2.75	11.07	55.67	46.53	0.00
Topaz	**Control**	2.79	19.73	8.13	80.50	19.00	3.00	11.02	61.10	47.61	0.00
	Fusarium culmorum	2.52	18.98	7.95	80.00	17.00	3.33	11.08	50.74	46.05	0.00
	Rhizoctonia oryzae	2.54	19.12	8.52	79.00	18.00	3.67	11.12	56.20	46.21	0.00
	Bipolaris sorokinana	2.65	19.41	8.47	80.00	18.00	4.00	11.19	55.59	47.01	0.00
	Average	2.63	19.31	8.27	79.88	18.00	3.50	11.10	55.91	46.72	0.00
	Control	2.84	19.79	8.14	80.58	18.00	3.00	11.14	61.24	47.52	0.00
LSD 05%	A- Fungi	0.37	0.48	0.47	0.82	0.70		0.39	4.68		
	B-Fungicide	0.30	0.79	0.49	0.66	0.57		0.40	3.84		
	C-(AB) Interaction	0.60	1.59	0.98	1.33	1.14		0.80	7.69		

Such results consequently followed by significant high parameters of plant growth illustrated in Table 6 that, Score revealed the highest value for each of root fresh weight (3.93 g), shoot fresh weight (19.58 g), spike length (11.08 cm) and 1000 grain weight (46.92 g), control produced, the lowest value for plant growth parameters.

Fungicides with the active substances of Tebuconazole, Propiconazole, Difenoconazole and Strobin (Azoxystrobin) groups has systemic features and commonly effectively used in the fungicide applications to seeds and leaves. These fungicides inhibit biosynthesis of ergosterol which plays an essential role in the cell membrane of the fungi and inhibiting fungal development by causing excess electrolyte loss **(Akgul and Erkilic, 2016; Koycu, 2019)**. Moreover, it increased the germination of seeds, plant height and decreased the severity of the disease in wheat plants. Azole group, inhibited mycelial growth and reduced mycotoxin of *F. graminearum*, *F. culmorum* by affecting one or more than one places within a fungal cell **(Dekker, 1982; Paul *et al*., 2008)**. **Somani *et al.* (2019)** explained propiconazole mode of action was by its inhibiting the biosynthesis of sterols of *Cochliobolus sativus* which building blocks of fungal cell membranes and the demethylase enzymes involved.

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كفاءة بعض معاملات المكافحة الحيوية والكيميائية ضد مرض عفن الجذور والتاج فى القمح

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عزلت فطريات فيوزايوم كولمورم، بيبولارس سوروكينينا، ريزوكتونيا أوريزا، فيوزاريوم، من نباتات القمح التى ظهر عليها أعراض الإصابة بعفن الجذور والتاج من مناطق مختلفة من محافظة الشرقية خلال الموسم الزراعي ٢٠١٥/ ٢٠١٦، أظهر إختبار القدرة المرضية أن فطر بيبولارس سوروكينينا كان الأكثر ضراوة فى حالة موت البادرات ما قبل الظهور فوق سطح التربة، تلاه فطر فيوزايوم كولمورم، بينما كان فطر فيوزاريوم كولمورم الأكثر ضراوة فى حالة موت البادرات ما بعد الظهور فوق سطح التربة، أظهر فطر ريزوكتونيا أوريزا النسبة الأعلى لعفن الجذور، في حين كان فطرى فيوزايوم كولمورم و بيبولارس سوروكينينا الأكثر في حالة نسبة الإصابة، بينما كان فطر فيوزايوم كولمورم الأعلى فى شدة الإصابة، معمليا كان فطر ترايكودرما ورواشح نمو مزرعته الأكثر تأثيراًعلى تثبيط النمو الميسليومى للفطريات فيوزايوم كولمورم و بيبولارس سوروكينينا وريزوكتونيا أوريزا، كما أظهر فطر ترايكودرما نتائج واضحة فى تقليل موت البادرات ما قبل الظهور فوق سطح التربة وموت البادرات بعد الظهور فوق سطح التربة وعفن الجذور ونسبة وشدة الإصابة مقارنة بالبذور غير المعاملة، بالإضافة إلى أن المعاملات بكائنات المكافحة الحيوية أدت إلى زيادة النباتات السليمة، وقد كان لتلك المعاملات تأثير إيجابي ومعنوي على صفات نمو النبات والإنتاج (الوزن الجاف والرطب لكل من الجذر والساق، طول الساق، طول السنبلة، ووزن الألف حبة). أبدى المبيد الفطري سكور وأميستار توب فاعلية في تثبيط النمو الميسليومى لفطر ريزوكتونيا أوريزا، تلاه فى ذلك مبيد أميستار توب على فطر بيبولارس سوروكينينا ثم مبيد سكور على الفطر فيوزايوم كولمورم. كان مبيد سكور الأكثر فاعلية فى الحصول على أعلى نسبة من النباتات السليمة تلاه مبيد أميستار توب، في حين أظهر مبيد سكورأعلى نسبة حماية ضد عفن جذور وتيجان القمح لكلاً من نسبة وشدة الإصابة.

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