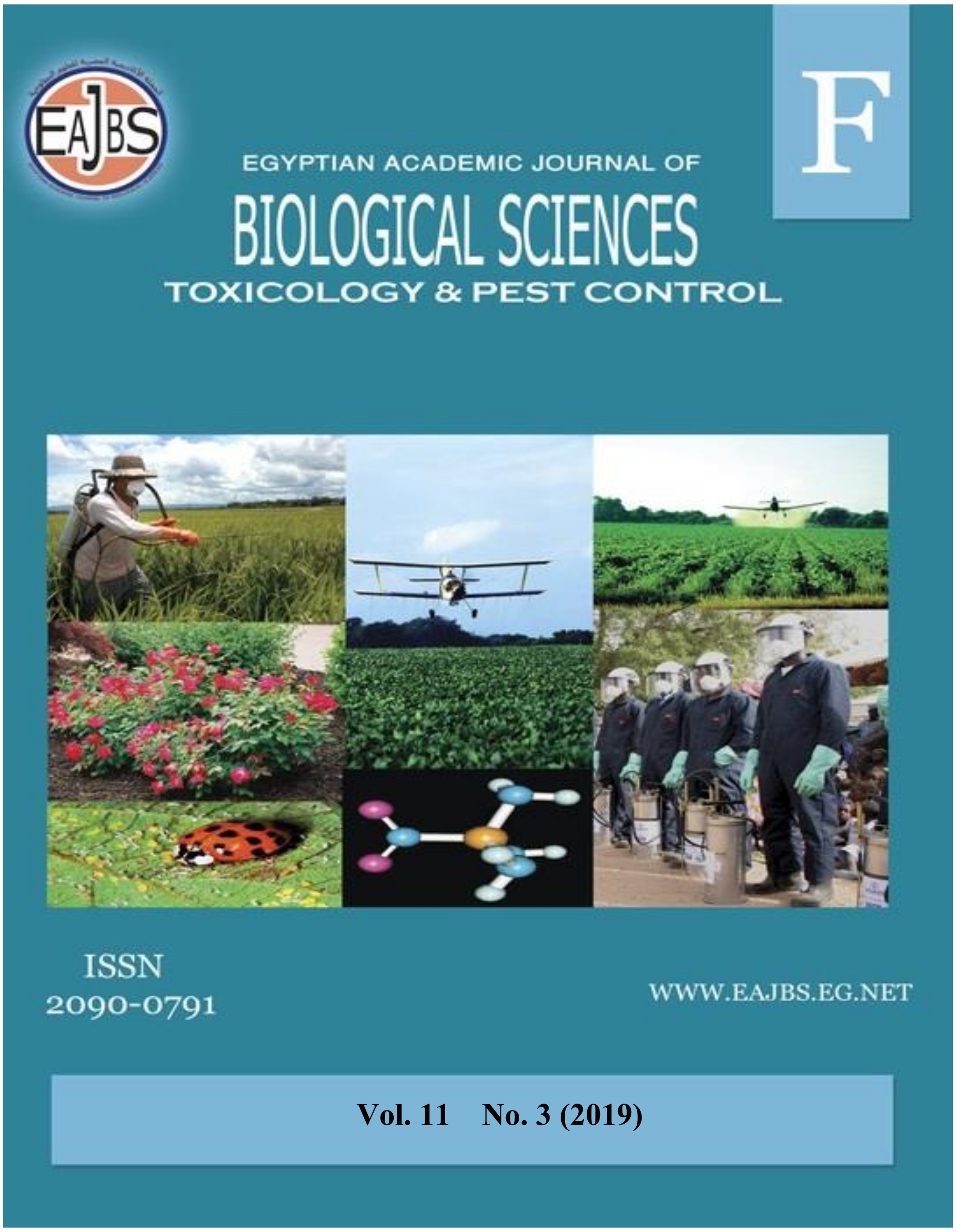

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Biocontrol of Bean and Wheat Aphids by Fungi Isolated from Indigenous and Invasive Insects Collected from Different Locations in Minia Governorate, Egypt

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ABSTRACT

A total of 26 fungal strains were isolated from aphids and tomato leaf miner as indigenous species and from red palm weevil and peach fruit fly as an invasive insect. Fungal strains tested for their abilities to attack both bean and wheat aphids. The mortality of aphids due to these fungi was estimated. Results showed that eight entomopathogenic fungi *Scopulariopsis brevicaulis*, *Verticillium* sp., *Fusarium chlamydosporum, Fusarium proliferatum, Fusarium semitectum, Pochonia chlamydosporia* var. *catenulata*, *Fusarium solani* and *Fusarium verticillioides* exhibited high virulence 60-100%. However, *Scopulariopsis brevicaulis*, *Verticillium* sp., *Fusarium chlamydosporum* and *Fusarium solani* proved to be the most virulent species against the target aphids inducing 90%-100% mortality.

INTRODUCTION

Faba bean is considered one of the main crops grown for seed in Egypt, being cultivated from the North to the South and it is the third legume crop in the world. According to FAOSTAT, production of broad, dry and horse bean is about 112871 tons/year (FAO 2017). Because of its high richness in valued nutrients, it is a primary protein source in the diet of masses. It is a winter crop sown from mid-October through November following the major summer crops include maize, rice, soybean, and cotton. Harvesting starts in spring and early summer (Gratwick, 1992).

Black bean aphid (*Aphis fabae* Scopoli) is a common pest of broad beans, runner beans, mangel, sugar beet, fodder beet, and spinach. It also presents on fat-hen, poopy and dock. Very similar, black aphids infest other cultivated plants and weeds including rhubarb, dahlia, nasturtium, dock, and thistle. Mainly, damages are caused by the loss of plant sap and by the injury in plant tissues during feeding. The presence of many aphids' clusters in a little time reduces the strength of the plants.

Wheat (*Triticum aestivum* L.) is the most important cereal crop in Egypt. It is consumed as food for humans and animals. About 600000 feddans are currently cultivated with wheat. The Egyptian Agricultural Policy aims to increase wheat production to decrease the consumption and production gap. Worldwide, wheat has the largest cultivated area and the quantity produced is more than that of any other crop. Leading wheat-producing countries are China, Russia, USA, France, and Canada (Shah, 1994).

Most wheat insect pests belong to seven major orders: Orthoptera, Homoptera, Hemiptera, Coleoptera, Diptera, Lepidoptera, and Hymenoptera. Among these Orders cereal aphids of Order Homoptera are gaining importance since their population has increased over the last few years (Atwal, 1976; Ghanem and El-Adl (1983); Hatchett *et al*., 1987; El-Serafy, 1999; El-Heneidy *et al*., 2004; Youssef. 2006 and Ahmad *et al*., 2016).

Wheat aphids (*Diuraphis noxia*) are serious insect pests attacking wheat in Egypt and in the world. It causes losses in crop averaged 7.5-18.7% of the total wheat production in Middle and Upper Egypt (Tantawi, 1985). Also, aphids are known for their ability to quickly colonize their prized plants. Their thick habit of aggregation in clusters and the high production of honeydew are not only the unsightly; but also, aphids are effective plant virus's transmitter and cause devastating damage at high population size and density. Large numbers of aphids affect plant growth and production that it weakens the seedlings and cause leaf stunting, on mature plants, yellowing and curling may occur. Aphids are a global insect, it is distributed worldwide, mainly in temperate zones. Through passive dispersal by riding on winds, they can migrate long distances (Roberts and Humber, 1981).

Entomopathogenic fungi are naturally occurring biological control agents of aphids and safe agents compared to chemical compounds. Khan *et al*. (2012) reported that entomopathogenic fungi infection route is different from other infectious microorganisms. They directly penetrate the cuticle by breaching it and enter the insect hemocoel, while other microorganisms enter through the mouth and then cause diseases by ingestion. Insect cuticle main component chitin and protein surrounded by layers of wax and lipid or fatty acids. Fungal pathogenesis starts by degrading cuticle with the secretion degrading enzymes. The most important cuticle degrading enzymes are chitinases, proteases, and lipases which degrade chitins, proteins, and lipids of the insect cuticle.

Chemical insecticides induced major and well-known problems such as health hazards to humans and animals, destruction of biological control agents and increased resistance of insects to insecticides (Picard, 1987).

So, the present work was conducted to lighten up the pathogenicity effect of some fungal strains isolated from different insects and plants collected from different localities in Minia governorate against bean and wheat aphids.

MATERIALS AND METHODS

Twenty-six fungal species were isolated and identified from aphids and Tomato leaf miners as an example of the indigenous species and red palm weevil and peach fruit fly as an example of the invasive insects from different plants and localities in Minia governorate of Northern Upper Egypt (250 km South of Cairo).

Preparation of Conidial Suspension:

Fungal strains were cultured on Sabouraud dextrose agar (SDA) at 25ºC for 7-days. From each tested strain, conidia were scraped with a sterile blade then suspended in sterile distilled water. The final concentration of spore suspension was adjusted at $11x10^6$.

Source of Aphids:

The aphid's stock was collected from a field population of aphids infesting bean and wheat plants in the farm of Experimental Agricultural Researches Station (EARS) in Mallawi, Minia.

Virulence Bioassay:

Three replicates of conidial concentration from each of the 26 fungal strains plus control were involved in the bioassay. Ten aphids were put in each sterilized Petri dish under the sterilized condition and 1ml of the spore suspension was gently poured for immersing the aphids. Petri dishes (6 cm diameter) were sealed with parafilm and incubated at 25ºC. The numbers of dead aphids were observed and recorded daily for seven consecutive days.

Statistical Analysis:

Data were statistically analyzed by SPSS (one-way Anova-test).

RESULTS

Incidence of Fungi Isolated from Indigenous and Invasive Insects:

The mycological analysis of the insect samples revealed the isolation of 26 fungal species belonging to 14 genera of filamentous fungi (Table 1). The broadest spectrum (20 species) was recovered from aphid samples, whereas the narrowest (4 species) was gotten from tomato leaf miner. Cultures of red palm weevils and peach fruit fly produced 8 and 9 fungal species, respectively. The common fungal species on aphids comprised *Aspergillus niger* (37% of samples) followed by *Toxicocladosporium irritants* (24%), *Scopulariopsis brevicaulis* (20%), *Alternaria tenuissima* and *Mucor racemosus* (19% for each), *Fusarium chlamydosporum* and *Fusarium proliferatum* (17% for each) and *Fusarium solani* (16%). The remaining fungal species were rare (1-6%). Due to the low number of insect samples representing tomato leaf miner, red palm weevil and peach fruit fly the percentages of colonizing fungi seemed to be as high as 50% (e.g. *Aspergillus niger*) or 75% in case of *Alternria tenuisima*.

Scopulariopsis brevicaulis, *Verticillium* sp., *Fusarium chlamydosporum*, *Fusarium proliferatum*, *Fusarium semitectum*, *Pochonia chlamydosporia* var. *catenulata* and *Fusarium solani* and *Fusarium verticillioides* have high virulence against bean aphids causing 60-100% mortality of tested aphids (Table 2, Figure 1). However, *Aspergillus chevalieri*, *Aspergillus flavus*, *Aspergillus niger, Aspergillus sydowi, Botryotrichum atrogriseum*, *Epicoccum nigrum*, *Fusarium subglutinans*, *Mucor racemosus*, *Penicillium aurantiogriseum* and *Penicillium oxalicum* showed moderate virulence against aphids 30-50% table (2) and figure (1). The other fungal species showed a low infectious effect against aphids compared to other isolates. All treatments with different fungal strains induced a significant effect on the target insects.

Scopulariopsis brevicaulis, *Verticillium* sp., *Fusarium chlamydosporum*, *Fusarium solani, Fusarium proliferatum*, *Pochonia chlamydosporia* var. *catenulata*, *Fusarium verticillioides* and *Fusarium semitectum* have high virulence against bean aphids 60-100% (Table 3, Figure 2). While, *Aspergillus flavus*, *Aspergillus sydowi*, *Botryotrichum atrogriseum*, *Epicoccum nigrum*, *Fusarium subglutinans*, *Mucor racemosus*, *Penicillium aurantiogriseum*, *Penicillium oxalicum*, *Talaromyces piophilum* and *Toxicocladosporium irritans* showed moderate virulence against bean aphids (30-50%). The remaining fungal species showed a low level of virulence against bean aphids.

The results in both table (2) and table (3) represented that 8 fungal species have high virulence against bean and wheat aphids and can be used for biological control.

Table 1. Incidence of fungal species isolated from indigenous and invasive insects

Fungal species	Indigenous insects		Invasive insects	
	Aphids (no.=70)	Tomato leaf miner (no.=4)	Red palm weevil (no.=6)	Peach fruit fly (no.=5)
Alternaria alternata	7 (10%)	0 (0%)	0 (0%)	2 (40%)
Alternaria tenuissima	13 (19%)	3 (75%)	0 (0%)	2 (40%)
Aspergillus chevalieri	1 (1%)	0 (0%)	0 (0%)	0 (0%)
Aspergillus flavus	4 (6%)	1 (25%)	4 (67%)	3 (60%)
Aspergillus niger	26 (37%)	2 (50%)	1 (17%)	3 (60%)
Aspergillus rugulosus	1 (1%)	0 (0%)	0 (0%)	0 (0%)
Aspergillus sydowi	5 (7%)	0 (0%)	0 (0%)	2 (40%)
Aspergillus terreus	3 (4%)	0 (0%)	0 (0%)	0 (0%)
Botryotrichum atrogriseum	3 (4%)	0 (0%)	0 (0%)	0 (0%)
Cochliobolus spicifer	1 (!%)	0 (0%)	0 (0%)	0 (0%)
Epicoccum nigrum	2 (3%)	0 (0%)	0 (0%)	0 (0%)
Fusarium chlamydosporum	12 (17%)	0 (0%)	0 (0%)	0 (0%)
Fusarium proliferatum	12 (17%)	0 (0%)	2 (33%)	0 (0%)
Fusarium semitectum	2 (3%)	0 (0%)	0 (0%)	0 (0%)
Fusarium solani	11 (16%)	0 (0%)	1 (17%)	0 (0%)
Fusarium subglutinans	0 (0%)	0 (0%)	1 (17%)	0 (0%)
Fusarium verticillioides	1 (1%)	0 (0%)	0 (0%)	2 (40%)
Mucor racemosus	13 (19%)	1 (25%)	0 (0%)	1 (20%)
Nigrospora oryzae	0 (0%)	0 (0%)	0 (0%)	1 (20%)
Penicillium aurantiogriseum	1 (1%)	0 (0%)	0 (0%)	0 (0%)
Penicillium oxalicum	0 (0%)	0 (0%)	0 (0%)	1 (20%)
Pochonia chlamydosporia var. *catenulata*	0 (0%)	0 (0%)	0 (0%)	1(20%)
Scopulariopsis brevicaulis	14 (20%)	0 (0%)	1 (17%)	0 (0%)
Talaromyces piophilum	0 (0%)	0 (0%)	1 (17%)	0 (0%)
Toxicocladosporium irritans	17 (24%)	0 (0%)	0 (0%)	0 (0%)
Verticillium sp.	0 (0%)	0 (0%)	1 (17%)	0 (0%)
Total no. of species	20	4	8	9

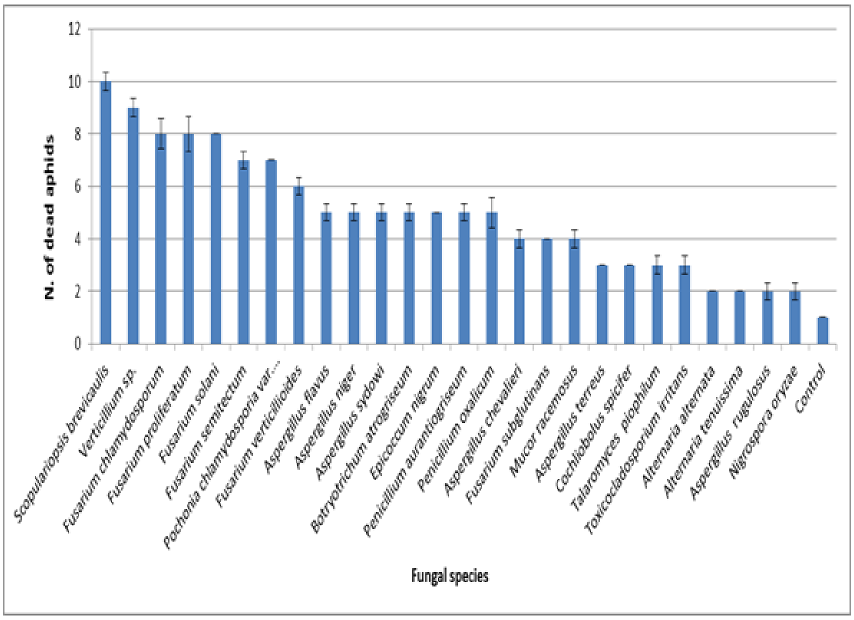

Fig. 1. Virulence of different fungal strains against bean aphids.

Table 2. Virulence of isolated fungal species against bean aphids

Fungal species	No. of aphids	No. of dead aphids			Mortality (%)
		after 24h	after 48h	after 72h	
Alternaria alternate	10	1± 0.00	2± 0.33*	2± 0.33*	20
Alternaria tenuissima	10	1± 0.33	2± 0.33	2± 0.33	20
Aspergillus chevalieri	10	4± 0.33	4± 0.58	4± 0.58	40
Aspergillus flavus	10	4± 0.58	5± 0.67	5± 0.67	50
Aspergillus niger	10	5± 0.33	5± 0.00	5± 0.00	50
Aspergillus rugulosus	10	2± 0.33	2± 0.33	2± 0.33	20
Aspergillus sydowii	10	4± 0.33	5± 0.00*	5± 0.00*	50
Aspergillus terreus	10	2± 0.00	3± 0.33	3± 0.33	30
Botryotrichum atrogriseum	10	4± 0.58	5± 0.33	5± 0.33	50
Cochliobolus spicifer	10	1± 0.33	3± 0.33	3± 0.33	30
Epicoccum nigrum	10	4± 0.33	5± 0.33	5± 0.33	50
Fusarium chlamydosporum	10	6± 0.33	8± 0.33*	8± 0.33*	80
Fusarium proliferatum	10	7± 0.33	8± 0.00*	8± 0.00*	80
Fusarium semitectum	10	7± 0.33	7± 0.33	7± 0.33	70
Fusarium solani	10	7± 0.67	8± 0.58	8± 0.58	80
Fusarium subglutinans	10	3± 0.33	4± 0.33	4± 0.33	40
Fusarium verticillioides	10	6± 0.33	6± 0.00	6± 0.00	60
Mucor racemosus	10	2± 0.33	4± 0.33*	4± 0.33*	40
Nigrospora oryzae	10	2± 0.33	2± 0.00	2± 0.00	20
Penicillium aurantiogriseum	10	4± 0.33	5± 0.00*	5± 0.00*	50
Penicillium oxalicum	10	3± 0.67	5± 0.33	5± 0.33	50
Pochonia chlamydosporia var. *catenulate*	10	5± 0.33	7± 0.33*	7± 0.33*	70
Scopulariopsis brevicaulis	10	8± 0.33	10± 0.00*	10± 0.00*	100
Talaromyces piophilum	10	3± 0.33	3± 0.00	3± 0.00	30
Toxicocladosporium irritans	10	3± 0.58	3± 0.33	3± 0.33	30
Verticillium sp.	10	8± 0.33	9± 0.33	9± 0.33	90
Control	10	0± 0.00	1± 0.00	1± 0.00	10

*: The mean difference is significant at the 0.05 level.
High virulence = 60-100%.
Moderate virulence= 30-50%.
Low virulence= <30%.

Table 3. Virulence of isolated fungal species against wheat aphids

Fungal species	No. of aphids	No. of dead aphids			Mortality (%)
		after 24h	after 48h	after 72h	
Alternaria alternata	10	1± 0.33#	2± 0.00*#	2± 0.33*	20
Alternaria tenuissima	10	1± 0.33	2± 0.00*#	2± 0.33*	20
Aspergillus chevalieri	10	2± 0.33	3± 0.00*	3± 0.33*	30
Aspergillus flavus	10	3± 0.33	3± 0.00*#	4± 0.33*	40
Aspergillus niger	10	2± 0.00#	3± 0.33*#	3± 0.00*	30
Aspergillus rugulosus	10	2± 0.33	2± 0.33*	3± 0.00*#	30
Aspergillus sydowi	10	3± 0.00#	3± 0.33#	4± 0.33#	40
Aspergillus terreus	10	2± 0.33#	2± 0.33*	3± 0.00*#	30
Botryotrichum atrogriseum	10	3± 0.33	4± 0.33	4± 0.00#	40
Cochliobolus spicifer	10	2± 0.33	2± 0.00*#	3± 0.33*	30
Epicoccum nigrum	10	2± 0.33	3± 0.33*	4± 0.00*#	40
Fusarium chlamydosporum	10	9± 0.33	9± 0.33*	10± 0.00*#	100
Fusarium proliferatum	10	7± 0.33	8± 0.33*#	8± 0.00*	80
Fusarium semitectum	10	5± 0.33	6± 0.00*#	7± 0.33*	70
Fusarium solani	10	8± 0.33	9± 0.33*	10± 0.33*	100
Fusarium subglutinans	10	4± 0.33	5± 0.00*#	6± 0.00*#	60
Fusarium verticillioides	10	5± 0.33	6± 0.33*#	7± 0.00*	70
Mucor racemosus	10	2± 0.33	3± 0.00*#	4± 0.33*	40
Nigrospora oryzae	10	2± 0.33	3± 0.33#	3± 0.00	30
Penicillium aurantiogriseum	10	2± 0.33	3± 0.33*#	4± 0.33*#	40
Penicillium oxalicum	10	3± 0.33	3± 0.00#	4± 0.33	40
Pochonia chlamydosporia var. *catenulate*	10	6± 0.33	7± 0.00*#	8± 0.00*#	80
Scopulariopsis brevicaulis	10	9± 0.33	10± 0.33*#	10± 0.00*	100
Talaromyces pinophilus	10	4± 0.33	4± 0.00*	5± 0.33*#	50
Toxicocladosporium irritans	10	3± 0.33	3± 0.33*	4± 0.00*#	40
Verticillium sp.	10	8± 0.58	9± 0.58	10± 0.33	100
Control	10	1± 0.33	2± 0.33	2± 0.33	20

*: The mean difference is significant at the 0.05 level.
#: denotes to test significance between bean and wheat,

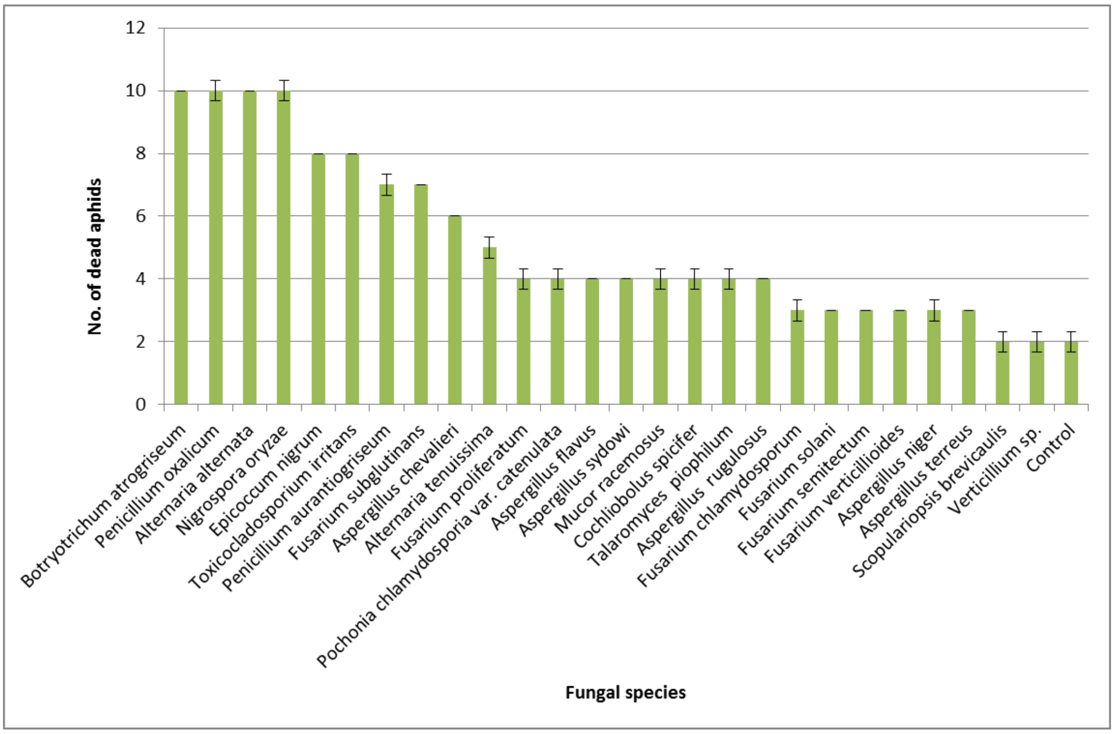

Fig. 2. Virulence of different fungal strains against wheat aphids

DISCUSSION

Fungal pathogens are important natural control agents of many insects and other arthropods and frequently cause epizootics that significantly reduce host populations (Burges, 1981; Carruthers and Soper, 1987; McCoy *et al*., 1988). The different species of Entomopathorales and Hyphomycetes isolated from aphid cadavers are common and recorded from several aphid species (Domsch *et al*., 2007). Aphids can be externally contaminated with spores of these fungi. The hyphomycete species, *Beauveria bassiana*, *Metarhizium anisopliae,* and *Verticillium lecanii* are well-known insect pathogens and are useful biocontrol agents.

Insecticolous fusaria interact and associate with insects, either in mutualism relation as a symbiont, saprophyte-eating decaying body, opportunistic pathogen, or as an entomopathogen. Associations of fusaria with insects have been reported by several investigators. Li (1984) reported four *Fusarium* spp from different insect-pests infesting rice in China. Feng-Yan *et al*. (1991) reported 180 *Fusarium* isolates from about 150 dead insects or diseased ones including spiders and other insect-related to Coleoptera, Lepidoptera, Hymenoptera, Homoptera, and Araneida. Additional studies were reviewed by Teetor-Barsch and Roberts (1983) indicated pathogenicity of *Fusarium* spp. either in the laboratory or on- the field natural mycoses, toward insects from different orders. The authors proposed using entomopathogenic fusaria in insect biological control and listed their advantages, such as insect-pathogenic strains specificity for host; the feasibility of growing in a laboratory; it is not harmful to plants; and their survival ability as saprophytes in soils. Claydon and Grove (1984) reported similar observations on the entomopathogenicity of fusaria. Although, studies in this area focused on using *Fusarium* as an insect biological control agent but did not study the side effect of releasing of phytopathogens into agroecosystems. O'Donnell *et al.* (2012)

argued that differentiation between beneficial entomopathogenic fusaria and harmful phytopathogenic *Fusarium* spp. could be done using gene marker.

In Sri Lanka, *Fusarium semitectum* was isolated from diseased cadaver of *Aphis gossypii* Glover (Hemiptera, Aphididae) by Mikunthan and Manjunatha (2006) who found that this fungus produced mycosis and caused mortality to sucking pests such as chili thrips (*Scirtothrips dorsalis*), broad mite (*Polyphagotarsonemus latus*), sugarcane wooly aphid (*Ceratavacuna lanigera*), spiraling whitefly (*Aleyrodicus disperses*), whitefly (*Bemisia tabaci*, *A. gossypii* and coconut mite (*Aceria guerreronis*). However, the same fungus did not cause death on lepidopteran larvae or ladybird beetle (*Menochilus sexmaculatus*), predatory mite (*Amblysius ovalis*) and larval parasitoid (*Goniozus nephantidis*). Likewise, this fungal species was unsuccessful infecting *B. mori* larvae or *A. indica*. It was isolated from thrips *Scirtothrips dorsalis* (Parker *et al*., 1996).

A toxic substance to the insects called beauvaricine was isolated from *F. semitectum* (Gupta *et al*., 1991), from tobacco aphid Manjunatha *et al*., (2009) and from sugarcane wooly aphid Aswini *et al*., (2007). In Tunisia, *F. semitectum* was reported as aphidopathogenic fungus attacking *Capitophorus elaeagni* (Del Guercio) prospected in many regions of production of artichoke (Jouda *et al.,* 2010). In India, Jayasimha *et al.*, (2012) evaluated the efficiency of *F. semitectum* against okra aphid, *Aphis gossypii* Glover under laboratory and greenhouse conditions. Their results showed that the highest mortality of 79.90 % and 64.40 % nymphs and adults, respectively was recorded at 4.6 x 10^{9} spores per ml of *F. semitectum*. The earlier instars were more susceptible to fungal infection than the later stages. The combination of *F. semitectum* at 4.6 x 10^{9} spores per ml + dicofol 0.03 % recorded the highest mortality of 66.30%t whereas dicofol alone caused mortality of 87.26%. *Fusarium chlamydosporum* was considered as entomopathogenic fungus and has the efficiency of biocontrol according to (Abd El-Ghany, *et al*., 2012).

The Indian investigators Mehetre *et al*., (2007) conducted a study to determine the natural existence of entomopathogenic fungi and the possibility for utilization as a biological control for the woolly aphid (*Ceratovacuna lanigera* Zehntner) in sugarcane plantations. *Fusarium verticillioides* was found to be a potential biocontrol agent where it caused up to 60% reduction in aphid populations when applied as two sprays at a week interval in the field. In Argentina Pelizza *et al*., (2011) isolated *F. verticilliodes* from the grasshopper *Tropidacris collaris* (Stoll) (Orthoptera: Acridoidea: Romaleidae) that died within 10 days. Positive pathogenicity results were recorded. The pathogenecity of *F. verticillioides* also was tested on harmful grasshopper, *Ronderosia bergi* (Stål) (Acridoidea: Acrididae). The mortality reached 58±6.53% by 10 days after inoculation.

In the present study, *Fusarium proliferatum* showed high virulence (80% mortality) against bean aphids. In agreement with these findings Laith *et al*., (unpublished) reported the pathogenicity effect of *F. proliferatum* and *Beauveria bassiana* against the adult of wheat flour *T. confusum* by treatment the body and food of the adult insect and the mortality of adults was recorded. Tosi *et al*., (2014) recorded *F. proliferatum* as entomopathogenic fungus against gall wasp *Dryocosmus kuriphilus* (DK). *Fusarium solani* also has the ability to control bean aphids and recorded high virulence. Majumdar *et al*., (2008) considered this fungus as a native entomopathogen of the sugar beet root maggot, *Tetanops myopaeformis* (Röder), 44% of larvae collected from a field site near North Dakota were infected with fungus. The mean LC_{50} of *F. solani*, assessed by multiple-dose bioassays with laboratory-reared pupae was 1.8×10^{6} conidia/ml. Symptoms of *F. solani* infection included pupae deformity and failure adults emergence. Infected Pupae transverse dissections showed growth of dense hyphal inside puparia, suggesting fungal infection. After tissue depletion Mycelia emerged from pupae host. At high concentration on older pupae, developed adults died inside puparia. As mentioned by Amatuzzia *et al*., (2018) *F. solani* induced low mortality (32%) when applied as a biocontrol agent of *Duponchelia fovealis* (Zeller) (Lepidoptera:Crambidae)

Many studies were conducted on the safety of using insect-pathogenic fusaria on plants showed different results. A study was performed to test the infectious effect of *F. oxysporum* isolated from the brown planthopper, *Nilaparvata lugens* Stål (Hemiptera: Delphacidae) on the rice, cotton and tomato plants. The entomopathogenic strain was found safe for the plants (Kuruvilla and Jacob 1979). The earlier study conducted by Morquerand Nysterakis (1944) revealed that conidial sprays of *Fusarium* on grape phylloxera *Daktulosphaira vitifoliae* Fitch (Hemiptera: Phylloxeridae) caused a reduction on the insect populations size included eggs, larvae and adults and the sprayed *Fusarium* was found to be associated as saprophyte with grape leaves and caused no infections in the plant.

In the current study *Pochonia chlamydosporia* var. *catenata* was responsible for 80% mortality of the tested aphids. This species was frequently reported as a parasite of nematodes and their eggs. Manzanilla-López *et al.* (2013) studied its performance as a biological control agent of endo-nematodes. The biological control potential of *P. chlamydosporia* var. *chlamydosporia* against *Meloidogyne javanica* was also reported by Ebadi *et al*. (2018). Extracts from cultures of *Pochonia chlamydosporia* was reported to induce 100% mortality of the pea aphid after 72 h of exposure (Lacatena *et al.* 2019). Chemical analysis of this extract showed the existence of a novel azaphilone compound named chlamyphilone.

More recently, Saad *et al*. (2019) tested the effectiveness of spore suspension of some endophytic fungi for their pathogenicity to the larvae of the cotton leafworm, *Spodoptera littoralis* (Boisd.) (Lepidoptera: Noctuidae) and found that *Alternaria alternata* caused 33.3% mortality. In our study *A. alternata* affected only 20% of the tested aphids.

In conclusion, the obtained results demonstrated that *Scopulariopsis brevicaulis, Verticillium* sp., *Fusarium chlamydosporum, Fusarium proliferatum, Fusarium semitectum, Pochonia chlamydosporia* var. *catenulata*, *Fusarium solani,* and *Fusarium verticillioides* have high virulence against wheat and bean aphids and can be used in biological control of these insects.

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ARABIC SUMMARY

المكافحة الحيوية لمن الفول و من القمح باستخدام أنواع الفطريات المعزولة من أنواع حشرات مستوطنة و غازية جمعت من مناطق مختلفة من محافظة المنيا, مصر

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تم عزل 26 نوع من الفطريات المصاحبة لأنواع مختلفة من الحشرات المستوطنة (حشرة المن- حشرة صانعات الانفاق) والغازية (حشرة سوسة النخيل الحمراء- حشرة ذبابة الخوخ). جميع أنواع الفطريات التي تم عزلها اختبرت لتحديد قدرتها الممرضة علي حشرتي من الفول ومن القمح. أظهرت النتائج ان الفطريات التالية: *Scopulariopsis brevicaulis, Verticillium* sp., *Fusarium chlamydosporum, Fusarium proliferatum, Fusarium semitectum, Pochonia chlamydosporia var. catenulata, Fusarium solani, Fusarium verticillioides* كانت ذات قدرة عالية علي إحداث المرض (60-100%). بينما الأنواع الأكثر قدرة ممرضة على انواع المن وتسبب أعلى نسبة موت بلغت 90-100% كانت *Scopulariopsis brevicaulis, Verticillium* sp., *Fusarium chlamydosporum and Fusarium solani*.