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Original Paper

Endophytic fungi of three economic plant roots in Sohag, Upper Egypt

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Abstract

Ninety species in addition to three species varieties belonging to thirty-one genera were isolated and identified from three economic plant roots (*Saccharum officinarum*, *Corchorus olitorius* and *Triticum aestivum*) on PDA and water agar at 28±2˚C. *Fusarium* (15 species, 45/60 samples and 31.4% of total fungi) and *Aspergillus* (15+2, 34/60 and 17%) were the dominant genera on PDA, whereas, *Fusarium* (13 species, 38/60 samples and 33.8% of total fungi) and *Drechslera* (6, 28 and 13.1%) were the commonest on water agar media. Of the previous genera *F. udum*, *F. anthophilum*, *F. subglutinans*, *A. terreus* var. *aureus*, *A. flavus*, *D. biseptata* and *D. bicolor* were the most detected species on PDA and WA. The endophytic fungi isolated belonging to anamorphic fungi (57 species, 23 genera of 11 order), Ascomycotina (26, 4 of 1) and Zygomycota (1, 1 of 1) on PDA and (38, 15 of 8) & (11, 2 of 1) belonging to anamorphic fungi and Ascomycotina on WA, while Zygomycota disappeared on WA.

Key words: Endophytes, sugarcane, jute, wheat, roots.

Introduction

Fungal endophytes are micro fungi that colonize living tissues of plants without producing any apparent symptoms or obvious negative effects (Hirsch and Braun, 1992). The endophytic fungi represent an important and quantified component of fungal biodiversity, and are known to affect on plant community diversity and structure (Krings *et al*., 2007). Moreover, the fungal endophytes are known to play several roles such as providing protection against herbivorous insects, plant parasitic nematodes, plant pathogens, etc. (Vega *et al*., 2008).

Sugarcane (*Saccharum officinarum* L.) is the main source for sugar production and plays a vital economic role in many tropical countries as well as in Egypt (Jangpromma *et al*., 2010; Singh *et al*., 2010). Moreover, it is widely used in Egypt for fresh juice consumption and molasses industry. In addition to being a food crop, sugarcane is an efficient crop for producing fuel ethanol, biogas byproducts and fertilizers (Mahmood *et al*., 2007; Souza *et al*., 2010). Notably, the ascomycete *Epicoccum nigrum* has been frequently isolated as an endophyte of sugarcane plants (Stuart *et al*., 2010; Fávaro *et al*., 2011).

Jute (*Corchorus olitorius* L.) is an important green leafy vegetable in many tropical area including Egypt (Basu *et al*., 2004; Samra *et al*., 2007). The leaf extract of the plant is also employed in folklore medicine in the treatment of gonorrhea, pain, fever and tumor (Ndlovu and Afolayan, 2008). The crop is an excellent source of vitamin A and C, fiber, minerals including calcium, and iron. It is reportedly consumed as healthy, vegetable in Japan because of its rich contents of carotenoids, vitamin B1, B2, C and E, and minerals (Ibrahim and Fagbohun, 2011). The production quality and yield of this economically important crop is affected by several biotic e.g. fungi, pest, insect, nematode, virus and mite (BBS, 2004; Keka *et al*., 2008).

Wheat (*Triticum aestivum* L.) is one of the important cereal crops of high nutritive value in the world as well as in Egypt. The total cultivated area by wheat in Egypt is about 3.2 million feddans during 2012/2013 season, produced about 8.5 million tons which not sufficient for national

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consumptions. Therefore, Egypt has to import about 8.5 million tons (FAO, 2013). The grains of wheat contain high amounts of proteins, carbohydrates in addition to some minerals and vitamins (Zaki *et al.*, 2007; Bhoja *et al.*, 2011). It is the most import staple food for about two billion people (36% of the world population).

This work paves the way to further study the diversity of endophytic fungi isolated from roots of some economic plants for further investigations.

Materials and Methods

Collection of Plant Samples:

Roots of three economical plants, sugarcane, jute and wheat (*Poaceae* and Tiliaceae) were collected from different locations in Sohag Governorate. The plants (each, 20 samples) were chosen to isolate of endophytic fungi. The collected plant materials were stored in separate plastic bags at 4°C in an ice box until isolation of endophytic fungi (Strobel and Daisy, 2003).

Fungal Isolation and Identification:

Isolation of endophytic fungi was done according to the method described by (Hallmann *et al.*, 2007). The plant roots were rinsed gently in running water to remove adhered dust and debris. Samples were surface sterilized by ethyl alcohol (75%) for 1 min, soaked in sodium hypochlorite solution (5%) for 3 min, and then rinsed with ethyl alcohol (75%) for 30 sec. They were finally rinsed with sterile distilled water and dried between two sterilized filter papers in laminar air flow chamber and the roots were cut into segments (1 cm).

Twenty sterilized segments of each root sample were placed on both PDA (potatoes ″extract‶, 200.0 g; glucose, 20.0 g; agar, 15.0 g; distilled water, to 1.0 L) and WA media (agar, 15.0 g; distilled water, 1.0 L). The plates (4 plates, 5 segments for each) were incubated at 28°C for 15 days. The plates were periodically observed for fungal growth. The growing fungi were then sub-cultured on PDA and glucose-Czapek's agar media plates (glucose , l0.0 g; NaNO3, 2.0 g; KH_2P0_4, 1.0 g; $MgSO_4.7H_2O$, 0.5 g; KC1, 0.5 g; $FeSO_4$.7H2O, 0.01 g; agar, 15.0 g; distilled water, 1.0 L; pH, 6.5-7) for purification and identification purposes. The endophytic fungal isolates were identified microscopically on the basis of their critical morphological structure such as hyphal features, arrangement of spores and reproductive structures (Raper and Fennell, 1965; Ellis, 1971; Pitt, 1979; Leslie and Summerell, 2006). Isolates that failed to produce reproductive structures after 3-4 weeks of incubation were referred to as sterile mycelia, and divided into their colour.

Results and Discussion

Endophytic fungi were isolated from roots of three economic plants. Most isolates were recorded in the first two weeks of incubation. These results correspond with other results obtained for the rate of isolation of endophytic fungi from other hosts (Shebany, 2008).

Ninety species and three species varieties which belong to thirty-one genera were isolated and identified based on anamorph and teleomorph from 60 samples of economic plant roots, sugarcane, jute and wheat (each, 20 samples) on both of PDA and WA media at 28±2˚C (Tables, 1 & 2). While, seventy-eight species and six varieties belonging to twenty-one genera were isolated and identified from 60 samples of leguminous plant roots (peanut, alfalfa and broad bean) on both of PDA and WA media (El-Maghraby *et al*., 2013). The results in this study showed that most taxa isolated during this study belong to genera which have already been described as endophytes from different Egyptian hosts at different locations (Shebany, 2008; Nath *et al*., 2012).

The mycological studies in this investigation indicated that the endophytic fungi belonged to anamorphic fungi (57 species, 23 genera of 11 order), Ascomycotina (26, 4 of 1) and Zygomycota (1, 1 of 1) on PDA and (38, 15 of 8) & (11, 2 of 1) belonging to anamorphic fungi and Ascomycotina on WA, while Zygomycota disappeared on WA (Table, 3).

The authors worked in this field reported that members of the Ascomycotina and Deutromycotina have been isolated as endophytes (Clay, 1991; Abd-Elaah and Soliman, 2005). Also, (Valachová *et al.*, 2005). showed that most fungal endophytes belonged to Ascomycetes (Ascomycotina) and anamorphic fungi.

A total of 984 isolates from the three non-leguminous plant roots used were listed from sugarcane, jute and wheat (314 & 266, 143 &

96 and 74 & 91 isolates on PDA and WA, respectively) as shown in tables (1 & 2). In this respect, a total of 597 isolates were isolated from the three leguminous plant roots (peanut, alfalfa and broad bean) on PDA and WA (229 & 209, 230 & 188 and 138 & 102 isolates, respectively) (El-Maghraby *et al*., 2013). The broad diversity of genera and species were isolated on PDA medium (20 genera & 44 species + 2 varieties; 14 & 36 + 1 and 14 & 31 + 2, respectively) compared with WA medium (12 & 22 + 1; 12 & 20 + 1 and 10 & 21, respectively) from sugarcane, jute and wheat, respectively. These results more acceptable with fungal genera and species isolated from leguminous plant roots (13 genera & 41 species + 3 varieties; 13 & 36 + 2 and 12 & 32 + 1) on PDA compared with WA media (12 & 26 + 4; 9 & 29 and 8 & 23 + 1) (El-Maghraby *et al*., 2013). The differences in the number of isolates rely on the nature, age and other factors of the plants. Hoff *et al*. (2004). mentioned that endophytic fungi usually occur in above ground plant tissues but, are also found in root unlike mycorrhizal fungi, fungal endophytes of roots lack extra radical (outside the root) hyphal networks and mantles (sheaths around the roots).

Of the three economic plants studied, the most frequently occurring genus was *Fusarium* (21-36.6% & 27.5- 38.4% of total fungi) and (60-100% & 40- 95% of the total samples) on both PDA and WA media, respectively. Followed by *Aspergillus* and *Drechslera* which were recorded with high frequency (15- 90% & 10- 90% of the total samples) and low in the total fungal count (4.4- 21.3% & 2.2- 21.8% of total fungi on both PDA and WA media, respectively). Moreover, (El-Maghraby *et al*., 2013). reported that the most dominant genera isolated from three leguminous plant roots were *Fusarium*, *Aspergillus* and *Penicillium*. Most of genera were previously isolated as endophytic fungi by several researchers from different plants such as *Fraxinus excelsior*, *Gossypium* sp., *Gynoxis oleifolia*, *Manilkara bidentata*, *Picea abies* and *Taxus* sp. (Caruso *et al*., 2000; Wijeratne *et al*., 2006; Wang *et al*., 2007), twigs of *Kandelia candel* and *Avicennia marina* (Abdel-Wahab, 2000), different parts of *Altheae rosea*, *Calotropis procera* and *Nerium oleander* (Shebany, 2008) and roots, stems and leaves of *Hyoscyamus muticus* (Fatma *et al*., 2010).

Fusarium (16 species) was the most common genus regarding the number of cases of isolation and total fungal count from sugarcane, jute and wheat (100, 60 & 65% of the samples and 36.6, 21 & 36.5% of total fungi, respectively) on PDA medium and (95, 55 & 40% and 38.4, 35.4 & 27.5% of total fungi, respectively) on water agar medium (Tables, 1 & 2). Also *Fusarium* (13 species) was the most common genus from peanut and alfalfa, each 95% of the samples and 28.4 and 44.35% of total fungi, respectively on PDA and 75 & 80% of the samples and 22.5 & 34.6% of total fungi, respectively on water agar medium (El-Maghraby *et al*., 2013). *Fusarium* spp. have been recorded as endophytes from *Amomum siamense*, *Altheae rosea*, *Calotropis procera* and *Nerium oleander* (Bussaban *et al*., 2001; Tian *et al*., 2004; Shebany, 2008). Of the species, *F. udum*, *F. solani*, *F. anthophilum*, *F. subglutinans*, and *F. proliferatum* were the dominant species recovered from the three economic plants (5-65% of the samples, 3.3-40% of total *Fusarium* and 0.7-13.7% of total fungi) on PDA and (5-50%, 2.9-30.4% and 1-11.7%) on WA media. These results more agree with results obtained by (El-Maghraby *et al*., 2013). where, *F. solani*, *F. subglutinans*, *F. oxysporum*, *F. nygamai* and *F. anthophillum* were the dominant species recovered from the three legumonous plants (5-55% & 5-45% of the samples, 1.5-49.23% & 2-60% of total *Fusarium* and 0.32-14% & 0.48-13.4% of total fungi on both PDA and WA media, respectively). In contrast, some of these species were recovered by (Shebany, 2008). with low counts from shoot system (9.88 & 10.29% of total *Fusarium* species and 1.75 & 3.23% of total fungi) of *Altheae rosea* and *Nerium oleander*, respectively. On the other hand, *F. solani* was isolated from healthy leaves of *Quercus ilex* as endophytic fungi (Weber *et al*., 2007). and from healthy leaves of *Manilkara bidentata* (Lodge *et al*., 1996). *F. oxysporum* was isolated from roots of mangrove plants and also from branch of *Theobroma cacao* (Rubini *et al*. 2005).

Aspergillus was the second most prevalent genus based on the counts constituted 21.3, 14.7 & 15% of total fungi from sugarcane, jute and wheat, respectively on PDA and occupied the third place on WA (4.5, 19.8 & 4.4% of total fungi) from the three previous plants. The genus was represented by 15 species in addition to 2 species varieties of which the most dominant species were *A. terreus* var. *aureus* and *A. flavus* (3/3 plants for each) and in counts (14.9, 10.4; 15.8, 31.6 & 18.2, 18.2% of total *Aspergillus* and 3.2, 2.2; 2, 4.2 & 2.7, 2.7% of total fungi from sugarcane, jute and wheat, respectively) on PDA as shown in table (1). *A. terreus* var. *aureus* appeared only in 2 plants (sugarcane and jute) on WA (58.3 & 5.3% of total *Aspergillus* and 2.6 & 1% of total fungi, respectively) (Table, 2). The genus was represented by 13 species in addition to 4 varieties of which, the most dominant species were *A. tubingensis* and *A. terreus* in three leguminous plant roots with low counts on PDA and WA media (El-Maghraby *et al*., 2013). The previous species were also recorded from lemon, sweet basilicum, mulberry and guava (Mohammed, 2010). *A. tubingensis* was isolated from sugarcane and wheat as the most dominant *Aspergillus* species (45 & 5% of the samples; 16.4 & 9.1% of total *Aspergillus* and 3.5 & 1.4% of total fungi, respectively) on PDA and (15 & 10%; 33.3 & 50% and 1.5 & 2.2%, respectively) on WA media. Moreover, *A. tubingensis* was the most dominant species isolated from three leguminous plant roots (peanut, alfalfa and broad bean) (18.2-24% of total *Aspergillus* and 2.6-5% of total fungi on PDA) and (23.3-31.3% and 2.7-4.9% on WA) (El-Maghraby *et al*., 2013). Also, *A. tubingensis* was isolated from mulberry, mille fleur and guava with rare frequency and low count (5% of the samples for each, 7.7, 14.3 & 4.5% of total *Aspergillus* and 3.23, 5 & 3.33% of total fungi, respectively) (Mohammed, 2010).

Also, *Drechslera* was isolated from sugarcane, jute and wheat with moderate or low counts which collectively comprised 2.2 & 21.8, 9.8 & 3.1 and 13.5 & 14.3 % of total fungi and high, moderate or low frequency 20 & 90, 40 & 10 and 25 & 40% of the samples on PDA & WA, respectively. These results were in agreement with results obtained by (Shebany, 2008 and Mohammed, 2010). that isolated *Drechslera* spp. from root and leaves of some medicinal plants. Also, (El-Maghraby *et al*., 2013). isolated *Drechslera* with rare in counts (3-1.5% & 1.4-9% of total fungi) and moderate or less in frequency (10-20% & 5-40% of the samples) on PDA and WA media, respectively from three leguminous plant roots. *D. biseptata* and *D. bicolor* were the most detected species (1.4- 12.8% & 1.1- 7.14% of total fungi and 10-65% & 5-35% of the samples, respectively) on the two isolation media. These species were recovered as endophytic fungi from many plants around the world (Rubini *et al*., 2005; Ganley and Newcombe, 2006; Weber *et al*., 2007).

Five genera namely, *Penicillium* (7 species), *Cylindrocarpon* (2 species + 1 variety), *Curvularia* (6 species), *Humicola* (2 species) and *Alternaria* (3 species) were recorded in all plants tested with low or moderate count (0.32-17.5% of total fungi) and frequency (5-30% of the samples). Also, two genera were observed in two plants with low in counts (0.96- 7%) and rare or low frequency (5-20%) and these were *Paecilomyces* (2 species) and *Macrophomina* (1 species) on PDA only as shown in table (1). On the other hand, *Penicillium*, *Cylindrocarpon* and *Curvularia* were also recorded in all plants tested with less in counts (0.38- 13.5% of total fungi) and frequency (5- 30% of the samples) on WA, table (2). While, *Alternaria* was observed in two plants with less in counts (1.1- 1.5% of total fungi) and frequency (5-10% of the samples) and *Humicola* in only one plant with rare in counts (2.1% of total fungi) and frequency (10% of the samples) on WA medium (Table, 2). These species were recovered as endophytic fungi from many plants (Rubini *et al*., 2005; Ganley and Newcombe, 2006; Weber *et al*., 2007). *Penicillium* spp. have been commonly recorded as endophytes from leaves and roots of various hosts such as soybean leaves (Larran *et al*., 2002). and roots of *Alnus glutinosa* (Cappellano *et al*., 1987; Fisher *et al*., 1991; Caruso *et al*., 2000). isolated *Alternaria* from woody tissues and herbaceous tissues of *Taxus* sp. In particular, *Alternaria* was isolated from all the analysed plant materials and can be considered a resident genus of *Taxus* tissues. Moreover, *Cylindrocarpon* was isolated from roots of healthy potato plant (Götz *et al*., 2006).

Sterile mycelia were observed in high diversity of colour (4.9-13.1% & 3.1- 17.6% of counts on PDA & WA, respectively) from the three plant roots tested, where sugarcane had the best frequency and counts (100 &70% of the samples and 13.1 & 10.5% of the counts on PDA & WA, respectively) as shown in tables, (1 & 2). White sterile fungi were the most dominant in three plant roots (65, 5, 10% of the samples and 10.2, 0.7, 4.1% of the total fungi from sugarcane, jute and wheat, respectively) on PDA and prevalent in two plant roots on WA media (35 & 10% and 7 & 2% from sugarcane and jute, respectively). In contrast, brown or blackish sterile fungi isolated from conifer roots were referred to by Melin (1922, 1923) as *Mycelium radicis atrovirens* Melin (MRA), but very little is known what comprises MRA, because the name has since been applied to any sterile, dark and septate fungus isolated from roots or soil (Jumpponen and Trappe, 1998). This group of fungi is prevalent in endophyte studies (Lacap *et al*., 2003; Shebany, 2008). recovered sterile mycelia from different organs of *Altheae rosea, Calotropis procera* and *Nerium oleander* with low counts (10.8% of total fungi). Also, (Caruso *et al*., 2000). isolated sterile mycelium from woody and herbaceous tissues. Moreover, dark septate endophyte symbioses may indeed function physiologically as mycorrhizas in natural conditions, since some dark septate endophytes have been found to enhance host mineral nutrition and growth (Fernando and Currah, 1996; Jumpponen *et al*., 1998). Mycorrhizal fungi enable their host plant to tolerate environmental extremes such as nitrogen and phosphorus deficiency, drought, low pH, soil pollution, negative effects of some root pathogens etc. (Sylvia and Williams, 1992).

Conclusion:

The results obtained in this investigation in general accepted with the previous studies where, endophytic fungi are an ecological, polyphyletic group of highly diverse fungi, mostly belonging to ascomycetes and anamorphic fungi (Huang *et al*., 2001; Arnold, 2007). In addition to the positive role of endophytic fungi within the host depend on the nature of the association between endophytic fungi and their hosts are not considered as saprophytes (Valachová *et al*., 2005). They are associated with living tissues, and may in some way contributed to the well being of the plant. That is, the plant thought to provide nutrients to the microbe, while the microbe may produce factors that protect the host plant from attack by animals, insects or microbes (Müller and Krauss, 2005; Lucero *et al*., 2006). Also, the dormance of endophytes in three non-leguminous compared with leguminous (El-Maghraby *et al*., 2013). may be related to presence of nitrogen fixing bacteria as endophytic bacteria.

Genera and species	Sugarcane		Jute		Wheat	
	TC	NCI	TC	NC I	TC	NCI
Fusarium	**115**	**20**	**30**	**12**	**27**	**13**
F. udum Butler	43	13	12	8	3	2
F. solani (Mart.) Appel & Wollenweber emend. Snyder & Hansen	20	9	8	4	-	-
F. anthophilum (A. Braun) Wollenweber	16	7	1	1	6	3
F. subglutinans Wollenweber & Reinking	9	4	2	2	7	4
F. proliferatum (Matsushima) Nirenberg	6	3	2	1	3	3
F. scirpi Lambotte & Fautrey	5	3	-	-	-	-
F. thapsinum Klittich, Leslie, Nelson & Marasas	4	3	-	-	2	2
F. verticillioides (Saccardo) Nirenberg	7	2	-	-	-	-
F. oxysporum (Schlecht. emend.) Snyder &	3	2	-	-	4	2
Hansen	1	1	-	-	-	-
F. nygamai Burgess & Trimboli	1	1	-	-	-	-
F. xylarioides Steyaert	-	-	2	1	-	-
F. poae (Peck) Wollenweber	-	-	2	1	-	-
F. semitectum Berkeley & Ravenel	-	-	1	1	-	-
F. equiseti (Corda) Saccardo	-	-	-	-	2	1
F. decemcellulare Brick	**67**	**18**	**19**	**9**	**11**	**5**
Aspergillus	11	9	-	-	1	1
A. tubingensis (Schö-ber) Moss	15	5	-	-	-	-
A. parasiticus Speare	10	5	3	2	2	1
A. terreus var. *aureus* Thom & Raper	10	4	-	-	-	-
A. ochraceus Wilhelm	8	4	-	-	-	-
A. flavus var. *columnaris* Fennell & Raper	7	4	6	4	2	1
A. flavus link	2	2	3	2	-	-
A. ficuum (Reich.) Hennings	-	-	-	-	2	2
A. ustus (Bain.) Thom & Church	2	2	-	-	1	1
A. phoenicis (Cda.) Thom	1	1	-	-	-	-
A. flavo-furcatis Batista & Maia	1	1	4	3	1	1
A. terreus Thom	-	-	1	1	-	-
A. fumigatus Fresenius	-	-	1	1	-	-
A. subsessilis Thom & Raper	-	-	1	1	-	-
A. terricola Marchal	-	-	-	-	1	1
A. puniceus Kwon & Fennell	-	-	-	-	1	1
A. speluneus Thom & Raper	22	8	-	-	-	-
Trichoderma ghanense Doi, Y. Abe & J. Sugiyama	-	-	2	2	-	-
Emericella nidulans (Eidam) Wint						

Table (1): Total counts (TC, calculated per 400 root segments) and number of case of isolation (NCI, out of 20 samples) of fungal genera and species isolated from sugarcane, jute and wheat roots on potato dextrose agar (PDA) at 28±2˚C.

Genera and species	Sugarcane		Jute		Wheat	
	TC	NCI	TC	NCI	TC	NCI
Hypocrea vinosa Bissett	18	8	-	-	-	-
Penicillium	**13**	**6**	**1**	**1**	**2**	**2**
P. corylophilum Dierckx	4	3	-	-	-	-
P. ducluxi Delacroix	3	1	-	-	1	1
P. islandicum Sopp	2	1	-	-	-	-
P. rubrum Stoll	2	1	-	-	-	-
P. funiculosum Thom	1	1	1	1	-	-
P. pulvillorum Turfitt	1	1	-	-	-	-
P. resticulosum Birkinshaw, Raistrick and Smith	-	-	-	-	1	1
Drechslera	**7**	**4**	**14**	**8**	**10**	**5**
D. biseptata (Sacc. & Roum.) Richardson & Fraser	7	4	2	2	5	3
D. halodes (Drechsler) Subram. & Jain	-	-	4	4	-	-
D. hawaiiensis (Bugnicourt) Subram. & Jain ex M. B. Ellis; Subram. & Jain	-	-	2	2	-	-
D. holmii (Luttrell) Subram. & Jain	-	-	4	1	-	-
D. miyakei (Nisikado) Subram. & Jain	-	-	1	1	-	-
D. rostrata (Drechsler) Richardson & Fraser	-	-	1	1	-	-
D. bicolor Paul & Parbery	-	-	-	-	4	2
D. carbonus Nelson	-	-	-	-	1	1
Cylindrocarpon	**5**	**4**	**25**	**6**	**1**	**1**
C. didymium (Hartung) Wollenweber	5	4	-	-	-	-
C. radicicola Wollenweber	-	-	25	6	-	-
C. candidum var. *majus* Wollenweber	-	-	-	-	1	1
Stachybotrys bisbyi (*Bisby*) Corda	4	2	-	-	-	-
Cladosporium	**3**	**2**	-	-	-	-
C. herbarum (Pers.) Link ex S. F. Gray	2	1	-	-	-	-
C. cladosporoides (Fresen.) de Vries	1	1	-	-	-	-
Paecilomyces	**3**	**2**	-	-	**1**	**1**
P. fumosoroseus Bainier	3	2	-	-	-	-
P. terricola Bainier	-	-	-	-	1	1
Botryotrichum atrogriseum van Beyma	-	-	5	2	-	-
Curvularia	**2**	**2**	**11**	**6**	**5**	**3**
C. clavata Jain	1	1	-	-	1	1
C. lunata (Wakker) Boedijn	1	1	6	4	-	-
C. oryzae Bugnicourt	-	-	3	2	-	-
C. ovoidea (Hiroe & Watan.) Muntañola	-	-	2	1	-	-
C. pallescens Boedijn	-	-	-	-	3	1
C. brachyspora Boedijn	-	-	-	-	1	1

Table (1): continued.

Genera and species	**Sugarcane**		**Jute**		**Wheat**	
	TC	**NCI**	**TC**	**NCI**	**TC**	**NCI**
Macrophomina phaseoli (Maublanc) Ashby	4	1	10	4	-	-
Gilmaniella humicola Barron	2	1	-	-	-	-
Humicola	**2**	**1**	**2**	**1**	**2**	**2**
H. grisea Traaen	2	1	-	-	1	1
H. fuscoatra Traaen	-	-	2	1	1	1
Alternaria	**1**	**1**	**11**	**4**	**2**	**1**
A. tenuissima (Kunze: ex Pers.) Wilshire	1	1	3	3	-	-
A. alternata (Fr.) Keissler	-	-	7	3	2	1
A. longipes (Ellis & Everh.) Mason	-	-	1	1	-	-
Ascotricha xylina Lentz & Hawksworth	-	-	-	-	1	1
Cephalosporium coremioides Raillo	1	1	-	-	-	-
Histoplasma capsulatum Darling	-	-	-	-	1	1
Memnoniella subsimplex (Cooke) Deighton	-	-	-	-	1	1
Mucor hiemalis Wehmer	1	1	-	-	-	-
Myrothecium roridum Tode ex Fries	-	-	2	1	-	-
Nigrospora panici Zimm	1	1	-	-	-	-
Scopulariopsis	**1**	**1**	**2**	**1**	**1**	**1**
S. humicola (Sacc.) Bainier	1	1	-	-	-	-
S. brevicaulis (Sacc.) Bainier	-	-	2	1	-	-
S. brumptii Salvanet-Duval	-	-	-	-	1	1
Scytalidium lignicola Pesante	-	-	1	1	-	-
Spicaria violacea Abbott	-	-	1	1	-	-
Torula herbarum (Pers.) Link ex Fries	-	-	-	-	1	1
Trichothecium roseum (Pers.) Link ex Gray	1	1	-	-	-	-
Sterile mycelium (white)	32	13	1	1	3	2
Sterile mycelium (gray)	2	2	2	2	2	2
Sterile mycelium (pale brown pink)	2	2	-	-	-	-
Sterile mycelium (gray green)	2	1	-	-	-	-
Sterile mycelium (olive-gray)	-	-	-	-	2	2
Sterile mycelium (white yellow)	2	1	-	-	-	-
Sterile mycelium (white orange)	1	1	-	-	-	-
Sterile mycelium (drip white)	-	-	-	-	1	1
Sterile mycelium (rose-white)	-	-	2	1	-	-
Sterile mycelium (violet-white)	-	-	1	1	-	-
Sterile mycelium (versicolor)	-	-	1	1	-	-
Total count	**314**		**143**		**74**	
NO. of genera	20		15		14	
NO. of species+ varieties	44+2		36+1		31+2	

Table (1): continued.

Genera and species	**Sugarcane**		**Jute**		**Wheat**	
	TC	**NCI**	**TC**	**NCI**	**TC**	**NCI**
Fusarium	**102**	**19**	**34**	**11**	**25**	**8**
F. solani (Mart.) Appel & Wollenweber emend. Snyder & Hansen	25	10	3	3	-	-
F. udum Butler	31	6	5	2	2	1
F. thapsinum Klittich, Leslie, Nelson & Marasas	19	5	-	-	16	5
F. scirpi Lambotte & Fautrey	8	4	-	-	-	-
F. chlamydosporum Wollenweber & Reinking	14	3	-	-	-	-
F. anthophilum (A. Braun) Wollenweber	3	1	-	-	6	2
F. nygamai Burgess & Trimboli	2	1	-	-	-	-
F. semitectum Berkeley & Ravenel	-	-	16	4	-	-
F. oxysporum (Schlecht. emend.) Snyder & Hansen	-	-	7	4	-	-
F. equiseti (Corda) Saccardo	-	-	1	1	-	-
F. proliferatum (Matsushima) Nirenberg	-	-	1	1	-	-
F. verticillioides (Saccardo) Nirenberg	-	-	1	1	-	-
F. subglutinans Wollenweber & Reinking	-	-	-	-	1	1
Drechslera	**58**	**18**	**3**	**2**	**13**	**8**
D. biseptata (Sacc. & Roum.) Richardson & Fraser	34	13	-	-	-	-
D. bicolor Paul & Parbery	19	7	-	-	1	1
D. spicifer Nelson	3	1	-	-	7	3
D. halodes (Drechsler) Subram. & Jain	2	1	2	1	2	2
D. miyakei (Nisikado) Subram. & Jain	-	-	1	1	-	-
D. dematioidea (Bubák & Wróblewski) Subram. & Jain	-	-	-	-	3	2
Hypocrea vinosa Bissett	15	7	-	-	-	-
Aspergillus	**12**	**6**	**19**	**7**	**4**	**3**
A. tubingensis (Schö-ber) Moss	4	3	-	-	2	2
A. terreus var. *aureus* Thom & Raper	7	2	1	1	-	-
A. ochraceus Wilhelm	1	1	-	-	-	-
A. terreus Thom	-	-	18	7	-	-
A. ficuum (Reich.) Hennings	-	-	-	-	2	1
Cylindrocarpon	**11**	**5**	**13**	**5**	**6**	**4**
C. didymium (Hartung) Wollenweber	11	5	4	2	6	4
C. radicicola Wollenweber	-	-	9	5	-	-
Cephalosporium coremioides Raillo	20	4	-	-	-	-
Stachybotrys	**9**	**2**	**1**	**1**	**1**	**1**
S. bisbyi (*Bisby*) Corda	9	2	-	-	-	-
S. atra Corda	-	-	1	1	1	1

Table (2): Total counts (TC, calculated per 400 root segments) and number of case of isolation (NCI, out of 20 samples) of fungal genera and species isolated from sugarcane, jute and wheat roots on water agar (WA) at 28±2˚C.

Genera and species	Sugarcane		Jute		Wheat	
	TC	NCI	TC	NCI	TC	NCI
Alternaria alternate (Fr.) Keissler	4	2	-	-	1	1
Scopulariopsis	**2**	**2**	**3**	**3**	**7**	**3**
S. brumptii Salvanet-Duval	2	2	-	-	7	3
S. brevicaulis (Sacc.) Bainier	-	-	3	3	-	-
Penicillium	**3**	**1**	**1**	**1**	**11**	**5**
P. ducluxi Delacroix	3	1	-	-	-	-
P. corylophilum Dierckx	-	-	-	-	5	2
P. funiculosum Thom	-	-	-	-	4	2
P. islandicum Sopp	-	-	-	-	1	1
P. rubrum Stoll	-	-	-	-	1	1
P. piscarium Westling	-	-	1	1	-	-
Cladosporium	**-**	**-**	**-**	**-**	**6**	**3**
C. cladosporioides (Fresen.) de Vries	-	-	-	-	3	3
C. herbarum (Pers.) Link ex S. F. Gray	-	-	-	-	3	1
Curvularia	**1**	**1**	**10**	**6**	**1**	**1**
C. intermedia Boedijn	1	1	-	-	-	-
C. lunata (Wakker) Boedijn	-	-	10	6	-	-
C. ovoidea (Hiroe & Watan.) Muntañola	-	-	-	-	1	1
Nigrospora panici Zimm	1	1	-	-	-	-
Humicola grisea Traaen	-	-	2	2	-	-
Macrophomina phaseoli (Maublanc) Ashby	-	-	5	2	-	-
Epicoccum purpurascens Ehrenberg	-	-	1	1	-	-
Sporotrichum pruinosum Gilman & Abbott	-	-	1	1	-	-
Sterile mycelium (white)	19	7	2	2	-	-
Sterile mycelium (olive-brown)	6	4	-	-	-	-
Sterile mycelium (white gray)	2	2	-	-	2	1
Sterile mycelium (white yellow)	1	1	-	-	-	-
Sterile mycelium (rose-white)	-	-	1	1	-	-
Sterile mycelium (gray)	-	-	-	-	6	5
Sterile mycelium (white olive)	-	-	-	-	8	3
Total count	**266**		**96**		**91**	
NO. of genera	12		12		10	
NO. of species+ varieties	22+1		20+1		21+0	

Table (2): continued.

Phylum	Order	PDA	WA
Anamorphic fungi	Hypocreales	26 species under 10 genera	19 species under 5 genera
	Pleosporales	17 species under 3 genera	11 species under 4 genera
	Sordariales	3 species under 2 genera	1 species under 1 genus
	Microascales	3 species under 1 genus	2 species under 1 genus
	Capnodiales	2 species under 1 genus	2 species under 1 genus
	Botryosphaeriales	1 species under 1 genus	1 species under 1 genus
	Trichosphaeriales	1 species under 1 genus	1 species under 1 genus
	Xylariales	1 species under 1 genus	-
Ascomycota	Onygenales	1 species under 1 genus	-
Zygomycota	Helotiales	1 species under 1 genus	-
	Saccharomycetales	1 species under 1 genus	-
	Stereales	-	1 species under 1 genus
	Eurotiales	26 species under 4 genera	11 species under 2 genera
	Mucorales	1 species under 1 genus	-
3	**14**		

Table (3): Number of fungal genera, species, order and phylum of endophytic fungi isolated from the three non-leguminous plants and their order and phylum on PDA and WA at 28±2˚C.

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الملخص العربى:

استهدف هذا البحث دراسة مدى تنوع الكائنات الدقيقة الداخلية (فطريات) المصاحبة لجذور ثلاثة نباتات اقتصادية وهى القصب، الملوخية و القمح في محافظة سوهاج (٢٠ عينة من كل نبات) من صعيد مصر. تم عزل ٩٠ نوعا″ و٣ أصناف تنتمي إلى ٣١ جنسا″ من الفطريات على الوسط الغذائي بطاطس ديكستروز أجار و ماء الأجار (WA) عند درجة حرارة ٢٨±٢°م. جنس فيوزاريوم كان الأكثر شيوعا وانتشارا (٣/٣ من النباتات، ٦٠/٤٥ من العينات و ٣١،٤٪ من العدد الكلى للفطريات) وكان ممثلا″ بـ ١٥ نوعاَ يليه جنس الأسبرجيللس الذي احتل المرتبة الثانية من حيث التعداد وعدد مرات الظهور(٣/٣ من النباتات، ٦٠/٣٤ من العينات و ١٧٪ من العدد الكلى للفطريات) حيث كان ممثلا بـ ١٥نوعا بالإضافة إلى صنفين من الأسبرجيللس وذلك على وسط بطاطس ديكستروز الأجارى . بينما كان جنس الفيوزاريوم (١٣ نوعا، ٦٠/٣٨ من العينات و ٣٣،٨٪ من العدد الكلى للفطريات) و جنس الدريشسليرا (٦، ٢٨ و ١٣،١٪) هما الأكثر شيوعا على الوسط الغذائى ماء الأجار. كانت الأنواع الفطرية الآتية: فيوزاريوم اودم، فيوزاريوم انثوفيلوم، فيوزاريوم سابجلوتينانس، أسبيرجيللس تيريوس صنف أوريوس، أسبيرجيللس فلافس، دريشسليرا بايسبيتاتا و دريشسليرا بايكولور الأكثر شيوعا على وسطى التنمية. الفطريات الداخلية التى تنتمى إلى الفطريات الناقصة (٥٧ نوعا، ٢٣ جنسا تنتمي إلى ١١ رتبة) كانت أكثر شيوعا من تلك التي تنتمى الى الفطريات الزقية (٢٦، ٤ و ١) والفطريات الهلامية (١، ١ و١) وذلك على المنبت الغذائى بطاطس ديكستروز أجار. بينما على المنبت الغذائي ماء الأجار كانت (٣٨، ١٥ و٨) ، (١١، ٢ و ١) تنتمي إلى كلا من الفطريات الناقصة و الفطريات الزقية على التوالي بينما لم تظهر الفطريات الهلامية على هذا الوسط.