Biodiversity and Classification of Arbuscular-Mycorrhizal Fungi (Glomales) in Ismailia Governorate

M. A. Baraka[1], T. S. Abd-Elmoneim[1], El-S. M. Ramadan[2] and Alaa F. Mohamed[1]
[1]Botany Department, Faculty of Agriculture, Suez Canal University
[2]Botany Department, Faculty of Agriculture, Ain-Shams University
Received: 12/5/2011

Abstract: Soil and roots samples were taken from the rhizosphere of the growing plants of a different field during summer season 2008 which are grown at different locations in Ismailia governorate (El- Salhea, Abu Suwerr, Ismailia and East Suez Canal). Soil and plant root samples were prepared for measuring root colonization, spores counting and classified.The highest number for spores of arbusculer mycorrhizal fungi (AMF) in soil samples was recorded on *Triflium alexandrium* plant in Abo_Suwerr location (1250 spores/100 gm of soil).The highest root colonization % for AMF was observed in *Zea mays* plant in Abo_Suwerr location (57%). Six species of *Glomus* (*Glomus mosseae, G etunicatum, G. coronatum,G. intraradices, G. invarmaium* and *G. viscosum*)are described and illustrated.

Keywords: Arbusculer mycorrhizal, Classification, Distrbution, Locations, Glomus

INTRODUCTION

"Mycorrhiza" is a term used to describe the symbiotic association between a plant root and a fungus (Frank, 1885), and it is derived from the Greek word "Mykes" meaning fungus and "Rhizo" meaning root. Mycorrihzal associations are the most wide spread symbiosis between plants and microorganisms (Marschner, 1995). Over 80% of plant species are associated with mycorrhizal fungi, amongst which are vascular and non vascular plants and some important crops such as carrots, maize, leek, coffee, cocoa, soybeans, citrus, fruits, tomatoes and pepper (Bonfante and Perotto, 2000 and Muchovej, 2004). Taxonomy of AM fungi has based on morphological and anatomical characteristic of their spores and other modern techniques. Vascular arbuscular mycorrhizal (VAM) fungi were placed in phylum Zygomycota, in the family Endogonaceae into the order Endogonales (Gerdemann and Trappe, 1974 and Morton and Benny, 1990). But the molecular analyses found that these fungi haven't relation with either members of the Zygomycota or other known major fungal groups (Schüßler *et al.*, 2001). Consequently, AM fungi were removed from the Zygomycota to be accommodated in a new phylum, and named Glomeromycota. This new phylum is divided into four orders, seven families and ten genera. The major distinguishing characters of their genera are their differences in spore-wall, spore formation, root colonization patterns and tolerance to biotic and abiotic factors (Morton and Benny, 1990 and Brundrett *et al.*, 1996).

The objective of the present investigation was surviving and diversity of *glomeromycota* at different locations in Ismailia governorate under natural nutrient limited soil conditions.

MATERIALS AND METHODS

Soil Sampling and Roots Collection

Soil samples including roots were collected from the surrounding vegetation of a different field such as tomato, broad bean, mango, peach, maize, peanut and potato which are grown at different location in Ismailia governorate (El- Salhea, Abu Suwerr, Ismailia and East Suez Canal). The points of collected samples were formed as a digital map by using GPS device program. The samples were collected during summer season 2008. Soil and roots samples were taken from the rhizosphere of the growing plants by digging the soil to a depth of 15-30cm with a trowel. Then samples were kept in polyethylene bags, label and sent directly to the laboratory in the same day.

Extraction of AM Fungi from Soil Sample and Determination of Spores

Quantitative Estimation of Spore from Soil

Mix a volume of 250 gm soil sample in 1000 ml water in a glass container and allow heavier particles to settle for a few seconds. Then pour liquid through soil-sieves (500,250, 45 μm) to remove large pieces of organic matter. After that, washing small amounts of the remaining on the last sieve, then transfer to a Petri dish. Taken about 1.0 ml from this solution in filter paper in a Petri dish to count the spores under a dissecting microscope.

Determination of Spores Shape, Color and Layers

The shape and size of spores characterized were determined based on at least 15-25 intact spores mounted in a drop of water or lactic acid placed on a microscope slide. The dimensions were determined using a digital computer program connected with light microscope (LIECA model MD502). The thickness of layers of spore wall and germination walls was measured in spores freshly isolated and crushed in Polyvinyl-Lacto-Glycerol (PVLG) or PVLG + Melzer's reagent. Colors of spore wall layers or germinal wall layers were determined in spores crushed in either water or PVLG. Colors were determined according to Kornerup and Wanscher, (1983).

Clearing and Staining Mycorrhizal Roots

Roots were cleared and stained according to the method modified by Philips and Hayman, (1970) as follow:

The roots were rinsed thoroughly in tap water. Then roots were soaked in aqueous solution of KOH (10% w/v) on a hot plate at 90°C for 10-30 min. After that roots were rinsed thoroughly in tap water, and soaked in HCl 1% overnight. Root samples were stained in acidic

glycerol with 0.05% trypan blue for 24hr at room temperature as described by Brundrett *et al.*, (1984). Root samples were de-stained at room temperature in acidic glycerol (Koske and Gemma, 1989). Randomly selected segments of fine lateral roots were mounted on microscope slides to detect the presence of vesicles, arbuscules and any unusual features.

Measuring of AM Root Colonization

The roots colonized by AM fungi were measured according to Brundrett *et al.*, (1996). Randomly disperse cleared and stained roots in dish with grid lines then assess mycorrhizal colonization under a dissecting microscope.Follow all horizontal and vertical lines. Count intersects with roots and mycorrhizas separately.

RESULTS

Study of the Biodiversity of Glomeromycota in Ismailia Governorate

A Survey study was conducted during the summer 2008 through 36 sites representing in Ismailia governorate (6 sites in El-Salhea, 14 sites in Abu Suwerr, 6 sites in Ismailia city and 10 sites in East Suez Canal region), to determine the biodiversity of glomeromycota. One hundred and eight rhizosphere soil samples were collected from fruit orchards, field crops and vegetables. The soil salinity and pH value and soil texture were analyzed for each soil sample to investigate the relationship between these environmental factors and the occurrence of glomerian fungi. ` Data presented in Table (1) and illustrated in Fig.(1) showing the occurrence of glomeromycota associated with different plant species in study area in Ismailia governorate. The highest number for spores of arbusculer mycorrhizal fungi (AMF) in soil samples was recorded on *Triflium alexandrinum* plant at site No. 10 in Abo_Suwerr location, *Zea mays* plant at site No. 4 in El_Salhea location, *Mangifera indica* at site No.24 in Ismailia city and *Psidium guajava* plant at site No. 35 in East Suez Canal Region (1250, 1000, 750 and 700 spores/100 gm of soil respectively). On contrast the lowest number for AMF spores in collected soil samples were observed at site No. 8 and 9 in Abo_Suwerr in two plants *Malus domestica* and *Persica vulgaris* (100 AM spores/100 gm of soil), but the lowest number of AMF spores in Ismalia city was found in site No. 22 on *Zea mays* plant (125 AM spores/100 gm of soil). While *Hibiscus esculentus* plant at site No. 32 in East Suez Canal Region and *Triticum aestivium* at site No. 2 in El_Salhea were recorded 225 and 275 AM spores/100 gm of soil respectively.

The highest root colonization % for AMF was observed in *Zea mays* plant at site No. 15 in Abo_Suwerr location (57% in sandy soil when pH 7.72 and E.C 0.91 dSm^{-1}), then in the same plant but at site No. 4 in El_Salhea location (56% in sandy loam soil at pH 7.82 when E.C 1.10 dSm^{-1}) Fig.(2) While the root colonization% was found at rate 50 % on *Psidium guajava* plant at site No. 35 in East Suez Canal Region, and 45% in root of *Mangifera indica* plant at site No.24 in Ismailia city. On the other hand the lowest root colonization % for AMF was recorded on *Triflium alexandrium* plant at site No. 36 in East Suez Canal Region (10% in sand soil at pH 8.01 when E.C 1.03 dSm^{-1}), followed by *Persica vulgaris* plant at site No. 9 in Abo_Suwerr location (14% in loamy sand soil at pH 8.26 when E.C 1.00 dSm^{-1}), then *Solanum melogena* plant at site No. 25 in Ismalia city (17% in sand soil at pH 7.24 when E.C 0.37), and *Triflium alexandrium* plant at site No. 5 in El_Salhea location (18% in loamy sand soil at pH 8.31 when E.C 1.90 dSm^{-1}) .

Classification of Glomeromycota

One hundred and eight plant root and rhizosphere soil samples were examined for classification AMF based on a morphological characters of spores as color, shape, size, wall layer and subtending hyphae details. The characterized of spores were determined based on at least 15-25 intact spores mounted in a drop of water or lactic acid placed on a microscope slide. Data presented in Table (2) and illustrated in Fig. (4) Showing the morphological characters of extracted AM spores from collected soil samples and identified according to species. *Glomus* was the dominant genus in plant root tissues and rhizospheric soil samples. The genus *Glomus* was appeared in seven species as *Glomus etunicatum, G. coronatum, G. intraradices, G. mosseae, G. invarmaium, G. viscosum* and *Glomus* sp.

The first specie (*Glomus etunicatum*) was appeared in 9 sites, 4 sites in El_Salhea location (1,3,4 and 5) on the plants (*Musa sapientum, Vitis cordifolia, Mangifera indica, Zea mays, Lycopersicom esculentum* and *Triflium alexandrium*) , 3 sites in Abo_Suwerr location (10,14 and 20) on the plants (*Triflium alexandrium, Lycopersicum esculentum*)1 site in Ismailia city site No. 23 on the rhizosphere region of plant (*Triflium alexandrium)* and 1 site in East Suez Canal region at site 29 on the plant (*Citrus nobilis*).

The second specie (*Glomus coronatum*) was observed in 9 sites, 2 sites in El_Salhea location (1 and 2) on the crops (*Musa sapientum, Triticum aestivium* and *Solanum tuberosum*) ,5 sites in Abo_Suwerr location (8,9,10,14 and 15) on the plants (*Malus domestica, Persica vulgaris, Triflium alexandrium, Lycopersicum esculentum* and *Zea mays*) then 2 sites in East Suez Canal region at sites No.(35 and 36) on the rhizosphere region of plant (*Pesidum guajava* and *Triflium alexandrium).*

The third specie (*Glomus intraradices*) was recorded in 9 sites, 2 sites in El_Salhea location (3 and 5) on the plants (*Vitis cordifolia, Mangifera indica* and *Triflium alexandrium*) , 4 sites in Abo_Suwerr location (7,8,11and12) on the plants (*Solanum melogena, Malus domestica, Citrus aurantium* and *Triticum aestivium*) ,one site in Ismailia city site (25) on the rhizosphere region of plant (*Solanum melogena*) and 2 sites in East Suez Canal region at sites (27 and 33) on the plants (*Pyrus communis* and *Citrus aurantium).*

The fourth specie (*Glomus mosseae*) was appeared in 11 sites, three sites in El_Salhea location (3, 5 and 6) on the rhizosphere region of plants (*Vitis cordifolia, Mangifera indica, Triflium alexandrium* and *Solanum tuberosum*) , followed by 5 sites in Abo_Suwerr location (7,13,14,16 and 20) on the plants (*Solanum melogena, Cucurbita pepo, Lycopersicum esculentum, Phaseolus vulgaris,* and *Lycopersicum esculentum*).

One site in Ismailia city at site No.23 on the plant (*Triflium alexandrium*) and 2 sites in East Suez Canal region at site (29 and 32) on the plants (*Citrus nobilis* and *Hibiscus esculentus).*

The fifth specie (*Glomus invermaium*) was observed in 9 sites, one of them in El_Salhea location (1) on the plants (*Musa sapientum*) , 4 sites in Abo_Suwerr location (7,15,17 and20) on the plants (*Solanum melogena, Hibiscus esculentus, Lycopersicum esculentum* and *Zea mays*) ,followed by 2 sites in Ismailia city at sites (21 and 25) on the rhizosphere region of plants (*Vicia faba, Solanum melogena*) and 2 sites in East Suez Canal region at sites (30 and 31) on the plants (*Prunus armeniaca* and *Malus domestica*).

The sixth specie (*Glomus viscosum*) was appeared in 10 sites, one site in El_Salhea location NO.3 on the plants *(Vitis cordifolia* and *Mangifera indica*) , 4 sites in Abo_Suwerr location (7,9,18 and 19) on the plants (*Solanum melogena, Zea mays, Persica vulgaris* and *Triticum aestivium*), 3 sites in Ismailia city at sites (22,24 and 26) on the plants (*Zea mays, Mangifera indica* and *Lycopersicum esculentum*) and 2 sites in East Suez Canal region at site NO. 28 and 34 on the plants (*Pesidum guajava* and *Solanum melogena*).

Table 1. The occurrence of glomeromycota associated with different plant species in study area in Ismailia governorate.

Site No.	Location	Plant species	Soil Texture	AM Spores\100g of soil	Root Colonization%	Soil pH value	ECdSm^{-1}
1	El_Salhea	*Musa sapientum*	Loamy Sand	300	46	8.02	0.90
2		*Triticum aestivium*	Loamy Sand	275	25	8.24	1.00
		Solanum tuberosum	Sand	420	30	8.25	0.80
3		*Vitis cordifolia*	Sand	300	46	8.22	1.78
		Mangifera indica	Sand	600	39	7.80	1.40
4		*Zea mays*	Sandy loam	1000	56	7.82	1.10
		Lycopersicum esculentum	Sandy loam	800	33	8.03	1.18
5		*Triflium alexandrium*	Loamy Sand	750	18	8.31	1.90
6		*Solanum tuberosum*	Sand	300	46	8.01	1.16
7		*Solanum melogena*	Sand	400	30	8.08	1.97
8		*Malus domestica*	Loamy Sand	100	16	8.21	0.69
9		*Persica vulgaris*	Loamy Sand	100	14	8.26	1.00
10		*Triflium alexandrium*	Loamy Sand	1250	45	8.20	1.43
11		*Citrus aurantium*	Sandy loam	190	20	8.23	1.47
12	Abo_Suwerr	*Triticum aestivium*	Sand	350	50	7.01	0.87
13		*Cucurbita pepo*	Sand	250	16	7.88	1.11
14		*Lycopersicum esculentum*	Sand	250	29	7.96	1.45
15		*Zea mays*	Sand	460	57	7.72	0.91
16		*Phaseolus vulgaris*	Sand	500	25	7.85	0.67
17		*Hibiscus esculentus*	Sand	600	15	8.22	1.56
18		*Triticum aestivium*	Sand	750	20	8.25	1.00
19		*Zea mays*	Sand	250	31	8.22	0.65
20		*Lycopersicum esculentum*	Sand	250	27	7.86	0.48
21	Ismailia City	*Vicia faba*	Sand	150	18	7.73	0.51
22		*Zea mays*	Sand	125	35	8.21	1.14
23		*Triflium alexandrium*	Loamy Sand	350	30	7.75	3.86
24		*Mangifera indica*	Sand	750	45	7.82	0.42
25		*Solanum melogena*	Sand	250	17	7.24	0.37
26		*Lycopersicum esculentum*	Sand	400	30	7.77	2.27
27		*Pyrus communis*	Sand	300	30	7.83	0.53
28		*Pesidum guajava*	Sand	300	20	7.81	1.31
29	East Suez Canal region	*Citrus nobilis*	Loamy Sand	500	15	7.76	2.41
30		*Prunus armeniaca*	Sand	450	20	8.03	1.38
31		*Malus domestica*	Sand	500	37	7.83	1.23
32		*Hibiscus esculentus*	Sand	225	25	8.21	1.00
33		*Citrus aurantium*	Sand	300	20	8.26	1.10
34		*Solanum melogena*	Sand	250	25	8.03	1.51
35		*Pesidum guajava*	Sand	700	50	8.31	1.56
36		*Triflium alexandrium*	Sand	400	10	8.01	1.03

Finally *Glomus* sp. was recorded in 9 sites, 2 sites in El_Salhea location (2 and 5) on the plants *(Triticum aestivium, Solanum tuberosum* and *Triflium alexandrium)* , 4 sites in Abo_Suwerr location (8,10,12 and 20) on the plants (*Malus domestica, Triflium alexandrium, Triticum aestivium* and *Lycopersicum esculentum*), 2 sites in Ismailia city (24 and25) on the rhizosphere region of plants (*Mangifera indica* and *Solanum melogena*) and one site in East Suez Canal region at site (35) on the plant (*Pesidum guajava*).

The plants of *Mangifera indica, Lycopersicum esculentum, Solanum melogena* and *Triflium alexandrium* were associated with the highest number of mycorrhizal fungi species (6-5 species each). On contrast the plants of Citrus *aurantium, Cucurbita pepo, Phaseolus vulgaris* and *Vicia faba* were associatd with lowest number of mycorrhizal fungi species (one species each).

DISCUSSION

In the present study, which is concerned with Ismailia that the genus of arbiscular mycorrhizae fungi which was identified as only one genus of AM fungi being *Glomus* represented by six species *(Glomus etunicatum, G. coronatum, G. intraradices, G. mosseae, G. invarmaium* and *G. viscosum*). In the previous studies of AM fungi in Wadi Allaqi at the Southern part of Eastern Desert, Egypt, showed all examined plants (20) were mycorrhizae. Five taxa are including three species of *Glomus* and one species of each of *Acaulospora* and *Gigaspora* (El-Zayat *et al.*, 2007). Abdel-Moneim and Abdel-Azeem, (2009) studied the diversity of arbuscular mycorrahizal fungi in Saint Katherine protectorate, Egypt by examined 300 plant roots and rhizospheric soil samples. They found that 7 taxa namely; *Glomus* sp., *Glomus clavisporum, G. etunicatum, G. invermaium, Gigaspora* sp., *Gigaspora margarita* and *Aculospora* sp. In a study by Agwa and Al-Sodany, (2003) on the AMF of roots and rhizospheric soils of 26 plant species belonging 18 families representing five different habitats at El-Omayed, they found that the most dominant genus of AM was *Glomus* followed by *Gigaspora* and *Scutellospora* but *Acaulospora* and *Entrophospora* were scanty to absent .the variation in the biodiversity in different locations may be attributed to many factors such as soil type, seasons, heat and inorganic fertilizer application.

With respect to root colonization rates and spore counts, it was found that the highest root colonization was noticed in *Zea mays* plant at Abo-Suwerr location (57%), however, root colonization was 56 and 50% in roots of *Zea mays* (at El_Salhea location) and *Psidium guajava* plant (at East Suez Canal Region), respectively. It was 45% in root of *Mangifera indica* plant in Ismailia city.While the lowest root colonization for AMF was recorded on *Triflium alexandrium* plant in East Suez Canal Region (10%), followed by *Persica vulgaris* plant in Abo_Suwerr location (14%), then *Solanum melogena* plant in Ismalia city (17%), and *Triflium alexandrium* plant in El_Salhea location (18%).

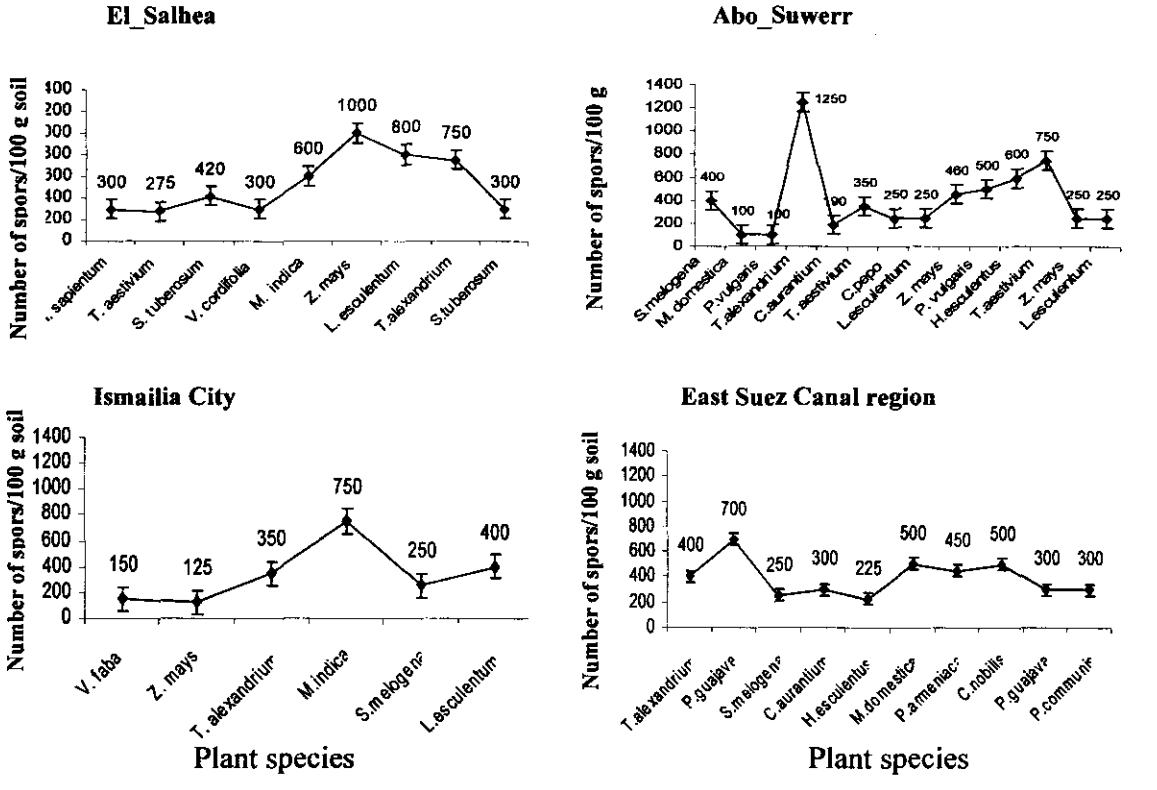

Figure 1. The total count of AM spores/100 g of soil samples at different examined locations.

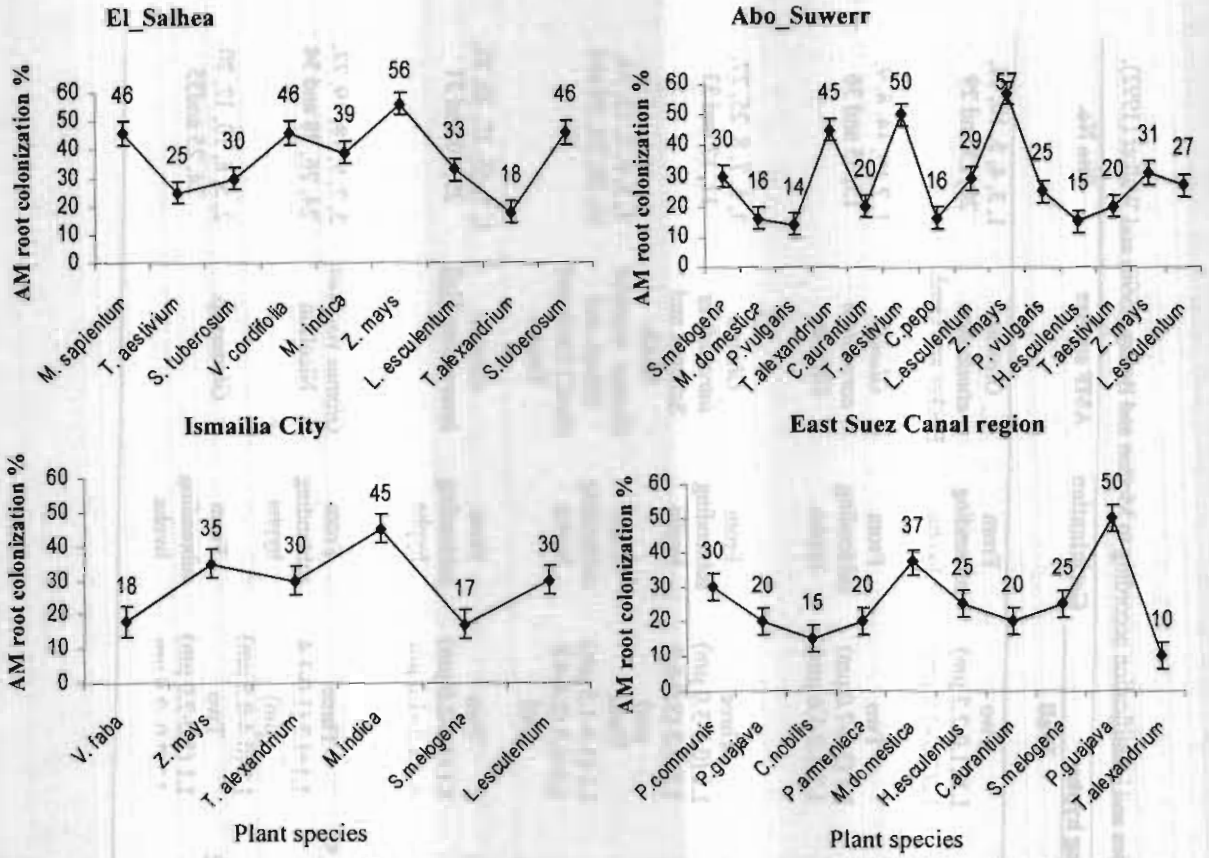

Figure 2. The percentage of root colonization by AM fungi on different plant species at different examined locations.

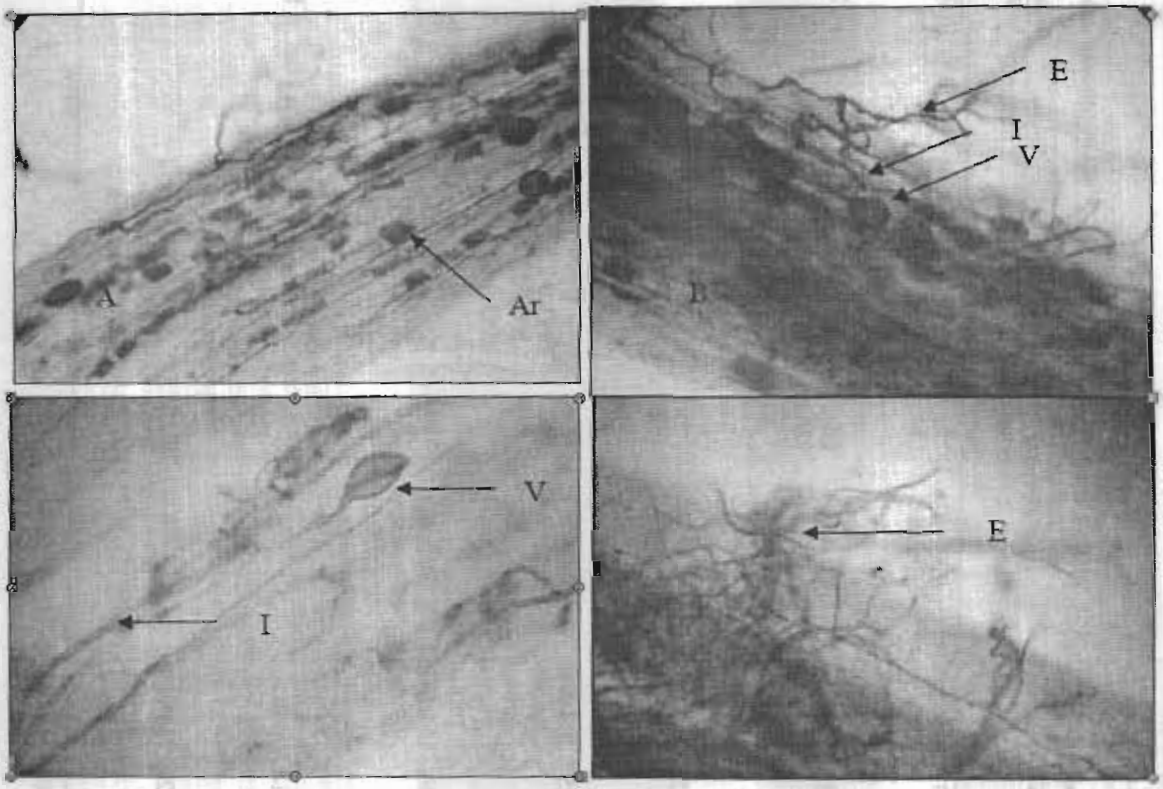

Figure 3. Photomicrographs for arbusculer mycorrhizal fungi (AMF) structures in plant roots after clearing and staining (200x). Typical vesicle (V), arbusculer (Ar) , Internal (I) and External (Ex) hayphae formed by AMF in the root cortex of plant samples.

Table 2. Morphological characters of the extracted AM spores from collected soil samples and identification according to Morton and Benny (1990) and Walker (1992).

N*	Spores characters				Subtending hypha			Germination	AMF species	Site No.
	Color	Shape	Size µm	Wall layers/size	Shape	Width µm	Wall			
20	Orange to red brown (0-60-100-0)	Globose to subglobose	59-150	Two L1 (0.5-2.2 µm) L2(4.0 -6.0 µm)	Cylindrical	5.0-11	Two L1 (1.0-2.2 µm) L2(3.0 -1.0 µm)	From subtending hypha.	*Glomus etunicatum* Becker and Gerd.	1, 3, 4, 5, 10, 14, 20, 23 and 29
25	Pale orange-brown (0-20-60-0)	Globose to subglobose and some irregular.	80-230	Two L1(1.5-4.0 µm) L2(3.0-6.0 µm)	Funnel	29-39	Two L1 (3.0-7.0 µm) L2(1.2-1.6 µm)	From subtending hypha.	*Glomus coronatum* Giovann	1, 2,10, 14, 8, 9, 15, 35 and 36
15	Yellow brown (0-10-40-0)	Globose or subglobose	50-150	Three L1 (0.5-3.0 µm) L2(1.5-5.0 µm) L3 (3.0-7.0 µm)	Cylindrical	10-16	Three L1 (0.5-3.0 µm) L2+L3 (3.0-6.4 µm)	From subtending hypha	*Glomus intraradices* Schenck and Smith.	3, 5, 7, 8, 25, 27, 11, 12 and 33
25	Dark orange-brown (0-30-100-10)	Globose to subglobose and some irregular	90-250	Three L1 (1.0-2.2 µm) L2(0.6-1.7 µm) L3 (3.0-6.5 µm)	Funnel	14-30	Three L1 (1.0-1.5 µm) L2+L3 (2.4-4.8 µm)	From subtending hypha	*Glomus mosseae* (Nicol. and Gerd.) Gerd. and Trappe	3, 5, 6, 7, 13, 14, 16, 20, 23, 29 and 32
20	Bright yellowish orange (0-10-60-0)	Globose, subglobose, occasionally ovoid	100-240	Two L1 (1.0-2.2 µm) L2(3.7 -5.6 µm)	Cylindrical	15-28	Two L1 (1.6-2.0 µm) L2(2.5 -1.0 µm	From subtending hypha	*Glomus invermaium* Hall	1, 7, 15, 17, 20, 21, 25, 30 and 31
18	pale straw (0-5-20-0)	Globose to subglobose	50-120	Three L1+L2 (1.0-2.0µm) L3(0.5-0.6 µm)	Cylindrical	8.0-10.5	Three L1+L2 (1.0-1.4 µm) L3 (0.4-0.5 µm)	From subtending hypha	*Glomus viscosum* Nicolson	3, 7, 9, 18, 19, 22, 24, 26, 28 and 34
20	yellow-brown (0-10-40-0)	Globose to subglobose	120-240	Three L1 (1.0-1.1 µm) L2(2.0-5.0 µm) L3 (1.0-1.5 µm)	Funnel	16-32	Two L1 (1.0-2.0 µm) L2(2.0 -2.6 µm	From subtending hypha	*Glomus* sp.	2, 5, 8, 10, 12, 20, 24, 25 and35

(N*): Size of tested spores sample.

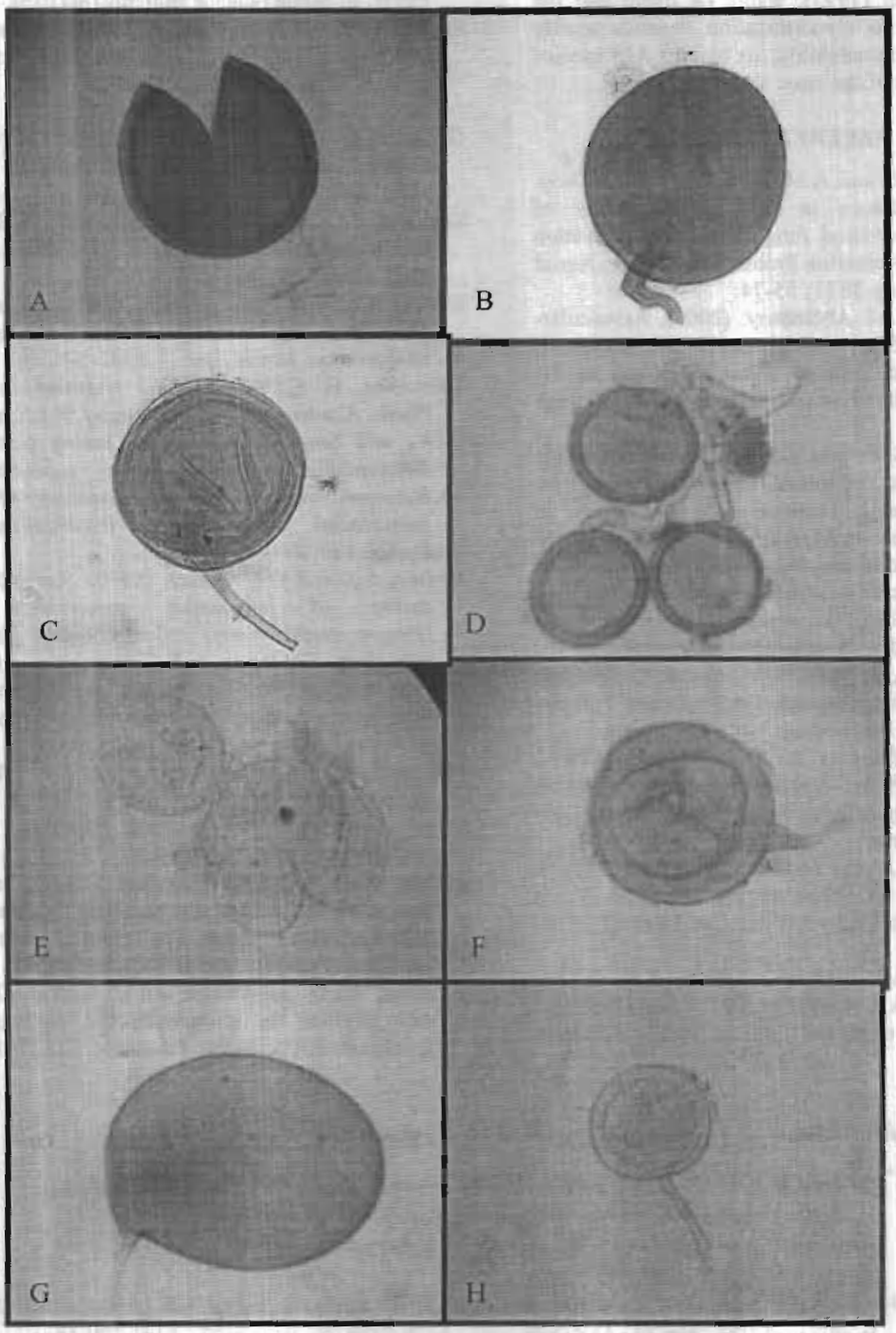

Figure 4. Photomicrographs for spores of arbusculer mycorrhizal fungi (AMF) in soil samples A- dead spore of *Glomus invermaium* B- live spore of *G. invarmaium* C- *Glomus intraradices* D-*Glomus mosseae* G:*Glomus etunicatum* E- *Glomus viscosum* F- *Glomus coronatum G and H: Glomus* sp.(120x).

The highest spore numbers of arbusculer mycorrhizal fungi (AMF) were recorded in soil samples collected from *Triflium alexandrium* plant at Abo_Suwerr location, *Zea mays* plant at El_Salhea location, *Mangifera indica* in Ismailia city and *Psidium guajava* plant at East Suez Canal Region, since they were 1250, 1000, 750 and 700 spores/100 g soil, respeetively. On contrast the lowest number of AMF spores in collected soil samples was 100 AM spores/100 g of soil at Abo_Suwerr for *Malus domestica* and *Persica vulgaris* plants, and they whereas 125 spores/100 g were observed in soil of *Zea mays* plant in Ismalia city. While *Hibiscus esculentus* plant grown on East Suez Canal soil and *Triticum aestivium* grown on El_Salhea soil were 225 and 275 AM spores/100 g soil, respectively. The colonization rates and spores count showed that the species of the same genus do not necessarily showed the same order of root colonization

and spores count. Similar observations were also noticed by Bougher (1995), where he found that the response of plant to mycorrhization depends mostly upon: i) nutritional availability, ii) type of AM species and iii) every strain of the same species.

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التوزيع الحيوى وتقسيم فطريات الميكورهيزا الداخلية (جلومالس) فى محافظة الاسماعيلية

متولى على بركة*- تامر شوقى عبدالمنعم*- الشحات محمد رمضان**- الاء فتح الله محمد فرج*

*قسم النبات الزراعى – كلية الزراعة – جامعة قناة السويس

** قسم الميكروبيولوجى – كلية الزراعة – جامعة عين شمس

أجريت هذه الدراسة في كلية الزراعة جامعة قناة السويس وكانت اهم اهداف هذه الدراسة هو دراسة التنوع البيولوجى للميكورهيزا الداخلية فى محافظة الاسماعيلية . تم جمع عدد من عينات التربة وجذور النباتات (١٠٨) عينة خلال الموسم الصيفى لعام ٢٠٠٨. تم تجهيز عينات التربة والجذور لتقييم نسبة مستعمرات الميكورهيزا داخل الجذور ، حساب عدد الجراثيم وتعريف أجناس الميكوريزا. وقد أوضحت النتائج المتحصل عليها الآتى: ١) أمكن تعريف جنس واحد وستة انواع تابعة له (*Glomus etunicatum, Glomus coronatum, Glomus intraradices, Glomus mosseae, Glomus invarmaium and Glomus viscosum*) ، ٢) معدل انتشار الميكورهيزا فى الجذور لا يختلف فقط من جنس الى اخر بل يختلف من نوع الى اخر داخل نفس الجنس. كما اوضحت النتائج ايضا ان اعلى معدل للانتشار وجد فى نبات الذرة الشامية فى منطقة ابوصوير (٥٦%) و اعلى معدل لكثافة الجراثيم فى التربة وجد فى نباتات البرسيم فى ابوصوير بمعدل (١٢٥٠ جرثومة/١٠٠ جرام تربة).