Research Article

SOHAG JOURNAL OF SCIENCES

https://doi.org/10.21608/sjsci.2022.158510.1027

Aspects of Fertility and Healthy of Cultivated Soil in Upper Egypt

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Received: 25th August 2022, **Revised:** 5th September 2022, **Accepted:** 7th September 2022.
Published online: 1st January 2023

Abstract: Plants are usually exposed to different abiotic (climate changes, salinity… etc.) and biotic (pathogenic and/or toxicogenic micro-organisms, pests… etc.) stresses which limit the growth and productivity as well as cause considerable loss of worldwide agricultural production. We investigated the soil texture and moisture content and analyzed the chemistry of the cultivated soils in Upper Egypt. Examined soil has mean values of 1.4 % organic matter, 0.04 % total dissolved salts, and 7.17 pH. The moisture content of the samples was moderate (mean=15.75). All of the cultivated soil samples (100% of the samples) proved to be contaminated by filamentous fungi. A total of 148 fungal species + 7 varieties of 40 genera were isolated and identified using the dilution plate method. The gross fungal count was 653.7 colonies/mg of dry soil. *Aspergillus* was the most dominant genus based on frequency (97.5% of the samples) and count (45.77% of the total fungal counts). *Penicillium* had a second place (82.5% of the sample and 23.49% of gross count). *Fusarium* occupied the third place (67.5% and 6.55%). *Acremonium* was one of the dominant genera (4th place). It occurred in 45% of the samples examined and 5.95% of gross fungal counts. *Curvularia* and *Humicola* were moderate in frequency (30% and 25% of the samples) with low counts (1.53% and 4.04% of the fungal counts), and other genera were low and rare in frequency. Whereas sterile mycelium was high species in frequency (55% of the samples) but low in count (1.9% of fungal counts). Finally, the cultivated soils in this region, in general, are fertile but not completely healthy.
Keywords: Cultivated soil- Chemical analyses- Filamentous fungi- Czapek's agar medium - Upper Egypt.

1. Introduction

The agricultural area in Egypt is mainly distributed around the Nile Valley and the Delta area, which are subjected to moderate Mediterranean climates. The alluvial soils with loamy texture are incredibly fertile for their high content of organic matter and mineral. The alluvial sediments deposited by running water of the river Nile through flooding, soil erosion and layering resulted in deposited organic matter. The most labile and mobile fractions of soil organic matter are termed water extractable organic matter (WEOM) and contribute to significant soil chemical processes such as metal adsorption and solubilization and responses of soil microbial activities promoting mineralization /humification processes [1].

The WEOM is extracted by aqueous solutions and contains carbohydrates, amino acids, proteins, peptides, nucleic acids, and amino sugar [2]. The charge of soil components function groups also depends on multivalent cations and anions in the soil solution. Adsorption and binding of proteins on clay minerals are involved in various physical and chemical interactions, cation exchange sites, hydrogen, bonding, and hydrophobic interactions [3].

The fungi are an immensely diverse group of organisms, encompassing a huge range of forms from microscopic single-celled yeasts to large macrofungi, as exemplified by the well-known mushrooms and toadstools and the largest of fruitbodies, the giant puffball. The published estimates for the number of fungal species is around 138,000 [4]. It seems likely that the great majority of fungal species have some part of their life cycle either in or directly associated with the soil environment. Their role in the soil is a highly complex and fundamental to the soil ecosystem [5, 6]. However, it is difficult to assess in absolute terms the number and range of species present in the soil as available techniques for isolation and detection of fungi from the soil are limited, although comparatively few species have yet been isolated or reported from soil. No critical assessment of the number of species so far separated from soil appears to have been made. Detecting which fungi are present in a soil sample is a challenging task, one of the major problems being the fastidious nature of the great majority of species. This is a well-known phenomenon [7] and estimates suggest that of the known fungi, only 17% can be readily grown in culture [8]. In addition, although some soil inhabiting fungi can be grown in culture, in many cases it is not yet possible to germinate resting structures such as spores, so that only vegetative mycelium is available for detailed analysis [9].

The present study aimed to study: 1) Soil analyses including soil texture, moisture, and organic matter contents, pH values, total dissolving elements salts in addition to macro- (Ca^{2+} Mg^{2+} & K^{+}) and micro- (Fe^{2+}, Mn^{2+} & Zn^{2+}) elements plus sodium (Na^{+}) as stress element. 2) Isolation and identification of filamentous fungi from the soil with special reference to pathogenic and protecting fungal genera and species.

2. Materials and method

A total of 40 samples (~ 500 g) of cultivated soils were collected (autumn, winter, and spring, 2020 &2021) from the rhizosphere of 25 plants (24 species + 1 variety of 23 genera) in Upper Egypt (Sohag, Qena, Luxor and Aswan Governorates) as shown in Table,1. Regarding the fertility and healthy of the

soils, some parameters were taken in consideration:-

2.1. Analysis of soil samples

For soil texture, the pipette method was used for particle size [10]. Moisture content (M.C.) was determined by drying the soil sample (100 g) in an oven at 105°C for 24h. and the percentage (M.C.%) was calculated according to the equation:

$$M.C.\% = \frac{W1 - W2 \times 100}{W1}$$

W_1 = initial weight (100 g) of soil W_2 = dry weight of soil

Organic carbon was determined by the wet digestion method [11] through the oxidation of soil carbon using an acid dichromate reagent. Total dissolving salts were estimated by evaporation of soil solution (1:10) in an oven at 105°C, and the percentage per dry soil was calculated. The pH-meter (EUTECH instruments pH 510 pH/mV/°C meter) was used to determine soil pH. The pH was measured potentiometrically in a suspension of 10 g soil in 100 ml sterile dist. water. Cation exchange capacity was calculated as the sum of charge equivalents of exchangeable K^+, Na^+, Ca^{++}, Mg^{++}, Fe^{++}, Zn^{++} and Mn^{++} as determined in 5 g soil in 100 ml sterile bi-dist. water by flame atomic absorption spectrophotometer (Perkin Elmer analyst 400 models). Total elemental contents were measured in dilute HNO3 solutions [12, 13].

2.2. Isolation and identification of soil fungi

Filamentous fungi were isolated by dilution plate method [14] on 1% glucose-Czapek's agar medium ($NaNO_3$, 2; KH_2PO_4, 1; $MgSO_4$. $7H_2O$, 0.5; KCl, 0.5; glucose, 10; agar-agar, 18; per 1 liter) at 28°±1°C. Isolated, predominant, morphologically distinct colonies were selected, purified by repeated culturing, and maintained on glucose-Czapek's agar slants at 4°C. The isolates were identified based on their colony characteristics and microscopic observations, including hyphae and spores' morphology [15-20].

3. Result

3.1. Soil analyses

The cultivated soil was subjected to some chemical analyses as the followings:

3.1.1. Moisture content: The moisture content (M. C. %) ranged between 1.2 - 28. 9 % (mean = 15.75 % M.C.) where 3, 5, 21, and 11 samples had ≥ 5 %, 5-10 %, 10-20 % and ≤ 20 %, respectively.

3.1.2. Organic matter content: The organic matter (O.M. %) was ranged between 0.99 % - 3.1 % (mean = 1.94 % O.M.) of which 2, 19, 14, and 5 samples contained ≥ 1 %, 1-2 %, 2-3 % and ≤ 3 %, respectively.

3.1.3. pH value: The pH value was fluctuated between 6.28 - 7.9 (mean = 7.17), where 12, 3, and 25 samples proved to be slightly acidic, neutral and slightly alkaline, respectively.

3.1.4. Total dissolving salts: The T.D.S. ranged between 0. 003-0.099 mg/g soil (mean = 0.04) where 11, 16, and 13 samples had ≥ 0.025, 25-50, and ≤ 50-100 mg/g, respectively.

3.1.5. Element contents: Based on the total dissolving salts of the soils , the water extracts (di-ionized water) were subjected for estimating the concentrations of mono- (Na^+ and K^+) and bi-equivalents (Ca^{++}, Mg^{++}, Fe^{++}, Mn^{++} , Cu^{++} and Zn^{++}) ions.

3.1.5.1. Mono-equivalent ions.

Sodium ions (Na^+) had the highest counts amongst the cations of the cultivated soil tested and ranged between 3500-36,300 (mean= 7,427.5) µg/g x 10^{-3}.

Potassium ions (K^+) (the second mono-equivalent cation) were in general, very low compared with sodium ions and varied between 5.4 - 35.4 (mean = 14.799) µg/g x 10^{-3}.

3.1.5.2. Bi-equivalent ions.

Five bi-equivalent ions were calculated in the soil extracts of the cultivated soils under investigation. The cations (ions) were classified into macro-elements (Ca^{++} and Mg^{++}) and micro-elements (Fe^{++}, Mn^{++}, Cu^{++} and Zn^{++}) based on their utilization by the plants.

Macro-elements: The two macro-elements were calcium (Ca^{++}) and magnesium (Mg^{++}), where Ca^{++} had the higher counts in Egyptian soils and fluctuated between 8.6 - 321.9 (mean = 55. 25) µg/g x10^{-3}. Whereas Mg^{++} ions were very less in counts compared with Ca^{++} and ranged between 2.5-66.7 (mean =8.26) µg/g x 10^{-3}.

Micro-elements (trace elements): Three micro-element ions (Fe^{++}, Mn^{++} and Zn^{++}) were subjected for quantities analyses. Fe^{++} had the best counts and ranged between 0.231-13.845 (mean = 1.705) µg/g x10^{-3}. Manganese (Mn^{++}) and Zinc (Zn^{++}) contents in soil were very Low compared with iron (Fe^{++}) ions. Zn^{++} in all samples varied between 0.015-0.098 (mean = 0.046) µg/g x10^{-3} in bi-ionized dist. H_2O extracts of cultivated soils. Whereas Mn^{++} had the lowest in quantity and estimated by 0-307 (mean = 0.024) µg/g x10^{-3} with regarding wholly disappeared in 13 samples of the tested soils (Table 1).

3.2. Mycoflora of cultivated soils

A total of 148 fungal species + 7 varieties of 40 genera were identified from the forty collected soil samples. The gross fungal count was high (652.4 colonies/mg dry soil) in the soils (Table, 2). *Aspergillus* was the most dominant based on frequency (97.5 % of the samples) and count (47.118 % of gross count). The genus was represented by 29 species + 3 varieties. *A. niger* and *A. terreus* were superior in counts collectively, 71.3 % of total aspergilli. *Aspergillus flavus, A. ustus* and *A. versicolor,* had moderate counts (collectively, 14.77%) and moderate occurrence (32.5, 27.5 & 27.5 % of the samples, respectively). Three species (*A. ochraceus, A. sulphureus* and *A. sydowii*) in addition to 2 species varieties (*A. terreus var. aureus* and *A. terreus var. africanus*) were low in frequencies (12.5 - 20% of the samples) with variable counts (collectively, 7.16%). Whereas other *Aspergillus* species were identified in low frequencies (2.5 - 10 % of the sample) with counts collectively, 7.09 % of gross fungal count.

Table (1): Collection of cultivated soil (40 samples)from the rhizosphere of dominant plants in Upper Egypt and their moisture contents (M.C. %) with some chemical analyses of soil including organic matter content (O.M%), pH values (pH), total dissolved salts (T.D.S mg/g) and some ions of elements µg/g x10^{-3} including mono-equivalent (Na^+ and K^+) and bi- equivalent ($Ca^{++,}$ Mg^{++}, Fe^{++}, Zn^{++}, and $Mn^{++).}$

sample No.	Place of collection	Latin name of the plants	M.C.%	O.M %	pH	T.D.S mg/g	Element µg/g x10^{-3}						
							Na^+	K^+	Ca^{++}	Mg^{++}	Fe^{++}	Mn^{++}	Zn^{++}
1	Sohag	*Triticum vulgare*	17.8	3.1	7.10	0.025	6700	11.3	17.9	5.1	0.829	0.002	0.047
2	Sohag	*Trifolium alexandrinum*	14.4	2.7	7.20	0.061	5800	7.1	8.6	2.9	0.924	0	0.033
3	Sohag	*Brassica oleracea var. capitate*	28.9	1.25	7.75	0.012	8200	35.3	51	16.6	0.492	0	0.029
4	Sohag	Solanum lycopersicum	12.6	1.64	7.06	0.023	12300	12.1	60.5	21.7	0.260	0.014	0.033
5	Sohag	*Allium cepa*	16.5	1.82	7.01	0.030	8900	33.3	136	66.7	0.232	0.01	0.022
6	Sohag	*Trifolium alexandrinum*	12.2	1.08	7.24	0.047	6000	10	35.6	4.2	1.501	0.095	0.038
7	Sohag	*Trifolium alexandrinum*	9.7	1.22	6.80	0.038	14200	8.9	30.3	6.7	0.248	0.004	0.017
8	Sohag	*Triticum vulgare*	11.3	1.09	6.77	0.068	12400	20	45.5	9.4	0.436	0.02	0.087
9	Sohag	*Allium cepa*	10.3	1.99	6.80	0.048	8200	9.5	321.9	29.2	0.234	0.035	0.028
10	Sohag	*Anethum graveolens*	24.4	2.55	6.55	0.009	8500	8.2	60.6	7.3	0.448	0.01	0.041
11	Sohag	*Petroselinum crispum*	15.3	2.66	6.25	0.027	6300	7.9	55.1	8.5	0.280	0	0.073
12	Sohag	*Mentha arvensis*	8.3	3.00	6.65	0.069	8500	27.2	64.9	6.1	0.442	0.011	0.040
13	Sohag	*Aloe vera*	1.2	1.69	7.26	0.076	5600	14.7	42.1	4.1	1.875	0.049	0.043
14	Sohag	*Cuminum cyminum*	24.6	1.85	6.80	0.041	4300	18.1	52.9	5.9	0.429	0.02	0.056
15	Sohag	*Vicia faba*	16.9	1.44	7.01	0.003	4800	11	54.1	4.3	1.537	0.008	0.021
16	Sohag	*Allium sativum*	28.1	1.72	6.77	0.099	8100	9.4	43.3	7.5	0.820	0.002	0.032
17	Sohag	*Petroselinum crispum*	26.5	1.46	6.25	0.037	12900	12.4	65.5	5.6	0.581	0	0.033
18	Sohag	*Zea mays*	21.8	2.22	6.55	0.082	6100	21.2	37.7	4.2	2.282	0.006	0.029
19	Sohag	*Mangifera indica*	9.2	2.42	7.00	0.061	4300	23.8	40.7	2.5	0.993	0	0.038
20	Sohag	*Saccharum officinarum*	24.6	2.82	6.89	0.044	5200	17.4	35.5	4.6	1.008	0.01	0.022
21	Sohag	*Raphanus sativus*	17.4	2.61	7.15	0.049	3500	5.4	31	2.5	1.986	0	0.027
22	Sohag	*Allium cepa*	17.1	0.999	6.90	0.029	3600	8.1	30.9	3.2	0.279	0	0.044
23	Qena	*Vicia faba*	17.7	1.12	7.25	0.055	5100	9.8	50.5	6.3	0.346	0.004	0.085
24	Qena	*Allium sativum*	20	1.03	7.43	0.009	36300	8.8	72.8	8	0.688	0	0.015
25	Qena	*Lactuca sativa*	21.5	1.08	7.48	0.008	6900	13.8	70.9	6.5	13.845	0	0.019
26	Luxor	*Vicia faba*	15.9	1.11	7.25	0.019	4100	9.9	37	4.9	0.248	0.307	0.085
27	Luxor	*Brassica oleracea var. capitata*	12.8	1.12	7.38	0.056	6200	13.7	53.1	5.1	1.857	0.075	0.087
28	Luxor	*Allium sativum*	12.6	1.01	7.45	0.077	5700	18.3	47.6	4.2	1.988	0	0.098
29	Aswan	*Vicia faba*	13.3	1.00	7.40	0.071	6200	16.8	39.1	4.4	8.410	0.105	0.117
30	Aswan	*Saccharum officinarum*	15.5	1.12	7.26	0.036	5200	11.2	29.5	8.7	5.306	0.014	0.062
31	Aswan	*Triticum vulgare*	16.7	2.50	7.80	0.080	5600	17.6	33.3	6.9	3.660	0.012	0.039
32	Aswan	*Trifolium alexandrinum*	22.7	2.07	7.90	0.004	5900	12.2	37.8	4.4	0.859	0	0.043
33	Sohag	*Psidium* guajava	20.7	2.00	7.90	0.029	6400	18.2	69.3	5.3	0.388	0	0.075
34	Sohag	*Citrus limon*	12.8	2.09	7.00	0.003	4800	10.1	33.8	3.3	2.556	0.041	0.034
35	Sohag	*Citrus reticulate*	8.9	2.12	7.80	0.046	4100	13.5	55.7	9.2	0.801	0	0.029
36	Sohag	*Opuntia ficus-indica*	5	3.10	7.00	0.027	5300	16.4	57.3	8.9	0.446	0.002	0.043
37	Sohag	*Phoenix dactylifera*	11.6	2.78	7.85	0.012	4400	10.1	52.6	4.4	1.998	0.016	0.029
38	Sohag	*Aloe vera*	4.1	3.08	7.90	0.026	8200	20.6	61.2	2.9	1.866	0.014	0.064
39	Sohag	*Rosa arabica*	20.5	3.087	7.19	0.033	6700	21.7	44.5	3.5	1.260	0.02	0.017
40	Sohag	*Ocimum basilicum*	8.5	3.00	7.82	0.052	5600	16.9	42.4	4.6	3.555	0.063	0.088
Average (mean)			1.2-28.9 (15.75)	0.99-3.10 (1.94)	6.28-7.9 (7.17)	0.003-0.099 (0.04)	3500-36300 (7427.5)	5.4-35.3 (14.80)	8.6-321.9 (55.25)	2.5-66.7 (8.257)	0.232-13.845 (1.705)	0-0.307 (0.024)	0.015-0.098 (0.047)

Penicillium (34 species and 1 species variety) was isolated and identified from cultivated soils tested represented 23.54% of gross count , of which 3 species (*P. duclauxii* , *P. funiculosum* and *P. citrinum*) had variable degree of counts, and occurrence. *P. duclauxii* was superior in frequency (37.5 % of the samples) with count (2.97 % of gross fungal count), *P. funiculosum* was the superior of *Penicillium* count (4.04 % of gross fungal count) with moderate frequency (32.5 % of the samples). *P. citrinum* was moderate in frequency (27.5% of the samples) and low in count (0.92 % of gross fungal count). Whereas two *Penicillium* (*P. asperum* and *P. purpurogenum*) were observed in low counts (2.79 % of gross counts) and low in frequencies (each, 12.5% of the samples). The remaining Penicillium species were rare in frequencies (10 – 2.5% of the samples) with variable counts (collectively, 12.81 % of gross fungal count).

Fusarium occupied the third place according to the occurrence (67.5 % of the samples) and count (6.6 % of gross fungal counts). Of the genus, 9 species, +1 variety, were isolated and identified. Three species (*F. moniliforme, F. oxysporum* and *F. solani*) were the dominant (30 %, 30 % & 25 % of the samples; 18.22 %, 57.47 % & 12.15 % of total *Fusarium* and 1.19 %, 3.76 % & 0.79 % of gross count). Whereas the other 6 species, in addition to 1 species variety, had low counts (collectively, 12.15% of total Fusarium) with rare occurrence (2.5–5 % of the samples).

Acremonium (*A. strictum* and *A. implicatum*) had the fourth place based on frequency and count (45 % of the samples and 5.94% of gross count), *A. strictum* was parallel with the genus as frequency (40 %) and count (69.59 %). But *A. implicatum* was less in frequency and count (25 % of the samples and 30.4 % of total *Acremonium*).

Two genera of dematiaceous hyphomycetes (*Curvularia* and *Humicola*) were moderate in occurrence (30 & 25 % of the samples) with very low and low counts (1.53 & 4.04 % of gross count). Of the two genera, 3 and 5 species were identified of which *C. pallescens* and *H. grisea* were detected in low frequencies and counts (*H. fuscoatra* had 20 % of the samples and 93.94 % of total *Humicola* and *C. lunata* had 20% of the samples and 68 % of total *Curvularia*). The remaining species of the two genera were listed in rare frequencies with low counts.

Emericella (4 species) had the seven-place based on frequency (22.5 % of the samples) with relatively low count (1.16 % of gross count). *E. nidulans* was isolated in low frequencies (12.5 %) and counts (15.79 % of total *Emericella*). Whereas, the three other *Emericella* (1 species +2 species varieties) were detected in rare frequencies and counts (5 – 7.5 % of the samples and 13.16 – 47.37 % of total *Emericella*).

Eight genera namely: *Mucor, Stachybotrys, Circinella, Cylindrocarpon, Trichoderma, Cladosporium, Drechslera* and *Paecilomyces* were detected in low frequencies of occurrence (12.5 % - 22.5 % of samples) with very low in counts (0.43 % - 0.83 % of gross count). Of the previous 8 genera, 24 species, were identified of which M. *racemosus, M. hiemalis, C. simplex, D. spicifera*, were low in frequencies (12.5 – 17.5 % of samples) and their counts were parallel to their genera counts. Concerning of number of species per genera, *Stachybotrys* (7 species) was superior, followed by *Trichoderma* (4 species) and *Cylindrocarpon, Paecilomyces* and *Cladosporium* (3, 3 & 2 species, respectively). Regarding of the rare frequency of occurrence (≥ 10 % of the samples) of cultivated soil, 37 species of 25 genera were listed. Of the previous genera 2, 8 and 15 genera were represented by 3, 2 and 1 species, respectively collectively accounting 3.65% of gross fungal count. Five species (*Syncephalastrum racemosum, Cunninghamella elegans, Torula herbarum, Nectria inventa* and *Ulocladium alternariae*) had the best counts (1.65 % of gross count). The dematiaceous hyphomycetes e.g *Alternaria, Torula* and *Ulocladium* (3, 2 & 1 species, respectively) in addition ascospore-forming fungi e.g *Chaetomium* and *Microascus* (2, 1 species) were rare in frequencies and counts. Sterile mycelia (black and white) were dominant (55 % of the samples and 1.9% of gross fungal count) as shown in Table, 2.

3.3. Occurrence Remark (OR):

H: High occurrence, 20-40 samples (50-100% of the samples).
M: Moderated occurrence, 10-19 samples (25-47.5% of the samples).
L: Low occurrence, 5-9 samples (12.5-22.5% of the samples).
R: Rare occurrence, 1-4 samples (2.5-10% of the samples).

4. Discussion

Fungi are very successful inhabitants of soils, due to their high plasticity and their capacity to adopt various forms in response to adverse or unfavorable conditions [21]. Due to their ability to produce a wide variety of extracellular enzymes, ability to break down all kinds of organic matter, decomposing soil components and there by regulating the balance of carbon and different nutrients [22]. Fungi convert dead organic matter into biomass, organic plus amino acids and carbon dioxide [23]. The diversity and activity of fungi is regulated by various biotic (plant and other organisms) and abiotic (soil pH, moisture, salinity, structure and temperature) factors [24, 25]. Fungi can be found in almost every environment and can live in wide range of abiotic factors [26]. Therefore, the present study was designed to throw light on soil analyses, and mycoflora of cultivated soils in Upper Egypt.

4.1. Soil analyses

Regarding the results obtained, the cultivated soils were clay (loamy) in texture, moderate to high moisture contents (based on rate of irrigation), low to available organic matter, around neutral pH with low concentration of total dissolving salts. The elements in the soil samples had available contents of macro-elements (K^+, Ca^{++} & Mg^{++}) in addition to Fe^{++} with low contents of Mn^{++} and Zn^{++} as micro-elements whereas, Na^+ as stress element was relatively low in most samples tested. Based on soil analyses with correlation to the micro-organisms (bacteria and fungi) of the previous literature in this aspect, soil health and the closely related terms of soil quality and fertility are considered as one of the most important characteristics of soil ecosystems. The integrated approach to soil health assumes that soil is a living system and soil health results from the interaction between different processes and properties, with a substantial effect on the activity of soil microbiota [23]. The colonization of land by plants has coincided with the appearance of mycorrhiza- like fungi. Over evolutionary time, fungi have maintained their prominent rate forming of mycorrhizal associations.

Table (2): Total count (TC) of fungal genera and species isolated from cultivated soils (40 sa-mples), number of cases of isolation (NCI), and occurrence remark (OR) on 1% glucose-Czapek's agar at 28 ± 1°C.

Type of soil / Genera & species	Cultivated (clay) soil	
	T.C	N.C.I & O.R
Aspergillus	**307.4**	**39 H**
A. niger Van Tieghem	146.5	34 H
A. terreus Thom	72.6	28 H
A. flavus Link	12.0	13 M
A. ustus (Bainier) Thom & Church	20.0	11 M
A .versicolor (Vuillemin) Tiraboschi	13.4	11 M
A. terreus var. *aureus* Thom & Raper	11.0	8 L
A. ochraceus Wilhelm	3.4	6 L
A. terreus var. *africanus* Fennell & Raper	3.2	6 L
A. sulphureus (Fresenius)Thom & Church	1.2	5 L
A. sydowii (Bainier & Sartory) Thom & Church	3.2	5 L
A. candidus Link	1.2	4 R
A. melleus Yukawa	0.8	4 R
A. wentii Wehmer	1.0	4 R
A. awamori Nakazawa	0.6	3 R
A. deflectus Fennell & Raper	2.0	3 R
A. flavus var. *columnaris* Raper & Fennell	1.2	3 R
A. fumigatiaffinis Hong, Frisvad & Samson	1.0	3 R
A. spelunceus Raper & Fennel	1.4	3 R
A. caespitosus Raper & Thom	1.6	2 R
A. diversus Raper & Fennel	0.8	2 R
A. flavipes (Bainier & Sartory) Thom & Church	0.6	2 R
A. fumigatus Fresenius	0.6	2 R
A. silvaticus Fennell & Raper	4.8	2 R
A. aeneus Sappa	0.2	1 R
A. asperescens Stolk	0.6	1 R
A. carneus Blochwitz	0.4	1 R
A. cervinus Massee	0.2	1 R
A. janus Raper & Thom	0.2	1 R
A. japonicus Saito	0.2	1 R
A. oryzae (Ahlburg) Cohn	0.2	1 R
A. rugulosus Thom & Raper	0.2	1 R
A. tamarii Kita	2.0	1 R
Penicillium	**153.6**	**33 H**
P. duclauxii Delacroix	19.4	15 M
P. funiculosum Thom	26.4	13 M
P. citrinum Thom	6.0	11 M
P. asperum (Shear) Raper & Thom	16.6	5 L
P. purpurogenum Stoll	1.6	5 L
P. varians Smith	1.0	4 R
P. rubrum Stoll	0.8	3 R
P. chrysogenum Thom	2.4	2 R
P. corylophilum Dierckx	0.4	2 R
P. italicum Wehmer	1.0	2 R
P. janthinellum Biourge	1.6	2 R
P. jensenii Zaleski	0.4	2 R
P. lanosum Westling	0.4	2 R
P. resticulosum Birkinshaw, Raistrick & G. Smith	6.6	2 R
P. variabile Sopp	2.0	2 R
P. aegyptiacum Van Beyma	0.8	1 R
P. baarnense J.F.H. Beyma	8.4	1 R

P. camemberti Thom	19.2	1 R
P. caseicolum Bainier	30.8	1 R
P. commune Thom	1.0	1 R
P. daleae K.M. Zalessky	2.0	1 R
P. gladioli L. McCulloch & Thom	0.2	1 R
P. vinaceum Gilman & Abbott	0.2	1 R
P. islandicum Sopp	0.4	1 R
P. lanosocoeruleum Thom	0.2	1 R
P. martensii Biourge	0.2	1 R
P. miczynskii K.M. Zalessky	0.8	1 R
P. nigricans Bainier	0.2	1 R
P. olsonii Bainier & Sartory	0.4	1 R
P. piscarium Westling	0.6	1 R
P. purpurogenum var. *rubisclerotium* Stoll	0.2	1 R
P. putterillii Thom	0.8	1 R
P. rugulosum (Thom) Samson, Yilmaz, Frisvad & Seifert	0.2	1 R
P. lavendulum Raper & Fennell	0.2	1 R
P. tardum Thom	0.2	1 R
Fusarium	**42.8**	**27 H**
F. moniliforme Sheldon	7.8	12 M
F. oxysporum Schlechtendal	24.6	12 M
F. solani Martius	5.2	10 M
F. poae (Peck) Wollenw.	0.4	2 R
F. dimerum Penzig	0.4	1 R
F. equiseti (Corda) Saccardo	1.0	1 R
F. moniliforme var. subglutinans Wollenweber & Reinking	2.8	1 R
F. semitectum Berkeley & Ravenel	0.2	1 R
F. sporotrichioides **S**herbakoff	0.2	1 R
F. tricinctum **(**Corda) Sacc.	0.2	1 R
Acremonium	**38.8**	**18 M**
A. strictum W. Gams	27.0	16 M
A. implicatum (Gilman & Abbott) Giraldo, Gen & Guarro	11.8	10 M
Curvularia	**10.0**	**12 M**
C. lunata (Wakker) Boedijn	6.8	8 L
C. pallescens Boedijn	3.0	4 R
C. clavata Jain	0.2	1 R
Humicola	**26.4**	**10 M**
H. fuscoatra Traaen	24.8	8 L
H. grisea Traaen	0.4	2 R
H. nigrescens Omvik	0.4	2 R
H. piriformis De Bertoldi	0.4	2 R
H. pulvericola Wei Wang, Houbraken & Seifert	0.4	1 R
Emericella	**7.6**	**9 L**
E. nidulans Eidam	1.2	5 L
E. heterothallicus Kwon-Chung, Fennell & Raper	0.8	3 R
E. nidulans var. lata Thom & Raper	2.0	3 R
E. nidulans var. echinulata Fennell & Raper	3.6	2 R
Mucor	**5.4**	**9 L**
M. racemosus Fresenius	3.8	7 L
M. hiemalis Wehmer	1.6	6 L
Stachybotrys	**3.2**	**9 L**
S. kampalensis Hansf.	0.6	3 R
S. microspora Mathur & Sankhla	0.4	3 R
S. oenanthes (M.B. Ellis) L. Lombard & Crous	0.4	3 R
S. chartarum (Ehrenberg) Hughes	0.6	2 R
S. bisbyi (Pers. Ex Fr.) Sacc.	0.2	1 R
S. elegans (Pidopl.) W.Gams	0.4	1 R
S. sansevieriae G.P. Agarwal & N.D. Sharma	0.6	1 R

Circinella simplex Van Tieghem	**4.2**	**7 L**
Cylindrocarpon	**2.8**	**6 L**
C. candidum (Link)Wollenweber	0.6	3 R
C. echinulata Wollenweber	2.0	2 R
C. congoense Meyer	0.2	1 R
Trichoderma	**3.4**	**6 L**
T. hamatum (Bonorden) Bainier	2.0	3 R
T. koningii Oudemans	0.8	2 R
T. viride Persoon	0.4	2 R
T. harzianum Rifai	0.2	1 R
Cladosporium	**5.0**	**5 L**
C. cladosporioides (Fresenius) de Vries	1.0	3 R
C. sphaerospermum Penzig	4.0	2 R
Drechslera	**2.8**	**5 L**
D. spicifera (Bainier) Von Arx	1.6	5 L
D. halodes (Drechsler) Subramanian & Jain	1.2	3 R
Paecilomyces	**3.0**	**5 L**
P. lilacinus (Thom) Samson	0.4	2 R
P. variotii Bainier	0.4	2 R
p. terricola (Mill., Giddens & Foster) Giraldo, Gen & Guarro	2.2	1 R
Syncephalastrum racemosum Cohn ex Schröter	**1.8**	**4 R**
Alternaria	**1.4**	**4 R**
A. alternata (Fries) Keissler	1.0	3 R
A. chlamydospora Mouchacca	0.2	1 R
A. longissima Deighton & Mac Garvie	0.2	1 R
Epicoccum	**1.4**	**4 R**
E. nigrum Link	0.6	3 R
E. purpurascens Ehrenberg	0.8	1 R
Gliocladium	**1.4**	**4 R**
G. catenulatum Gilman & Abbott	0.4	2 R
G. roseum Bainier	1.0	2 R
Cunninghamella	**2.2**	**3 R**
C. echinulata Thaxter	0.6	2 R
C. elegans Lendner	1.6	1 R
Scopulariopsis	**1.6**	**3 R**
S. brumptii Salvanet-Duval	0.6	2 R
S. brevicaulis (Saccardo) Bainier	0.8	1 R
S. canadensis F.J. Morton & G. Smith	0.2	1 R
Torula	**3.2**	**3 R**
T. herbarum (Pers.) Link ex S. F. Gray	2.8	2 R
T. fici Crous	0.4	1 R
Chaetomium	**0.4**	**2 R**
C. bostrychodes Zopf	0.2	1 R
C. cochliodes Palliser	0.2	1 R
Microascus desmosporus (Lechmère) Curzi	**0.8**	**2 R**
Nectria	**2.4**	**2 R**
N. haematococca Berkeley & Broome	0.2	1 R
N. inventa Pethybridge	2.2	1 R
Rhizopus	**0.8**	**2 R**
R. oryzae Went & Prinsen-Geerligs	0.6	1 R
R. stolonifer (Ehrenb.) Vuill	0.2	1 R
Terricola daghestanicus Shidlovsky	**0.8**	**2 R**
Trimmatostroma	**0.4**	**2 R**
T. betulinum (Corda) Hughes	0.2	1 R
T. salicis Corda	0.2	1 R
Ulocladium alternariae (Cooke) Simmons	**2.4**	**2 R**
Acrophialophora fusispora (Saksena) Samson	**0.2**	**1 R**

Ascotricha guamensis Ames	**0.2**	**1 R**
Botryotrichum piluliferum Saccardo & Marchal	**0.2**	**1 R**
Stemphylium botryosum Wallr	**0.2**	**1 R**
Macrophomina phaseolina (Tassi) Goidanich	**0.2**	**1 R**
Malbranchea sulfurea (Miehe) Sigler & Carmichael	**0.2**	**1 R**
Gonytrichum macrocladum (Sacc.) Hughes	**0.2**	**1 R**
Papulaspora sepedonioides Preuss	**0.2**	**1 R**
Rhizoctonia solani Kühn	**0.4**	**1 R**
Sepedonium lanuginosum Griffon & Maublanc	**0.8**	**1 R**
Verticillium tenerum (Nees) Link	**0.2**	**1 R**
Sterile mycelia (S.m.) S.m. (black) S.m. (white)	**12.4** 7.8 4.6	**22 H** 16 M 10 M
Gross total count	**652.4**	
No. of genera and species	**148 sp. + 7 var. of 40 genera**	
No. of infected samples (%)	**100 %**	

In addition, however, they have occupied other terrestrial niches of which the decomposition of recalcitrant organic matter is perhaps the most remarkable [27]. Plant roots exude substantial amounts of low molecular weight organic compounds such as amino acids, sugars, and organic acids, resulting in increased microbial population and activity [28-31]. During the evolution of terrestrial microbial life, fungi become the significant decomposers of recalcitrant organic matter. On the other hand, bacteria have been able to maintain a significant role in the degradation of simple substances [27].

The soils had variable pH values (6.28 - 7.9), as estimated in the soils tested. The variation in soil pH is related to the parent material, rainfall, topography, and organic matter content of the soil [32]. In this respect, The correct pH is crucial for healthy plant growth and its affects on the amount of nutrient available [33]. Also, soil pH is considered one of the essential factors influencing plant uptake of trace elements [34]. Based on the results obtained concerning total dissolving salts (TDS) and sodium ions (Na^+) concentrations in the soils tested, the soil had a concentration of TDS (mean= 0.04 µg/g dry soil) as well as Na^+ concentration (mean= 7427.5 µg/g $x10^{-3}$). According to previous studies concerning soil salinity is one of the key factors that threaten plant existence worldwide and is a major challenge to sustaining crop production and soil quality. It limited research on pones of microbial communities and enzyme activities under soil amendments application of saline-alkaline soils [35]. Agricultures land derived from saline-alkaline soils will not have high plant growth and productivity unless they are ameliorated by using the appropriate agronomic and amendments practices [36]. Soil enzyme activities play a key role in nutrients recycling making them accessible to plants and micro-organisms [37]. Soil micro-organisms are considered to be one of the vital factors for evaluating soil quality and the application of soil amendments increasing the enzyme activity, which leads to a higher yield [36-39]. Also, regulations of the microbial community Composition and function involve a pH-dependent mechanism [37].

Concerning the available micro-elements contents, four elements (Fe^{++}, Mn^{++}, Zn^{++} & Cu^{++}) were estimated, where the iron ions have the best counts in the soil tested. In this respect, iron (Fe) is one of the most studied elements in the mineral nutrition of plants [40], it relatively high abundance in cultivated soils, "plant iron acquisition is often impaired, a fact resulting in severe crop losses. The total Fe in soils is clearly higher than soluble Fe^{++} required for optimal growth, the availability of the free Fe^{+++} in agricultural soils is low, which depends mainly on pH [41].

4.2. Soil mycoflora

Based on the dilution plate method using glucose-Czapek's agar medium at 28°C, 148 species + 7 varieties of 40 genera were isolated and identified as glucophilic fungi from the soils tested. In this respect, Soil fungi can be classified into three functional groups including (1) biological controllers, (2) ecosystem regulators, and (3) species participating in organic matter decomposition and compound transformations [42, 43]. Ecosystem regulators are responsible for soil structure formation and modification of habitats for other organisms by regulating the dynamics of physiological processes in the soil environment. Biological controllers can control diseases, pests, and the growth of other microorganisms [44]. Also, fungi improve plant growth by increasing nutrient uptake and protecting them against pathogens [44].

Of soil samples examined for fungal diversity (saprophytic fungi), the samples proved to be rich in saprophytic fungi (652.4 colonies/mg dry soil in every 40 samples. Concerning this category, fungal populations are strongly influenced by the diversity and composition of the plant community and in return, affect plant growth through mutualism, pathogenicity, and their effect on nutrient availability and cycling [45-47]. Moreover, fungi participate in nitrogen fixation, hormone production, biological control against root pathogens, and protection against drought [48-50]. They also play an important role in the stabilization of soil organic matter and the decomposition of residues[51].

Aspergillus (29 sp. + 3 var.) and *Penicillium* (34 sp.+ 1 var.) were the superior genera based on number of isolated species and frequencies (97.5% & 82.5% of the samples, respectively). The two genera were counted 47.12% and 23.54% of gross fungal count (totally, 70.67% of 652.4 colonies/ mg dry soil in every samples). Members of genera, *Aspergillus* and *Penicillium* are cosmopolitan and prevalent components of different ecosystems in a wide range of environmental and climatic zones [52-62].

Regarding *Aspergillus* groups [53] isolated and identified in this study, *A. niger* (3 species), *A. terreus* (1 sp. + 2 var.) and *A. flavus* (3sp. + 1 var.) groups, respectively had the highest counts and occurrence followed by *A. ustus* (2 sp.), *A. versicolor* (3 sp.) and *A. ochraceus* (3 sp.), respectively with moderate to low counts and occurrence. Of the previous groups *A. niger* van Tieghem, and *A. terreus* Thom had the highest counts and frequencies (high occurrence), whereas *A. flavus* Link *A. ustus* (Bain.) Thom & church and *A. versicolor* (Vuillem). Tiraboschi were less in the previous two parameters. Concerning the previous studies of soil fungi isolated from cultivated soil [63-67], the previous five *Aspergillus* species were detected in addition to *A. flavus* var. *columnaris*, *A. fumigatus* and *A. sydowii* in variable degrees of counts and frequencies. Of *Penicillium* [52] section and sub-section, Asymmetrica-Divaricata had the highest number of species with moderate count (~21% of total penicillia), followed by symmetrica-Biverticilla and Asymmetrica-lunata in number of identified species (9 sp. + 1 var. and 5 sp., respectively and counts (34.03 and 33.64% of penicillia, respectively). Also, sub-section Asymmetrica-Velutina, was represented by 3 species in moderate or rare frequency (5% -27.5% of the samples) and collectively had low count (5.3% of gross count). The remaining *Penicillium* species of section Monoverticillata and sub-section Asymmetrica-Funiculosa Plus Asymmetrica-Fasciculata were low in the number of species (each, 2 species) with rare frequencies (each, 2.5%) and deficient in counts except *P. resticulosum* (5% of samples and 4.3% of penicillia count. Of isolated *Penicillium* species, *P. duclauxii*, *P. funiculosum* and *P. citrinum* were moderate frequencies (27.5% - 37.5% of the samples and counts (collectively, 33.72%). *P. asperum* and *P. purpurogenum* (each, 12% of the samples) and collectively, 17.64% of total penicillia. On the other side, and based on the previous studies of cultivated soils, *P. notatum* (or *P. chrysogenum*) and *P. corylophilum*, belonging to Asymmetrica-Velotina, were the dominant [62- 65].

Fusarium (67.5% of the samples and 6.56 of gross fungal count) had the third place of isolated filamentous fungi in the cultivated soil of Upper Egypt. Concerning the genus, *Fusarium* is a cosmopolitan genus of filamentous fungi that includes many toxin-producing plant pathogens of agricultural importance. Collectively, *Fusarium* diseases, including wilts, blight, rots, and cankers of many horticultural, field, ornamental and forest crops in both agricultural and natural ecosystems, in addition to mycotoxin producers and opportunistic human pathogens [68]. The genus was dominant in cultivated [62-65] in Egypt compared with sandy [61, 65] soils. Of the genus, 9 species and 1 variety were isolated of which *F. moniliforme*, *F. oxysporum* followed by *F. solani* were moderate (25-30% of the samples) in frequencies with the highest counts (totally, 87.85% of total *Fusarium* count). The previous three species were only observed and associated with peanut damping off and wilting the seedling [69], also had pathogenicity effects on peanut seed germination. It is worthy for mention that, *F. oxysporum* is ranked the fifth out of top plant pathogens of scientific economic importance [70, 71]. Of *Fusarium*-related genera, *Acremonium* (2 species, 45% of the samples and 5.95% of gross fungal count), Cylindrocarpon (3, 15% and 0.43%) and Nectria (2, 5% and 0.37%) were identified in these cultivated soils. Concerning the previous three genera, *Acremonium* (4 species) was isolated from sediment soil and tufa samples of closed salt lake in California, U.S.A. [72]. *A. strictum* was detected from Puerto Rico soil as tropical region of the world [73]. In Egypt, *A. strictum* and *A. implicatum* had moderate commonality in desert soil [61] as well as from paddy grains, have silica shell, [74]. *Cylindrocarpon candida* was the only species of the genus isolated and identified from some sources [61, 62, 74- 76].

Concerning to order: Mucorales, eight species of 5 genera were isolated and identified of which *Mucor racemosus*, *M. hiemalis*, *Circinella simplex*, and *Syncephalastrum racemosum* had low frequencies (10-17.5% of the samples) with low counts (collectively, 1.75 of total fungal count), whereas, *Cunninghamella* and *Rhizopus* (2 species, each) were rare (5 - 7.5%) and very low in count (0.45%). With respect to Mucorales (zygomycetous), most species are saprobic fungi with ruderal characteristics, including rapid growth, prolific spore production and ability to use only relatively simple fixed carbon compounds [77-79]. The Mucorales can degrade organic matters [80] and safe hydrocarbons (aliphatic and aromatic) biodegradation [81]. On the contrary, fungi of order Mucorales cause mucormycosis, a rare but highly fatal fungal infection. They can cause cutaneous, rhino-orbital, pulmonary, rhino-cerebral, and disseminated bloodstream infections [82], recently these fungi have been frequently reported to infect the COVID.-19 patients as black fungi [83].

Regarding dematiaceous hyphomycetes (DH) [84,85], a total of 33 species belonging to l4 genera were detected and identified, accounting for 8.74% of the gross fungal count. In this respect, dematiaceous hyphomycetes are darkly pigmented fungi ubiquitously found worldwide as plant pathogens and saprophytes [86], contain melanin and melanin-like pigments with their hyphae and/or spores. The presence of melanin in fungi confers certain advantages, such as increasing their survival potential and virulence and also reported as opportunistic human and animal pathogens [87- 89]. Of isolated DH 2 (*Curvularia* and *Humicola*) and 3 (*Stachybotrys*, *Cladosporium*, and *Drechslera*) genera had moderate and low frequencies (12.5-30% of the samples). Regarding this group (DH), the most frequently associated DH genera in mycotic Keratitisinclude *Curvularia*, *Alternaria*, *Exserohilum* and *Cladosporium* [89-91]. Also, DH has emerged as the third most common causative agent of mycotic Keratitis after *Fusarium* and *Aspergillus* [92]. In Egypt, this group was widely detected as airborne fungi in addition to phyllosphere and phylloplane of some cultivated and desert plants [65].

Of biocontrol fungi against plant pathogens listed in the previous literature, *Trichoderma* (4 species) was low in

frequency (15% of the samples) and deficient in count (0.52% of gross counts). The genus has been known since at least 1920 for its ability to act as a biocontrol agent against plant pathogens. Recent advances demonstrate the effects of *Trichoderma* on plants, including inducing systemic or localized resistance. The genus colonizes the root epidermis and outer cortical layers and releases bioactive molecules that cause welting off of the *Trichoderma* thallus; this due to increased plant growth and nutrient uptake occurs, in addition to induction of pathways for resistance in plants. Also, these fungi produce a rich mixture of antifungal enzymes, including chitinases and 3-1, 3 glucanase which is synergistic with each other with other antifungal enzymes to act as mycoparasitism [**93**].

The fungal species isolated in rare frequencies had very low counts, including root infecting fungi (e.g., *Rhizoctonia solani*, *Verticillium tenerum*), pathogens of a shoot system (e.g., *Stemphylium botryosum*), in other side bio fertilizer fungi (e.g., *Papulaspora sepedonioides*) were also recorded.

5. Conclusion

The cultivated soils in Upper Egypt in general are fertile but not completely healthy. Therefore, micro-organisms are biofertilizer and biocontrol against pathogens, so it must be taken in the consideration for increasing the fertility of the soils and facing the pathogenic fungi.

Recommendation

The Egyptian must protect the cultivated soils from the desertification based on its nature fertility and first class of water irrigation.

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