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Original Research Article

Study of the Fungal Community of the Soil of *Solanum melongena L.plant*

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Abstract: Eggplant (*Solanum melongena L.)* is one of the most widely cultivated solanaceous vegetable crops worldwide, grown mostly in tropical and subtropical regions. Fungi are important organisms that impact the environment. Researchers have been interested in the presence of fungi in soil and their relationship with plants. Studies in this area have been diverse, including the study of soil fungi. Microbes within and outside the root zone can directly or indirectly affect plant growth. Species isolated from both study areas included: *Fusairum solani, Fusarium oxysporium, Alternaira alternata, Rhizoctiani, Aspergillius sp., Penicillium spp., Yeast, Macrophomina phaseolina, Rhizopus stolonifer, Mucor sp., and Trichoderma sp*. Ascomycota dominated the soilborne fungi isolated from all eggplant areas, followed by Myxomycetes, and finally Basidiomycetes. The results of the study showed that the Al-Sudair region was more abundant in fungi than the Afak region fungal similarity was found to be 72% in the Sudair region and 27% in the Afak region, according to the study. In the AL-Sudair region, the degree of fungal community (ISD) similarity was 26, but in the Afak region, it was 19.

Keywords: Biodiversity, *Aspergillus Sp, Rizoctiani,* Rhizoplane, Diversity, Ascomycota.

INTRODUCTION

The crust that covers the surface of the Earth is known as soil; it has a texture, a smell, and is filled with insects, plants, and microbes (Handelsman, & Cohen, 2021). With microorganisms making up a significant portion of it (Timmis, K., & Ramos2021), soil is h ome to one of the most varied microbial ecosystems on the planet's surface (Xu *et al*., 2013). Due to variations in soil formation variables, the soils of Iraq differ greatly from one another (Muhaimeed *et al*., 2014). The relationship between biodiversity and soil is intimate (Sylvain& Wall 2011), since soil serves as the focal point for extensive assemblages of living species and engages with the biosphere (Salazar *et al*., 2020). Soil is the vital habitat for microorganisms (bacteria and fungi) (Griffiths *et al*., 2001). All around the world, including Iraq, agricultural soils are home to a diverse array of fungus, some of which are beneficial to plants and others of which are harmful (Verbruggen *et al*., 2013). The kingdom fungi of as essential ecosystem agents that control soil carbon cycle (Gougoulias *et al*., 2014), plant nutrition, and pathology (Bajpai *et al*., 2019), fungi are among the most varied groups of creatures on Earth ((Muslim *et al*., 2024). Although fungi are found in all terrestrial habitats, little is known about the distribution of individual species, phylum, and functional groupings (Tedersoo *et al*., 2014). The beneficial fungus enriches the soil by breaking down organic materials (Odelade, &

Babalola,2019), processing plant and animal wastes, producing carbohydrates, recycling elements like phosphorus, potassium, sulfur, and nitrogen, and converting protein compounds into ammonia and simple nitrogen compounds (Biswas, & Kole,2017). Pathogenic fungi, on the other hand, infect plants and result in significant financial losses (Horbach *et al*., 2011). Eggplant (*Solanum melongena. L*) is a popular food in most parts of the Middle East (Salamatullah *et al*., 2021) and belongs to the Solanaceae family (Knapp *et al*., 2019). It is one of the important summer vegetable crops in Iraq and is grown for its fruits (Murad *et al*., 2020), which are eaten after cooking or used in making pickles and preserves (Butt *et al.,* 2018). It can be used to lower blood cholesterol levels also also It is a stressful crop due to its long growth period, so it needs sufficient amounts of nutrients (Gürbüz *et al*.,2018). Eggplant is a plant that is sensitive to cold and cannot tolerate low temperatures (Sekara *et al*., 2012). It needs a warm climate for a long time. Eggplant grows in all types of soil provided that it is fertile and well-drained, but it grows well in fertile, well-drained, sandy, mixed soils rich in organic matter (Caruso *et al*., 2017). The root system of the eggplant plant is sensitive to excess moisture in the soil, and flooding the soil with water causes the roots of the plants to rot (Li *et al*., 2024), so good drainage of the soil is essential. Eggplant is planted in February for early (covered) cultivation, in March for early summer cultivation, and in the period from August to mid-September when planted in greenhouses (Nayak *et al*., 2021). The aim of the study is to identify the fungal species that are Rhizosphere and non –Rhizosphere to the roots of the *Solanum melongena L* plant and the species surrounding it, and knowing the extent of fungal diversity present in these soils that accompany this plant for it understand the environmental conditions that affect the diversity of fungi.

MATERIALS AND METHODS

Samples & Study Site

Five soil samples (500–1000 g). AL-Diwaniyah Governorate was chosen as the study site. Samples were taken from the Al-Sudair area, 18 km south of Al- Diwaniyah, and from the Afak area, 30 km southeast of AL-Diwaniyah. These soils are characterized by being sandy mixtures with high salinity. Samples of *Solanum melongena L* roots and surrounding soil were collected from March 2024 to the end of June 2024.

Collection Samples and Isolation

One hundred and twenty samples of *Solanum melongena L*. were collected from Afak and Al-Sudair regions. Isolation of fungi attached to the root surface Rhizoplane, the roots were cut into 1 cm lengths and washed with distilled water several times under sterile conditions. Then the roots were dried on sterile Watmann No. 1 filter papers. Four pieces of dried roots were planted on the surface of the previously prepared solidified culture media and incubated in the incubator under the same previous conditions. Then the growing fungi were examined after the incubation period (Abdel-Hafez& El-Maghraby 1992). Isolation Non-Rhizosphere, The five soil samples from each site were mixed, 0.5 g of the suspension was taken and dissolved in 100 ml of distilled water, i.e., at a ratio of 1:200 g soil/distilled water. After shaking for one minute, 1 ml of the suspension was withdrawn and 0.5 ml of it was poured into a sterile Petri dish. Then, the culture medium was added in two repetitions, stirred until well mixed, left to solidify and incubated in an incubator at 28°C for 5-7 days.

Identification of Isolated Fungi

After the fungi had grown in the plates, they were examined and isolated into pure cultures. Slides were prepared for microscopic examination using an Olympus microscope specifically designed for this purpose. The following sources were used as references for the classification of the isolates (Baron *et al*., 1994).

Statistical analysis of the fungal community

1. Analysis of the general structure of the fungal community

The total number of isolates in the two eggplant regions was calculated after the fungal colonies grew in the plates, as well as the total number of isolated fungal species. Then, the percentage of the total number of isolates was extracted according to the following equation:

$$\textit{Percentage of the total number of isolates} = \frac{\text{Number of isolates in one region}}{\text{Total number of isolates in both areas}} * 100$$

2. Similarity

The overall similarity of fungal species found on plant was calculated by calculating the Total Similarity Index (TSI) as follows: $TSI = \frac{a}{n} * 100$

TSI = Total Similarity Percentage.

a = Number of fungal species shared between the two regions.

n= Total Number of Isolates.

The Jaccard index (ISD) was used according to the Jaccard method explained by (Daraj, 1989). The method was used to determine the degree of similarity in fungal communities on plants as follows: $ISD = \frac{a}{a+b+c} * 100$

a = number of fungal species shared between the two regions

b = number of fungal species found in the first region

c = number of fungal species found in the second region

3. Diversity: The diversity of the fungal community in eggplant plants was calculated for both regions and during the study months using the Simposon method, shown below and described by (Muhsin and Booth, 1987).

1=Dv= $\sum$(P1)+^{2}(P2)................ +^{2}(Pi)

Dv = diversity coefficient.

P = number of isolates of each fungus isolated from the plant.

(P is calculated by dividing the number of isolates of one species by the total number of isolates of all fungal species on the plant, then squaring it.)

4-Frequency %: The percentage frequency of fungi in the two plant zones was calculated.

$$F = \frac{\textit{Number of fungal isolates per plant}}{\textit{Total number of isolates per area per plant}} * 100$$

RESULTS AND DISCUSSION

According to the current study, the following fungi were isolated from the *Solanum melongena L*plant's rhizoplane and non-rhizoplane areas: *Fusairum solani, Fusairum oxysporium, Alternaira Alternata, Rizoctiani, Aspergillius sp, Penicillium, Yeast, Macrophomina phaseolina, Rizopus stolonifer, Mucor sp, Trichoderma sp.* The rhizosphere's biotic and abiotic elements have a significant impact on plant quality. Significant differences in the frequency and relative abundance of fungus linked to *Solanum melongena L*. were discovered.

One thousand two hundred and fifty-four fungal samples were isolated from were obtained from the rhizoplane and non-rhizosphere of *Solanum melongena L*. The highest frequency of fungi isolated from the Rhizoplane non Rhizoplane and in the Al-Sudair region was (22%) for *Rizoctiani*, (18%) for *Rizopus stolonifer*, 16% for *Penicillium*. As for the fungi *Trichoderma sp*, *Mucor sp, Yeast* and *Macrophomina phaseolina* they appeared at a somewhat similar frequency of respectively(3%),(4%)(5%)(7%),While the fungi *Fusairum solani and Alternaira Alternata* the same frequency(14%) also *Fusairum oxysporium* and *Aspergillus sp* were appeared at the same frequency (8.5%)table 1.

Aspergillus sp. (28%), Alteraira Alternata (24%), Rizopus stolonifer (21%), and Rizoctiani (38%) were the highest frequency fungus in the Afak region, both Rhizoplane and non-Rhizoplane. *Fusirium oxysporium and Mucor sp* have the same frequency (15%) while *Trichoderma sp and Penicillium* (17%). Yeasts have lower frequency (2%) comparative study was conducted by (Raaijmakers *et al*., 2009) where 49 fungi were isolated, the highest species appearing being *Aspergillus* and *Penicillium,* table 1. These fungi fall into the Ascomycota division (*Fusirium solani , Fusirium oxysporium. Alternaira Alternata, Aspergillus sp, Penicillium. Yeast, Trichoderma sp),* These fungus belong to the division of Mucoromycota (*Rizopus stolonifer, Mucor sp)*, *Rizoctina*, at last, is a member of the fungus division Basidiomycota.

In every location, Ascomycota accounted for the majority of the fungus isolated from soil, followed by Mucroycota and Basidimycota. The Domination of Ascomycota fungi in soil is consistent with the findings of (Samir& Nashat, 2014, Minati & Mohammed-Ameen, 2020; Al-Atrash *et al*., 2021) the current study differs from the findings of (Al-Abbasi *et al*., 2021), where the dominant fungi were Oomycetes.

Table 1: Fungi isolated from the regions of (AL-Sudair and Afak)

Isolation Fungi	AL-Sudair				Afak			
	Rhizosphere		Non-Rhizosphere		Rhizosphere		Non-Rhizosphere	
	Number of colonies	Frequency %	Number of colonies	Frequency %	Number of colonies	Frequency %	Number of colonies	Frequency %
Fusirium solani	78	14%	39	11%	-	-	-	-
Fusirium oxysporium	45	8.5%	24	7%	23	15%	-	-
Alternaira Alternata	73	14%	-	-	37	24%	-	-
Rizoctiani	115	22%	56	16%	61	38 %	-	-
Aspergillus sp	44	8.3%	32	9%	11	7%	61	28%
Penicillium	74	14%	57	16%	13	8%	37	17%
Yeast	27	5%	-	-	3	2%	4	2%
Macrophomina phaseolina	35	7%	-	-	9	6%	-	-
Rizopus stolonifer	-	-	63	18%	-	-	45	21%
Mucor sp	22	4%	52	15%	-	-	32	15%
Trichoderma sp	14	3%	31	8%	-	-	37	17%

Total	**527**	**100%**	**354**	**100%**	**157**	**100%**	**216**	**%100**
Total	**881**				**373**			

The results in Table (2) indicate that the number of fungal colonies in the Al-Sudair region is more than double that in the Afak region, The moisture content, in addition to the kind of soil and organic matter, is responsible for the occurrence of a wide variety of fungus in farms(Esmaeilzadeh, & Ahangar,2014). The results of calculating diversity in the fungal community in the two study areas were very close, among the key elements affecting the fungal community are soil pH, soil organic carbon, soil moisture, and evaporation. The diversity of soil fungal communities in a location is often shaped by variations in soil characteristics with elevation (Wang *et al*., 2014).

The Rhizosphere and Rhizoplane regions recorded the highest similarity and similarity values in theAL- Sudair region. The study showed that the percentage of fungal similarity in the Sudair region reached (72%), while in the Afak region (27%). The extent of similarity in fungal communities (ISD) in the Sudair region was (26) while in the Afak region (19), because the secretions in these regions encourage fungal growth, and any two adjacent regions are more harmonious in their effect and influence than others (Al-Zujaji, 2000).

Table 2: The percentage of isolated fungi, the diversity of the fungal community, the overall similarity of fungal species, and the extent of similarity in fungal communities on plants

Regains	Total number of fungal%		DV	TSI	ISD
AL-Sudair	Rhizoplane	70%	1.74	72%	26
	Non-Rhizosphere		1.68		
Afak	Rhizoplane	30%	1.8	27%	19
	Non-Rhizosphere		1.6		

CONCLUSION

Biodiversity plays a crucial role in maintaining ecosystem functions. Grazing activities alter environmental conditions and plant biodiversity in plant communities, which in turn affects the structure of the soil fungal community. Fungi play an important role in soil biodiversity. The study areas are agricultural areas, although fungal diversity levels were similar in both study areas, fungal populations were higher in the Sudair region.

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