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## Isolation and Identification of Soilborne Fungi in Fields Irrigated by GAP in Harran Plain Using Two Isolation Methods

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**Abstract:** The microfungal flora of field soils irrigated by the South-eastern Anatolia Project (GAP: Güneydoğu Anadolu Projesi) in Harran Plain were investigated in terms of quality and quantity, using the soil dilution plate and soil washing methods. A total of 1690 microfungi were isolated from 105 soil samples. With the identification of these isolates, 109 species plus 16 different sterile fungi were identified. Sixty-two of these taxa were isolated through the soil dilution plate method, seven through the soil washing method, and 40 through both methods. The results indicate that ten of these species belong to *Mucorales*, four to *Sphaeriales*, one to *Coelomycetes* and 94 to *Hyphomycetes*. The most widespread genera were *Penicillium* Link ex Gray (24 species), *Aspergillus* Mich. ex Fr. (20 species), and *Acremonium* Link ex Fr. with the soil dilution plate method. The most common species were *Aspergillus niger* Tiegh. (284 colonies), *Penicillium lanosum* Westling (238 colonies), *Penicillium canescens* Sopp. (170 colonies), *Penicillium brevicompactum* Dierckx (174 colonies) and *Penicillium clavigerum* Demelius (146 colonies). The results obtained from the soil dilution plate method show that fresh soil bulk equivalent to 1 g of oven-dried soil contains on average 72 487 propagules.

**Key Words:** *Hyphomycetes*, Microfungi, Soil

### Harran Ovası GAP Sulama Alanı İçerisinde Kalan ve Sulamaya Alınan Tarla Toprak Funguslarının İki Metod Kullanılarak İzolasyon ve İdentifikasyonu

**Özet:** Harran Ovası GAP sulama alanı içerisinde kalan ve sulamaya alınan tarla topraklarından alınan 105 toprak örneğinin Toprağı Sulandırma ve Toprağı Yıkama metodlarıyla kalitatif ve kantitatif olarak incelenmesi sonucu toplam 1690 mikrofungus izolatu elde edilmiştir. Bu izolatların teşhislerinin yapılması sonucu 109 tür ayrıca 16 farklı steril mikrofungus elde edilmiştir. Bu taksonların 62 tanesi Toprağı Sulandırma, 7 tanesi Toprağı Yıkama, 40 tanesi ise her iki metolla da elde edilmiştir. Bunlardan 10 tanesi *Mucorales*, 4 tanesi *Sphaeriales*, 1 tanesi *Coelomycetes* ve 94 tanesi *Hyphomycetes* takımlarına aittir. Elde edilen cinsler arasında Toprağı Sulandırma metoduna göre en yaygın cinsler sırasıyla *Penicillium* Link ex Gray (24 tür), *Aspergillus* Mich. ex Fr (20 tür) ve *Acremonium* Link ex Fr. (9 tür)'dur. En yaygın türler ise *Aspergillus niger* Tiegh. (284 koloni), *Penicillium lanosum* Westling (238 koloni), *Penicillium canescens* Sopp. (170 koloni), *Penicillium brevicompactum* Dierckx (174 koloni) ve *Penicillium clavigerum* Demelius (146 koloni)'dur. Toprağı Sulandırma metoduna göre 1 g fırın kuru toprağa karşılık gelen taze toprakta ortalama 72487 birim mikrofungus bulunmuştur.

**Anahtar Sözcükler:** *Hyphomycetes*, Mikrofungus, Toprak

### Introduction

GAP (Güneydoğu Anadolu Projesi) investigations are carried out to enhance the productivity of field soils in South-east Anatolia within the scope of the project involving irrigation and energy production. As dry farming used to be carried out in south-east Anatolia, it is expected to observe changes in the activity of soil micro-organism as a result of the newly initiated farming using irrigation.

The insufficient amount of total rainfall per year before irrigation used to reduce and limit the ecological

activity of micro-organisms in the field soils. This investigation was undertaken to determine the ecological changes resulting from irrigation.

Studies on soil mycology in Turkey have primarily been concentrated on North-eastern Anatolia (Hasenekoğlu, 1982; Hasenekoğlu & Azaz, 1991; Hasenekoğlu & Sülün, 1991; Sülün & Hasenekoğlu, 1993), the vicinity of İzmir (Ekmekçi, 1974 a and b; 1975; Asan & Ekmekçi, 1994; Öner, 1974) and Thrace (European Turkey) (Asan, 1997 a and b).

### Description of research area

The study area is located at 37°10'N, 36°41'E and 38°41'E, 39°10'E. The investigation covers 89 farmland sites in the south and south-east parts of Şanlıurfa, the first to be irrigated. The stations were selected on maps of 1/200,000 scale created by the 19<sup>th</sup>. District Directorate of Rural Affairs, and 1/50,000 scale created by the General Directorate of State Hydraulic Works (D.S.İ.). The sample sites were chosen randomly and marked on maps (Figure 1). Prior to irrigation, wheat (*Triticum sativum* L.), barley (*Hordeum vulgare* L.), lentil (*Lens culinaris* Medik.) and other such plants were grown in the area. Since the start of irrigation, crops such as cotton (*Gossypium* L. spp.), sesame (*Sesamum indicum* L.) pepper (*Capsicum annuum* L.) and tomato (*Lycopersicon esculentum* Miller) have been grown in the area.

### Materials and Methods

In the collected samples, first a soil profile was extracted and then the surface of the profile was cleaned. Vertical samples were taken from 10 cm depths with a disinfected spatula. The spatula was applied perpendicular to the vertical surface of the profile. The samples were stored in a large sterilized cooled thermos bottle until they reached the laboratory. The samples were processed in an isolation process using the soil dilution plate (Waksman, 1922) and soil washing methods (Gams et al., 1987) in the laboratory. The moisture content of a certain amount of soil was determined and fresh soil quantities corresponding to 25 g of oven-dried soil were calculated (Öner, 1973). Then 1/10,000 dilutions of the samples were prepared (Warcup, 1955). Before the settling of organic matter and soil particles (Phara & Kommedahl, 1954), 1 mL of the dilutions was applied to prepared Peptone Dextrose Agar. Plates were then inoculated with each sample (Gams et al., 1987) and incubated at 25 °C for 10 d. In order to suppress bacterial growth, 30 mg/L of streptomycin was added and to restrict the colonial growth 30 mg/L of rose bengal was added to the isolation medium (Martin, 1950).

Twenty grams of fresh soil was placed in a glass funnel lined with muslin (pore size 0.5 mm) for isolation using the soil washing technique. The soil samples were first washed with 2 L of tap water and the outflow was

collected in a funnel. The procedure was then repeated using 2 L of sterile water. After this treatment, the muslin and its contents were transferred into a sterile petri dish with the same water containing streptomycin. Organic particles floating on the surface of the water and the washed soil particles were picked up with a loop and forceps and transferred onto plates of Peptone Dextrose Agar with rose bengal. The plates were incubated at 25 °C for 10 d (Gams et al., 1987).

The colonies were counted and identified using the soil dilution plate method. The counting and identification procedure was carried out under a stereomicroscope. Then the identified colonies were transferred to petri dishes containing agar. In the petri dishes, different types of colonies developed around the soil, and organic particles were isolated using the soil washing technique. For identification purposes, the genera *Aspergillus* Mich. ex Fr. and *Penicillium* Link ex Gray were plated on Czapek Dox Agar and Malt-Extract and the others on Malt-Extract Agar. For the identification of the isolates, Smith (1971) was followed. Identification of the taxa were carried out according to Hasenekoğlu (1991), Subramanian (1983), Ellis (1971), Gerlach & Nirenberg (1982), Raper & Thom (1949), Raper & Fennell (1965), Zycha et al. (1969), Samson & Pitt (1985), and Samson & Pitt (2000). Citation of the names of authors presented is standardized according to the Authors of Fungal Names (Kirk & Ansell, 1992).

The reason for using the soil dilution plate method was to isolate the propagules of microfungi occurring inactively in the soil, whereas the reason for using the soil washing technique was to isolate active microfungus hypha.

### Results

A total of 1690 isolates were obtained from the analyses of 105 soil samples taken from the area in August 1997 through soil dilution plate and soil washing methods to determine the microfungi flora of field soils irrigated in Harran Plain in Şanlıurfa within the GAP irrigated area. The identification of these isolates resulted in 109 species and varieties plus 16 sterile microfungi. Among the identified species, ten of these belonged to *Mucorales*, four to *Sphaeriales*, one to *Coelomycetes*, and 94 to *Hyphomycetes* (Tables 1 and 2). Sixty-one of the taxa were isolated with the soil dilution plate technique,

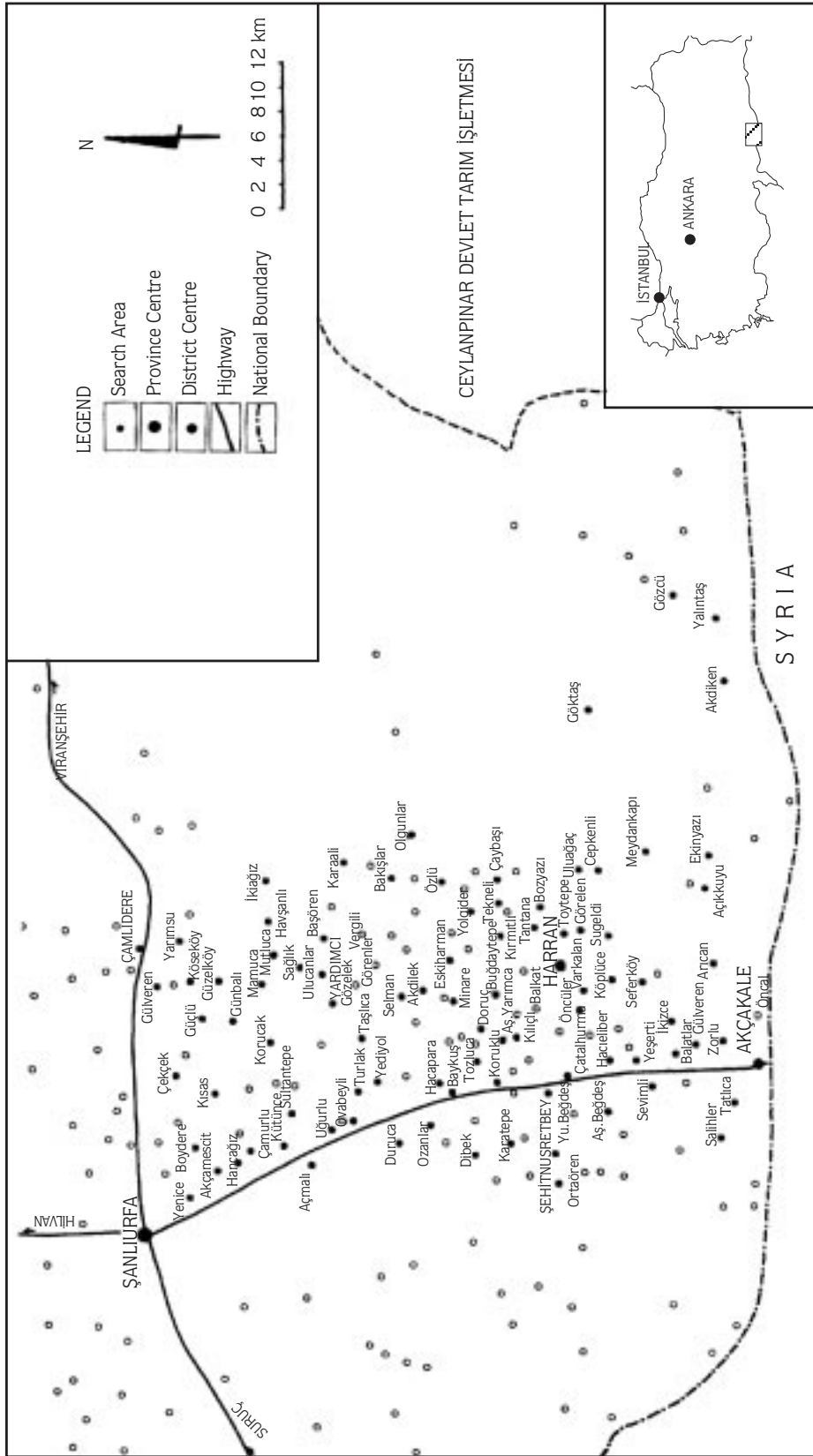


Figure 1. The Soil Collection Stations in the Study Area.

Table 1. The colony and isolate numbers of genera, their ratio to total number and comparison of the two methods.

	Soil Dilution Plate Method		Soil Washing Method	
	Colony Number	Ratio to total Number (%)	Isolate Number	Ratio to Total Number
MUCORALES				
<i>Absidia</i> Tiegh.	16	0.431	4	1.081
<i>Circinella</i> Tiegh. & F.Monnier	-	-	1	0.270
<i>Cunninghamella</i> Matr.	15	0.404	11	2.972
<i>Mucor</i> Michx. ex Fr.	-	-	38	10.270
<i>Rhizopus</i> Ehrenb.	136	3.671	-	-
SPHAERIALES				
<i>Chaetomium</i> Kunze ex Fr.	38	1.025	2	0.540
COELOMYCETES				
<i>Phoma</i> (Fries.) Desm.	3	0.080	-	-
HYPHOMYCETES				
<i>Acremonium</i> Link ex Fr.	275	7.424	63	17.027
<i>Alternaria</i> Nees ex Fr.	7	0.188	-	-
<i>Aspergillus</i> Mich. ex Fr.	770	20.788	45	12.162
<i>Beauveria</i> Vuill.	76	2.051	1	0.270
<i>Botryotrichum</i> Sacc. & Marchal	-	-	2	0.540
<i>Botrytis</i> Mich. ex Fr.	21	0.566	-	-
<i>Cladosporium</i> Link ex Fr.; Link	35	0.944	-	-
<i>Dicyna</i> Boulanger	3	0.080	-	-
<i>Drechslera</i> Ito	2	0.053	-	-
<i>Embellisia</i> E.G.Simmons	6	0.161	-	-
<i>Fusarium</i> Link ex Fr.	8	0.215	-	-
<i>Geomyces</i> Traaen	7	0.188	6	1.621
<i>Gliocladium</i> Corda	92	2.483	-	-
<i>Gliomastix</i> Gueguen	36	0.971	2	0.540
<i>Harzia</i> Costantin	1	0.026	-	-
<i>Humicola</i> Traaen	19	0.512	3	0.810
<i>Melanopsamma</i> Niessl.	29	0.782	-	-
<i>Myrothecium</i> Tode ex Fr.	74	1.997	-	-
<i>Paecilomyces</i> Bainier	72	1.943	17	4.594
<i>Penicillium</i> Link ex Gray	1464	39.524	80	21.621
<i>Scolecobasidium</i> E.V.Abbott	-	-	1	0.270
<i>Scopulariopsis</i> Bainier	7	0.188	-	-
<i>Stachybotrys</i> Corda	102	2.753	1	0.270
<i>Trichoderma</i> Pers. ex Fr.	6	0.161	1	0.270
<i>Trichothecium</i> Link ex Gray	1	0.026	-	-
<i>Ulocladium</i> Preuss.	55	1.484	2	0.540
<i>Verticillium</i> Nees ex Link	88	2.375	4	1.081
Sterile 1	47	1.268	2	0.540
Sterile 2	10	0.269	3	0.810
Sterile 3	45	1.214	2	0.540
Sterile 4	32	0.863	9	2.432
Sterile 5	13	0.350	12	3.243
Sterile 6	-	-	2	0.540
Sterile 7	3	0.080	1	0.270
Sterile 8	2	0.053	1	0.270
Sterile 9	6	0.161	-	-
Sterile 10	4	0.107	-	-
Sterile 11	4	0.107	-	-
Sterile 12	7	0.188	28	7.567
Sterile 13	3	0.080	3	0.810
Sterile 14	30	0.809	1	0.270
Sterile 15	8	0.215	-	-
Sterile 16	26	0.701	22	5.945

Table 2. The colony and isolate numbers of the taxa and their ratios to their own genera, to the total colony number and to the isolate number, and comparison of the two methods.

	Soil Dilution Plate Method			Soil Washing Method		
	Colony Number	Ratio to Own genus (%)	Ratio to Total Number (%)	Isolate Number	Ratio to Own genus (%)	Ratio to Total Number (%)
<b>MUCORALES</b>						
<i>Absidia cylindrospora</i> Hagem	16	100	0.431	1	25	0.270
<i>A. cylindrospora</i> var. <i>rhizomorpha</i> Hesselt. & J.J.Ellis	-	-	-	3	75	0.810
<i>Circinella rigida</i> A.H.Sm.	-	-	-	1	100	0.270
<i>Cunninghamella echinulata</i> Thaxt	15	100	0.404	6	54.545	1.621
<i>C. elegans</i> Lendner	-	-	-	5	45.454	1.351
<i>Mucor circinelloides</i> van Tiegh. f. <i>griseo-cyanus</i> (Hagem) Schipper	-	-	-	10	26.315	2.702
<i>M. hiemalis</i> Wehmer f. <i>hiemalis</i>	-	-	-	16	42.105	4.324
<i>M. hiemalis</i> f. <i>luteus</i> Schipper	-	-	-	12	31.578	3.243
<i>Rhizopus oryzae</i> Went & Prins. Geerl.	103	75.735	2.780	-	-	-
<i>R. stolonifer</i> (Ehrenb. Fr.) Vuill. var. <i>stolonifer</i>	33	24.264	0.890	-	-	-
<b>SPHAERIALES</b>						
<i>Chaetomium muelleri</i> Arx	8	21.052	0.215	-	-	-
<i>C. raii</i> G. Malhotra & Mukerji	12	31.578	0.323	2	100	0.540
<i>Chaetomium</i> sp.1	12	31.578	0.323	-	-	-
<i>Chaetomium</i> sp.2	6	15.789	0.161	-	-	-
<b>COELOMYCETES</b>						
<i>Phoma</i> (Fries) Desm.sp.1	3	100	0,080	-	-	-
<b>HYPHOMYCETES</b>						
<i>Acremonium butyri</i> Beyma W. Gams	10	3.636	0.269	3	4.761	0.810
<i>A. furcatum</i> F. & V. Moreau ex W.Gams	3	1.090	0.080	-	-	-
<i>A. strictum</i> W.Gams	144	52.363	3.887	26	41.269	7.027
<i>Acremonium</i> sp.1	20	7.272	0.539	-	-	-
<i>Acremonium</i> sp.2	21	7.636	0.566	12	19.047	3.243
<i>Acremonium</i> sp.3	5	1.818	0.134	10	15.873	2.702
<i>Acremonium</i> sp.4	34	12.363	0.917	3	4.761	0.810
<i>Acremonium</i> sp.5	16	5.818	0.431	5	7.936	1.351
<i>Acremonium</i> sp.6	22	8.00	0.593	4	6.349	1.081
<i>Alternaria alternata</i> Keissl.	7	100	0.188	-	-	-
<i>Aspergillus alliaceus</i> Thom & Church	34	4.415	0.917	1	2.222	0.270
<i>A. allahabadii</i> B.S. Mehrotra & Agnihotri	10	1.298	0.269	-	-	-
<i>A. candidus</i> Link	10	1.298	0.269	-	-	-
<i>A. carneus</i> Blochwitz	46	5.974	1.241	2	4.444	0.540
<i>A. equitis</i> Samson & W. Gams	15	1.948	0.404	-	-	-
<i>A. ficuum</i> (Reichardt) Henn.	22	2.857	0.593	8	17.777	2.162

Table 2 (Continued)

<i>A. flavus</i> Link	39	5.064	1.052	3	6.666	0.810
<i>A. fumigatus</i> Fresen.	19	2.467	0.512	-	-	-
<i>A. heteromorphus</i> Bat. & H.Maia	14	1.818	0.377	-	-	-
<i>A. niger</i> Tiegh.	284	36.883	7.667	21	46.666	5.675
<i>A. ornatulus</i> Samson & W.Gams	7	0.909	0.188	5	11.111	1.351
<i>A. oryzae</i> (Ahlb.) Chon	2	0.259	0.053	-	-	-
<i>A. phoenicis</i> (Corda) Thom	6	0.779	0.161	3	6.666	0.810
<i>A. sclerotiorum</i>						
G.A.Huber	93	12.077	2.510	-	-	-
<i>A. terreus</i> Thom	35	4.545	0.944	-	-	-
<i>A. terricola</i> var. <i>americanus</i> Marchal in Thom & Church	12	1.558	0.323	2	4.444	0.540
<i>A. tubingensis</i> (Schöber) Mosseray	9	1.168	0.242	-	-	-
<i>A. ustus</i> (Bainier) Thom & Church	34	4.415	0.917	-	-	-
<i>A. versicolor</i> (Vuill.) Tirab.	64	8.311	1.727	-	-	-
<i>A. wentii</i> Wehmer	15	1.948	0.404	-	-	-
<i>Beauveria alba</i> (Limber) Saccas	12	15.789	0.323	-	-	-
<i>B. bassiana</i> Vuill.	48	63.157	1.295	1	100	0.270
<i>B. brongniartii</i> (Sacc.) Petch	16	21.052	0.431	-	-	-
<i>Botrytis cinerea</i> Pers. & Nocca & Balb.	21	100	0.566	-	-	-
<i>Botryotrichum</i> sp.1	-	-	-	2	100	0.540
<i>Cladosporium cladosporioides</i> (Fresen.) G.A.Vries	20	57.142	0.539	-	-	-
<i>C. herbarum</i> (Pers) Link ex Gray	13	37.142	0.350	-	-	-
<i>C. sphaerospermum</i> Penz.	2	5.714	0.053	-	-	-
<i>Dicyna</i> sp.1	3	100	0.080	-	-	-
<i>Drechslera australiensis</i> (Bugnic.)						
Subram & Jain ex M.B.Ellis	2	100	0.053	-	-	-
<i>Embellisia chlamydospora</i>						
(Hoes, Bruehl & Show) Simmons	6	100	0.161	-	-	-
<i>Fusarium solani</i> (Matr.) Appel & Wollenw.						
Emend.Snyd. Hans.	3	37.5	0.080	-	-	-
<i>Fusarium</i> sp.1	3	37.5	0.080	-	-	-
<i>Fusarium</i> sp.2	2	25.00	0.053	-	-	-
<i>Geomyces pannorum</i> Sigler & J.W.Carmich. var.						
<i>pannorum</i> Oorschot	7	100	0.188	6	100	1.621
<i>Gliomastix murorum</i>						
Corda var. <i>felina</i> (Marchal) G.C.Hughes	24	66.666	0.647	2	100	0.540
<i>G. musicola</i>						
C.H. Dickinson	12	33.333	0.323	-	-	-
<i>Gliocladium catenulatum</i> J.C.Gilman & Abbott	62	67.391	1.673	-	-	-
<i>G. roseum</i> Bain.	6	6.521	0.161	-	-	-
<i>G. solani</i>						
(Harting) Petch	24	26.086	0.647	-	-	-
<i>Harzia</i> sp.1	1	100	0.026	-	-	-
<i>Humicola fuscoatra</i> Traaen var. <i>fuscuastra</i>	1	5.263	0.026	-	-	-
<i>H. grisea</i> Traaen var. <i>grisea</i>	18	94.736	0.485	3	100	0.810
<i>Melanopsamma pomiformis</i> Niessl	29	100	0.782	-	-	-

Table 2 (Continued)

<i>Myrothecium roridum</i> Tode ex Fr.	74	100	1.997	-	-	-
<i>Paecilomyces carneus</i>						
(Duché & R.Heim) Brown & Smith	2	2.777	0.053	-	-	-
<i>P. farinosus</i> Holm ex S.F.Gray	9	12.5	0.242	-	-	-
<i>P. lilacinus</i> (Thom) Samson	55	76.388	1.484	17	100	4.594
<i>P. variotii</i>						
Bainier	6	8.333	0.161	-	-	-
<i>P. brevicompactum</i> Dierckx	174	11.684	4.696	13	15	3.242
<i>P. canescens</i> Sopp.	170	11.611	4.588	13	16.25	3.594
<i>Penicillium charlesii</i> G.Sm.						
<i>P. chermesinum</i> Biourge	6	0.409	0.161	2	2.5	0.540
<i>P. chrysogenum</i> Thom	83	5.669	2.240	2	2.5	0.540
<i>P. citrinum</i> Thom	15	1.024	0.404	2	2.5	0.540
<i>P. claviforme</i> Bain.	6	0.409	0.161	-	-	-
<i>P. clavigerum</i> Demelius	146	9.972	3.941	-	-	-
<i>P. decumbens</i>						
Thom	4	0.273	0.107	-	-	-
<i>P. diversum</i> Raper & Fennell	107	7.308	2.888	-	-	-
<i>P. expansum</i> Link	46	3.142	1.241	8	10.00	2.162
<i>P. herquei</i> Bainier & Sartory	17	1.161	0.498	-	-	-
<i>P. italicum</i> Wehmer var. <i>italicum</i> Samson,						
Stolk & Hadlok	113	7.718	3.050	9	11.25	2.432
<i>P. janthinellum</i> Biourge	78	5.327	2.105	5	6.25	1.351
<i>P. jenseni</i> W.Zalessky	45	3.073	1.214	12	15.00	3.243
<i>P. lanosum</i> Westling	238	16.256	6.425	3	3.75	0.810
<i>P. madriti</i> G.Sm	9	0.614	0.242	-	-	-
<i>P. multicolor</i> Grig. Man. & Porad.	68	4.644	1.835	3	3.75	0.810
<i>P. olsonii</i> Bain. & Sartory	20	1.366	0.539	-	-	-
<i>P. roqueforti</i> Thom	12	0.819	0.323	-	-	-
<i>P. simplicissimum</i> (Oudem.)Thom	4	0.273	0.107	4	5.00	1.081
<i>P. steckii</i> W.Zalessky	14	0.956	0.377	-	-	-
<i>P. variabile</i> Sopp.	13	0.887	0.350	-	-	-
<i>P. verrucosum</i> var. <i>cyclopium</i> (Westling) Samson,						
Stolk & Hadlok	64	4.371	1.727	5	6.25	1.351
<i>Scolecobasidium constrictum</i> Abbott						
	-	-	-	1	100	0.270
<i>Scopulariopsis brumptii</i> Salv.-Duval						
	7	100	0.188	-	-	-
<i>Stachybotrys microspora</i> (Mathur et Sankhla)						
Jong et Davis	95	93.137	2.564	1	100	0.270
<i>S. parvispora</i> S.Hughes						
	7	6.862	0.188	-	-	-
<i>Trichoderma harzianum</i> Rifai						
	2	33.333	0.053	1	100	0.270
<i>T. pseudokoningii</i> Rifai						
	4	66.666	0.161	-	-	-
<i>Trichothecium roseum</i> (Pers.)Link ex Gray						
	1	16.666	0.0269	-	-	-
<i>Ulocladium atrum</i> Preuss						
	52	94.545	1.403	2	100	0.540
<i>U. tuberculatum</i> E.G.Simmons						
	3	5.454	0.080	-	-	-
<i>Verticillium dahliae</i> Kleb.						
	5	5.681	0.134	-	-	-
<i>V. lecanii</i> (Zimm.) Viégas						
	83	94.318	2.240	4	100	1.081



eight with the soil washing technique and 40 with both methods. The number of colonies obtained by the soil dilution plate method was 3704, and 370 were isolated using the soil washing technique.

The genera with the greatest number of species were *Penicillium* (24 species), *Aspergillus* (20 species), *Acremonium* Link ex Gray (nine species) in the soil plate method. The most widely distributed and abundant colony forming taxa in the soil plate method were *Penicillium* (1464 colonies), *Aspergillus* (770 colonies), *Acremonium* (275 colonies), *Rhizopus* Ehrenb. (136 colonies) and *Stachybotrys* Corda (102 colonies).

With the soil dilution plate technique, the richest genera in terms of the number of species were *Penicillium* and *Aspergillus*, and the most common ones in these two were *Aspergillus niger* Tiegh. (284 colonies), *Penicillium lanosum* Westling (238 colonies), *P. canescens* Sopp. (161 colonies), *P. brevicompactum* Dierckx (160 colonies) and *P. clavigerum* Demelius (146 colonies) (Tables 1 and 2).

The most common taxa obtained from the soil washing technique were Sterile 12 (28 isolates), *Acremonium strictum* W.Gams (26 isolates), *Aspergillus niger* (21 isolates), *Paecilomyces lilacinus* (Thom) Samson (17 isolates), *Mucor hiemalis* Wehmer f. *hiemalis* (16 isolates), *Penicillium canescens* (13 isolates), *P. jensenii* W. Zalesky (12 isolates) and Sterile 5 (12 isolates) (Tables 1 and 2).

An average of 72,487 propagules of microfungi were calculated in fresh soil equivalent to 1 g of oven-dried soil.

## Discussion

One hundred and nine different species and strains and also 16 different sterile microfungi were obtained as a result of the analysis with the soil dilution plate and soil washing methods of 105 soil samples taken from 89 farmland sites within the area of GAP irrigation. Fresh soil equivalent to 1 g of oven-dried soil contained an average of 72,487 propagules of microfungi using the soil dilution plate method. For some isolations, the soil washing method was used. In this method, fungus propagules are removed from the soil by a washing procedure. Sixty-one different taxa assumed to be actively present in the soil were isolated.

Azaz & Hasenekoğlu (1997) isolated a total of 3102 microfungi from 203 soil samples prior to irrigation in the same area; they used the same methods as presented in this paper. The identification of these isolates resulted in 133 discrete species and strains and an additional 23 sterile microfungi. The richest genera in terms of the number species were *Aspergillus* (25 species), *Penicillium* (22 species), *Acremonium* (seven species) and *Fusarium* (six species). Although *Aspergillus* has the largest number of species, *Penicillium* has the most abundant colony formation in taxa. On the other hand, *Penicillium* comes first in terms of the numbers of species and colony formation, but *Aspergillus* is in second place in both cases. Quantitatively it was determined that there was an increase in microfungus propagules in 1 g of oven-dried soils equivalent to fresh soil microfungi after irrigation.

Azaz & Hasenekoğlu (1998) conducted an investigation on the field soils and uncultivated soils in Harran Plain in the GAP irrigation area. They obtained 2676 isolates from 124 soil samples with the same methods described in their paper. After the identification of these isolates they reported 100 discrete species and strains and 15 sterile microfungi. They found approximately 46,326 propagules of microfungi in 1 g of oven-dried soil equivalent to fresh soil using the soil dilution plate method. Also according to this method, genera with the richest species were *Penicillium* (27 species), *Aspergillus* (24 species) and *Acremonium* (six species). These results correspond to the investigation carried out after irrigation.

Hasenekoğlu (1985) performed quantitative analysis of the microfungi flora of forest, grass and field soils in the vicinity of Sarıkamış. He reported that the genus *Penicillium* is the most common in terms of species and intensity in his research.

Asan (1992) studied the flora of *Penicillium* and *Aspergillus* in different habitat soils in Edirne. He found 23 species and two varieties belonging to *Aspergillus* and 16 species belonging to *Penicillium*.

Sülün & Hasenekoğlu (1993) researched the flora of *Penicillium* and *Aspergillus* in North-east Anatolia. In their research they found 20 species of *Aspergillus* and 22 of *Penicillium*.

The results of these studies performed in different regions of Turkey are in accordance with those of our

paper, which proves that the genus *Penicillium* is the most common in soil.

İsmail & Abdullah (1977) conducted research on the soil of Iraq where climatic and edaphic factors are very similar to those of our research field. They obtained an average of 31,425 microfungus propagules in 1 g of oven-dried soil from four different soil samples in their research. They reported that there were 5000 and 4700 microfungus propagules in the samples of soils with a water holding capacity of 38% and 21.7% and 66,000 and 50,000 in samples of soils with a water-holding capacity of 48% and 44%, respectively. Therefore, the numbers of microfungi in each sample are different from each other.

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