

Assessing soils of Gaziantep having high susceptibility to erosion from the point of view of microfungus



Biology

KEYWORDS : Mikrofungal diversification, soil, aggregate stability

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ABSTRACT

*The aim of the present study has been to determine microfungi flora of 43 soil samples, extracted from a depth of 0-15 cm, from 43 agricultural localities taking place in Yavuzeli, Araban, Karkamış, Nizip and Oğuzeli counties of Gaziantep with high susceptibility to erosion through the soil dilution method at the level of species. In these soils, which have quite high K-factor ranging between 0.3 and 0.79, quite poor in organic matter and have slightly alkaline nature, 2 divisions, 3 subphyla, 4 classes, 4 subclasses, 5 orders and 7 genera from microfungi flora were determined. The microfungi species, has been *Rhizopus sp.*, *Mucor sp.*, *Penicillium sp.* and *Aspergillus sp.* respectively. *Cladosporium sp.*, *Acremonium sp.* and *Candida sp.* species have also been encountered in a couple of localities. The results suggest that microfungal diversity of these soils under study is low due to high susceptibility to erosion and insufficient organic content.*

1 Introduction

Soil erosion does not only cause loss of plant nutrient elements but also affects living conditions of microfungi and other organisms living in the soil. The objective of the present study has been to search microfungal diversity of soils with high susceptibility to erosion (K factor). For this purpose, the object of the present study has been to determine microfungi flora of 43 soil samples, extracted from a depth of 0-15 cm, from 43 agricultural localities taking place in Yavuzeli, Araban, Karkamış, Nizip and Oğuzeli counties of Gaziantep with high susceptibility to erosion (K-factor) through the soil dilution method at the level of species. However, many studies relating to the fact that soil microfungi have a positive effect on formation and stability of soil micro and macro aggregate have been seen in different countries. Lynch (1984) and Tisdal (1991) determined in their study that there is a strong correlation between soil aggregate stability and organic matter content as well as microorganism activities. In the same way, Lynch and Bragg (1985) found that saprophyte fungi increase macroaggregate stability while Emerson et al. (1986) determined that ectomycorrhizal hyphae have a significant role in formation and stability of macroaggregate in forest soils. Tisdal (1994) evidenced in his study that soil microorganisms have significant positive effect on size of soil aggregates. Aggregate stability is an important factor determining tendency to erosion (Coote et al. 1988). An increase in aggregate stability increases resistance to erosion (Bryan 1976, Luk 1979, Lane and Nearing 1989).

Fungi perform many activities in soil. Most important ones may be listed as *Aspergillus*, *Penicillium*, *Rhizopus*, *Trichoderma*, *Chaetomium* and *Zygorhynchus*, which use mannans in tissues of plants (Rumack and Salzman 1978).

Soil is a biologically balanced system and even the smallest change in its nature can modify soil enzyme activities and microbial populations related to matter cycle (Pozo et al. 2003). For this purpose, microfungal status was determined in this study in soils, whose erodibility factor had been found high. Soil's aggregate stability would increase significantly in presence of microfungi. Presence of microfungi is an indicator for soil nutrient elements also because fertility of soils is very closely related to activities of microorganisms and direction of the reactions caused by them. The elements like carbon, nitrogen, phosphorus, sulfur, iron, magnesium etc required by plants are converted into a useful form for soil as a result of various syntheses and analyses mediated by microorganisms. Furthermore, certain microorganisms are regarded as an important criterion for status of nutrient elements. For example, *Aspergillus sp.* is regarded as an indicator for P, K, Mg and different microele-

ments in soil (Scheffer and Schachtschabel 1992).

Jonasson et al. (1996) determined in their study that soil microorganisms that most of them are heterotrophic convert complex compounds like protein, starch, cellulose, lignin and phosphate esters into the forms, which are useful both plants and themselves, through the enzymes secreted by them.

The studies conducted in many countries have shown that soil fungi have been negatively affected by different environmental problems. Especially, it has been found that fungal diversity in polluted soils is lower compared with that in non-polluted soils. It has been found that organic content is low while lime and pH is higher in polluted soils. It has been reported that these factors affect microfungi flora negatively (Singh et al. 1990, Hemida 1992, Hasanekoğlu and Sülün 1991, Azaz 2003). Ocağ et al. (2004) conducted a similar study by comparing microfungi flora in soils polluted by Gaziantep Cement Plant to those in the closest non-polluted soils. In the study, 116 different microfungal isolates were obtained in the study. *Penicillium sp.*, *Aspergillus sp.*, *Ulocladium sp.*, *Rhizopus sp.* and *Cladosporium sp.* of them were found as the most prevalent species. However, a richer flora in both number and species diversity was found in non-polluted soils. Analyzing soil showed that lime content and pH is higher while organic content is lower in polluted soils. They reported that these factors affect microfungal flora negatively. The objective of our study has been to search microfungal status in soils, whose organic content has been low and pH has been 7 and higher, from agricultural fields having high erodibility in Gaziantep.

2 Maternal and Methods

The here presented soil erosion study was conducted at five towns in Gaziantep province (Nizip, Oğuzeli, Araban, Yavuzeli and Karkamış). In the east of the study site, the river Euphrates flows. The soil of the Gaziantep catchment area assemble from 55.38 % Chromic Cambisols, 23.09 % , colluvial soils, 8.13 % Cambisols, 7.37 % soils from basaltic parent rock and 1.28 % other soil types such as Regosol, Terra rossa and Terra fusca (Anonymous 1992).

2.1 Geology

The geomorphological character of Gaziantep province is marked by hilly surfaces. In the south, the Amanos (Nur) mountains are the boundary between Hatay and Osmaniye with the highest peak at 1527 m. The other mountainous part of this province is located parallel to the Nur mountains. The northern border of the eastern region extends to the Euphrates. The peaks of the adjacent mountains are from south to north:

Dormik mountain 1250 m, İkkiz mountain 1200 m, Kas mountain 1250 m, Sarıkaya mountain 1250 m and Gülecik mountain 1400 m. The Karadağ mountain between the study sites Araban and Yavuzeli reaches a height of 950 m. Colluvial soils are found between Gaziantep and the Nur (Amanos) mountains. In the north run the streams Karasu and Merzimen, both draining to the Euphrates. Floodplain soils are established at the valley bottom. In the southern and south-eastern region of Gaziantep province the Barak plain is located with flat and slightly inclined ground surfaces. Wilson and Krummenacher (1957) identified the substrates as clayey limestone, limestone and gypsum, that orientate the topographical character of the region. Occasionally, thick limestone layers are found instead of loamy and calcareous soils.

2.2 Climate, vegetation and land use

The climatic conditions of southeastern Anatolia are distinctly continental with dry and hot summers and cold winter times with a low precipitation rate. Mean annual precipitation is 578.8 mm in Gaziantep, 328.2 mm in Karkamış, and approximately 464 mm in Araban, Yavuzeli and Nizip. Pistachio nuts are frequently cultivated in Gaziantep, as are olives, almonds and occasionally wine. The natural vegetation mainly consists of grasslands with dwarf shrubs, and to a smaller extent also steppe, garrigue, forest and macchia. Large steppes exist particularly south of **Karkamış und Oğuzeli. In the mountainous landscape of the study site Nizip grows oak coppice as well as pistachio nut and olive groves. In the mountainous areas of the Yavuzeli site grow oak forests, the lowlands are agricultural areas for the production of pistachio nuts, barley and wheat. At the Araban site barley, wheat, chickpeas and lentils are cultivated.** In Gaziantep Province occur especially the following plants: *Alnus* sp., *Pinus nigra*, *Cedrus libanii*, *Cupressus* sp., *Fagus orientalis*, *Populus* sp., *Quercus* sp., *Juniperus* sp., *Olea europaea*, *Arbutus andrachne*, *Pistachio terebinthus*, *Styrax officinalis*, *Euphorbia* sp., *Paliurus spina-christi*, *Urtica* sp. and *Rubus* sp. (Tunc et al.2013).

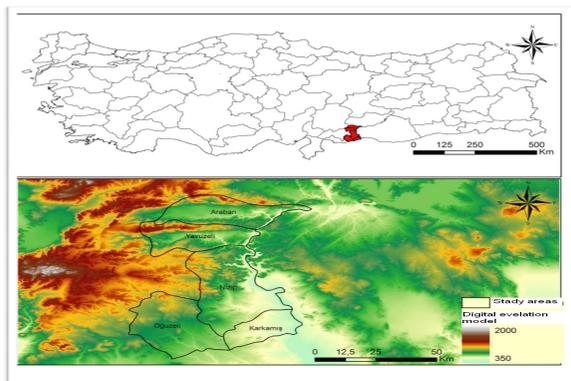


Figure 1: Natural landscape units and study sites.

2.3 Methods

Culture techniques

The culture technique used was based on Soil Dilution Plate Method described by Waksman 1922, in using this technique, moisture content of a certain amount of soil was determined and fresh soil quantities corresponding to 25 g of oven-dried soil were calculated. Then 10^{-3} dilutions of the samples were prepared and 20 plates of Dextrose-Peptone agar were inoculated from dilution of each sample. 30 mg/L streptomycin and 30 mg/l rose bengal were added to Dextrose-Peptone agar for inhibition bacterial growth and restriction fungal colony. The plates were kept at 25 °C for 10 days. Culture plates were examined macroscopically and then colonies were enumerated. Different colonies were isolated to Potato-Dextrose Agar and Czapek Dox Agar and identified on these media at ambient temperature.

Identification of microfungi

Identification of the isolates was performed according to the Raper and Thom (1949), Raper and Fennell (1965), Simmons

(1967), Dickinson (1968), Rifai (1969), Zycha et al. (1969), Booth (1971), Ellis (1971), Samson (1974), Bertoldi (1976), Tulloch (1976), Arx (1981). Identification of the isolates for *Penicillium* sp. and *Aspergillus* sp. was performed according to the Ellis (1971), for *Cladosporium* sp. according to the Hanlin (1973, 1990), for *Candida* sp. according to the Barnett and Hunter (1972), for *Rhizopus* sp. according to the Schipper (1984), for *Mucor* sp. according to the Zycha et al. (1969), for *Acremonium* sp. according to the Alexopoulos et al. (1996).

Physical and chemical characterization of the soil samples

The soil organic C content (Corg) was measured by dry combustion at 550°C with a Leco-RC 412 analyser. Total soil nitrogen (Nt) was measured at 1100°C with a Leco CHN 1000 analyser. Colour of soil by use of Munsell Soil Chart (Munsell Color 2000), pH-value via Schlichting and Blume (1966) with Hanna Model (HI 83140 model), electrical conductivity after Richards (1954), CaCO₃ content by means of Scheibler-method after Kretzschmar (1984) by the use of Eijkelkamp M1.08.53.D Model calcimeter, grain size analysis after Schmidt (1996) by means of Retsch Model AS 200, aggregate classes after Ad-hoc-AG Boden (1982) and permeability classes after Ad-hoc-AG Boden (1994) and K-factor after Schwertmann et al. (1987). Fe, Zn, Mn and Cu after Lindsay and Norvell (1978) by means of the AAS device, plant available phosphorus (P) after Olsen et al. (1954), Potassium (K), Ca and Mg by ASS device after Jackson (1958). Statistical analysis was accomplished via SPSS 10.0 for Windows. A total of 43 soil samples were taken at a depth of 0-15 cm from arable land with an inclination of approximately 10 %. Each sample position was recorded by means of GPS (Magellan 500) For the isolation of soil microfungi was used the soil dilution plate method by Waksman (1922).

Determination of K-factor (eq. 1)

$$K = 2.77 * 10^{-6} * M^{1.14} * (12-OM) + 0.043 * (A-2) + 0.033 * (4-D) \quad (\text{Eq. 1})$$

with

$M = (\% \text{ silt} + \% \text{ fine sand}) * (\% \text{ silt} + \% \text{ sand (excluding fine sand)})$

OM = % organic matter

A = Aggregate stability

D = Permeability class

Statistical analysis

All tests were performed using IBM SPSS Statistics 21.0 software package. Correlations between variables were tested using the correlation coefficient r according to Pearson. Results were presented as arithmetic means (AM) ± standard deviation (SD).

3 Results

Soil physical and soil chemical properties

For the tested soils, we found pH-values from 7.24 to 7.89 and an electrical conductivity between 0.03 and 0.12 mS cm⁻². This results are particularly of interest for this study, because Boşgelmez et al. (2001) found alkaline soils particularly prone to erosion. The soil organic matter (SOM) of the tested soils was found to be low between 0.13 and 2.96 %, the content of CaCO₃ was high.

Macronutrients (K, Ca and Mg) and micronutrients (Fe, Cu, Zn, Mn) were determined and evaluated after Lindsay and Norvell (1978). There was a sufficient Cu-supply for all sites (>0.2 ppm). The Fe-content was found too low for a sufficient supply (< 2.5 ppm), supporting the work by Güçdemir and Kalınbacak (2008). The Mn-content of all soils was found sufficient (>1 ppm, after Viets und Lindsay 1973), what was also found by Çakmak et al. (2003). The Potassium content of all soils was measured very high (>2,56 ppm), supporting the work by Atalay (1988). Very high (after FAO 1990) was also the content of C and Mg. 65.63 % of the study area showed a Zn-content between 0.5 and 1.0 ppm, which is considered too low, and 34.38 % showed a suf-

cient content >1.0 ppm, supporting the findings by Çimrin and Boysan (2006). The content of nitrogen was determined very low with values ranging from 0.033 to 0.171.

Soil Erodibilitysfaktor (K-factor)

The investigation on 43 study sites provided K-factors ranging from 0.34 to 0.79, corresponding to a mean of 0.51. This value can be considered as high.

Of the tested soils, 40.94 % showed a K-factor between 0.3 and 0.4; 20.84 % between 0.4 and 0.5, 19.91 % between 0.5 and 0.6, and 12.61 % between 0.6 and 0.7. Only 5.71 % showed a K-factor >0.7 .

microfungis of Soil

In this study, an assessment on samples from agricultural soils from Nizip, Oğuzeli, Yavuzeli and Araban counties of Gaziantep being highly susceptible to erosion was conducted. In our study, microfungi were studied until the species level. According to the obtained results, 2 divisions, 3 subphyla, 4 classes, 4 subclasses, 5 orders and 7 genera from microfungi flora were determined. The fields under study are the fields in which dry agriculture is made and have a tendency to erosion. Therefore, they are quite poor in natural flora.

pH content generally indicates a slight alkalinity and soils in this region are quite poor in organic matter.

pH was found as 7.69, salinity in % as 0.07, organic content in % as 1.58, and lime content in % as 15.17 for Araban County in average. pH was found as 7.56, salinity in % as 0.07, organic content in % as 1.61, and lime content in % as 8.92 for Yavuzeli County in average. Microfungi species in Araban County are *Rhizopus sp.*, *Candida sp.*, *Aspergillus sp.*, *Mucor sp.*, and *Penicillium sp.*

pH was found as 7.63, salinity in % as 0.05, organic content in % as 1.96, and lime content in % as 15.78 for Oğuzeli County in average. Microfungi species in Oğuzeli County are *Mucor sp.* and *Rhizopus sp.*

pH was found as 7.54, salinity in % as 0.05, organic content in % as 0.88, and lime content in % as 23.05 for Nizip County in average. Microfungi species in Nizip County are *Mucor sp.* ve *Rhizopus sp.* *Nizip was found as the county having the lowest organic content in % and the highest lime content in %.*

pH was found as 7.60, salinity in % as 0.05, organic content in % as 1.10, and lime content in % as 21.84 for Karkamış County in average. Microfungi species in Karkamış County are *Rhizopus sp.*, *Aspergillus sp.*, *Mucor sp.*, *Penicillium sp.* and *Acremonium sp.* Microfungi species in Yavuzeli County are *Rhizopus sp.*, *Aspergillus sp.*, *Mucor sp.*, *Penicillium sp.*, *Cladosporium sp.* and *Acremonium sp.* Tables 1 give the observed fungi species according to the localities.

Table 1 Fungi species according to the localities

Fungi	Nr. of soil
Rhizopus sp.:	1,6,7,10,11,12,13,14,15,16,17,18,20,22,24,25,27,28,29,30,33,35,37,39,41,42,43
Mucor sp.:	2,3,4,5,7,8,11,19,21,29,38
Penicillium sp.:	8,29, 31, 32, 34, 36
Acremonium sp.:	8, 40
Aspergillus sp.:	8, 26, 31, 32, 34, 40
Candida sp.:	23
Cladosporium sp.:	31,40

Table 2. Physical and chemical characterization of the soil samples

Localities	pH	EC mS cm ⁻²	CaCO3 %	Corg g kg ⁻¹	texture	K-factor
1	7,56	0,07	4,5	2,9	medium clayey loam	0,34
2	7,58	0,03	22	1,3	loamy sand	0,61
3	7,51	0,04	22	0,13	poor clayey loam	0,49
4	7,69	0,04	22	1,6	poor sandy loam	0,69
5	7,61	0,05	20	1,5	poor clayey loam	0,45
6	7,62	0,05	21	1,6	sandy loam	0,5
7	7,56	0,05	22	1,4	poor sandy loam	0,61
8	7,57	0,05	22	1,6	poor clayey loam	0,47
9	7,67	0,04	21	1	poor clayey loam	0,52
10	7,56	0,04	23	1,3	poor sandy loam	0,66
11	7,58	0,04	21	1,2	medium clayey loam	0,35
12	7,64	0,06	20	0,72	medium clayey loam	0,41
13	7,57	0,06	23	0,52	poor clayey loam	0,61
14	7,48	0,04	21	1	medium clayey loam	0,43
15	7,6	0,09	21	1,6	loamy clay	0,38
16	7,24	0,08	27	2,9	poor clayey loam	0,38
17	7,31	0,08	2	1,2	medium clayey silt	0,65
18	7,5	0,1	27	0,78	sandy-loamy silt	0,78
19	7,56	0,08	5,9	0,91	silty-loamy sand	0,77
20	7,76	0,09	13	0,65	sandy clayey loam	0,34
21	7,68	0,07	22	0,52	loamy sand	0,53
22	7,62	0,06	21	2,3	poor clayey loam	0,53
23	7,58	0,09	16	1	medium clayey loam	0,45
24	7,6	0,07	1,5	1,8	medium clayey loam	0,49
25	7,47	0,05	3	2,3	medium clayey loam	0,33
26	7,78	0,07	23	1,9	sandy loam	0,61
27	7,83	0,03	22	0,72	sandy-loamy silt	0,72

28	7,89	0,09	5	0,71	silty loam	0,64
29	7,42	0,07	24	2,7	silty loam	0,77
30	7,57	0,07	2	0,42	sandy loam	0,79
31	7,82	0,09	2	1,8	medium clayey loam	0,46
32	7,89	0,05	21	1,1	medium clayey loam	0,43
33	7,43	0,12	3	1,4	medium clayey loam	0,41
34	7,84	0,05	21	3	medium clayey loam	0,35
35	7,55	0,09	5	1,2	poor clayey loam	0,47
36	7,85	0,06	21	0,42	silty loam	0,43
37	7,79	0,08	21	1,5	poor silty clay	0,66
38	7,72	0,07	21	2	sandy loam	0,43
39	7,76	0,09	21	1,6	medium silty clay	0,44
40	7,55	0,11	2	1,5	poor silty clay	0,58
41	7,66	0,09	5	1,6	medium clayey loam	0,37
42	7,46	0,07	23	2,5	medium clayey loam	0,33
43	7,73	0,09	21	2,3	medium clayey loam	0,37

4 Discussion

A significant fungal diversification was not observed in the fields under study due to low organic content, high temperature averages, low precipitation, low soil humidity and fungicide use in the fields. Furthermore, alkalinity of soils and the fact that lime cannot be washed out from soil due to low precipitation also affect significantly living conditions of fungi.

It was frequently observed during the researches that soils of the fields under study had been fallowed in certain intervals because they were used for agricultural purposes and their straw was then burnt. Therefore, biodiversity has been significantly affected in these fields. To increase biological activity in these soils, unnecessary chemical fertilization should be prevented and mycorrhizal applications should be conducted to increase organic content of soil (Dorioz et al. 1993) because organic content increases aggregate stability and thus, it makes soil more resistant to water and wind erosion and it ensures better ventilation and water uptake for soil. Furthermore, microorganisms prepare a good environment for growth of plant roots in addition to the increase in aggregate stability (Tisdale et al. 1982, Miller and Jastrow 1990). Mycorrhizal fungi applications to soil may result in an increase in aggregate stability and may provide good protection against erosion. In fact, Bearden and Petersen

(2000) evidenced in their study on semi-arid vertisol soils in India that arbuscular mycorrhizal (AM) fungi application to soil has a significant positive effect on aggregate stability and geometrically soil aggregate size and also increases fertility of soil. These plants, which are important in terms of preventing erosion, are distributed in Gaziantep region and can all be recommended to prevent erosion. *Convolvulus arvensis* L. species, belonging to Convolvulaceae family, which is commonly known as field bindweed, has a deep root system. The roots can reach 3 m, and lateral roots can reach 2 m. Furthermore, new plants can grow on rhizomes which have a length of more than 1 m. These plants are perennial ones and widely distributed in meadows, pastures, rocky, stony, pebble, arid slopes, fields and cultivated lands. Especially sloped areas should be vegetated with horizontally developing and creeping plants with different root depths. Intensification and widespread use of these pioneer plants in the region will significantly eradicate erosion problem in the region (Tunc et al.2013).

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