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The Investigation of Microalgea Status of Agriculturlands with Erosion Problem in Gaziantep

Agriculture

KEYWORDS : Gaziantep, soil erosion, mikroalgea diversification, aggregate stability,

Erdihan Tunca University of Gaziantep, Faculty of Arts & Science, Department of Biology, 27310 Sehitkamil, Gaziantep, Turkey

Sabahat Mekki University of Gaziantep, Faculty of Arts & Science, Department of Biology, 27310 Sehitkamil, Gaziantep, Turkey

ABSTRACT

The objective of the present study has been to determine microalgea flora of 46 soil samples, extracted from a depth of 0-15 cm, from 46 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. 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, 3 divisions, 3 phyla, 3 classes, 6 orders 7 families and 8 genera from microalgea flora were determined. The microalgea species, which have been encountered in the highest number of localities, has been Chroococcidiopsis sp., Pseudoanabaena sp., and Anabaena sp. respectively. Nostoc sp., Hantzschia sp., Tetraselmis sp., Hasallia sp. , Phormidium sp. and Cylindrospermum 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. Therefore, the required measures should be taken for microbial enrichment of the soils. If the required measures are not taken, aggregate stability of the soils also may decrease. Microalgea increase resistance of soils to erosion because there is a strong correlation between aggregate stability and microalgea activity.

1 Introduction

Algae are present in most of the soils where moisture and sunlight are available. Their number in soil usually ranges from 100 to 10,000 per gram of soil. They are photoautotrophic, aerobic organisms and obtain CO2 from atmosphere and energy from sunlight and synthesize their own food. They are unicellular, filamentous or colonial. Soil algae are divided in to four main classes or phyla as follows: Cyanophyta ,Chlorophyta, Xanthophyta and Bacillariophyta (Anonymous, 2013)

Microalgae are a group of mostly photoautotrophic microorganisms that includes both prokaryotic and eukaryotic species. These organisms can photosynthetically convert CO2 and minerals to biomass, but some species also grow heterotrophically (Richmond, 2004). Microalgae grow in most of the natural environments including water, rocks and soil, but interestingly also grow on and in other organisms (Doung et al., 2012).

Algae plays important role in the maintenance of soil fertility especially in soils. Add organic matter to soil when die and thus increase the amount of organic carbon in soil. Most of soil algae act as cementing agent in binding soil particles and thereby reduce/prevent soil erosion. Soil algae through the process of photosynthesis liberate large quantity of oxygen in the soil environment and thus facilitate the aeration in submerged soils or oxygenate the soil environment. They help in checking the loss of nitrates through leaching and drainage especially in uncropped soils. They help in weathering of rocks and building up of soil structure (Anonymous, 2013).

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). 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, microalgeal 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 Algea. 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.

Soil erosion cause loss of plant nutrient elements and living conditions of micro organisms living in the soil. The objective of the present study has been to search algea diversity of soils with high susceptibility to erosion (K factor). For this purpose, the object of the present study has been to determine algea flora of 46 soil samples, extracted from a depth of 0-15 cm, from 46 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.

2 Materıal 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 at1527 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 moutain 1250 m, İlkikiz mountain 1200 m, Kas mountain 1250 m, Sarıkaya mountain1250 m and Gülecik mountain 1400 m. The Karadağ mountain between the study sites Araban and Yavuzeli reaches a hight 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 calcereous 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).

2.3 Methods
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 microalgea was used the soil dilution plate method by Johnson (1959).

Determination of K-factor
K-factor after Schwertmann et al. (1987), the RUSLE model after Renard et al. (1994).

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

with

M = (% silt + % fine sand) * (% silt + % sand (excluding fine sand))

OM = % organic matter
A = Aggregate stability
D = Permeability class

Isolation and Identification of Soil Algea
Isolates of *Algea* from soil simple was performed according to the Skinner (1932). Identification of the isolates for *Algea* was performed according to the Johnson et al., (1959), Komárek and Anagnostidis (1986,1989, 1999, 2005), Komárek and Fott (1983), Komárek et al., (2003). and Algaebase (2011).

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 testet soils, we found pH-values from 7.24 to 7.89 and an electrical conductivity between 0.03 and 0.12 mS cm^{-2}. The soil organic matter (SOM) of the tested soils was found to be low between 0.13 and 2.96 %, the content of $CaCO_3$ 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). The Mn-content of all soils was found sufficient (>1 ppm, after Viets und Lindsay 1973). The Potassium content of all soils was measured very high (>2,56 ppm). 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 sufficient content >1.0 ppm. The content of nitrogen was determined very low with values ranging from 0.033 to 0.171.

Soil Erodibility factor (K-factor)
The investigation on 46 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 (Table 1) .

Table 1. K-factor (Erodibility), Physical and chemical characterization of the soil localite.

	pH	EC	CaCO3	Corg		
Localite		mS cm-2	%	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	7,7	0,09	21	2,3	medium clayey loam	0,37
44	7,7	0,07	6	1,2	medium clayey loam	0,37
45	7,7	0,05	3	0,9	medium clayey loam/poor silty clay	0,45
46	7,4	0,05	7	1,3	medium clayey loam	0,38

Soil loss of the study area

From our investigation, the respective erosion threat for each study site could be derived. It can be stated, that there is a very high erosion risk on 7.42 % of the area, a high erosion risk on 12.26 %, a moderate risk on 31.72 % and a low erosion risk on 48.61 % of the entire area. The results were confirmed by the K-factors calculated basing on soil type, organic matter content, aggregation class and permeability .

Algea 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, microalgea were studied until the species level. According to the obtained results, 3 divisions, 3 phyla, 3 classes, 6 orders, 7 family and 8 genera from microalgea 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. Microalgea species in Araban County are *Chroococcidiopsis sp., Pseudoanabaena sp., Anabaena sp., Hantzschia sp.,* and *Tetraselmis sp.*

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. Microalgea species in Yavuzeli County are *Nostoc* sp.,*Chroococcidiopsis sp., Pseudoanabaena sp., Hantzschia sp., Hasallia sp., Phormidium sp.* and *Cylindrospermum sp.*

pH was found as 7.63, salinity in % as 0.05, organic content in % as 1.96, and *CaC03* content in % as 15.78 for Oğuzeli County in average. Microalgea species in Oğuzeli County are Chroococcidiopsis sp., Anabaena sp. and Tetraselmis sp.

pH was found as 7.54, salinity in % as 0.05, organic content in % as 0.88, and *CaC03* content in % as 23.05 for Nizip County in average. Microalgea species in Nizip County is Chroococcidiopsis sp. *Nizip was found as the county having the lowest organic content in % and the highest CaC03 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. Microalgea species in Karkamış County is *Tetraselmis sp.* Tables 2 give the observed Algea species according to the localities.

Table 2. Microalgea species according to the localities

Microalgea	Nr. of soil localites
Chroococcidiopsis sp.:	5, 12, 13, 14, 15, 16, 17, 19, 23, 28, 31, 32, 34, 35, 37, 40, 44, 46
Pseudoanabaena sp.:	1, 2, 5, 8, 15, 16, 18, 22, 31, 32, 37, 38, 40, 41, 42, 43, 44, 45
Anabaena sp.:	1, 2, 5, 6, 7, 8, 10, 11, 16, 30, 31,40, 43 , 45
Hantzschia sp. :	41, 42
Tetraselmis sp.:	2, 4, 5, 8, 31, 41
Hasallia sp. :	45
Phormidium sp.:	42
Cylindrospermum sp.:	36, 38, 44, 45
Nostoc sp:	19

4 Discussion

A significant Microalgeal diversification was not observed in the fields under study due to low organic content, high temperature averages, low precipitation, low soil humidity and pesticide use in the fields. To increase biological activity in these soils, unnecessary chemical fertilization should be prevented and algeal applications should be conducted to increase organic content of soil because organic content increases aggregate stability and thus, it makes soil more resistant to water and soil erosion and it ensures better ventilation and water uptake for soil (Williams et al., 1995, Lynch and Bragg 1985). These plants, which are important in terms of preventing erosion, are distributed in Gaziantep region and can all be recommended to prevent erosion. 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). Blue-green algae applications to soil may result in an increase in aggregate stability and may provide good protection against erosion (Rao and Burns 1990, Rogers and Burns 1994, Hu et al. 2002). Cyanobacterial (*Anabaena doliolum, Cylindrospermum sphaerica and Nostoc calcicola*) application to the organically poor semi-arid soil played a significant role in improving the status of carbon, nitrogen and other nutrients in the soil. Higher TOC in treated soils can be attributed to autotrophic nature of the cyanobacteria,which synthesize and add organic matter to soil (Nisha et al. 2007).

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