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# INVESTIGATION OF TOTAL CARBON AND NITROGEN CONTENT OF GAZIANTEP AGRICULTURAL SOILS

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## ABSTRACT

Microbial biomass is a very important feature for plants to take nutrients from the soil and increase their yield. In addition to soil pollution by using unnecessary chemical fertilizers, groundwater is also polluted and reappears as an environmental problem. Microbial biomass, which is very effective in preventing soil erosion, is significantly damaged by these chemical fertilizers. In this study, the Cmic and Nmic contents of agricultural soils in Gaziantep province were determined and the relationship between microbial carbon and nitrogen contents and organic carbon and organic nitrogen contents in the samples was determined. Approximately 40 soil samples were taken from the agricultural areas where the study was conducted and some physical and chemical properties of the soil as well as Cmic and Nmic contents, which play a role as bio-indicators in soil health and fertility, were determined. As a result of the analyzes, it was determined that the microbial carbon and microbial nitrogen contents of the soils were not sufficient and organic fertilization was urgently needed. In addition, it was determined that there is a statistical relationship between the microbial carbon and nitrogen contents and the organic carbon and nitrogen contents of the soils.

**Keywords**: Chloroform, fumigation extraction, microbial biomass carbon (Cmic), microbial biomass nitrogen (Nmic), soil.

## 1. INTRODUCTION

Microorganisms can be used as a sensitive indicator for numerical expression of soil health [1]. Microorganisms react very quickly to environmental changes and adapt quickly to environmental conditions. These features allow the evaluation of soil fertility and various microbial analyzes [2, 3]. For this reason, the microorganism density in the soil and the activities carried out depending on this density constitute important criteria in soil fertility [1,4,5]. Microorganisms in the soil actively participate in many processes such as the mineralization of plant and animal wastes and the biochemical transformation of plant nutrients, and they also have important effects on soil fertility [1,4]. In addition, soil organisms can contribute to the regulation of the air-water balance of the soil by affecting the physical properties of the soil, such as the formation of a good aggregate and therefore structure in the soil [2,4,6,7,8]. Microorganism activities have a significant effect on aggregate formation and stability in soils [2]. This effect occurs on different aggregate sizes by different microbial communities [6]. For example, while macro aggregates are generally affected in soils with intense fungal activity, micro aggregates are affected in soils where bacterial activities are intense [5]. If no microbial application is made to the soil, fungal and bacterial biomass in macro aggregates decreases [2-4,7,8,9]. Fumigation-extraction method is generally preferred for determination of microbial activity in soil [10,11]. In this study, it was aimed to investigate the microbial biomass carbon ($C_{mic}$) and nitrogen ($N_{mic}$) amount of the soils by considering the microbiological characteristics of agricultural soils in Gaziantep. Decrease in microbial biomass C and N contents means a decrease in organic matter in the soil and consequently a decrease in soil aggregation and humus content. This accelerates erosion and causes a decrease in yield [2,7]. The amount and activity of microbial biomass in the soil is an important indicator of soil fertility [5]. As with $CO_2$ formation, green manures cause a more significant effect on microbial biomass than farm manure [12]. Soil does not only consist of mineral fractions such as sand, silt and clay and organic matter at various levels of decomposition. Soil contain a complex world of living things, both microscopic and macroscopic [1]. Soil is the most important habitat of terrestrial microorganisms and creates a very suitable environment for the reproduction of microorganisms [1,2,5,7,8].

Microbial activity may vary depending on ecological conditions. Especially in the spring and autumn seasons, the number of microorganisms in the soil can reach thousands of tons of live weight compared to the summer and winter seasons [1]. Microorganisms in the soil, which are an integral part of the soil and give it vitality and fertility, perform important functions [5,7,13]. The role of soil organisms in oxidation and reduction reactions in the microbiological cycle of nitrogen is of great importance for natural ecosystems. The effects of heavy metal pollution, which may be caused by irrigation, on the microbial events related to C metabolism of soil microflora in agricultural lands irrigated by Iznik Lake were investigated [14]. According to the research results, it has been revealed that the examined ecophysiological parameters can provide useful information in examining soils with different chemical properties and agronomic histories, and may be important when they are used as an indicator of soil microbial metabolism, especially under stress conditions [14]. As a result of soil pollution, living life in the soil is also adversely affected [15]. While the soil fertility has been increased with the bacteria that enable the degradation of organic wastes for thousands of years, the use of chemical fertilizers and pesticides has caused the soil to become unproductive, the bacteria's abilities to be lost, the natural production of plant nutrients and the inability to decompose the wastes [15]. The aim of this study is to determine the microbial biomass of the soil and to develop new solutions for increasing the biomass. To this end, using the chloroform fumigation extraction method (CFE) [8,16,17], microbial biomass C and microbial biomass N contents in the upper parts of Gaziantep agricultural soils (0-10 cm) were determined.

## 2. MATERIALS & METHODS

### 2.1 Soil Sampling

Approximately 3 kg of soil samples from the first 0-10 cm depth of 40 localities determined by cross-drawing in the fields were taken into a basin, cleaned of foreign substances by mixing, and placed in nylon bags and labeled. All samples were taken from agricultural fields.

### 2.2 Analysis of soil physical and chemical parameters

Soil samples were taken with a soil core sampler from 0-10 cm depth at the beginning of the vegetation period in the years 2020 to 2021. The 40 samples were sieved (2 mm mesh size) and air dried for soil chemical analysis. The pH was determined potentiometrically within a $CaCl_2$-solution (0.01 M), using a Hanna pH-electrode (HI 83140 model) [19], whereas determination of electrical conductivity (EC) followed [20]. The $CaCO_3$ content was measured by means of the Scheibler-method [21] by the use of Eijkelkamp M1.08.53.D model calcimeter. Soil organic C content ($C_{org}$, syn. SOM) was measured by dry combustion at 550°C with a Leco-RC 412 analyzer [22]. The soil structure analysis of the soils of the study area was made according to [23].

Phosphorus (P) was determined by the $NaHCO_3$ method [24]. K contents were determined in ammonium acetate solution. From the prepared soil samples, 5 g was weighed into the erlen mayers and 50 ml of ammonium acetate (pH: 7.1 N) was added. After shaking for 1 hour, the samples were filtered with the help of Whatman filter papers. The obtained filtrates were read with the help of a flame photometer and the phosphorus and potassium contents of the soil samples were determined [25]. Soil microbial biomass C contents were determined according to the chloroform-fumigation-extraction method [16,17]. Soil microbial biomass nitrogen content was determined according to the Kjeldahl digestion - distillation - titration method [16,18]. All soil Extractions were measured on the Shimadzu TOC N, Fumigation extracted samples were also measured on the Shimadzu TOC-V CPN instrument.

### 2.3 Statistical analyses

The differences between the characteristics of agricultural soils were examined with the correlation test. Analysis of variance (ANOVA) was applied for the differences between the measured soil properties (SPSS, 11 Package Program).

## 3. RESULTS and DISCUSSION

The pH values of the soils vary between 7.24 and 7.89. The salt content of the soils varies between 0.03 and 0.12, and the average salt content is calculated as 0.06%. According to the results of the analysis, the organic matter content of the soils varies between 0.13 and 2.96, with an average of 1.416%. Lime content was also found to be quite high. The pH contents of the soils of the study area show alkaline properties. Organic matter contents of the working soils detected very low.

The microbial carbon contents of the soils at the research station ranged from 90.30 to 448.50 ppm, with an average of 229.23 ppm (Figure 3.1.). The microbial nitrogen content of the soils ranged from 0.19 to 26.53, with an average of 11.67 (Figure 3.2.).

A significant relationship was found between $C_{mic}$ and $C_{org}$ in soil samples (Table 3.1). In various studies, it has been stated that there is a significant relationship between $C_{mic}$ and $C_{org}$ [26,27]. [28] determined that the microbial biomass carbon varied between 219-864 µg $g^{-1}$ in different land use patterns. In this study, $C_{mic}$ and $C_{org}$ values were found to be low in soil samples (Figure 3.1).

Table 3.1. Correlation and variation relations of the studied parameters with each other

| | | Variation | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **pH** | **OM** | **$C_{mic}$** | **$N_{mic}$** | **C/N** | **Lime** | **Sand** | **Silt** | **Clay** |
| **Correlation** | **pH** | 1 | 0,099 | 0,901 | 0,902 | 0,905 | **0,021** | 0,273 | 0,597 | 0,442 |
| | **OM** | -0,265 | 1 | 0,643 | 0,539 | 0,264 | 0,609 | 0,892 | 0,265 | 0,194 |
| | **$C_{mic}$** | 0,020 | 0,076 | 1 | **0,000** | 0,123 | 0,785 | 0,929 | 0,516 | 0,580 |
| | **$N_{mic}$** | 0,020 | -0,100 | **,569**** | 1 | **0,000** | 0,888 | 0,416 | 0,848 | 0,437 |
| | **C/N** | -0,019 | -0,181 | -0,248 | **,613**** | 1 | 0,931 | 0,346 | 0,436 | 0,740 |
| | **Lime** | **,363*** | -0,083 | -0,045 | 0,023 | -0,014 | 1 | **0,007** | 0,123 | 0,123 |
| | **Sand** | 0,178 | -0,022 | -0,015 | 0,132 | 0,153 | **,418**** | 1 | **0,000** | **0,000** |
| | **Silt** | -0,086 | -0,181 | 0,106 | -0,031 | -0,127 | -0,248 | **-,601**** | 1 | 0,062 |
| | **Clay** | -0,125 | 0,210 | -0,090 | -0,126 | -0,054 | -0,248 | **-,584**** | -0,298 | 1 |

*. significant correlation at the 0.05 level
**. significant correlation at the 0.01 level
$p<0.05$ significant differences exist

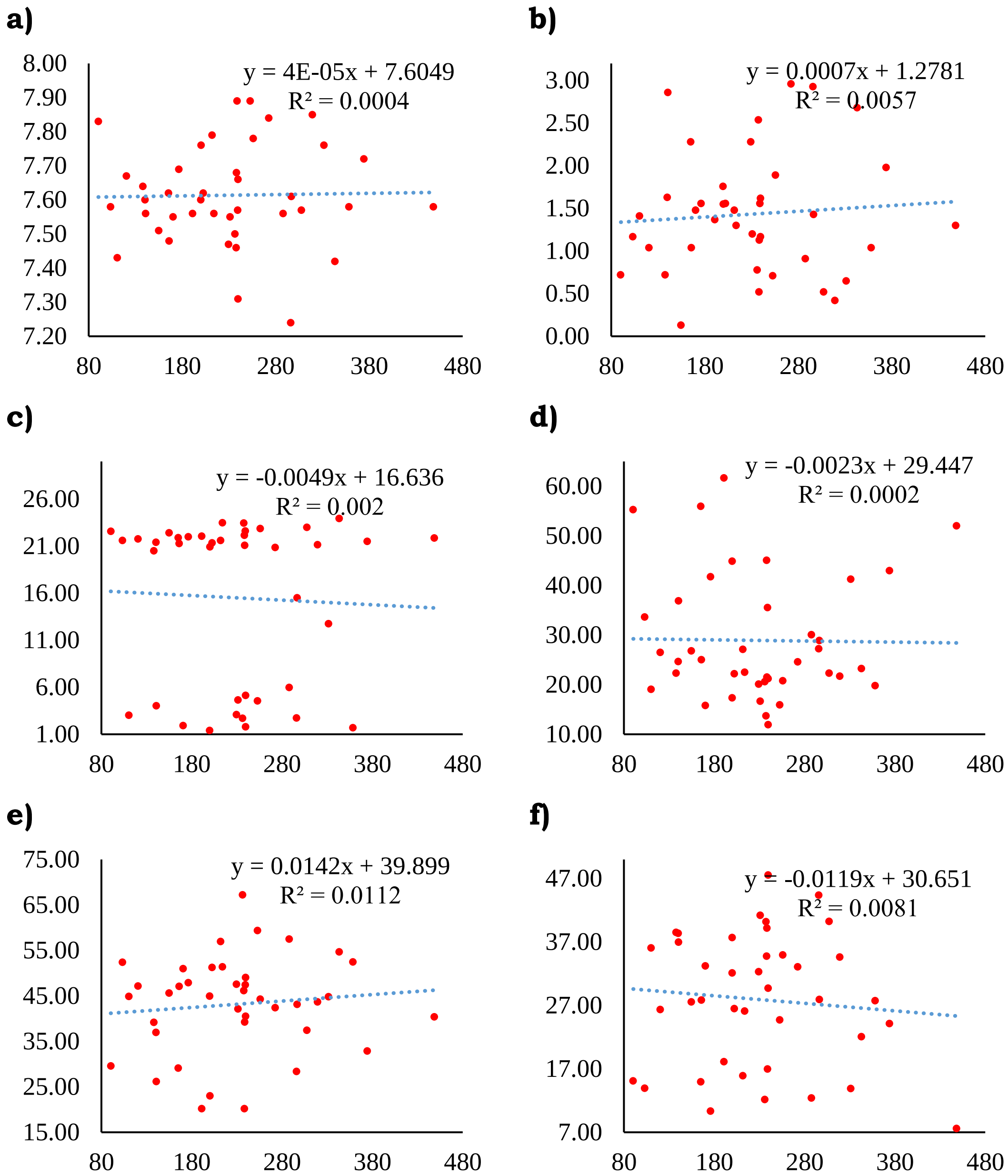


Figure 3.1. Regression plots for the relationships between $C_{mic}$ and soil pH (a), organic matter (b), lime (c), sand (d), silt (e) and clay (f).

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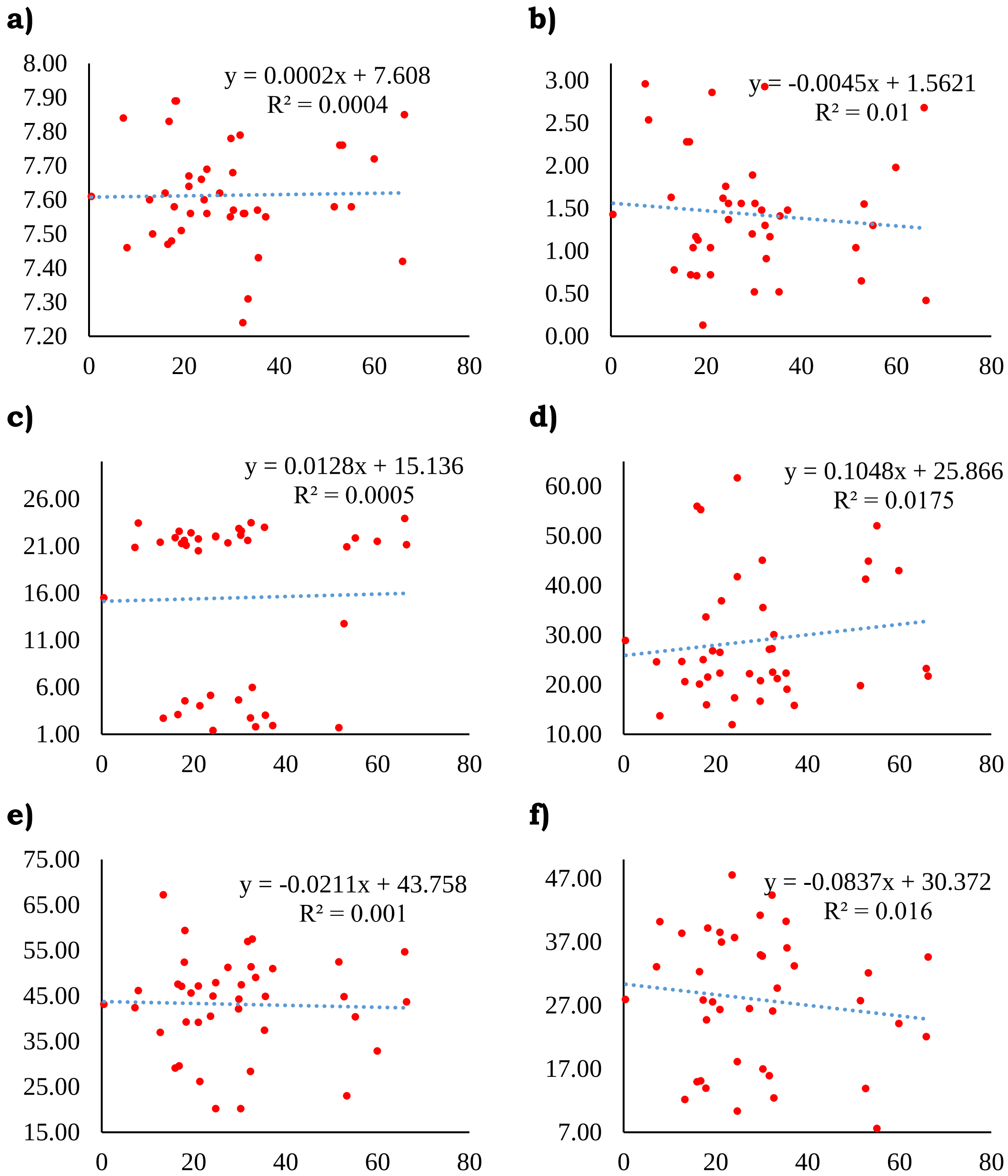


Figure 3.2. Regression plots for the relationships between $N_{mic}$ and soil pH (a), organic matter (b), lime (c), sand (d), silt (e) and clay (f)

The reason for the low amount of $C_{org}$ in the agricultural area can be listed as the lack of continuous vegetation on the area, the rapid decomposition of organic matter as a result of the upside down and mixing of the soil as a result of agricultural activities and its washing with precipitation. [29] stated in their study that organic carbon may be lost through erosion, runoff and leaching. [30] in their study in 2002, stated that soil organic matter constitutes most of the nitrogen reserves in the soil. There is a significant difference between the organic nitrogen contents of soils and the nitrogen contents of microbial biomass. The reasons for this are that soils negatively affect microbial biomass nitrogen in agricultural soils with high clay, lime, electrical conductivity and pH. [31] found a significant and negative relationship between electrical conductivity and microbial biomass N. In the same study, it was emphasized that the microbial community was negatively affected by soil salinity. Ref. [32] stated that soil salinity has more negative effects on soil microorganisms than heavy metals. Microorganism activities have a significant effect on aggregate formation and stability in soils. This effect occurs on different aggregate sizes by different microbial communities. In soils with intense fungal activity, macroaggregates are generally affected, while in soils with intense bacterial activity, microaggregates are affected. When no microbial application is made to the soil, fungal and bacterial biomass in macroaggregates decreases [9].

Organic matter has a strong effect on aggregate formation and stability in the upper part of the soil [2,7]. This is explained by the fact that stable aggregates have a higher carbon content than other parts of the soil. In addition, the proportion of large aggregates increases with long-term organic fertilization. The low organic matter content of the agricultural soils used in our study, the low microbial carbon and nitrogen value, and the high silt and sand content of the soils indicate that there is a potential risk of erodibility [7]. In studies comparing conventional and organic agriculture, it has been reported that phosphatase, protease, urease, dehydrogenase enzyme activity increases in organic farming soils [33,34,35,36]. Ref. [37] stated in their study, 10 soil samples were taken from forest and agricultural areas, and the relationships between microbial biomass C and N in soils and some physical and chemical soil properties were examined and it was determined that the land use pattern led to significant differences in microbial biomass C and N contents. Microbial biomass C and N and texture, organic C, total N, lime content, pH etc. There was also a statistical relationship between them. While investigating the microbiological properties of soils, the products formed as a result of microbial activity and the enzymes secreted during the activity can also be measured [15].

## 4. Conclusions

In this study, it was found that the amount of organic matter, microbial biomass, carbon and nitrogen in the soil was low. This study is also confirmed by our previous studies in this region [1,3,4,5,6,7,8]. In addition, soil fertility is affected by low Cmic and low Nmic.

Microbial activity ensures the absorption of plant nutrients. Soil fertility is low when microbial activity is low. Thus, the expected yield and product cannot be obtained from the soil. For this reason, it is recommended to use organic fertilization to increase the microbial carbon and microbial nitrogen of the soil and to increase the content of organic matter in the soil, as well as to grow nitrogen-fixing legumes and sprinkle the soil with alternative composts.

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