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# DETERMINATION OF PHYSICAL AND CHEMICAL PROPERTIES OF SOME SOILS FOR AGRICULTURAL USE IN FIER DISTRICT OF ALBANIA

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***Abstract***

*This study aims to determine the effects of different land management systems on the physical and chemical properties of soil. Soil samples were collected at a depth of 0-30 and 30-60 cm from the greenhouses area and were analyzed in the laboratory using standard protocols. The physical properties) and chemical properties of the soil samples were examined. pH values recorded in the control site ranges from 7.9 to 9.7 indicating that all the soils studied were moderate to strong alkaline. The conductivity values range from 230 µS/cm-8.6 dS/m which indicated that all the soils vary from non-saline to moderately saline. Organic matter ranges from 0.3-1.6%, which indicates that its content is classified from very low to low. Available phosphorus also varies from 0.2-1.3 mg/kg, which indicates a low content of this element. From the study it was concluded that soil properties change through soil management based on the physical and chemical properties of soils through their classification for soil quality and environmental protection.*

***Key words***: *soil composition, physic-chemical parameters, soil pollution*.

## INTRODUCTION

Soil is a major component of the Earth's ecosystem. The world's ecosystems are impacted in far-reaching ways by the processes carried out in the soil, with effects ranging from ozone depletion and global warming to rainforest destruction and water pollution. With respect to Earth's carbon cycle, soil acts as an important carbon reservoir (Amelung et al., 2022) and it is potentially one of the most reactive to human disturbance (Pouyat et al., 2002) and climate change (Davidson & Janssens, 2006). Soil is a key element for the production of food on which life lives on this earth. Soil ecosystem provides various functional services, such as maintenance of soil fertility, promoting ecosystem stability, and regulating climate change (Kaur et al., 2022). Soil acts as an engineering medium, a habitat for soil organisms, a recycling system for nutrients and organic wastes, a regulator of water quality, a modifier of atmospheric composition, and a medium for plant growth, making it a critically important provider of ecosystem services (Dominati et al., 2010). Soil is used in agriculture, where it serves as the anchor and primary nutrient base for plants. The types of soil and available moisture determine the species of plants that can be cultivated. Agricultural soil science was the primeval domain of soil knowledge, long time before the advent of pedology in the 19th century. However, as demonstrated by aeroponics, aquaponics and hydroponics, oil material is not an absolute essential for agriculture, and soilless cropping systems have been claimed as the future of agriculture for an endless growing mankind (Sambo et al., 2019). Soil acts as an engineering medium, a habitat for soil organisms, a recycling system for nutrients and organic wastes, a regulator of water quality, a modifier of atmospheric composition, and a medium for plant growth, making it a critically important provider of ecosystem services (Dominati et al., 2010). Soil composition is an important aspect of nutrient management. While soil minerals and organic matter hold and store nutrients, soil water is what readily provides nutrients for plant uptake. Soil air, too, plays an integral role since many of the microorganisms that live in the soil need air to undergo the biological processes that release additional nutrients into the soil. The basic components of soil are minerals, organic matter, water and air. The composition of the soil can fluctuate on a daily basis, depending on numerous factors such as water supply, cultivation practices, and/or soil type (Clellan, 2022). Soils supply plants with nutrients, most of which are held in place by particles of clay and organic matter (colloids) (Brady & Raymond, 2007). The nutrients may be adsorbed on clay mineral surfaces, bound within clay minerals (absorbed), or bound within organic compounds as part of the living organisms or dead soil organic matter. These bound nutrients interact with soil water to buffer the soil solution composition (attenuate changes in the soil solution) as soils wet up or dry out, as plants take up nutrients, as salts are leached, or as acids or alkalis are added (Soil Colloids: e-Book). Plant nutrient availability is affected by soil pH, which is a measure of the hydrogen ion activity in the soil solution. Soil pH is a function of many soil forming factors, and is generally lower (more acidic) where weathering is more advanced (Miller, 2016). The physicochemical study of parameters is important to agricultural chemists for plants growth and soil management. The physical properties of soils, in order of decreasing importance for ecosystem services such as crop production, are texture, structure, bulk density, porosity, consistency, temperature, color and resistivity. Soil texture is determined by the relative proportion of the three kinds of soil mineral particles, called soil separates: sand, silt, and clay (Gardner et al., 2017). Therefore, the main objective of this investigation is to examine the limitations of the USDA textural triangulation using data collected from a large number of samples so that the results are statistically stable and to evaluate the degree of salinity, the Cation Exchange Capacity through the physic-chemical analysis of the soil, with the aim of using these soils for cultivation in greenhouses.

## MATERIALS AND METHODS

### Study Areas

This area belongs to two climatic zones: the Mediterranean hilly area under the southeaster zone and the mountainous Mediterranean area under the southern zone, which is characterized by a weather of relatively strong and wet and hot winters and hot and almost dry summers. Precipitation falls mainly in the form of rain, but snowfall during the winter months is also a common phenomenon. The municipality of Fier owns it 5,288.85 ha of forest and pasture area, excluding protected areas. The largest area it occupies Forestry with 2,827.99 ha of total area, followed by areas unproductive with 937.00 ha and plant and forest area with approximate values (371.24 and 387.85 respectively). Also of interest are the pasture areas, with area 537.10 ha. From the digitization carried out in the framework of the preparation of General Local Plans (GLP), from 620 $km^2$ which is the total area of Fier Municipality, 435.82 $km^2$ is agricultural land 12 (here cultivated and uncultivated lands are included) and 127.87 $km^2$ it is natural soil (forests, pastures). The municipality of Fier is crossed by the rivers Seman and Gjanice and is rich with underground and surface water sources. The total water surface occupies 9.8 $km^2$.

### Soil analysis

An agronomic soil test extracts a portion of the plant-available nutrients contained in a soil sample and results are then classified as low, medium, high, or very high based on expected crop response to added crop nutrients. The soils have been analyzed on a physical and chemical level according to the following standards:

***Particle Size Analysis:*** The analysis was done with the Hydrometer method (Carter & Gregorich, 2007). The method is based on Stoke's law governing the rate of sedimentation of particles suspended in water.

***Soil pH:*** The pH of the suspension is measured by glass electrode using a pH-meter in a 1:5 (volume fraction) suspension of soil (ISO 10390:2021)

***Soil organic carbon Walkley-Black Titration Method***: The determination of soil organic carbon is based on the Walkley & Black chromic acid wet oxidation method (Walkley & Black, 1934).

***Exchangeable Bases:*** The exchangeable bases (Ca, Mg, K and Na) in the different soil samples were extracted with 0.05N $NH_4OAc$ buffered at pH 7.0 (Thomas, 1982).

The exchangeable K and Na contents of the extracts were read on Nova 400P AAS spectrometer while the exchangeable Ca and Mg were determined by titration method (Pereira et al., 2011).

***Cation Exchangeable Capacity (CEC):*** The effective cation exchangeable capacity is the summation of exchangeable bases and total exchangeable acidity and was taken as the effective cation exchange capacity value and determined following the standard procedures (Okalebo et al., 2002).

## RESULTS AND DISCUSSIONS

### Soil texture

Soil texture refers to the percentage of sand, silt, and clay-sized particles that make up the mineral portion of the soil. Since textural triangulation developed by the US Department of Agriculture (USDA) has traditionally been a basic tool in soil classification, a thorough examination of its suitability was conducted in this research. Soils were classified according to traditional particle size criteria using the USDA structure triangle shown in Figure 1a and 1b. The texture triangle illustration was created using the R package "ground texture" (Groenendyk et al., 2015). A total of 30 soil samples from two different depths (0-30 cm and 30-60 cm) containing textural data (percentage of sand, silt and clay) were analyzed. The content of sand, clay and silt ranges from 2.32% to 58.86%, 2.07% to 42.47% and 45.68% to 74.37% respectively. However, these samples are located in the loam group. There are no significant changes in the soil texture for the samples taken at a depth of 30-60 cm, making the calculated classification to categorize the soil as silty (Figure 1b).

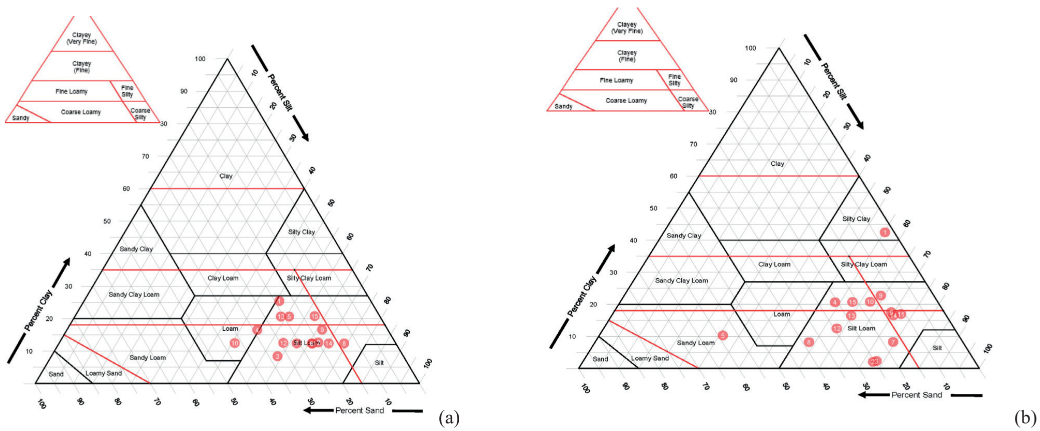


Figure 1. USDA Soil Texture Triangle for soil samples a) 0-30 cm and b) 30-60 cm

### Principle Component Analysis describing the soil properties from the characterization data averages that influence each soil depth

Soil data were analyzed using JMP. 11 software packages. Principle Component Analysis (PCA) is a multivariate statistical technique used to analyze relationships between a large number of variables and smaller number of objects. In this study, the objects are the soil samples and the variables are the soil characterization components (i.e. pH, EC, L.O., N-Tot., P-exch, K-as, Na-as, Mg-as, Ca-as and CEC). The results are presented in (Figure 2 and Figure 3).

One of the strongest relationships that emerged from the two PCA plots was the negative relationship, as per definition, between the sand and clay and silt contents. Silt and loam content also maintains an inverse relationship with a number of chemical compounds, such as carbon content, N-Tot., pH and P-exch. In Figure 2 the soil samples are represented by: EC, K-as, Mg-as, Na-as, Ca-as and CEC in component 1 with 42% of total variation meanwhile 22% on the component 2 were represented by N-Tot., pH, L.O., and P-exch. In this soil P-exch do not correlate with EC, K-as, Mg-as, Na-as and CEC.

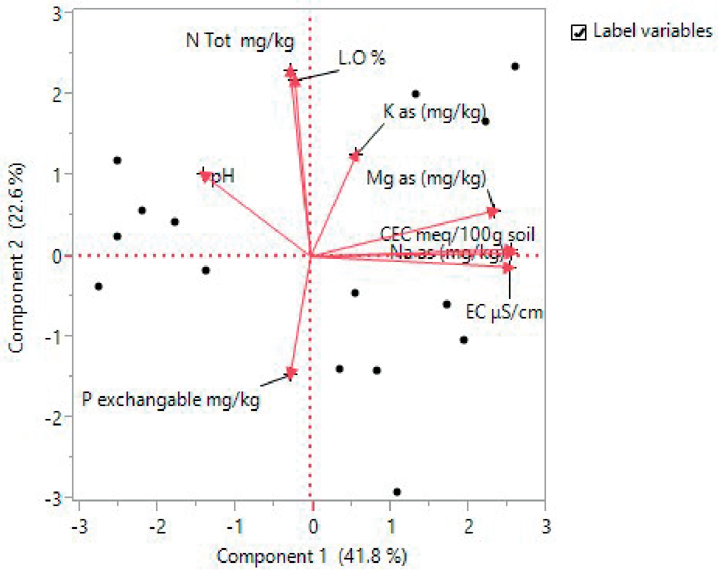

Figure 2. Principal Component Analysis showing the relationships between CEC and soil parameters (0-30 cm depth)

It also appears that the with EC, K-as, Mg-as, Na-as and CEC strongly corelate with each other and are not the dominant overall drivers in Loam soils, compared with Silty soils. In Loam soil pH, N-Tot. and Organic Matter are two constituents necessary to create stable aggregates.

In soil samples 30-60 cm deep (Figure 3), PCA analysis showed that component 1 represents 47% of the total variability, has higher positive correlations with EC, K-as, Mg-as, Na-as, Ca-as, N-Tot., P-exch., L.O., and CEC in component 2 the Ca-as and pH represent the 20% of total variation.

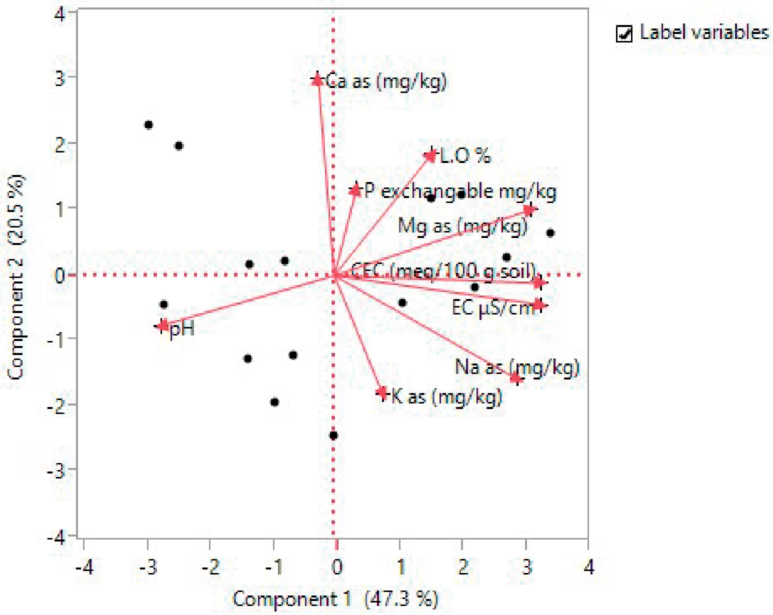

Figure 3. Principal Component Analysis showing the relationships between CEC and soil parameters (30-60 cm depth)

In the Silty soil the all the parameters do not correlate with the pH, but the strengthens and relation between the EC, K-as, Mg-as, Na-as, Ca-as, L.O., N-Tot., P-exch, and CEC is dominant. Further studies could assist in investigating the new relationship between soil texture and fertility parameters by distinguishing soil properties and reactions. The main objective is to use PCA and other statistical analyses to distinguish soil texture based on chemical, physical, and biological properties and to make predictions about the environmental responses of specific soil types. These predictions will include the fate of soil, water and contaminant transport, degradation, sorption properties, fertility, field capacity, and other responses. Utilizing this approach would benefit various stakeholders, including people in the army and military, farmers, animals, plants, marine life, and the environment.

## CONCLUSIONS

The precise evaluation of soil quality is a very important issue for precise farming (in particular) and for the proper management of sustainable agricultural practices (in general).
This evaluation facilitates the identification of the most suitable crops and the potential agricultural uses of the area. Soil quality is affected by agricultural practices and climatic conditions, which, in turn, affect the physical, chemical, and fertility properties of the soil. In this study, the nutrients and physical and chemical properties of the soil were evaluated for their relationship trough PCA explained 41-47% of the total variance of soil data. In addition, the soil data were classified into Loam and Silt Loam and the soils has low level of macronutrients. Phosphorus (P) is more interesting, although it generally does not correlate with soil texture, it is positively correlated with pH in the case of samples taken in 0-30 cm. However, increase in silt soil pH, and exchangeable Ca, decreased P dissolution in soil in relation to the solubility product principle.

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