STUDY OF THE QUALITY OF SOILS IN THE ANNABA REGION NORTH EAST ALGERIA

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Abstract:

In this experimental study we are interested in identifying some physicochemical characteristics that determine the quality of the soils of the plain of Annaba willaya, North East Algeria. In order to know the physicochemical properties of the soils of the plain of Annaba, we have based on a systematic sampling plan. Analytically, the results show that the studied soils revealed a degree of acidity ranging from 7.30 to 7.80, with a clayey texture, the electrical conductivity is variable between 692 and 2042 µs/cm², and a relatively strong rate of limestone, also, the porosity values are very variable, and variable organic matter contents (1.27 to 5.68) %. From the analytical results, we were able to classify the soil of the plain of Annaba, willaya of Annaba, North East Algeria, in the system of classification of French soils CPCS (1967), and these are soils belonging to the class of Mediterranean red soils.

Key words: soil, physicochemical characteristics, plain, organic matter, classification.

ETUDE DE LA QUALITE DES SOLS DE LA REGION D'ANNABA. NORD EST ALGERIEN

Résumé

Dans cette étude expérimentale nous intéressons d'identifier certaines caractéristiques physico-chimiques qui détermine la qualité des sols de la plaine d'Annaba willaya d'Annaba, Nord Est Algérien. Dans le but de connaître les propriétés physico-chimiques des sols de la plaine d'Annaba, nous avons basés sur un plan d'échantillonnage systématique. Sur le plan analytique, les résultats montrent que les sols étudiés ont révélé un degré d'acidité allant de 7,30 à 7,80, avec une texture argileuse, la conductivité électrique est variables comprises entre 692 et 2042 µs/cm², et un taux de calcaire relativement fort, aussi, des valeurs de porosité sont très variables. Et des teneurs en matière organique variables (1,27 à 5,68) %. A partir des résultats analytiques, nous avons pu classer le sol de la plaine d'Annaba, willaya d'Annaba, Nord Est Algérien, dans le système de classification des sols française la CPCS (1967) [1], ce sont des sols appartenant à la classe des sols rouges méditerranéens.

Mots clés : sol, caractéristiques physico-chimiques, plaine, matière organique, classification

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Introduction

Soil is a natural [2], superficial and often loose entity resulting from the transformation of the underlying parent rock, under the influence of physical, chemical and biological processes" [3]. Soil is a complex mixture of weathered rocks (pebbles, sands, silts, clays), organic matter (living or dead), gas, water and soluble minerals, formed over time as a function of climate (temperature, humidity, wind, ice...), parent rock, topography and living organisms [4]. But beyond its constituents, a soil is defined by its properties, mainly its texture (proportion of sand, silt, clay) and its structure (size and organization of the particles between them), which influence all other properties.There is thus a great variety of soils, which ensure vital functions for humanity (plant growth, life support...) [5]. It should be remembered here that an agricultural soil," results from the transformation by man of virgin soil in order to obtain crops. This transformation is accompanied by changes in the morphology, properties, and composition of the soil. The soil is also an ecosystem in its own right, containing an immense quantity and variety of living organisms, which perform essential ecological functions [6].

The soil is characterized by different microbiological, physical, chemical and mechanical factors, and is therefore the support of an intense biological activity. As a result, soil is an essential resource for human societies and ecosystems: an economic resource for food production, as it is the basis for 90% of human and animal food, and as a support for all human activity. The soil being under increasing pressure (agricultural production, urban and industrial development, natural environmental problems, etc.) [7]. The quality of a soil, can be defined as the system of abiotic and biotic characteristics that ensure the functioning of the soil ecosystem. These characteristics must therefore have a certain minimum above which the quality of a soil will vary depending on the phase of succession and the type of soil ecosystem [8]. It is obvious that the quality of soil for a given use depends on its intrinsic properties, its geochemical and climatic environment and its use by man [9].

The soil is a non-renewable and fragile resource that we must know better to better control the use we make of it [10].

The region of Annaba is considered an area characterized by a highly productive agricultural plain and consuming organic matter fertilizer, a dense and diversified industrial fabric consumer of fossil energy and a relatively well preserved forest area that plays the role of purifier of this atmosphere.

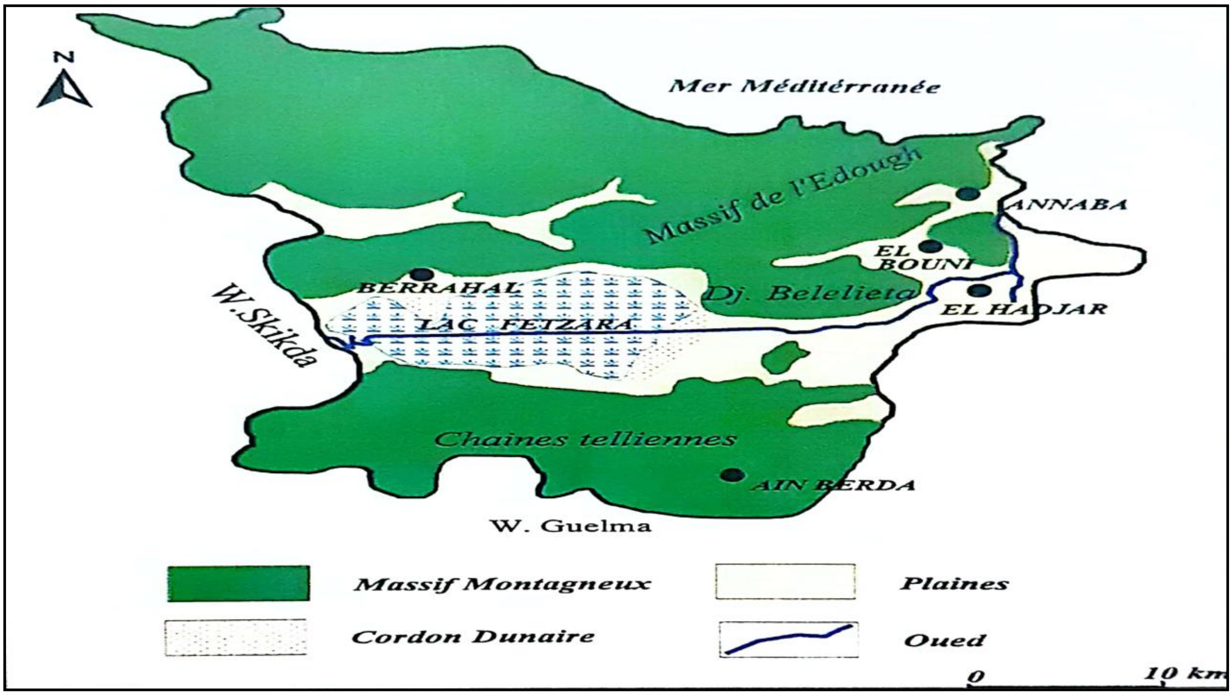
This study which is a contribution to a better knowledge of the soils of Algeria, in particular the soils of the plain of Annaba willaya (North East Algeria). Of which our study aims at the determination and the quality of the physicochemical properties of the soils of this plain.

1- Materials and Methods:

Presentation of the study area:

The plain of Annaba is located immediately behind the city of Annaba. It is limited to the north by the Mediterranean Sea, the north-west by the anticline of the Edough massif and the south by the anticline of the Numidian chain, with a relatively regular topography, In the space thus defined three sectors each have different forms; the low plain in which the wadi Seybouse is encased, the edges where we can observe glacis and the coastline or some quaternary formations are visible [11].

This low plain has a sloping and slightly curved shape with the Seybouse as a drainage axis. This one presents a more rectilinear layout [12] [13].



According to the climagram of Emberger (1954), it appears that the climate of the Annaba region presents contrasting seasons, with a wet and cool period of 6 months and a dry and hot period of 6 months. It corresponds to a sub-humid Mediterranean climate (Fig 2).

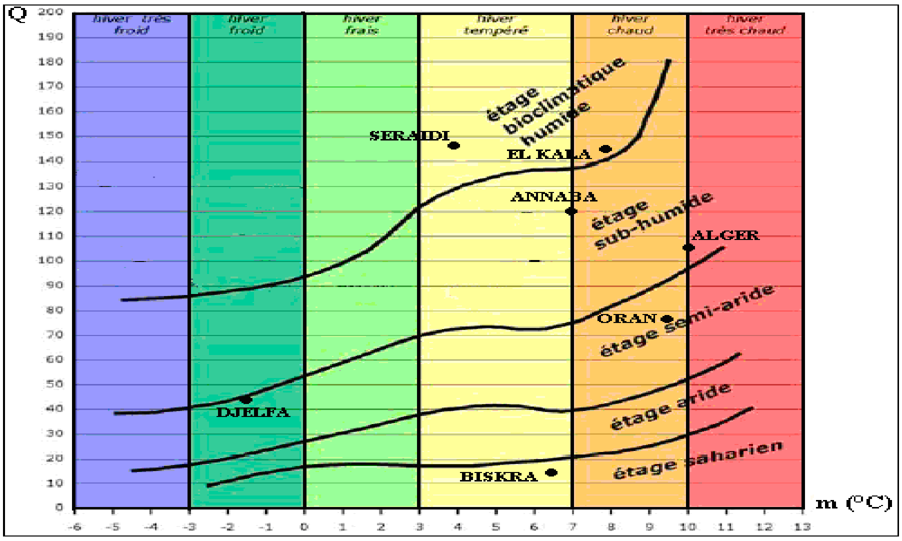


Fig 2. The climatic stage of the study region after the Emberger climagrammaton, 1977.

The various methods of studying and characterizing soils that have been proposed all lead to the collection of samples of the topsoil [16]. However, soil sampling does not only consist in taking a certain quantity of soil and analyzing it in the laboratory, it must respond to a necessity related to the context of the site and its occupation [17]. Several factors can be taken into consideration for the realization of this operation such as the geological substrate, lithosols, geomorphology, land use and vegetation [18].The plain of Annaba has a large surface (101Km2), the choice of the sampling method was based on a systematic strategy. Adapted to large areas [19], this method appears useful to analyze the distribution of soil properties [17], and especially to minimize the maximum error of geostatistical kriging [20].

The approach we adopted consists of a systematic sampling plan. The first point which was the central point of this sampling was taken as geo-reference and then samples were taken at 10m distance, in each of the 4 cardinal directions with respect to the central point. We chose 12 squares representative of the area in question. The collected soil samples were dried, crushed and sieved, then analyzed in the laboratory. On the fine fraction of the soil the following physicochemical analyses were made:

The pH eau, pH KCl	pH meter.
Electrical conductivity	Conductimeter. .
Hygroscopic humidity	Oven drying (24h at 105°C).
Organic matter	Incineration in a muffle furnace (4h at 450°C).
Total limestone	Tetrimetric method.
The granulometry	International pipette method.
The real density	Pycnometer.

And on the unmilled soil fraction, only one analysis was performed:

The apparent density	with kerosene [21].

Results and Discussion:

The results obtained have been grouped in the graphs and histograms below. The granulometric analysis is used to determine the texture of the soil. According to the textural triangle of the U.S.D.A [22] and using the textural triangle of [23], we deduce that with the exception of sample E which has a silty clay texture, and sample L which has a sandy clay texture, the remaining soil samples A, B, C, D, F, G, H, I, J, K, (Fig 3) have a clay texture. These soils are characterized by a higher cohesion the higher the clay content. Because of the considerable cohesion they are tough and sticky when wet and hard when dry. They are therefore difficult to work and the working time is very limited. These soils are called heavy [24].

The particle size of a soil is important because it has a direct effect on the porosity. Fine particles (clay) increase water retention, but decrease aeration [25].

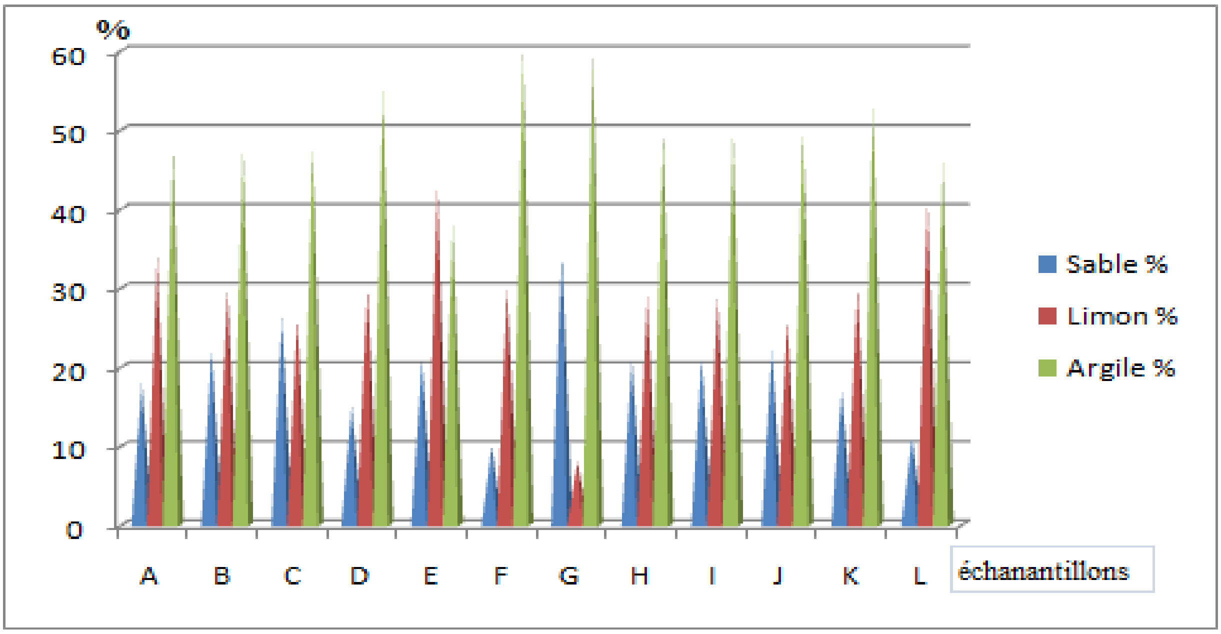


Fig 3: Variation in particle size in the soils studied.

Results in table 1 represent the comparison of the levels of sand, silt and clay in the plain of our study, which shows the higher levels of clay in the soil with significant low levels of sand.

Table 1. Mean of Granulocyte (sand, slit anc clay percentages) of the soils of the El Hadjar plain, wilaya of Annaba. Results are expressed as mean±SD.

	Sand	Silt	Clay
Granulomere:	**19.83±6.48[c]**	**29.67±8.65[b]**	**50.50±6.05[a]**

Means that do not share the same letter are significantly different at $p < 0.05$.

The measure of the acidity of a suspension of soil in water, with a standardized soil/water ratio (1:5). It also indicates the concentration of "H+" ions present in the water. [26].

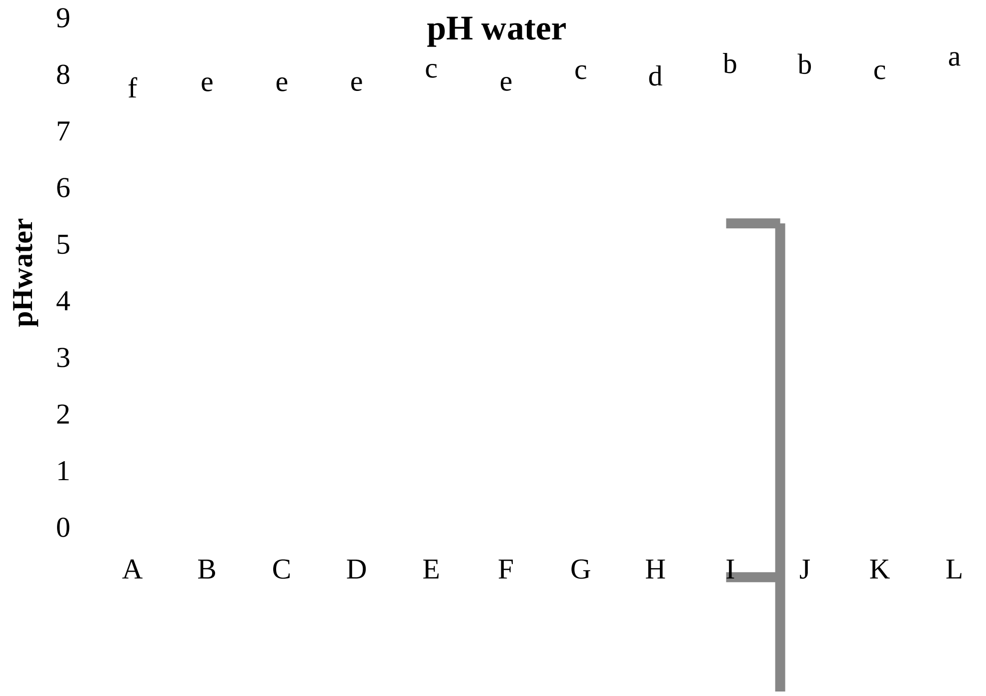
The reading of the results of fig 4 shows that the values of the pH water of the soil of the region of Annaba range between a little basic pH to and a basic pH. They are under the control of several factors which are mainly; the topographic position, the nature of the mother rock and the nature of the vegetation cover.

According to the standards of interpretation presented by (international NF ISO 10390), the samples A, B, C, D, F are little alkaline and the other samples namely the E, G, H, I, J, K, L, are alkaline (basic) (fig 4), the values of pH are included between 7, 30 and 7.80, they cover the largest area of the Annaba region and they develop under different plant cover They are either agricultural or urban or reconstituted, but all are characterized by a significant content (>23%) of limestone CaCO3.

The graphical representation of the results in a histogram shows that sample L, is the most alkaline. Sample A, on the other hand, is the least alkaline.

pH KCl: The pH kCl expresses the exchange acidity or potential acidity. It is an experimental index of the degree of saturation of the absorbing complex, as well as the chemical nature of the fixed ions. The pH kCl values of all the soils studied (Fig 4) evolve in the same direction as the water pH. This situation allows us to say that the absorbing complex is sufficiently saturated, and that there is a certain equilibrium between the actual and potential acidity.The difference between pHwater and pHkCl does not exceed unity, this is related to the presence of a quantity of limestone that provides the soil with a fairly important buffering capacity.

The analysis of these two "2" parameters pH water and pH kCl shows that our soils present a certain stability and resist quite well to all brutal modifications of the soil reactions. The significance changes between samples are represented in figure.



5.

Fig 4. Determinations of pHwater in different samples of the soils are taken from the El Hadjar plain, wilaya of Annaba. Results are expressed as mean±SD. Means that do not share the same letter are significantly different at p<0.05.

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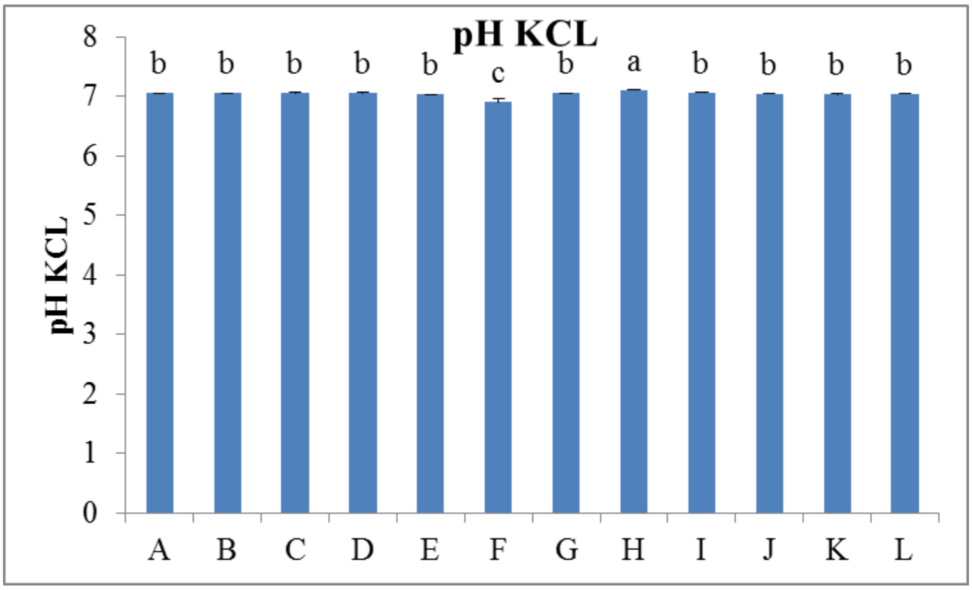

Fig 5. Determinations of pH KCl in different samples are taken from the soils of the El Hadjar plain, wilaya of Annaba. Results are expressed as mean±SD. Means that do not share the same letter are significantly different at $p<0.05$.

The electrical conductivity (E.C.), this physicochemical measurement gives us an idea of the concentration of electrolytes in the soil solution on the one hand and the degree of salinity of the soil on the other. According to Duchaufour (1983) [27], electrical conductivity is proportional to the quantity of ionizable salts, and is a good indicator of the degree of mineralization of the soil solution. The electrical conductivity in the Annaba region records low values varying from 692 to 902 µs/cm². This shows that the majority of soils have a low to medium electrical conductivity (< 1000 µs/cm²) such as sample: B, C, D, E, F, J, L showed in figure 6; this is regardless of the nature of the substrate and the type of soil. Soils with high electrical conductivity are located in areas of accumulation and stagnation of irrigation water where drainage channels rarely function, such as sample: A and H. The clay texture also favors the accumulation of electrolytes, and this is the explanation for the increase in eclectic conductivity that exceeded 1890 µs/cm²; this is the case of soils G, I, K. The graphical representation of the results in histogram shows that the values of C.E are not homogeneous for all the samples analyzed. Sample K is the most salty, while the sample L is the least provided in salts.

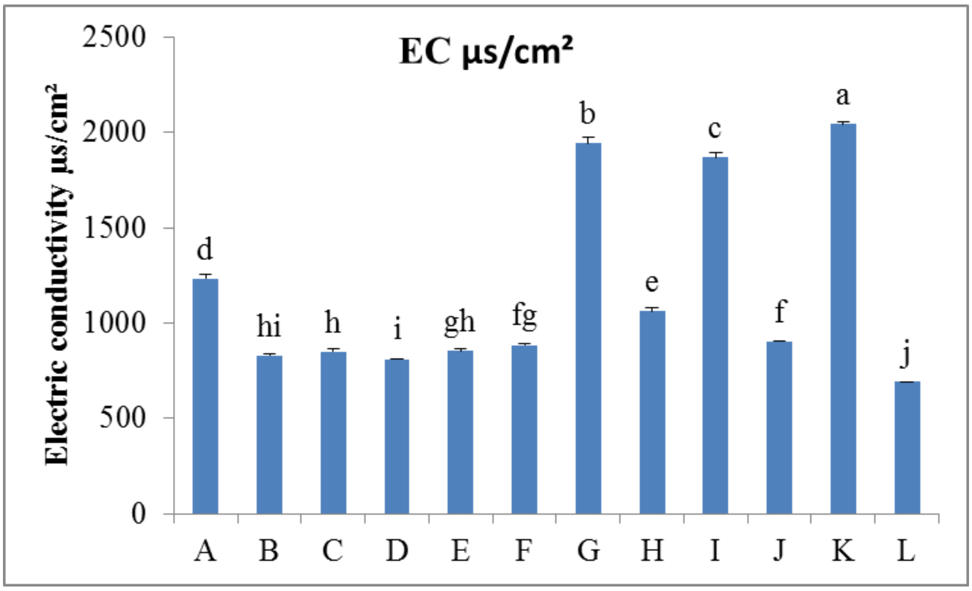

Fig 6. Determinations of electric conductivity (EC µs/cm²) in different samples are taken from the soils of the El Hadjar plain, wilaya of Annaba. Results are expressed as mean±SD. Means that do not share the same letter are significantly different at $p<0.05$.

Hygroscopic moisture (H%) represents the amount of water that a soil can retain under natural drying conditions. It is also the amount of water retained on the outer surface of soil particles in equilibrium with atmospheric pressure and moisture. The evaluation of hygroscopic moisture gives values between 4.2 % and 5.6 %; (Fig 7), these values are related to the texture of the soil, because fine-textured clay soils retain more water than sandy soils with a particulate structure. The graphical representation of the results in a histogram shows that the hygroscopic moisture values are homogeneous for all the samples analyzed.

The apparent density-actual density relationship defines soil porosity (Poro %), The porosity is the void (the pores) existing in a soil. It depends on the granulometric composition and the structure of the soil; according to the results obtained, our soils are more porous, this is the case of samples; A, B, E, F, L. This granulometric composition changes in the rest of the results with an increase in the rate of clay where it becomes almost compact in the sample: C, D, G, H, I, J and K. whose values are between 3, 88 % and 7, 04 %. The graphic representation that corresponds to the (Fig 8) shows that the porosity values are not homogeneous for all the analyzed samples. Sample E is the most porous with a value of 40.54% and sample G is the least with a value not exceeding 3.88%.

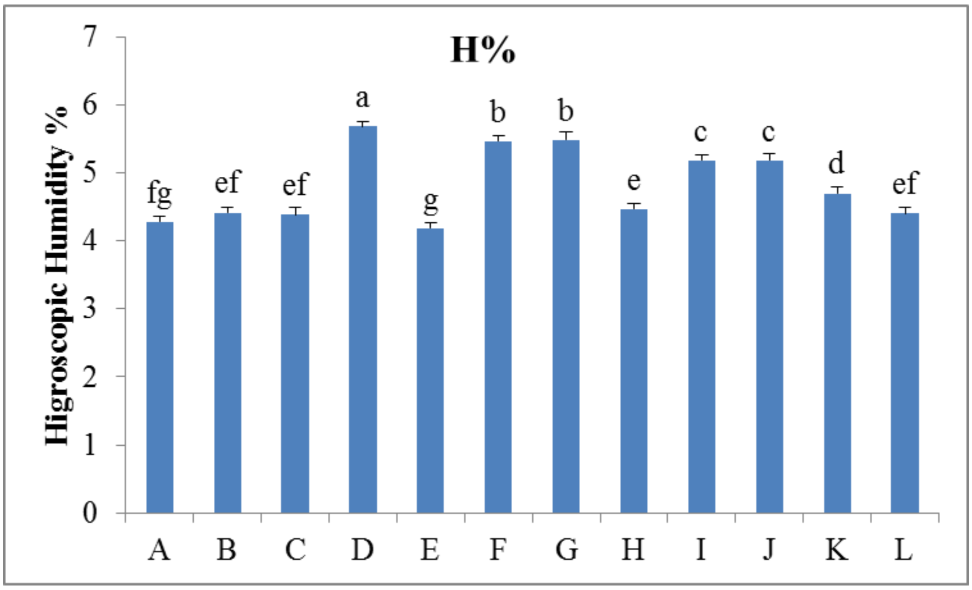

Fig 7. Determination of hygroscopic humidity (H %) in different samples are taken from the soils of the El Hadjar plain, wilaya of Annaba. Results are expressed as mean±SD. Means that do not share the same letter are significantly different at p<0.05.

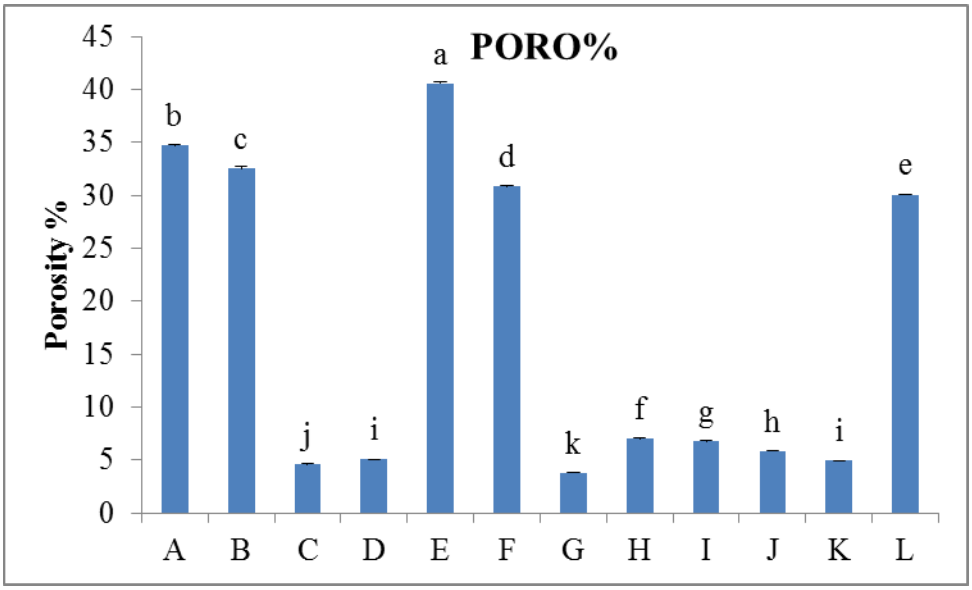

Fig. 8. Determination of porosity (PORO %) in different samples are taken from the soils of the El Hadjar plain, wilaya of Annaba. Results are expressed as mean±SD. Means that do not share the same letter are significantly different at p<0.05.

Organic matter (OM%) and ash content TxCend % realized by incineration of the soil after passing through the muffle furnace at 480°C for 24 hours, it is expressed as a percentage of the dry weight of the soil. [28] The evaluation of the rate of organic matter and according to Lambert, 1975[29] has allowed classifying the soils of this plain in 3 classes:

Soils with an organic matter content of between 1% and 2%: these are soils with low organic matter content such as sample G. They are characterized either by a low litter content or by high biological activity. It is in these soils that the mineralization process dominates. All the organic matter is integrated into the soil.

Soils with an organic matter content between 2% and 4%: This class represents the great majority of our soils (samples: A, D, C, E, K, L) and shows that in these soils, there is a low accumulation of organic matter, so these soils are moderately rich in organic matter.

Soils with organic matter > 4%: This class includes some soils that are characterized by a high accumulation of organic debris (samples: B, F, H, I, J; thus these are organic matter rich soils.

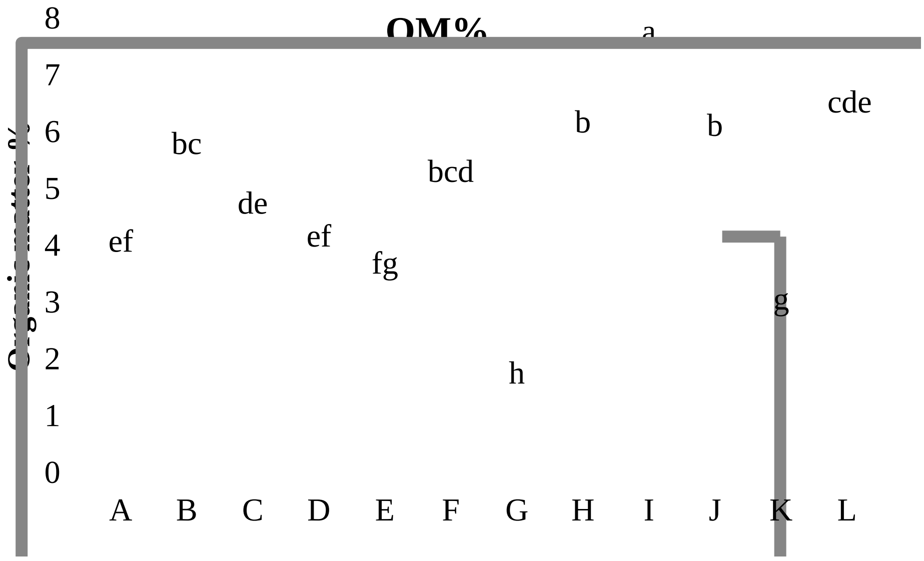

Fig 9. Determinations of organic matters (OM %) in different samples of the soils are taken from the El Hadjar plain, wilaya of Annaba. Results are expressed as mean±SD. Means that do not share the same letter are significantly different at $p<0.05$.

The rate of ash confirms the mineral character of the soils of the Annaba region (Fig 10).

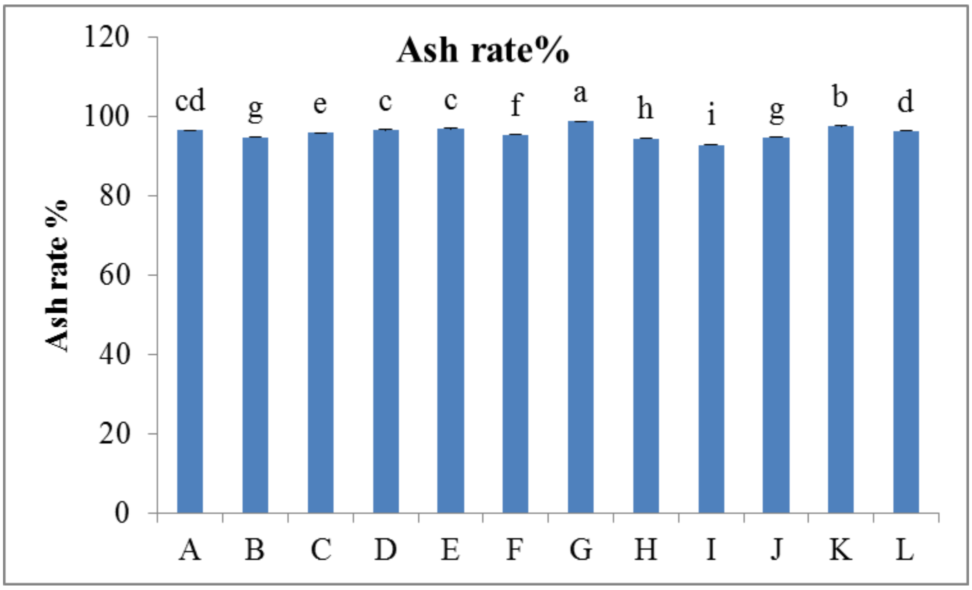

Fig 10. Determinations of ash rate % in different samples of the soils are taken from the El Hadjar plain, wilaya of Annaba. Results are expressed as mean±SD. Means that do not share the same letter are significantly different at $p<0.05$.

The dosage of total limestone ($CaCO_3$%) in our soils shows relatively high values especially for soils developed on sand or in reconstituted soils. The presence of limestone played a great role in the ionic equilibrium, especially in the pH values. The total limestone values recorded in our study area are between 23.22% and 24.93% (Fig 11). The limestone content related either to the nature of the substrate or to the various artificial contributions related to correct the pH of the soil and to reinforce the buffer power of these studied soils.

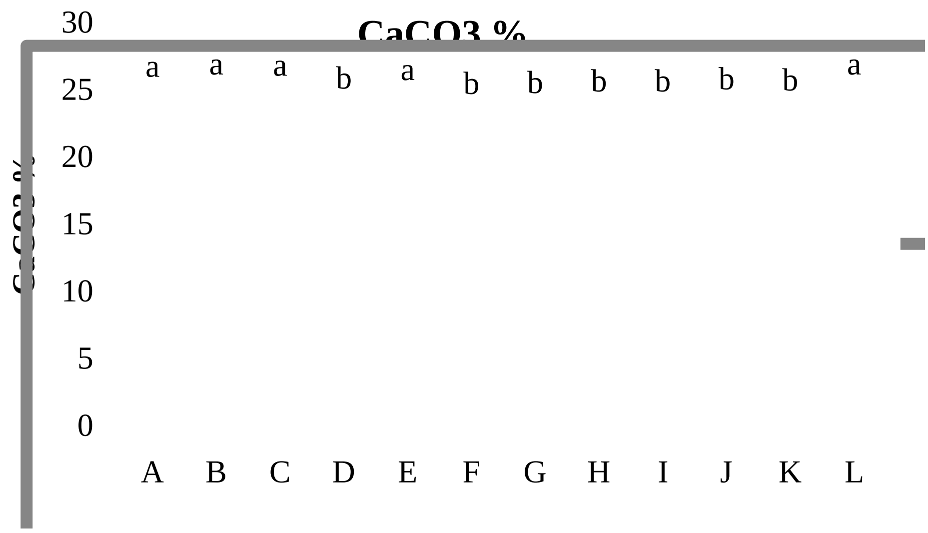

Fig 11. Determinations of $CaCO_3$ % in different samples of the soils are taken from the El Hadjar plain, wilaya of Annaba. Results are expressed as mean±SD. Means that do not share the same letter are significantly different at $p<0.05$.

To conclude, this research aim to identify some physicochemical characteristics of soils, our work was oriented towards the analytical analysis of soils of the plain of Annaba, willaya of Annaba, North East Algeria.

The choice of the sampling method was based on a systematic strategy, we have chosen 12 representative points of the area in question, the collected soil samples were dried, crushed and sieved. The fine soil obtained was then homogenized and 500g were taken for soil and chemical analysis.

The results of soil analysis show that the soils of the 12 samples are slightly alkaline to alkaline, the pH values are between 7.30 and 7.80.

The graphical representation of the results in a histogram shows that the electrical conductivity values are not homogeneous for all the samples analyzed. Sample K is the most salty. Sample L is the least saline.

The soil at the level of the Annaba plain is dominated by the clay fraction, except for sample E which has a silty clay texture, and sample L which has a sandy clay texture, the remaining soil samples A, B, C, D, F, G, H, I, J, K, have a clay texture, have a low porosity except for samples A, B, E, F, L. is more porous.

The evaluation of hygroscopic moisture gives values between 4.2 % and 5.6 %), these values are related to the texture of the soil, because the clayey soils with fine texture retain more water

The dosage of total limestone in our soils shows relatively high values, the soil containing organic matter with variable rates.

This study which is a contribution to a better knowledge of the quality of the soils of Algeria, in particular the soils of the wilaya of Annaba requires a thorough study of the organic matter of the soil to determine and protect the quality of the soils of the plain of Annaba.

References:

[1]: CPCS, 1967: C.P.C.S., 1967: Commission de Pédologie et de Cartographie des sols. Laboratoire de Géologie-Pédologie de l'E.N.S.A. Paris-Grignon, 87 p.

[2]: Baize, D. and Girard, M.C., 1995: Référentiel pédologique, Paris, 332 pp.

3]: Girard M.C., Walter C., Remy J.C., Berthin J., Morel J.L., 2005: Sol et l'environnement. Ed. Dunod, Paris, 45-397p.

[4]: Boulaine J., 2003: Géographie des sols. PUF: 42pp.

[5]: Legros J.P., 2007: Les grands sols du monde. Presses polytechniques et universitaires romandes, 574 p.

[6]: Morón-Ríos A., Rodríguez Miguel Á., Pérez-Camacho L., Rebollo S., 2010: Effects of seasonal grazing and precipitation regime on the soil macroinvertebrates of a Mediterranean old-field. European Journal of Soil Biology 46, 91-96p.

[7]: FAO, 2015: Food and Agriculture Organization.

[8]: Eijsakers H., 1983: Soil fauna and soil microflora as possible indicators of soil pollution. Environmental Monitoring and Assessment. 3, 307-316.

[9]: Badraoui,M.,Soudi, B., Merzouk, A., Farhat, A., M'hamdi, A, 1998: Changes of soil qualities under pivot irrigation in the Bahira region of Morocco: Salinization. Advances in Geoecology 31, 503-508

[10]: Stengel, P; Bruckler, L; Balesdent, J. 2009: Le sol. Paris, France. 182.

[11]: Boudjemaa S., 2010: Mapping soil-water-vegetation relationships in a saline environment (Lake Fetzara). Thesis of master in Plant Ecology. Université Badji Mokhtar -Annaba, Algeria.

[12]: Belhamra A: 2001 - Control of the salinity of the waters of the lake Fetzara to the sea. Magister thesis, Department of Marine Science, University Badji Mokhtar, Annaba, 110 p.

[13]: Habes S: 2006: Saline pollution of a lake, case of the lake Fetzara, Algerian East (Annaba).Mémoire de Magister, Département de Géologie .Université Badji Mokhtar, Annaba. ; 130 p.

[14]: Daheche S, 2014: Impact of sea breeze on thermal comfort in the Eastern Maghreb during the hot season. Cybergeo: European Journal of Geography.

[15]: Emberger L., 1954: A biogeochemical classification of climates. Institut de Botanique. Montpellier, 7: p 3-43.

[16]: Marc P, 1998: Observation on Mediterranean lands and soils: lands and soils in Costières, 146p.

[17]: Laperche, V. and J.R. Mossman, 2004: Sampling protocol polluted urban soil with lead, RP-52928-EN, PDF Doc.

[18]: Baise, D. and B. Jabiol, 1995: Guide for soil description, edition INRA, Paris, p: 375.

[19]: Frontier S., 1983: L'échantillonnage de la diversité spécifique. In Sampling strategy. Edit. Frontier et Masson, Paris (Coll. D'Ecologie).

20]: Webster R and Oliver M, 2001: Geostatistics for environmental scientists, 2nd edition. P330.

[21]: Samai I, 2020: The determination and estimation of the plain's soil quality of El Hadjar-Annaba: the Algerian North East. Wulfenia journal. Vol 27, No. 8;Aug 2020

[22]: Baize D., 2000: Guide des analyses en pédologie, INRA. second revised and expanded edition. 257 pp.

[23]: Jamagne, M., 1967: Bases et techniques d'une cartographie des sols.

[24]: Halitim A., 1988: Les sols des régions arides d'Algérie. Ed. O. P. U, Algiers. 384 p.

[25]: Soltner D., 1987: Les bases de la production végétale. TOME 1 : Le sol, 15éme Edition.465p.

[26]: Morel R., 1986: Les sols cultivés. Lavoisier. 1st Edition. Paris.

[27]: Duchaufour Ph, 1983: Pedogenesis and classification 2nd edition. Mass. Ed (1-2,26-29, 196-199).

[28]: Benslama-Zanache H., 1998 - Contribution to the study of the diversity of microorganisms (saprophytic fungi of the soils of the wet complex of El-Kala, North Algerian). "Case of the stations of El-Khoubzi, Righia and Lac Noir".

[29]: Lambert J., 1975: Classes of abundance of organic matter.