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Effect of Fire Reccurents on the Physico-Chemical Characteristics of Soils of Forest (Djaafra Chéraga) Saida (Algeria).

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Abstract

In this research, we have tried to know changes in the physico-chemical properties of forest soil following the reccurents fires. For this we have analyzed 20 soil samples collected in the forest of Djaafra Chéraga (wilaya of Saïda, Algeria) along a chonosequence of 2, 3, 4, and 20 years after the last fire (4 modalities of time since the last fire replicated 5 times). The results showed that the recent fires decrease replenishment and uptake of moisture to the fields in effect, the water regime is disrupted following the destruction of vegetation and this to effect the reduction of water retention. Repeated fires significantly reduced the organic matter rate in these soils have an effect on density and porosity, recent fires increase density and poor so the porosity and the permeability of these soils, indeed the volume density increases due to the collapse of aggregates and the blockage of the gaps by ash and dispersion of mineral clays.

Key words*:* Forest, Vulnerability ; Fire, Impact ; Ground ; Semi arid ; Organic matter ; Humidity.

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1. Introduction

At the happy times as in the dark years of their history, humans have ceased to appeal to foster forest, refuge, forest source of energy and raw materials [1]. Today, can still be advantage that another time, this forest plays a key role in the physical, biological and economic balance. In Mediterranean regions, it has been shaped by weather conditions and a human environment very individuals. But despite its appearance degraded and depleted, the presence of forest cover there is even more necessary than elsewhere due to the fragility of the natural balance [2] . Among the dangers the most important that can threaten the balance of Mediterranean forests and without zero doubt fires, for which need urgent measures, having regard to the considerable damage that results from both the ground and the life [3].

Forest fires traverse each year several million hectares worldwide, it is the most dangerous natural disaster to human life and the most serious economically [4], it is a difficult to model complex natural phenomenon as function of a large number of parameters, varying both in time and in space [5]. This space is valuable and often very long to recover [6]. Mediterranean soils are always subject to the repetition of fire and this made adapted [7]. Recovery post fire physico-chemical characteristics and the resilience of the forest of Western Algerian soil microbial properties are strongly dependent on weather conditions and the pastoral uses of fire systems [8]. Many works have focused on the effect of fire on vegetation but everything remains to be done in what concerns the influence of fire on the ground.

This work is designed to assess the impact of forest fires on some physico-chemical characteristics of the soil. The study area is located in the forest of Djaafra Chéraga (area located in the town of Ain El Hadjar, wilaya of Saïda, ecosystem developed on rocks calsimagnesique). These soil properties was investigated in four terms of fire, with an area where there have been no fire for more than 20 years we have call control station.

2. Material and methods

2.1. Presentation of the study area

The wilaya of Saïda (fig 1) is located north-west of the Algeria, it is bounded on the North by in Mascara province, on the South by that of El Bayadh, on the East by the wilaya of Tiaret, and on the West by the wilaya of Sidi bel Abbès. The wilaya of Saïda spans an area 6765 km^2 and a population of 340,000 inhabitants, administratively, it consists of 6 Dairates and 16 Communes [9].

The town of Ain El Hadjar (fig 1) is located 190 km from Oran coastline on National Highway 6 connecting Sig to Béchar. It covers an area of 448 km2 and is bordered on the South by the high steppe plains and North by the Oran Tell Atlas. The forest of Djaafra Chéraga spans Ain Manaa oued falette douars fairbairn of the mixed town of Saida.

It was definitely classified in the field of the State and subject to the forest by governmental decree of 25 February. The forest of Djaafra Chéraga (fig 1) occupies a total area of approximately 10177 ha, it is located between the mountains of Saida and DJ Hadid, Oum graf and El-Assa [10], currently divided into 13 cantons, the forest lies between 20 and 25 km west of the city of Saida and 8 km from the town of Ain El Hadjar. It is entirely located in the wilaya of Saïda. The forest is managed by the conservation of the forests of Saida, much of this forest is managed by the constituency and Ain El Hadjar district and the rest by the district of Youb.

From a climate point of view Djaafra Chéraga forest enjoys a climate long semi arid (m = 3°C; P = 344.6 mm) belonging upstairs of vegetation of the Mediterranean thermo(m > 3°C, 200< P<400 mm)

This forest receives an annual rainfall instalment irregular. The seasonal regime of these rains is of type HPAE, where rainfall is more abundant in winter and spring with a dry almost 6 month period extending from May to mid-October [11].

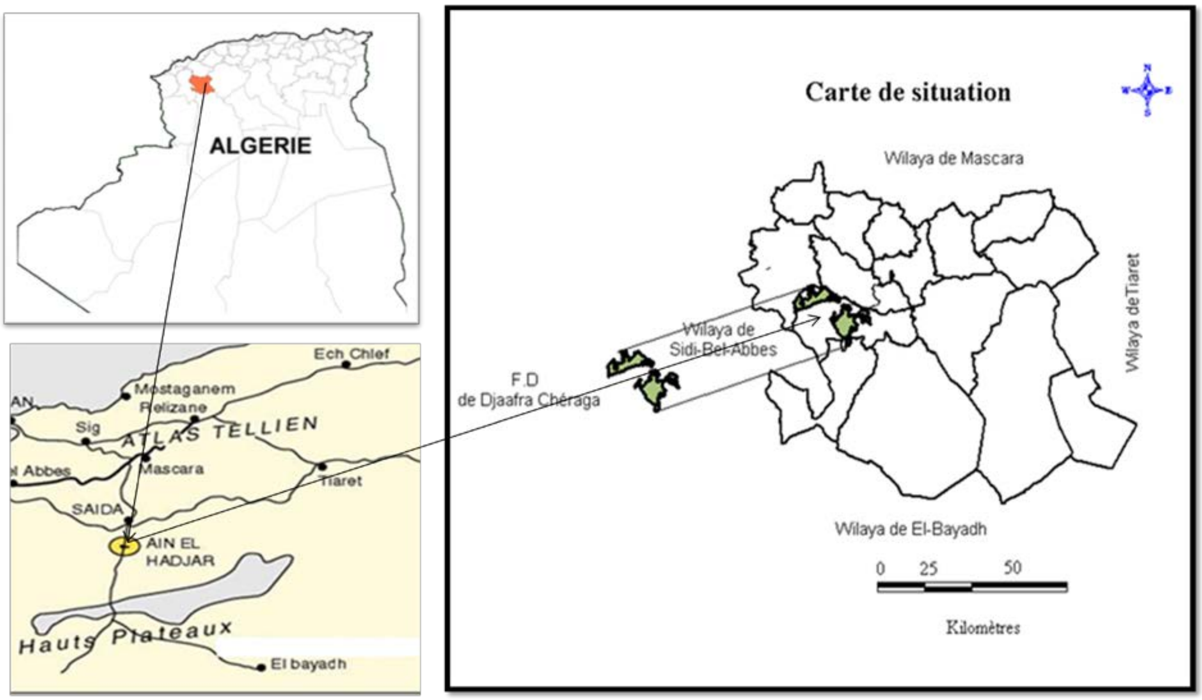

Fig 1. Location of the study area

2.2. Selecting the post fire and sampling of soil chronosequence

History of fire: A survey of regional and local forest services allowed to accurately determine the dates of the fires in the forest of Djaafra Chéraga on a 20 year period from 1990 to 2009.

In this forest massif, 20 plots of 400 m^2 each have been selected on the basis of the date of the last known fire for study, in climatic, orographic and geo-pedological conditions fairly homogeneous, the structural stability of the soil after the passage of the fire from a chronosequence of 2, 3, 4, and 20 years after the last fire. For statistical reasons (representativeness and data processing), five plots by modality of fire were considered.

General characteristics of the plots: in order to avoid the influence of other factors than plan fires on the variability between sites, selected plots (fig 2) have very homogeneous characteristics on the climate map, orographic and geo-pedological:

-A reduced study area and a little range of altitudes (800-950 m) for homogeneous climate conditions;

-One type of soil (limestone Brown according to the CPCS, calcosol according to the RP);

-Sites overwhelmingly exposed to the East or West (neutral radiation balance);

-Situations of representative average slopes of this type of relief (10-25%).

Soil sampling: on each parcel of study, five soil samples were collected randomly, after eliminating the litter at a depth between 0 and 5 cm corresponding to the organo-mineral surface horizon has. Five soil samples were then mixed to obtain a composite sample (1 kg).

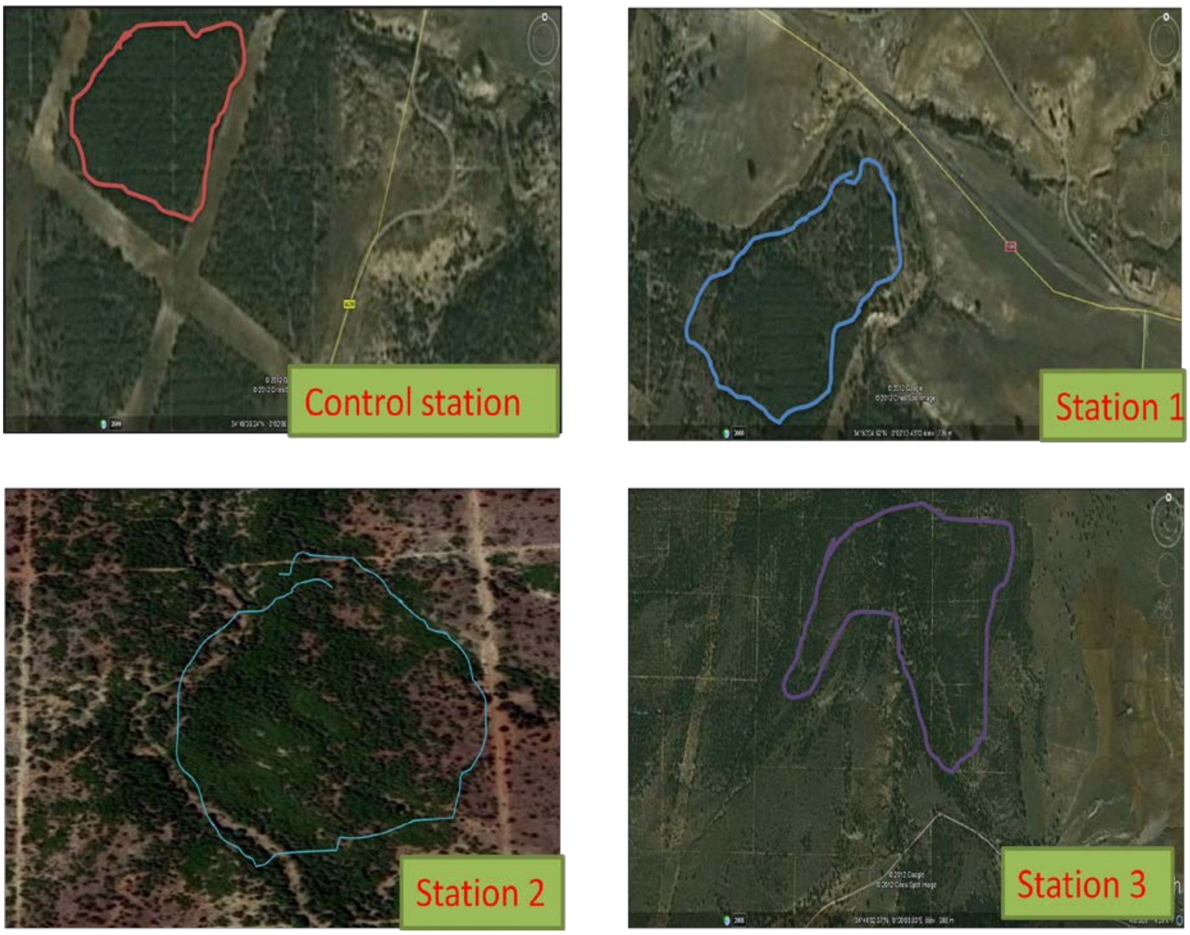

Fig 2: Location of stations of studies

2.3. Physico-chemical analysis

2.3.1. Particle size analysis and ground color

Particle size distribution (%) of 3 fractions (sands 2000 µm to 50 µm, coarse silts from 50 µm to 2 µm, clays < 2 µm) of fine soil was determined by sedimentation under the pipette Robinson [12] and sieving method. The colors were determined by «Mensell soil color chart».

2.3.2. Gravimetric moisture

The moisture gravimetric (% dry weight) was estimated by drying an aliquot of sample at 105 ° C for 24 hours. It was obtained by subtracting the mass of a sample of soil dried than this sample before drying.

2.3.3. Retention capacity

The water retention capacity was determined by the Bouyoucos method. The sample is dampened for 12 hours by capillary rise in a sintered glass filter of Buchner. Then the filter is placed on a flask vacuum connected to a trunk water to eliminate the water in the pores of less than 8 µm in diameter. The difference between the wet weight and dry weight (after drying at 105 ° C) allows to know the capacity of water in (%) retention of dry weight [13].

2.3.4. Organic matter

Organic matter content was measured by loss of mass of a dry sample during calcination at 550 ° C for 16 hours.

2.3.5. pH measurement

Soil pH was measured in a suspension of soil: distilled water (1: 2.5). The measurement was made after 2 h of stabilization at room temperature using a pH meter Métrom (Hérisau, Switzerland).

2.3.6. Electrical conductivity

Overall salinity samples was expressed in the form of the sum of the ions of aqueous extracts

2.3.7. Density apparent and actual

Bulk density was determined by the method [14]. The actual density was estimated by the method [15].

2.3.8. Porosity

Calculated porosity to been done starting from apparent and actual earthy sample densities [16].

2.3.9. Permeability

The permeability was determined by the method [15].

2.3.10. Measurement of the levels of calcium carbonate

Calcium carbonate levels were determined by Bernard calcimetre [12]. In a flask for Bernard calcimetre was introduced in the finger 5ml of HCL ½ with a straight pipette, then were weighed 10 g of finely ground soil that have been inserted into the vial, then it has dampened the Earth with water demineralised without excess.

2.4. Statistical study

Analyses of variance (ANOVA) to 1 factor were used to test the effects of time since the last fire on the physico-chemical properties of soils. Test post-hoc least differences of Fisher (LSD) was used to make multiple comparisons of means.

3.0. Results and discussion

The texture of the soil may be affected by the temperature rise; It is in fact only the fine Earth fraction (particles less than 2 mm) which is affected, i.e. the relative proportion of sand, silt and clay. Amended at the particle level by temperatures over 200 ° C, and mineral levels above 400 ° C [17].

With regard to our results, on the basis of the average particle size composition, studied soils have a texture Sandy (table 1) and cela for any selected stations. Apparently for our study area, the time since the last fire has no significant impact on the proportions in sands, silts and clays of the soil, so the texture is not affect by these fires, our results corroborate with [8] made in the forest of fenouane.

Table 1: Results of analyses particle size and color of the soil.

Station	Station T	Station 1	Station 2	Station 3
Texture + color	Sandy Brown	Sandy Reddish	Sandy Reddish	Sandy Reddish

These can be explained either by low-intensity fires that has experienced this forest which has not altered the texture or even the poor transmission of heat by these soils in fact only 5-15% of the energy released during combustion is transmitted to the ground. Moreover, the sandy earth misconducts heat: the layer of soil affected by a significant temperature rise does not exceed 5 to 10 cm thick [18]. Also the absence of litter and a permanent humus especially in summer do not increase the temperature of the soil the ors from a fire and significantly deprived the probability of a surface fire. According to certain author litter and humus have fundamental roles as they can be, depending on their thickness, their structure and their water content, or fuels and then contribute to the heating of the ground, is instead insulating [19]. The first visible consequence of fire is changing the color of soil that can serve as an indicator of the severity of the fire [20]. Generally soil color in black after a fire severe, which is of to the carbonization. Our results show that all the sites studied have a « reddish » indicator of presence of specific red fersiallitic soil iron oxide very present in the forest Djaafra Chéraga [10]. Which indicates that the fires have not altered the color of these soils and this confirms that their intensities was not very important. Our results are shown that these soils are calcareous. No literature shows the impact of the fires on this limestone in the soil, indeed its presence is of course to the geological substrate of this area which is rich in limestone as shown in some of the work of the [10], soils in the study area are quite diverse forming a mosaic where are distinguished from soils canraw minerals, fersiallitic and limestone Brown.

We notice on (fig 3) the low rate of soil moisture in stations 1, which has undergone a fire in 2009 and station 3 affected by a fire in 2010, however this humidity is almost same for the control station and station 2 which has suffered a fire in 2008, also that it is no significant difference between the control station and station 2 also station 1 and 3. Can be explained cela by the fact that the recent fires does not allow ground to recover quickly and will reduce the chances of plant regeneration and revitalisation of the biological activity and therefore the reconstitution and uptake of moisture to the fields, some authors shows also the soil moisture rate increases when the number of fires decrease or when the time after the fire increases [21].

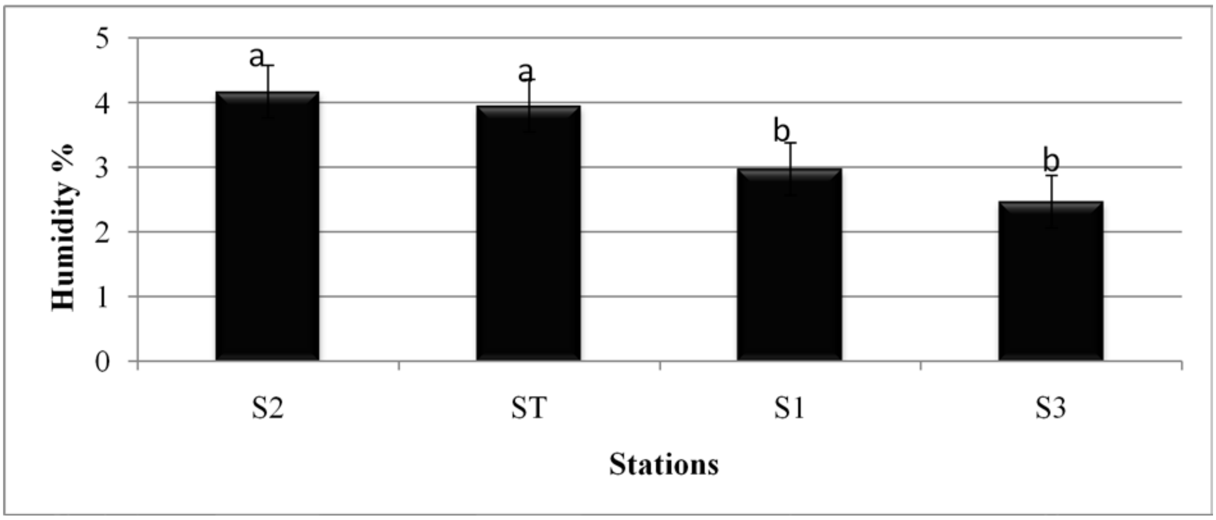

Fig 3. Soil moisture

Soil analysis shows station 2 which has suffered a fire in 2008 presented the most important organic material (fig 4) quantity, indeed in this station fire spurred the reconstitution of plants (especially at the level of the stratum herbaceous and shrub), and the time since the last fire has allowed a good reconstruction of plant material and so the recovery of the stocks of organic matterin fact [8], showed that in the forest of Fenouane four years were sufficient for the activities bound to organic matter found the level measured in soils not burned.

The control station has a low rate of organic matter compared to station 2. This can be explained by the fact that this station is undergoing degradation to the level of herbaceous and shrub stratum affected by several factors such as overgrazing, the anthropic action, severe climatic factors and the absence of fire for stimulation of the vegetation. Stations 1 and 3 fire respectively in 2009 and 2010 shows a low rate of organic matter. The burns gradually deplete soil organic matter [8, 20]. This shows that these stations have suffered several fires that have significantly reduced organic matter rate in these soils. The low rate of organic matter can also be explained by the low rate of recovery as well as the nature of hardly degradable foliage [22].

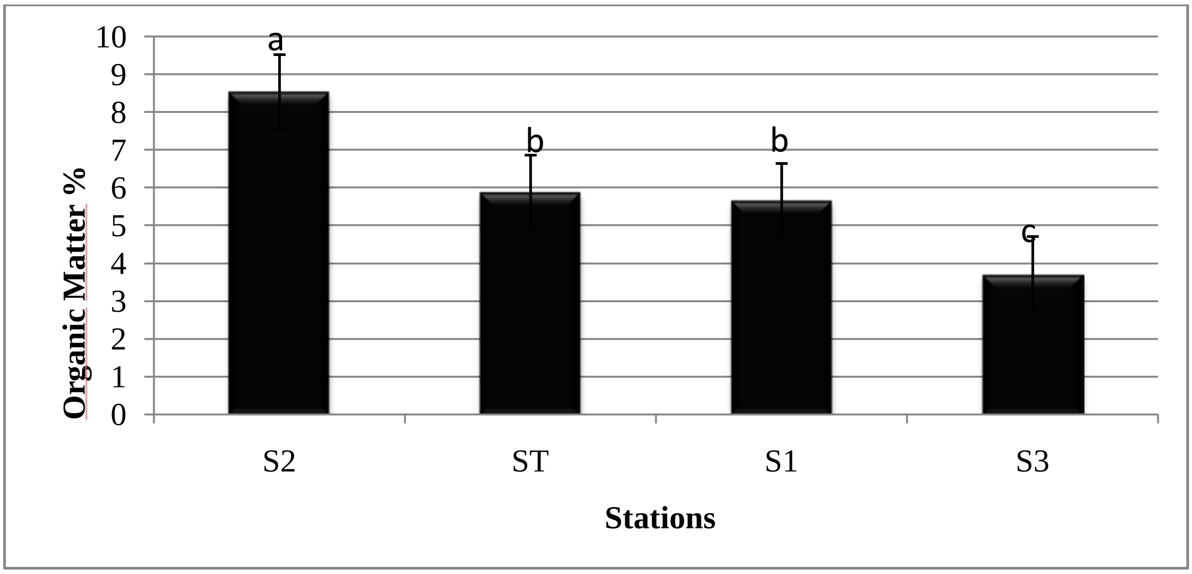

Fig 4. Organic matter

Of after results (fig 5), there is an increase in the rate of station 2 holding capacity higher than stations control, station 1 and station 3 who undergoes a fire recently in fact, the water regime is disrupted following the destruction of vegetation this to result the decrease of water retention.

Several authors agree that retention capacity decreases if organic matter is destroyed by fire [19]. The results of [23] also show that fire decreases the retention capacity of the soil water [8]. Fire induced a decrease in the stability of aggregates leading to a particulate structure. This transformation results in the reduction of capacity to retain water [24].

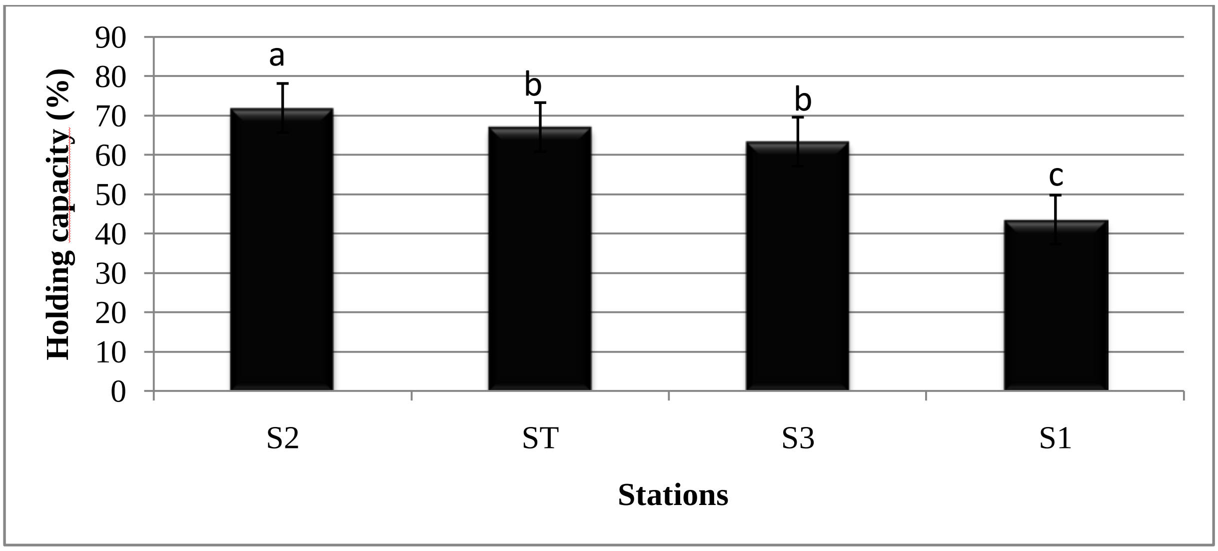

Fig 5. Retention capacity

These measures of the water pH and pH KCL (fig 6), helped to highlight the negligible difference in acidity between different soils and a tendency to neutrality for all the stations that do not have suffered fire in recent years. This confirms our results with [25] which show that forest fires do not have a great influence on the pH of the soil. Reaches pH level can increase for a year, and then back down to its initial value as a result of repeated fires. Return to the initial state is faster that the burning was of low power [19]. Also [26], has shown that the pH increases in non-calcareous soil after a fire or our soils are very hard.

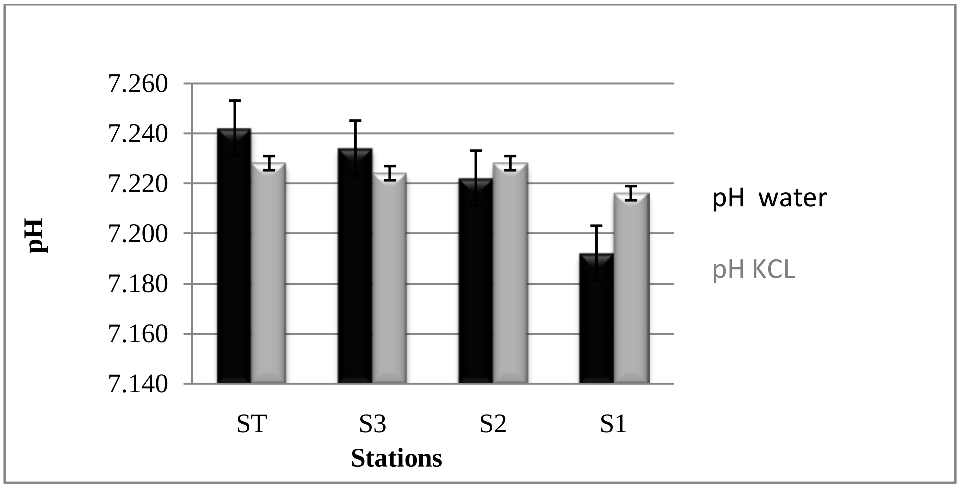

Fig 6. pH water and KCL

Based on the salinity scale, note that all stations are classified as unsalted (fig 7), indeed fire did not directly affect the salinity of the soil. Some authors have shown that at very low concentrations, some salts present in the natural state in the soil are absorbed as nutrients by plants.

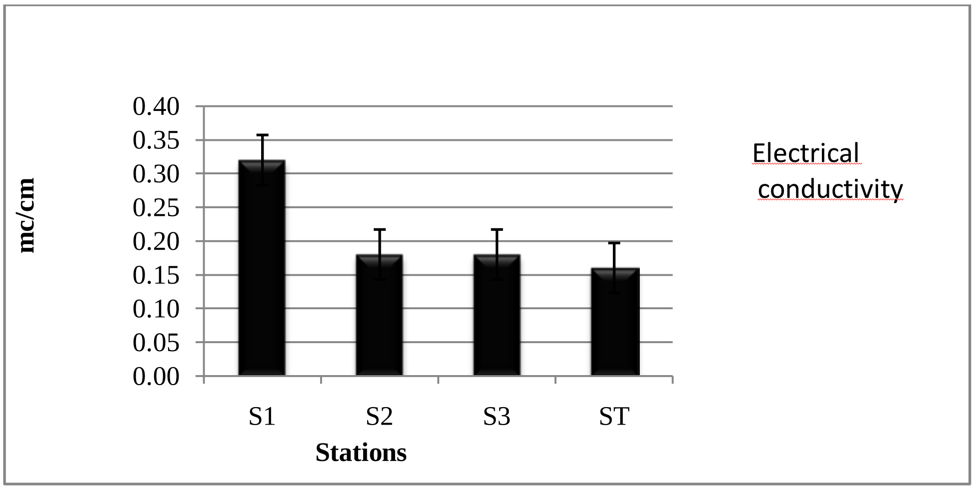

Fig 7. Electrical conductivity

And after the results obtained (fig 8 and 9) observed low rates of actual density and apparent density level control stations and station 2 having suffered a fire in 2008 compared with stations 1 and 3, which have important density rates.

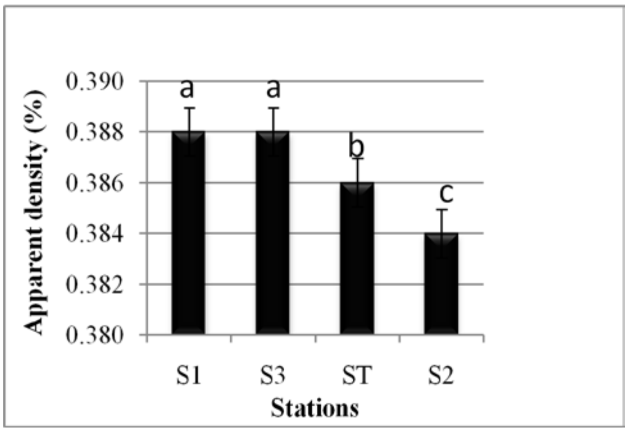

Fig 8: Apparent density

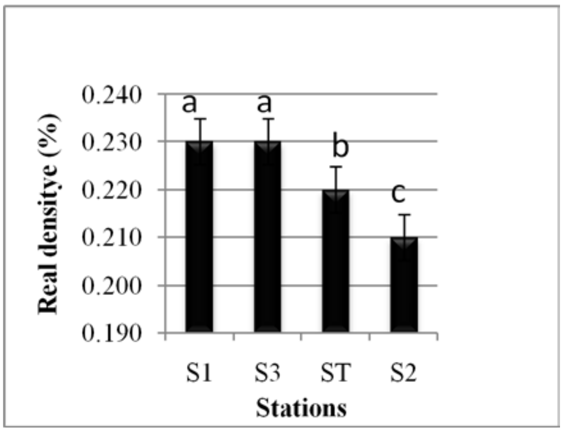

Fig 9: Real density

However there is the opposite effect for porosity and permeability (fig 10 and 11) that at the level of the control station and station 2 are higher stations 3 and 2, who suffered a fire recently in 2009 and 2010, this shows that fires have an effect on these parameters, the recent fires increase density and thus deprived the porosity and the permeability of soils Indeed the volume density increases due to the collapse of aggregates and the blockage of the gaps by ash and dispersion of mineral clays.

This has a consequence on the porosity and the permeability of the soil that decrease [26]. Also [19] shows that the infiltration capacity of the water in the soil, closely related to the porosity of the soil, is therefore also affected by ash clogging the pores. Its decline may also be due to the creation of a hydrophobic layer. Several authors agree that the porosity of the soil may be affected either by the clogging of the pores by the ashes, a collapse of the structure consecutively to the loss of organic matter [19]. Fire reduces the porosity of the soil. Overall, the soils of "burned" plots are less porous than soils of the unburned plots [27]. Moderate soil fires create a thin continuous and hydrophobic surface thereby decreasing its permeability [20].

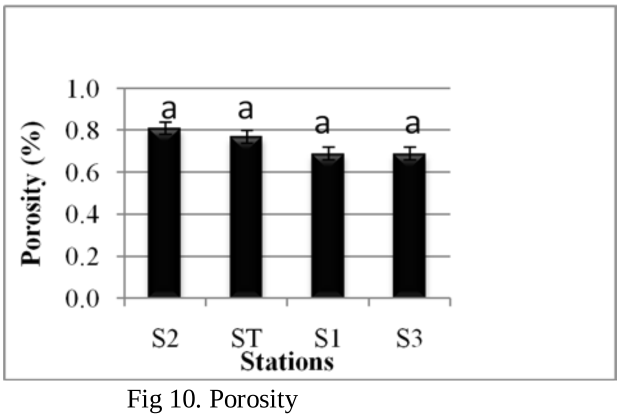

Fig 10. Porosity

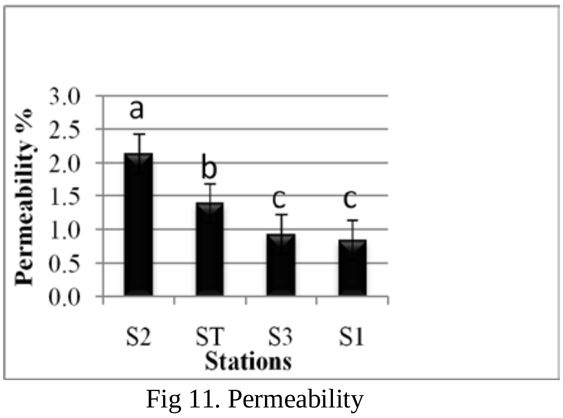

Fig 11. Permeability

4.0 Conclusion

Forest fires are increasingly news. The subject is all the more worrying that it is difficult to predict the future of the forests of much of the Mediterranean and semi-arid and arid area. Some speak of rapid restoration of forests after fire. Except that moving on the ground, the conclusion is quite different. Degrade the landscapes, ecosystems are getting poorer and diversity faunistic and floristic tends to decrease. It is therefore important to assess the impact of the fire in time.

In this study we sought to highlight the consequences of fires on the physico-chemical characteristics of soils based on the time after the last fire and see the type of disturbance that affects the soil.

There is that fire has no visible effect on the texture, color and the soil pH because the fires which have affected the study area was low-intensity on the other hand, they have a direct and immediate effect on density, permeability and porosity of the soil, as soon as a fire occurs the porosity decreases, it is the balance of the soil that is threatened.

A period without fire of 4 years is obviously sufficient for a natural physico-chemical and this quality restoration regardless of the history of fire. Longer term, frequent fires permanently alter the chemical quality of the organic matter of the soil.

« *The soil is a non-renewable resource essential to the survival of ecosystems and human activity* ». Its preservation requires a study and follow-up based on its quality indicators.

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