Study of the principal properties of Humiferes horizons under Retama retam Webb, Tamarix gallica L and Tamarix aphylla (L) Karst in the dunes cordon of El-Mesrane (W. Djelfa) in Algeria

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Abstract:
Our study will allow to identify the effect of the litter quality under three plantations types on the formation of the superficial horizon of grounds, by a description of the morphology of the formed horizons and a chemical characterization of the litter accumulated under the various plantations of Retama retam Webb, Tamarix gallica L and Tamarix aphylla (L) Karst in the dunes cordon of El-Mesrane (W. Djelfa) in Algeria. The obtained results show that the contents C % and C/N is high under the majority of the statements realized under Retama retam by report in the plantations of Tamarix aphylla and Tamarix gallica and the report C/N under Retama retam. Webb presents a maximum value. It shows an improvement compared with dunes fixed by Tamarix gallica. L and Tamarix aphylla. (L) Karst, what expresses the situational potentialities relatively better.

We so register a change of the pH of the sandy soil, the balkanization of the superficial horizons (H.A) under main fixed dunes and a low difference between the pH (H₂O) and the pH (KCL), what shows that grounds present a low capacity of exchange.

The measure of the thickness of the superficial layer of the ground of studied dunes showed that are well dunes fixed by Retama retam. Webb and Tamarix gallica. L which present rather important thicknesses in front of those fixed by Tamarix aphylla. L Karst where we note its absence in the lively dunes.

The analysis of the profiles shows that the profiles realized in the fixed dunes are of type AC where we note the absence of the horizon B with an active physical disintegration and a low rate of humus, what allowed us to classify them in the little evolved grounds and the ground of dunes submitted to the influence of fixation in the raw mineral grounds.

Key Words: Zahrez Gharbi, El-Mesrane, Desertification, Fixation, dune, Retama retam Webb, Tamarix gallica L and Tamarix aphylla (L).

Introduction
The ground is not any more considered as do not sluggish reflecting, only the composition of the underlying rock, it originates, it evolves under the effect of the environment said (‘active); climate and vegetation. The development of a ground is confidentially connected to that of the vegetation.

The dunes cordon appears as a major topographic element at the level of the pond of Zahrez (Gharbi and Chergui), and constitute a permanent threat for the surrounding ecosystems. Under the influence of the wind dynamics, free sands colonize the bordering zones (ground of culture, parcour and infrastructure). Considered as one of the most visible appearances of the desertification, dunes by their mobilities, engender considerable economic and social repercussions.

The different fixation works on dunes led by the NIFR (the national institute of the forest researches) since 1982, in the two experimental projects on the dune cordon of Zahrez Gharbi at the area called El-Mesrane (W. Djelfa) consist in testing the different mechanical and biological dunes fixation technically and in comparing their resistance to the environment conditions, as well as their efficiency to reach a stabilization model that is secure and economical. However, consequently to these dunes fixation studies, the current necessity is to establish a qualitative and quantitative evaluation of the different experienced operations. Many studies to have been achieved in the dune cordon of El-Mesrane (W. Djelfa) In order to know and inquire of the reaction and efficiency of the different alive and inert materials, introduced at an experimental level on the lively dunes. We cite as an example, the Makhlouf works 1992. on the sedimentologic studies of the sands of the dunes cordon in the Zahrez Gharbi basin (Djelfa), Choulal, Hammoudi, Makhlouf and Tolba (2000), which have proved the Algerian experience in the area of mechanical and biological fixation of the windmill formations, such as the case of the experimental

In our study; according to the works of fixation of dunes led by the NIFR since 1983, the sandy grounds of the dune cordon of El-Mesrane (W.Djelfa) evolving under a vegetation of *Retama retam*. Webb, *Tamarix gallica* L and *Tamarix aphylla*. (L) Karst so their floral processions show considerable differences which are easily translated by the thickness, the structure and the chemical composition of the humifere horizon.

To study the effect of the litter quality under three plantations types of on the formation of the superficial horizon of grounds, It is necessary to deepen the knowledge in the plots of land experimented on the influence of the vegetation on the main properties of humifere horizons in ugly of a description of the morphology and a chemical characterization of the main horizons as well as the litter under the various plantations (*Retama retam*. Webb Retined, *Tamarix gallica* L and *Tamarix aphylla*. (L) Karst)

**Description of the studied area**

**Geographic situation**

The studies area is situated at the dunes cordon level according to Pouget (1980), this area is part of the Zahrez Gharbi basin in the high south plain of Algiers. Our studies area called El-Mesrane, at 35 kilometers of the north of Djelfa Town; it represents a middle altitude of 860m, which geographic coordinates are:

- Longitude: 3° 00 and 3°03 E.
- Latitude: 34°34’ and 34° 36 N.

The specific studies area includes the different fixed dunes in 1983 by the INRF in the fixation projects experimental of the dunes (Fig 1).

**Fig 1: Location of the fixation projects experimental of the dunes on the dune cordon of Djelfa Bousaada.**
Geology and geomorphology
The dune cordon is a recent geologic formation appears at the end of the tertiary and the beginning of the quaternary, coming from the soft rocks (marlstone and red clay). Which have been extracted by the erosion of the mountainous, as well as the presence of salt Limestone Gypsum and soluble salts) has many effects on the composition of waters either underground ones or superficial one. (fig 2 and 3).

Figure 2: The coalescent dunes that form the dunes cordon.
Photo taken by Guerrache, March 2013.

Pedology
According to Pouget (1980); the color of the sands varies from the red (5 YR 5/6-6/6) to the white (IO YR 8/1) while passing through the yellow (7, 5 YR 6/6 à 6/4). As for most windmill formation of this kind, the granulometric fractions inferior to 50µ (clays and thin Silt) are practically absent. Figure 4 (a, b, c, d)
Vegetation

The dunes cordon is characterized by sandy vegetation and phreatophyte (figure 5: a, b) (Tamarix sp, imperata cylidrica, phragmites communis). We can distinguish several groups:

To the north: the principal Nebkas are colonized by the following groups: Tamarix and salocornes, sparte (Lygeum spartum, Artemisia campestris, Drinn (Aistida pungens), saccocalyx saturoides.

Between the Zahrez the crassulescentes steppes to Salicornia arabica and Suaeda mollis are dominant to the south –west of the dune cordon on the alluvial soils: steppes at white Artemisia (Artemisia herba alba), sparte (Lygeum spartum), Artemisia campestris, as well as cereal cultures between these different formations. The species used for the biological fixation at the level of El-Mesrane dunes are: Atriplex halimus, Atriplex canescens, Atriplex...
nummularia, Acacia cynophylla, Acacia cyclos, Eleagnus angustifolia, Gleditchea triananchos, Lycium arabicum Medicago arborea, Opuntia ficus indica, Pistachia atlantica, Prosopsis juliflora, Retama retam, Tamarix aphylla, Tamarix gallica.

Climate
To support the climatic characteristics of our studied zone, we made a synthesis of the data for the meteorological national office of Djelfa of a period of 30 years (1983-2012). The climate presents characters qualified with a pronounced dry tendency, dry semi lower type in winter freshly characterized by a long dry season going from May till October due to the geographical position, between the influences of the South and that of the Mediterranean in the North.

The climate is rigorous extreme and uncertain, a low and irregular annual pluviometric slice, it is of the order of 313, 99 mm / year. And the annual average temperatures accuse one maxima in July (32, 91°C), and of minima in January (9, 46°C) more winds are often violent what would prevent any installation of the vegetation without an adequate system of protection.

Methodology and Sampling
Sampling of the ground and Taking of the litter
At the level of the dunes cordon several species were tested. We were interested in our study in Retama retam webb, Tamarix gallica L and Tamarix aphylla (L) Karst.

The composition of the litter depends on the date of harvest of the plant material with the aim of its analysis; that is why, within the framework of this study, litters were collected at the same time by their vegetative cycle. The sampling was made at the end of the spring, 2013.

We preceded takings of the ground from the soil profiles only the superficial horizon (5 in 15cm) was considered.

For the edaphic data, we were largely inspired by studies supplied by Aubert (1978), Duchauffour (1970) and Maignien (on 1969 and 1980).

We defined the layer of litter, the layer of fermentation and the layer humifere with their respective thickness.

Chemical dosage of the ground and the litter
The samples of grounds and litters were weighed wet then dried in 70°C in bags of paper until the obtaining of a constant weight.

The mineral fraction was then sieved in 2 mm to standardize the material. The litter was finely crushed; this material was then used for the chemical analyses. (PH, organic carbon and the total nitrogen). Baize (1988 and 2000).

Measure of the pH
Consists measured the acidity current (H₂O) and the potential acidity (KCL) by the method électrometrique.
Measure of the Organic carbon
To determine the content in organic matter; we used the method of ANNE (1945) which consists in determining the rate of carbon principal constituting of organic matter.

Measure of the Total nitrogen
It is determined by the method of KJELDHAL. This method allows transforming the nitrogen of organic compounds into ammoniacal nitrogen by the sulfuric acid concentrated in the presence of a catalyst. This technique takes place in three stages among which the mineralization of organic compounds, the distillation and the dosage (FNOS, on 1999). The result expresses in percentage (%).

Numerical treatment of the data
We applied multivariate statistical methods; Analysis in principal Components (APC) and the ascendant hierarchic classification (AHC) to the results of the chemical dosages of the ground and the litter. We utilized the software; version 5 statistica.

Principle of the ascending hierarchical classification
The AHC is a technique of classification. It tries to group by similarity the individuals of a set of data (the statements, the variables) this similarity is estimated by “homogeneous” classes. Benzecri (1993) and Tenenhaus M (2007).

The Analysis in principal Components (APC)
The principle of this essentially descriptive method consists in transforming p initial quantitative variables quite more or less correlated between them, p new not correlated quantitative variables were called Component main. It is the method which allows presenting graphically the maximum of information contained in a board of data Benzecri (1993) and Tenenhaus M (2007)

Results and Discussions
Description of the morphology of humiferes horizons
On the ground we realized soil profiles. Every profile is characterized by one or several horizons. The following figures represent soils profiles realized under the studied plantations:

Profile of dunes fixed by Tamarix gallica. L
The figure 6 of the soil profile realized on dunes fixed by Tamarix gallica. L two very different horizons, horizon allowed us to distinguish A and horizon C.

The horizon A of 0.5 Cm in 10 Cm; it is constituted by fragments of dead vegetables (needles of Tamarix gallica. L twigs) more or less transformed into aerobic conditions and situated in the top of the soil cover. According to the degree of transformation of the plant fragments, we distinguish 3 types of horizons:

A00 or L): of a thickness remarkable from 0.5 to 1 cm on quite the fixed surfaces, groups the big very recognizable part of litter, contain insects and ants.

A0 (O): organic horizon with modified original structure or destroyed more than 30 % of the organic matter (litter).

A1 or (Ah): of 8cm in 10 Cm, mixed horizon containing a mixture of the organic matter (less than 30 %) and some mineral. We observe the beginning of structuring, polyhedral structure subangular average in very fragile liqueur brandy with unrefined texture, with a hairy root of various diameters very plentiful, of color brown red (5 R 5/6 to 7,5 YR 5/6) colored by the organic matter.

The horizon C: horizon determined by a sandy texture and a particular structure of red color and the rate of implanting vary according to the depth also the humidity. The presence of roots bigger than that of the horizon A.
Figure 6: soil profile of the ground of dunes fixed by *Tamarix gallica*.

**Profile of dunes fixed by *Tamarix aphylla*. L) Karst**
The analysis of the soil profile realized on grounds fixed by *Tamarix aphylla* (L) Karst (fig.7.) allows us to distinguish two horizons A and C.

**The horizon A;** whose litter generates a humus layer moderately asset by bioturbation in the first centimeters of the horizon A.

**A00 L;** of an important thickness vary of 0.5 cm in 5 cm, it consists of cool or already partially split up litter, the main part of the litter consists by the material resulting from *Tamarix aphylla*. L). Karst: needles in the various stages of fragmentation, inflorescences and the twigs forming the most resistant part in the decomposition and as well as that of mycelial strands which indicate a zone of lesser biological activity.

**A0;** we do not however assist an accumulation of organic matter not decomposed present a black color with the apparition of a low polyhedral structuring.

We note the absence of mixed horizon (A1) (mixture of the organic matter (less than 30 %) and some mineral) so a low structuring and the absence of roots.

**The horizon C:** horizon determined by a sandy texture and a structure particular of red and very wet color. We note a low rate of implanting with the presence of bigger roots from 30 cm.
Profile of dunes fixed by Retama retam, Webb

The soil profile of 30 cm realized at the level of dunes fixed by Retama retam. Webb (fig.8) also reveals two horizons A and C.

The horizon A; vary between 0.5 in 10 cm containing some organic matter result litters of leaves, flowers and twigs of Retama retam. Webb as well as the litter of the annual, this horizon he even is subdivided into three under horizons differentiate by the rate of degradation of the litter, the structure and the color.

A00 or (L): with a 0.5 cm thickness remarkable on quite the fixed surfaces, includes the big part of good litter recognizable, contain insects and ants.

A0 (O): organic horizon of some millimeters with modified original structure or destroyed more than 30 % of the material where we note black spots depreciates on a layer of some mm with the presence of some human beings (ants, worms, earthworms).

A1 or (Ah): takes the big part vary of 5 cm in 10 cm, mixed horizon containing a mixture of the organic matter (less than 30 %) and some mineral. We observe the beginning of structuring, polyhedral structure subangular average in very fragile liqueur brandy assured by a hairy root very fine little abounding. Of reddish yellow color (7,5 YR 6/6 in 6/4) colored by the organic matter.

The horizon C; takes the big part of the profile determined by a sandy texture and a particle structure of red color and the rate of implanting vary according to the depth also the humidity. The presence of roots bigger than that of the horizon A.
Profile of the lively dunes submitted to the influence of the fixation
The soil profile (fig.9) reveals that the lively dunes present a single mineral horizon (C) of particle structure, in sandy texture of reddish yellow color (7, 5 YR 6/6 in 6/4).

Comparative study
The comparison of the soil columns realized under the various dunes fixed so the lively dunes considered as witness, show as the profiles realized in the fixed dunes are of type AC where we note the absence of the horizon B with an active physical disintegration and a low rate of humus, what allowed us to classify them in the little evolved grounds and the ground of dunes loose in the raw mineral grounds.
Indeed even if the composition of the mineral fraction is homogeneous as well as the same period of plantation; the structure, the thickness so the degree of decomposition of the litter is very heterogeneous.

The best grounds are best humidified with a thick layer, the more it is thick, the more it contains of humus, more are favorable to the hydro-air and nourishing conditions existing in the ground.

The thickness of the horizon A00 layer of litter is almost absent for dunes loose; on the other hand it is very important in dunes fixed especially dunes fixed by *Tamarix aphylla* (L). Karst followed by dunes fixed by *Tamarix gallica*. L and finally dunes fixed by *Retama retam*. Webb

This difference can be explained by the influence of the fixing vegetation (*Retama, retam* Webb, *Tamarix gallica*. L and *Tamarix aphylla*. (L) Karst) and the contribution of the litter engendered by each of these species as well as its speed of decomposition which to allow him in the accumulation on the surface of the ground.

In spite of the annual effects from litter (leaves, flowers, fruits) of *Retama retam*. Webb is brought up, their accumulation on the surface of the ground is less important than the litter of *Tamarix aphylla* L) Karst and *Tamarix gallica*. L also the accumulation of the litter under *Tamarix aphylla* (L) Karst is superior to that of *Tamarix gallica*. L, thus the accumulation of the litter in the superficial horizon depends on the nature and the rate of biodegradation of the litter. We speak about improving litter, rich in nitrogen, and of acidifying litter, who decompose more with difficulty. The first ones activate the microbial life; the second depress it, what explains the biological low activity under the litter of *Tamarix aphylla* (L). Karst. Bardgett R.D. (2005).

The skin of the leaves of *Tamarix aphylla* (L) Karst contains bicellular glands that secrete a declining salt which crystallizes by extending beyond the cavity, forming white cupules Trabut (1927), what gives probably to leaves their grey color.

What gives probably to leave their grey color. So the analysis of the galls of flowers to which preceded Trabut (1927). Revealed that 49.95 % is represented by tannins and congener, who plays a tanning role, which prevents and blocks the mineralization of the nitrogen. This is confirmed by the report C/N which is lower than 6 under these plantations.

Killian (1948), which studied the humification of the nebka with *Tamarix aphylla* (L) karst, concludes that the litter is plentiful of the tree has a very slow decomposition because of the weakening of the microbial life of in the drought of the climate and in the salinity of the ground.

We also note a difference of the thickness, the color and the structure at the level of the horizon A0, it is absent in the lively, very low dunes in dunes fixed by *Tamarix aphylla* L). Karst, and of some millimeter in the grounds of *Tamarix gallica*. L and *Retama retam*. Webb. It is formed by organic matter with modified original structure or destroyed more than 30 %, varies according to the fixing vegetation because of the activity of microorganisms, earthworms, ants etc. more intense due in the conditions of humidity more favorable.

This decomposed organic matter allows the formation of a superficial film rich in organic matter favorable to the preservation and to the development of the vegetation and give afterward the stability of the fixed dunes.

It is advisable to indicate still the absence of the horizon A1 in the lively dunes as well as the dunes fixed by *Tamarix aphylla* (L) Karst with an important improvement of this horizon in the grounds of dunes fixed by *Retama retam*. Webb and *Tamarix gallica*. L which is colored by black spots of organic matter. This is explained by an accumulation of the organic matter decomposed of *Retama retam*. Webb and *Tamarix gallica*. L in the mineral horizon after a washing from the horizon A0. These results confirm the low contribution of litter under *Retama retam*. Webb and *Tamarix gallica*. L.

The absence of roots in the first 30 centimeters of the ground of *Tamarix aphylla* L) Karst returns to the development of a system root powerful and deep; which can affect the groundwater more than 25 m. According to Quezel (1965). The groundwater of the grounds which it colonizes varies between 7 and 8 m.

**Results of the physico-chemical analyses**

To complete the previous study, an Analysis in Main Components (APC) was made on thirty (30) observations and five (5) variables by means of the software STATISTICA version 5.1.

This analysis, show that the first two axes (tab. 1) reconstruct 73 % of the information with a net decrease between the second and the third axis.

**Table1**: extraction of the main components and the clean values of 3 reserved axes

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<td>ValPropr</td>
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<td>2</td>
<td>1.542222</td>
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<tr>
<td>3</td>
<td>0.884646</td>
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</table>
The coefficients of correlation between the initial variables and the main axes (tab. 2 and Fig 10) highlight the contributions of each of these variables in the construction of these axes.

We notice a good representation and a grouping of 2 variables on 5 (tab. 2) which contributes to the formation of the 1st axis ($r > 0.8$). Variables PH-(H$_2$O), PH-KCL, and C contribute with regard to the formation of axes II and III ($r > 0.8$).

**Table 2:** contribution of variables to the formation of axes I, II and III (method of extraction raw Vari-max).

<table>
<thead>
<tr>
<th>Suite...</th>
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<td>C</td>
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<tr>
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<td>Prp. Tot</td>
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</table>

We shall retain for our analysis the plan I-II which allows us to separate the various statements according to their content in PH (KCL and water) in Carbon and in report C/N.

The distribution of variables with compared with the plan I-II (fig. 10) show that variables C and C/N contributes to the formation of the axis I (marked weight > 0.8), variables PH-WATER and PH-KCL contributes to the formation of the axis II and the variable N % in the formation of the axis III.

Therefore, the characters which correspond globally to the concentration of the carbon in touch with the nitrogen (C and C/N) intervene in the similarity between the various statements while variables PH-WATER and PH-KCL creates the difference.

The projection of the coordinates of the individuals on the plan I-II (fig. 11) forms three clouds of clearly separated points. But as it is not always easy to draw net limits between certain points of the cloud, and to solve the difficulties met by the APC, we were brought to complete our analysis by the use of the results supplied by the AHC (Fig 12).
The representation of this one is supplied under the shape of a tree or dendrogram who allows the partition of all the statements in groups. Continuation at the level of cut chosen, the analysis of the hierarchical tree (figure12) so reveals the differentiation of three groupings.

The first group to the left (G1) of the graph is formed by the statements which have concentrations raised in Carbon and in report Carbone- Nitrogen contrary to the second group to the right of the graph (G2) which groups the statements which are characterized by low content in Carbon and C/N.

Contrary in both first one groups the third group (G3) at the bottom of the graph is formed by the statements among which the PH-water and the PH-KCL are high.

This analysis allowed us to separate the statements with compared their content in Carbon in report C/N and in pH (H₂O) and pH (KCL).

Board 2 gives us the distribution of statement in strong contributions in the formation of both factors in various groups, as well as their content C %, C/N, pH (H₂O), pH (KCL).

These results watch that the contents C % and C/N is high under the majority of the statements realized under *Retama retam* (G1). With compared with the plantations of *Tamarix aphylla* and *Tamarix gallica* (G2).
The carbon varies between 60, 29 % and 77.16 % under Retama retam against 2.11 % and 8.46 under Tamarix aphylla and Tamarix gallica. The C/N varies between 15.30 and 19.58 in G1 and between 0.53 and 2.1 in G2. The report C/N informs about the wealth in nitrogen of the humus and consequently about the speed of mineralization. The more the report C/N is low, the more the mineralization is fast and big. Above a C/N = 25 (inactive Mor), the mineralization is slow and produces only a small quantity of mineral nitrogen Dommergues and Mangenot (1970). It affects its maximum threshold for a value of C/N of 10; this report constitutes a good criterion allowing characterizing the humus.

The properties of litters are the reflection of the vegetation which so exercises an important action on the pedogenesis by their intermediary, a good presence of carbon (organic matter) and total nitrogen in the ground so engendering a more or less optimal report C/N.

The evaluation of C / N in our case shows that all the values are lower than 25 and between 2, 75 and 21.5. It means that the organic matter is directed to a strong mineralization.

The report C/N under Retama retam. Webb presents a maximum value. It shows an improvement compared with dunes fixed by Tamarix gallica. L and Tamarix aphylla. (L) Karst, what expresses the site potentialities relatively better, it is understandable that the content in carbon which is significantly brought up compared with the other grounds studied so a low content in nitrogen.

So on these plantations we note a vegetation herbaceous sandy plants young, little lignified tissues diversify compared with two other plantations, in broad outline, are rich in water-soluble favorable to the microbial activity; they quickly decompose.

These results watch however the feeble difference between the pH (H2O) and the pH (KCL); what shows that its grounds present a low capacity of exchange.

This is explained by their low content in organic matter, of clay and devoid of colloids. According to Pouget (1980), in the raw mineral grounds of wind contribution the content in fine elements (clay and fine silt) is always very weak (C + FS 5 %). Grounds little evolved in wind contribution, the coarse texture, (C + FS) between approximately 5 and 10 %. That influences negatively the formation of the complex clayey humique absorbent and afterward the capacity of exchange.

**Conclusion**

The objective of this work is a contribution to the qualitative and quantitative study and the decomposition of the litter under Retama retam. Webb Tamarix gallica. L and Tamarix aphylla. (L) Karst in the dune cordon of El-Mesrane (W.Djelfa). That this was to include the effect of the vegetation on the evolution of the humus horizon and improvement of the physico-chemical properties of the ground.

To study the effect of the quality of the litter under three types of plantations on the formation of the superficial horizon of grounds, we realized a characterization of humus horizons is necessary for ugly of a qualitative and quantitative study of the floral diversity so a description of the morphology and a chemical characterization of the litter under the various plantations (Retama retam . Webb, Tamarix gallica L and Tamarix aphylla. (L) Karst).

The analysis in main component of the main chemical elements of the humus horizon shows that the contents C % and C/N is brought up under the majority of the statements realized under Retama retam report in the plantations of Tamarix aphylla and Tamarix gallica and the report C/N under Retama retam. Webb presents a maximum value. It shows an improvement compared with dunes fixed by Tamarix gallica. L and Tamarix aphylla. (L) Karst, what expresses the site potentialities relatively better.

A change of the pH of the sandy soil, the alkalization of the superficial horizons (H.A) under main fixed dunes. A low difference between the pH (H2O) and the pH (KCL), what shows that its grounds present a low capacity of exchange.

The results physico-chemical of the ground of the fixed places were very decisive suggesting the existence of a edaphic " evolution " beneficial for the ground and very useful especially for the development and the growth of the installed vegetation.

The measure of the thickness of the superficial layer of the ground of studied dunes showed that are well dunes fixed by Retama retam . Webb and Tamarix gallica. L which present rather important thicknesses in front of those fixed by Tamarix aphylla. L) Karst where we note its absence in the lively dunes.

The comparison of the soil columns realized under the various dunes fixed so the lively dunes considered as witness, show as the profiles realized in the fixed dunes are of type AC where we note the absence of the horizon B with an active physical disintegration and a low rate of humus, what allowed us to classify them in the little evolved grounds and the ground of dunes submitted to the influence of fixation in the raw mineral grounds.

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