THE USE OF EDAPHIC SPECTRA OF THE DOMINANT SPECIES FOR THE CHARACTERIZATION OF THE RHIZOSPHERE SOIL IN THE EXTREME NORTHWEST ALGERIA

M. AMARA [1,2,] , M. BOUAZZA [2]

[1] Bouchaïb Belhadj University Centre, Department of Natural Sciences and Life, Aïn Temouchent, Algeria
[2] Laboratory of Ecology and Management of Natural Ecosystems , Abou Bakr Belkaïd University, Tlemcen, Algeria
Corresponding author: amara.univ@gmail.com

Abstract: *The extreme west of Algeria is today, like the arid and semi-arid Mediterranean areas of North Africa, the seat of a negative and continuous ecological imbalance, due to especially over-exploitation of their natural resources.This degradation takes place in particular as a huge loss of edaphic capital, linked to an uncontrollable erosion which is accompanied by the deterioration of the biological capital by the disappearance of the most significant species on the one hand, and the infiltration of others less popular and / or more xerophilic species on the other hand.The Invasion of steppe species such as Artemisia herba-alba and Noaea mucronata (recovery more than 90%) remains the essential character of resemblance to the steppe of the highlands of the Oranian southwestern..In the context of the soil survey, we have tried to clarify the state of the soil variables in order to know the requirements and tolerances of certain steppic species and prey-species : Artemisia herba-alba, Noea mucronata. , Atriplex halimus, Pistacia atlantica with respect to each measured factor such as soil moisture, grain size, pH, salinity, total limestone and organic matter.The majority of the samples represent a balanced sandy-loam texture that is very sensitive to the soil Crusting.The moisture content is between 4 and 12%. This reflects the degree of edaphic drought..The limestone contents generally reach 18.82 to 36.82% or even 44% samples in the Pistacia subsoil sample with a sandy-loamy texture. This sandy texture of this sample is related to the abundance of carbonates. These last contribute to the increase of the pH.The edaphic analysis of each species has shown us that our results are close to steppe soils. Thus, it appears that this environment is close to the arid steppes in the process of desertification..Despite the intensity of degradation, edaphic attributes in the worst case, have not reached the levels observed in a desert and rehabilitation remains possible.*

Keywords :*. Degradation, Arid / semi-arid, Spectra edaphic, Steppisation,*

INTRODUCTION

The existence and/or absence of species in a given area is the result of their tolerance or requirement to certain ecological factors.

According to OZENDA, (1982**)** in some cases everything happens as if one or two factors act alone, conditioning the existence and distribution of a species or grouping.

AUBERT *ET AL.* 1981 report that When the dominant abundance of a species exceeds 50% of the surface area; it has a significant effect on pedogenesis.

In the study area, the invasion of steppe species remains the essential similarity with the steppe of the highlands of southwestern Oranais.

These species require the same ecological and edaphic conditions for their establishment as the steppe environment.

- **Study area :**

The test territory is located in the North-West of the wilaya of Tlemcen as well as on a national scale. (Figure n°1).

The study area extends from 1°44' West longitude to 1°30' East longitude. In latitude it extends from 34°66' to 34°84' North latitude.

From a climatic point of view, a comparison of recent work on the Oranie (BENABADJI,1995; BOUAZZA, 1995; BENABADJI AND BOUAZZA, 2000; AMARA, 2003; AMARA 2014) with that of SELTZER (1946), which covers the period from 1913-1938, confirms that there are currently no changes of the Mediterranean climate type but rather in its characteristic with an increase in summer drought that can reach 7 months and a less rainy winter period.

Emberger's rain-thermal climate (LE HOUEROU, 1995) places the region between the average arid stage in temperate winter (Q2= 31.48 m°C = 3.32) and the upper arid stage in mild winter (Q2=38.93, m°C= 5.26).

However, in the arid and semi-arid Mediterranean areas of North Africa, repeated droughts have contributed to some extent, particularly over the past two decades, to worsening the water balance and soil aridity situation and consequently the organization of vegetation structures.

Fig. 1. Location of the study area

MATERIAL AND METHODS

Our objective is to characterize the rhizosphere of the soils in the study area and to understand the dynamic aspects and evolution of plant groups.

The choice of the two representative stations (Fillaoucene and Hammam boughrara at the level of the maghnia plain) is based on the stratified sampling method on the one hand and data collected at the plant ecology laboratory on the other.

In this study, we tried to clarify the condition of the soil variables to determine the requirements and tolerances of certain steppe and presteppe species (*Artemisia herba-alba, Noea mucronata, Atriplex halimus, Pistacia atlantica*) for each measured factor such as soil moisture, granulometry, pH, salinity, total limestone and organic matter.

Our soil samples were taken at the rhizosphere of these species and along the transect to determine the influence of microtopography on ecological factors

RESULTS AND DICUSSIONS

Most of the soil samples studied in the study area contain coarse elements in sometimes high quantities. In the tables below we have the results of measurements of the soil parameters of the rhizosphere of the selected species, in total we have 14 samples.

Table 1

Results of measurements of soil parameters of the rhizosphere of the species *Artemisia herba-alba*

Species	***Artemisia herba-alba***			
Station	**1**		**2**	
Samples	1	4	2	3
Depth	0 - 25 cm	0 - 25 cm	0 - 25 cm	0 - 25 cm
Colour according to MUNSELL	10YR (4/4)	10YR (5/3)	7.5YR (4/6)	10YR (4/2)
Granuluometry				
Clay %	13,04	10,28	2,51	7,52
fine silts %	38,38	20,57	33,83	20,06
Coarse Silts %	3,31	25,81	19,58	25,07
Silt Total%	41,69	46,37	53,41	45,14
Fine Sand%	34,92	35,28	24,01	40,41
Coarse Sand %	9,99	7,74	19,84	6,62
Total sand %	44,92	43,02	43,84	47,03
Texture	**LS**	**LS**	**LLS**	**LS**
Humidity %	7.337	7.921	4.628	7.793
pH water	7.86	7.91	7.83	8.23
pH kcl	7.24	7.2	7.27	7.05
Electrical conductivity	1.3	0.1	0.7	0.2
Caco3 %	27.02	24.390	18.969	23.577

Table 2

Results of measurements of soil parameters of the rhizosphere of the species *Pistacia atlantica*

Species	***Pistacia atlantica***			
Station	**1**		**2**	
Samples	**5**	**6**	**7**	**8**
Depth	0 - 25 cm	0 - 25 cm	0 - 25 cm	0 - 25 cm
Colour according to MUNSELL	10 YR (5/4)	10YR (4/3)	10YR (6/4)	10YR (4/4)
Granuluometry				
Clay %	3,01	0,00	7,03	10,29
fine silts %	30,62	32,64	15,58	26,86
Coarse Silts %	21,50	20,88	15,04	22,43
Silt Total%	52,11	53,53	30,62	49,28
Fine Sand%	29,09	28,43	22,05	23,62
Coarse Sand %	15,41	17,61	39,80	16,41
Total sand %	44,50	46,04	61,85	40,04
Texture	LLS	LLS	SL	LS
Humidity %	5.898	8.281	5.451	9.909
pH water	8.6	7.9	8.62	8.46
pH kcl	7.25	7.16	7.94	7.6

Electrical conductivity	1.5	0.1	0.2	0.2
Caco3 %	31.80	35.179	44	29.226

Table 3

Results of measurements of soil parameters of the rhizosphere of the species *Noaea mucronata*

Species	*Noaea mucronata*			
Station	**1**		**2**	
Samples	9	10	11	12
Depth	0 - 25 cm	0 - 25 cm	0 - 25 cm	0 - 25 cm
Colour according to MUNSELL	10YR (3/3)	10YR(6/3)	10YR (5/3)	10YR (5/4)
Granuluometry				
Clay %	8,27	15,82	8,78	12,04
fine silts %	20,55	17,83	11,79	14,55
Coarse Silts %	24,02	25,06	24,75	20,77
Silt Total%	44,57	42,89	36,55	35,32
Fine Sand%	31,78	33,97	47,28	32,23
Coarse Sand %	15,12	6,86	7,01	20,10
Total sand %	46,91	40,83	54,29	52,33
Texture	LS	LS	LS	LS
Humidity %	6.033	9.284	6.236	4.931
pH water	7.75	7.85	8	7.8
pH kcl	7	7.23	7.09	7.25
Electrical conductivity	0.3	0.6	0.4	0.7
Caco3 %	18.818	36.818	31.609	26.417

Table 4

Results of measurements of soil parameters of the rhizosphere of the species *Atriplex halimus*

Species	*Atriplex halimus*	
Station	1	
Samples	13	14
Depth	0 - 25 cm	0 - 25 cm
Colour according to MUNSELL	10 YR (4/3)	10YR (6/3)
Granuluometry		
Clay %	7,53	12,05
fine silts %	28,62	32,89
Coarse Silts %	16,73	10,82
Silt Total%	45,35	43,71
Fine Sand%	33,30	20,94
Coarse Sand %	13,39	22,88
Total sand %	46,69	43,82
Texture	LS	LS
Humidity %	11.11	12.887
pH water	7.45	7.95
pH kcl	7.17	7.3
Electrical conductivity	1.8	0.9
Caco3 %	31.64	29.41

1. Texture :

The texture diagram places the majority of our soil samples in the silt-sand area with a balanced texture.

A high proportion of sandy particles is recorded for other samples. They reach 54.29% for sample N°10 (Noaea) with a still silty-sandy texture and reach a maximum threshold of 61.85% below ground in *Pistacia atlantica* (N°5) with a sandy-silt texture.The results in Table 2 show that the high content of sand in the latter sample is mainly due to the dominance of coarse sand. SOLTNER in 1988 reported that when the latter dominate in a soil, it becomes filtering (retains little water) and light (sensitive to erosion). This increase in sand content in the surface horizon is related to deflation combined with alteration of the bedrock (BESTAOUI, 1990)

According to AIDOUD *ET AL* (1999) "The increase in the rate of the sandy fraction can be attributed either to the fine textural fraction, following soil destruction, or to wind power".

We note that on average the highest rate is in the sands with 46.66%, followed by silts with 44.35% and finally clays with only 8.61% (Table 5).In our case, this high rate of sand is due to the transport of fine elements by rainwater;the low % of clay confirms this Coarse and total sands naturally vary according to an inverse gradient of those of clays and silts present in fine soil. (BOUAZZA, 1991-1995).

The granulometric composition of our samples shows us that clay is the lowest mineral fraction compared to silts and total sands.

the percentage of clay elements does not exceed 16% (figure n°2); it reaches its maximum underground rate at *Noaea mucronata* with 15.82% (samples n°12) and a little less for Armoise with 13.04% (samples n°1) and Atriplex with 12.05% (samples N14°). According to AIMÉ (1991), the depletion of this material seems to correspond both to the poverty of the rock, but also to the youthfulness of the profile, which is increasingly evolving under semi-arid climatic conditions.

Unlike clays, the silt fraction (Figure 2.) also remains quite high: it varies between 30.62 and 53.53% (samples N°5 and N°7 of Pistacia) Silt, due to its fineness and the small spaces that separate it from Soltner in 1988, tends to dominate when it dominates a soil that has formed a battance crust on the surface,under the effect of rain,which makes it impermeable and asphyxiating. AIDOUD in 1983 also reported that these silts form a 1 to 3 mm thick icing or beating film on the surface.

This icing film is unfavourable to seed germination (KADI-HANIFI, 1990), which accentuates the regressive dynamics.

The sensitivity to beating and the ability to settle vary according to the textural classes of the soil (Table n° 6)

Table 6

Sensitivity to battance and ability to settle

Species	Sample	Texture	Sensitivity to beat		Compressive strength			
			Not very sensitiv e	Very sensitiv e	Very low	Low	Moderat e	Somewhat important
Artemisia inculta	1	**LS**		+			+	+
	2	**LLS**		+	+			
	3	**LS**		+			+	+

	4	**L**		+			+	+
Pistacia atlantica	5	**S**	+			+	+	
	6	**LLS**		+	+			
	7	**LLS**		+	+			
	8	**L**		+			+	+
Noaea mucronata	9	**L**		+			+	+
	1	**L**		+			+	+
	1	**L**		+			+	+
	1	**L**		+			+	+
Atriplex halimus	1	**L**		+			+	+
	1	**L**		+			+	+

The analysis of the table above shows that the settlement capacity of the majority of samples is quite high underground with LS texture. On the other hand, it is very low when the texture is LLS. All samples are very sensitive to battance except the samples (N°5) with SL texture. From a floristic point of view, we note that under these edaphic conditions of the environment, steppe species such as white wormwood and Noaea dominate, especially in the Fillaoucene station.

AIDOUD in 1983 shows that the high rate of silt and fine sand is a characteristic of white Armoise facies. From an edaphic point of view, the requirements of this plant seem more clearly defined, particularly for texture (AIDOUD, 1988).

In Algeria, however, according to the most recent works by POUGET (1980); DJEBAILI (1984); AIDOUD (1983-1988); AIDOUD F. (1989); AIME (1988) ;BOUAZZA (1991-1995)

;BENABADJI (1991-1995) the most widespread texture of the mugwort is rather limone- sandish . This same fine texture according to BENABADJI in 1999 is one of the characteristics of Atriplexaie. The Houerou in 1995 reports that *Noaea mucronata* is among the species that are linked to squelhetic soils (lithosols, more or less superficial limestone crusts, gypsum crusts), it is dominant in the degraded paths on limestone crust in the high Algerian- Moroccan plain, until the eastern foothills of the Middle Atlas.The Atlas pistachio tree seems to have a large amplitude compared to other species with regard to texture that varies from sandy-silty to silty-sandish (Table n° 2 and (Figure n°2.)

2. Humidity : (Figure n°2.)

Texture is the most important physical characteristic with regard to the soil's water behaviour, especially in arid climates. (AIDOUD, 1983)

The analysis of the results concerning the hydric behaviour of the soil in our study stations shows us that the increase in humidity is accompanied by a decrease in the sand content (Figure n°2.)
from the analysis of the results and tables (1 ,2,3,3,4) it appears that for each species the maximum moisture value corresponds to the high clay content and the minimum sand content. We find that the coarser the grain size, the less water is retained.

Silty environments have a water reserve available for vegetation: much lower than that of sandy environments (FLORET AND PONTANIER, 1982).

At our study stations, the high battance sensitivity, despite the predominance of sands; explains the low humidity percentage.

This is due to the quasi-permanence of a glaze film which, due to its low permeability, slows down or prevents the infiltration of water into the soil, resulting in groundwater runoff.

According to the work of FLORET AND PONTANIER (1978), infiltrated water may only represent 56% of the rains of the surrounding soils

Samples N°2, 5 and 11 with different textures have almost the same moisture content. Under these conditions the wilting rate of the plants also differs.

Indeed, for the same annual rainfall, sandy soils have, on average, a drought period for plants that is 60% shorter than that of silty soils. (FLORET AND PONTANIER, 1982)

We point out that at the level of the soil samples under Atriplex (N°13 and 14) with silt-sandish texture the humidity is still almost equal but with limit values (Table n° 4) This increase in humidity comes from the position of these samples at the bottom of the slope, which benefit from water supply by runoff (water compensation). Underground in Armoise and Noaea the % of humidity is quite comparable in each station

The percentage of moisture at the two study stations is less than 13%; this low rate really reflects the degree of soil dryness.

Floret and Pontanier (1982) report that soil droughts generally occur 1 or 2 months after those related to rainfall, and that not all the water in the soil is accessible to the plant, which explains the rapid wilting of some plants during the increase in heat (therophytes) (HASNAOUI ,1998)

3. Total limestone (Caco3) (Figure n°2.)

In Algeria and more generally in North Africa, pedogenesis is carried out on rocks that are generally carbonated and often saline, such as marl, limestone or sandstone (DURAND, 1957).

Limestone acts as a calcium reserve in the soil and can be a limiting factor for some crops (DURAND, 1958)

Soils formed on limestone bedrock (as in our study stations), an often important part of the sandy elements is composed of limestone (SOLTNER ,1988)

The limestone contents reach in all the samples 18.82 to 36.82% or even 44% in the N°5 underground sample in Pistacia with a sandy-silty texture. This sandy texture of this sample is related to the abundance of carbonates, which contribute to the increase in pH..The Ca+++ cation tendency encourages the formation of OH- ions

According to these assessments, the majority of the samples are highly calcareous except for the samples under wormwood (N°3,4,5) and Noaea (N°9) which are moderately calcareous.

On average, the total carbonate content in the two stations is 29% (Table 5)

The soils of the carbonate sector are basic reaction (always rich in limestone their granulometry depends on the nature of the substrate on which they develop these soils can be classified as rendzins, more generally as calcimorphic soils with calcareous accumulation (AIMÉ *ET AL.* ,1983)

These soil conditions inhibit the establishment of calcifuges species. Noaea has the largest amplitude with respect to total limestone (Figure n°2.) Calcicolous species react to excess calicium by the emission of chelating substances (siderophors) that mobilize Fe and Mn, while calcifugal species ,that do not have this property ,suffer from chlorosis due to a deficiency in these two elements (DUCHAUFOUR ,1997)

4. pH (Figure 2)

The strong summer desiccation, characteristic of continental or Mediterranean climates, causes a restoration of the calicium complex (thus an increase in pH (DUCHAUFOUR,1997) the water pH values of our samples are between 7.45 and 8.62 which means that the pH of the two stations varies from neutral to basic ;this is due to the presence of calicium in abundant quantity .With regard to pH variations in slightly alkaline limestone environments, DUCHAUFOUR in 1968 cites that MOLINAT (1965) and CRACHET (1967) have shown the essential role of CO2 voltage variations in pH variations; in periods of high biological activity (spring), producing a lot of CO2. The pH of calcareous soils can drop below neutrality (bicarbonate formation) on the surface; in dry periods, the pH rises by decreasing biological activity and therefore CO2 tension; bicarbonate gives back carbonates that become insoluble.

pH KCl is a more stable parameter over time than water pH (BAIZE, 2000)

The pH KCl is more acidic than the pH water, because the K+ ions, by taking the place of H+ ions which pass into solution on the complex, create an exchange acidity lowering the pH This lowering compared to the pH water is all the stronger as the potential acidity is high (sample N°6 and 3). Based on the results obtained from the double pH measurement, it appears that the difference varies from 0.28 (samples N°13) to 1.35 pH units. The pH value depends largely on the total limestone content.

From the analysis of the results obtained it appears that the maximum pH value (7.94) corresponds to the higher content of CaCo3 with a maximum sand content (sample n°5 for Pistacia). the Min of the pH (n°9 Noaea) corresponds to the min. of CaCo3

It appears that *Artemisia, Atriplex* and *Noaea* (Figure n°2.) do not offer a large ecological amplitude with respect to the pH factor. on the other hand for pistachio the interval is more or less wide (0.78) but always remains slightly alkaline. The pH water remains alkaline, characteristic of steppe soils (KILLIAN, 1948).

5. Electrical conductivity

Surface conductivity varies by a factor of three depending on the season and the amount of precipitation recently fallen (FLORET AND PONTANIER, 1982)

It depends on the content of electrolytes (Cl-, So4--,H(co3) of Na+,Ca++ and Mg++), the term salt usually indicates the predominance of sodium chloride.

The measured electrical conductivity is based on samples of unsalted, slightly salted and salted soils for both stations, with values ranging from 0.1 to 1.8 Miliselens/cm. (Tables 1, 2, 3 ,4). conductivity indicates that species coexist under the same salinity conditions these soils are slightly alkaline and unsaline (REEP, 1961)

The tolerance of plants to salinity varies from one species to another.

the pistachio tree of the atlas has the greatest amplitude with 1.4 followed by the white mugwort with 1.2. the latter species also tolerates salt (AIDOUD ,1983)

Noaea has the lowest ecological spectrum (Figure n°2.)

Analyses of the Atriplex soil samples (Figure n°2.) show high salinity (electrical conductivity =1.8mS/cm) According to BENABADJI in 1999, the electrical conductivity of soil samples from atriplexaies was 1.6 mS/cm for a 1/5 extract, made of 10 g of soil and 50 ml of distilled water.

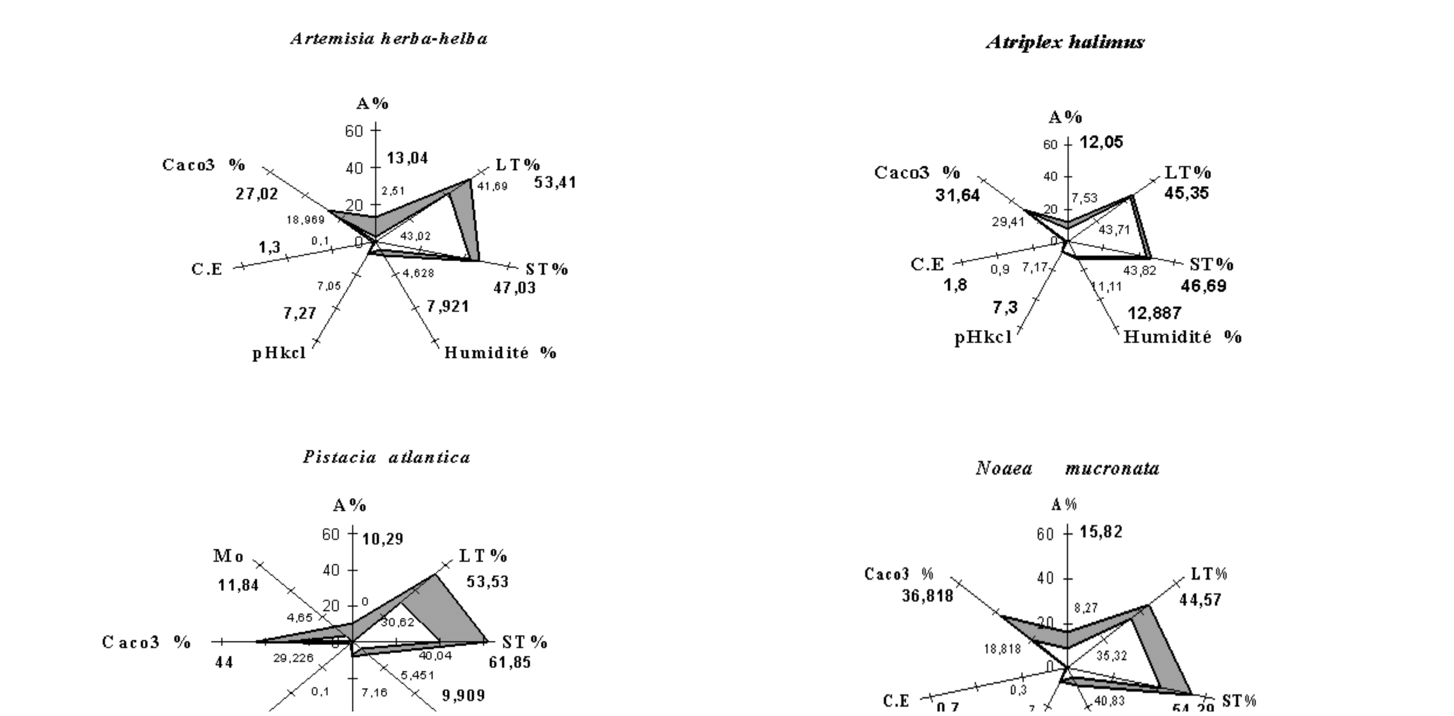

Fig..2 Edaphic spectra of certain steppe species

6. The color

The dark yellowish brown (light) colour linked to the release of calcareous concretions that give the light colour. the colour of these soils is generally brown, characteristic of steppe soils (POUGET ,1980). We note that the soils of this region are part of the brown limestone soils belonging to the class of calcimagnetic soils.

CONCLUSION

The following conclusions can be drawn from this study regarding the soil samples tested:

1. the majority of soil samples studied in the study area contain coarse elements in sometimes high quantities.
2. A silty-sandy texture Very sensitive to battance with a reduction in soil permeability, an increase in runoff followed by a decrease in the soil's water balance.
3. A humidity level is between 4 and 12%, which reflects the degree of soil dryness.
4. Medium to high limestone content (18% to 44%) due to the nature of the bedrock.
5. the pH of the two stations varies from neutral to basic due to the presence of calcium in abundant quantity.
6. the electrical conductivity is between 0.1 and 1.8 on average indicates the low salinity of the medium.

It appears that this environment is close to the arid steppes in the process of desertification.

Despite the intensity of the degradation, the soil attributes in the worst case scenario have not reached the levels observed in a desert and rehabilitation remains possible. (AIDOUD *ET AL.*, 1999)

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