STUDY OF THE IMPACT OF THREE SPECIES OF ATRIPLEX (*ATRIPLEX HALIMUS, ATRIPLEX NUMMULARIA AND ATRIPLEX CANESCENS*) ON THE SOIL PHYSICO-CHEMICAL PARAMETERS IN THE STEPPE ZONE; CASE OF THE SOUTH WEST OF ALGERIA

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Abstract

The introduction on large areas of the genus Atriplex, in the Algerian steppe zone characterized by a fragile soil with an intense human and climate pressures, requires a study of its impact on the soil physico-chemical characteristics.

The introduction of three species of Atriplex: a local specie *Atriplex halimus*, a second is *Atriplex canescens* originally from America and the third *Atriplex nummularia* from Australia.

In each of these three species planting perimeter planted before 7 years a collect of the soil samples was conducted in the spring. The comparison between the soils results of the three species reveals the impact of Atriplex on some soil characteristics.

The specie that improves the soil and does not disturb its physico-chemical characteristics is the local specie *Atriplex halimus*.

Keywords: Forage shrubs, Soil physico-chemical characteristics, Atriplex, South-western Algeria.

Introduction

The Development and rehabilitation of rangelands has attracted in the recent years an increasing interest for a number of authors (Benrebiha, 1984, 1987; Smail, 1992; Bouzid et al, 2011). One of the management techniques adopted in the vast program launched by the state is the planting using exotic forage species like *Medicago arborea*, *Opuntia ficus indica*, *Atriplex nummularia* and/or *Atriplex canescens*.

Those works are part of the activities undertaken by the High Office for the Development of the Steppe who is since 1994 combating the desertification where the forage planting are used to restore the degraded rangelands.

The present work's objective is the evaluation of the impact of fodder plantations based on Atriplex canescens, Atriplex nummularia and Atriplex halimus on some physico-chemical soils characteristics.

Materials and methods

The adopted approach is based on the synchronic study comparing soils planted by the three species of Atriplex and a control soil; all four perimeters are closed for protection for 7 years.

The goal is to determine the effects of the type of plantations on some physico-chemical soil parameters.

Overview of the study area

Geographic location

Covering an area of 5000 ha, the perimeter of Morghad Chergui is located in the town of Sidi Ahmed, 45 km south-east of the city of Saida. It is bordered on the east by the town of Maâmora and in the west by a track linking it to the road Sidi Ahmed-El May (Fig.1). The Lambert coordinates of this site are ; X_1 : 284,3, X_2 : 293,5 ; Y_1 : 433,1 et Y_2 : 440,1.

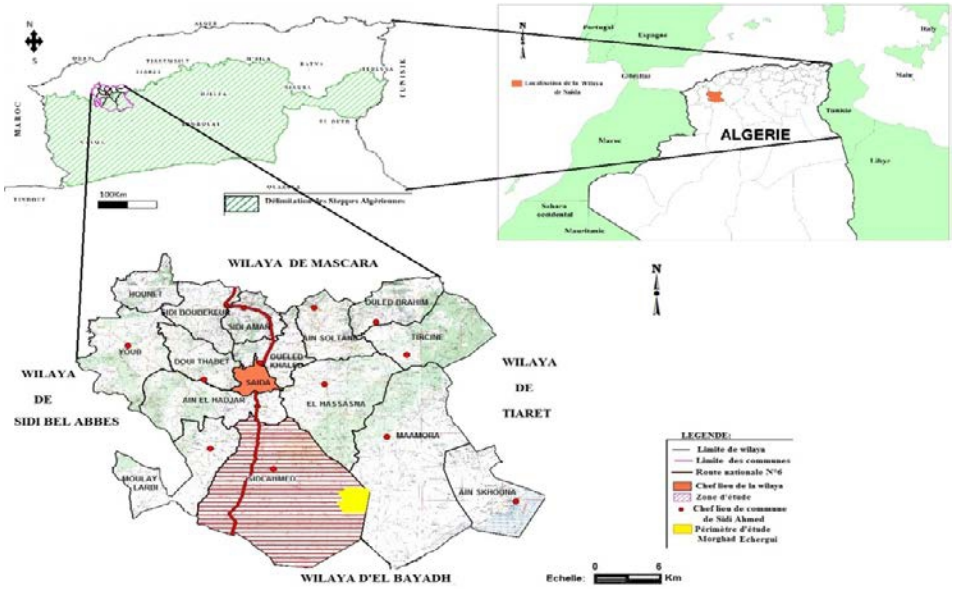

Figure 1: Location of the study area « Morghad Chergui ».

Natural and physical environment description

The study area belongs to the arid hot and dry summer bioclimatic zone characterized by a period of seven months summer drought (April to October) and an average number of days of Sirocco of 28 days/year (ONM of Saida,2010).

The terrain is relatively homogeneous and flat, and the slopes don't exceed 3%. The altitude varies between 1050 and 1130 meters. The dominant soils are the types of raw minerals covering approximately 80% of the perimeter where the slightly developed soils occupy the rest almost 20% of the total area (Bneder 2010). The study area is classified in the highly degraded steppe area (GCA, 2010).

The improvement project by restoring the degraded rangelands through fodder shrubs plantation based on the Atriplex (*A. canescens*, *A. nummularia* and *A. halimus*) and Tamarix followed by an exclosure was achieved by the GCA in 2004. Those works can be summarized on a planting forage of 2000 ha, an exclosure of 2940 ha, reforestation of 50 ha and dunes fixation based on tamarisk in 10 ha.

Study objective

In the aim of studying the impact of various Atriplex species plantations on the physico-chemical parameters of the soil, samples were collected in a random sampling basis fairly representative of the four study areas. A total of 32 soil samples were collected in 2010, at a rate of 8 per type of plantations (Fig. 2).

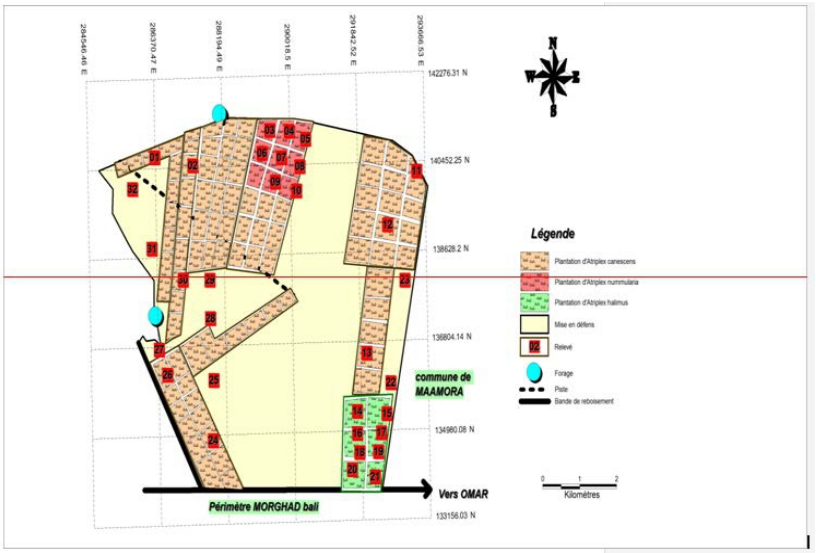

Figure 2: Location map of the soil bearings.

The analyzed parameters are : grain size, organic matter, nitrogen, total calcium, the active calcium, salinity and pH where 1000 g of the soil were taken from the As horizon (18 to 25 cm depth) and prepared for analysis.

The Analysis focused only on the fine fraction (diameter <2 mm). The particle size is made by the Robinson pipette. It is performed in two steps: a first step which consists in removing silt and clay by pipetting followed by the collect of sand by siphoning.

The organic matter was determined by the ANNE method; Total nitrogen was determined after mineralization, distillation and titrimetry according to the method of KJELDAH.

The total calcium was evaluated with the Bernard calcimeter and the active limestone by the Drouineau-Galet method.

1. The pH and electrical conductivity were measured by a pH-conductivity meter. The determination of exchangeable and soluble bases (K^+, Na^+, Ca^{++} and Mg^{++}) present in the soil in the form of salts (NaCl, $CaCl_2$, $CaSO_4$, etc.). We determinate the cations in the filtrate soil by flame photometry and we did make the determination of chloride Cl^- by potentiometric titration with $AgNO_3$.

Results and discussion

Comparative analysis of the lignification rates and success

The comparative analysis of the introduced species in the Morghad Chergui perimeter showed that after 7 years of planting *Atriplex canescens*

and *Atriplex nummularia* a very high lignification rate sometimes exceeding 90% (Figure 3) while the local specie, *Atriplex halimus*, presents a lesser rate than the two introduced species (Tab.1).

Figure 3: Lignification of the *Atriplex canescens* and *Atriplex nummularia* tufts of in the study area 'Morghad Chergui' (photo 14/02/2011).

The lignification is generally accompanied by a reduction in consumable green part which essentially locates at the top of the feet and remains inaccessible to livestock.

The analysis of the success rate showed that the native species (*A. halimus*) presented the highest values (65%) compared to the two other introduced species (Table 1). It should be noted that the natural regeneration of these three species is null, with a decreasing overall vegetation cover, especially in areas with *Atriplex canescens* and *Atriplex nummularia* estimated at only 22%, against the zone planted with *Atriplex halimus*, this area has a higher overall vegetation cover estimated 47%.

Table 1 : Characteristics of the 03 planted areas and the exclosure.

	Planted zone			**Exclosure**
	Atriplex canescens	***Atriplex nummularia***	***Atriplex halimus***	
height **(m)**	**>1**	**>1**	**≤1**	//
Lignification Rate (%)	**90**	**90**	**70**	//
Regeneration	**Nulle**	**Nulle**	**nulle**	**present**
Success rate **(%)**	**50**	**50**	**65**	//
Recovery rate **(%)**	**22**	**22**	**25**	**35**
Vegetation	**Ac-Rr-Nm-Ls- Ph**	**An- Aha- Ls-Ph- Rr**	**Ah- Aha- Ls-Rr- As- Ph**	**St- Aha- As-Ls- Ph**

Ah: Atriplex halimus, Aha: Artemisia herba alba, As: Atractylis serratuloides Ac: Atriplex canescens, An: Atriplex nummularia, Nm: Noaea mucronata
Ls: Lygeum spartum, P h : Peganum harmala, Rr: Retama retam, St: Stipa tenacissima.

Impact on the physicochemical parameters of the soil

The overall texture is a loam sandy type, with a respectively percentage of sand of 80% and 76% for the plantations sample (*Atriplex canescens*, *Atriplex nummularia* and *Atriplex halimus*).

The statistical analysis carried out by the variance test (ANOVA) showed a very high uniformity of the profiles of the three plots for the total nitrogen and the organic material. For the other parameters (total and active calcium, pH, electrical conductivity, salinity, and mineral content) a difference was detected.

The samples taken from the *A. canescens* plantations zone showed significantly a higher quantity of the minerals elements compared to the other species.

The results obtained on the total calcium, active calcium, pH, electrical conductivity, salinity and mineral salts content confirms that the local specie do not significantly alter these parameters. By against soil planted with *A. canescens* and *A. nummularia* exhibit a significant increase in these parameters.

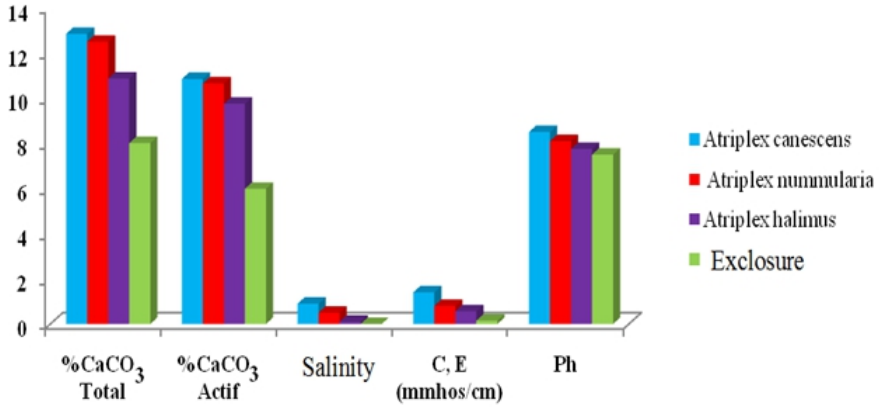

Figure 4: Representation of the chemical analyzes results in the study area.

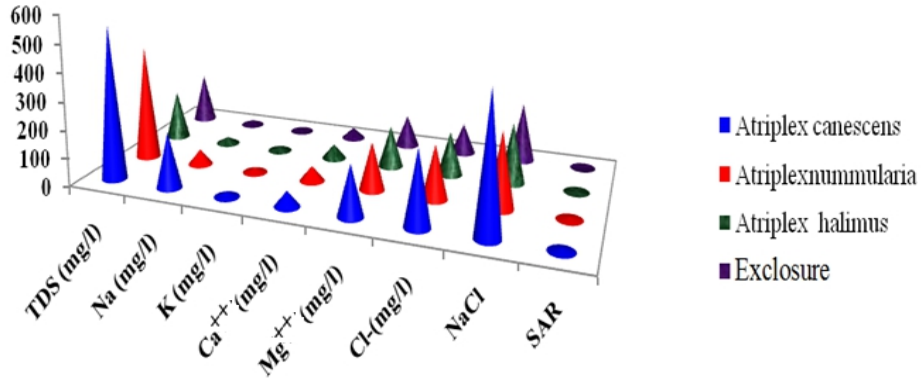

Figure 5: Representation of the mineral elements results in the study area.

Conclusion

In light of the results obtained, it is possible to confirm that the plantation based on *Atriplex halimus* has the best success rate estimated at 67%, while for other species it does not exceed 49%. These results match with those obtained in the region of Djelfa by Kaba (1996); Benabdi (1997) in the town of Zaafrane; Said and Zaidi (2001) in the Ain Oussera plain; Mesbahi (2002) in the Ain El Bel region; Berno et al (2006) in the El Mesrane region; Bekai and Hamidou (2008).

I draw the attention to the work of Bouhroud et al (2006) in the Sidi Hadjeres region (province of M'sila), Aboura (2006) on the north and south of the province of Tlemcen; Ben Ahmed Ben and Saha (2007) in the province of Laghouat; Merzougui and Bounif (2008) in the region of Ain Skhouna (Saida) and Boularak et al (2009) in the South of Oran provinces.

The comparative results of the impact of the two species *Atriplex canescens* and *Atriplex nummularia* used in the development of rangeland, on the physicochemical parameters allow the following observations:

- A low success rate especially in the calcareous soils with a lack of natural regeneration even 7 years after planting and exclosure;
- An elevation in the rate of the total and active calcium due to the taproot altering the limestone slab,
- An elevation in the electric capacity, which promotes exchanges ground-vegetation that leads to alkalizing
- An elevation in the pH of the soil under the effect of the alkalizing An elevation of the minerals elements induced by increased salinity

This study shows that the introduction of exotic species of Atriplex in a steppe environment has a negative impact on some physicochemical characteristics of the soil and on the rate of success.

The results confirm that the plantation based on *A. canescens* and *A. nummularia* have disadvantages on the soils, especially in the limestone depressions, by increasing the rate of limestone and the soil salinity inducing alkalinization with an osmotic stress on plants.

The ideal growing area of *Atriplex halimus* with improvements in the physicochemical characteristics of the soil are salty soils around the chotts (saline lakes) and sebkhas (salt flat), silted environments and heavily degraded where natural perennial species has disappeared.

With an exclosure higher than 3-5 years, the rehabilitation of overexploited rangeland, the restoration of degraded lands, the reducing of salinity and the fight against wind erosion and thus the fight against desertification remains a possible target.

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