

**Original Research Article**

**Study of the Effect of Dunes Mechanical Fixing on Properties of Ground and the Vegetation Evolution in the Area of Oumache, Biskra (Algeria)**

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Abstract	Keywords
<p>The degradation of soil through wind is a big phenomenon in the world. Algeria is one of the most affected countries with this aspect of desertification. One of the developed techniques in fighting against desertification is the mechanical fixing of the dunes to enable biological protection to occur. Our study carried out on the ground in the Oumache zone which is situated in the Wilaya of Biskra, South-East of Algeria, has allowed us to notice that after dune fixation (dunes and interdune depressions), many changes of the environmental conditions appear especially viz. an amelioration of the soil properties; an installation of a diversified flora; a richness in delicate elements and the appearance of superficial layer which protects the subsoil. Seasonal moisture of the soil has been improved in the fixed areas due to the accumulated delicate elements which have the characteristic of moisture keeping, water intake and storage. In addition to this it is necessary to note that the physico-chemical properties of the soil became better than in the initial state (before fixation). These properties are summarized in: a partial diminution of the total calcaire; an accumulation of organic matter and total nitrogen; a rich soil with soluble ions especially Ca<sup>2+</sup> and Mg<sup>2+</sup>. Finally, it is worth noting that the stabilized areas were characterized by composites and gramineae family plants, which indicate the fixation areas and the considered soils, however, the unstabilized areas were characterized by a proliferation of the sandy plants which are more adapted to this type of soils.</p>	<p>Biodiversity Dune environments Evolution of vegetation Natural vegetation Phytoecology Soil properties</p>

**Introduction**

The basic principle consists on installing obstacles (palisades) that are able to stabilize (to protect) sands on one hand and to reduce as well as to attenuate the speed of the active

winds to a level lower or equal at the speed of actuation of the sand particles on the other hand. It's a question of creating a stability of the dune medium essential condition for the

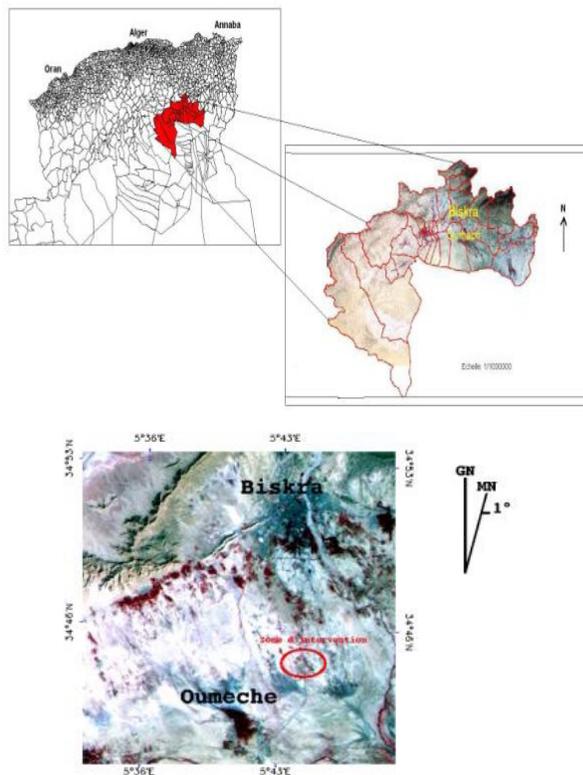
development of the introduced seedlings and with the natural vegetation to regenerate and colonize the dune (Brague and Bencherif, 2001; Kaabache, 2001; Oldache, 1988). Dunes fixing in the area of Oumach (Biskra), including: the depression of the treated dunes, sand stabilization, also the installation of an abundant and diversified flora, illustrates such kind of restoration projects where extraordinary changes of the treated places (Chouiala, 1999; Djebaili, 1984 ; Kaabache, 1990).

Drawing from a work whose main objective is to study the effect of mechanical fixing on the evolution and the dynamics of dunes, our study would emphasize impacts of dunes fixing on the improvement of the physicochemical properties of the ground and on the evolution of vegetation in these places.

### Localization and Climatic Characteristics of Study Zone

The area of Biskra is located at the South-east of Algeria. It spreads over an area of 21.671 km<sup>2</sup>, that corresponding to 0.91% of the national territory (Fig. 1).

**Fig. 1: Locator map of the area of Biskra and the intervention zone.**



Our study area belongs to the commune of Oumache which is located in the southern part of the Wilaya of Biskra. The relief of the area of Biskra can be schematically split into four great homogeneous geographical units. The relief organization in corridors through Southern Piedmont justifies the wind dynamics which affects the whole area of Biskra. The wind action within these corridors is reflected in the sand silting of the Oases where a progression towards the south of Barkhanes front, is currently occurring.

On the climatic level, the area of Biskra is located in the Saharan bioclimatic stage a soft and a dry winter which presenting an important thermal amplitudes thus accelerating the evaporation process exceeding the low and irregular rainfall amount received in one year. The mechanical dunes fixing of in the region of Oumache was carried out on a site of 100 ha (Fig. 1).

Our study area is located approximately 10 km South of the town of Biskra, it presents the economic lung, in both date palm and greenhouse cultivation. It is exposed to constraints of sand silting, deflation... etc. Overall 5000 ha of ground are affected by the phenomenon of sand silting.

### Materials and methods

The aim of this research is to study the effect of the mechanical dunes fixing on the change of the physicochemical characteristics of the dune grounds and the appearance of new plant species in the fixed dunes, of which the work undertaken between the year 2001 and 2003. Our study is related mainly to dune ground: We chose two mechanically fixed dunes and a not fixed dune (pilot).

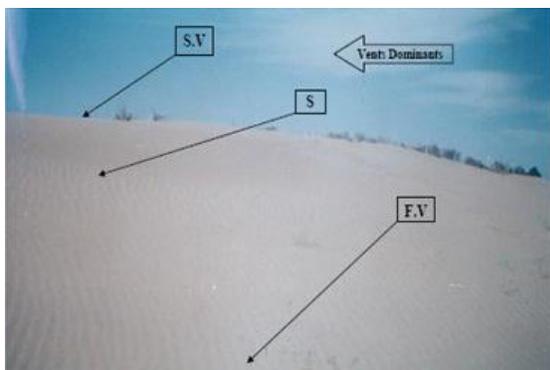
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## The Analysis Methods of Studied Grounds

The dune ground belongs to rough mineral grounds group of wind contribution (Halitim, 1988; Oldache, 1988). For better characterize these grounds we have carried out two samples for each toposéquence of the dunes and each shallow.

- i) A surface sampling: H1 (from 0 to 20cm).
- ii) A deep sampling: H2 (from 20 to 50cm).

**Fig. 2: Positions of the toposéquences.**



After sampling, the grounds are dried at the laboratory temperature, then they are crushed and screened using 2 mm sieve.

- i. Ground analysis: granulometric sand analysis.
- ii. Ground physico-chemical Analysis.
- iii. Moisture quantification of the sandy ground.

## Natural vegetation study

The adopted methodological approach, to carry floristic-ecological statements is inspired from the sigmatist school founded by BRAUN-BLANQUE. The statements surface depends on the minimal area within the meaning of Gounot (1969), its form is circular and on each one of them we noted the variables illustrated by Tables 4 and 5 as well as the list of all species has a presentiment. Noting that each species is affected by a qualitative index which is abundance-predominance given by the following scale:

- 1: abundant species and weak covering.
- 2: abundant species and covering higher than 5%
- 3: abundant species and covering of 25 - 50%
- 4: abundant species and covering of 50 - 75%

- 5: abundant species and covering higher than 75%.

## Results and discussion

In order to properly identify impacts and incidences of the sand dune fixing operation on the environment, as well as to better determine the physico-chemical characteristics of the ground and the evolution of the vegetation in the study area; we proceeded to a pedological analysis of the dune ground and hollows on one hand, and of the floristic statements on the other.

For the topographic sequence factor, we note clearly that the position (SV) of fixed dunes has the highest rate in delicate elements. It is a zone of accumulation which is placed at a shelter from winds. Whereas the others topographic sequences (S) and (FV) had a very low rate in delicate elements, they remain starting zones. For the all analyzed samples, the pH remains alkaline, it is noted that the highest pH is recorded for the dune lives (pilote) about: 7.89, on the other hand, fixed dunes had a pH between 7.33 and 7.62. We can consider that the dunes fixing operation supported the fall of the pH degree. For electrical conductivity and according to the results consigned in Table 2, it appears that the dune ground of our zone of study has a low salinity.

We note in addition, that the limestone rate of the various dunes oscillates between 18 and 32% which means that the ground is moderately calcareous. Indeed, we do not notice a great difference of the content of total CaCO<sub>3</sub> between the studied factors. It appears then clear that the rate of limestone is not under the dependence of dunes stabilization operation. For the organic matter, we note that the organic carbon rate of the various dunes remains rather weak. The highest rate of the organic carbon observed for the fixed dune N°01 is 0.83% however it is 0.30% for the pilote. This shows that the dunes fixing operation supported the accumulation of the organic matter in the treated zones along the time.

Noting finally that the sand dunes fixing operation did not support the enrichment of the

ground out of nitrogen. According to the obtained analytical results, the highest value of report/ratio C/N is observed for the sharp dune, it is of 16.47. That is explained by the presence of a weak mineral release of the substances and a weak humification; one will also note that the presence of organic matter is in the form of remains or of dust. That is probably with the pH of the alkaline ground, the dune ground will be thus low in nitrogen and report/ratio C/N is high. For the moisture of the ground in winter one notes relatively high water contents of the

dune ground, which vary between 12.10 and 26.20%. In such a way that the fixed dunes introduce the more important rate of moisture in summer is with 2.92 % compared to the pilot dune which presents only 0.94%, this is certainly with the sand stability.

**Case of the shallows:** According to the results consigned in Table 2, we can note that bottoms - treated funds have more important rates in fine elements (fine sand + limon+ Argile) compared to the pilot shallow.

**Table 1. Results of the grain size analysis of the dune grounds**

N. of dune		Fixed dune N°1			Fixed dune N°2			Dune lives		
Topo-sequences	S.V	S	F.V	S.V	S	F.V	S.V	S	F.V	
The texture of Particles	S.G	42.60	52.6	61.8	27.45	46.75	52.70	62.40	62.30	66.10
S.F	52.54	43.32	34.64	46.58	46.75	32.70	32.50	52.62	33.32	
L+A	5.06	4.08	3.66	25.47	6.50	5.10	5.10	3.20	0.56	

**Table 2. Results of the physico-chemical analysis of shallows soils**

N° the Shallow	Shallow fixed N°01		Shallow fixed N°01		Shallow fixed N°01		Shallow witness	
Place	<i>Nitraria retusa</i>		<i>Aristida pungens</i>		<i>Astragalus gombo</i>		/	
Horizon	H1	H2	H1	H2	H1	H2	H1	H2
S.G	31.60	53.82	47.40	53.58	26.67	39.40	52.40	47.63
S.F	62.07	40.60	44.99	40.53	66.43	41.42	44.25	46.93
L+A	6.07	5.58	8.51	5.89	6.90	19.18	3.35	5.44
pH	7.47	7.52	7.36	7.55	7.25	7.35	7.83	7.78
CE	2.30	2.40	2.00	1.16	1.90	1.70	2.25	1.90
Limestone Total.	32.00	27.50	28.00	27.50	18.00	28.50	27.50	32.00
Carbon %	0.70	0.63	0.94	0.76	1.33	0.94	0.35	0.33
M.O (%)	1.30	1.42	1.61	1.30	1.66	1.34	0.49	0.56
Nitrogen Total.	0.175	0.180	0.180	0.200	0.210	0.250	0.022	0.017
C/N	4.34	4.61	5.22	3.82	6.33	3.88	15.9	19.14
Moisture Winter	17.60	18.00	13.00	16.90	16.46	22.10	13.10	15.20
Moisture Summer	1.01	2.56	4.71	5.26	4.69	5.98	0.95	2.46

We thus noted the abundance of the species of the family of leguminous plants such as *Astragalus gombo*, and graminaceous such as *Aristida pungens*, on the level of the fixed shallows. These species contribute effectively to the enrichment of the ground out of organic matter. It is noted an abundance of the species belonging to leguminous family plants such as *Astragalus gombo*, and graminaceous such as *Aristida pungens*, in fixed shallows. These species contribute effectively to the organic matter enrichment in the ground. The work of dunes fixing in the area of Oumache (Biskra)

generated a change of the inventory of fixtures by the improvements of physicochemical properties of the ground and the installation of new plant species.

- ✓ The granulometric sand analysis of the study zone (dunes and shallows) has typically detected that rates of delicate particles (Clay, silts, sands fine) are higher in the fixed places than those not fixed. All things otherwise being equal, the rates of large particles remain more important in not fixed places.

- ✓ An enrichment of the sand dune of the fixed places in fine elements water sensors and emmagasinateurs involve an improvement of the water holding capacity, which leads to increase the sand seasonal moisture.
- ✓ Thus, the improvement of these physical and chemical characteristics of the fixed places dunal sands is more important

under the leguminous species *Astragalus gombo* and respectively followed by *Aristida pungens* and *Nitraria retusa*. This allows us to suppose, the existence of a beneficial edaphic genesis for the ground, and the creation of a favorable microclimate to the development and the installation of vegetation.

**Table 3. Results of the phytocological observations of the dunes.**

N° the dune	Fixed dune N°1			Fixed dune N°2			Dune lives		
Height of the dune (m)	8			6			8		
N° Statements	1	2	3	4	5	6	7	8	9
Topo-sequences	FV	S	SV	FV	S	SV	FV	S	SV
Slope (%)	8	-	14	6	-	10	6	-	12
Rate of covering (%)	15	20	35	<5	15	25	<5	10	10
<i>Aristida pungens</i>	2	3	3	1	3	3	3	3	3
<i>Astragalus gombo</i>	1		+		1	1			
<i>Atriplex halimus</i>		1				+			+
<i>Cutandia dichotoma</i>	2	2	1	2	1		1	1	3
<i>Echinops spinosus</i>	+	+		+	+	+		+	+
<i>Limoniastrum guygonianum</i>			1						
<i>Lotus halophilus</i>			+						+
<i>Malcolmia aegyptiaca</i>	2	3		3	3	2	1	1	2
<i>Nitraria retusa</i>		+	2		+	1			
<i>Salsola vermicula</i>		1		+				1	
<i>Salicornia arabica</i>			1			+			1
<i>Suaeda mollis</i>			+	+			1	+	
<i>Traganum nudatum</i>					2	1		+	1

**Table 4. Results of shallows phytocological observations.**

N° the Shallow	Shallow fixed N° 01	Shallow fixed N° 02	Shallow fixed N° 03	Shallow no fixed
N° Statements	10	11	12	13
Rate of covering (%)	35	45	40	20
<i>Aristida pungens</i>	2-3	4-4	3-4	2-2
<i>Astragalus gombo</i>	1-2	1-2	4-4	
<i>Atriplex halimus</i>	1-2	1-1		
<i>Cutandia dichotoma</i>		2-3	3-3	
<i>Echinops spinosus</i>		+		
<i>Limoniastrum guygonianum</i>	2-2	1-2	2-2	
<i>Lotus halophilus</i>		+		+
<i>Malcolmia aegyptiaca</i>	1-1	3-4	1-2	1-1
<i>Nitraria retusa</i>	3-3	1-1		
<i>Salsola vermicula</i>	1-2	1-2	1-1	1-1
<i>Suaeda mollis</i>	1-1	+		+
<i>Traganum nudatum</i>	2-3	1-2	1-2	

Generally, covering is rather weak, which necessarily implies a poor plant association in species, mainly made up by a unit of psammophile species which constitute the first series of the vegetation evolution after the dunes stability treatment. In order to realize this mechanical control which is effective only for a short duration, it is imperative to proceed to the definitive biological fixing. This operation can only be performed by planting species that are adapted to the conditions and aptitudes of the physical environment in question.

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