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RESEARCH ARTICLE

Choice of fixing species dunes and their effect on vegetation

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Abstract:

The experimental project of sand dune fixation was launched in 1982 by INRF in El-Mesrane, Djelfa. To fix the dunes and thus limit the advance of sand towards urban areas and agricultural lands and allow the natural vegetation and planted to reclaim the lead and thus constitute a reserve of fodder for livestock. Several materials have been used for mechanical attachment that allows a temporary stabilization of sand input and departures, as some fixing species were tested for biological fixation with the success rate varies with soil and climatic factors. Our objective is to identify the species that fixing set and effectively colonized the dune promoting biological recovery.

The overall percentage of vegetation increases in line with the altitudinal gradient, it occupies the lowest topographies of the dune where soil moisture is high and the wind is minimal; topographies upwind are usually difficult to colonize; they are drier and more exposed to the dominant (SW) wind, against the topography downwind who are in shelter are cooler and therefore easily colonized. Each species occupies fixing the dune differently as follows:

Retama retam Webb, grows throughout the dune different topographies and exhibitions. *Tamarix gallica* L colonizes all topographies of the dune peaks except at high altitudes windy. *Tamarix aphylla* (L.) Karst and *Eleagnus angustifolia* L colonize the lower slopes and inter-dune areas. *Lycium arabicum* Boiss recorded a success rate of less than 10%, mainly topographic position facing the wind.

Key Words: Desertification, Biological fixing, Mechanical fixing, vegetation.

Introduction

The fight against desertification is one of the key issues of the world consequences of desertification are social, economic, political and environmental.

The debate on this issue has been launched after the great drought of the 1970s. Gradually, the international community is interested in this issue, embodying this realization by the implementation of the UN Convention United Nations Conference on desertification in 1994.

Control methods that need to be well studied, effective and above all integrated into a comprehensive policy to fight against desertification (KADIK B 1982; NEDJRAOUI, 2006). Faced with this situation, great efforts and many programs have been made at different times at the Algerian steppe (DGF, 2007).

From 1962 to 1969 he 99.000ha are forest plantations have been made in the context of improving and rangeland management and the fight against wind erosion.

To 70 years Algeria has launched the Green Dam, a huge belt 1500km long and 20km wide (3 million hectares) to protect the northern part of Algeria to the inexorable advance of the desert.

In 1983 the adoption of the steppe file resulted in the creation of the High Commissioner for Development Steppe (HCDS), responsible for implementing an integrated development policy on the steppe, taking into account all economic and social aspects and rehabilitation of degraded by deferred grazing and planting journey.

The fight against the phenomenon of silting by technical dune fixation and protection paths with trees and shrubs has always been the work of the research recently in Algeria, Tunisia, and Morocco.

Algeria has launched a pilot project in 1982 by INRF, El-Mesrane at the dune cordon Djelfa-Boussaâda which aims to:

- Stabilize dunes and limit the advance of the sands to the towns and farmland.
- Allow natural vegetation and planted to regain the lead and thus constitute a reserve of fodder for livestock.

Several sand dune fixation materials have been used for the mechanical fixation which allows a temporary stabilization of the increase and decrease of sand. Also, several fixative species have been tested for the biological fixation wherein the success rate varies depending on pedoclimatic (soil and climate) conditions; according to several study and research: MELZI (1986), AIDOUD (1989), KADI HANIFI (1998), KADIK B (1982), OLDACHE (1988), CHOUAIL (1992) and TOLBA (2000), KADIK L et al (2010), GUERRACHE N (2010), AKKOUCHE S (2011), GURRACHE et al (2014).

The objective of this work is to study five-fixing species dunes to see who effectively fixed dunes and promotes biological recovery.

Presentation of the study area

According Pouget (1980), Basin Zahrez, highlighted by a remarkable dune cordon where our area of El Mesrane study is located in the town of Hassi-Bahbah (Wilaya de Djelfa), it is about 30km north of Djelfa, it has an average altitude of 870m, and whose geographic coordinates are: Longitude: 3 ° 03'Est Latitude: 34 ° 36'Nord . (Fig. 1).

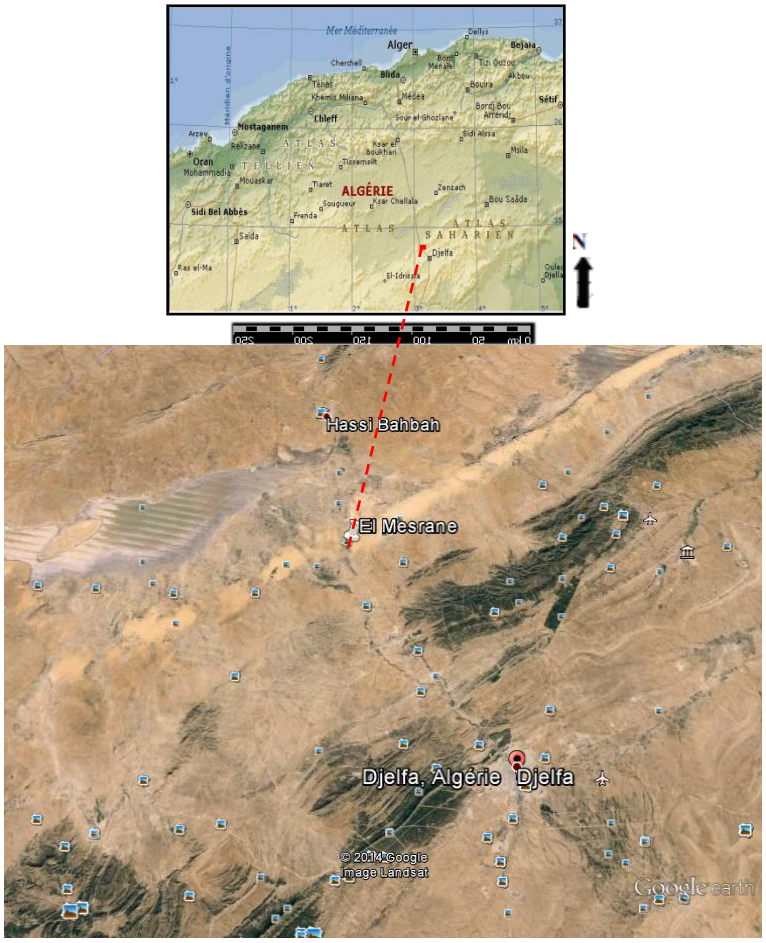


Figure 1: Location of the area the cord dune El Mesrane, province of Djelfa

Materials and methods

1. Purpose of work in the study area

The dunes of Zahrez is always extended, and more sandy buildings bury infrastructure, farmland, even threaten areas. This prompted the Forest Services to adopt two pilots fixing El-Mesrane. We summarize below the fixation methods applied in these projects (KADIK, 1982).

1. Principle dune fixation

The main objective is to prevent the movement of dunes by the different techniques to restore a proper canopy. Different materials may be used. The fixation can be obtained by three methods:

- Barrier dead: often made of plants or artificial materials.
- Living barrier, formed by fixing species.
- Protective cover by spraying the surface of bitumen emulsion.

1. Techniques dune fixation: Dune fixation has two phases that occur simultaneously.

- Phase 01: mechanical fixing
- Phase 02: final determination by planting or by natural vegetation.

1.1. Mechanical fixation of sand dunes

The basic technique is to build perpendicular to the prevailing wind barrier of 0.5 to 1 m high, which causes the formation of a small dune, treatment should be bottom-up in order to slow the wind speed and limit displacement of sand. Once the first barrier coated sand, it establishes a second, and so on until the dune height has reached its equilibrium.

Currently used as barrier materials are varied (wooden board, corrugated asbestos, tree branch, plastic mesh, ...).

1.2. Chemical fixation

Method of setting the surface of sand dunes by spreading oil products derivatives this layer acts as cement. It has the advantage of being easily positioned, the cost is very low but the downside is that it prevents the recovery of natural vegetation after 2-3 years the layer begins to disintegrate (ZAAFOUR, 1983).

1.3. Biological fixation

The final dune fixation is only possible with a reforestation or resumption of suitable vegetation. These plants must have features such as (rotating deep roots, ability to withstand loosening or burial by sand, resistance to intense evaporation, ...).

This study aims to evaluate the spatio-temporal growth of the main dune-fixing species (*Tamarix gallica* L, *Tamarix aphylla* (L.) Karst, *Retama retam* Webb, *Eleagnus angustifolia* L and *Lycium arabicum* Boiss) at the dune El-Mesrane Wilaya de Djelfa. For this, we adopted a methodological approach based on the comparison of phytoecological surveys in 1984 and 1987 than in 2005 and 2009, which will allow us to identify the species that gave the best results by setting and effectively colonizing dunes.

3. Dendrometric data collection

Dendrometric parameters allowed us to have an idea about the state of development of different species planted. The selected parameters are:

- Height individuals was measured using a measuring tape for shrubs and method for the pole shafts.
- Diameter foot species were characterized by their development tuft more or less homogeneous; to appreciate this development we have found it useful to measure the diameter or the area occupied by all discharges of individuals. The same tape measure was used for the measurements.
- Crown diameter is an important parameter to dendrometric know the estimation of the surface of the shadow cast by the species.

Results

On the El Mesrane pilot project, several fixers were used to stabilize dunes in different exhibitions and topographies, but only a few species gave optimum growth and high success rate. These rates are related to certain soil and climatic factors to determine. The pictures below illustrate the original and current status of the project after more than 26 years of fixation.

Figure 2: The current state of consolidated after 26years fixing dunes.

On the whole project was surveyed 120 plots (the same plots sampled in 2005). At the time of our sample, we found that the overall percentage of vegetation was 70% on the north side and 45% on the southern slopes. The distribution of species in space shows a clear dominance of *Retama retam* Webb with a recovery of 43.2% represented by 86 individuals followed by *Tamarix gallica* L (17.6%), *Lycium arabicum* Boiss (15.5%), *Eleagnus angustifolia* L (14%) and *Tamarix aphylla* (L.) Karst (9.5%); represented successively by 35, 31, 28 and 19 feet (fig. 3).

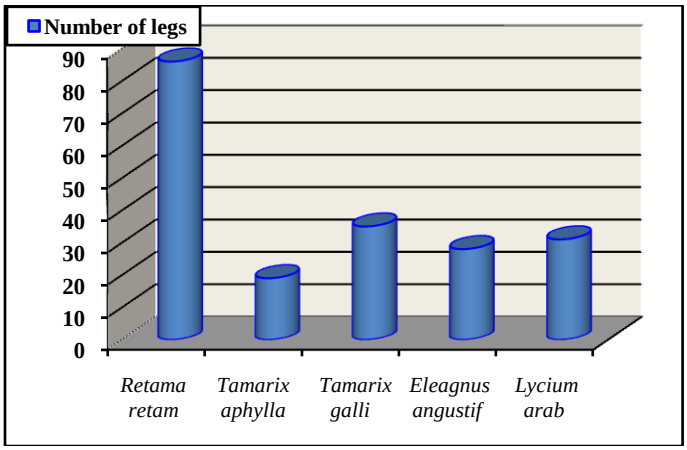


Figure 3: Number of individuals of different species studied (2009). In first position *Retama retam* Webb, who holds the entire project and *Tamarix gallica* L, *Lycium arabicum* Boiss, *Eleagnus angustifolia L* and *Tamarix aphylla* (L.) Karst

To illustrate the current distribution of fixing species throughout the project we have shown schematically distribution under different topographic positions on the dune (Fig. 4).

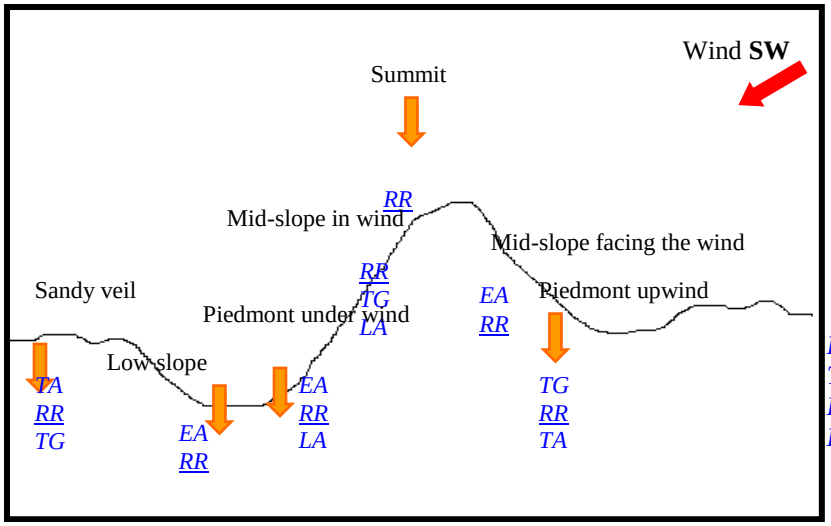
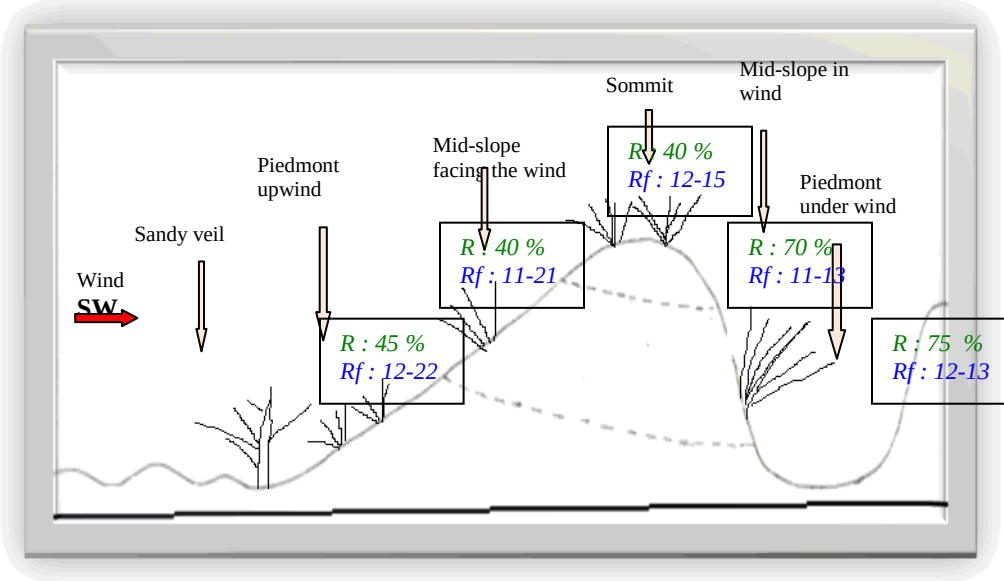


Figure 4: Schematic representation of the occupation of space by the species which have a high success rate (optimum development). *Retama retam* Webb holds the most difficult positions exposed to wind.

Across stational on the same dune and during the same sampling season (the same rainfall, temperature and M m uniforms), different growth fixing species was observed and a change in their floristic processions. For this and highlight the most influence on the spatial distribution of vegetation factor, we considered fixed dunes by *Retama retam* Webb in conducting surveys along the dune, as defined transects on the ground. The results are very significant, as shown in figure 5.



R : Global vegetation cover *(%).* *R f : Floristic richness.*

Figure 5: Representation of the floristic richness and the overall recovery of the vegetation on the different topographies of the dune. The toposequences face of the wind are richest floristic but not covered by vegetation unlike toposequences leeward.

We obtained conflicting results with those obtained by researchers INRF (1988), who conducted surveys on non dunes and recently established, where they identified a very small number of species and variables according to the

different positions topographic, this number decreases headwind increases and sheltered from the wind, where the seeds Therophytes settled, accumulate and germinate; by the wind against the seeds of small size fly in the absence of tufts of plantations and plastic mesh that accumulate. Figure 6 illustrates the change in the number of species on unfixed dunes (controls), recently established and formerly fixed.

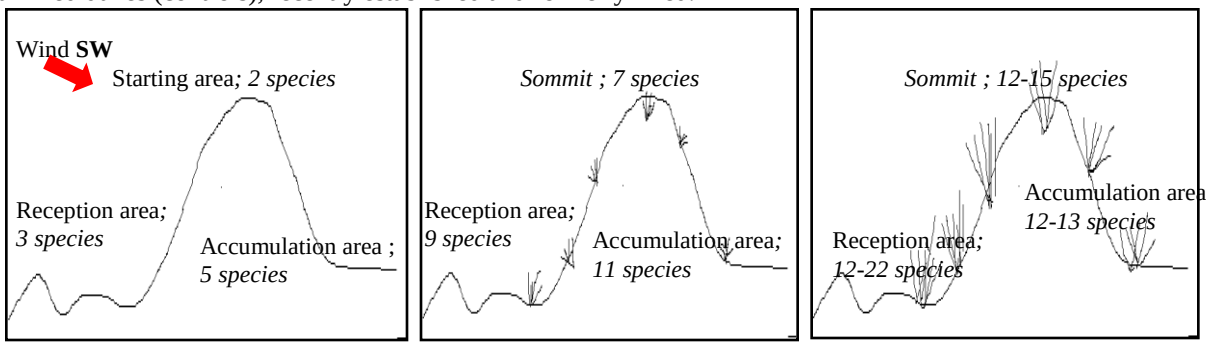


Figure 6: Floristic richness dunes not recently and previously fixed. At the beginning of the attachment zones accumulations are richer floristically under the effect of the wind but with the growth of fixing species, areas receiving become richer.

A study conducted in 1987 by the INRF the study site showed that the position sheltered from the wind generally has relatively sizeable humidity, vis-à-vis the positions facing the prevailing wind dry and drying (fig. 7).

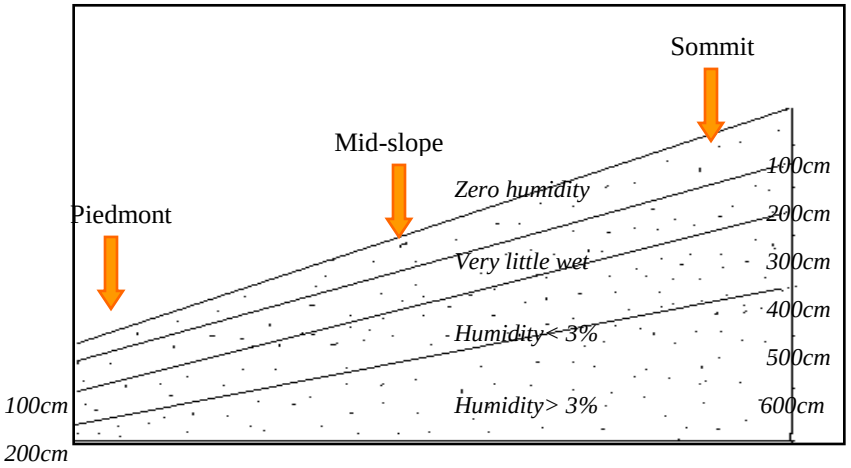


Figure 7: Distribution of moisture in the dune, in ZOGHT (1978). Soil moisture is higher in the foothills of the dunes that at the top.

ZOGHT (1978) concluded, after many measurements made at different locations on the dune that the distribution of relative humidity in the dune roughly follows the shape of the dune; that is to say it decreases at the top of the foot of the dune, conditioned by certain micro-site factors (slope and exposure) and the other climate particularly temperature increases the drying soil factors, which gradually increases the month April to June, which limits plant growth.

Soil moisture increases as a function of depth; zero or low at the top and mid-slope, but high in the foothills. These results are confirmed by the observations of GAOUAS (1977), in the region of the cord to Boussaâda dune. This moisture that changes depending on the topography of the dune is the wind that explains the colonization of the wettest of the dune by certain portions moisture demanding species.

To enhance the influence of the biological fixation (fixing the species) on the distribution of the accompanying vegetation, we compared the species richness (Fig. 8), then the recovery occupied by this vegetation underfoot (the shadow of bouquet) and between the legs of various species tested (Fig. 9), on fixed dunes since 1983.

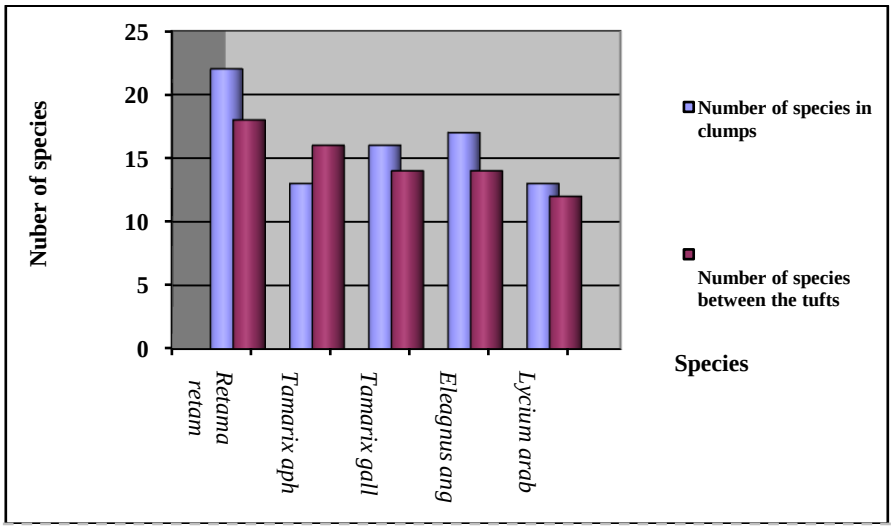
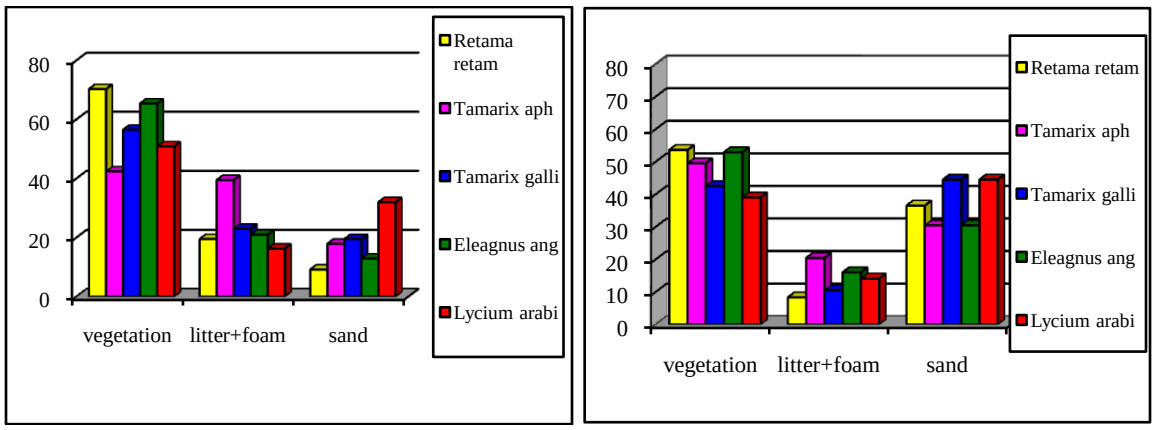


Figure 8: Number of accompanying species under and between fixing species. *Retama retam* Webb throne the first position.

As regards the use of space; the line method allowed us to know the state, we had an idea about the state of the surface of our study area, calculating the recovery rate of the different elements that occupy the ground such as sand, vegetation, litter and foams and in between the feet of each scavenging gas, as shown in figure 9.



Under the fixers ***Between fixers***

Figure 9: Use of space under and between the legs of species.

Discussion

Figure 3 highlights the number of feet of each species identified in fixing the station sampled in 2009. This comparison provides valuable information on the resistivity and the adaptive capacity of each species in the silted areas. According to the data available from the INRF; (B KADIK 1982; MAKHLOUF, 1988) *Eleagnus angustifolia* L was planted on the lower slopes above, but other species were tested on different topographies. . It is reported that *Retama retam* Webb regenerates naturally by seed; was observed in the field of seedlings that will eventually new feet. The optimum development of this taxon in this resort explains its dominance over the entire project.

Figure 4 shows the presence of *Retama retam* Webb on all topographies, this species colonizes the entire dune top to bottom, it can be considered as the only species that colonizes successfully summits exposed to winds.

Tamarix aphylla (L.) Karst develops mainly on sandy sails and low inter-dune slopes. Planting of this species is recommended for this type of topography, due to its resistance to wind phenomena, speed of growth and good root

development. It should be noted that rapidly colonizes sand dunes and sandy formations makes it invulnerable to the adverse effects of wind. So it tolerates soil and climatic constraints of the region.

Eleagnus angustifolia L colonizes the lower slopes of the dunes where the humidity is very high and the adverse effect of wind is moderate.

Lycium arabicum Boiss successfully develops over the foothills and lower slopes protected from the wind, yet it has a high mortality rate in the windward stations. ZAAFOUR (1981) noted a low success rate of about 0-3% of the plantations on the mid-slope and at the top of the sand dunes without mechanical protection.

Tamarix gallica L has an optimum development on sandy dunes sails and low slope or micro-dunes, but not the peaks at high altitudes exposed to strong wind.

These differences in growth and success indicate that the success rate of planting remains dependent on a set of interactive factors: site characterization of nature (wind, exposure, the height of the dune), climate-related (rainfall, temperature and wind) or physiological (forms of physiological adaptations fixing species to climate constraints).

The fixing species *Retama retam* Webb, has very good growth on all topographies of the dune; this is a species that grows as a bouquet , which is very resistant to the action of wind and bombardment of grains of sand, it grows in width than in height and therefore is exposed to hot and less frequent drying winds (OZENDA, 1991), which creates a favorable environment for the installation of colonizing species that cover the sand dune consolidated microclimate; we note that the recovery of these species reduces the wind (reception area) and increases downwind (accumulation zone), inversely to their numbers increase against the wind, which could be explained by :

• The positive action of wind on the floristic richness; the wind carries the seeds of which are accumulated Therophytes foothills and mid-slope, by planting tufts and plastic mesh that acts as a barrier and a trapping site.

• Its effect is negative on the recovery of vegetation, because of its direction SW which increases evapotranspiration and water deficit causes a negative impact on the density of vegetation cover.

From the figure 6 it was noted that the floristic richness is variable as follows:

* The wind-protected (SV) zone has the highest average since this is an area "hidden", sheltered from the winds "accumulation zone".

* The area upwind (FV) scores less than the previous area where windblown seeds are pressed against the ground where some settled and the majority is gone with the wind "reception area" to mean the accumulation area.

* The top (S) recorded the lowest average. This is the most exposed to drying winds (BOUZIANE 1986) zone "zone out".

The existence of vegetation in such an environment without treatment is mainly due to biotic factors (phenology of the species, for example). This vegetation is particularly present on the lower slopes of the dunes, sheltered from the wind where the humidity is relatively high and weeds are susceptible to this soil and climate parameter. What has been noticed on the field, where we have identified a dense vegetation with even the presence of foam, moisture indicator. Recovery and vegetation density vary with exposure, topography and slope.

Based on the review of the results of work on the dune areas (ZAAFOUR, 1981) and field observations, we can say that the humidity increases at an increasing gradient ranging from sand dunes to dunes covered:

- Under the effect of treatment (mechanical and biological); the sand is stabilized by plastic mesh and fixing species, this stabilization is followed by the installation of a species capable of fixing the moving material, eventually forming a smaller screen against moving sand (initial stage pioneer).
- When the sand becomes very mobile, other species with previous generally lack adaptation to sand movement settle and subsequently form a surface layer of soil, sometimes reduced to a few centimeters allowing new plants s' feed readily available moisture at this level.
- The modification of the structure of the ground (for input elements, clays and silts) allows a relatively large water retention, preserved for a long period of year.

This clearly shows that the treatment of dunes by the mechanical and biological fixation has contributed significantly to the installation of a suitable fixing ground vegetation (decrease the harmful effects of wind and increased soil moisture). In the short term it is the mechanical attachment that acts primarily on the spatial distribution of vegetation, but in the long term, biological fixation that interposes.

Lycium arabicum Boiss is miltibranches shrub that can reach 2m in height. By the right port, it differs from *Retama retam* Webb and *Tamarix gallica* L whose branches grow forming a bouquet, the lower branches cover large areas of ground (fig.8). This difference in shape has an influence on the weed species. *Lycium arabicum* Boiss is more open and it only covers 45% of the soil. The average number of accompanying species is 13 underfoot and 12 species between them, *Retama retam* Webb (22 / 17espèces), followed by *Eleagnus angustifolia* L (17/15 species), *Tamarix gallica* L (16/14 species) but for *Tamarix aphylla* (L.) Karst we denombré13 species only under the tree and 16 outside. This difference is caused by TRABUT (1927) acidity litter *Tamarix aphylla* (L.) Karst, which

inhibits the installation of annual; and KILLIAN (1948), concluded that the tree litter decomposition is very slow due to the weakening of microbial life due to the dry climate and soil salinity.
Figure 9 can be noted that the recovery of the vegetation under the feet of plantations is more important than outside. It changes according to the dominant scavenging species; eg under the feet of *Retama retam* Webb where the foliage of the species offers shade and protection by creating an environment conducive to regeneration factor, there is an overlap of 70.3%, but between tufts only 53.6% is identified. This result is the same for all species planted with a cover of the accompanying flora exceeding 50% but less in tufts between them, however an exception is made for *Tamarix aphylla* (L.) Karst where vegetation occupies relatively equivalent surfaces in the foot of the tree and outside of the foot, despite the importance of litter that covers 35% of the surface on average.
In summary, we note that the fixing species also play an important role in the distribution of the accompanying vegetation. Diversity and number of species vary according to the species planted.

Conclusion

The objective of this study was to assess the state of occupation of space after 26 dune fixation in the cord dune El-Mesrane to enhance the impact and usefulness of setting mechanical and biological dynamics of vegetation.
In general, the overall percentage of vegetation increases in line with the altitudinal gradient, it occupies the lower topography of the dune where soil moisture is high and the wind is minimal; topographies upwind are usually difficult to colonize; they are drier and more exposed to the dominant (SW) wind, against the topography downwind who are in shelter are cooler and therefore easily colonized. Each species occupies fixing the dune differently as follows:
Retama retam Webb grows throughout the dune different topographies and exhibitions. *Tamarix gallica* L colonizes all topographies of the dune peaks except at high altitudes windy. *Tamarix aphylla* (L.) Karst and *Eleagnus angustifolia* L colonize the lower slopes and inter-dune areas. *Lycium arabicum* Boiss recorded a success rate of less than 10%, mainly topographic position facing the wind.

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