J. Mater. Environ. Sci. 2 (S1) (2011) 552-555 *Chergui et al.*
ISSN : 2028-2508
CODEN : JMESCN
Colloque International « Journées des Géosciences de l'Environnement »
Oujda, 21, 22 et 23 Juin 2011 « Environnement et développement durable ».

The Contribution of the Study of the Bordering Dunes Vegetation in the Moulouya Embochure: The Marram Grass (*Ammophila arenaria L.*) case.

Chergui. A*[1], El Hafid. L* , Melhaoui. M*
* Laboratory of Hydrobiology and General Ecology, Mohamed first University, Faculty of Sciences. Oujda – Morocco

Email (1): Albounakal.geo@hotmail.fr ; Tel: (+212)677514128

Abstract
The bordering dunes in Saidia are coastal habitats of great ecological importance. The most typical plant is *Ammophila arenaria* (or Marram Grass) which plays numerous ecological roles. One of these roles is the fixation of sand. The anatomy and the physiognomy of this plant enable it a perfect adaptation for hydric and salt stress in these dunes. The marram grass develops on a sandy soil structure. The moisture of this substrate increases with the depth while the salinity decreases. The intensity of these two factors varies according to the climatic conditions. In the experimental conditions, a sandy ground with daily watering yields a better vegetal growth of the Marram Grass starting from Cuttings of rhizomes.

Keys words: *Ammophila arenaria*, bordering dunes, adaptation, rhizome, soil.

Introduction
The bordering dunes or foredunes [9] are littoral dunes which naturally issue from a fixation of sand by vegetation. The dunal flora should adapt to the mobility of sand, the poverty of the soil in nutrition, hydric stress, salt stress and aggression of the wind. The marram grass is the most typical plant of coastal habitats in Saidia (Moroccan Mediterranean). The aim of this study is to put into focus the relation between anatomic organization of this species and its adaptation to its habitat, and to study some soil parameters and to test the effect of the ground composition and the quality of watering on its growth. The site of this study is localized in the SBEI of the Moulouya situated at the extreme north-east in Morocco [3]. The annual average of precipitations is 303.9 mm, the minimal temperature is 4.4 °C and the maximal one is 32°C. The storey of vegetation is thermomediterranean with a semi arid climate [7].

Materials and methods
1-Histological study of the vegetative organs
Histological study was carried out according to the experimental protocol of double staining with Carmino-green.
2-Study of some physicochemical parameters of marram grass soil
2-1 - Texture
The proportion of silts and clays is determined by using the Robinson pipette, while the sand is weighed after separation by sieve (50 microns). Soil texture is then deduced using the texture triangle [6].
2-2 - Moisture and salinity
The soil samples of marram grass (top of the dunes) are taken at three different depths: the surface (S0) to 20cm (S1) and 50cm (S2) deep. The moisture was monitored during four months (March-June 2008). Its value is determined by weight difference between the fresh sand and the sand dried at 100 ° C in an oven for 24 hours and expressed as a percentage of fresh weight. Salinity is measured by the electrical conductivity [1] measured on an extract to 1 / 5 (a volume of soil to 5 parts water).

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3-*The effect of soil composition and quality of irrigation on the growth of marram grass*

Fragments of the same size of rhizome (cuttings) were cut so that each fragment contains two nodes and a bud. These fragments are grown for two months (March-April, 2008) in bags of 20 cm deep and 9 cm in diameter under ambient temperature and under the conditions mentioned in Table 1. The growth of cuttings was estimated by measuring the dry leaf mass produced: the leaves produced were weighed after drying in an oven at 100°C for 48 hours.

Table 1: Experimental conditions for planting marram grass cutting

	W	A	B	C
Daily watering (3 trials)	T1 T2 T3	T1 T2 T3	T1 T2 T3	T1 T2 T3
Watering every week (3 trials)	T1 T2 T3	T1 T2 T3	T1 T2 T3	T1 T2 T3
Watering every 15 days (3 trials)	T1 T2 T3	T1 T2 T3	T1 T2 T3	T1 T2 T3

T: trial; W: witness (sand); A: 1/4sand+3/4 peat; B: 1/2sand+ 1/2 peat; C: 3/4 sand+ 1/4peat

Results and discussion

1-Histological study

The root: root hairs and well developed meta xylem increase water supply which enables the plant to withstand water stress (Figure 1).

Stem: the abundant sclerenchyma provides support, strength and flexibility to the rhizome in the sandy substrate. The metaxylem well developed also provides a quick and efficient conduction of sap (Figure 2).

Leaf: This organ has a very thorough adaptation to water stress, salt stress, wind and sand action: outer cuticle thick and hydrophobic [10], sclerenchyma abundant, winding blades [2], and stomata sunken in piliferes crypts (Figure 3).

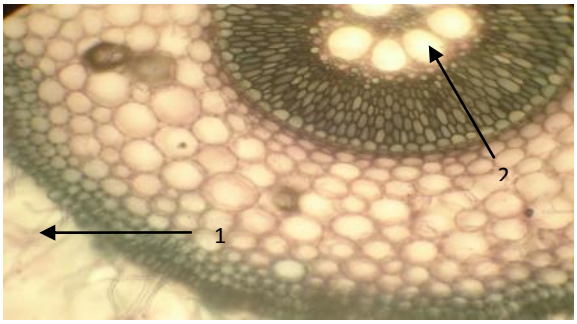

Figure 1: Histological section of the root

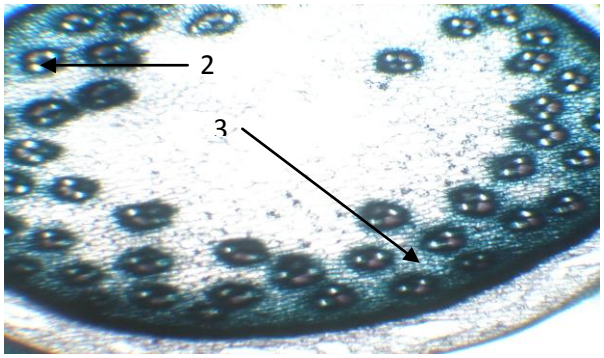

Figure 2: Histological section of the stem

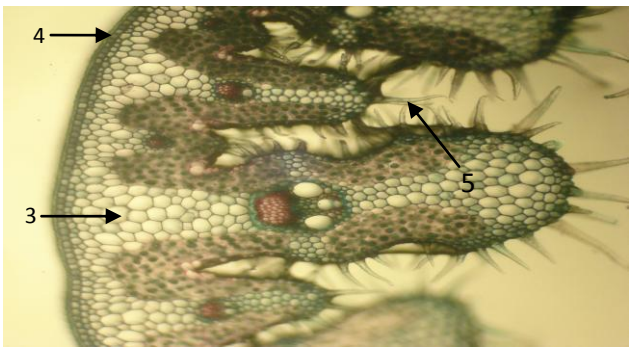

Figure 3: Histological section of the leaf

1: root hairs, 2: meta xylem, 3: sclerenchyma, 4: cuticle, 5: pilifers crypts

2-Study of some physicochemical parameters of Marram grass soil

2-1 - Texture

The soil of marram grass has a sandy texture (table 2). This gives the ground a special porous structure which has the disadvantage of not retaining enough water. But it has the advantage of allowing a good circulation of free water and especially good aeration of the roots and rhizome which prevents the risk of asphyxiation of the plant.

Table 2: Percentage of various fractions of soil

Percentage of sands	Percentage of Clays	Percentage of Silts
99%	0,5%	0.5%

2-2 Moisture and salinity

Soil moisture varies with depth and months (Figure 4). Marram grass whose roots can penetrate up to 1m deep. Changes in the months are due to precipitation. Moisture, salinity for instance varies with depth and months, except for S2 (Figure 5).Salinity is well below the tolerance limit for marram grass (2% = 30.7 mmhos / cm) which is beneficial for this species. Overall salinity decreases with depth. This is due to the increase in moisture with depth that contributes to the phenomena of dilutions.

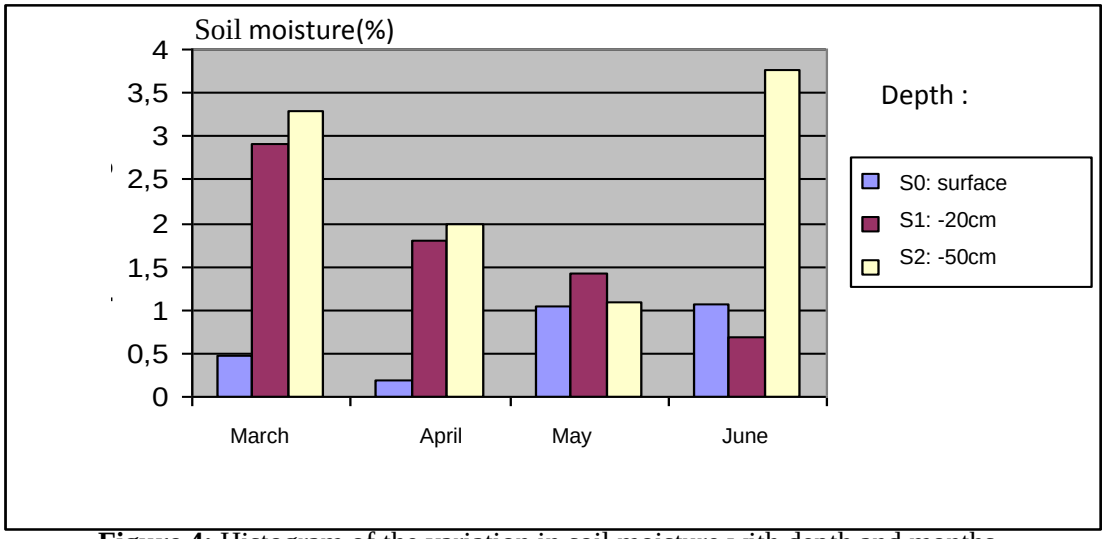

Figure 4: Histogram of the variation in soil moisture with depth and months

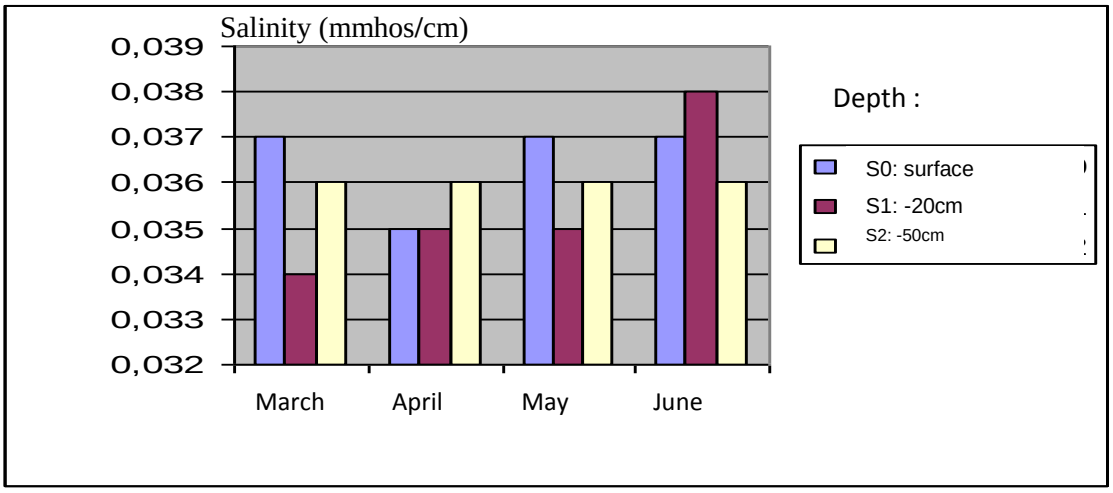

Figure 5: Histogram of the variation in soil salinity with depth and months

3-The effect of soil composition and quality of irrigation on the growth of marram grass
Under the experimental conditions, sand with a daily watering gives the best yield (figure 6). Peat-rich soils inhibit growth of marram grass because of reduced aeration (asphyxiation) and the increase in imbibitions forces [4- 8- 5].

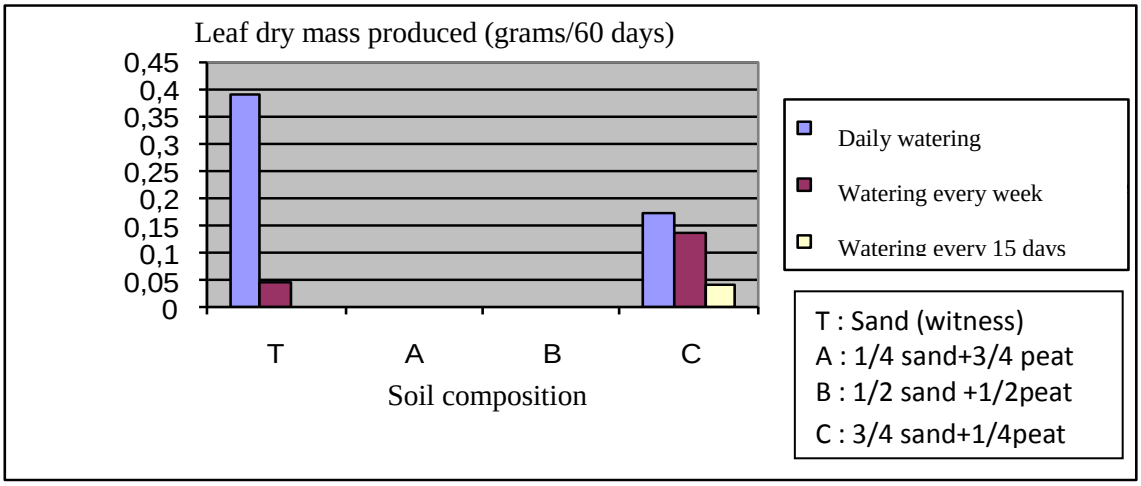

Figure 6: Effect of irrigation quality and soil composition on the leaf dry mass produced by *Ammophila arenaria* for 60 days

Conclusion

Marram grass grows on sandy soil structure. The moisture level of the substrate increases with depth while salinity decreases. The intensity of these two factors varies depending on climate conditions (precipitation). Under the experimental conditions, a sandy soil with a watering day, gives a better vegetative growth from cuttings of rhizomes. Thus they can be used in the restoration and rehabilitation of degraded dunes. Bordering dunes are fragile ecosystems and complex, human pressure is their first threat, hence the need for a management plans for sustainable development.

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