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Morphological and anatomical characteristics of the laminas of the tufts of *alfa* (*Stipa tenacissima* L.*)* of different populations of Kasserine region in Tunisia

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Abstract

The alfa (*Stipa tenacissima* L.) it's a long- lived species which develops in a very wide climatic range. It has a great economic-social importance. Ecologically, it takes part in the maintenance of the balance of the local ecosystem and in fight against the desertification in the arid regions and presaharien. Economically, it constitutes a primary material for the manufacturing of the paper pulp for the Cellulose Factory in Tunisia. Our study was interested in the determination of the morphological characteristics of the laminas of the tufts of *alfa (Stipa tenacissima* L.*)* of different populations of Kasserine region: This study is based on the measure of length and the thickness and in addition to determinate the anatomical characteristics of the laminas which consists in developing the quality of *alfa* by determining the rate of the Dryness and the cellulose content for the summer period. Our results showed that the recumbent of *El Guira* presents the most important length of the laminas (0.46m), and there cumbent of *Oum lagssab* has the highest thickness (1.45mm). The chemical analysis of the leaves of *alfa* showed that: cellulose content is higher at the population of *Oum lagssab* (30.6%) and *Zelfan* (30.33%) during the active period (autumn) whereas it is important at the population of *Guira* (36.6%) for the latent period (summer). The rate of Dryness of the leaves of is higher in autumn for the population of *Zelfan* (70.10%) on the other hand is maximum at the population of *Oum lagssab* (74.04%) in the summer.

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Introduction

The *alfa* (*Stipa tenacissima* L.) is an herbaceous plant, long-lived monocotyl belonging to the *poaceas* family. It's a plant which finds on the steppes, it is typically Mediterranean especially localized in the western part of the area of Mediterranean: South East of Spain, Eastern of Morocco, in Algeria, in Tunisia and Libya (Boudy, 1952). It develops in a very wide climatic range and undergoes all the irregularities of arid zones (Rejeb, 1977). In Tunisia, the producing recumbent is located on the high plateaus and the lowest steppes of Tunisia central (Mokhtar, 2002).

The *alfa* has important eco-socio-economic role. Besides it constitutes the principal raw material for paper industry in the SNCPA (National Company of cellulose and paper) it constitutes also an interesting source of employment.

This morphological study is based on the measure of length and the thickness and in addition to determinate the anatomical characteristics of the laminas which consists in developing the quality of *alfa* by determining the rate of the Dryness and the cellulose content for the summer period.

It appears necessary to preserve these recumbent by treating various possibilities of these producing surfaces. So, the determination of the morphological of tufts of the characteristics of the laminas of the leaves of various populations of the recumbent by taking account of soil characteristics proves to be a dynamic and deterministic stage various sources of *alfa* and its quality.

Materials and methods

Vegetable materials

Our study related to the lamina of the tufts of *alfa (Stipa tenacissima* L.*)* of different population of recumbent (*Dj. Essalloum, El Guira, Oum Lagssab, Jelma* and *Zelfane*).

Methods

Choice of sites**:** The experimentation was carried out in five sites of study located in the region of *Kasserine* (Western Center of Tunisia).

The choice was based on the bioclimatic, the geographical distribution and the relief.

Choice of populations: Our study was carried out on five representative populations per site:

Morphological and anatomical parameters measurement of lamina of leaves of the tufts of *alfa (Stipa tenacissima* L).

The length and thickness measurement **of** lamina of leaves were taken during the month of july 2008.

The rate of Dryness and the content of Cellulose measurement were taken during the month of November 2008.

The length and thickness

Measurement of lamina of leaves.

The length measurement of lamina of leaves, exploitable part of *alfa (Stipa tenacissima* L), and the thickness proves be a paramount stage which helps us to characterize the recumbent while being based on the study of the regressive and progressive evolution of the tufts of *alfa (Stipa tenacissima* L).

In each site we chose circular small squares (Radius of 5,6 m which corresponds to a surface of 100 m^2)and selected five tufts from which we take ten laminas in order to measure the length(m) and the thickness (mm) by considering the average for the two parameters.

Rate of dryness

The method of determination of Dryness is applicable on samples of the leaves of *alfa* which are subjected to treatments by drying; by the way it is applied to the wet or dry paste. It is used for the determination of the content of dry matter of taken samples of the lamina of the leaves of *alfa* or of the paste. The bottle containing the fresh *alfa* is weighed which gives us a weight P_1.

The bottle containing the sample is put on room temperature 80°C during 48 hours and weighted again and obtains a weight P_2.

The rate of Dryness (S) is the report of percent of the two pondered values.

$$S(\%) = (P2 / P1) * 100$$

The operations of analysis and extraction are in conformity with the work methods suggested by the laboratory of the Cellulose Factory of Kasserine (*SNCPA*).

Cellulose content

The method of determination of Cellulose content is applicable on fibers of leaves consists in achieving the proportion of cellulosic feedstock contained in cellulosic fibers of the *alfa* leaves compared to the whole of the components of the plant. This operation is also used for the paste.

To determine this rate we proceed in the following way:

We put one gram of dry *alfa* (P_1=1g) in an Erlenmeyer in the presence of 30 cm^3 of alcohol at 95° during 3 hours at the boiling temperature point of solvent ; all the resin and the wax contained in the *alfa* leaves are those extracted.

We attack the rest of the *alfa* by the nitric acid (HNO_3) (at a rate of 10 cm^3 for 1g of *alfa*) to dissolve the rest of the components of the *alfa* put except for cellulose.

-We wash Erlenmeyer with warm water;

We filter the mixture to have a solid residue which is the cellulose;

-We dry the residue with drying oven at 110 °C during 12 hours;

We weigh the residue to obtain a weight P2.

The cellulose rate(C) is the report, in percent, of the difference of two weights (P_1-P_2) on the initial weight (P_1).

$$T(\%) = \left[(P1 - P2) / P1\right] \times 100$$

Statistical processing

It is carried out by the software (SAS). The whole of measurements was the object of analysis of the variance with two factors by the test F of Fisher to check the assumption of equality of the averages to the threshold of risk of 5%.

It is supplemented by multiple comparisons of the averages by the test of Newman and Keuls when the assumption of equality of the averages is rejected, (Steel Robert and Torie 1980; Dagnélie 1986). The present figures were carried out with the software Excel XP.

Results

Study of the morphological parameters

The length (m)

The recorded results length of the *alfa* lamina are about 0,46 ; 0,43 ; 0,38 ; 0,35 et 0,35 m respectively in the recumbent of plain of *El Guira* in *Hassi El Frid, Jilma, Oum Lagssab*, in *Zelfane* and the montain of *Essalloum* during july 2008 (Fig. 1).

The thickness (mm)

The recorded results of thickness of the alfa laminas are about 1,16 ;1,29 ; 1,45 ; 1,27 and 1,03 mm respectively in the dense recumbent of plain of *El Guira* in *Hassi El Frid*, in *Jilma* , in *Oum lagssab*, in *Zelfane* and the mountain of *Essalloum* during july 2008 (Fig. 2).

The quality of alfa leaves according to the season

Rate of primary Cellulose

The recorded results show that the cellulose content in *alfa's* leaves is about

28 % ; 24,4 % ; 30,6 % ; 21, 3 % ; 30, 33 % respectively for the site of *Essalloum* , *Guira*,*Oum Lagssab, Jilma* and *Zelfane* during November (autumn).

While in august 2008 (summer) this content is about 33,3% ; 36 ,6% ; 21,33% ; 24 % et de 33 ,6% respectively for *Essalloum , Gwira, Oum Lagssab, Jilma* and *Zelfane* (Fig. 3).

The statistical analysis shows a significant difference between the populations for the two periods by the test F of Fisher to the threshold 5 %.

Table 1. Characteristics of geographic, bioclimatic and relief of different populations of Kasserineregion in Tunisia.

Site	Populations	Level bioclimatic	Relief	Altitude	latitude	Longitude	Code
1	*Dj. Essalloum*	Semi-arid lower	montagne	1225	35°05'	08°54'	ES
2	*El Guira*	arid lower	plaine	800	35° 02"	08° 56'20"	GU
3	*Oum Lagssab*	arid lower	plaine	800	35° 47' 35"	08° 22'	OL
4	*Jelma*	arid	plaine	421	-	-	JE
5	*Zelfane*	Semi-arid higher	plaine	1000	35° 23'25"	08° 47' 5"	ZE

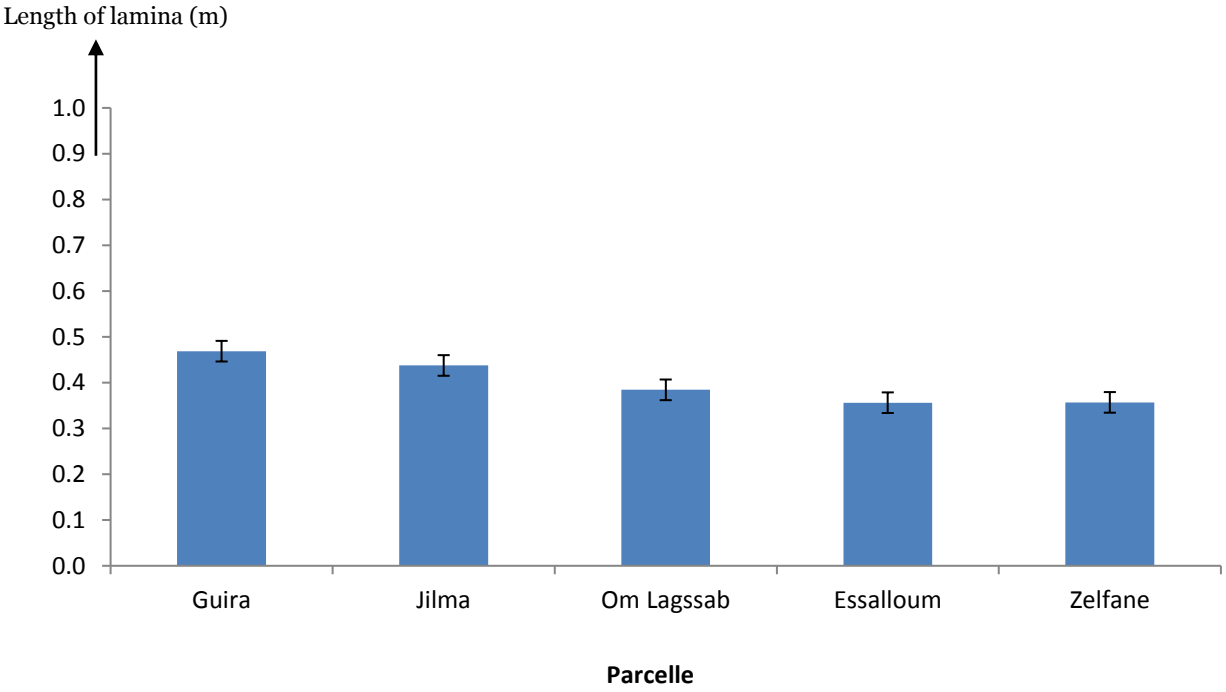

Fig. 1. The length of the *Alfa lamina* according to the alfa populations.

Rate of dryness

The recorded results show that the rate of Dryness in alfa leaves is about de 60,5% ; 66,08% ; 67,87% ; 64,16 % et 70,10% respectively for the sites of *Essalloum, Gwira, Oum lagssab, Jilma* and *Zelfane* during November (autumn).

While in august 2008 (summer) this rate is about 72,41%, 71,04%, 74,04%, 68,87%, and of 72,79 % respectively for *Essalloum, Gwira, Oum lagssab, Jilma*, and *Zelfane* (Fig. 4).

The statistical analysis shows a significant difference between the sites for the two periods by the test F of Fisher to the threshold 5 %.

Discussion

Study of morphological parameters

The highest length of *alfa* laminas tufts is recorded at the populations of *El Guira* in *Hassi El Frid*, *Jilma* with least degree at *Oum Lagssab*, *Zelfane* and *Dj. Essalloum*.

Indeed, the evolution of *alfa* tufts in length depends on the heterogeneity of several intrinsic and extrinsic factors: the interaction of the climatic characteristics, knowing the temperature, the rainfall (moisture), the luminosity (sunning) on one hand and physic-chemical characteristics of the *alfa*.

Moreover, the growth of the shoots of the *alfa* tufts is variable according to the experimental sites and this difference could be due to the state of the recumbent (density) in fact the higher density can support the competition intra specific, resulting by the low growth of individuals in the surrounding where the trophic levelis low and the improvement of the climatic conditions and during seasons, the lamina lengthen more with an increasingly height rate growth (Ghrab, 1981).

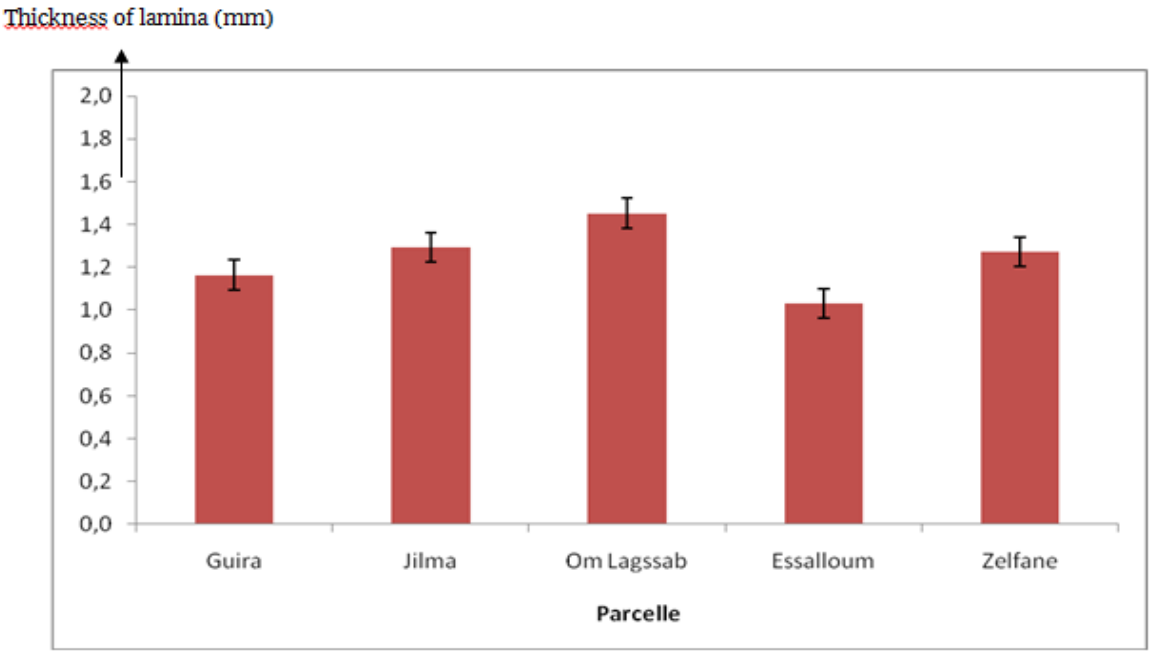

Fig. 2. The thickness of the *alfa lamina* according to the alfa populations.

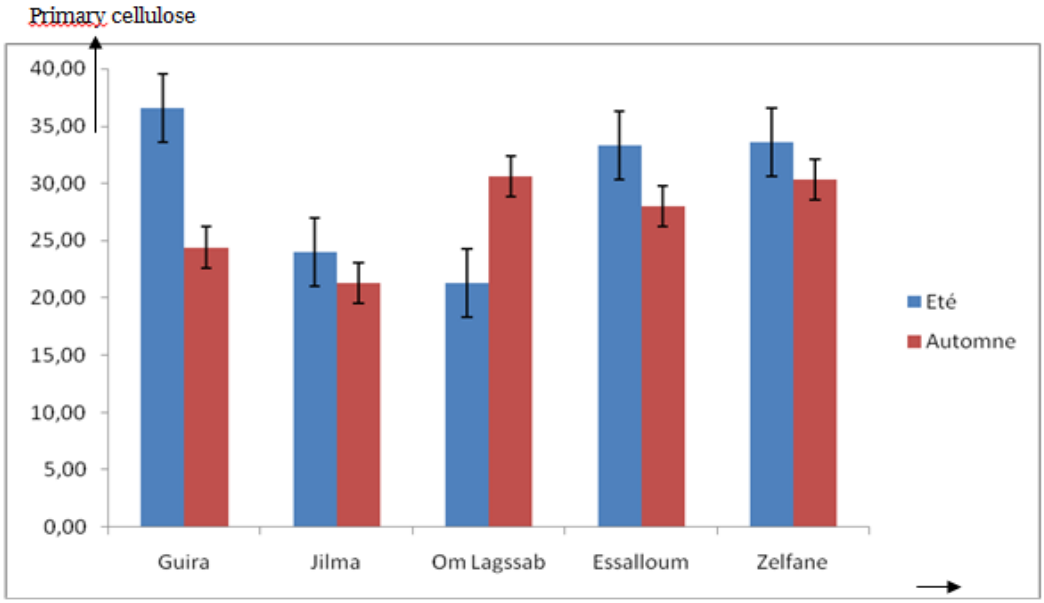

Fig. 3. Variation of the primary cellulose content in alfa leaves for different populations according to the seasons.

The measures was taken in summer (july), in fact during the winter and the summer which attest extreme temperatures of heat and cold and difficult climatic conditions, the growth and the development of the plant stop. The cells of the leaves are in plasmolysis and attend a higher evaporation. The plant enters thus in latent life or vegetative rest (Errebii, 2006) which explains the low values of the heights recorded at the sites.

By the way the conditions of the season of the summer (2008) severe (prolonged drought) and cold winter without rain explains the variation of this parameter.

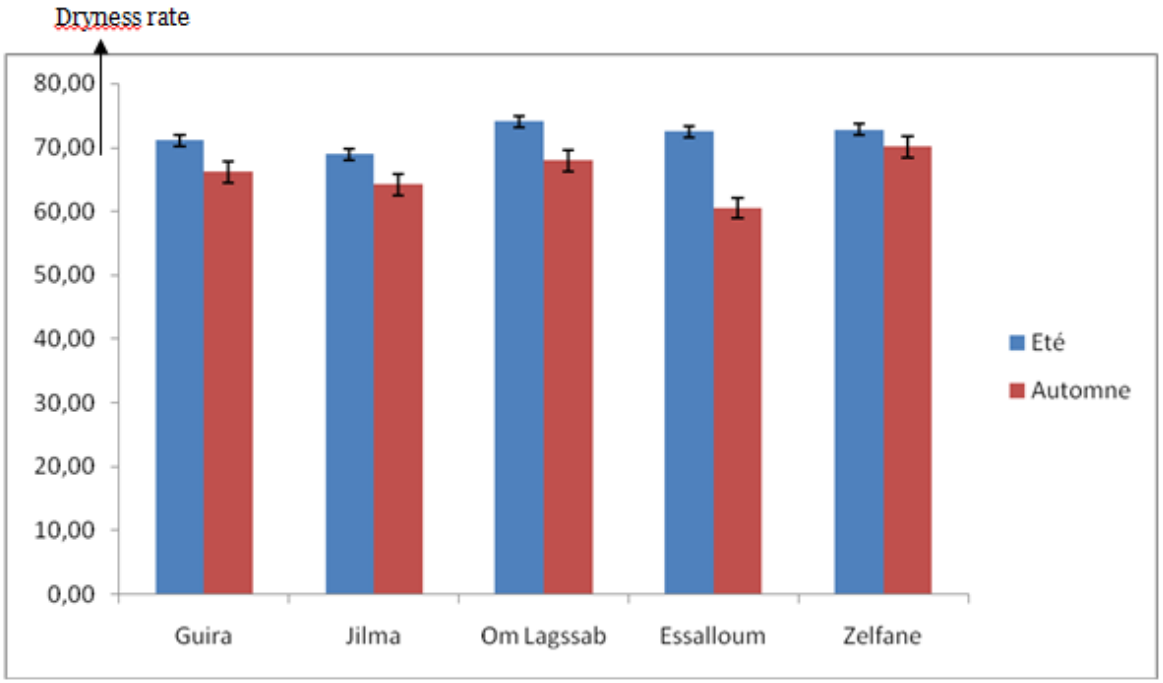

Fig. 4. Variation of the dryness rate in alfa leaves for different populations according to the seasons.

The reduction in the cellular extension which represents one of the first answers to the drought (Durand etal.1995 ; Freitas, 1997 in Ben Sehil 2007) and since the foliar composition of *alfa (Stipa tenacissima* L*)* in total lipids and fatty acids at the summer is represented by a set of fatty-acids saturated (lauric acid, myristic acid, acid palmitic and stéaric acid) characteristics of the states with resistance to the drought (Mehdadi *et al*., 2006) wich make a decrease in the height development of *alfa* tufts.

In spite of the hydrous reserves of the ground during the winter season the *alfa* presents a slowdown of its vegetative growth. It expresses an important sensitivity toward the low temperature which is unfavorable in continuation of its photosynthetic process.

The state of the recumbent requirements of the plant itself to achieve its vegetative cycle, its photosynthetic phases (water, nutritive elements, sunning, temperature and cold) contribute in the evolution or the regression of these parameters (Floret and Pontanier, 1982).

Concerning the *alfa* lamina thickness, the maximum is recorded in the station of *Oum Lagssab* (1, 45 mm) lesser at *Jilma* (1,29 mm), *Zelfane* (1,27 mm) and d'*El Guira* in *Hassi El Frid* (1,16 mm) and a minimum at *Essalloum* (1,03 mm).

The thickness growth of the lamina tufts of *alfa* during seasons of the year is related to the intensity of the rain and its distribution on the *alfa* recumbent. Moreover, the shoot growth of the lamina tufts of *alfa* is variable according to the experimental sites.

This inter-regional thickness variation corresponds to an ecological diversity of the *alfa* recumbent and a variation of the soil fertility as well as the variation of the rainfall distribution (Errebei, 2004; Kheriji, 2005). However, the variation of these parameters is also related to the composition of the xerophytes plant itself (*Stipa tenacissima* L*)* by its physic-chemical characteristics and its adaptation of arid climat.

Study of the quality of the alfa leaves

The results recorded show that maximum cellulose content in the *alfa* leaves are at *Zelfane* (30, 33 %), *Oum Lagssab* (30,6 %) and *Essalloum* (28 %) with lesser at *Guira* (24,4 %) and *Jilma* (21, 3 %) in November (autumn).

In august during summer (low down life); the important variation is between the stations and it can be explained by the interdependence of several parameters; the maximum recorded at *Gwira* (36 .6%), *Zelfane* (33.6%) and *Essalloum* (33.3%) lesser at *Jilma* (24 %) and *Oum Lagssab* (21.33%);

The cellulose

Substance organized out of fibers, is constituent the most abundant of the cells membranes forming fabrics of the higher plants (Beldzki A. K. *et al*., 1999).

The rate of cellulose

Proportion of cellulosic feedstock, contained in the leaves cellulosic fibers of the *alfa*, compared to the whole of the components of plant (Ghrab, 1981).

The interregional variation of these contents could be correlated to the climatic characteristic conditions of the region (climate, temperature, water) and the relief (mountain, plain, slope, and glaze).

The cellulose content appears more important in the most arid regions (Kheriji, 2005). While, according to the farming operations, it proves that the cellulose content is higher in the fertilized recumbent. The richer the ground the more the plant is productive.

Space and seasonal variability of the fibers cellulose content of the *alfa* can be correlated with prime factor which is the humidity (water).

These contents are lower in winter because of very low temperatures which inhibit the synthesis of cellulose where the plant is in latent life (Ghrab, 1981). In spring when the climatic conditions become favorable, the plant taken over its biological activity and the development of its sap and to show by consequence a better content of cellulose at the end of its vegetative cycle during the summer (Ghrab,1981).
Several parameters influence the cellulose content in the plant, indeed the plant chemical composition change according to the growth of the fibers (Han, 1998). According to (El Rhazi, 2003), there is variation of cellulose content related to the season what could be related with the plant vegetative.

A difference in the chemical and physical composition of the fibers not wood according to the fibers growth (Han, 1998). For the Kenaf, it results in an increase of cellulose content, lignin, glucose and xylose, and in reduction in the anabiose, galactose and mannose where resides composition factor of the *alfa*.

The results of the leaves Dryness rate of the *alfa* show a maximum in november (autumn) in *Zelfane* (70,10%) lesser in *Oum lagssab* (67,87%) and *Gwira* (66,08%) and minimal in Jilma (64,16 %) and Essalloum (60,5%); While in august 2008 (summer) this rate is maximum in Oum lagssab (74,04%) lesser in Essalloum (72,41%), Zelfane (72,79) and Gwira (71,04%) et minimal in Jilma (68,87%).

The rate of Dryness indicates the percent of the dry matter present in the leaves compared to the total weight of the fresh green plant. The Dryness variation depends on several intrinsic and extrinsic factors; indeed the climate and water present the principal parameters (Pouget, 1980).

The results show that the rate of Dryness is high within the sites during the summer when the alfa plant is under latent life and the biological activity ceases.

By the way the results got during alfa active life showed Dryness maximum rates (70.10 %) in alfa leaves of Zelfane in autumn. Whereas the minimal (60.5 %) were recorded in the site of Essalloum.

These got results show that the rate of alfa leaves Drynessis variable according to the stations and seasons besides the phases of vegetative cycle of the alfa.

The same results were obtained by (Errebeii, 2006) in the regions of Om Jnib (Kasserine), and Gallel (Sidi Bouzid).

Tyerman *et al.* (2002) affirms that the plant water statute is determined by the ratio exchange of water between the ground and the atmosphere through the plant. It depends on the water contents in the ground, the atmospheric evaporative request, and the morphological and physiological characteristics of the plant.

The alfa leaves collected in these various Dryness rates are stored put in wind-rows, under conditions makes it reached Dryness optimal rata80 % (Errebeii, 2006).

Then, the action of alfa drying leaves before the entry in paper industry is necessary for getting better transformation and better paste quality.

Conclusion

The alfa (*Stipa tenacissima* L.) it's a long- lived species which develops in a very wide climitic range. It has a great economic-social importance. Ecologically, it takes part in the maintenance of the balance of the local ecosystem and in fight against the desertification in the arid regions and presaharien. Economically, it constitutes a primary material for the manufacturing of the paper pulp for the Cellulose Factory in Tunisia.

The results got during *alfa* active life show that Dryness rate maximum (70.10 %) was recorded *alfa* leaves of *Zelfane* for the bioclimatic level higher semi arid. Whereas, the minimal values (60.5 %) got in the site of *Essalloum* in the semi level bioclimatic arid lower.

They got results shows the morphological and anatomical characteristics *alfa* laminas tufts of each nappe.

The recorded results shows important values for the two parameters: The cellulose content and the Dryness rate at population of *El Guira* allowed by the population of *Zelfane* and the population of *Essalloum* and lesser the populations of *Om Lagssab* and *Jilma* from where it marks the importance the recumbent alfa on the quality plan of *alfa* Laminas for the manufacturing of the paper pulp.

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