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Quercus faginea in the Mounts of Tlemcen (North-west Algeria): State of Knowledge

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Abstract. In this study, we present a summary of the dendrometric characteristics, the microscopic image and the physic-mechanical properties of wood and principally leaves morphology for to show the existence of zeen oak (*Quercus faginea*) population in the far North West of Algeria with specific characters. The morphology of 400 mature leaves taken from 10 trees at the 4 exposures shows that the length of the leaf blade is about 8.568 cm, the width is 4.955 cm, its perimeter about 14.280 cm and its surface area 15.14 cm². The mature leaf is composed of 20 lobes; the length of the six largest lobes is about 3.098 cm and the angles of their ribs 51.352°. The morphological characters studied have relatively high variability between the four aspects. Leaves at southern aspect have the lowest vegetative values. In contrast, at eastern aspect trees have large leaves with vegetative characters developed.

Key words: *Quercus faginea*, wood characteristics, leaf morphology, aspects.

Introduction

The total forest area in the Wilaya of Tlemcen (North West Algeria) amounts to 209 230 hectares, 22.30% of the Wilaya's total area (LETREUCH-BELAROUCI, 1995). This forest rate makes consider the area among the greatest forest zones of the Algerian west territories.

Oaks figure amongst preponderant national forest trees; they are mainly confined to mountainous areas of the Mounts of Tlemcen. If holm oak and at a lesser extent cork oak cover great spreads, zeen oak is recorded only in the South West, when certain conditions of topography (cool valleys), aspect (North East) and coolness are gathered. As for kerm oak, it is a shrub associated with holm oak and cork oak.

Quercus faginea is a deciduous oak which can easily reach height of 15 m. This tree (Fig. 1a & Fig. 1b) carries either a flattened crown when in thin stands or pyramidal crown when in dense stands on a very slender trunk. Its bark (Fig. 1c) is deeply fissured and dark brown colored. The acorns of yearly maturity (Fig. 1d), are slightly enclosed in a cup. Morphologically, the zeen oak of the Mounts of Tlemcen differs from the other varieties of zeen oak with its leaves (Fig. 1e) which are more or less villous on above, parallel secondary nerves and with the presence of intercalated nerves.

State of knowledge includes the following information: *Quercus faginea* in Forestry ambiance; *Quercus faginea* wood and use; Descriptive analysis of morphological parameters; Quantitative analysis of morphological parameters.

Material and Methods

Plant material. The leaves used for the present study come from the zeen oak forest of Moutas hunting reserve, located in the state forest of Hafir about 26 km south-west from the chief town of Tlemcen (Fig. 2).

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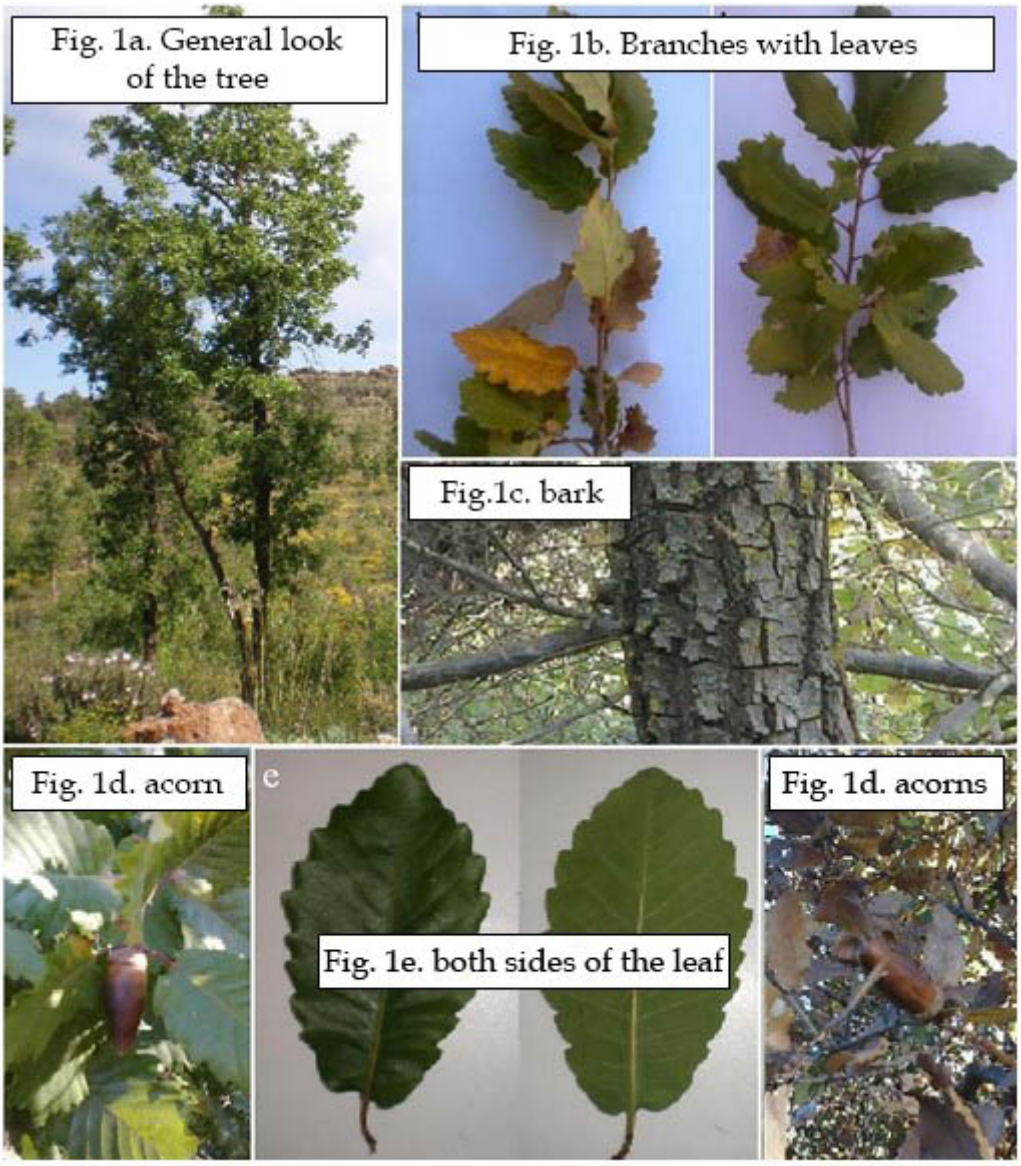

Fig. 1. General traits of zeen oaks in the Mounts of Tlemcen.

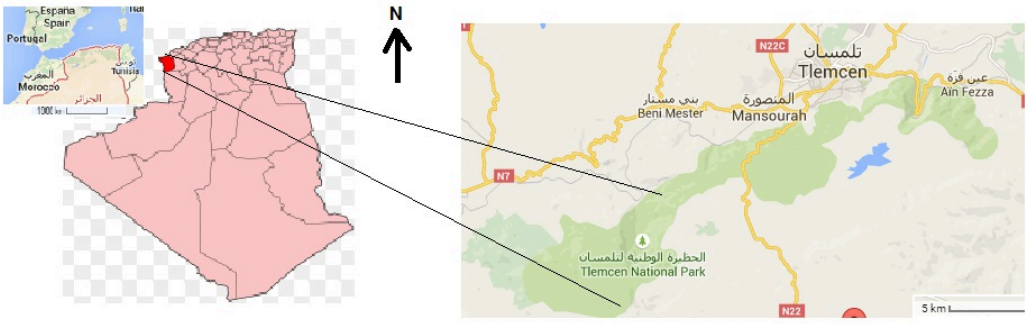

Fig. 2. Location of the study area.

On the deep soils of the valleys of Moutas Hunting Reserve (Fig. 3), zeen oak is associated with holm oak and cork oak, either in the form of isolated trees or in the

form of sparse clusters. It thrives well in the areas relatively well protected from human penetration, either because the ground is too rough or the forest is protected (GAOUAR, 1980).

Fig. 3. Zeen oak in Northern slopes «golden» with holm oak «copse».

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The morphological description is based on the measurement of a great number of quantitative characters linked to leaves. Ten trees have been randomly selected. From each tree and from the four exposures, two branches have been drawn. At the laboratory, the leaves have first been the object of a general description, later from each branch, 5 mature leaves have been the object of a quantitative analysis. On the whole, 400 leaves distributed on the four exposures have been analyzed.

Collecting and techniques measurement. The studied parameters are the length of petiole (cm), the length of leaf-blade (cm), the maximal width of leaf-blade (cm), the length of leaf-blade at the greatest width (cm), the surface of leaf-blade (cm^2), the perimeter of leaf-blade (cm), the number of lobes, the mean length of the six greatest lobes (cm) and the mean angles of veins of the six greatest lobes (Fig. 4).

The collected leaves are put in a plastic bag with a wet paper towel in the dark. This type of conservation keeps the initial shape of the leaves. At the laboratory, the leaves are individually scanned at a scale of « 1/1 ». The obtained images are then processed through a computer software reconfiguration the digital synthesis images (Fig. 5).

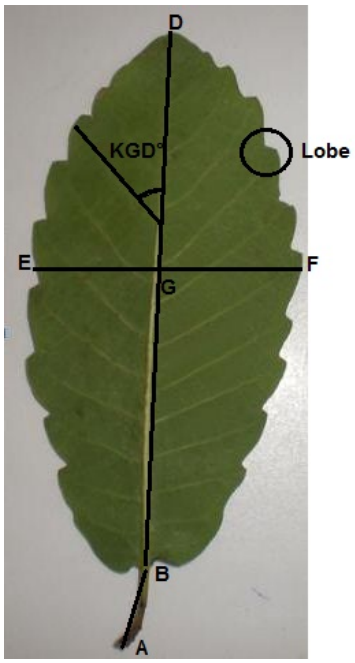

Fig. 4. Localization of morphological parameters.

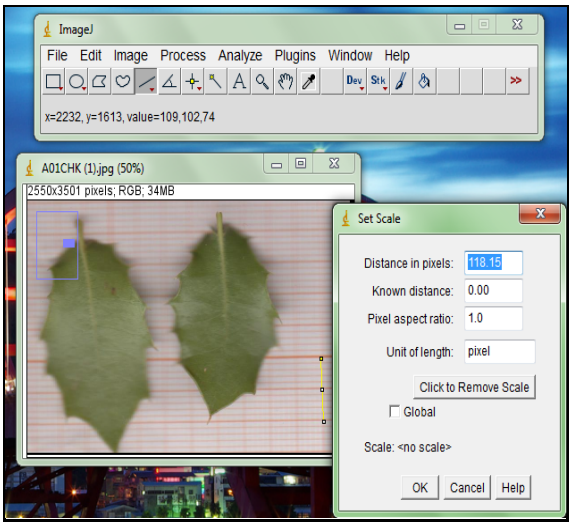

Fig.5. Measurement of quantitative traits by the software (Imag J).

Processing software and image analysis, allows computing the different leaves morphological parameters [imagej.net].

The variability of each morphological parameter in the same exposure and between the exposures is based on an analysis of variance (ANOVA). The correlation between the parameters is

carried out using the Statistica 6.0 software (BERNARD, 2004).

The measurements are realized on leaves called «characteristic» which are adult leaves where the causes of variation due to the growth and to polymorphism are eliminated. We have purposely limited our study to the macroscopical characters excluding anatomical and microscopical criteria.

Table 1 summarizes the measured parameters of the leaf of *Quercus faginea.*

Table 1. Measured parameters of the leaf of *Quercus faginea*

Measured parameters	Codification
length of petiole (AB, cm)	LP
length of leaf-blade (BD, cm).	LL
maximal width of leaf-blade (EF, cm).	LM
length of leaf-blade at the greatest width (BG, cm)	BG
surface of leaf-blade (cm^2)	SU
perimeter of leaf-blade (cm)	PE
number of lobes	NL
mean length of the six greatest lobes (cm)	HL
mean angles of veins of the six greatest lobes	KGD°

Results and Discussion

Quercus faginea in forestry ambiance. When zeen oak stands are mixed with cork oak or holm oak, we remark on the favor of lighting, the existence of zeen clusters seemingly even-aged but not having the same age. Those clusters of some hectares won our interest. We can well imagine a high-forest having the look of an uneven-aged forest treated in even-aged clusters of graduated ages where shall be practiced inside of each of them the classical operations of even-aged high-forests. That shall have as a result an adulatory out-line of very fine appearance and in the same time productive. Here also, the entire question is about applying mixed oak stands management focusing on conservation and enrichment of zeen oak populations (LETREUCH-BELAROUCI, 1995). A dendrometrical study of those zeen oak clusters showed a basal area running to 10-11 m^2/ha with a dominant height of 11m. The mean diameter reaches 20 cm for a density of 400 trees/ha (BERRICHI & BOUAZZAOUI, 2011).

The vegetation surveys in the forest of Hafir show that it's mainly formed with *Quercus suber* L. on siliceous soil to which is sometimes associated zeen oak. In west, holm oak succeeds to cork oak (MAHBOUBI, 1995). In the cork oak forest, the Zeen dominates in the north exposure and in the medium altitudes (LETREUCH-BELAROUCI *et al.*, 2009).

The accompanying flora of zeen oak consists of: *Arbutus unedo, Cratagus oxycantha, Erica arborea, Juniperus oxycedrus, Phillyrea angustifolia, Rosa canina, Lonicira implexa* and *Viburum tinus.* The herbaceous layer is composed of: *Ampelodesma mauritanica, Cistus monspeliensis, Daphnie gnidium, Asparagus acutifolius, Lavandula stoechas, Genista tricuspidata, Ruscus aculeatus,* and *Pteridium aquilinum*.

Quercus faginea wood and use. BERRICHI (2010a) mentioned that the wood of *Quercus faginea* is yellowish brown colored. Sapwood is lighter colored than heartwood; growth rings are visible to the eye discerned by the presence of final wood sheaths. On the microscopic point of view, the description and the quantification of the elements of the ligneous plan, emphasizes the following points. Zeen oak presents a wood with «semi-porous zones», the pores of initial wood are isolated, sometimes joined, round or oval-shaped and of variable size. The pores of final wood have the shape of a flame; they have a smaller size almost uniform. The parenchyma is of apotracheal type with isolated and dispersed cellules, sometimes disposed in chainlets and the paratracheal parenchyma in confluent bands and circumvascular (Fig. 6). In quantitative microscopy, the pores of initial wood have 149.84 µm in diameter, they are qualified «Means» in size. The pores of final wood are «Very Small » and have 22.163 µm in diameter. The sheaths are of mean frequency, running to 10 sheaths at mm^2.

In a synthesis of the physical and mechanical characteristics of *Quercus faginea* wood in the Mounts of Tlemcen realized according to the standard NF B 51-002, BERRICHI (2010b) showed that zeen oak wood have a density of 0.91 kg/dm^3, it is qualified as «heavy».

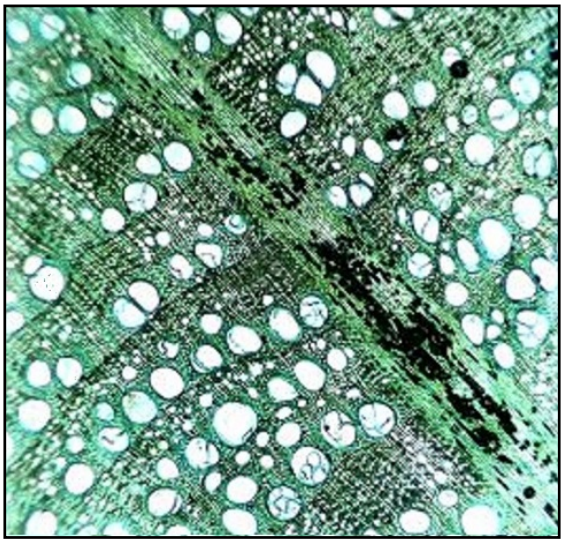

Fig. 6. Cross section of *Quercus faginea* wood.

The total volumetric contraction is less than 10%, it follows that it wood is «low contraction», thus qualified of good dimensional stability, being able to dry before cutting up, fit to wood-peeling and modelling. The resistance to static flexion confirms throughout rear resistance, the use of zeen oak wood as warning wood. If subjected to the resistance of dynamic flexion constraint, the zeen oak wood develops a «good» resistance to shock (0.73 kg/cm^3), this category of wood resists to violent shocks, such as aviation, tools' necks, ski blades, rackets, and uses comprehending vibrations. The tensile strength perpendicular to fibers is 39 kg/cm^2, qualified as «mean to strong resistance», having for origin the strong adherence of fibers. In acceptable dimensions, the zeen oak wood is suitable to common uses in the field of building and carpentry. The strong resistance to splitting (29.53 kg/cm) is due to the fibers tangle. The strong resistance to shearing (163 kg/cm^2) is influenced with thickness of fibrous tissue walls. The «half-hard» wood of zeen oak reflects its aptitude to manufacturing (carpentry and floor-planks making).

MASSAOUDENE *et al.* (2009) put zeen oak wood from the forest of Aït Ghorbi in Kabylie (humid bioclimatic area with annual rainfall varying from 900 to 1 400 mm) in the category of strong contraction woods, responsive to very responsive and half-heavy to heavy, and can provide a good quality wood for cabinet-making, floor-planks making and handycraft if growth constraints are reduced through the creation in the stands of moderate state of competition

Descriptive analysis of morphological parameters. The descriptive morphology of the leaf of *Quercus faginea* reveals an alternated leaf position, a thick leaf-blade, tough and broad with an asymmetrical base and heart-shaped with margins crossed by 6 to 14 pairs of lobes little deep. Young leaves are tomentose then became progressively glabrous. The color of the young leaves is grey reddish-brown, then green bright above, paler and glaucous beneath, conserving traces of indumentum along median vein, and at last yellow brown in fall. Leaf-stalk is dark pink.

Quantitative analysis of morphological parameters. On the quantitative point of view, the obtained results have been the object of statistical analysis to seek the existing variability in a same parameter for a same aspect and between aspects (Table 2).

The analysis of data in Table 2 and on the graphs of Fig. 7 show that the mean length of petiole is 1.386 cm, the longest petioles are in Eastern aspect (1.508 cm), the shortest in Western aspect (1.264 cm). The mean length of leaf-blade is 8.568 cm, the longest leaf-blades are in Eastern aspect (9.349 cm) and the shortest in Northern aspect (8.227 cm). The maximal leaf-blade width is 4.955 cm, the narrowest leaf-blade are in Southern aspect (4.774 cm) and the longest in Eastern aspect (5.186 cm). Leaf-blade's length at the greatest width is 4.427 cm, the longest is at the Eastern aspect (4.978 cm) and the shortest at the Southern aspect (4.231 cm). The mean surface of leaf-blade is 15.14 cm^2, it's more important in Eastern aspect (15.85 cm^2) and less developed in the Southern aspect (11.25 cm^2). The mean perimeter of leaf-blade is 14.280 cm, the longest is at the Eastern aspect and the shortest at the Southern aspect.

The mean angles of veins is 51.352°, this criterion also presents a peculiarity: the highest values are recorded at the Western aspect (KGD° = 52.305). The petiole length (LP), the length of leaf-blade at the greatest width (BG), and the surface of leaf- blade

Table 2. Quantitative analysis of leaf parameters.

Measure-ments	EAST			WEST			NORTH			SOUTH			P
	$\overline{X}$	σ	CV %	$\overline{X}$	σ	CV %	$\overline{X}$	σ	CV %	$\overline{X}$	σ	CV %	
LP	1,508	0,394	26,14	1,264	0,338	26,77	1,438	0,440	30,56	1,334	0,343	25,68	***
LL	9,349	1,477	15,80	8,364	1,723	20,61	8,227	1,576	19,16	8,332	1,210	14,52	***
LM	5,186	0,942	18,16	4,922	1,152	23,41	4,937	1,058	21,44	4,774	0,888	18,61	*
BG	4,978	1,310	26,32	4,260	1,001	23,50	4,238	0,973	22,95	4,231	0,927	21,90	***
SU (cm²)	15,14	5,63	37,19	13,82	5,68	41,10	13,5	5,014	37,15	13,33	4,125	29,46	**
PE (cm)	15,060	3,131	20,79	14,018	3,290	23,47	14,407	2,901	20,13	13,636	2,268	16,63	*
NL	20,62	1,75	8,47	19,87	1,15	5,77	20,5	1,41	6,90	19	1,41	7,44	**
HL (cm)	3,098	0,539	17,41	2,754	0,628	22,81	2,816	0,565	20,06	2,721	0,486	17,85	***
KGD°	49,610	5,782	11,66	52,305	5,704	10,91	52,027	6,087	11,70	51,464	5,693	11,06	**

Legend: X: arithmetical mean; σ: standard deviation; CV %: coefficient of variation. LP: length of petiole; LL: length of leaf-blade; LM: maximal width of leaf-blade; BG: length of leaf-blade at the greatest width; SU: surface of leaf-blade; PE: perimeter of leaf-blade; NL: number of lobes; HL : mean length of the six greatest lobes; KGD: mean angles of veins of the six greatest lobes. « 0.01< P <0.05 » non-significant difference (*), « 0.001< P <0.01 » significant difference (**), « P <0.001 » very significant difference (***).

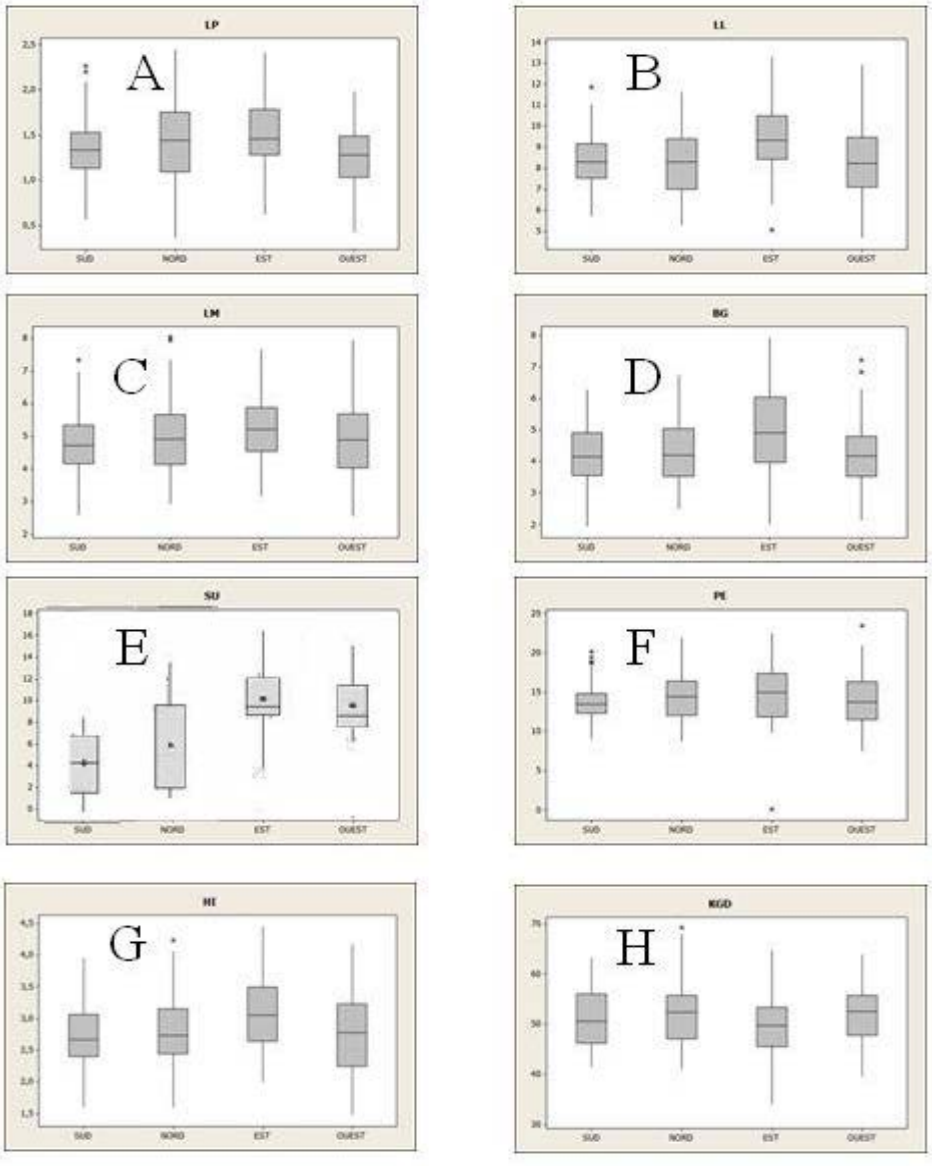

Fig. 7. Graphical presentation of variability of LP (A); LL (B); LM (C); BG (D); SU (E); PE (F); NL (G) and KGD (H).

(SU) present an important scattering around the mean (CV >20%).On the other hand, the lobes number (NL), the mean length of the six greatest lobes (HI) and the mean angles of veins of the six greatest lobes (KGD) are less heterogeneous with CV <10%. The leaves at the Southern aspect have the weakest vegetative values constituted with the smallest leaves. In return, at the Eastern aspect, trees present big sized leaves with very developed vegetative characters.

The results of the variances analysis (ANOVA) of Table 2, present very weak P values (P<0.001). The petiole length, the leaf-blade length, the length of leaf-blade at the greatest width and the mean angles of veins of the six greatest lobes of mature leaves of *Quercus faginea* have a quite high variability among the four aspects, they are very developed at Eastern aspect. Consequently, there is a very high heterogeneity between the four aspects for several characters. The lobes number, the leaf-blade surface and the mean angles of veins of the six greatest lobes have P values included between 0.001 and 0.01 which reveal the existence of a significant difference between aspects.

The analysis of the variance shows a not very significant difference (0.01< P <0.05) between the aspects for the maximal leaf-blade width and its perimeter. Morphological characters of *Quercus faginea* have a quite high variability between aspects. There is a very strong heterogeneity between the four aspects for many characters. The leaves at the Southern aspect have the weakest vegetative values constituted with the smallest leaves. In return, at the Eastern aspect, trees present big sized leaves with very developed vegetative characters. As discussions, the observation can be attributed to the dependence of photosynthetic activity of the effect of the illumination.

Correlation coefficients. The analysis of the Pearson's correlation matrix (Table 3) conducted on the studied characters shows that several characters are correlated between them: surface of leaf-blade is correlated to leaf-blade length (r=0.916), to leaf-blade width (r=0.903), to leaf-blade perimeter (r=0.918) and to the mean length of the six greatest lobes (r= 0.823). The leaf-blade perimeter is correlated to the leaf-blade length (r=0.837) and to the maximal leaf-blade width (r=0.890) and to the mean length of the six greatest lobes (r=0.861). In the same way, the mean length of the six greatest lobes is correlated to the maximal leaf-blade width (r=0.870). With low correlation coefficients, the mean angles of veins of the six greatest lobes (KGD) are not dependent on the other measured morphological characters.

Conclusions

Unfortunately, we do not have sufficiently detailed morphological data for the other oak species to assert with certainty

Table 3. Correlation coefficients between the different leaves' morphological parameters of *Quercus faginea*

	LP	**LL**	**LM**	**BG**	**SU**	**PE**	**NL**	**HL**	**KGD**
LP									
LL	0,46								
LM	0,27	**0,74**							
BG	0,5	**0,77**	0,55						
SU	0,29	**0,70**	**0,70**	0,58					
PE	0,34	0,53	0,51	0,53	**0,9**				
NL	0,321	**0,750**	0,463	0,360	0,499	0,538			
HL	0,36	**0,77**	**0,83**	0,61	**0,74**	0,54	0,45		
KGD	-0,15	0,03	0,33	-0,12	0,19	0,12	-0,14	0,03	

Legend: LP: length of petiole; LL: length of leaf-blade; LM: maximal width of leaf-blade; BG: length of leaf-blade at the greatest width; SU: surface of leaf-blade; PE: perimeter of leaf-blade; NL: number of lobes; HL: mean length of the six greatest lobes; KGD: mean angles of veins of the six greatest lobes.

the specificity of the Mounts of Tlemcen zeen oak with regard to the other oaks. Effectively, when we compiled the bibliographical resources, the only morphological parameters met with were the leaves length and width; they were mentioned with wide intervals taking into account oak leaves polymorphism to enclose the different stages of leaf maturity so as that they could not be profitable for the results interpretation.

The morphological variation of zeen oak in the Mounts of Tlemcen is linked to sampling conditions, aspect namely. We can say that this work reflects the existence of probably unknown zeen oak stands in this area. This «test-approach» of the morphology have to be enlarged to a much bigger sample, concerning the other *Quercus* species and suited with deepest research namely in botany and genetics, and to try to integrate the other biometrical parameters for a better description.

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