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Morphological and Biometrical Characterization of Seeds of Some Algerians Lentil Accessions: Quantitative and Qualitative Characters

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Abstract The preliminaries characterization of a collection of twenty three Algerians accessions of lentil (*Lens culinaris* M.) were done before sown. Seed thickness (STH), Seed diameter (SDM), thickness/diameter ratio (T/D) and Weight of 100 seeds (WHS), are a quantitative traits measured. Altitude and Rainfall of location of origin of accessions are considered as a supplement variables. Also, qualitative characters: Grain form (GFR), Ground color of seed testa (GCT), Pattern of testa (PAT), Cotyledons color (COC), were considered. From the result of Principal Component Analysis (PCA), axis 1 explains 65.08% of the variance in the qualitative character and it showed a strange negative correlation with seed diameter (SDM), Weight of 100 seeds (WHS) and altitude (ALT).Whereas, it was positively and significantly correlated with thickness/diameter ratio (T/D) variable. The second component, accounting for 23.58 % of the total variation, was correlated positively with seed thickness (STH). Hierarchical discriminate analysis revealed major differences between accessions from different regions. Three major regional groups were apparent: 1) a Western group characterized by accessions of the *Macrosperma* type, 2) a more Northern group of the *Microsperma* type and 3) A mixture group gathered all regions and the two types. Regarding qualitative traits, the application of Multiple Correspondence Analyses (MCA) showed that seeds with globular form (*Microsperma*) are two types: 1) Brown or green tasta with dotted seed coat pattern or note and yellow cotyledons and 2) Brown tasta with orange cotyledons. In addition, seeds with flat form (*Macrosperma*) are divided into two types: 1) Brown, Beige or Green tasta with yellow cotyledons, 2) Brown tasta with dotted seed coat pattern and yellow cotyledons.

Keywords: *Lens culinaris, quantitative traits, qualitative characters, Microsperma, Macrosperma*

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1. Introduction

Among pulses, lentil (*Lens culnaris* M.) is one of the most important grain legume consumed by Algerians population [1]. Where its seed is an important local dietary item rich in protein [4,16]. However, yield instability at different locations and among seasons has been recognized as a persistent problem [13]. This is due to many causes. Including the absence of a local germoplasme evaluation data, regarding desirable traits of seeds. Which is a very important step, in identification of better genotypes, which can be helpful for successful breeding program.

Numerous studies have been conducted in this subject area and most of the studies have been largely focus on phenological and vegetative characters, such as: Time to flower day, plant height, number of pods per plant, number of seed per pods, seed yield, time to maturity, etc. [2,8,10,11,15,17]. On the other hand, there is limited research regarding seed characters evaluation [3,12,18,19].

The objective of this study, were to investigate the relationships between the important characters of seeds (quantitative and qualitative) on the basis of location of origin of accessions.

2. Materiel and Method

2.1. Plant Materiel

The vegetal material consisted of thirty two lentil accessions originating from differences localities of Algeria. Lentil accessions within each region were collected in 2011. Relevant passport data of populations are given in Table 1.

2.2. The Methods

To determine average seed size, 20 seeds were randomly picked from each accessions and their two dimensions (diameter (SDM) and thickness (STH) were

measured using a digital caliper with an accuracy of 0.01 mm. For the same seeds, qualitative characters: Grain form (GFR), Ground color of seed testa (GCT), Pattern of testa (PAT) and Cotyledons color (COC) were examined by visual method. 100-seed weight (WHS) was determined using an electronic balance to an accuracy of 0.001 g.

Table 1(a). List of thirty two (32) lentil genotypes and Agro climatic characteristics of the location of origin

Genotypes	Site	Lat.	Long.	Alt.
ALG1	El-Khroub	35.25	6.61	675
ALG2	El-Khroub	36.28	6.67	560
ALG3	Yakouren	36.73	4.43	1252
ALG4	Azazga	36.56	4.45	1147
ALG5	Mila	36.45	6.26	486
ALG6	Dahmouni	35.33	1.90	1083
ALG7	Dahmouni	35.45	1.41	995
ALG8	Dahmouni	35.45	1.73	908
ALG9	Dahmouni	35.37	1.31	995
ALG10	Hassi-Zahan	35.11	0.38	483
ALG11	Malza	35.19	-0.64	470
ALG12	Ain Trid	35.10	-0.63	483
ALG13	Benchiba	34.83	-0.50	485
ALG14	Merine	35.19	-0.63	476
ALG15	El-Maleh	35.28	1.08	224
ALG16	Agllal	35.30	-1.14	250
ALG17	Bouskine	36.26	2.45	981

Table 1 (b). List of thirty two (32) lentil genotypes and Agro climatic characteristics of the location of origin

Genotypes	Site	Lat.	Long.	Alt.
ALG18	Bouskine	36.08	2.75	981
ALG19	Bouskine	36.08	3.00	1005
ALG20	Bouskine	36.08	3.00	1005
ALG21	Bouskine	36.08	3.00	1005
ALG22	Bouskine	36.08	3.00	1005
ALG23	Bouskine	36.08	3.00	1005
ALG24	Bir Aghbalo	36.25	4.17	1005
ALG25	El-Khroub	36.33	6.66	694
ALG26	Bir Ayad	36.22	3.36	525
ALG27	Ridden	35.35	3.53	500
ALG28	Khbouzia	36.38	3.90	530
ALG29	Illoula	36.71	4.05	264
ALG30	Ifigha	36.71	4.04	225
ALG31	Janet	24.33	9.29	1050
ALG32	Beni Fouda	36.09	5.26	1100

2.3. Statistical Analysis

Data were subjected to differences statistical analysis: For all characters, descriptive statistics were calculated, together with Pearson correlation coefficient.

Principal Component Analysis (PCA) on the average standardized values was also carried out to study the relationship between quantitative characters, followed by cluster analysis with the CLUSTER procedure using the Ward's minimum variance hierarchical method.

Qualitative characters were analyzed by Multiple Analyze of Correspondence (MCA).

Statistical analyses were made with the XLSTAT 2011 statistical program (version 13.02.05).

3. Results and Discussion

3.1. Descriptive Statistics and Analysis of Correlations (Pearson (n))

Table 1 gives the size (SDM, STH and T/D) and the weight (WHS) distribution of the lentil seeds. The diameter seeds varied from 2.3 mm to 6.90 mm with an average mean of 4.5±1.83 and seeds thickness ranging from 1.56 mm to 2.90 mm with an average mean of 2.48±0.34. Regarding 100 seeds weight, it varied from 3.00 g to 6.94 with an average mean of 5.15±1.1.

These observations are in agreement with previous related studies. In fact, [9], reported that, the mean diameter and thickness of lentil were 4.45-6.82 and 2.36-2.55 mm respectively.

Table 2. The average seed size (Diameter, thickness and thickness /diameter ratio), weight of 100 seeds and standard deviation data from 32 observations

Variable	Min	Max	Mean	SD
SDM (mm)	2.393	6.931	4.588	1.837
STH (mm)	1.566	2.906	2.489	0.341
T/D	0.248	1.197	0.669	0.338
WHS(g)	3.000	6.940	5.150	1.127

Table 3 shows Pearson correlation coefficients among quantitative characters; SDM and WHS were positively and significantly correlated. While, STH it was positively and significantly correlated with T/D. SDM was negatively and significantly correlated with STH and TD. Whereas, WHS was only negatively and significantly correlated with STH. Altitude was positively and significantly correlated with SDM and negatively and significantly correlated with T/D. However, rainfall was not correlated significantly with any of these characters.

Table 3(a).Correlation between characters with Pearson correlation coefficient of 0.05

Variables	SDM	STH	T/D	WHS	ALT	RFL
SDM	1	-0.355	-0.968	0.564	0.364	0.304
STH	-0.355	1	0.528	-0.077	-0.221	-0.280

Table 3(b). Correlation between characters with Pearson correlation coefficient of 0.05

Variables	SDM	STH	T/D	WHS	ALT	RFL
T/D	-0.968	0.528	1	-0.482	-0.375	-0.277
WHS	0.564	-0.077	-0.482	1	0.053	0.217
ALT	0.364	-0.221	-0.375	0.053	1	0.332
RFL	0.304	-0.280	-0.277	0.217	0.332	1

Regarding qualitative traits, wide variability was observed for all of the characters among the thirty two lentil accessions (Table 3). Flat and Globular (GFR) types of seeds were found in 71.87% and 28.12% respectively. Color of seed coat (CSC) varied from normal brown (78.12%) and green (15.62%) to Beige (6.25%).Yellow cotyledon was shown by 90.62%, while orange and green was shown by 6.25% and 3.12% of the accessions respectively. 90.62% of accessions did not show any seed coat pattern (SCP), however, seed coat pattern with spots was found in 6.25% accessions and dotted seed coat pattern was shown by only 3.12%.

3.2. Multivariate Analysis

3.2.1. Principal Components Analysis

Table 4 shows relative and per cent proportions of the total variance for each of the first two principal components, the calculated eigenvalues and the coefficient of correlations between the principal components (PC1 and PC2) and the original variables; these coefficients indicate the contribution of each trait to the formation of PC1 and PC2.

Table 4. Effectives and percent (%) of qualitative characters

Variables	Modalities	Effectives	%
FRG	Globular	9	28.125
	Flat	23	71.875
PAT	Dotted	1	03.125
	without	29	90.625
	Spotted	2	06.250
GTC	Beige	2	06.250
	Green	5	15.625
	Brown	25	78.125
COC	Yellow	29	90.625
	Orange	2	06.250
	Green	1	03.125

Table 5. Eigenvalues of the Correlation Matrix

	F1	F2	F3	F4
Eigenvalues	02.588	00.943	00.457	00.011
Proportion (%)	64.710	23.576	11.437	00.276
%Cumulative	64.710	88.286	99.72	100.00

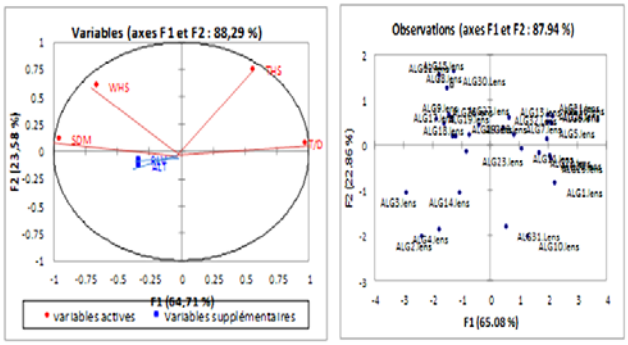

Figure 1. Principal components analysis (PCA) for variables {a} and observations {b}. Amount of variance captured by axes 1 and 2 is shown

Eigenvalues of the first two principal components were greater than 1 and accounted for 88.28% of variance. PCA axis 1 explains 64.71% of the variance in the qualitative character, and is related in the negative side to seed size (SDM) and Weight of 100 seeds (WHS) and Altitude (ALT). And in the positive side to diameter /thickness ratio (T/D). Accessions with the strongest positive scores along this axis present a high E/D (ALG1, ALG5, ALG6, ALG16, ALG20, ALG21, ALG22, ALG24 and ALG25. A small seeded type they may have a globos shape (*Microspema*) with thickness / diameter ratio higher than 1. Most of the other accessions (ALG3, ALG9, ALG7, ALG11, ALG17, ALG18, ALG23, ALG28, ALG29, ALG27 and ALG26) have negative scores on axis 1, this mean, that they have a small diameter and a light weight (*Microsperma*) and are originating from the low altitude.

As stated by [2], the cultigen lentil is divided by Barulina (1930) in two subspecies on the basis of seed size and seed weight: *Macrosperma* (large seeded with seed diameters between 6 and 9 mm) with the 100 seed weight range from 4 to 2.8 g, and *Microsperma* (small seeded with seed diameters between 4 and 6 mm) generally have a range from 1.1 to 4 g.

The second component, accounting for 23.57% of the total variation, was correlated positively with seed thickness (THS). This mean that, all populations on the side present, a big thickness (*Microsperma*).It's the case of following accessions: ALG8, ALG12, ALG13, ALG15, ALG19, ALG30 and ALG32. The other populations from the negative side of the PC2 axis (ALG2, ALG4, ALG10, ALG14 and ALG31) present a small thickness.

No attempt was made to interpret other PCA axes because they explained little additional variance (the eigenvalues for axes 3 and 4 were 0.457 and 0.011, respectively).

3.2.2. Cluster Analysis

To study and categorize the studied accessions, Ward method was used in cluster analysis (Similarity index=0.38 based on assessed traits in six groups. Specifications for each cluster are presented below:

First group comprises 3 genotypes: ALG11, ALG7 and ALG13. These accessions present a short diameter and light 100 seed weight, they belong to the *Microsperma* type and all of them are originating from the west of Algeria.

Second group contains 7 genotypes: ALG1, ALG20, ALG25, ALG5, ALG22, ALG6, and ALG21, present a high thickness / diameter ratio of the type *Microsperma*. Native from East, North and West.

Third group included 2 genotypes: ALG10, ALG31, both are *Macrosperma* and originating from West and south of Algeria respectively.

Fourth group comprised 4 genotypes: ALG32, ALG23, ALG19, and ALG28, from the north expect ALG32. They have a small diameter and a light weight (*Microsperma*).

Group five: ALG14, ALG2, and ALG4, all of them are Macrosperma with a small thickness.

Group six comprises 11 genotypes: ALG3, ALG17, ALG26, ALG18, ALG9, ALG29, ALG8, ALG15, ALG30, ALG12 and ALG27. Most of them are originating from west of Algeria of the type *Microsperma.*

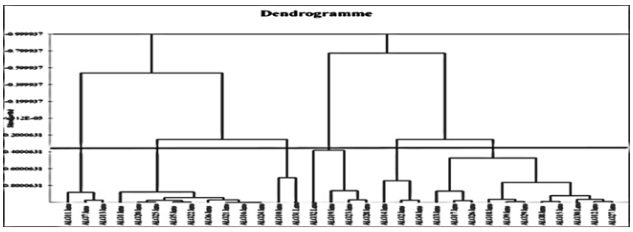

Figure 2. A Dendrogram for 32 accessions of lentil using Ward method

3.2.3. Multiple Correspondence Analysis

The application of multiple correspondence analysis showed that the total inertia explained is equal to 1.75 (percent of inertia: 50.87% is due to the first axis and 9.10% due to the second axis). A visualization of the results is presented in Figure 3. As we can see the profiles of Grain form (FRG): Flat (*Macrosperma*) an Globular (*Microsperma*) are quite different, as it was expected. In particular, presence of Brown or green tasta (CTG), with yellow cotyledons or orange (CDC), seems to characterize the globular form (*Microsperma*). On the other hand, seeds with flat form (*Macrosperma*) are characterized by: Brown, Beige or Green tasta (TGC) with dotted seed coat pattern or not (PAT) and yellow cotyledons (COC).

In lentil, the size of seeds increases from the types grown in eastern regions to western types. Two types, namely: *Macrosperma*, found mainly in the Mediterranean region and the New World (yellow cotyledons with little or no pigmentation), and *Microsperma* (with red orange or

yellow cotyledons) found on the Indian subcontinent, Near East and East Africa, respectively, are known [14].

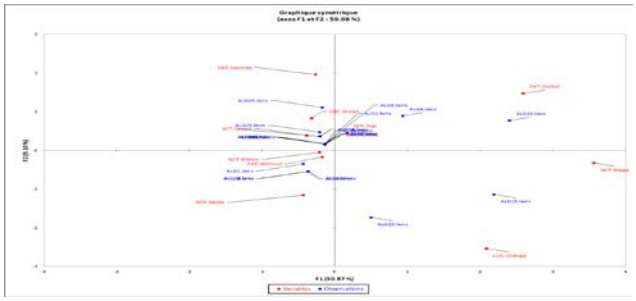

Figure 3. Multiple correspondence analysis of quantitative characters**.**

4. Conclusion

The results of this study revealed the presence of genetic variation in terms of quantitative traits and qualitative characters, among the studied of Algerians lentil seeds. It was possible to identify the most promising genotypes for inclusion in the lentil-breeding program.

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