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 culinaris 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. Material and Method

2.1. Plant Material

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.
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 (b). 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| 6.01  | 6/75 |
| ALG2      | El-Khroub| 36.28| 6.67  | 560  |
| ALG3      | Yakouren | 36.73| 4.43  | 1252 |
| ALG4      | Azaiza   | 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 | 35.35| 1.31  | 995  |
| ALG10     | Hassi-Zahan| 35.11| 0.38  | 438  |
| ALG11     | Malaa    | 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     | Agilal   | 35.29| -1.14 | 250  |
| ALG17     | Bouskine | 36.26| 2.45  | 981  |

Table 1 (a). 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     | Riddane | 35.35| 1.53  | 590  |
| ALG28     | Khbouzia | 36.38| 3.90  | 530  |
| ALG29     | Illoua   | 36.71| 4.05  | 264  |
| ALG30     | Ifgaha   | 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 characteristics.

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 | 0.528 | -0.077 | -0.221 | -0.280 |
| STH       | 0.564 | 0.317 | 0.564 | 0.364 | 0.364 | 0.304 |
| T/D       | -0.096 | 0.528 | -0.0482 | -0.375 | -0.277 |
| WHS       | 1   | 0.053 | 0.332 | 0.127 |
| ALT       | 1   | 0.332 | 1   |
| RFL       | 0.304 | -0.280 | 0.277 |

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 (78.12%) and green (15.62%) to Beige (6.25%).

3.2. Multivariate Analysis

3.2.1. Principal Components Analysis

Table 4 shows relative and percent proportions of the variance of each of the first two principal components, the calculated eigenvectors 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.
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*.

### 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 (*Macrospema*) an Globular (*Microspema*) 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 (*Microspema*). On the other hand, seeds with flat form (*Macrospema*) 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; *Macrospema*, 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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