Genetics and Biodiversity Journal

Journal homepage:http://ojs.univ-tlemcen.dz/index.php/GABJ

Original Research Paper

OPEN ACCESS

Study of the phenotypic variation of some accessions of beans (*vicia faba.l)* in the wilaya of Tlemcen

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Article history: Received: July 15-2018, Revised: July 29-2018, Accepted: August 15-2018

Abstract
The aim of this study was the morphometric characterization of 8 bean accessions (vicia faba L) in different localities in the wilaya of Tlemcen, we studied 8 agromorphological characters, were the objects of a statistical study by the software R. Phenotypic diversity was determined by the Shannon-Weaver diversity index (H ') at different levels. The estimated H showed high phenotypic variability for different traits with an average H of 0.63. The results of the Multiple Correspondence Analysis (PCA) and the Hierarchical Classification (CAH) showed a clear distinction between the accessions.
Keywords: vicia faba , morpho-metric characterization , genetic diversity , Tlemcen

Introduction

Genetic diversity is the basis of plant breeding. Knowledge of this diversity has a significant impact on the progress of crop selection. (Hedjaoui Kamel, 2013).

Faba bean (Vicia faba L.) is one of the most important legumes for its seed high protein content and nutritional value (Crepona et al., 2010), has been cultivated for a long time in various agro-climatic regions, local varieties nowadays offer a choice of alternatives and a great genetic diversity. The importance of this genetic wealth for the development of improved varieties is indisputable and requires safeguarding actions to reduce the effects of genetic erosion. For example, in Egypt, bean genetic resources have been used for the development of more productive varieties with high levels of resistance to various biotic and abiotic stresses (Khalil S.A. et al., 1996). Genetic variation among faba bean genotypes is imperative for their efficient utilization in plant breeding schemes and effective conservation (Megahed H et al., 2015).

Morphological characters are the first to be observed. These traits are of interest to different parts of the plant, for example stalk length, leaf area, initiation of flowering (Cui et al.2001, Gomez et al.2004). These characters are used similarly to estimate intra- and inter-population variation. They are generally limited in the number of characters recorded and directly influenced by the environment. Nevertheless, they provide useful information for describing and identifying biological material (Andersson et al.2006).

The objective of this research is to identify and morpho-metrically characterize local bean populations (Vicia faba .L) in the wilaya of Tlemcen. Same studies have already been conducted in Algeria on other species such as barley accessions Warda Taibi et al (2016) and wheat varietes Bellatreche A et al (2012).

Materials and Methods

Region of study

Our study is based on the identification and morphometric characterization of bean varieties (Vicia faba .L). The characteristic plant material is the result of a prospection in the field, during the year 2017-2018 in the wilaya of Tlemcen (Figure01). We performed measurements on 30 different plants taken randomly in the field. These plants were collected from five (05) localities belonging to different sites in the study area. A total of two hundred and forty (240) bean plants are studied.

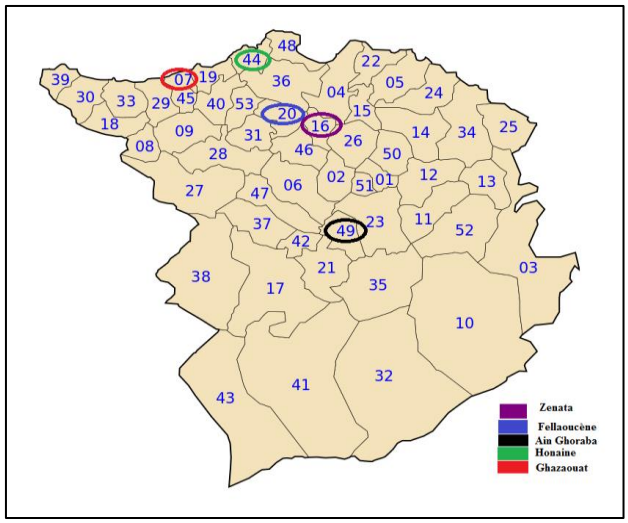

Figure 1. Location of the fields of the bean samples studied

Methodology

Eight accessions of beans selected from five different regions: "Boukdama" from Ghazaouat region; "Blanche A" from Ain Ghoraba region; "Mazouzi" from Tounen region; "Bousbaa" from Ghazaouat region; "Blanche F" from Fellaoucène region; "Noir" from Ain Ghoraba region; "Claro de Luna" from Fellaoucène region; "Luz de Otono" from zenata region(Table 01).

Table 1. Geographic coordinates of the study areas

Accessions	Region	Longitude	Laltitude	Altitude
Luz de Otono	Zenata	-1°27'1.79"O	35°00' 33"N	284 m
Blanche F	Fellaoucène	1º 36' 21" O	35º 2' 6" N	303 m
Claro de Luna				
Blanche A	Ain ghoraba	1º 23' 21" O	34º 42' 50"N	829 m
Noir				
Mazouzi	Honaine	1º 39' 18" O	35º 10' 35"N	8 m
Boukdama	Ghazaouat	1º 51' 37" O	35º 8' 38" N	33 m
Bousbaa				

The following parameters are thus measured for each plant: length of the plant (LP), number of leaflets (NF), number of grain per clove (NG), leaflet shape (FF), number of stem in plant (NT), Leaflet Size (TF), clove Length (LG), Foliage Color (CF) (UPOV, 2003).

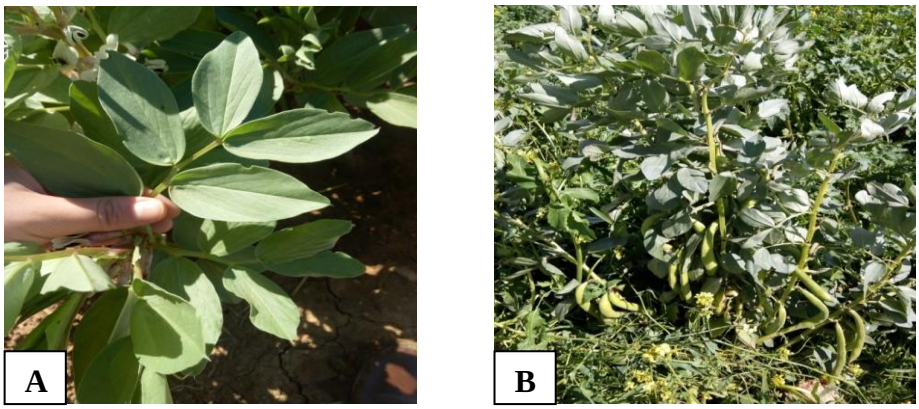

Figure 02. Examples of measured characters (A: number of leaflets) and (B: number of stem).

Statistical analysis

The 08 characters were assigned to classes , and analyzed using the Shannon–Weaver diversity index (H; Shannon and Weaver 1949) as defined by Jain et al. (1975) to calculate phenotypical variation of each accession:

$$H = -\sum_{i=1}^{n} Pi\ Ln\ Pi$$

H = Shannon and Weaver diversity index

Pi = Frequency of each phenotypic class *i* of a given character

n = Number of phenotypic classes of each character

The index (H) is converted towards the relative phenotypic diversity index (H ') by dividing it with its Maximum value: H max (Ln (n)) to obtain 0 to 1 values.

H was standardized by converting it to a relative phenotypic diversity index (H') after dividing it by Hmax (Ln (n)) to obtain 0 to 1 values.

$$H' = -\sum_{i=1}^{n} Pi\ Ln\ Pi\ /\ Ln(n)$$

Using FactoMineR software (version R-2.15.3) a multivariate analysis was performed to discriminate accessions with **principal component analysis** (PCA) and **cluster analysis (**Hierarchical ascending classification: CAH)

Results and discussion

Comparison of means and SD of the different characters studied of bean genotypes:

For quantitative characters:

The average of the plant length varies from 70.65 cm for Mazouzi accession in Tounen region to 131.37 cm for Boukdama in Ghazaouat region, in a study carried out on Tunisian local bean population, they found that the overall average length of plant varies from 32 to 33cm (Al Mohandes Dridi et al., 2011). The average number of stems of the plant varies from 3.97 for Blanche in Fellaoucene region to 7.70 for Luz variety de otono in Tafna region, for a result found on local Tunisian bean populations; they found that the greatest number of stems per plant is of the order of 3.3 on average (Al Mohandes Dridi et al., 2011).

The average number of leaflets per plant varies from 4.57 for Blanche in Ain Ghoraba region to 6.57 for Bousbaa in Ghazaouat region.forThe number of seeds per clove varies from 4.1 for Blanche (Ain

ghoraba) to 7.77 for Boukdama (Ghazaouat). The average of the length of clove varies of 17.63 cm for Blanche (Ain ghoraba) to 32.18 cm for Boukdama (Ghazaouat).

For qualitative characters:

The average character of the leaflet form of the plant varies from 1.73 for Boukdama in Ghazaouat region to 2.43 for Blanche in Ain ghoraba region. The average size of the leaflet size of the plant varies from 1.2 for Mazouzi in Tounen region to 2.7 Bousbaa in Ghazaouat region. The average color of the foliage of the plant ranges from 2.77 for Luz de Otono in Tafna region to 3.67 for Bousbaa in Ghazaouat region.

Table 2. Mean and standard error (SD) of the different characters studied of bean genotypes

Genotype	L.P	N.T	F.F	N.F	T.F	N.G	L.G	CF
Luz de Otono	117.32±0.11	7.70±0.03	2.37±0.03	5.27±0.04	2.37±0.03	6.60±0.02	24.68±0.03	2.77±0.05
Claro de Luna	113.8±0.05	8.57±0.03	2.2±0.03	5.13±0.06	2.13±0.03	6.73±0.01	20.63±0.05	3.6±0.05
Blanche A	111.75±0.27	9.53±0.08	2.43±0.03	5.1±0.05	2.37±0.03	4.1±0.03	17.63±0.12	2.83±0.05
Noir	113.05±0.27	8.63±0.08	2.2±0.03	4.57±0.07	1.87±0.03	5.53±0.04	22.43±0.12	3.63±0.05
Blanche F	102±0.09	3.97±0.04	1.8±0.02	5.9±0.03	2.17±0.02	4.83±0.02	19.65±0.11	2.93±0.06
Boukdama	131.37±0.11	5.07±0.02	1.73±0.02	5.03±0.03	2.37±0.03	7.77±0.01	32.18±0.03	2.93±0.06
Mazouzi	70.65±0.04	6.3±0.02	1.9±0.02	6.2±0.02	1.2±0.01	5.4±0.03	18.87±0.04	3.5±0.05
Bousbaa	97.33±0.04	5.1±0.03	2.03±0.03	6.57±0.02	2.7±0.02	6.63±0.02	30.33±0.04	3.67±0.06

The Shannon and Weaver Diversity Index

Relative index of diversity of the different characters studied:

The relative index of diversity (mean H) of all the studied accessions of the bean was 0.63 reflecting the great morphological diversity of the samples of this collection (Table 03). This index was lower than those reported by Ali et al.,(2011) with an H diversity index of 0.743 in Vicia faba L populations of Tunisia, and higher than that of Hedjaoui Kamel (2013) in a local bean population of Morocco with an index of 0.52 for a genetic characteristic.

This index varies between 0.44 for the Boukdama variety of the Ghazaouat region and 0.87 for the Black variety of Ain ghoraba.For the length of the plant we found an index (H '= 0.38) and leaflet size (H' = 0.73).For the characters this index varies between 0.45 for the number of stems and 0.56 for the number of seeds.Concerning the clove length we found (H '= 0.43) and for the color intensity of the foliage (H' = 0.93).For the leaflet shape (H '= 0.71) and the number of leaflets (H' = 0.85).

The highest average diversity indices (H'≥0.60) are obtained for five accessions (Luz de Otono, Claro de LUNA, Blanche A, Noir, Blanche F). And the other values (0.40≤H '<0.60) are obtained for three accessions (Boukdama, Mazouzi, Bousbaa).

Table 3. Relative index of diversity of the different characters of the bean genotype studied.

Varieties	LP H'	TF H'	NT H'	NG H'	LG H'	CF H'	FF H'	NF H'	moy H'
Luz de Otono	0,48	0,82	0,50	0,48	0,00	0,90	0,85	0,95	0,62
Claro de LUNA	0,18	0,87	0,18	0,42	0,58	0,95	0,96	0,99	0,64
Blanche A	0,88	0,96	0,51	0,61	0,67	0,90	0,85	0,96	0,79
Noir	0,87	0,84	0,72	0,99	0,92	0,89	0,85	0,90	0,87
Blanche F	0,11	0,76	0,46	0,72	0,78	0,96	0,49	0,86	0,64
Boukdama	0,00	0,82	0,32	0,00	0,00	0,97	0,67	0,78	0,44
Mazouzi	0,00	0,36	0,50	0,68	0,46	0,96	0,49	0,74	0,52
Bousbaa	0,49	0,44	0,39	0,55	0,00	0,94	0,54	0,60	0,49
moy H'	0,38	0,73	0,45	0,56	0,43	0,93	0,71	0,85	**0,63**

Principal Components Analysis (PCA)

we observe at the PCA in figure 02 that the characters studied in the bean accessions are closer in their majority to the circle, which statistically means a high level of significance.e.It is also noted that the ACP represents 68.9 % of the information used for statistical processing which is very significant.

We distinguish the formation of three groups of characters. This reflects a positive correlation between these parameters at the level of each group. The first group includes clove length (LG), grain number (NG), leaflet size (TF), plant length (LP), the second group contains the number of leaflets (NF), the foliage color (CF) and third group noted a negative correlation between these parameters at leaflet shape (FF) and stem (NT) level. Similar results found by Mani F and Hanachi C (2015), Negative correlations are noted between pea yield and parameters: Fresh weight of aerial part (APWP) and dry weight of aerial part (PSPA). These results indicate that; In fact, for a small number of pods, the energy supplied by the plant is directed towards the aerial part.

The correlation of these characters can be explained either by the influence of genes, that it means these characters are controlled by a certain number of genes in common, or these characters react in the same way with respect to genes. Environmental conditions.

To exclude one or the other probability we need to have the situation or the same population evolves in the same biotope is to see if the correlations change, if not it means that these characters are correlated by a certain number of genes in common.

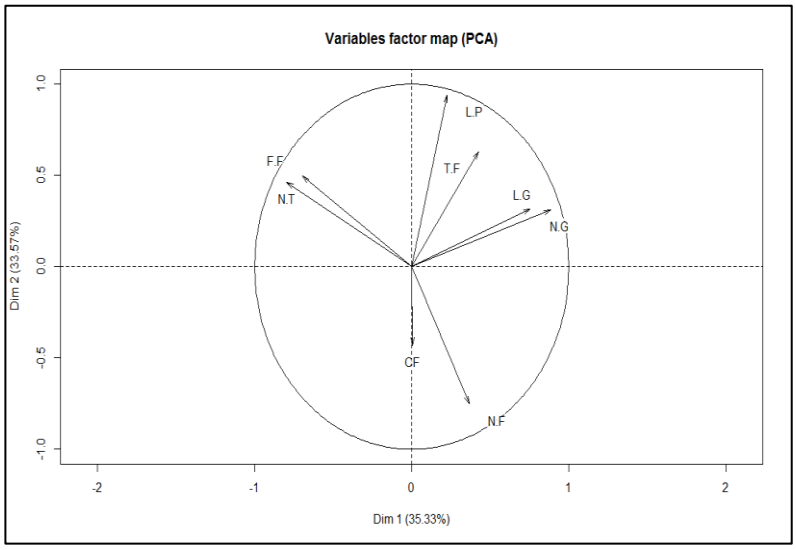

Figure 3. PCA of bean accessions according to the averages of the different characters for all individuals and regions studied.

Ascending Hierarchical Classification (CAH)

The dendrogram shows the relation between the different genotypes studied (figure 04) divides its last ones into two large groups of which: The first group includes a subgroup consisting of two genotypes Noir and Claro de luna and the second subgroup contains genotypes Blanche Ain ghoraba and Luz de otono. The second group includes a subgroup consisting of Mazouzi and Blanche F genotypes and the second subgroup contains two Bousbaa and Boukdama genotypes.So we explain this phylogenetic tree by a genetic effect because we have two different varieties in the same region.The geographical distribution as well as the differentiation of subspecies does not necessarily imply a genetic similarity (Hadjaoui Kamel, 2013).

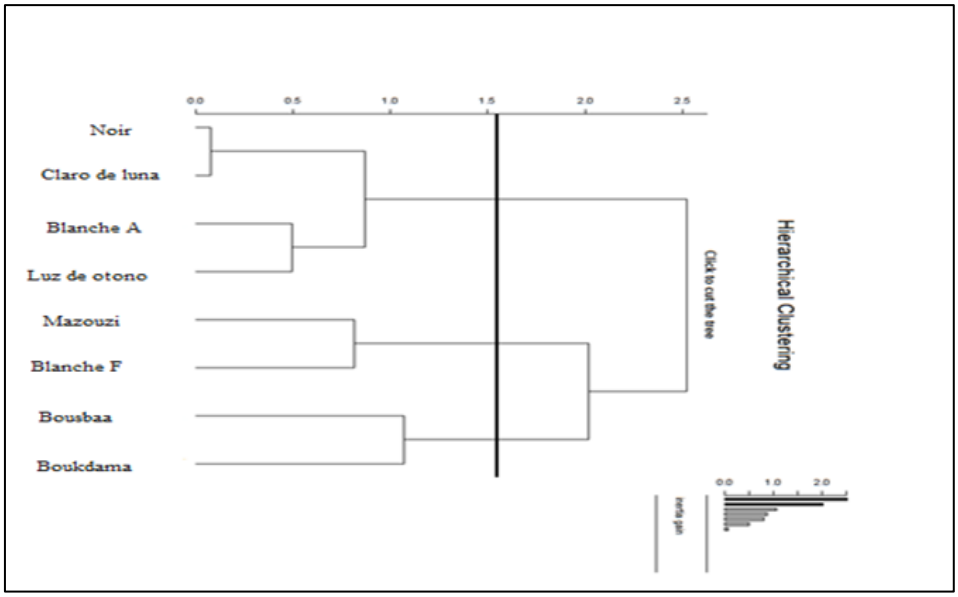

Figure 4. Hierarchical ascending classification (CAH) of bean genotypes.

Conclusion:

During our experimentations on the identification and morphometric characterization of local bean populations (Vicia faba), a significant phenotypic variability is recorded for the characteristics studied such as: plant length, stem number, leaflet shape, leaflet number, leaflet size, number of seeds, pod length, foliage color. Based on the results of the measured trait means, it appears that: the two local varieties "Boukdama" and "bousbaa" are the most productive and therefore, we propose to use it in the selection program and improvement of local bean population. The results of Principal Components Analysis (PCA) and Hierarchical ascending classification (CAH) showed a clear distinction between accessions.

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