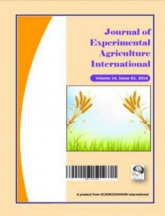

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Genetic Parameters in the Initial Phase of Collaborative Plant Breeding in Lima-Beans (*Phaseolus lunatus)*

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Authors' contributions

This work was carried out in collaboration among all authors. Authors ARA, MRBS and JCSS designed the study. Author JCC guided the research and Author NCLJ performed the statistical analysis. All authors read and approved the final manuscript.

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ABSTRACT

Participatory genetic improvement is a component of the management of genetic diversity, aiming at the systematic inclusion of farmers' knowledge, skills, experiences, practices and preferences. This modality of improvement is based on the knowledge of conventional genetics, physiology and economics, combined with those of anthropology, sociology, knowledge of the producers and with the principles of product development. The development of participatory strategies in the improvement of different crop species in the farmers field involves some fundamental aspects such as: rescue of different species and of different varieties within each species, valorization of local varieties, development of new varieties, valorization of cultural aspects and nutrition, agroecosystem management, agro-ecological crop systems, adaptation to the local environment with increased production from participatory improvement. Initially a search was made for communities in the forest

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area of Pernambuco, Brazil, which preserve, store and use native varieties. After the identification of the localities contemplated. The seeds were obtained in the municipality of Lagoa de Itaenga. The proposal was submitted to farmers living in the Marrecos community. At the same time, the importance of the conservation of local cultivars, the maintenance of the genetic identity of these genotypes, the importance of the isolation of the cultures, mainly the Creole ones and the practice of the participatory improvement were also treated. In addition, seed samples were collected and stored by the farmers, for later implantation of the germplasm bank (*in vivo*) at the Federal Institute of Pernambuco. At the time of collection, the forms of storage adopted by farmers were observed, being of great relevance for the guarantee of the genetic reserves of the crops. The experiments were conducted in a phyto-bacteriology laboratory and in a greenhouse of the Department of Agriculture of the Federal Institute of Pernambuco (IFPE) in Vitória de Santo Antão-PE. The plants were cultivated in the field in an organic cultivation system. The results showed that there is genetic divergence, based on agro-morphological markers, among fava varieties studied as a function of germplasm origin. Thus, samples from the Germplasm Collection of IFPE-Camps Vitoria correspond to different materials. The existence of genetic divergence among the varieties indicates the possibility of selection of superior genotypes. The evaluated characteristics present high potential to differentiate the genotypes and should serve as parameters for other studies.

Keywords: Improvement; genotypes; germplasm bank; phyto-bacteriolog; organic.

1. INTRODUCTION

Participatory Genetic Improvement (PGI), which is a component of genetic diversity management, began shaping in the early 1980s and presents as a key ingredient the systematic inclusion of farmers' knowledge, skills, experiences, practices and preferences. This modality of improvement is based on the knowledge of conventional genetics, physiology and economics, combined with those of anthropology, sociology, knowledge of the producers and with the principles of product development [1]. The PGI has multiple objectives, which are broader than those governing formal improvement.

The development of participatory strategies in the improvement of different crop species in the agriculture involves some fundamental aspects. In addition to the aspects related to production, the participatory improvement also takes into account, valorization of local cultural aspects and nutritional, agroecosystem management and adaptation to the local environment [2].

In the Northeast, Brazil, almost 30 years ago a movement of notorious importance was triggered that encouraged the creation of community seed banks, based on collaborative actions among rural families. The local dynamics have been rescuing ancient customs, building knowledge and strengthening agroecology in the various regions. The sharing of crop seeds (?) between families and communities and the interaction with public institutions is aimed at preserving the local genetic diversity [3].

Participatory genetic breeding of plants reverse the historical trend of separating farmers and breeders, so that together they can develop new varieties or improve what already exists. The focus is on sustainable rural development in adverse environments and especially on conserving biodiversity that still exists in rural communities [4]. Basically, one of the important aspects of the promotion of knowledge through participatory improvement is the awareness of farmers about the maintenance, protection and perpetuation of the varieties of creole seeds, since they carry a very strong genetic identity in terms of adaptation to local climatic conditions. Creole seeds are seeds that have not been genetically modified through breeding techniques.

Fava bean (*Phaseolus lunatus* L.) is considered more tolerant to drought, excess moisture and heat when compared to common bean (*Phaseolus vulgaris* L.), adapting to the most diverse environmental conditions. This is important, especially considering how global warming will affect development and productivity. The rainfall irregularity can affect some of the most critical phenological stages for the final production, which are the germination and emergence of seedlings [5].

Thus, the seed becomes the main input in the crop production systems, and its physiological quality is the main factor responsible for the initial

good development in the field, generating a good crop and high productivity [6]. The physiological potential of the seed is related to the attributes of germination. The physiological quality of the seeds may influence the germination and emergence velocity and, consequently, interfere with the uniformity of the final stand, leading to productivity losses [7].

The best harvest is determined by the seed that has the best genetic, physiological and agronomic attributes adapted to the region of interest. However, in the Brazilian semi-arid regions some cultivars have not obtained satisfactory performance due to irregular rainfall [8]. Therefore, what prevails in these conditions is the use of creole seeds, which are traditional varieties, selected by farmers from generation to generation, over several decades [9].

In Brazil, some studies using morphological descriptors have been conducted with accessions present in the germplasm bank of the Federal Institute of Pernambuco, which detected great variability among the studied subsamples. There is genetic variability among the bean cultivars in the state of Piauí, with a tendency for regionalization, that is, there is little interchange of materials between groups of the studied areas. Although studies involving bean fava are available, there are no studies with genetic and phenotypic parameters that could help in the definition of breeding strategies to be used with culture in Brazil [10].

The objective of this research was to determine the genetic parameters in fava beans, the important morphological characteristics and use in selection prices in participatory breeding programs.

2. MATERIALS AND METHODS

2.1 Identified Communities

Initially a search was made for communities in the state of Pernambuco (7°56'12'S and 35°17'25'' W), Brazil, which preserve, store and use native crop varieties. The pamphlets were elaborated on the importance of the genetic preservation of the creole varieties and the reproduction mechanisms of the plants cultivated by these peoples, since a large part of this population is not aware of the pollinating mechanisms of the cultivated species and that the use of hybrids and improved or transgenic cultivars in the vicinity of their properties can interfere in the preservation of the creole seeds, being necessary to insulate the species.

The identified communities received training, addressing themes related to the reproductive systems of plants, forms of propagation, form of isolation to avoid contamination with pollen and forms of propagation. From the meetings the identification of the local species and varieties cultivated, then with their consent, the collection of satisfactory quantities of seeds or for the installation of a germplasm bank at the Federal Institute of Education, Science and Technology of Pernambuco (IFPE) at the Vitória de Santo Antão campus.

2.2 Obtaining Seeds from the Farmers

The seeds were obtained in the municipality of Lagoa de Itaenga. The proposal to procure seeds was submitted to farmers living in the community of Marrecos. At the same time, the importance of the conservation of local cultivars, the maintenance of the genetic identity of these genotypes, the importance of the isolation of the cultures, mainly the creole ones and the practice of the participatory improvement were also treated. In addition, seed samples were collected and stored by the farmers, for later maintenance in the germplasm bank (ex situ) at the Federal Institute of Pernambuco. Currently the institute presents only slightly more than 50 beans. This is why it is important to consider the genetic diversity of samples and encourage more collections. At the time of collection, the forms of storage adopted by farmers were observed, being of great relevance for the guarantee of the genetic reserves of the crops.

2.3 Plant Cultivation

The experiments were conducted in phyto-bacteriology laboratory and in a greenhouse of the Department of Agriculture of the Federal Institute of Pernambuco (IFPE) in Vitória de Santo Antão-PE, with an average temperature of 28 ± 5°C and relative humidity of 72,2 ± 5.5%. The plants were cultivated in the field in an organic cultivation system. The research was carried out between the months of March and June of the year 2018.

Six genotypes of fava bean (Table 1) were raised in a randomized complete block design. The plots were of 4.8 m^2 containing six plants with an interplant spacing of 1.0 m X 0.8 m.

Table 1. *Phaseolus lunatus* accessions and their respective accession numbers, collection city

	Identification	City
1	IFJC01	Limoeiro
2	IFJC13	Lagoa do Itaenga
3	IFJC23	Limoeiro
4	IFJC25	Limoeiro
5	IFJC31	Limoeiro
6	IFJC50	Limoeiro

In the organic cultivation system, fertilization consisted of the addition of 3L of tanned corral manure and 50 g of lima beans cake for each plant [11]. Three cover fertilizations were applied with 36g of castor bean cake during each application. Phytosanitary treatments for this system were restricted to weekly sprays with sulphocalcico (1%) and neem oil (5%).

2.4 Analyzes

The data were standardized using the following formula: x = (species mean - general mean) / standard deviation. Principal component analysis was used to identify the variables that most contributed to the data variation [12]. A cluster analysis was performed to evaluate the similarity degree among the species studied, using Euclidean distance as a unit of measure. These analyses were performed through the Genes program [13].

3. RESULTS AND DISCUSSION

About the morphoagronomic markers, the growth habit was the variable that most contributed to the genetic divergence, with 30.07%, leaf number with a relative contribution of 25.89% and leaflet width with 18.49% (Table 2). Descriptors with the greatest contribution to divergence are the most important for the breeding program. These descriptors support to select the parents for the creation of segregating populations with a greater probability of success through the combination of these genotypes [14].

Table 2. Relative importance of eight descriptors for genetic divergence in *Phaseulus lunatus*

Characters	S.j	S.j (%)
Leaf number	37189.2	25.89
Plant height	545.0	0.38
Leaflet height	29508.0	20.55
Leaflet width	26552.0	18.49
Leaflet form	2317.2	1.61
Growth habit	47504.0	33.08

'S.j: contribution of variables to mean Euclidean distance between genotypes i and i'

Plant selection based on morphological characters may be efficient, allowing breeding workers to use genetic variability to aggregate desirable alleles through crosses with superior genotypes [15]. Genetic variability means the possibility to direct the crosses using the most divergent accessions [16].

All the accessions were distinct and did not have any duplicates. The occurrence of unidentified duplicates in germplasm banks makes it expensive and difficult to maintain the material, generating problems related to the organization and access of users to the genetic resource [17].

Morphological dissimilarity dendrogram using the UPGMA method in six *P. lunatus* accessions showed two groups considering the mean dissimilarity of 90.5% (Fig. 1).

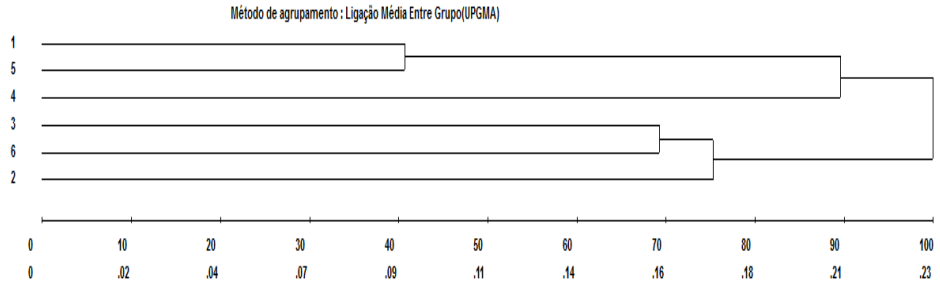

Fig. 1. Morphological dissimilarity dendrogram using the UPGMA method for the six *Phaseolus lunatus* accessions belonging to the germplasm bank from federal institute of pernambuco, Vitória de Santo Antão, PE

The first group was formed only by accesses collected in communities located in the city of Limoeiro. This group can be separated into two subgroups, isolating accession FJC25 from accessions IFJC01 and IFJC31. The material that was isolated showed dissimilarity at 90% of the others. The second group is formed by the accessions IFJC13, IFJC23 and IFJC50.

4. CONCLUSION

There is genetic divergence, based on agromorphological markers, among fava varieties studied as a function of germplasm origin. Thus, samples from the Germplasm Collection of IFPE-Camps Vitoria correspond to different materials. The existence of genetic divergence among the varieties indicates the possibility of selection of superior genotypes adapted to the state of Pernambuco, Brazil. The evaluated characteristics present high potential to differentiate the genotypes and should serve as parameters for other studies.

CONSENT

From the meetings the identification of the local species and varieties cultivated, then with their consent, the collection of satisfactory quantities of seeds or for the installation of a germplasm bank at the Federal Institute of Education, Science and Technology of Pernambuco (IFPE) at the Vitória de Santo Antão campus.

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COMPETING INTERESTS

All authors disclose any financial and personal relationships with other people or organizations that could inappropriately influence (bias) their work.

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