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Preliminary Diversity Assessment of Lima Beans (*Phaseolus lunatus*) Cultivated in Côte D'Ivoire

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Abstract

Lima bean is a legume belonging to Fabaceae family cultivated for edible seeds known to generic name of "haricot". In Côte d'Ivoire, it's cultivated on small scale in rural zone by local farmers. The main objective of this study was to document and collect local varieties of Lima beans (*Phaseolus lunatus*) grown in Côte d'Ivoire in order to define efficient strategies for better conservation, preservation and improvement of its genetic resources. Investigations were carried out in seventeen localities of Côte d'Ivoire from November 2018 to September 2020. A total of 433 accessions were collected. Based on seed coat color, nineteen morphological types were identified. The length of seeds is ranged from 10 mm to 23 mm. The width of seeds varies from 7 mm and 15 mm. The 100-Seeds-weight are ranged from 31 g to 120 g. Comparison using analysis of variance (ANOVA) showed a significant difference between the nineteen morphological types of common bean. Two morphological types were observed: large seed cultivars and small seed cultivars. Data showed that the species studied have a good market potential. Thus, their promotion can contribute to the economic well-being of farmers due to their cultural and culinary importance.

Keywords

Haricot, Lima Bean, Genetic Resources, Côte D'Ivoire, Cultivars

1. Introduction

Haricot is the common name of some food legume cultivated and consumed crops in Africa and Côte d'Ivoire in particular. Among them are the Lima beans, whose major production comes from landraces cultivated in traditional farming

system. The seeds are consumed in various forms (pulp, paste and alimentarius complement).

So, despite the importance of bean in the eating habits of certain peoples, the cropping system is still not developed and sustainable, mainly due to the crops' natural characteristics and current human practices. On the other hand, nowadays in reason of search of benefits, most peasants have opted for industrial crops. Local food crops continue to be neglected.

Yet overcoming food and nutritional insecurity with the ever-growing population size remains a real challenge for African countries, mainly in sub-Saharan Africa. The continent abounds in a rich agricultural and nutritional diversity that can significantly contribute to the reduction of the poverty and the hunger in this region of the world. In this context, an approach based on enhancement of local plants becomes necessary absolutely.

Unfortunately, knowledge of local resource of some of these plants is critically short in plant breeders capable to develop cultivars and stimulate seed systems that meet communities' needs in the face of climate change. In addition, connecting agriculture, food processing and nutrition can be a sustainable and resilient approach to solving nutritional insecurity problems while helping to improve farmers' livelihoods. Plant genetic resources are the basis of food security. They serve as a raw material for plant breeding [1] and it is therefore essential that these resources are properly preserved, characterized and evaluated for current and future uses [2].

The conservation and characterization of indigenous genetic resources are necessary to fulfill the needs of breeders. Both aspects are decisive or critical, especially in the success to initiate a plant breeding program [3] [4] [5]. The diversity of different landrace collections, the evaluation of phenotypic variation are still crucial for determining the adaptation and agronomic potential as well as the breeding and nutritional values [6].

The objectives of this study are to identify, document, collect information on the bean. The phenotypic diversity of a set of Lima bean landraces from south of Côte d'Ivoire in the context of traditional farming systems was evaluated. To achieve this objective, prospect and collect were realized in different regions of Côte d'Ivoire. Systematic collection of seeds of bean landraces has been realized. The landrace concept is useful for naming or distinguishing among cultivated varieties through simple traits that are locally adapted to traditional farming systems.

2. Material and Method

2.1. Plant Materials, Sampling Strategy and Collection

Plant material used in this study was constituted to seeds of Lima bean cultivated in areas prospected based on peasant's knowledge. Sampling strategy has followed hierarchical approach top-down. We designed a survey sheet. The investigations realized in Côte d'Ivoire have started on the greatest markets in Abid-

jan to select the regions of origin of the seeds sold. When regions have been selected, we determined cities where production of Lima bean is regular. For each city, villages where the crop is cultivated were selected. In each village seeds were collected in field or stock of producer. Investigations were carried out in seventeen localities of Côte d'Ivoire from November 2018 to September 2020. In each zone, a participatory method was used to gather local community knowledge of traditionally cultivated lima beans. The selection criteria were mainly a color and shape of seeds. A systematic collection was carried out. Samples collected in field or stock of producer constitute an "accession".

2.2. Phenotypic Evaluation and Data Collected

The phenotypic and genetic diversity of Lima bean landraces were typically evaluated through morphological traits: grain color and grain size. Seed characteristics were observed on mature seeds. Different measures were carried out, seed length (30 seeds chosen at random per morphotype) seed width (30 seeds chosen at random per morphotype) and 100-Seed weight (three lots of 100 seeds per morphotype).

2.3. Data Analysis

The data obtained have been subject of descriptive analysis. They're used here to describe the basic features of the data of each sample. They provide simple summaries about the morphological type. They help us to simplify large amounts of data. To evaluate differences among the morphological types Analysis of Variance (ANOVA) basing of the three parameters was carried out. When significant differences were observed a post ANOVA test Newman-Keuls based on smallest significant differences was carried out.

3. Results

Phenotypic diversity of Lima bean collected, number and distribution

A total of 433 accessions were collected from seventeen localities of south zone of Côte d'Ivoire. Accession is a sample collected in a field or seeds stock of one peasant. The accessions numbers collected in each locality are presented in Table 1. Basing on seed coat color, nineteen morphological types were identified. Among them, six with single color: white, light brown, light red, dark red, black and beige. For thirteen morphological types, seeds are bicolor with very varied patterns (Table 2). The length of seeds is ranged from 10 mm to 23 mm. The width of seeds varies between 7 mm and 15 mm. The 100-Seeds-weight are ranged from 31 g to 120 g (Table 3).

Morphological variation

Comparison of seeds length, seeds width and 100-seeds weight using analysis of variance (ANOVA) showed a significant difference between the nineteen morphological types of Lima bean (Table 3). Two major groups were observed. The first is composed of seven morphological types. The seed length is between

Table 1. Accessions of lima bean collected during 2018-2020 in Côte d'Ivoire.

Localities	Geographical coordinates	Number of accessions
Aboisso	5˚44'06"N - 3˚24'12"W	26
Agboville	5˚49'60"N - 4˚15'0"W	15
Adzopé	6˚06'25"N - 3˚51'51"W	27
Biankouma	7˚44'00"N - 7˚37'00"W	5
Bingerville	5˚21'20"N - 3˚53'7"W	1
Bocanda	7˚4'60"N - 4˚25'0"W	12
Bondoukou	8˚02'23"N - 2˚47'54"W	4
Bongouanou	6˚38'55"N - 4˚11'57"W	39
Broffodoumé	5˚18'34"N - 4˚0'45"W	5
Dimbokro	6˚38'48"N - 4˚42'19"W	27
Divo	5˚30'0"N - 5˚15'0"W	1
Kouon Fao	7˚29'17"N - 3˚15'06"W	65
Sikensi	5˚40'34"N - 4˚34'33"W	150
Songon	5˚18'53"N - 4˚15'29"W	1
Soubre	5˚47'08"N - 6˚36'30"W	32
Tabou	3˚00'50"N - 4˚00'70"W	17
Tanda	7˚48'121"N - 3˚10'6"W	6
Total		**433**

Table 2. Lima bean morphological type cultivated in Côte d'Ivoire.

Morphological type	Description	Code	Description	Morphological type	Code
	Uniform white, no color around the hilum	UWnC		Dotted black on a brown background, no outline around the hilum	DBB
	Uniform light brown, no color around the hilum	ULB		Dotted black on an orange background, no outline around the hilum	DBO
	Uniform light red with no color around the hilum	ULR		Black, with outline around the hilum	BLU
	Uniform dark red with color around the hilum	UDR		Dotted gray on a maroon background, no color around the hilum	DGM
	Uniform white with color around the hilum	UWC		Dark red with grey dotted with color around the hilum	RDG

Continued

	Gray speckled with black with color around the hilum	GSB		Grey with red dotted no color around the hilum	GrD
	White speckled with dark red Dark red with stripe with color around the hilum	WSD		White with black dotted with color around the hilum	WBD
	Dark red with stripe gray with color around the hilum	DRG		White black with color around the hilum	WBL
	Black with stripe gray no color around the hilum	BSG		Beige uniform without color around hilum	BEU
	Black Uniform no color around the hilum	BUN			

Table 3. Values of three traits analyzed according to morphological type of Lima bean and results of statistical tests.

Morphological type	Seeds Length (mm)	Seeds width (mm)	100-seeds-weight (g)
UWnC	20.75 ± 1.96^{abcd}	13.28 ± 0.88^{c}	112.5 ± 17.61
ULB	18.87 ± 4.85^{cd}	14.34 ± 0.74^{abc}	108.4 ± 20.98
ULR	21.14 ± 0.37^{abcd}	13.27 ± 0.35^{c}	105.67 ± 7.03
UDR	22.51 ± 0.94^{a}	14.98 ± 0.65^{a}	119.41 ± 12.85
UWC	21.3 ± 0.00^{abcd}	13.17 ± 0.00^{cd}	114.5 ± 0.00
GSB	20.97 ± 1.47^{bcd}	14.05 ± 0.98^{bc}	109.85 ± 20.15
WSD	22.83 ± 0.27^{a}	14.57 ± 0.26^{ab}	136.97 ± 4.23
DRG	20.99 ± 1.83^{bcd}	13.68 ± 1.48^{c}	107.67 ± 21.84
BSG	21.33 ± 1.43^{abc}	14.004 ± 0.96^{bc}	110.77 ± 17.25
BUN	22.43 ± 0.00^{ab}	15.18 ± 0.00^{a}	110.30 ± 0.00^{bcd}
DBB	21.04 ± 1.97^{bcd}	13.60 ± 1.006^{c}	109.19 ± 20.90
DBO	21.51 ± 1.96^{ab}	14.12 ± 1.14^{bc}	109.68 ± 20.68
BLU	14.79 ± 1.02^{e}	10.70 ± 0.73^{de}	47.39 ± 7.50^{de}
DGM	16.59 ± 0.00^{cde}	11.49 ± 0.00^{cde}	57 ± 0.00^{cde}
RDG	15.41 ± 0.99^{de}	10.87 ± 1.05^{de}	54.49 ± 13.60^{cde}
GrD	11.11 ± 0.93^{e}	8.49 ± 0.28^{e}	34.51 ± 3.38^{e}
WBD	10.64 ± 0.00^{e}	8.71 ± 0.00^{de}	33.86 ± 0.00^{e}
WBL	10.77 ± 0.00^{e}	7.25 ± 0.00^{e}	29.51 ± 0.00^{e}
BEU	11.215 ± 0.32^{e}	8.21 ± 0.71^{e}	29.08 ± 1.79^{e}
F	45.56	40.57	33.33
P	<0.001	<0.001	<0.001

*Means within a column followed by different superscripts were significantly different (P ≤ 0.01), based on Newman-Keuls.

11 mm and 17 mm. Seed width between 7 mm and 12 mm and 100-seeds weight varied from 29 g to 58 g (BLU; DGM; RDG; GrD; WBD; WBL; BEU). The second group is constituted of twelve morphological types (UWnC; ULB; ULR; UDR; UWC; GSB; WSD; DRG; BSG; BUN; DBB; DBO). The seed length varied between 18 mm and 23 mm. The seeds width of this group is between 7 mm and 12 mm and 100-seed weight varied from 105 g to 137 g.

4. Discussion

The evaluation of quantitative and qualitative traits guide to the choice of the breeder on the most adapted morphological type in future breeding activities or to conserve and use them for typical production with high quality. The color, shape and size of seeds are of special attention for consumers. This parameter has often been used by several authors to distinguish different genotypes of cultivated plants [7] [8] [9]. Landraces are indispensable gene stores for developing new cultivar. Our study showed morphological heterogeneity within the Lima bean cultivated in Côte d'Ivoire. A large variety of seeds color was observed between studied landraces. The results of this study suggest that the Lima beans cultivated in Côte d'Ivoire could have a very broad genetic basis. Diverse accessions of them in terms of seed size and seed weight from the Southern of Côte d'Ivoire indicate that this region could be a center of diversity. Diversity of Lima bean based on seed color has been reported by [10]. These observations suggested that preference of people for different seed colors might have played a vital role in the distribution of these accessions. Color of seed could use to classify lima beans landraces cultivated in Côte d'Ivoire. However, analysis of the additional parameters is required before a definitive conclusion. Agronomic characterization and molecular analysis could help to elucidate this hypothesis and highlight the genetic potential of the resource. Based on length and width of seeds, accessions collected could be grouped into two cultivars: large seeds cultivar and small seeds cultivar. This criterion has been used to classify morphological types of oleaginous cucurbit by [6].

5. Conclusion

This study is a review of genetic resources of Lima bean in Côte d'Ivoire. It highlighted nineteen distinct colors of seeds of Lima bean cultivated on small scale in Côte d'Ivoire. Their seeds represent great importance in the sociocultural live of several people. The diversity of color indicates a high genetic variability of the resource. Data collected constitute a preliminary step of our program of valuation of this species. The future study of genetic characterization would help us to appreciate the diversity of Lima bean in Côte d'Ivoire in the objective to carry out sustainable management of the resource.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Baudoin, J.-P. (2001) Contribution des ressources phytogénétiques à la sélection variétale de légumineuses alimentaires tropicales. *Biotechnology Agronomy Society Environment*, **5,** 221-230.

[2] Nass, L.L., Sigrist, M.S., da Costa Ribeiro, C.S. and Reifschneider, F.J.B. (2012) Genetic Resources: The Basis for Sustainable and Competitive Plant Breeding. *Crop Breeding and Applied Biotechnology*, **S2**, 75-86. https://doi.org/10.1590/S1984-70332012000500009

[3] Frankel, O.H. (1974) Genetic conservation: Our Evolutionary Responsibility. *Genetics*, **78**, 53-65.

[4] Brown, A.H.D. and Briggs, J.D. (1991) Sampling Strategies for Genetic Variation in Ex Situ Collections of Endangered Plant Species. In: Falk, D.A. and Holsinger, K.E., Eds., *Genetics and Conservation of Rare Plants*, Oxford University Press, Oxford, 99-119.

[5] Eyzaguirre, P.B. (1995) *In Situ* Conservation and Sustainable Use of Minor Vegetable and Fruit Species. In: Engels, J.M.M., Ed., *In Situ Conservation and sustainable Use of Plant Genetic Resources—For Food and Agriculture in Developing Countries*. IPGRI/DSE, Bonn-Röttgen, 104-116.

[6] Zoro Bi, I.A., Koffi, K.K., Djé, Y., Malice, M. and Baudoin, J.P. (2006) Indigenous Cucurbits of Côte d'Ivoire: A Review of Their Genetic Resources. *Sciences & Nature*, **3**, 1-9.

[7] Tiryaki, G.Y., Cil, A. and Tiryaki, I. (2016) Revealing Seed Coat Colour Variation and Their Possible Association with Seed Yield Parameters in Common Vetch (*Vicia sativa* L.). *International Journal of Agronomy*, 1-10. https://doi.org/10.1155/2016/1804108

[8] Sultan, S.M., Dar, S.A., Dand, S.A. and Sivaraj, N. (2014) Diversity of Common Bean in Jammu and Kashmir, India: A DIVAgeographic Information System and Cluster Analysis. *Journal of Applied and Natural Science*, **6**, 226-233. https://doi.org/10.31018/jans.v6i1.406

[9] Missihoun, A.A., Milognon, H.W., Montcho, D., Agbo, R.I., Sedah, P. and Agbangla, C. (2017) Diversité variétale et gestion paysanne des haricots cultivés du genre Phaseolus cultivés au Centre et au Sud Bénin (en Afrique de l'Ouest). *Journal of Applied Biosciences*, **118**, 11817-11828.

[10] Nadeem, M.A., Karaköy, T., Yeken, M.Z., Habyarimana, E., Hatipoğlu, R., Çiftçi, V., Nawaz, M.A., Sönmez, F., Shahid, M.Q., Yang, S.H., Chung, G. and Baloch, F.S. (2020) Phenotypic Characterization of 183 Turkish Common Bean Accessions for Agronomic, Trading, and Consumer-Preferred Plant Characteristics for Breeding Purposes. *Agronomy*, **10**, 272. https://doi.org/10.3390/agronomy10020272