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ANALYSIS OF THE EX SITU MORPHOMETRIC VARIABILITY OF THE PIGEON PEA (CAJANUS CAJAN L.)

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Abstract: Pea cultivation is one of the most important due to its uses and its nutritional value in human and animal nutrition. The objective of the research was to describe the morphological characteristics of the pea crop in Villaflores, Chiapas and to characterize its morphological variability in situ. The methodology used was the description of characteristics of plants taken at random,using the pea taxonomic botanical descriptor. Multivariate methods were used for statistical analysis and 15 quantitative variables were evaluated. From the results obtained, the variables with the highest coefficient of variation stand out: number of flower clusters, length and diameter of the stemthat correspond to characteristics of flowering and architecture of the plant. The discriminant analysis determined 64.9% of the variability in the samples evaluated. The variables that reached the highest number of samples in the classification coefficient were: plant height, stem diameter and length, leaf length and diameter. The principal components analysis in 15 evaluated quantitative characters managed to explain 78.0% of the total variance, obtaining six components, which were related to the leaves, stem and fruits. The result obtained from the discriminant analysis indicates that the variables in the four functions obtained were related to stems and leaves.When performing the conglomerate analysis through the dendrogram, most of the samples with variables related to fruits were grouped, which present a marked morphological variability, accentuating this aspect in different vegetative parts of the plant, which can be concluded that genes with possibilities of improving this species are found. Studies related to the knowledge of the pea must be carried out to spread and adopt this genetic resource. The morphological variability described provides elements to consider for the improvement of varieties with greater potential in the propagation of the species.

Keywords: Quantitative, descriptors, grains, pods.

INTRODUCTION

The pigeon pea is a legume that is produced in arid or semi-arid climates, it has proteins, starches, fiber and other useful components in food and possible application in the food industry (Navarro et al., 2014). This legume is very important in places where staple foods such as corn, beans, and rice, among others, cannot be purchased. There are two types of peas that are consumable, although one is from a temperate climate and the other is from a tropical climate. In this case, the present investigation refers to the study of the tropical climate pea, its main characteristic is drought tolerant and does not have adaptability problems, resistant to tropical diseases.

In Chiapas, the pigeon pea is not widely consumed, only green canned in rice, mainly it is very usual to see it in local or traditional festivals in the towns, however, there are places where it is frequently consumed as a staple crop, as is the case of the Altos de Chiapas, a place inhabited by indigenous people who cultivate it, consume it green and as a grain, and also market it. In the Frailesca region, this crop is not traditional, and there is a lack of knowledge of its management and its uses in food. There is evidence that there were programs in the region that established demonstration plots to make it known to the population. These plots demonstrated the importance of this crop for the adoption of producers, however,

In the region there are no investigations related to the characterization of the morphological variation of the pea, so the objective of this work was to ccharacterize the in situ morphological variability of peas in Villaflores, Chiapas.

MATERIALS AND METHODS

The research was carried out in the Atotonilco ejido irrigation unit and municipality of Villaflores, Chiapas, located between the geographic coordinates 16° 14' 57.77" north latitude, 93° 14' 34.59" west longitude at an average height of 540 meters above sea level. with a territorial extension of 1,232.10 km2. (INEGI, 2001).This work began in the months of November 2018 to February 2019. 30 samples of plants that grew spontaneously in this ejido plot were characterized, which were identified with consecutive numbers (1-30), subsequently, they proceeded to evaluate their characteristics using the quantitative characters reflected inthe botanical taxonomic descriptor of Peas (Cajanus cajan) edited by IBPGRI/ICRISAT (1993).

Statistical analyzes were performed, using the multivariate method according to the methodology recommended by Franco and Hidalgo (2003), from which elementary statistics were obtained to determine the variation, discriminant analyzes to determine the percentage of variation and discriminate the number of variables. An analysis of main components to know the percentage of variation and the variables that contribute the most in discrimination. Stem color classification analysis Cluster analysis was performed to group pea plant samples and their similarity among them according to their common characteristics. Fourteen quantitative variables related to leaves, branches, stems, flowers and grains were evaluated.

RESULTS AND DISCUSSION

Table 1 shows the different elementary statistics obtained from the quantitative data of the 30 samples of pea plants, in which the variables with the greatest variation are distinguished: number of flower clusters with 61.72%, which correspond to flowering characteristics based on breeding systems. The variables related to the fruit had low CV of 6.16% and 8.39% respectively.

In order to know the levels of genetic variation of the pea, in this case, a discriminant analysis was carried out with the purpose of determining those variables that discriminate this morphotype and that present morphological markers. The result obtained from the discriminant analysis showed that they presented 64.9% variability in the evaluated samples of the pea (Table 2). The variables that are highly discriminant in the two functions obtained were: plant height, stem diameter, length of stem in function 2 and leaf length, leaf diameter function 1. Discriminant analysis of two functions. The manifested genetic variability was grouped in the characters related to plant and stem, which coincide with the results obtained by Escalante, (2009).), who determined that the source of variability of Cajanus cajan is expressed in the stems, in the pedicel, branches, but also in the flower and finally in the pods.

The analysis of main components in 15 quantitative characters evaluated (Table 3.) managed to explain 78.0% of the total variance, obtaining six components, of which are related to the architecture of the plant, leaves, flowers and fruits, which were the that contributed positively and negatively in six components. The results obtained in the analysis indicate that the first component one and two allowed to distinguish the accessions with a plant height, stem length in the second component and seed length in the first. Seed length in the first component is the one that contributed the most in the first component and those related to stem and leaf were found in components two and three respectively, that is, the variables seed length, stem length, leaf diameter,Escalante (2009), the variability in the pole bean is

	N	Half	E.E	OF	Variance	CV
AP	30	3.42	0.184	1.01	1.02	29.53
SD	30	4.90	0.412	2.26	5.11	**46.08**
LOT	30	44.21	3,843	21.04	443.07	**47.60**
NRA	30	3.73	0.248	1.36	1.85	8.39
NRF	30	16.23	1,829	10.01	100.39	**61.72**
MF	30	6.16	0.116	0.63	0.40	10.36
av	30	1.04	0.047	0.25	0.06	24.81
LP	30	1.26	0.075	0.41	0.17	32.67
ACE	30	0.70	0.034	0.18	0.03	26.53
LS	30	0.68	0.025	0.14	0.02	20.49
NSPV	30	4.06	0.208	1.14	1.30	28.09
LH	30	5.64	0.284	1.56	2.43	27.64
HD	30	2.28	0.096	0.52	0.28	23.19
LF	30	1.70	0.071	0.39	0.15	23.06
P100G	30	12.53	0.141	0.77	0.60	6.19
CT	30	1.93	0.143	0.78	0.61	40.60

AP= plant height; SD= Stem diameter; LOT= Stem length; NRA= Number of branches; NRF= Number of flower clusters; LV= Sheath length; AV= sheath width; LP= Peduncle length; AS= grain width; LS= grain length; NSPV= Number of seeds per pod; LH= Leaf length; DH= Leaf diameter; LF= Length of flowers; P100G= Weight of 100 grains, CT= Color of the stem.

Table1. Elementary statistics in pea.

Function	self value	% variance	% accumulated	Correlation
1	0.903	64.9	**64.9**	0.689
2	0.488	35.1	100.0	0.573
Standardized coefficients of discriminant functions				
	FUNCTION			
	1		2	
AP	0.816		**-1,360**	
SD	0.178		1,202	
LOT	-0.333		0.996	
NRA	0.478		0.190	
NRF	0.137		-0.193	
MF	-0.512		0.732	
av	0.231		0.254	
LP	-0.432		-0.371	
ACE	0.294		0.902	
LS	-0.327		-0.344	
NSPV	0.496		0.033	
LH	**-1,647**		0.649	
HD	**1,365**		0.046	
LF	0.049		0.001	
P100S	0.043		-0.582	

Table 2. Discriminant analyzes in peas.

	Initial eigenvalues			Sums of squared saturations		
Component	**Total**	**% variance**	**% accumulated**	**Total**	**% variance**	**% accumulated**
1	3,086	19,288	19,288	3,086	19,288	19,288
2	2,762	17,265	36,553	2,762	17,265	36,553
3	2,554	15,965	52,518	2,554	15,965	52,518
4	1,810	11,315	63,833	1,810	11,315	63,833
5	1,235	7,717	71,550	1,235	7,717	71,550
6	1,038	6,489	78,039	1,038	6,489	**78,039**
7	0.904	5,650	83,689			
8	0.734	4,589	88,279			
9	0.623	3,897	92,175			
10	0.397	2,484	94,659			
11	0.299	1,867	96,525			
12	0.208	1,299	97,824			
13	0.134	0.838	98,662			
14	0.107	0.671	99,333			
15	0.073	0.458	99,790			
16	0.034	0.210	100,000			
	COMPONENT					
	1	2	3	4	5	6
AP	0.144	**0.677**	0.148	-0.499	0.288	0.085
SD	-0.460	0.259	-0.198	-0.371	**0.638**	-0.003
LOT	0.339	**0.771**	0.159	0.246	-0.032	0.180
NRA	-0.672	0.133	-0.005	0.190	0.353	-0.421
NRF	-0.193	0.659	0.158	-0.255	-0.263	0.379
MF	-0.458	-0.128	0.458	0.342	0.029	0.439
av	0.415	0.433	0.485	0.284	0.230	0.069
LP	-0.332	0.538	0.325	0.439	0.001	-0.347
ACE	0.453	-0.018	**-0.634**	-0.188	0.040	0.179
LS	**0.815**	-0.175	-0.100	0.107	0.265	0.033
NSPV	-0.582	-0.347	0.430	-0.011	0.002	0.395
LH	0.384	-0.342	**0.655**	-0.284	0.353	-0.063
HD	0.404	-0.237	**0.781**	-0.260	0.059	-0.080
LF	0.390	0.399	-0.219	0.533	0.090	0.045
P100S	-0.177	-0.201	-0.426	0.293	0.520	0.398
CT	-0.235	0.414	-0.168	-0.554	-0.132	-0.021

Table 3. Analysis of components in 15 quantitative characters.

high, being a property that all plants present, which is the tendency of individuals to differ from each other.

According to Escalante (2009) and Mula and Saxena (2010), who maintain that the source of variability of Cajanus cajan is expressed, among other characteristics, in the shape and maturity of the pods.

According to Escalante (2009), variability in pole beans is a property that all plants have and is the tendency of individuals to differ from each other. Mula and Saxena (2010) maintain that the source of variability of the pigeon pea is expressed in the shape and maturity of the pods.

In Table 4, of the coefficients of the classification function, it can be seen that the variables that reached the largest number of samples were leaf diameter, seed length, weight of 100 seeds and pod width. It is evident that the tendencies of greater results stood out the characteristics related to leaves, seeds and pod within the pea, considered as greater potentiality the seed. Which indicates that the alternate variable is closely related to the aforementioned variables,The genetic characteristics of importance are those that are generated from one plant to another plant and it is possible that these characteristics are heritable and can be observed over time and in different environmental conditions. Considering mainly: form of leaflets; banner type; pod shape; shape, color, pattern, green seed pigmentation and type of inflorescence. With the same criteria, it considers of lower taxonomic value: the phenology, size and shape of the bush, production, pigmentation of the stem and calyx, and the color and design of the pod, due to susceptibility to the environment.

Variables	**STEM COLOR**		
	Green	**Red**	**Purple**
AP	27.60	27,632	30,292
SD	-6.88	-6,194	-7,069
LOT	-0.43	-0.411	-0.492
NRA	9.70	10,403	10,361
NRF	0.02	0.031	0.071
MF	19.48	19,272	16,999
av	**-36.66**	**-34,303**	**-35,391**
LP	5.85	3,349	4,222
ACE	3.73	10,792	4,031
LS	**80.57**	**74,340**	**77,084**
NSPV	-3.62	-2,887	-2,711
LH	-23.96	-25,297	-26,510
HD	**90.73**	**94,980**	**96,146**
LF	4.65	4,853	4,913
P100S	**45,032**	**44,411**	**45,625**
(Constant)	-428,757	-431,646	-428,720

Table 4. Analysis of the coefficients of the classification function.

CONCLUSIONS

The variables with the highest coefficient of variation were those related to the flowers and stem, which indicates a greater concentration of genetic variation in the reproductive parts and architecture of the plant, likewise the variables with low CV are those related to the fruit, weight of 100 seeds and number of pods, which indicates that these variables behave adequately.

The result obtained from the discriminant analysis showed that they presented 64.9% variability in the pea samples evaluated, the highly discriminant variables in the four functions obtained were: plant height, stem diameter and stem length in function 2 and in function 2. function 1 blade length, blade diameter. The genetic variability was grouped in the characters related to plant and stem.

The analysis of main components in 15 evaluated quantitative characters managed to explain 78.0% of the total variance, obtaining six components, of which are related to the architecture of the plant, leaves, stem and fruits, which were the ones that contributed in the form positive and negative in seven components.

The variables that reached the largest number of samples were the variables leaf diameter, seed length, weight of 100 seeds and pod width, although the variables plant height and leaf length presented good results within the classification coefficients.

The variables related to fruits are the ones that presented the greatest variability and grouped most of the samples under study in the dendrogram.

The evaluated variables maintain a marked morphological variability, emphasizing this aspect in different vegetative parts of the pea plant, which can be concluded that there are possible genes with a view to improving the plants of this species.

Studies related to the knowledge of pea cultivation must be carried out with the purpose of disseminating and adopting this genetic resource by the population.

The morphological variability described in this work provides elements to consider for the improvement of varieties with greater potential in the growth and propagation of the species.

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