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Research

Studies on genetic variability of some quantitative and qualitative characters in pigeon pea - *Cajanus cajan* (L.) Millsp. (Fabaceae)

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Abstract

Thirty-four accessions of Pigeon pea, Cajanus cajan, from different geographical origins in Nigeria were evaluated for twenty-four characters. Genetic variability was evaluated by Analysis of Variance (ANOVA), Coefficient of Variation, Cluster Analysis (Dendogram), Correlation Coefficient and Principal Component Analysis (PCA). Genetic difference was recorded for all the characters except number of days from sowing to emergence (DSE) and number of days from sowing to production of secondary leaflets (DSS). This shows genetic variability in the experimental materials with respect to different characters. Total number of pods per plant (NPP) was important for highest estimates of coefficient of variation. Only number of flowers at first flowering (NOF) did not show any positive association with NPP among the characters studied. Of the 34 accessions grouped into different clusters (I-III), only one (CL 14) was found in Cluster I and differed from other accessions in Cluster III, some of which arose from the same geographic area. This indicates wide diversity among genotypes originating from the same geographic region.

Keywords: Genetic variability, cluster analysis, *Cajanus cajan*, accession, Fabaceae

Introduction

The information on genetic variability for different characters is of economic importance and prerequisite for studies on any plant species (Rathhaswammy, *et al*., 1973). Pigeon pea *(Cajanus cajan (L) Millsp.)* is predominantly self-pollinated with occasional cross-pollination (6-7%) leading to genetic variability (Rat-naparhke *et al.*, 1995). The extent of outcrossing varies and studies have shown variability in a representative germplasm collection of 877 types (Reddy & Rao, 1975). Varying levels of natural outcrossing, up to 70%, occur in some cultivars (Souframanien *et al*., 2003). Taking advantage of the natural variation, promising varieties have been isolated and cultivated (Reddy & Singh, 1975). *Cajanus cajan* survives well in a wide variety of soils, ranging from sandy to heavy clay with pH 5.8-8.0. A well-drained, deep loam soil free from excessive soluble salts and near neutral pH is most suitable for pigeon pea while water-logging is detrimental to its growth (Pathak, 1970). *Cajanus cajan* is notably heat-tolerant, resistant to drought, pests and diseases, grows well on poor soil and is grown mainly as an intercrop with cereals like maize and sorghum (Owere *et al.,* 2000). These attributes made *Cajanus cajan,* a very successful tropical crop (Jodha, 1979, Kimani, 2000). Though found in a wide range of agro-ecological situations, its deep rooting and drought-tolerant characters made it a useful crop in areas of low, uncertain rain and light soil (Laxman and Sharivastava, 1976).

The magnitude and range of phenotypic variability for the plant was high for most characters except in number of seeds per pod and pods per plant (Joshi, 1973). High values for genotypic coefficients of variation and hence greater diversity with respect to pod and seed yield per plant have been observed in Pigeon pea (Karif *et al*., 1973).

Odeny, 2000 observed short and long maturing varieties of Pigeon pea. The early maturing (short duration) varieties produced lower yields than the late maturing ones owing to the higher number of pods per plant in the latter (Chauchan & Singh, 1981).

The early systematic studies of the genus *Cajanus* were based on phonological or morphological characteristics which have been shown to have limited genetic resolution especially at species levels (Van der Maesen, 1980, Kimani *et al*., 2000).

Generally, a wide range of genetic diversity among plants is essential for successful hybridization programme. Usually, plant breeders are interested in the relationship between geographical and genetic diversities. However, the geographic diversity may not necessarily be related to genetic diversity as shown by the clustering pattern among genotypes of cluster beans (Chaudhary & Singh, 1977). Sarma and Roy (1994) found that days from sowing to flowering, plant height and pod length contributed significantly to genetic diversity and variability.

Economically, Pigeon pea is used as forage legume and green manure which improve soil structure. It also provides ground cover in sugar cane (Krauss, 1932) and pineapple plantations (Mitchell, 1953) and crop rotation (Neme, 1955; Melloo & Brasil, 1960). The leaves are used as weak decoction for the treatment of measles, catarrh and hepatitis. Equally, an aqueous infusion of the seeds sometimes mixed with the leaves is dispensed for the management of sickle-cell anaemia (Dhar, 1968).

Improvement of pigeon pea has mainly been limited to selection. A large and diverse germplasm collection and preservation has, therefore, become necessary (Frankel & Bennett, 1970). Owing to its importance, *Cajanus cajan* deserves as much attention as has been paid to Cowpea and other field peas. It is the aim of this study to characterize *Cajanus cajan* accessions using samples collected from different locations in Nigeria.

Material and methods

Thirty-four accessions of *Cajanus cajan* from diverse geographic background were collected from different market locations in Nigeria (Table 1). The experimental studies were conducted in the screen house and the garden of the Department of Botany and Microbiology, University of Ibadan, Ibadan, Nigeria from May to December 2002. The experimental design involved three replicates of the seeds planted in soil and pots. A plot of single row of 6m long, 1m between rows and 30cm between plants was marked. One seed from each accession was planted in different pots and in soil at 2-3cm depth.

Observations on plant growth, yield attributes and pod characters were taken from four randomly selected plants (24 characters) at different growth stages. The mean values of all the characters studied were obtained and subsequently subjected to Analysis of Variance (Al-Jibouri *et al*., 1958), Coefficient of variation (Rao, 1952), Principal Component Analysis (PCA) and Pearson Correlation coefficients (Dewey 1959) and a dendogram constructed.

Table 1: *Seed samples collected from different market locations*

Accession name	State	Market Location
CL 1	Niger	Bida
CL2	Niger	Mokwa
CL3	Kaduna	kaduna
CL4	Kaduna	Kafachan
CL5	Kogi	Ajowa
CL6	Kogi	Lokoja
CL7	Kwara	Ilorin
C L8	Kwara	Omu-Aran
CL9	Plateau	Langtang
CL10	Plateau	Shendam
CL11	Plateau	Jos
CL12	Kano	Wudil
CL13	Kano	Kano
CL14	Oyo	Ogbomoso
CL15	Oyo	Saki
CL16	Osun	Osogbo
CL17	Osun	Osogbo
CL18	Edo	Ekpoma
CL19	Edo	Benin
CL20	Oyo	Ibadan
CL21	Niger	Mnina
CL22	Kogi	Bacita
CL23	Edo	Auchi
CL24	Ondo	Ikere/Akoko
CL25	Benue	Makurdi
CL26	Ogun	Ode-Remo/Ishara
CL27	FCT	Suleja
CL28	Kwara	Offa
CL29	Plateau	Yelwa
CL30	Plateau	Pankshin
CL31	Nassarawa	Lafia
CL32	Kogi	Kabba
CL33	Benue	Gboko
CL34	Zamfara	Talata-Mafara

Results

General statistical performance

Tables 2 & 3 show the general performance of the accessions and the composition of characters scored for each accession. A wide range of variation was ob-

Table 2: Statistical data of qualitative characters for thirty-four accessions of Pigeon pea

Characters/ Accessions	DSE	DSP	DSS	DST	DSF	DSP	NBT	NBF	NSP	NPM	NPP	NOF
	days											
CL1	3	8	12	18	168	172	17	22	5.5	15	43	3
CL2	5	11	16	21	210	217	16	19	2.5	3	10	1
CL3	4	9	13	19	166	172	16	16	5	18	42	4
CL4	3	8	13	19	215	217	17	18	4	6	18	1
CL5	4	10	15	20	212	172	8	20	3	4	12	2
CL6	5	12	16	21	200	221	7	19	4	5	14	2
CL7	3	9	15	21	196	218	6	14	4	6	16	1
CL8	4	8	13	19	194	210	12	16	4	7	22	2
CL9	3	7	12	18	191	203	3.8	2.6	4	7	15	1
CL10	3	7	12	18	190	210	7	18	2	6	14	2
CL11	4	10	14	19	203	200	5	12	3	5	17	1
CL12	4	10	15	22	202	200	11	18	3	4	21	2
CL13	3	9	14	22	210	209	12	18	5.5	17	48	1
CL14	4	10	15	21	214	210	19	24	3	10	32	1
CL15	4	8	13	18	167	271	16	25	4	12	25	3
CL16	3	8	12	19	170	221	17	28	4	15	38	3
CL17	3	7	12	18	201	180	14	21	4	16	41	1
CL18	4	10	14	20	201	216	21	27	4	8	29	2
CL19	3	8	14	20	200	210	10	18	3	11.5	31	1.5
CL20	4	9	13	19	170	176	13	20	3	3.5	11	2.5
CL21	3	8	14	20	185	193	11	19	3	22	66	2
CL22	3	8	13	19	189	196	17	24	2.5	25	69	1.5
CL23	4	9	16	21	164	174	1	6	3	5.5	17.5	2.5
CL24	5	8	13	19	156	176	2	9	4.5	31	140.5	1
CL25	4	7	13	19	104	108	1.2	4	4	23	50.5	4.5
CL26	5	8	14	22	113	126	2	8	5.5	25	64	3.5
CL27	4	8	15	22	110	131	1	5	4.5	18.5	44.5	5
CL28	4	7	12	17	148	163	1	9	3.5	5.5	14.5	1
CL29	5	9	16	21	100	118	4	10	5.5	20.5	85.5	1.5
CL30	5	8	14	22	137	144	1	16	3.5	5	17	2.5
CL31	5	8	13	19	142	155	2	18	3	3.5	20.5	2
CL32	4	7	12	17	165	169	3	13.5	3	6.5	26.5	2
CL33	5	9	16	21	170	176	4	11.5	2.5	4.5	15	1
CL34	5	8	14	22	154	162	1	9.5	2.5	6.5	18.5	2
Mean	3.94	8.53	13.77	19.79	174.03	183.66	8.99	16.03	3.68	11.21	33.81	2.00
SE	0.640	0.758	1.038	0.968	1.324	1.47	1.167	1.414	0.388	1.224	1.116	0.543
ANOVA	0.137	0.004**	0.068	0.005**	0.0**	0**	0**	0**	0**	0**	0**	0**
Co. Var.	25.52	16.64	12.37	9.14	18.82	17.17	72.77	40.97	27.98	69.60	78.95	59.85
Variance	1.01	2.01	2.90	3.27	1073.11	994.70	42.75	43.12	1.06	60.68	712.39	1.43

DS: Number of days from sowing to: DS**E**: emergence, DS**P**: production of primary leaflets, DS**S**: production of secondary leaflets, DS**T**: production of tertiary leaflets, DS**F**: production of first flower, DS**P**: production of first pod; **NB**: Number of branches at: NB**T**: ten weeks, NB**F**: production of first flower; **NPM**: Number of pods per plant at maturity, **NPP**: Total number of pods per plant at harvesting, **NOF**: Number of flowers. **P<0.001

served in the mean values of the characters scored for each accession. CL27 was the shortest (101.5cm), while CL9 was the tallest (243.5cm) at maturity. Whereas, CL29 flowered and matured early (100-days), CL4 flowered and matured lately (215 days). CL9, CL13, CL17 and CL29 showed higher seed yield per pod (0.2g each) compared to other acce-ssions (0.1g). The results also indicated that early maturing accessions produced higher grain yield than late maturing ones as shown by CL29. Some long duration accessions (CL29 191days, CL13 210days and CL17 201days) produced higher seed yield compared to short duration (CL25 104 days, CL26 113days, CL27 110days and CL30 137days). Twenty-eight access-ions produced yellow flowers, four produced red while two had orange flowers.

Analysis of variance (Table 2) showed that significant differences (P<0.001) existed for 21 characters while number of days from sowing to emergence (DSE) and number of days of sowing to production of secondary leaflets (DSP) were not significant. Seed weight (SW) was significant for block effects (P <0.001), Table 3. Coefficient of variation was high (41-79%) for numb-er of flowers at first flowering and some pod and bra-

Table 3: Statistical data of quantitative characters for thirty-four accessions of Pigeon pea

Accessions/ characters	LLM	LWM	SLM	SDM	LPP	WPP	HFF	SLT	NSP	SWP	PWP	SW
					cm						g	
CLA	6.5	2.8	162	6.4	7.2	1.05	160	120	5.5	0.05	0.75	0.1
CLB	5.5	2.1	228	7.15	3.35	0.35	220	108	2.5	0.3	0.4	0.1
CLC	8.5	2.5	225	6.95	7	0.85	215	135	5	0.45	0.65	0.1
CLD	5.8	2.5	200.5	6.15	3.75	0.5	190	125	4	0.45	0.45	0.1
CLE	5.6	2.1	158	7.05	3.20	0.5	155	116	3	0.3	0.35	0.1
CLF	5.7	2.1	165	7.1	3.85	0.5	160	118	4	0.3	0.4	0.1
CLG	5.9	2.8	152.5	6.35	4.10	0.6	150	131	4	0.4	0.5	0.1
CLH	6.1	2.7	211.5	7.3	3.75	0.5	210	130	4	0.4	0.5	0.1
CLI	5.1	2	243.5	6.45	4.2	0.4	140	140	4	0.4	0.5	0.2
CLJ	5.3	2.1	205	6.05	3.2	0.4	200	134	2	0.3	0.35	0.1
CLQ	5.9	3.1	210	6.6	3.4	0.4	205	170	3	0.3	0.4	0.1
CLR	7.3	3.4	226.5	6	3.05	0.4	220	162	3	0.3	0.4	0.1
CLS	9.8	3.6	179.5	6.35	7.6	0.95	170	115	5.5	0.45	0.6	0.2
CLT	10.1	3.8	225.5	5.9	3.5	0.5	215	126	3	0.3	0.4	0.1
CLU	7.1	3.2	188.5	6.25	3.6	0.5	185	130	4	0.4	0.45	0.1
CLV	7.4	3.4	190	6.5	3.7	0.6	188	134	4	0.4	0.5	0.1
CLW	7.8	3.3	172	5.25	3.65	0.6	165	123	4	0.4	0.6	0.2
CLX	8.1	3.6	178	6.4	3.6	0.6	172	129	4	0.4	0.5	0.1
CLY	7.5	3.05	169	5.35	3.35	0.4	163.5	121	3	0.3	0.4	0.1
CLZ	7.15	3.15	200	5.15	3.7	0.55	193	153	3	0.3	0.45	0.1
CL1	8.5	1.4	151	6.6	3.4	0.45	142.5	131	3	0.3	0.4	0.1
CL2	7.8	3.25	161.5	6.1	3.1	0.35	156	125.5	2.5	0.3	0.35	0.1
CL3	5.65	2.3	176	6.3	3.5	0.45	180.5	149	3	0.3	0.4	0.1
CL4	10.25	3.5	144	6.5	7.35	0.65	139.5	101	4.5	0.45	0.55	0.1
CL5	11.5	3.8	180.5	7.85	6.5	0.55	100	80	4	0.10	0.5	0.1
CL6	10.15	4.15	152	7.4	8.1	1.15	104.5	78	5.5	0.55	0.65	0.1
CL7	9.2	3.25	101.5	8.1	6.85	0.65	88	75.5	4.5	0.45	0.5	0.1
CL8	5.55	2.15	198	5.7	4.05	0.65	189.5	109.5	3.5	0.35	0.45	0.1
CL9	6.95	2.9	170	7.3	6.75	0.6	151	115	5.5	1.00	1.1	0.2
CL10	6.15	2.55	207	6.6	3.85	0.5	200	135	3.5	0.35	0.45	0.1
CL11	6.75	2.7	215	6.9	3.8	0.45	210.5	153.5	3	0.3	0.04	0.1
CL12	6.4	2.95	228	5.9	3.6	0.4	220	178	3	0.3	0.04	0.1
CL13	5.35	2.15	223	6.2	3.3	0.35	218	164	2.5	0.25	0.04	0.1
CL14	5.95	2.7	206	5.8	3.15	0.45	196	137.5	2.5	0.25	0.35	0.1
Mean	7.13	2.91	188.34	6.47	4.41	0.55	178.66	128.02	3.68	0.37	0.49	0.11
±SE	0.133	0.111	1.594	0.126	0.106	0.039	1.980	1.378	0.388	0.034	0.041	0.000
Anova	0**	0**	0**	0**	0**	0**	0**	0**	0**	0**	0**	0**
Co. Var.	23.60	20.32	16.53	10.69	35.90	35.14	20.35	18.46	27.98	39.08	30.89	29.03
Variance	2.83	0.35	968.70	0.48	2.51	0.04	1321.2	558.25	1.06	0.02	0.002	10.54

LLM: Leaf length at maturity, LWM: Leaf width at maturity, SLM: Stem length at maturity, SDM: Stem diameter at maturity, LPP: Length of pods per plant, WPP: Width of pods per plant, HFF: Height at first flowering, SLT: Stem length at ten weeks, NSP: Number of seeds per pod, SWP: Seed weight per plant, PWP: Pod weight per plant, SW: Seed weight per pod. **P<0.001

nch characters while it was low (9-19%) for number of days from sowing to production of leaflets, first flower and pod, and stem characters (Tables 2 & 3).

Variance was high (321-1073) for height at first flowering, emergence of first flower and pod, pods per plant at maturity and stem length. Seed weight per pod and, pod weight and width per plant were lowest (0.02-0.04), Table 3.

Pearson correlation coefficients (PCC)

Number of days from sowing to emergence was significantly correlated with production of secondary leaflets. Similarly were the numbers of branches at 10 weeks and number of days from sowing to emergence of first flower and pod with stem diameter at maturity (Table 4). The number of days from sowing to emergence was significantly correlated with number of days from sowing to production of primary and tertiary leaflets. A positive correlation was established between the days of sowing and production of primary, secondary and tertiary leaflets on one hand and production of first pod and first flower on the other. Number of branches at 10 weeks and number of branches at production of first flower were positively associated with days from sowing to production of primary leaflets. Furthermore, number of days

Table 4: *Correlation matrix among eighteen Pigeon pea characters*

	DSE	DSP	DSS	DST	DSF	DSP	NBT	NBF	HFF	SLT	NPM	NPH	NOF	LLM	LWM	SLM	SDM	LPP
DSE	1.00																	
	*																	
DSP	0.29	1.00																
	**	**																
DSS	0.38	0.67	1.00															
	*	**	**															
DST	0.29	0.53	0.79	1.00														
	**	**																
DSF	-0.34	0.36	0.04	-0.06	1.00													
	**	**																
DSP	-0.34	0.36	0.04	-0.06	0.99	1.00												
	**	*																
NBT	-0.35	0.25	-0.09	-0.12	0.60	0.59	1.00											
		*			**	**	**											
NBF	-0.22	0.29	-0.08	-0.08	0.58	0.57	0.84	1.00										
					**	**		*										
HFF	0.03	0.13	-0.09	-0.18	0.47	0.44	0.21	0.29	1.00									
					**	**												
SLT	-0.04	0.10	-0.04	-0.16	0.37	0.33	0.05	0.24	0.77	1.00								
					**	**			**	**								
NPM	-0.08	-0.22	-0.10	0.04	-0.41	-0.38	0.05	-0.1	-0.66	-0.58	1.00							
					**	**			**	**	**							
NPP	0.06	-0.17	-0.06	0.03	-0.37	-0.32	-0.06	-0.1	-0.54	-0.45	0.90	1.00						
					**	**			**		**							
NOF	0.09	-0.11	0.007	0.13	-0.54	-0.56	-0.04	-0.12	-0.39	-0.30	0.32	0.10	1.00					
LLM	0.01	-0.10	-0.02	0.19	-0.31	-0.29	0.10	-0.07	-0.61	-0.55	0.74	0.67	0.33	1.00				
										**	**	**	**	**				
LWM	-0.03	-0.07	-0.06	0.15	-0.19	-0.18	0.23	0.13	0.11	0.43	0.34	0.52	0.31	0.38	1.00			
										**	**	**	**	**	**			
SLM	0.10	0.03	-0.12	-0.19	0.28	0.23	0.14	0.12	0.15	0.34	0.42	0.61	0.38	0.37	0.54	1.00		
	**		*		**	**		**		**	**			**	**	**		
SDM	0.31	0.15	0.26	0.25	-0.45	-0.43	-0.23	-0.33	0.13	0.35	0.43	0.17	0.12	-0.35	-0.37	0.42	1.00	
					**	**		**		**	**	**	**	**	**	**	**	
LPP	0.11	-0.12	-0.04	0.12	-0.45	-0.52	-0.16	-0.34	-0.23	-0.38	0.53	0.36	-0.39	0.42	0.51	0.51	0.39	1.00

Significance: *P<0.05, ** P<0.01

Table 5: Cluster groups of thirty-four accessions of Cajanus cajan

Cluster group	Total no of accessions	Name of accessions
I	1	CL34
II	3	CL25, CL26, CL29
III	30	CL1, CL2, CL3, CL4, CL5, CL6, CL7, CL8, CL9, CL10, CL11, CL12, CL13, CL14, CL15, CL16, CL17, CL18, CL19, CL20, CL21, CL22, CL23, CL24, CL27, CL28, CL30, CL31, CL32, CL33

from sowing to production of secondary leaflets correlated with production of tertiary leaflets and stem diameter at maturity (P<0.001). Number of pods produced per plant at maturity correlated with height at first flower and total number of pods per plant. However, the number of flowers at first flower did not correlate with total number of pods per plant (Table 4).

Cluster analysis and dendogram

The 34 accessions were grouped into three different clusters (Table 5) from different geographic background. The largest cluster of 30 accessions were from Plateau (5), Kogi (4), Niger (3), Kwara (3), Edo (3), Oyo (3), Kaduna (2), Osun (2), Kano (2), Benue (2), Nasarawa (1), the Federal Capital Teritory (1) and Ondo (1) states. CL34 from Zamfara was the only accession in cluster I, Fig. 1.

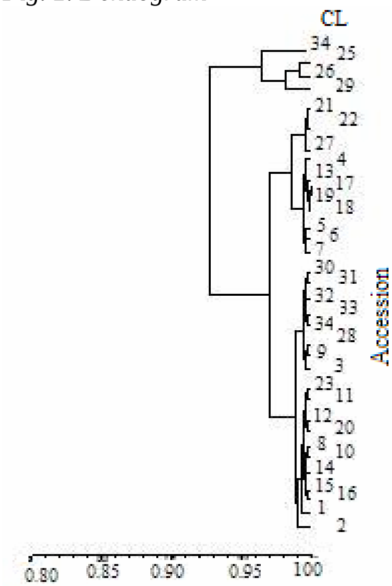
Principal components analysis (PCA)

Table 6 indicates delineation of accessions into groups using Principal Component Analysis (PCA). Prin 1 accounted for 33.37% of the total variation, Prin 2 30.83% while Prin 3 constituted the highest. The DSP (-0.04) was the lowest vector in Prin 1 while LPP (0.28) was the highest. In Prin 2, PWP (0.33) was the highest while NPP (0.00) was the lowest. Prin 3 have NBT and NBF (0.43) as highest eigen vectors while NSP (-0.01) was the lowest.

Discussion

Analysis of mean values of C*ajanus cajan* accessions indicates that there are variation in the characters studied (Tables 2 & 3). Long duration accession (CL1) produced higher mean seed yield than all the

Fig. 1. Dendogram



other accessions. Chauchan and Singh (1981) linked the higher yield in late maturing varieties to more significant stem length and number of pods per plant. Significant differences (P<0.01) exist in characters of the experimental materials indicating considerable variability and genetic difference among the accessions. Hanson and Weber (1961) and Croissant and Torrie (1971) obtained similar results for various traits in *Cajanus cajan*. In line with the report of Joshi (1973) and Kharif *et al*. (1973), the estimates of coefficients of variation were high for total number of pods per plant among other characters studied. Selection based on this character and the genetic diversity inherent in the plant could thus improve productivity considerably. Cluster analysis and Dendogram indicate that cluster groups consist of accessions from different geographical background. Thus, geographical diversity may not necessarily be associated genetic diversity (Saxena & Yada, 1974; Ganesh & Doraraj, 1990; Virangama & Goyal, 1994). Such grouping of genotypes from different locations may be attributed to the free exchange of breeding materials among the communities (Verma and Metha, 1976). Alternatively, the clustering of genotypes from different location may be due to unidirectional selection practiced by breeders at different locations (Malik *et al*., 1985). Furthermore, accession types from same geographic region were found in different clusters. Such wide adaptability has been attributed to similarity in requirements, heterogeneity, population genetic architecture, selection history and approach under domestic cultivation and developmental traits (Murthy & Arunachalam, 1986; Jaghoram, 1989; Ganesh &, Dorairaj, 1990).

Table 6: Principal Component analysis of the Cajanus cajan accessions

Character	Prin 1	*Prin 2*	*Prin 3*
DSE	0.09	-0.29	-0.11
DSP	-0.04	-0.18	0.28
DSS	0.09	-0.35	0.17
DST	0.12	-0.32	0.19
DSF	-0.24	0.17	0.32
DSP	-0.24	0.18	0.21
NBT	-0.10	0.26	0.43
NBF	-0.12	0.17	0.43
HFF	-0.26	0.06	-0.10
SLT	-0.25	0.11	-0.12
NPM	0.27	0.05	0.15
NPP	0.26	0.00	0.11
NOF	0.16	-0.25	0.11
LLM	0.23	0.04	0.27
LWM	0.18	0.08	0.31
SLM	-0.24	0.06	-0.14
SDM	0.06	-0.08	-0.12
LPP	0.28	0.15	-0.05
NSP	0.23	0.27	-0.01
SWP	0.18	0.28	-0.13
PWP	0.18	0.33	-0.15
WPP	0.22	0.23	0.13
SW	0.13	0.24	-0.05
FC1	-026	0.03	0.08
FC2	0.22	-0.09	0.05
FC3	0.12	0.08	-0.22
(%)	33.37	30.83	35.80

The lack of relationship between genetic and geographic diversities in this study suggests that forces other than geographic origin (such as exchange of breeding materials, natural and artificial selections) may be responsible for diversity. Hence, a wide range of characters should be involved in selection process for *Cajanus cajan*.

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