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Research Article

Assessment of genetic diversity in cowpea (*Vigna unguiculata*)

R.M.Nagalakshmi, R. Usha Kumari and M. B. Boranayaka

Abstract

Sixty six genotypes of cowpea (*Vigna unguiculata* (L.) Walp) were investigated to understand the extent of genetic diversity through twelve quantitative traits. Mahalanobis's D^2 analysis established the presence of wide genetic diversity among these genotypes by the formation of 23 clusters. Cluster I had the maximum number of genotypes i.e 22 and cluster 23 had only one genotype. Intra cluster distance analysis revealed that the minimum intra cluster distance was observed in the cluster II. The inter-cluster distance (D) was found to be the maximum between the clusters XXII and XXIII and the same was minimum between clusters II and V. The results indicated that grain yield per plant contributed maximum to the total divergence followed by 100 seed weight and days to 50% flowering. Number of branches per plant had least contribution to the total divergence followed by petiole length. The existence of wide genetic diversity among the types chosen from the same geographical location was obviously seen. In the present study, the variety Vellayani local had the maximum value for plant height and pod length and thereby distinguished from other varieties and it is present singly in the cluster XXIII. Hence it is proved to be widely divergent, since its yield is high, it can be used for further crossing and yield improvement. The cluster XVIII had the highest cluster mean values for number of clusters per plant and the cluster XIV has the highest mean value for grain yield per plant. These two clusters may be utilized in crossing programme which may yield in a wide spectrum of variability and for selection for seed yield in the subsequent generations. The clustering pattern of the varieties in the present study clearly indicated that there was no parallelism between genetic and geographic diversities. Based on the mean performance and genetic divergence, the genotypes Vellayani local, NBC 7, Lola, CP 18, CP 150, ACM 05-07 can be used for crossing and further selection.

Key words: Cowpea, genetic diversity, quantitative traits

Introduction

Cowpea is one of the ancient crops known to man. It is cultivated around the world primarily for seed, but also as a vegetable, cover crop and fodder. Its grain is rich in protein and digestible carbohydrate. Combined with cereals in the diet, lysine-rich cowpea complements the lysine-poor cereals. It is a fast growing, highly palatable and nutritious grain, fodder and vegetable crop. Hence, it is considered to be the most important leguminous crop. The crop is gaining popularity in developing and under developed countries, especially in arid regions of the world due to its nutritional value. Like other legumes, cowpea fixes atmospheric nitrogen, and thus contributes to the available N levels in the soil. One of the more remarkable things about cowpea is that it thrives in dry environments. Cultivars are available that produce a good crop with as little as 300 mm of rainfall. It is being cultivated in the drier parts of the world where other food legumes cannot withstand. Also, it is shade tolerant and compatible as an intercrop. This makes it the crop of choice for arid zone. Cowpea is a variable species composed of wild perennials, wild annuals and cultivated forms. Genetic diversity is the basic requirement for a successful breeding programme. Collection and evaluation of genotypes of any crop is a pre-requisite for any programme, which provides a greater scope for exploiting genetic diversity. A quantitative assessment of the genetic divergence among the collection of germplasm and their relative contribution of different traits towards the genetic divergence provide essential and effective information to breeder in his hybridization programme and thereby genetic improvement of yield. The necessity for finding out genetic divergence among the types is more pronounced because of two reasons i.e., i) genetically diverse parents if included in the hybridization programme are likely to produce high heterotic effect ii) a wide spectrum of variability could be expected in the segregating generation of crosses involving distantly related parents.

Agricultural College and Research Institute,
Madurai – 625 104

Materials and Methods

66 germplasm entries collected from all over India were used for the present study. 22 genotypes were obtained from Regional Research Station, Vamban, 21 genotypes from Central Arid Zone Research Institute, Jodhpur, eight from Agricultural College and Research Institute, Madurai, six from Kerala Agricultural University, Vellayani, four from Tamilnadu Agricultural University, Coimbatore, three from ARS, Durgapura and two from National Bureau of Plant Genetic Resources, Delhi. Each entry was raised in two rows of 3 m length spaced at 30 cm between rows and 20 cm between plants in each replication. The recommended agronomic practices were adopted uniformly. Border rows were grown on all sides of the experimental plots. The observations were recorded on three randomly selected plants in each replication and the average was worked out and used for statistical analysis. The following quantitative characters were studied, days to 50% flowering, plant height, number of branches per plant, Number of leaves per plant, Petiole length, Peduncle length, Number of clusters per plant, number of pods per plant, pod length, number of seeds per pod, 100 seed weight and grain yield per plant.

Results and Discussion

The observations on twelve quantitative characters in 66 genotypes of cowpea were analyzed for genetic diversity. The D^2 values corresponding to all possible combinations among the 66 genotypes were computed. The 66 genotypes were grouped into twenty three different clusters as shown in Table 1. Among the twenty three clusters, it was observed that the cluster I was the largest with twenty two genotypes followed by cluster VI with three genotypes. The clusters II**,** III, IV, V, VII, VIII, IX, X, XI, XII, XIII, XIV, XV, XVI, XVII, XVIII, IX, XX, XX1 and XXII had only two genotypes each. The cluster XXIII was recorded to be the smallest with one genotype.

The clustering pattern of the varieties in the present study clearly indicated that there was no parallelism between genetic and geographic diversities. The types collected from Kerala fell in different clusters like clusters I, VI and XXIII. Similarly types of Vamban fell in different clusters like cluster I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, XIII, XIV, XV, XVI, XVII, XVIII, XIX and XXIII. Types of different sources like Jodhpur, Vamban and Kerala fell in the same cluster i.e., cluster I. The existence of wide genetic diversity among the types chosen from the same geographical location was obviously seen. Many earlier studies on D^2 statistic in various crops already showed the lack of parallelism between genetic and geographic diversities. Similar reports were given by Vijay Prakash, 2006 in chickpea, Golani *et al.,* 2006 in Indian bean, Singh and Singh, 2006 in field pea, Dahiya *et al.,* 2007 in cowpea; Indradeo Pandey, 2007 in cowpea; Valarmathi *et al.,* 2007 in cowpea, Suganthi *et al.,* 2007 in cowpea and Sulnathi *et al*., 2007 in cowpea. The observations on types from different geographic regions falling into one cluster may be reasoned out as due to free exchange of genetic material from one place to another or due to the fact that unidirectional selection practiced in different places might have had a similar effect and therefore, varieties evolved under similar selection pressure might have clustered together irrespective of their geographic origin. In the present study, the variety Vellayani local had the maximum value for plant height and pod length and thereby distinguished from other varieties and it is present singly in the cluster XXIII. Hence it is proved to be highly divergent, since its yield is high, it can be used for further crossing and yield improvement.

The inter and intra cluster D^2 values among twenty three clusters are represented in Table 2. The minimum intra cluster distance was recorded in cluster II whereas the maximum was recorded in cluster XXII. Similarly the least inter cluster distance was observed between cluster II and V and maximum between XXII and XXIII.

The data on the means of all the twelve characters are presented in Table 3. It is evident that different cluster exhibit distinct mean values for almost all the twelve characters. A wide range of variation was observed among different clusters for all the cluster means. Cluster X has the highest mean value for petiole length and number of seeds per pod. Cluster XIV has the maximum mean value for grain yield per plant. Cluster XVIII has the maximum mean value for number of clusters per plant and number of pods per plant. Cluster XXI has the maximum mean value number of branches per plant and peduncle length. Cluster XXII has the maximum mean value for number of leaves per plant. Cluster XXIII has the maximum mean value for days to 50% flowering, plant height and pod length. Cluster VI has the maximum mean value for 100 seed weight. In the present study, the possibility of choice of highly divergent and desirable types based on D^2 cluster means and inter cluster distances was also examined. The cluster XVIII had the highest cluster mean values for number of clusters per plant and the cluster XIV has the highest mean value for grain yield per plant. The types in the two clusters may be utilized in crossing programme which may yield in a wide spectrum of variability and for selection for seed yield in the subsequent generations. Similarly the cluster XXIII which had highest cluster mean value for pod length and may be selected for crossing with the cluster XVIII for obtaining desirable segregants.

In the present investigation to assess the percentage contribution of different important traits towards the genetic divergence are calculated Table 4. The study indicated that days to maturity contributed maximum to the total divergence followed by 100 seed weight and days to 50% flowering. There is always difference in opinion in specifying the trait that is contributing high or low towards the genetic diversity. The contribution mainly depends upon the genotypes included in the study and the environment influences over the character. Regarding the least contribution, number of branches per plant and petiole length contributed the least. The minimum contribution by this trait reveals that this trait was least affected in course of evolution.

Considering all the diversity, mean performance genotypes Vellayani local, NBC 7, Lola, CP 18, CP 150, ACM 05-07 were found to be best for crossing and yield improvement in cowpea.

References

Dahiya, O.P., Dhirender Singh, and S.K. Mishra. 2007. Genetic divergence in cowpea(*Vigna ungiculata (*L.) Walp). Arid legumes, 4: 62-65.

Golani, I.J., M.V. Naliyadhara, D.R. Mehta, V.L. Purohit and H.M. Pandya. 2006. Legume Res., 29 **:** 286-288.

Indradeo Pandey, 2007. Genetic diversity in grain cowpea. Legume Res., 30 : 92-97.

Singh J.D. and I.P. Singh. 2006 . Genetic divergence in advanced genotypes for grain yield in field pea (*Pisum sativum* L.) Legume Res., 29 : 301-303.

Suganthi, S., S. Murugan and M. Venkatesan. 2007. D^2 analysis in cowpea (*Vigna ungiculata* (L.) Walp). Legume Res., 30 : 145-147.

Sulnathi, G., L. Prasnthi and M. Reddy Sekhar. 2007.Character contribution to diversity in cowpea. Legume Res., 30 : 70 – 72.

Valarmathi, C., C. Surendran and A.R. Muthiah 2007. Genetic divergence analysis in subspecies of cowpea (V*igna ungiculata ssp. ungiculata and Vigna ungiculata ssp. saequipedalis*).Legume Res., 30 : 192-196.

Viay prakash. 2006. Divergence analysis in Kabuli chickpea (*Cicer arietinum* L.). Indian J. of genet., 66: 241-242.

Table 1. Composition of D^2 clusters on Cowpea germplasm

Cluster	Number of genotypes	Names of the genotypes
1	22	NBC 7, NBC 8, NBC 9, NBC 13, NBC 15, NBC 19, NBC 20, NBC 28, NBC 30, NBC 32, NBC 33, NBC 37, NBC 41, NBC 42, NBC 43, NBC 49, Lola, Sarika, Subathra, Kanagamoni, CP 224, ACM 05-05
2	2	CP 6, CO 7.
3	2	CP 222, P 152.
4	2	CP 9, CP 43.
5	2	CP 128, CP 129.
6	3	Vellayani jyothika, PGCP 1, PGCP 2.
7	2	CP 89, CP 164.
8	2	CP 274, CP 19
9	2	CP 191, RC 1.
10	2	GC 3, CP 21.
11	2	EC 1, CO 6.
12	2	CP 186, ACM 05-07
13	2	P 491, CP 16
14	2	CP 18, CP 196.
15	2	CP 221, CP 235.
16	2	ACM 002, RC 2
17	2	CP 79, CP 137.
18	2	CP 8, CP 150.
19	2	V 585, CP 23.
20	2	RC 3, EC 2.
21	2	V 240, VBN 1.
22	2	CP 338, CP 25.
23	1	Vellayani local.

Table 2. Inter and intra (diagonal) cluster values of average of D^2 and D values (in bold)

Cluster	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
I	354..805	444.918	870.466	241.493	421.195	919.701	702.818	380.777	345.682	381.675	426.208	729.85
	18.836	21.093	29.504	15.54	20.523	30.327	26.511	19.514	18.593	19.537	20.645	27.016
II		41.032	218.247	161.816	68.79	999.884	202	210.45	214.234	127.608	119.55	122.886
		6.406	14.773	12.721	8.294	31.621	14.213	14.507	14.637	11.296	10.934	11.085
III			41.066	519.287	238.573	1225.116	439.684	540.781	457.584	364.426	318.937	363.693
			6.408	22.788	15.446	35.002	20.969	23.255	21.391	19.09	17.859	19.071
IV				46.013	186.075	803.76	324.911	138.915	223.318	118.24	217.497	353.232
				6.783	13.641	28.351	18.025	11.786	14.944	10.874	14.948	18.794
V					62.69	1004.649	275.342	268.2	191.766	207.131	101.686	234.207
					7.918	31.696	16.593	16.377	13.848	14.392	10.384	15.304
VI						1222.674	1245.761	819.402	1011.292	931.547	947.332	1308.587
						34.967	35.295	28.625	31.801	30.521	30.779	36.174
VII							75.562	541.873	493.947	306.502	341.266	209.125
							8.693	23.278	22.225	17.507	18.473	14.461
VIII								76.058	380.116	189.841	276.094	391.657
								8.721	19.497	13.778	16.616	19.79
IX									86.712	241.042	192.925	476.234
									9.312	15.526	13.89	21.823
X										87.484	265.946	285.289
										9.353	16.308	16.89
XI											87.741	334.627
											9.367	18.293
XII												120.482
												10.976

Table 2. contd…

CLUSTER	**XIII**	**XIV**	**XV**	**XVI**	**XVII**	**XVIII**	**XIX**	**XX**	**XXI**	**XXII**	**XXIII**
I	357.003	645.118	602.737	429.732	837.499	1236.832	640.655	339.922	1093.798	1235.673	4542.042
	18.895	**25.399**	**24.551**	**20.73**	**28.94**	**35.169**	**25.311**	**18.437**	**33.073**	**35.152**	**67.395**
II	118.304	252.965	210.723	358.758	242.779	609.436	283.79	254.23	444.807	871.96	3963.717
	10.877	**15.905**	**14.516**	**18.941**	**15.581**	**24.687**	**16.846**	**15.945**	**21.09**	**29.529**	**62.958**
III	449.21	614.516	280.063	745.444	309.031	904.496	587.842	484.76	436.043	826.347	3648.877
	21.195	**24.789**	**16.735**	**27.303**	**17.579**	**30.075**	**24.245**	**22.017**	**20.882**	**28.546**	**60.406**
IV	173.146	361.678	328.813	159.887	394.091	787.87	293.727	174.696	658.661	880.269	4189.36
	13.158	**19.018**	**18.133**	**12.645**	**19.852**	**28.069**	**17.138**	**13.217**	**25.664**	**29.669**	**64.725**
V	128.284	316.671	204.609	398.68	308.439	658.095	378.186	259.892	486.731	740.716	4051.042
	11.326	**17.795**	**14.304**	**19.967**	**17.562**	**25.653**	**19.447**	**16.121**	**22.062**	**30.674**	**63.648**
VI	827.499	1257.392	1300.288	1101.211	1385.666	2036.795	957.147	911.119	1536.531	1774.893	3104.421
	28.766	**35.46**	**36.06**	**33.184**	**37.225**	**45.131**	**30.938**	**30.185**	**39.199**	**42.129**	**55.717**
VII	315.055	160.476	531.031	543.652	232.146	739.399	444.347	493.87	660.179	993.521	4035.324
	17.75	**12.668**	**23.044**	**23.316**	**15.236**	**27.192**	**21.08**	**22.223**	**25.694**	**31.52**	**63.524**
VIII	236.038	602.851	353.823	254.595	508.73	766.974	210.726	308.723	542.472	1082.212	3826.713
	15.364	**24.553**	**18.81**	**15.956**	**22.555**	**27.694**	**14.516**	**17.571**	**23.291**	**32.897**	**61.86**
IX	206.795	432.964	241.484	380.988	547.739	909.799	637.562	206.708	791.742	961.548	4568.49
	14.38	**20.808**	**15.54**	**19.513**	**23.404**	**30.16**	**25.25**	**14.377**	**28.138**	**31.009**	**67.591**
X	238.032	340.461	295.704	302.075	339.386	854	314.874	205.307	569.708	782.546	4280.828
	15.428	**18.452**	**17.196**	**17.38**	**18.422**	**29.225**	**17.745**	**14.329**	**23.869**	28	**65.428**
XI	122.801	435.28	243.121	415.372	450.55	777.495	477.82	251.41	598.203	1116.635	3530.087
	11.082	**20.863**	**15.592**	**20.381**	**21.226**	**27.884**	**21.859**	**15.856**	**24.458**	**33.416**	**59.415**
XII	274.408	235.036	427.497	528.296	253.976	514.847	314.123	540.437	500.897	1014.578	4193.791
	16.565	**15.331**	**20.676**	**22.985**	**15.937**	**22.69**	**17.724**	**23.247**	**22.381**	**31.852**	**64.759**
XIII	123.373	294.119	369.679	407.514	471.76	779.395	349.002	284.661	674.997	1142.424	369.437
	11.107	**17.15**	**19.227**	**20.187**	**21.72**	**27.918**	**18.682**	**16.872**	**25.981**	**33.8**	**60.765**
XIV		144.197	661.956	635.251	417.681	850.328	506.147	537	867.896	110.191	4572.898
		12.008	**25.729**	**25.204**	**20.437**	**29.16**	**22.498**	**23.173**	**29.46**	**33.32**	**67.623**
XV			152.204	355.723	338.751	587.294	566.393	344.318	435.812	867.954	4601.532
			12.337	**18.861**	**18.405**	**24.234**	**23.799**	**18.556**	**20.876**	**29.462**	**67.835**
XVI				167.806	452.923	595.691	431.263	371.258	675.803	965.395	4671.616
				12.954	**21.282**	**24.407**	**20.767**	**19.268**	**25.996**	**31.071**	**68.349**
XVII					182.224	485.88	403.755	574.749	392.022	765.344	4430.959
					13.499	**22.043**	**20.094**	**23.974**	**19.8**	**27.665**	**66.565**

XVIII	290.824	687.47	115.509	575.139	1479.979	5210.852
	17.054	**26.22**	**33.399**	**23.982**	**38.47**	**72.186**
XIX		295.334	572.751	518.415	114.112	3790.908
		17.185	**23.932**	**22.769**	**33.378**	**61.57**
XX			358.706	824.802	930.756	4264.033
			18.94	**28.719**	**30.508**	**65.3**
XXI				729.706	1161.806	414.143
				27.013	**34.085**	**64.352**
XXII					1905.027	5520.532
					43.647	**74.3**
XXIII						0
						0

Table 3. Cluster means for twelve characters in 66 diverse accessions of Cowpea

Cluster	Days to 50% flowering	Plant height (cm)	Number of branches per plant	Number of leaves per plant	Petiole length (cm)	Peduncle length (cm)	Number of clusters per plant	Number of pods per plant	Pod length (cm)	Number of seeds per pod	100 seed weight (g)	Grain yield per plant (g)
I.	29.47	27.09	4.50	62.19	13.02	15.58	10.74	22.30	14.37	13.44	13.47	14.70
II.	34.25	30.75	4.98	90.09	13.02	27.55	10.59	25.99	15.28	16.04	9.92	24.07
III.	36.00	44.99	6.48	155.17	12.04	31.22	9.41	24.82	17.03	12.77	9.32	24.24
IV.	28.75	28.17	4.55	78.88	11.73	20.25	12.79	27.47	16.39	13.30	13.03	21.29
V.	35.00	31.06	5.30	88.46	14.18	28.00	12.50	24.86	13.58	10.53	12.12	20.01
VI.	28.50	64.31	4.82	63.09	12.51	16.73	7.62	13.75	23.11	15.54	16.97	12.06
VII.	34.75	35.69	6.01	91.09	12.50	24.59	18.15	27.93	18.62	16.30	11.51	34.36
VIII.	27.50	31.18	4.17	65.87	10.55	28.87	10.52	26.48	17.29	15.16	11.97	15.37
IX.	35.25	34.09	5.08	103.46	12.37	13.78	11.62	27.49	11.87	15.78	8.62	14.97
X.	28.50	32.59	6.64	101.88	14.63	21.11	12.22	24.45	16.01	16.99	8.20	22.40
XI.	36.75	31.43	4.26	83.00	12.29	24.05	12.77	25.76	17.66	13.46	10.66	15.89
XII.	34.75	31.28	4.45	80.67	12.29	29.79	10.28	30.96	15.14	16.11	8.60	34.84
XIII.	35.25	35.99	4.30	55.12	14.75	23.58	10.60	22.94	15.82	16.71	12.03	18.31
XIV.	35.00	37.15	6.28	64.02	13.03	18.56	14.85	24.76	13.53	15.56	9.95	35.71
XV.	34.00	29.31	5.36	139.40	11.81	28.25	13.41	36.83	12.87	14.89	9.31	14.91
XVI.	27.25	27.32	4.46	100.65	9.40	19.81	15.29	45.16	16.22	13.36	12.73	21.51
XVII.	32.25	40.19	5.38	138.52	13.58	31.59	17.06	37.65	16.12	14.59	12.05	31.77
XVIII.	34.00	32.72	5.82	100.64	12.24	36.59	18.19	63.67	12.06	12.61	11.24	29.75
XIX.	27.50	42.80	4.59	62.60	12.38	33.86	12.00	27.62	17.67	15.71	13.92	24.89
XX.	31.25	27.18	5.28	102.10	10.22	17.28	10.70	22.02	15.90	15.24	10.85	16.76
XXI.	31.00	45.54	7.37	130.27	12.47	39.57	16.59	40.82	16.29	12.06	10.67	21.60
XXII.	28.50	38.69	4.89	183.85	10.59	20.26	10.24	30.88	14.13	14.11	10.93	32.08
XXIII.	39.50	123.00	4.50	50.43	9.36	26.45	8.78	13.30	55.84	12.73	15.92	11.54

Table 4. Relative contribution of twelve characters towards genetic divergence in 66 cowpea germplasm

S. No	Characters	Number of times ranked first	Contribution
1.	Days to 50% flowering	170	7.92
2.	Plant height (cm)	45	2.09
3.	Number of branches	0	0.00
4.	Number of leaves	138	6.43
5.	Petiole length (cm)	15	0.69
6.	Peduncle length (cm)	63	2.93
7.	Number of clusters	31	1.44
8.	Number of pods	164	7.64
9.	Pod length (cm)	108	5.03
10.	No of seeds / pod	98	4.56
11.	100 seed weight (g)	412	19.20
12.	Grain yield (g)	901	42.00
	Total	**2145**	**100**