Genetic Diversity in Cowpea

WD Lesly, MS Uma[1] and PM Salimath
Department of Genetics and Plant Breeding, University of Agricultural Sciences, Dharwad-580 005 (Karnataka)
[1] *Associate Professor, Super Elite Sunflower Seed Production Scheme, ZARS, UAS, GKVK, Bangalore-560 065*

In order to assess the divergence among 169 cowpea genotypes, mahalanobis D^2 statistics was applied. The analysis of variance revealed significant differences among the genotypes for all the traits. The 169 genotypes were grouped into 46 clusters, where clusters (6,8,9) were the largest, containing seven genotypes followed by the clusters 1,2,5,6 and 24 with six genotypes. The inter cluster distance was maximum between cluster 11 and 42 followed by cluster 34 and 42. Based on inter cluster distance and perse performance of genotypes, the entries viz., IC 259084, IC 259071, IC 257420, IC 257422, IC 202803, IC 97829, IC 198333, IC 97787, IC 202824 and IC 202781 were selected, which could be intercrossed to recover good recombinants and desirable segregants. The number of pods per plant contributed maximum divergence (14.75) which was followed by harvest index (14.74%) and days to flower termination (13.72 %).

Key words: Cowpea, Genetic divergence, D^2 statistics

Conventional procedure of indiscriminate hybridization on a massive scale in any crop results in an immense wastage of resources. Quatset (1979) opined that most often asked question among breeders is how to choose parents for crossing. Greater success can be achieved through judicious choice of parents for hybridization based on genetic divergence. Crosses between divergent parents usually produce greater heterosis than those between closely related ones (Moll and Stuber, 1971). Genetic divergence studies are the vital tools for the evaluation of germplasm lines and selection of parents for the breeding programme. So, the present study was undertaken to measure genetic diversity among the germplasm lines. Such information will be helpful for breeders to plan hybridization programme. Inclusive of diverse parents in hybridization programme can serve the purpose of combining desirable genes or to obtain superior recombination. Among several methods of multivariate analysis available to study genetic diversity in biological population, the D^2 analysis had been a perfect test in the quantitative estimation of genetic diversity.

Materials and Methods

The materials for the present investigation comprised 169 cowpea genotypes including 157 lines from the National Bureau of Plant Genetic Resources (NBPGR), New Delhi core collection from different parts of India, 7 from exotic collection, 3 released varieties and 2 local land races. Thus, the material represented a wide range of geographic diversity. The experiment was carried out in simple lattice square design with two replications during *kharif* 2004 and 2005, in the Botanical garden located at University of Agricultural Sciences, Dharwad, Karnataka, India. Each accession was grown in two lines of 4 m length. The spacing adopted between rows and between plants within a row was 60 cm and 20 cm, respectively. Observations on various morphological and yield components such as germination percentage, plant height (cm), number of branches, number of clusters per plant, number of pods per plant, pod length (cm), seeds per pod, days to flower initiation and termination, days to physiological maturity, seed weight of hundred seeds (g), harvest index and seed yield per plant (g) were recorded on five randomly selected plants of each entry in each replication. The mean data of two seasons were pooled and the test of homogeneity of error variance was found to be non-significant and hence the pooled data was further subjected to statistical analysis using Mahalonobis D^2 analysis (Mahalanobis, 1936). Grouping of genotypes into various clusters was carried out following Tocher's procedure (Rao, 1952) and the relative contribution of different characters to total D^2 distance was calculated as per Singh and Choudhary (1979).

Results and Discussions

Group constellation: Analysis to estimate D^2 values was done on the basis of relative magnitude of D^2 values, all the 169 genotypes were grouped into 46 clusters (Table 1).

The highest inter-cluster distance was observed between clusters 11 and cluster 42 (349.31) followed by clusters 34 and 42 (346.10), 26 and 41 ((343.99)

Table 1. Number of clusters and their varietal composition of cowpea

Cluster number	Number of genotypes	Name of genotypes
1	6	IC243489, IC249141, IC253268, IC219594, IC257445, IC257406
2	6	IC198321, IC198355, IC257422, IC201095, IC202720, IC202779
3	5	IC208618, IC215015, IC219872, IC202901, IC202846
4	5	IC202743, IC202782, IC202803, IC202705, IC198361
5	6	IC202824, IC202868, IC202791, IC204103, IC202778, IC202718
6	7	IC198333, IC199701, IC97856, IC202707, IC202762, IC97806, IC202786
7	5	IC198359, IC201099, IC198323, IC97767, IC97834
8	7	IC201079, IC202710, IC202775, IC198342, IC91556, IC202789, IC202823
9	7	IC202854, IC202924, IC214752, IC219141, IC243312, IC249133, IC202804
10	6	IC202730, IC202781, IC202799, IC202841, IC202893, IC207813
11	5	IC68786, BIALAHONGAL LOCAL , EC394805, IC259083, IC259105
12	5	IC198335, IC199704, IC202709, IC202772, IC97806
13	4	IC97764, IC198349, IC257420, IC97830,
14	5	IC259071, IC259085, IC257452, IC201098, IC202932
15	5	IC259058, IC259078, IC253277, IC257427, IC249593
16	4	IC202927, IC214833, IC202867, IC219592
17	5	IC249586, IC253276, IC257425, IC257453, IC259072
18	5	IC247430, IC253275, IC214836, IC219640, IC249585
19	3	IC97787, IC198327, IC97838
20	5	GOA LOCAL, EC394740, IC257447, IC5969, IC259100
21	5	IC202873, IC214835, IC202835, IC206240, IC202797
22	4	IC219574, IC243353, IC214759, IC249137
23	4	IC249140, IC253255, IC253288, IC243486
24	6	IC257449, IC259069, IC259084, IC202784, IC202931, EC3947
25	1	IC259063
26	5	EC394855, GC-3, C-152, IC68786, IC259104
27	5	IC249583, IC257407, IC243501, IC253270, IC219607
28	2	IC257411
29	4	IC202787, IC202809, IC202926, IC202860
30	4	IC247435, EC394823, IC259095, IC4506
31	1	IC97764
32	1	IC249132
33	1	IC201087
34	5	V-118, EC394753, IC259084, IC202702, IC259159
35	1	IC257424
36	1	IC259064
37	5	IC253181, IC253281, IC257435, IC259061, IC259081
38	1	IC257410
39	1	IC15567
40	1	IC97830
41	1	EC394745
42	1	IC257437
43	1	EC 394691
44	1	IC257441
45	1	IC97829
46	1	IC214834

and 25 and 42 (340.54). The lowest intra-cluster distance other than the solitary clusters was in the cluster of 19 (17.19). Twenty two clusters in between minimum and maximum values were observed showing different divergence groups. While, the highest intra-cluster distance was observed in cluster 37 (30.53) followed by cluster 10 (29.77) and 34 (28.99). The number and genotype composition of different clusters are presented in Table 2. The clusters 6, 8 and 9 were the biggest clusters with 7 genotypes in each cluster. Clusters 1, 2, 5, 10 and 24 are the second largest clusters with six genotypes in each. The clusters 3, 4, 7, 11, 12, 14, 15, 17, 18, 20, 21, 26, 27, 34 and 37 consist of five genotypes in each cluster and the clusters 13, 16, 22, 23, 29 and 30 consists of 4 genotypes in each. The solitary clusters were 25, 28, 31, 32, 33, 35, 36, 38, 39, 40, 41, 42, 43, 44, 45, and 46 they showed zero cluster distances.

Two multivariate analysis using D^2 statistic revealed that number of pods per plant and harvest index contributed maximum to the divergence followed by days to flower termination and number of branches per plant. Backiyarani *et al.* (2000) also reported largest contribution to total divergence by harvest index, followed by single plant yield and earliness in flowering. But in contrary to these results Ranganayaki and Rangaswamy (1991) reported that hundred seed weight as the major contributor to the genetic divergence, followed by pod length and seed yield.

Based on the mean values of different clusters (Table 3) the mean seed yield per plant had highest mean for cluster 40 (24.53) and lowest mean for cluster

Table 2. Average intra-cluster (bold) and inter-cluster D2 values of cowpea

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	**26.72**	183.79	242.47	225.72	71.11	211.92	195.45	147.50	220.89	188.57	254.89	153.79	122.89	222.60	238.49	178.03	272.73	196.86	217.75	251.73	184.19	192.93	204.85
2		**26.33**	137.51	130.71	128.99	164.51	91.82	146.51	168.85	93.68	249.79	178.16	95.43	163.64	187.63	166.22	162.60	114.09	140.69	197.27	49.89	209.52	200.71
3			**24.89**	48.99	205.57	154.54	114.41	203.22	155.09	146.43	277.78	173.21	188.88	236.81	167.26	215.00	62.34	179.79	85.46	174.29	156.77	174.69	238.84
4				**22.75**	185.69	122.02	98.43	181.76	121.89	133.87	262.46	146.69	167.67	228.52	136.53	194.56	104.22	168.66	43.32	145.13	151.05	148.10	220.61
5					**###**	172.70	144.43	119.76	183.72	137.16	239.65	135.24	59.41	182.75	205.52	151.32	240.49	148.63	177.27	219.72	133.83	178.37	185.36
6						**24.59**	132.38	127.98	50.84	159.08	180.86	96.97	159.72	241.23	87.85	126.19	204.62	188.87	98.17	121.12	180.27	114.61	141.26
7							**24.74**	165.09	128.73	59.13	257.96	161.19	119.83	165.69	142.62	182.02	150.73	100.18	101.77	149.05	121.43	190.26	210.87
8								**27.72**	139.75	181.77	150.13	112.21	122.01	249.74	165.11	51.78	241.59	205.34	170.15	187.71	141.52	166.08	89.71
9									**22.36**	157.04	187.89	117.34	170.33	240.82	45.97	137.36	204.29	187.01	97.19	77.94	184.26	135.98	150.88
10										**29.77**	269.75	180.88	110.84	113.59	168.93	197.93	174.61	51.73	137.08	175.05	124.06	207.37	224.87
11											**25.97**	184.08	240.69	319.48	203.04	106.11	307.11	288.19	253.31	231.31	246.49	223.41	65.92
12												**25.55**	146.56	254.56	146.47	121.09	218.39	207.98	128.93	173.99	188.15	81.80	139.72
13													**22.96**	163.83	193.36	149.30	225.75	124.16	160.22	206.73	100.78	186.22	186.94
14														**27.75**	248.81	262.07	253.03	71.80	231.17	253.89	184.93	273.90	282.79
15															**27.47**	161.64	212.89	196.63	114.17	45.21	201.92	159.64	171.56
16																**20.42**	251.99	220.63	183.37	187.77	161.79	173.87	48.93
17																	**23.79**	202.99	142.39	217.43	178.99	219.77	272.57
18																		**26.80**	171.08	201.51	141.90	231.05	245.73
19																			**###**	124.89	160.48	129.02	209.90
20																				**25.18**	210.56	184.19	200.07
21																					**27.39**	219.72	197.65
22																						**25.88**	188.12
23																							**22.87**
24																							
25																							
26																							
27																							
28																							
29																							
30																							
31																							
32																							
33																							
34																							
35																							
36																							
37																							
38																							
39																							
40																							
41																							
42																							
43																							
44																							
45																							
46																							

Table 2 Contd.

	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
1	228.34	229.84	260.40	203.79	128.46	163.77	292.60	231.64	255.01	92.68	66.37	205.67	39.09	225.82	144.33	134.11	186.17	250.39	314.62	227.71	228.14	143.47	46.72
2	149.12	234.88	271.17	99.92	139.89	183.74	183.63	175.34	140.85	117.37	238.13	135.11	213.32	241.21	170.08	163.77	38.82	183.18	206.26	174.52	212.48	118.24	160.87
3	239.04	267.35	215.09	193.86	204.85	164.95	100.61	251.50	38.61	197.48	282.36	208.78	265.37	193.89	180.91	177.17	115.16	264.76	128.69	250.90	250.42	185.94	224.33
4	234.35	251.39	194.31	188.86	183.02	137.49	143.29	243.94	78.67	176.37	268.06	197.44	250.07	170.32	155.41	151.36	109.17	259.10	171.84	239.03	232.51	163.44	206.24
5	194.86	217.14	250.47	162.15	100.49	146.19	263.15	193.91	218.76	38.17	129.35	161.01	102.56	214.93	122.98	112.14	131.93	220.78	287.73	188.32	205.10	102.04	52.88
6	252.62	170.12	182.02	212.69	143.74	94.65	239.13	254.03	179.78	167.34	252.91	210.86	235.54	144.76	104.50	99.46	151.13	272.96	268.03	244.76	154.07	131.80	193.31
7	219.38	243.91	252.44	170.16	162.69	163.52	178.39	184.20	127.97	137.37	244.35	132.54	223.18	222.16	155.00	147.74	65.96	248.35	204.17	177.63	222.79	143.14	169.09
8	185.93	126.21	245.17	157.08	43.43	130.72	267.33	259.09	217.86	114.88	188.52	224.29	167.61	203.43	96.04	92.45	149.30	203.64	292.01	252.43	114.41	49.66	141.45
9	255.83	177.64	198.64	215.87	155.30	117.15	239.61	253.79	182.34	178.18	260.61	209.63	243.43	163.36	122.47	119.42	155.34	276.29	266.79	244.31	162.62	143.82	202.45
10	219.85	255.68	265.96	173.29	178.47	182.56	197.73	132.61	156.15	133.26	239.24	81.01	217.61	237.58	175.51	165.85	79.13	252.43	221.04	127.16	235.97	161.69	160.75
11	275.94	34.55	287.99	255.96	187.07	201.98	328.72	323.86	290.33	237.62	280.24	300.42	267.42	247.12	178.38	181.46	249.02	288.19	349.31	322.08	53.17	186.48	251.02
12	254.55	166.60	269.24	218.12	120.85	45.85	248.69	266.67	195.06	135.94	185.53	227.13	171.86	122.79	37.92	37.43	165.61	274.31	276.73	259.46	159.41	118.77	145.75
13	171.47	221.83	255.79	134.39	106.85	155.97	249.86	175.96	201.86	39.81	183.10	139.03	156.01	222.18	134.88	125.46	101.26	199.65	275.27	169.60	201.19	92.09	103.14
14	257.30	306.98	320.97	222.97	246.27	255.01	267.99	34.05	241.61	185.03	268.57	39.06	249.09	198.25	251.11	239.73	166.99	292.69	285.28	41.14	291.36	235.54	198.10
15	269.57	194.11	213.53	231.24	180.14	144.71	247.83	261.43	194.97	200.42	275.34	218.30	259.19	182.09	152.07	149.12	174.79	289.59	272.76	252.17	181.71	170.35	221.25
16	202.25	85.49	251.38	175.49	86.81	141.77	277.38	269.83	229.50	145.48	216.08	237.84	196.96	208.36	107.44	107.73	167.76	218.58	301.39	264.58	68.75	83.38	171.29
17	255.03	297.57	252.91	212.61	243.43	211.16	46.73	266.32	95.40	234.23	308.83	230.09	293.38	235.34	224.89	221.27	142.60	281.33	71.27	270.82	283.49	226.17	256.45
18	230.03	274.49	284.86	187.80	201.31	208.65	223.17	89.78	187.47	147.35	246.84	39.05	225.63	259.03	203.44	192.48	110.17	264.92	243.95	83.57	255.93	187.14	169.27
19	240.91	241.72	179.24	196.81	171.29	118.39	181.74	246.89	116.82	167.94	260.35	198.38	242.31	153.30	139.03	134.75	121.63	263.88	210.54	238.05	222.35	152.99	197.83
20	275.13	222.31	231.38	237.99	198.90	170.78	252.06	266.63	202.15	213.51	287.33	223.39	271.18	204.12	178.86	175.42	185.23	294.82	275.07	257.24	209.23	188.73	234.44
21	108.80	231.13	280.15	60.59	133.40	194.52	197.93	195.69	159.32	116.73	238.86	162.37	212.81	250.53	179.74	174.11	70.29	142.24	218.39	196.02	209.61	112.65	169.59
22	278.75	209.85	92.23	245.57	171.46	49.04	252.20	285.10	200.17	177.31	220.47	248.13	209.47	49.74	113.41	104.63	198.69	297.23	280.30	279.16	204.37	169.08	185.61
23	234.63	43.10	261.88	210.41	125.74	159.71	296.39	289.28	252.18	183.21	235.66	260.78	220.04	218.70	129.51	130.99	200.54	249.34	319.14	285.26	44.01	127.25	199.87
24	**26.99**	261.90	328.04	56.42	176.39	259.42	269.04	263.78	240.83	175.58	276.53	242.39	250.78	303.42	248.19	243.43	173.29	46.18	283.14	266.52	244.25	164.72	227.29
25		**0.00**	278.35	241.22	161.87	185.36	319.41	312.04	280.13	216.88	254.33	287.39	242.54	236.21	159.18	161.19	234.56	274.86	340.54	309.71	48.37	165.52	227.31
26			**28.22**	300.23	248.74	133.80	283.66	330.54	239.84	248.26	282.19	298.69	274.18	55.44	202.08	192.42	262.47	343.99	309.12	326.53	274.66	246.24	254.89
27				**###**	148.10	223.65	228.99	231.89	196.07	143.07	255.58	204.23	229.29	273.09	210.98	206.16	122.27	87.41	246.34	233.61	221.27	131.54	196.49
28					**0.00**	136.08	268.82	256.49	219.16	96.29	171.86	220.71	149.29	209.45	104.39	98.29	145.02	194.26	293.62	248.87	151.56	38.89	123.92
29						**24.58**	242.97	267.19	188.94	146.03	194.80	227.72	181.87	89.70	73.20	62.19	171.73	279.27	271.39	260.07	178.42	134.19	155.13
30							**28.45**	280.31	69.69	258.13	326.21	248.71	311.74	267.02	253.65	250.25	165.29	295.17	36.63	288.27	307.02	252.64	277.51
31								**0.00**	255.80	196.73	276.55	57.05	257.48	308.44	263.63	252.11	182.27	300.49	296.73	37.55	297.06	246.47	207.94
32									**0.00**	211.29	294.05	216.11	277.36	219.29	200.31	196.86	118.83	267.33	97.61	257.45	263.69	200.28	237.31
33										**0.00**	152.70	161.48	125.05	213.63	124.29	114.07	121.77	201.00	283.02	190.48	199.32	87.81	80.58
34											**28.99**	254.35	33.49	249.25	177.91	169.67	238.56	295.59	346.10	273.34	260.74	192.76	92.53
35												**0.00**	233.77	274.32	223.32	212.09	138.68	277.56	268.20	50.15	270.02	208.33	179.35
36													**0.00**	240.28	162.92	154.00	215.17	270.56	332.42	254.11	244.63	168.63	69.09
37														**30.53**	155.47	147.09	231.31	320.39	293.86	303.88	232.79	207.33	219.97
38															**0.00**	24.64	157.34	268.12	281.21	255.47	150.35	102.47	135.65
39																**0.00**	152.12	264.58	277.97	243.75	152.25	97.79	124.32
40																	**0.00**	204.67	189.75	180.28	212.14	122.09	161.76
41																		**0.00**	309.33	302.35	258.32	184.49	252.45
42																			**0.00**	306.08	329.18	278.07	300.77
43																				**0.00**	293.21	238.83	203.25
44																					**0.00**	144.72	220.75
45																						**0.00**	133.07
46																							**0.00**

Table 3.Mean performances of different clusters of cowpea

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13
1	85.50	45.64	60.83	74.50	76.58	4.94	11.93	16.23	15.38	14.02	11.15	0.18	13.58
2	81.92	44.57	60.75	74.75	77.08	4.21	10.17	15.85	13.69	12.43	11.29	0.25	19.21
3	76.90	41.51	56.70	70.80	73.10	4.13	9.59	10.14	15.20	13.35	11.42	0.18	13.55
4	79.60	39.14	58.80	70.90	73.40	3.96	10.16	16.14	13.90	11.84	11.07	0.21	16.23
5	71.25	40.69	61.25	74.50	76.92	3.79	10.38	17.84	13.94	12.35	10.45	0.23	17.03
6	78.71	45.01	61.00	73.86	76.36	4.19	10.38	17.98	15.38	13.47	11.06	0.23	17.80
7	79.10	43.67	59.90	72.50	74.80	4.20	11.84	18.61	13.44	12.24	11.65	0.22	15.42
8	78.14	45.39	59.29	72.64	74.86	4.42	11.26	17.73	15.05	13.33	11.77	0.23	17.73
9	81.93	41.59	59.14	72.00	74.71	4.45	9.93	15.20	14.95	13.24	10.44	0.19	14.12
10	50.67	42.15	60.75	74.00	76.50	4.28	10.03	12.14	13.60	12.10	11.92	0.19	13.77
11	76.10	43.24	55.90	69.20	71.70	4.47	11.81	17.63	14.59	12.83	13.34	0.28	21.79
12	80.50	41.95	58.20	72.20	74.40	4.09	12.42	18.61	15.23	13.94	10.37	0.20	15.80
13	86.25	42.21	61.00	74.13	76.75	4.41	11.69	18.24	14.08	12.51	9.20	0.25	19.75
14	74.70	45.29	63.40	77.80	80.10	4.89	10.36	14.55	14.05	12.22	11.51	0.20	16.06
15	87.00	48.43	58.40	71.10	73.60	4.93	12.98	13.04	13.17	12.10	9.05	0.17	12.27
16	77.88	44.14	59.13	71.13	74.25	4.21	9.11	15.23	14.31	12.47	10.03	0.19	12.90
17	79.70	45.15	60.60	75.30	77.40	4.43	11.28	16.61	14.12	12.65	11.79	0.23	16.54
18	74.60	47.17	63.20	74.80	77.60	4.66	10.69	14.70	14.46	13.16	11.30	0.26	18.27
19	86.00	42.50	60.50	73.67	75.00	4.32	13.38	21.52	14.45	12.58	8.60	0.25	20.84
20	55.40	45.84	58.30	72.40	75.00	4.68	9.08	13.83	14.09	12.32	14.68	0.21	16.98
21	74.80	41.54	63.30	75.10	77.10	4.03	9.39	16.39	15.97	13.80	11.31	0.25	18.14
22	78.50	41.39	60.50	72.13	74.88	4.23	10.93	17.49	14.86	13.25	11.55	0.21	15.89
23	88.38	42.64	57.00	70.00	72.80	4.59	10.30	14.00	15.22	13.13	9.79	0.20	14.86
24	75.75	43.71	57.25	71.00	73.33	5.03	10.75	15.23	13.90	12.12	12.62	0.25	18.89
25	100.00	46.40	59.00	70.00	74.00	4.50	8.80	11.50	16.05	13.66	9.44	0.18	14.06
26	65.70	45.16	57.50	70.10	73.00	5.06	12.34	19.19	15.20	13.29	12.26	0.27	21.77
27	81.00	41.44	59.60	71.90	74.00	4.41	9.02	12.19	12.64	11.64	11.03	0.19	13.89
28	97.50	45.28	64.00	76.50	81.50	4.00	12.50	14.25	12.40	11.50	8.07	0.22	19.12
29	80.75	40.04	62.88	74.75	77.13	4.14	11.60	17.09	13.43	12.33	11.21	0.21	15.24
30	72.75	40.76	57.13	71.75	74.25	4.75	9.21	13.65	12.82	11.59	12.88	0.22	16.06
31	46.00	48.85	67.50	80.00	82.50	4.90	9.30	17.90	17.90	15.75	12.05	0.27	22.80
32	97.50	46.55	59.00	74.50	77.00	3.40	13.70	22.10	18.08	16.20	12.34	0.14	13.10
33	69.00	43.75	60.50	77.00	76.50	3.20	13.75	19.40	16.27	14.40	9.86	0.22	14.62
34	80.00	41.77	56.70	71.50	73.90	4.73	11.46	16.04	15.24	13.44	12.21	0.26	20.42
35	85.00	40.85	69.50	81.00	84.00	4.45	9.00	11.15	14.64	11.96	7.73	0.15	12.57
36	94.00	45.75	55.50	69.00	72.30	3.90	9.00	10.80	8.25	8.10	10.51	0.25	16.92
37	68.10	47.58	56.80	70.30	73.10	4.83	10.85	16.10	14.05	13.13	11.71	0.22	16.13
38	84.00	37.00	61.00	74.00	76.50	3.70	11.00	16.60	12.20	11.20	8.17	0.24	16.75
39	95.00	40.55	66.00	78.00	80.00	4.15	9.70	16.85	15.85	14.70	10.90	0.19	15.15
40	47.50	40.85	62.50	75.50	78.00	4.15	11.50	23.55	13.23	12.60	10.30	0.27	24.53
41	72.00	41.65	59.00	74.50	77.50	4.90	10.85	17.10	13.36	11.90	11.76	0.29	21.71
42	74.00	43.00	62.00	74.50	76.50	5.45	13.15	20.55	16.85	14.40	12.67	0.22	21.73
43	79.00	46.65	59.50	73.00	72.50	5.40	12.90	17.85	12.70	12.02	14.48	0.27	23.61
44	91.00	46.55	65.50	78.00	81.00	4.50	12.15	11.95	14.75	13.38	7.01	0.14	13.85
45	37.50	34.65	59.00	70.50	72.50	4.10	13.00	24.00	15.72	13.09	10.85	0.28	21.21
46	43.50	37.45	59.00	74.00	76.50	4.10	8.50	15.60	14.65	13.40	9.64	0.19	15.25

X1 = Germination percenmtage
X2 = Plant height
X3 = Days to flower initiation
X4 = Days to flower termination
X5 = Days to physiological maturity
X6 = Number of branches per plant
X7 = Number of clusters per plant
X8 = Number of pods per plant
X9 = Pod length
X10 = Number of seeds per pod
X11 = Hundred seed weight
X12 = Harvest index
X13 = Seed yield per plant

15 (12.27). The cluster 35 had highest mean values for days to flower initiation (69.50), days to flower termination (81.00) and days to physiological maturity (84.00) and also the cluster 36 showed the lowest means for the same traits and that indicates early maturing genotypes grouped in this cluster. Highest cluster mean was observed for pod length (18.08) and seeds per pod (16.02) in cluster 32, whereas cluster 36 showed lowest mean values for both the characters 8.25 and 8.10 respectively. Clusters 40, 41 and 42 had higher mean values for seed yield per plant, harvest index and number of clusters per plant respectively. Clusters 20, 25 and 31 had highest mean values for hundred seed weight, germination percentage and plant height respectively.

The highest inter cluster distance was observed between clusters 11 and 42 (349.31) followed by clusters 34 and 42(346.10). The lowest intra cluster distance other than the solitary clusters was in the cluster of 19 (17.19). Twenty two clusters in between minimum and maximum values were observed showing different divergence groups. The maximum intra cluster distance of 30.53 was observed for the cluster 37 involving the genotypes IC 253181, IC 253281, IC 257435, IC 259061 and IC 259081 followed by cluster 10 involving the genotypes IC 202730, IC 202781, IC 202799, IC 202841, IC 202893 and IC 207813. The cluster 37 included five genotypes, out of which two from IARI, New Delhi, two from NBPGR, New Delhi and one from NBPGR centre, Kerala respectively. Cluster 10 comprised of six genotypes, out of which 5 were landraces from Goa and Orissa and another one primitive cultivar from Andhra Pradesh.

The genotypes of early maturing, high yielding and disease resistance were IC 259084, IC 97834, IC 97838, IC 198333 and IC 97787 respectively which were belongs to clusters such as 24, 13, 19, 7 and 19 respectively. In future, these genotypes can be utilized for the hybridization programme to increase the grain yield per plant with desirable traits. In respect of mean values of different clusters, the highest mean seed yield of 24.53/plant was observed in cluster 40 involving only one genotype IC 97830 followed by cluster 43 involving EC 394745.

Practical utility: Based on the study of genetic divergence and disease resistance (Withanage Don Lesly *et al.*, 2005; Withanage Don Lesly and Uma, 2007) the following promising genotypes were identified, which can be used in breeding programme.

Genotypes	Desirable characteristics
IC 259084	Very Early, rust resistant
IC 259071	Very Early, rust resistant
IC 257420	High yielding
IC 257422	High yielding
IC 202803	High yielding
IC 97829	Mosaic virus resistant
IC 198333	Disease resistance-Powdery Mildew
IC 97787	Mosaic virus resistance-Powdery Mildew
IC 202824	Disease resistance-Powdery Mildew
IC 202781	Bold seeded, Bacterial leaf blight resistant

Acknowledgement

The authors are grateful to NBPGR for providing germplasm lines to carry out the present studies.

References

Backiyarani S, Nadarajan N, Rajendran C and Shaurthi S (2000) Genetic divergence for physiological traits in cowpea (*Vigna unguiculata* (L.) Walp) *Legume Research* **23(2)**: 114-117.

Mohalanobis PC (1936) On generalized distance in statistics. *Proceedings of National Institute Science Indian* **2**: 49-55

Moll and Stuber, CW (1971) Comparison of response to alternative selection prodcedures initiated with two population of maize (*Zea mays* L.) *Crop Sci.* **11**: 706-711.

Ovalset CO (1979) Mendelian genetics of quantitative characters with referance to adoptation and breeding in wheat. Proceedings of Fifth International wheat genetics symposium, Indian Society of Genetics and Plant Breeding, New Delhi **2**: 577-590.

Ranganayaki K and Rangasawmy SR (1991) Genetic divergence Vigna species. *Indian J. Pulses Res* **4**(2): 159-167.

Rao CR (1952) Advanced statistical methods in Biometrical Research Edn., 1., John Wiley and Sons, New York.

Singh RK and Choudhary, BD (1979) *Biometrical Methods in Quantitative Genetic Analysis*, Kalyani Publications, Ludhiana.

Withanage Don Leslly, Uma MS, and Salimath PM 2005. Evaluation of cowpea (*Vigna unguiculata*) genotypes against mosaic virus. Plant Pathology Newsletters 6, UAS, Dharwad

Withanage Don Lesly and Uma, MS 2007. Evaluation of Cowpea Germplasm for Resistance to Rust and Mosaic Virus Diseases. Environment and Ecology, Kalyani, West Bengal, India.