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Genetic Divergence Studies in Cowpea [*Vigna unguiculata* (L.) Walp.]

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ABSTRACT: The present experiment was carried out during February to May, 2021 in Research Field, Department of Horticulture, SHUATS, Prayagraj, Uttar Pradesh. To study the genetic divergence studies in cowpea [*Vigna unguiculata* (L.) Walp.]. The experiment was conducted in Randomized Block Design (RBD), consisting of thirty three genotypes, replicated thrice. The result from the present investigation revealed that genotype IC 201098 (9871.32 kg/h) and genotype IC 202743 (9837.61 kg/h) are desirable with maximum pod yield respectively. The analysis of variance indicated highly significant differences among genotypes for almost all the characters. Heritability was recorded for all characters which were highly heritable except plant height at maturity (88.97 cm) and TSS (°Brix) 92.68, in which heritability was recorded moderate. PCV is higher than GCV for all characters except number of seeds per plant (31.10) which was recorded same. Higher magnitude of GCV and PCV was recorded for number of seeds per plant (31.10). Genetic advance at 5% was recorded high for pod yield (3699.90 kg/h). In the present study high heritability (h^2) coupled with high genetic advance as % of mean at 5% was recorded for number of seeds per plant (99.99 & 64.08) and plant height at flowering (99.82 cm & 61.00 cm) respectively. Correlation coefficient analysis revealed that Plant height at flowering (0.27cm), Plant height at maturity (0.27 cm), Number of nodes on main stem (0.29), Days to 50% flowering (0.02), Days to 50% maturity (0.03), Number of pods per peduncle (0.02), Number of pods per plant (0.81), Pod length (0.06 cm), Number of seeds per plant (0.04), TSS (°Brix) 0.14, Protein (0.05%) showed significant positive correlation with Pod yield (kg/ha) at Genotypic level. Plant height at flowering (0.27 cm), Plant height at maturity (0.26 cm), Number of nodes on main stem (0.29), Days to 50% flowering (0.03), Days to 50% maturity (0.03), Number of pods per peduncle (0.01), Number of pods per plant (0.80), Pod length (0.06 cm), Number of seeds per plant (0.04), TSS (°Brix) 0.13, Protein (0.05%) showed significant positive correlation with Pod yield (kg/ha) at phenotypic level. The information regarding these traits could be considerable as reliable indices for selection and higher response. These traits could be expected from effective selection.

Keywords: Genetic variability, GCV, PCV, heritability (h^2), Correlation, Cowpea.

INTRODUCTION

Cowpea [*Vigna unguiculata* (L.) Walp.] is an annual, autogamous leguminous vegetable crop belongs to family leguminosae (2n=2x=22). Cowpea is a native to India (Vavilov, 1949) but tropical and central Africa is also considered as secondary centre of origin where wild races are found (Ng and Marechal, 1985). There are mainly two types of cowpeas growing in India for grain and vegetable purposes. Generally grain type cowpea varieties produce short pods with more number of seeds and mature early. Whereas, vegetable type varieties produce long pods with less number of seeds and mature late and the pods remain tender and soft for longer period. Its young leaves, pods and grains contain vitamins and minerals which have fuelled its usage for human consumption and animal feeding (Nielson *et al.*, 1997). Cowpea is also grown as a green manure crop for soil improvement. In the cultigens of cowpea, four cultigroups have been identified: (1) *unguiculata* (grain type), which is the major group; (2) *biflora or catjang,* produces small erect pods and mainly grown in South East Asia; (3) *sesquipedalis*, the yard long bean, with climbing growth habit grown in Asia; (4) *textilis*, which is grown in West Africa for textile purpose and fibres are obtained from its long peduncles (Valarmathi *et al.*, 2007). Among the different pulses grown in the world, cowpea is grown in 14.13 million hectare with production of 4.51 ('000 MT) and the productivity of 387.45 kg ha^{-1}. In India, the cowpea is grown in an area of about 3.91 million hectare with a production of 2.22 ('000 MT) having a productivity of 564.15 kg seed ha^{-1}. Genetic diversity is a valuable aid in crop improvement and the choice of parents is of very importance in any breeding program. Assessment of a large number of germplasm for genetic diversity is of utmost importance. The success of good breeding programme usually depends on the genetic variability present in the breeding material. Thus, knowledge of analysis of variance, genotypic and phenotypic variability, genotypic and phenotypic coefficient of variation, heritability and genetic advance, correlation coefficient, path analysis and genetic divergence in cowpea is essential for a breeder to choose good genotypes for the improvement in further developed new varieties. This

study was undertaken to estimate the nature and magnitude of variability for pod yield and pod yield related characters with the help of genetic parameters. To exploit the available variability present in the genetic material in the form of some specific group or classes, the divergence studies based upon some desirable parameter is very essential.Keeping in view the above mentioned facts, the present experiment was carried out with the following objectives, to screen out the most promising genotype of cowpea under Prayagraj Agro climatic condition, nature and extent of genetic variability and heritability, correlation for pod yield and its related traits and Genetic Divergence for growth, yield and quality of cowpea genotype.

MATERIALS AND METHODS

The experiment was conducted during Feb-May, 2021 at Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, (U.P.) Which is located at 25.57°N latitude, 80.54°E longitude and 98 m altitude above the mean sea level (MSL). The experimental land is situated in the river basin of the Ganga and Yamuna. Prayagraj (U.P.) region has a sub-tropical climate prevailing in the south-east part of Uttar Pradesh with extreme in temperatures, i.e, the winter and the summer. In winters, the temperature sometimes goes as low as 32° in December – January and very hot summer with temperature reaching unto 115° in the months May and June. During winter, frosts and during summer, hot scorching winds are also very common. The average rainfall is 1013.4 mm, with maximum concentration during July to September months with occasional showers in winters. The soil is sandy loam in texture, acidic in reaction (pH 6.20) medium in organic carbon (0.70%) and potassium (112.50 kg ha^{-1}), low in available phosphorus (18.0 kg ha^{-1}). The electrical conductivity of the soil was 0.15 ds m^{-1}. The experiment was conducted in Randomized Block Design (RBD), with thirty three genotypes, replicated thrice.

RESULTS AND DISCUSSION

The analysis of variance revealed significant differences among the 33 genotypes for 17characters under study. Thus, indicating the ample scope for selection of promising genotypes from the present gene pool.

Mean performance of cowpea for different genotypes. The maximum plant height at flowering was observed in genotype KashiGauri (165.48 cm) (Table 1(a)). The maximum plant height at maturity was also observed in genotype KashiGauri (181.58 cm) (Table 1(a)). The maximum number of nodes on main stem was observed in genotype EC 572715 (19.92) (Table 1(a)).

Table 1 (a): Mean performance of cowpea for different genotypes.

Sr. No.	Genotypes	Plant height at flowering (cm)	Plant height at maturity (cm)	Number of nodes on main stem	Days to first pod formation	Days to first flowering	Days to 50 % flowering	Days to 50 % maturity	No. of ped uncle per plant	No. of pods per peduncle
1.	KashiShyamal	122.91	139.54	16.01	38.84	33.92	41.12	58.89	15.58	2.86
2.	IC 52094	109.69	127.86	13.38	40.59	36.53	46.43	64.75	18.92	2.66
3.	IC 202835	84.79	101.26	18.29	36.02	31.15	51.41	67.30	22.03	2.86
4.	IC 214751	63.74	80.60	10.98	41.46	38.68	41.33	59.09	14.79	3.46
5.	EC 390213	131.17	149.62	13.88	36.37	32.75	40.56	58.69	25.66	3.86
6.	IC 209711	88.12	105.21	19.81	35.76	33.85	46.96	62.55	27.93	2.66
7.	IC 399251	79.32	96.27	15.34	37.82	35.40	52.20	68.89	13.16	4.86
8.	IC 249588	99.83	82.33	11.38	33.96	32.75	45.23	64.18	16.68	4.46
9.	KashiNidhi	142.06	159.39	18.93	42.11	36.73	48.44	63.27	23.88	4.80
10.	IC 202526	95.62	112.69	10.55	41.20	36.97	40.46	58.85	20.26	4.20
11.	IC 253281	133.21	150.42	14.96	40.07	38.61	44.87	61.90	16.00	3.80
12.	KashiKanchan	95.04	114.25	18.99	43.23	38.69	48.72	66.89	28.81	4.73
13.	IC 20514	151.82	170.08	13.29	41.16	37.45	44.24	65.75	14.94	2.80
14.	IC 201095	63.76	83.07	12.86	35.06	31.88	50.83	68.77	22.03	3.73
15.	IC 34009	122.17	140.02	19.81	42.14	37.18	45.57	65.16	19.12	3.46
16.	IC 202280	86.13	106.24	11.74	35.45	33.64	51.87	69.99	25.26	4.60
17.	EC 58905	68.63	89.19	17.37	40.62	39.09	44.38	60.79	29.52	3.33
18.	IC 201098	112.51	129.49	19.07	33.29	31.87	41.58	56.01	30.41	4.80
19.	EC 572715	155.39	172.43	19.92	36.44	32.58	51.80	69.95	14.34	4.66
20.	EC 97797	107.16	123.03	10.94	37.99	35.99	45.56	62.81	28.40	4.33
21.	KashiUnnati	94.31	112.13	16.42	32.80	29.57	40.28	56.46	21.07	4.53
22.	KashiGauri	165.48	181.58	18.32	36.67	34.43	44.92	64.77	31.18	2.66
23.	IC 202791	152.24	171.65	12.37	41.89	37.81	50.25	69.08	24.95	3.33
24.	IC 202743	67.28	87.95	19.15	43.35	39.55	49.47	67.26	17.67	4.06
25.	IC 202797	49.63	69.43	14.42	38.39	37.66	47.21	64.52	23.01	4.53
26.	IC 202800	85.87	102.91	11.98	36.58	34.34	46.22	64.19	25.32	4.33
27.	IC 214833	74.13	94.09	13.85	40.17	37.56	51.09	68.89	17.07	4.86
28.	IC 370499	97.47	113.61	19.64	35.99	32.44	49.67	67.44	20.20	3.40
29.	IC 202803	106.06	125.03	10.88	41.55	39.31	51.10	69.61	27.84	3.26
30.	IC 214757	55.29	72.53	15.24	34.52	31.49	45.78	63.40	30.49	2.86
31.	IC 202782	115.06	134.07	17.79	40.54	38.88	44.57	61.28	16.47	3.26
32.	IC 259083	133.45	153.27	19.13	42.75	42.57	52.27	70.52	25.06	4.4
33.	IC 202705	120.59	137.66	14.38	43.66	40.34	50.02	67.78	12.63	3.13
Mean		**103.94**	**120.88**	**15.49**	**38.74**	**35.81**	**46.86**	**64.54**	**21.84**	**3.81**
CV		1.26	8.91	4.12	1.03	1.32	1.57	1.17	2.74	4.24
SEm		0.75	6.22	0.37	0.23	0.27	0.42	0.44	0.35	0.09
CD at 5%		2.13	17.57	1.04	0.65	0.77	1.2	1.23	0.98	0.26

The maximum number of days to first pod formation was observed in variety IC 202705 (43.66) (Table 1(a)). The maximum number of days to first flowering was recorded in variety IC 259083 (42.57) (Table 1(a)). The maximum number of days to 50% flowering was recorded in variety IC 259083 (52.27) (Table 1(a)). The maximum number of days to 50 % maturity was recorded in variety IC 259083 (70.52) (Table 1(a)). The maximum number of peduncles per plant was recorded in variety KashiGauri (31.18) (Table 1(a)). The maximum number of pods per peduncle was recorded in variety IC 399251 (4.86) and IC 214833(4.86) (Table 1(a)). The maximum number of pods per plant was recorded in variety KashiKanchan (75.52) (Table 1(b)). The maximum pod length per plant was found in variety KashiShyamal (21.90 cm) (Table 1(b)). The maximum number of seeds per pod was recorded in genotype IC 202797 (16.48) (Table 1(b)). The maximum number of seeds per plant was observed in genotype EC 58905 (1002.28) (Table 1(b)). The maximum test weight was recorded in genotype IC 34009 (176.43) (Table 1(b)). Maximum TSS (°Brix) was observed in variety IC 202705 (14.66) (Table 1(b)). The maximum protein content was recorded in genotype KashiKanchan (26.61 %) (Table 1(b)).The maximum pod yield was recorded in variety IC 201098 (9871.32 kg/h) (Table 1(b)).These findings are in accordance with Badhe *et al.,* (2015); Aswathi *et al.,* (2015).

Table 1 (b): Mean performance of cowpea for different genotypes.

Sr. No.	Genotypes	No. of pods per plant	Pod length(cm)	No. of seeds per pod	No of seeds per plant	Test weight(g)	TSS (°Brix)	Protein (%)	Pod Yield (Kg/h)
1.	KashiShyamal	35.90	21.90	14.51	562.06	133.48	13.52	23.45	6125.80
2.	IC 52094	43.34	18.67	16.39	425.59	145.42	12.61	23.60	5557.98
3.	IC 202835	50.73	19.17	13.49	683.17	127.75	12.49	24.66	8837.58
4.	IC 214751	34.36	15.63	12.29	754.96	149.54	13.85	22.98	5078.64
5.	EC 390213	56.59	20.67	13.19	885.41	154.53	14.38	25.55	8562.61
6.	IC 209711	39.76	15.87	11.53	467.03	151.73	12.80	26.47	4815.41
7.	IC 399251	62.11	19.96	11.31	988.74	138.44	13.59	24.66	9772.06
8.	IC 249588	68.53	17.52	15.80	738.93	129.54	14.60	25.61	7111.84
9.	KashiNidhi	29.96	16.82	14.65	359.23	171.59	13.83	24.81	4819.85
10.	IC 202526	39.39	20.28	11.53	876.83	174.24	12.36	22.65	6258.25
11.	IC 253281	64.92	18.51	12.66	954.69	126.08	12.61	24.77	9705.09
12.	KashiKanchan	75.52	15.91	10.82	457.84	156.65	14.43	26.61	9198.26
13.	IC 20514	45.49	18.25	14.40	1000.02	136.40	13.65	23.00	8429.46
14.	IC 201095	71.28	21.50	13.82	523.90	157.28	12.32	26.57	8109.68
15.	IC 34009	34.80	16.66	11.70	599.29	176.43	12.95	23.38	5518.93
16.	IC 202280	39.27	19.39	12.43	778.06	141.95	12.60	25.57	4765.90
17.	EC 58905	37.89	21.00	11.32	1002.28	130.24	13.45	24.43	5489.39
18.	IC 201098	69.63	17.58	12.11	385.14	131.71	12.84	23.72	9871.32
19.	EC 572715	52.38	16.52	13.08	655.70	145.59	13.87	23.17	8628.29
20.	EC 97797	48.94	18.59	11.49	844.79	147.44	12.68	25.66	5970.79
21.	KashiUnnati	55.73	20.20	13.67	678.74	129.16	13.83	24.37	9533.78
22.	KashiGauri	65.71	19.42	11.32	936.89	131.50	12.70	26.52	9652.48
23.	IC 202791	73.59	16.62	12.65	740.53	133.86	13.60	23.66	9038.91
24.	IC 202743	63.07	16.49	11.64	411.64	141.46	14.44	25.33	9837.61
25.	IC 202797	32.48	15.95	16.47	666.44	139.71	13.60	23.59	6236.34
26.	IC 202800	38.68	17.65	15.67	623.87	135.69	12.5	24.65	6747.46
27.	IC 214833	33.21	19.65	11.50	550.54	154.58	13.57	25.62	5033.62
28.	IC 370499	64.78	21.83	15.36	984.73	137.39	14.24	23.51	7943.98
29.	IC 202803	35.69	18.72	16.27	924.32	155.59	14.43	26.42	6042.36
30.	IC 214757	60.20	20.12	12.64	372.34	135.35	12.54	25.39	7866.64
31.	IC 202782	65.96	17.74	11.50	351.83	127.19	12.62	24.41	9658.90
32.	IC 259083	40.66	21.55	15.83	841.77	137.00	13.65	22.91	7962.24
33.	IC 202705	53.84	18.18	12.32	571.70	151.49	14.66	25.61	9260.80
Mean		**51.05**	**18.62**	**13.20**	**684.82**	**143.52**	**13.39**	**24.65**	**7498.25**
CV		1.26	1.19	2.16	0.09	0.26	1.55	0.77	2.42
SEm		0.37	0.13	0.16	0.38	0.22	0.12	0.11	104.87
CD at 5%		1.05	0.36	0.46	1.06	0.62	0.34	0.31	296.28

Genetic variability (GV), Genotypic coefficient variation (GCV), Phenotypic coefficient variation (PCV), Heritability (h^2BS), Genetic advance and genetic advance as % of mean 5% for seventeen characters in cowpea.

Highest GCV and PCV were recorded for no. of seeds per plant (31.10 and 31.10) (Table 2) respectively. Heritability in broad sense was noticed high for all the characters and high was noticed for no. of seeds per plant (99.99) (Table 2). High genetic advance at 5 % were observed for the characters like pod yield per hectare (3699.90 kg) (Table 2). Similar findings high was also reported by Nwosu *et al.,* (2013).

High genetic advance as % of mean at 5% was high for no. of seeds per plant (64.08) (Table 2). High heritability (h^2) coupled with high genetic advance as% of mean 5% were observed for the characters like no. of seeds per plant (99.99 & 64.08) (Table 2). These findings are in accordance with Thorat and Gadewar (2013); Verma *et al.,* (2019); Reshma *et al.,* (2019).

Table 2: Genetic variability (GV), Genotypic coefficient variation (GCV), Phenotypic coefficient variation (PCV), Heritability (h^2BS), Genetic advance and genetic advance as % of mean 5% for seventeen characters in cowpea.

Character	Range		Mean	GV	PV	CV		h^2	GA 5 %	GA as % of mean at 5 %
	MIN	MAX		(σ^2g)	(σ^2p)	GCV	PCV	(bs)		
Plant Height At Flowering (cm)	49.64	165.48	103.94	949.07	950.87	29.63	29.66	99.82	63.40	61.00
Plant Height at Maturity (cm)	69.43	181.58	121.89	937.16	1053.25	25.32	26.84	88.97	59.48	49.21
Nodes on Main Stem	10.55	19.92	15.49	10.09	10.50	20.51	20.92	96.13	6.41	41.43
Days to First Pod Formation	32.80	43.66	38.74	10.28	10.44	8.27	8.34	98.47	6.55	16.92
Days to First Flowering	29.57	42.58	35.81	9.983	10.20	8.82	8.92	97.81	6.43	17.97
Days to 50 % Flowering	40.29	52.28	46.86	14.53	15.07	8.13	8.28	96.42	7.71	16.45
Days to 50 % Maturity	56.01	70.52	64.54	16.88	17.45	6.36	6.47	96.73	8.32	12.89
Peduncles/Plant	12.64	31.18	21.84	31.98	32.34	25.89	26.03	98.89	11.58	53.04
Pods/ Peduncle	2.67	4.87	3.81	0.57	0.59	19.82	20.27	95.63	1.52	39.94
Pods/Plant	29.96	75.53	51.05	201.26	201.67	27.79	27.82	99.79	29.19	57.19
Pod Length (cm)	15.63	21.90	18.62	3.58	3.63	10.16	10.23	98.64	3.87	20.79
Seeds/Pod	10.82	16.48	13.20	3.11	3.19	13.36	13.53	97.45	3.58	27.17
Seeds/ Plant	351.83	1002.28	684.82	45384.57	45384.99	31.10	31.10	99.99	438.85	64.08
Test Weight (g)	126.08	176.43	143.52	185.49	185.64	9.49	9.49	99.92	28.04	19.54
TSS (°Brix)	12.32	14.66	13.39	0.54	0.59	5.52	5.74	92.68	1.46	10.95
Protein (%)	22.66	26.61	24.65	1.46	1.50	4.91	4.97	97.60	2.46	9.99
Pod Yield (kg/ha)	4765.90	9871.32	7498.25	3258528.66	3291522.65	24.07	24.19	98.99	3699.90	49.34

Genotypic and Phenotypic correlation matrix for pod yield: At Genotypic level Plant height at flowering (0.27cm) (Table 3(b)), plant height at maturity (0.27) (Table 3(b)), number of nodes on main stem (0.29) (Table 3(b)), days to 50% flowering (0.02) (Table 3(b)), days to 50% maturity (0.03) (Table 3(b)), number of pods per peduncle (0.02) (Table 3(b)), number of pods per plant (0.81) (Table 3(b)), pod length (0.06), number of seeds per plant (0.04) (Table 3(b)), TSS (°Brix) 0.14 (Table 3(b)), protein (0.05%) (Table 3(b)) showed significant positive correlation with pod yield (kg/ha). Days to first pod formation (-0.11) (Table 3(b)), days to first flowering (-0.11) (Table 3(b)), no. of peduncles per plant (-0.11) (Table 3(b)), no. of seeds per pod (-0.19) (Table 3(b)), test weight (-0.47g) (Table 3(b)) showed significant negative correlation with pod yield (kg/ha) at genotypic level. At phenotypic level plant height at flowering (0.27 cm) (Table 3(a)), plant height at maturity (0.26) (Table 3(a)), number of nodes on main stem (0.29) (Table 3(a)), days to 50% flowering (0.03) (Table 3(a)), days to 50% maturity (0.03) (Table 3(a)), number of pods per peduncle (0.01) (Table 3(a)), number of pods per plant (0.80) (Table 3(b)), pod length (0.06) (Table 3(b)), number of seeds per plant (0.04) (Table 3(b)), TSS (°Brix) 0.13 (Table 3(b)), protein (0.05%) (Table 3(b)) showed significant positive correlation with pod yield (kg/ha). At phenotypic level Days to first pod formation (-0.11) (Table 3(a)), days to first flowering (-0.10) (Table 3(a)), number of peduncles per plant (-0.11) (Table 3(a)), number of seeds per pod (-0.19) (Table 3(b)), test weight (-0.47g) (Table 3(b)) showed significant negative correlation with pod yield (kg/ha). These findings are in accordance with Patel *et al*., (2016); Dinesh *et al.,* (2017); Kalambe *et al.,* (2019).

Table 3(a): Genotypic and Phenotypic correlation matrix for pod yield.

Sr. No.	Character	Plant height at flowering (cm)	Plant height at maturity (cm)	Number of nodes on main stem	Days to first pod formation	Days to first flowering	Days to 50 % flowering	Days to 50 % maturity	No of peduncle per plant	No of pods per peduncle
1.	**Plant height at flowering (cm)**	**1**	**0.999****	**0.200***	**0.195**	**0.1081**	**-0.0621**	**0.0481**	**-0.0685**	**-0.1525**
2.	**Plant height at maturity (cm)**	0.9433 ***	**1**	**0.244***	**0.268****	**0.1665**	**-0.0412**	**0.063**	**-0.034**	**-0.1732**
3.	**No. of nodes on main stem**	0.1962	0.2314 *	**1**	**0.0095**	**-0.056**	**0.1499**	**0.0271**	**0.1048**	**-0.0312**
4.	**Days to first pod formation**	0.1925	0.2436 *	0.0088	**1**	**0.917****	**0.1823**	**0.262****	**-0.254***	**-0.1049**
5.	**Days to first flowering**	0.1067	0.1473	-0.0555	0.9066 ***	**1**	**0.200***	**0.260****	**-0.1647**	**-0.0181**
6.	**Days to 50 % flowering**	-0.0603	-0.0164	0.1526	0.1756	0.1898	**1**	**0.950****	**-0.0593**	**0.168**
7.	**Days to 50 % maturity**	0.0462	0.0662	0.0272	0.2545 *	0.2553 *	0.9258 ***	**1**	**-0.1229**	**0.0618**
8.	**No. of peduncle per plant**	-0.0676	-0.0263	0.1046	-0.2516 *	-0.1622	-0.0538	-0.1184	**1**	**-0.025**
9.	**No. of pods per peduncle**	-0.146	-0.1626	-0.0264	-0.0994	-0.0175	0.1604	0.0571	-0.023	**1**
10.	**No. of pods per plant**	0.138	0.0869	0.1594	-0.2598 **	-0.2513 *	0.0531	0.0554	0.0562	0.0151
11.	**Pod length(cm)**	-0.0433	-0.025	-0.0861	-0.2618 **	-0.2422 *	-0.0457	-0.0237	0.0623	-0.1275
12.	**No. of seeds per pod**	0.045	-0.0081	-0.2059 *	-0.1089	-0.0738	0.105	0.1514	-0.0724	-0.0394
13.	**No. of seeds per plant**	0.1964	0.1736	-0.2970 **	0.0004	0.1048	-0.0202	0.1098	-0.0371	-0.0437
14.	**Test weight(g)**	-0.0081	0.0284	-0.0774	0.3848 ***	0.1997 *	0.0644	0.0953	-0.0059	0.1682
15.	**TSS (°Brix)**	0.1021	0.0551	0.0849	0.2940 **	0.2507 *	0.129	0.1648	-0.2480 *	0.1949
16.	**Protein (%)**	-0.1815	-0.1876	-0.0546	-0.1842	-0.1316	0.2565 *	0.2069 *	0.3890 ***	-0.0114
17.	**Pod Yield(kg/h)**	0.2720 **	0.2623 **	0.2909 **	-0.113	-0.106	0.031	0.034	-0.115	0.019

Genotypic Values: Bold; Phenotypic Values: Unbold

Table 3(b): Genotypic and Phenotypic correlation matrix for pod yield.

Sr. No.	Character	No. of pods per plant	Pod length(cm)	No. of seeds per pod	No. of seeds per plant	Test weight(g)	TSS (°Brix)	Protein (%)	Pod Yield (Kg/h)
1.	Plant height at flowering (cm)	0.1389	-0.0424	0.0444	0.1965	-0.0083	0.1075	-0.1845	0.273**
2.	Plant height at maturity (cm)	0.0921	-0.0221	-0.0061	0.1841	0.0299	0.0578	-0.213*	0.278**
3.	No. of nodes on main stem	0.163	-0.0862	-0.215*	-0.303**	-0.079	0.0883	-0.0602	0.299**
4.	Days to first pod formation	-0.262**	-0.265**	-0.1103	0.0004	0.389**	0.303**	-0.1889	-0.113
5.	Days to first flowering	-0.254*	-0.248*	-0.0713	0.1059	0.203*	0.264**	-0.1378	-0.11
6	Days to 50 % flowering	0.0527	-0.0431	0.1138	-0.0206	0.0659	0.14	0.265**	0.029
7.	Days to 50 % maturity	0.055	-0.0266	0.1549	0.1116	0.0969	0.1804	0.213*	0.03
8.	No. of peduncle per plant	0.0566	0.0614	-0.0744	-0.0373	-0.0067	-0.263**	0.393**	-0.117
9.	No. of pods per peduncle	0.0175	-0.127	-0.0466	-0.0446	0.1715	0.204*	-0.013	0.022
10.	No. of pods per plant	1	0.0245	-0.263**	-0.0585	-0.392**	0.076	0.291**	0.812**
11.	Pod length(cm)	0.0245	1	0.1412	0.385**	-0.1817	-0.15	-0.0218	0.063
12	No. of seeds per pod	-0.2597 **	0.1375	1	0.0702	-0.1328	0.1812	-0.244*	-0.196
13.	No. of seeds per plant	-0.0585	0.3821 ***	0.0694	1	-0.171	0.132	-0.1524	0.04
14.	Test weight(g)	-0.3914 ***	-0.1801	-0.1301	-0.171	1	0.082	0.0705	-0.476**
15.	TSS (°Brix)	0.0733	-0.1435	0.173	0.127	0.079	1	0.0547	0.141
16.	Protein (%)	0.2868 **	-0.0166	-0.2342 *	-0.1505	0.0701	0.0519	1	0.053
17.	Pod Yield (kg/h)	0.8064 ***	0.062	-0.196	0.04	-0.4736 ***	0.135	0.054	1

Genotypic Values: Bold; Phenotypic Values: Un bold

Intra and Inter cluster distances between 33 accessions of cowpea [*Vigna unguiculata* (L.) Walp.]: The maximum intra-cluster distance (D^2) was registered for cluster IV (9654.10) (Table 4). Maximum inter-cluster distance was observed between cluster III and II (359701.00) (Table 4). These findings are in accordance with Nguyen *et al*., (2017).

Table 4: Intra and Inter cluster distances between 33 accessions of cowpea [*Vigna unguiculata* (L.) Walp.].

	Cluster I	Cluster II	Cluster III	Cluster IV	Cluster V
Cluster I	3578.77	79329.93	107693.40	25762.67	22980.54
Cluster II		4267.44	359701.00	27549.12	166010.30
Cluster III			6870.09	215103.40	46151.04
Cluster IV				9654.10	76527.24
Cluster V					8937.20

Cluster mean: Considering the cluster means for various characters, cluster I and II were superior for most of the characters, whereas cluster V was generally poor. Cluster III and IV were found to be intermediate (Table 6 (a) & (b)). These findings are in accordance with Brahmaiah *et al*., (2014).

Table 5: Composition of different clusters of 33 accessions of cowpea [*Vigna unguiculata* (L.)Walp.].

Group K	N	Within SS	Cluster Members
1	6.00	4038.2610	**7, 11, 13, 17, 22, 28**
2	5.00	1667.2930	**5, 10, 20, 29, 32**
3	5.00	2052.0020	**1, 14, 15, 27, 33**
4	4.00	2100.3130	**4, 8, 16, 23**
5	5.00	2799.3940	**3, 19, 21, 25, 26**
6	8.00	5661.2420	**2, 6, 9, 12, 18, 24, 30, 31**

Table 6 (a): Cluster mean table.

Sr. No.	Cluster	Plant height at flowering	Plant height at maturity	Number of nodes on main stem	Days to first pod formation	Days to first flowering	Days to 50 % flowering	Days to 50 % maturity	No. of peduncle per plant	No. of pods per peduncle
1.	Cluster I	115.99	133.52	16.48	38.72	36.24	46.71	64.92	20.83	3.47
2.	Cluster II	114.69	132.73	13.08	39.97	37.52	45.99	64.09	25.44	4.01
3.	Cluster III	100.71	118.88	15.38	39.97	36.17	47.73	65.90	17.29	3.61
4.	Cluster IV	100.49	110.20	11.62	38.19	35.72	47.17	65.58	20.42	3.96
5.	Cluster V	94.00	111.63	16.15	36.04	33.06	47.38	64.48	21.15	4.18
6.	Cluster VI	98.13	116.34	17.79	39.17	35.95	46.49	63.17	24.32	3.73

Table 6 (b): Cluster mean table.

Sr. No.	Cluster	No of pods per plant	Pod length(cm)	No. of seeds per pod	No. of seeds per plant	Test weight(g)	TSS (°Brix)	Protein (%)	Pod Yield (Kg/h)
1.	Cluster I	56.81	19.83	12.73	977.89	133.34	13.37	24.48	8498.74
2.	Cluster II	44.25	19.96	13.66	874.62	153.76	13.50	24.64	6959.25
3.	Cluster III	45.81	19.57	12.77	561.50	154.65	13.40	24.93	6809.76
4.	Cluster IV	53.94	17.29	13.29	753.12	138.72	13.66	24.45	6498.82
5.	Cluster V	46.00	17.90	14.48	661.58	135.58	13.23	24.09	7996.69
6.	Cluster VI	55.93	17.40	12.66	403.83	145.13	13.26	25.04	7703.24

CONCLUSION

The results from the present investigation revealed that maximum pod yield was recorded in IC 201098. Number of seeds per plant and plant height at maturity was recorded high estimates of GCV and PCV. Plant height at flowering (cm), Plant height at maturity (cm), Number of nodes on main stem, Days to 50% flowering, days to 50% maturity, no. of pods per peduncle, no. of pods per plant, no. of seeds per plant, TSS (°Brix) & Protein (%) shows significant positive correlation with pod yield at phenotypic and genotypic level. At genotypic and phenotypic level, plant height at flowering (cm), Days to first pod formation, Days to 50% flowering, Pod length (cm) & TSS (^{0}Brix) had direct positive effect on Pod yield per plant.

FUTURE SCOPE

The present investigation reveals that these genotypes of cowpea might be considered as good sorting for the diverse parents for hybridization programmes intended at isolating desirable combinations for pod yield as well as other desirable characters. The results from the investigation could also be considered as the basic for further cowpea improvement programmes.

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Conflict of Interest. As a Corresponding Author, I Ijas Ahmed KT, confirm that none of the others have any conflict of interest associated with this publication.

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