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Estimates of genetic variability, heritability and genetic advance for yield and yield component traits in vegetable cowpea [*Vigna unguiculata* ssp. *sesquipedalis* (L.) Verdc.] Genotypes

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Abstract
Fifty diverse genotypes of vegetable cowpea were evaluated to estimate variability, heritability and genetic advance over mean for pod yield and component characters. Analysis of variance revealed significant differences for almost all the characters studied. High genotypic coefficient of variation was observed for pods per cluster, yield per plant, pod weight, pods per plant and clusters per plant, which indicate that there exists high genetic variability and better scope for improvement of these characters through selection. The characters clusters per plant, pods per cluster, pods per plant, primary branches per plant, pod yield per plant, pod weight, pod length, seeds per pod and main stem length had high heritability coupled with high genetic advance suggesting improvement of those characters though selection due to additive gene action. In the present study high heritability and low genetic advance was noted for days to 50% flowering and pod breadth indicating dominant gene action.

Keywords: Vegetable cowpea, heritability, genetic variability, genetic advance

Introduction
Vegetable cowpea [*Vigna unguiculata* ssp. *sesquipedalis* (L.) Verdc.] is a distinct form of cowpea grown as a vegetable crop in southern Asia and Far East for its immature pods. Being a legume crop, cow pea fits well in inter-cropping system. In Kerala, it is grown as a floor crop in coconut gardens, as an inter-crop in tapioca, fringe crop in rice fields and in garden lands. The crop is an integral part of sustainable agriculture. 100 g of green tender pods contain 4.3 g protein, 2.0 fibre, 8.0 g carbohydrates, 74 mg phosphorus, 2.5 mg iron, 13.0 mg vitamin-C,0.9 mg minerals, etc. (Africa is considered as primary centre of origin of cowpea). The effectiveness of selection in any crop improvement programme is primarily dependent on variation present in the population. Heritability and genetic advance are important selection parameters. The study of variability, heritability and genetic advance of different traits in the genetic stock will facilitate evaluation and identification of suitable genotypes. The estimates of heritability help in the selection of elite genotypes from diverse genetic population. Genetic advance measures the amount of progress that could be expected with selection in a character. High heritability coupled with high genetic advance indicates that the improvement could be made for a character by simple selection. Hence the present study focuses on assessment of available genetic variability, heritability and genetic advance for yield and yield related characters in fifty vegetable cowpea genotypes.

Materials and methods
The basic material for the study included fifty collections of vegetable cowpea from different ago climatic regions of South India including the released varieties of Kerala Agricultural University. The seeds of the fifty genotypes were laid out in randomised block design in rows at spacing of 1 x 0.3 m. In each replication ten plants per genotype were taken. Normal cultural methods as per the Package of Practices Recommendations of the Kerala Agricultural University were adopted.
Five plants per genotype were selected for recording the following biometric observations: days to 50% flowering, days to first harvest, clusters per plant, pods per cluster, pods per plant, primary branches per plant, pod yield per plant (g), pod weight (g), pod length (cm), pod breadth (cm), seeds per pod, length of harvest period, crop duration and main stem length (m). Data from mean of individual genotypes were subjected to method of analysis of variance and statistical analysis was performed to estimate genetic variability, phenotypic and genotypic

coefficient of variation, heritability and genetic advance.

Results and discussion

The mean performances of the fifty genotypes for all the characters are presented in table1. The analysis of variance with respect to the various characters revealed a wide range of variation for all the characters which suggests ample scope of improvement (Abe *et al*., 2015 [1] and Omoigui *et al.,* 2006 [2]). The range of variation was highest for pod yield per plant (21.03 – 406.06 g) followed by pod weight (3.27 – 26.49 g) and clusters per plant (3.12 – 22.32). Relatively low range of variability was recorded in respect to crop duration (72- 86) and days to first harvest (51.5 – 63.5).

The basic information which a breeder usually requires as a pre requisite to any breeding program of a particular crop species is the extend of variability present in the available germplasm. Since the observed variability is the sum of variation arising due to genotypic and environmental effects, knowledge on the nature and magnitude of genetic variation contributing to gain under selection is essential. In the present study high PCV and GCV was observed for pods per cluster, yield per plant, pod weight and pods per plant which indicates that there exists high genetic variability and better scope for improvement of these characters through selection (table 2). Similar results were noticed by Ajayi *et al*. (2014) [3] and Khanpara *et al*. (2016) [4]. Comparatively low GCV was observed for days to first harvest and crop duration indicating presence of low variability and thus limiting the scope for further improvement through selection. A critical perusal of the data showed that pod length and seeds per pod had very less difference in PCV and GCV (33.07 and 32.77; 11.42 and 10.74 respectively) indicating that variation in these traits are mainly due to genotype. Manggoel *et al.* (2012) [5] and Sarath and Reshma (2017) [6] also reported very less difference between PCV and GCV for seeds per pod in cowpea.

Information on heritability and estimates of genetic advance that could be obtained in the next cycle of selection are of vital importance to the breeder in deciding appropriate method of breeding. The estimates of heritability and genetic advance as percentage of mean of the various characters are expressed in the table 2 and fig1. High heritability estimates were recorded for all the characters except days to first harvest, length of harvest period and crop duration, which had moderate heritability. High genetic advance was noted for clusters per plant, pods per cluster, pods per plant, primary branches per plant, pod yield per plant, pod weight, pod length, seeds per pod and main stem length. However days to first harvest, pod breadth, length of harvest period and crop duration recorded low genetic advance.

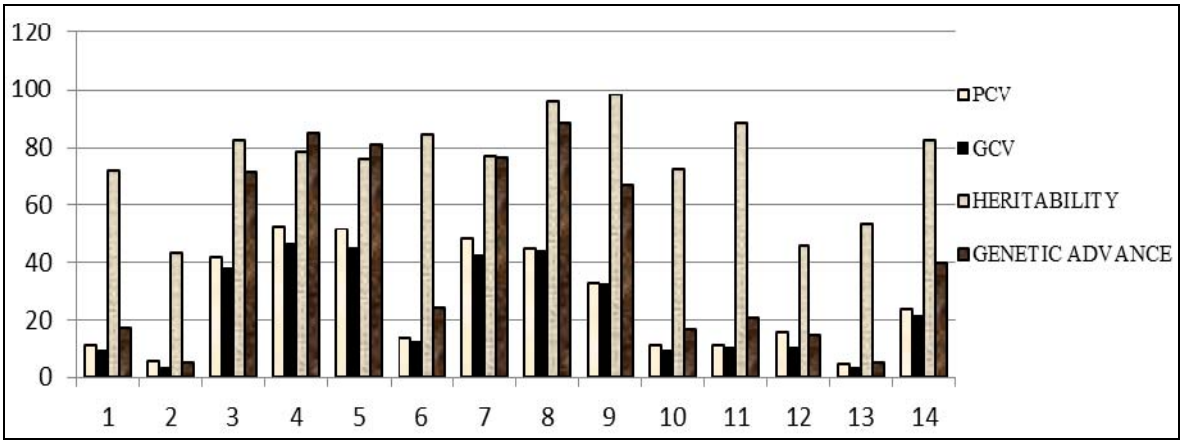

Fig 1: Variability parameters for different characters in vegetable cowpea germplasm

1)Days to 50% flowering 2) Days to first harvest 3) Clusters per plant 4) Pods per cluster 5) Pods per plant 6) Primary branches per plant 7) Pod yield per plant (g) 8) Pod weight (g) 9) Pod length (cm) 10) Pod breadth (cm) 11) Seeds per pod 12) Length of harvest period 13) Crop duration 14) Main stem length (m)

High heritability and high genetic advance of characters is indicative of additive gene action suggesting the possibility of genetic improvement of those characters through section. The characters clusters per plant, pods per cluster, pods per plant, primary branches per plant, pod yield per plant, pod weight, pod length, seeds per pod and main stem length had high heritability coupled with high genetic advance. The results are in conformity with Ramesh and Sangwan (2000) [7], Vidya *et al*. (2002) [8], Shahid *et al*. (2005) [9], and Mahesh *et al*. (2017) [10] indicating that these characters are under additive gene effects and are more reliable for effective selection. High heritability and low genetic advance of characters indicate dominant gene action suggesting the possibility of genetic improvement through hybridisation. In the present study high heritability and low genetic advance was noted for days to 50 % flowering (Nwosu *et al.*, 2013 [11] and Lesley, 2005 [12]) and pod breadth (Soniya *et al.*, 2008) [13].

Table 1: Varietal differences with respect to yield and related characters in fifty genotypes of vegetable cowpea

Genotypes	Days to 50% flowering	Days to first harvest	Clusters per plant	Pods per cluster	Pods per plant	Primary branches per plant	Pod yield per plant (g)	Pod weight (g)	Pod length (cm)	Pod breadth (cm)	Seeds per pod	Length of harvest period	Crop duration	Main stem length (m)
VS1	43.00	57.00	12.67	1.04	13.25	3.30	122.72	9.33	29.20	2.17	14.99	23.00	80.00	3.39
VS2	56.50	61.00	9.17	1.24	11.15	3.71	242.47	21.78	53.98	2.56	18.43	24.00	85.00	6.00
VS3	58.00	61.50	8.40	1.09	9.06	3.63	118.24	13.18	49.90	2.48	20.05	22.00	83.50	4.99
VS4	45.00	57.00	17.02	1.17	19.59	4.72	66.01	3.42	15.75	1.78	16.83	24.00	81.00	2.96
VS5	50.00	55.50	5.95	1.18	7.00	3.42	134.34	4.91	38.00	1.97	18.78	23.00	78.50	4.83
VS6	51.00	56.50	7.16	1.59	11.33	3.24	169.73	14.95	43.88	2.49	18.00	24.50	81.00	4.79
VS7	41.00	53.00	6.16	1.01	6.43	5.03	21.03	3.27	13.42	2.13	13.53	20.50	73.50	2.85
VS8	46.00	54.50	16.85	1.05	17.48	4.72	118.89	6.82	26.11	1.99	18.83	29.00	83.50	2.76
VS9	48.50	58.00	19.46	1.18	23.07	4.84	271.52	11.65	39.15	2.26	19.50	27.50	85.50	6.03
VS10	48.00	55.00	17.64	1.15	20.79	4.80	226.82	10.66	31.10	2.50	19.00	21.50	76.50	3.49
VS11	44.00	53.00	11.19	0.98	11.34	4.86	141.17	12.76	17.79	2.05	17.49	20.50	73.50	5.30
VS12	53.00	57.50	15.15	1.12	16.86	4.76	139.20	8.25	26.00	2.40	18.25	24.00	81.50	4.88
VS13	44.00	54.00	8.90	2.58	22.93	4.55	175.97	7.66	20.44	2.47	20.22	19.00	73.00	5.58
VS14	55.50	58.50	22.32	0.58	12.41	3.73	102.96	8.27	40.29	2.20	18.00	22.50	81.00	4.46
VS15	46.00	57.00	9.21	2.73	24.65	3.65	178.34	11.31	23.08	2.28	13.33	28.00	85.00	6.60
VS16	50.50	57.50	11.08	1.04	10.93	3.49	92.57	8.48	29.89	2.16	15.50	27.50	85.00	3.07
VS17	45.00	56.00	7.38	1.75	12.63	3.86	106.23	8.42	29.95	2.05	18.00	29.50	85.50	3.05
VS18	48.00	53.00	10.70	1.16	11.98	3.35	152.34	12.65	42.24	1.99	13.50	28.00	81.00	6.13
VS19	44.00	54.00	3.55	4.78	16.90	3.60	216.69	12.86	44.30	2.32	14.34	32.00	86.00	2.12
VS20	50.50	57.50	3.12	1.02	3.21	3.34	75.02	23.26	53.19	2.59	13.50	24.50	82.00	3.54
VS21	55.00	61.00	7.32	0.42	3.09	3.63	80.40	26.49	67.62	2.73	18.00	24.00	85.00	4.89
VS22	53.50	61.50	11.78	0.81	9.88	4.16	63.92	6.57	28.43	1.95	17.28	23.50	85.00	4.43
VS23	48.50	53.00	8.86	1.44	12.36	4.00	220.59	17.79	46.43	2.50	15.94	22.50	75.50	5.22
VS24	57.00	56.50	17.87	0.54	9.50	4.30	178.34	18.72	49.65	2.44	18.00	24.00	80.50	4.62
VS25	47.00	57.50	11.71	1.66	19.34	4.45	306.71	15.86	51.33	2.61	19.50	24.50	84.00	3.78
VS26	57.00	60.50	18.44	0.68	12.58	3.60	168.92	13.42	42.32	2.47	19.00	25.00	85.50	4.99
VS27	52.50	63.50	17.26	1.24	21.53	3.50	223.06	10.65	42.33	2.75	20.50	20.50	84.00	2.92
VS28	42.00	53.50	16.81	1.63	26.88	3.37	263.13	9.84	34.79	2.40	19.00	26.50	80.00	5.95
VS29	41.00	56.00	20.26	1.13	23.32	3.64	119.73	5.20	23.70	1.90	17.84	25.00	81.00	6.29
VS30	39.50	53.50	17.85	2.55	45.41	3.27	209.07	4.58	18.52	2.28	18.33	27.50	81.00	4.35
VS31	42.00	53.00	17.28	1.76	30.03	3.61	219.98	7.36	24.00	2.28	15.50	32.00	85.00	3.89
VS32	45.50	54.00	15.66	1.92	30.43	3.65	330.91	11.03	28.90	2.35	19.00	28.50	82.50	5.05
VS33	41.00	53.00	16.77	1.36	22.86	3.62	186.17	8.14	23.72	2.45	18.50	30.00	83.00	5.25
VS34	44.00	59.00	10.26	2.17	22.43	3.84	173.06	7.87	25.40	2.23	16.49	24.50	83.50	4.79
VS35	41.00	51.50	13.75	1.19	15.50	3.98	175.46	11.33	35.32	2.23	15.00	31.50	85.00	5.18
VS36	39.00	52.00	14.14	1.70	23.72	3.75	178.22	7.42	19.24	2.39	17.50	25.50	77.50	4.41
VS37	44.00	59.00	7.47	1.81	13.36	4.95	198.15	14.94	44.25	2.41	17.95	24.00	83.00	4.19
VS38	43.00	55.00	9.21	2.45	22.64	3.60	318.04	14.08	46.09	2.20	17.50	26.00	81.00	5.05
VS39	47.50	59.50	16.35	0.57	9.10	3.43	94.73	10.45	34.30	2.41	15.00	24.50	84.00	5.86
VS40	49.50	61.00	8.26	1.55	12.45	3.84	149.27	11.95	31.35	2.23	20.50	21.50	82.50	4.28
VS41	49.00	57.50	8.41	2.67	22.14	3.55	406.06	18.48	51.08	2.69	19.27	23.00	80.50	5.30
VS42	47.50	55.00	9.27	1.12	10.14	3.43	197.35	19.23	48.43	3.00	17.49	27.00	82.00	3.74

VS43	45.00	57.50	7.23	1.96	14.07	4.84	305.53	21.78	52.10	2.30	21.50	25.00	82.50	4.13
VS44	47.50	57.00	8.89	1.17	10.32	3.66	202.04	19.69	47.30	2.32	18.33	25.00	82.00	4.99
VS45	43.00	55.00	8.66	1.34	11.56	4.03	108.10	9.35	31.70	2.09	20.00	17.50	72.50	5.27
VS46	41.00	54.00	11.00	1.26	13.75	3.76	230.98	16.84	46.60	2.34	15.02	18.00	72.00	5.26
VS47	42.50	53.00	8.26	1.93	15.81	3.32	252.81	15.87	43.86	2.57	20.98	30.00	83.00	5.79
VS48	52.00	57.00	8.77	1.33	11.58	3.93	168.58	14.57	39.74	2.15	18.31	24.00	81.00	4.34
VS49	53.00	56.00	8.00	1.76	13.88	4.02	182.91	13.13	36.60	2.24	18.33	25.50	81.50	4.82
VS50	51.50	56.50	7.44	1.32	9.84	3.81	110.45	11.11	39.21	2.08	18.20	25.50	82.00	4.99
Mean	47.38	56.38	11.73	2.82	16.05	3.902	175.90	12.15	36.44	2.32	17.73	24.92	81.38	4.62
SE	2.07	1.79	1.45	0.25	2.84	0.15	28.75	0.78	1.14	0.10	0.49	2.05	2.00	0.32
CD	5.89	5.10	4.13	0.72	8.08	0.43	81.73	2.21	3.24	0.27	1.38	5.83	5.70	0.92

Table 2: Estimates of genetic parameters with respect to yield and related characters in vegetable cowpea

Sl. No.	Characters	Co-efficient of variation (%)		Heritability (H^2) %	Genetic advance as % of mean
		PCV	GCV		
1.	Days to 50% flowering	11.63	9.85	71.73	17.17
2.	Days to first harvest	5.98	3.94	43.38	5.35
3.	Clusters per plant	41.91	38.06	82.49	71.23
4.	Pods per cluster	52.39	46.45	78.60	84.83
5.	Pods per plant	51.46	44.95	76.31	80.88
6.	Primary branches per plant	13.98	12.86	84.66	24.39
7.	Pod yield per plant (g)	48.19	42.29	77.00	76.44
8.	Pod weight (g)	44.76	43.83	95.86	88.43
9.	Pod length (cm)	33.07	32.77	98.21	66.76
10.	Pod breadth (cm)	11.22	9.55	72.41	16.73
11.	Seeds per pod	11.42	10.74	88.42	20.70
12.	Length of harvest period	15.80	10.69	45.80	14.91
13.	Crop duration	5.11	3.74	53.55	5.63
14.	Main stem length (m)	23.53	21.35	82.30	39.89

Conclusion

The present study clearly indicate that greater variability exists in all the characters among the selected genotypes. The GCV estimates were high for pods per cluster, yield per plant, pod weight and pods per plant indicating higher magnitude of variability for these characters. The investigation suggests preponderance of additive gene effects for pod number per plant, pod weight, pod length and yield per plant, while days to 50 per cent flowering had non-additive gene action.

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