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Research Article

Genetic variability studies for seed yield and yield component traits in cowpea [*Vigna unguiculata* (L.) Walp.]

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Abstract
Thirty-two cowpea genotypes were evaluated in randomized block design to assess the nature and magnitude of variability, heritability and genetic advance for ten quantitative traits. Analysis of variance unveiled that differences among the genotypes were significant for all the characters considered indicating the presence of a substantial amount of genetic variation among the germplasm studied. High estimates of GCV and PCV were recorded for clusters per plant, seed yield per plant, pods per plant, plant height and seeds per pod, while high estimates of heritability were recorded for all the characters under study. High heritability coupled with high genetic advance as per cent of mean was observed for plant height, seed yield per plant, clusters per plant, pods per plant, test weight, seeds per pod, pod length and branches per plant suggesting predominance of additive gene effects and these characters could be improved through selection.

Keywords: Cowpea, GCV, PCV, Heritability, Genetic Advance

INTRODUCTION

Cowpea [*Vigna unguiculata* (L.) Walp.] is a diploid with chromosome number (2n=22) that belongs to the order Rosales, family Fabaceae, genus *Vigna* and is native to Central Africa (Darlington and Wylie, 1955). Cowpea is valued as one of the most important pulse crops in the world mainly in tropical and subtropical countries such as Africa, Asia, Central and South America (Anonymous, 2017). Because of its high protein content cowpea is referred to as “vegetable meat” and contains high grain and biological value on a dry weight basis. Cowpea is economically grown throughout India and is used for a variety of purposes such as seeds as pulses, long green pods, foliage as fodder for the cattle, green manure and cover crop. Cowpea grains have a nutritional profile of 23.4 per cent protein, 60.3 per cent carbohydrates and 1.8 per cent fat, as well as a good source of vitamins and phosphorus (Venkatesan *et al*., 2003). Cowpea is well-known in India and Southeast Asia for its immature tender pods and dry seeds, which serve as a cost-effective source of protein (20-25%) (Anonymous, 2017). Cowpea is also prized for its low fat content and high fibre content.

The development of high yielding cowpea varieties requires a thorough understanding of existing genetic variability. Furthermore, since the phenotypic expression of a character is the consequence of genotype-environment interaction, total variation needs to be partitioned into variance due to genotype (heritable) and variance due to environment (non-heritable) for assessing the true breeding behaviour of the phenotype. The efficiency of selection in plant breeding therefore largely depends upon the amount of heritable variation present in the material. Further, the effective use of

genetic variation for crop improvement programmes is possible only if it is considered in relation to heritability. High heritability coupled with high genetic advance has been reported to be more useful in predicting the resultant effect of selection for yield and its components. It also helps in determining the environmental influence on the expression of characters. In this context, the present investigation was undertaken to study genetic parameters in cowpea.

MATERIALS AND METHODS

The experiment was conducted at Regional Agricultural Research Station, Warangal, during *rabi*, 2020-21 with 32 cowpea genotypes sown in a randomized block design with three replications. Each entry was sown in three rows of four meters in length with 45 cm x 15 cm spacing, keeping the plot size 638 m². To prepare a fine tilth, tillage operations such as ploughing and harrowing were carried out. A fertilizer dosage of 25: 50: 25 NPK kg/ha was given to the crop as a basal application. The crop was raised using the standard package of practices for cowpea. Plant protection measures were taken for key pests and the crop was kept weed free. Observations were recorded on five randomly tagged plants per genotype per replication at various stages of crop growth by eliminating the borders and average values were subjected to statistical analysis. The differences among the genotypes for various characters were tested for significance by using the Analysis of Variance technique as proposed by Panse and Sukhatme (1961). The phenotypic coefficient of variations (PCV) and genotypic coefficient of variations (GCV) for all the characters was estimated by the formulae proposed by Burton (1952). Heritability in a broad sense was estimated as suggested by Allard (1960). Genetic advance as per cent of mean was estimated from heritability values using the formula described by Burton (1952) and Johnson *et al*. (1955).

RESULTS AND DISCUSSION

The analysis of variance revealed significant differences among the genotypes for all the characters considered indicating the presence of a considerable amount of genetic variation among the experimental material studied (**Table 1**).

The mean performance of cowpea genotypes for yield and yield component parameters is presented in **Table 2.** A perusal of **Table 2** revealed that TPTC-29, KBC-12 and KBC-9 are high yielding genotypes with reference to mean values for seed yield. Genetic parameters such as genotypic coefficients of variation (GCV) and phenotypic coefficients of variation (PCV), broad-sense heritability, genetic advance, genetic advance expressed as a per cent of mean (GAM at 5%) were estimated for ten quantitative characters and the results are presented in **Table 3**.

The number of clusters per plant had the highest magnitude of coefficient of variation (GCV=31.91% and PCV=35.37%) followed by seed yield per plant (GCV=27.26% and PCV=29.55%), the number of pods per plant (GCV=23.04% and PCV=25.77%), plant height (GCV=22.20% and PCV=22.98%) and the number of seeds per pod recorded moderate GCV (17.63%) and high PCV (20.56%) indicating wide genetic base among the genotypes studied and the possibility of genetic improvement through a selection of these traits. These findings were in agreement with Bhardwaj *et al*. (2014) for seed yield per plant and the number of pods per plant; Dinesh *et al*. (2017) for plant height and the number of seeds for pod and Thorat and Gadewar (2013) for the number of clusters per plant in cowpea.

Moderate values of coefficient of variation were recorded for characters such as test weight (GCV=18.61% and

Table 1. Analysis of variance for ten characters in cowpea genotypes

S. No.	Characters	Mean Sum of Squares			
		Replication	Treatment	Error	Total
		(d.f = 2)	(d.f = 31)	(d.f = 62)	(d.f = 95)
1	Days to 50 % flowering	0.260	30.922 **	2.325	11.613
2	Days to maturity	2.823	26.556 **	2.909	10.624
3	Plant height	12.641	507.782 **	11.824	173.681
4	Branches per plant	0.066	1.113 **	0.127	0.447
5	Pods per plant	1.946	38.692 **	2.985	14.615
6	Seeds per pod	2.441	15.924 **	1.706	6.361
7	Pod length	1.571	21.742 **	1.181	7.899
8	Clusters per plant	0.862	11.103 **	0.786	4.154
9	Test weight	0.125	12.652 **	0.189	4.255
10	Seed yield per plant	4.001	72.385**	3.966	26.312

** Significant at 1 percent level

PCV=19.03%), the number of branches per plant (GCV=16.46% and PCV=19.37%) and pod length (GCV=16.22% and PCV=17.57%). Similar results were reported by Kumar *et al*. (2015) for the number of branches per plant and pod length and Thorat and Gadewar (2013) for test weight in cowpea.

Table 2. Mean performance of 32 cowpea genotypes for 10 quantitative characters

S.No.	Genotypes	Days to 50% flowering	Days to maturity	Plant height (cm)	Number of branches per plant	Number of pods per plant	Number of seeds per pod	Pod length (cm)	Number of clusters per plant	Test weight (g)	Seed yield per plant (g)
1	TPTC-29	47.67	74.33	51.87	5.00	21.00	14.93	17.20	9.00	14.78	28.81
2	KBC-9	46.33	73.00	47.67	4.50	20.00	14.00	17.23	8.47	13.12	24.24
3	DC-15	39.33	71.67	51.07	4.20	19.70	10.53	12.43	8.33	10.84	22.27
4	PCP-0306	43.00	73.33	55.90	3.20	16.20	11.80	14.53	6.77	11.35	17.24
5	KBC-12	43.00	78.00	68.27	4.60	20.10	11.67	14.70	7.87	11.61	24.26
6	CPD-311	44.00	72.33	56.40	3.10	14.23	7.93	11.40	6.57	10.14	16.53
7	KBC-13	45.67	69.33	42.67	3.62	18.16	10.67	18.07	7.73	15.50	20.83
8	CPD-313	42.00	71.33	50.53	4.10	11.92	10.07	13.37	5.70	12.36	13.11
9	PGCP-69	44.00	72.67	53.60	4.20	15.90	11.67	12.90	6.43	11.86	17.62
10	PCP-1124	45.00	73.67	45.67	3.12	18.23	10.93	14.37	6.37	13.15	15.21
11	SKUA-WCP-149	42.67	72.00	47.27	3.55	11.63	9.87	13.63	4.50	12.20	13.78
12	CPD-331	47.33	76.67	47.20	3.99	14.42	10.60	14.09	7.20	11.81	18.10
13	TC-1901	46.67	74.67	47.40	3.20	15.13	13.80	17.00	8.37	10.43	20.34
14	GC-1712	45.33	74.00	55.81	3.27	13.20	12.80	15.80	7.57	11.73	19.53
15	PGCP-70	46.33	74.67	46.80	2.48	8.40	13.80	17.67	3.67	10.75	12.80
16	WCP-29	46.67	75.33	59.47	3.40	12.13	13.80	16.53	4.77	8.86	12.62
17	WCP-1	46.00	72.33	37.80	3.67	6.83	10.13	22.47	1.70	8.84	6.38
18	WCP-28	47.67	74.00	86.13	2.60	14.73	15.40	17.87	6.63	10.83	21.08
19	WCP-26	51.67	78.33	77.67	3.67	15.13	14.53	17.77	5.90	12.32	20.86
20	WCP-15	43.00	69.67	62.13	2.47	10.27	11.33	15.09	3.03	12.04	11.90
21	WCP-18	48.67	74.67	67.67	3.43	15.73	14.80	16.73	7.37	10.44	20.21
22	WCP-23	45.67	71.00	67.93	3.07	13.27	13.53	17.67	5.37	11.73	19.57
23	WCP-6	43.00	69.67	39.00	3.60	13.07	5.60	24.40	2.37	10.13	8.19
24	WCP-4	44.67	71.00	58.73	3.13	15.93	12.73	17.47	6.83	12.38	22.30
25	WCP-17	50.33	77.33	65.60	3.40	17.53	15.73	16.93	5.63	8.90	20.53
26	WCP-9	50.67	77.67	83.33	3.53	12.60	14.13	15.60	3.63	6.07	12.17
27	WCP-16	55.00	81.67	65.93	3.13	16.67	13.27	15.23	5.97	9.07	18.53
28	WCP-34	51.00	77.67	52.53	2.93	10.93	13.27	17.43	2.70	9.95	12.67
29	PMCP-1131	44.67	69.33	43.80	2.87	14.67	12.00	14.19	5.13	11.24	17.40
30	WCP-10	45.00	71.67	67.20	2.87	22.53	10.27	12.40	5.97	5.54	12.84
31	WCP-21	46.33	73.00	65.67	3.53	16.00	15.13	16.57	4.93	9.99	21.13
32	WCP-12	48.00	75.67	84.63	4.07	12.87	14.27	17.47	3.47	10.53	17.42
	General mean	46.14	73.80	57.92	3.48	14.97	12.34	16.13	5.81	10.95	17.52
	C.V %	3.31	2.31	5.94	10.21	11.54	10.58	6.74	15.25	3.97	11.41
	Maximum	55.00	81.67	86.13	5.00	22.53	15.73	24.40	9.00	15.50	28.81
	Minimum	39.33	69.33	37.80	2.47	6.83	5.60	11.40	1.70	5.54	6.38
	S.E	0.88	0.98	1.99	0.21	1.00	0.75	0.63	0.51	0.25	1.15
	C.D at 5 %	2.49	2.78	5.61	0.58	2.82	2.13	1.77	1.45	0.71	3.26
	C.D at 1 %	3.31	3.70	7.46	0.77	3.75	2.83	2.36	1.92	0.94	4.34

Table 3. Genetic parameters for 10 characters in cowpea

S.No.	Character	General Mean	Range		Phenotypic Coefficient of Variation (PCV) (%)	Genotypic Coefficient of Variation (GCV) (%)	Heritability in broad sense (%) (H_{bs})	GA as percent of mean (5%) (GAM)
			Maximum	Minimum				
1	Days to 50% flowering	46.14	55.00	39.33	7.46	6.69	80.40	12.36
2	Days to maturity	73.80	81.67	69.33	4.45	3.80	73.00	6.70
3	Plant height (cm)	57.92	86.13	37.80	22.98	22.20	93.30	44.18
4	Number of branches per plant	3.48	5.00	2.47	19.37	16.46	72.20	28.82
5	Number of pods per plant	14.97	22.53	6.83	25.77	23.04	79.90	42.44
6	Number of seeds per pod	12.34	15.73	5.60	20.57	17.64	73.50	31.16
7	Pod length (cm)	16.13	24.40	11.40	17.57	16.23	85.30	30.88
8	Number of clusters per plant	5.81	9.00	1.70	35.37	31.92	81.40	59.32
9	Test weight (g)	10.95	15.50	5.54	19.03	18.61	95.60	37.50
10	Seed yield per plant (g)	17.52	28.81	6.38	29.55	27.26	85.10	51.80

In contrast, lower estimates of GCV and PCV were recorded for days to 50% flowering (GCV=6.69% and PCV=7.46%) and days to maturity (GCV=3.80% and PCV=4.45%). Parallel results were reported by Sharma *et al.* (2019) for days to 50% flowering and Sabale *et al.* (2018) days to maturity in cowpea.

The estimates of heritability among different characters studied ranged from 72.20 to 95.60 per cent. All the characters displayed a high level of heritability indicating the influence of genetic components. The highest heritability was recorded for test weight (95.60%) followed by plant height (93.30%), pod length (85.30%), seed yield per plant (85.10%), the number of clusters per plant (81.40%), days to 50% flowering (80.40%), the number of pods per plant (79.90%), the number of seeds per plant (73.50%), days to maturity (73.00%) and the number of branches per plant (72.20%). These experimental results were in conformity with Devi and Jayamani (2018) for days to 50% flowering; Vir and Singh (2014) for days to maturity; Sharma *et al*. (2017) for plant height; Thorat and Gadewar (2013) for the number of branches per plant; Singh *et al*. (2020) for the number of pods per plant, the number of clusters per plant and pod length and Khanpara *et al*. (2016) for the number of seeds per pod, test weight and Nguyen *et al*. (2019) for seed yield per plant in cowpea.

The highest genetic advance as a per cent of mean was noticed for the number of clusters per plant (59.31%) followed by seed yield per plant (51.80%), plant height (44.17%), the number of pods per plant (42.44%), test weight (37.49%), the number of seeds per pod (31.15%), pod length (30.87%) and the number of branches plant (28.82%). Genetic advance as per cent of mean (GAM) was found to be moderate for days to 50% flowering (12.36%). However, lower estimates of GAM were reported for days to maturity (6.69%). These findings were in accordance with Verma *et al.* (2019) for plant height, test weight and the number of pods per plant; Viswanatha and Yogeesh (2017) for the number of branches per plant, the number of seeds per pod; Chattopadhyay *et al.* (2014) for pod length; Nguyen *et al.* (2019) for the number of clusters per plant and Tambitkar *et al.* (2020) for seed yield per plant in cowpea.

The heritability values coupled with high genetic advance as per cent mean were reported to be more reliable and useful in predicting the genetic gain under selection rather than heritability estimates alone. In the present investigation, high heritability coupled with higher estimates of genetic advance was recorded for plant height, seed yield per plant, the number of clusters per plant, the number of pods per plant, test weight, the number of seeds for pod, pod length and the number of branches per plant suggesting predominance of additive gene effects and these characters could be improved through selection.

High heritability coupled with moderate genetic advance was documented for days to 50% flowering and high heritability accompanied with low genetic advance was observed for days to maturity indicating that these characters are predominantly governed by non-additive genes and selection would be less rewarding for improvement of these characters.

Based on the current study it can be concluded that TPTC-29, KBC-12 and KBC-9 were found to be high yielding varieties. The phenotypic coefficient of variation (PCV) in general was higher than the corresponding genotypic coefficient of variation (GCV) for all the characters considered indicating the role of environment in the manifestation of these characters. High heritability coupled with higher estimates of genetic advance was recorded for plant height, seed yield per plant, the number

of clusters per plant, the number of pods per plant, test weight, the number of seeds for pod, pod length and the number of branches per plant suggesting predominance of additive gene effects and these characters could be improved through selection.

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