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Genetic Variability and Performance Evaluation of Cowpea [(*Vigna unguiculata* (L.) Walp] Accessions on High Altitude of Jos Plateau State, Nigeria

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Authors' contributions

This work was carried out in collaboration between authors DT and EHKN. Author EHKN the experiment, supervised the work and carried out statistical analysis. Author DT performed the experiment, collect the data, present the result and wrote the first draft of the manuscript.

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ABSTRACT

The present study was carried out to evaluate the genetic variability and performance evaluation of cowpea (*Vigna unguiculata* (L.) Walp) accessions with the objective of selecting accessions with the best adaptability and potentiality for upgrading grain yield and other related traits on high altitude of Jos plateau. A field experiment was therefore carried out at Dagwom farm at the National Veterinary Research Institute (NVRI) Vom, in Jos South Local Government area of Plateau state, during the 2013 and 2014 rainy seasons. The treatments consisted of eighty (80) cowpea g accessions obtained from International Institute for Tropical Agriculture (IITA) Ibadan, Nigeria. The experiment was laid out in a Randomized Complete Block Design (RCBD) in two replicates. The result was analysed using (ANOVA) model and showed significant difference at ($P<0.01$) among the entries for all the characters accessed. High phenotypic coefficient of variability (PCV) compared with genotypic coefficient of variability (GCV) coupled with low environmental coefficient of variability (ECV) were observed for all the yield and related traits accessed. High broad sense heritability (h^2) coupled with high genetic advance (GAM %) attributed to high additive gene effect observed for all

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the characters observed in this study, except days to maturity which recorded high heritability with moderate genetic advance. In terms of performance, TVU-2972 and TVU-2174 were selected as accessions with high establishment capacity, TVU-4578 and TVU-7705 were selected as the early maturing accessions, while TVU-10431 was selected as the bold seeded genotype. The highest grain yield was produced by TVU-3188 and TVU-7918. All the above accessions were selected based on their high mean performance compared to other accessions. There is, therefore, need for hybridization between these selected accessions for evolving unique varieties of cowpea on high altitude area of Jos plateau.

Keywords: Genetic; performance; accessions; heritability; genetic advance; Nigeria.

1. INTRODUCTION

Cowpea (*Vigna unguiculata* (L). Walp); is a diploid species with 2x=2n=22 chromosomes. It is a self-pollinated crop, with natural cross-pollination of up to one per cent. The crop plays a considerable role in nutritional balance and economy of rural people in West African sub region [1]. It provides protein in their diets as well as nutritious fodder for ruminant livestock [2]. The crop also has the ability of maintaining soil fertility through its excellent capacity to fix atmospheric nitrogen and thus does not require very fertile land for cultivation [3]. However [4] emphasized that all parts of the plant used as food are nutritious providing protein and vitamins, immature pods and peas are used as vegetables, while several snacks and main dishes are prepared from the grains.

Cowpea is eaten by millions of people in the developing world with an annual world production estimated around 4.5 million metric tons on 12 to 14 million hectares [5]. Cowpea is mostly grown by poor farmers in developing countries with over 80% of production in the dry savannah of West Africa [6]. But advances in crop development have opened opportunities for its production in wet agro-ecologies [7].

Cowpea is a heat loving crop which can thrive well in areas with temperature ranges between 25-35^{0}C night and day during the growing season, and in area where rainfall ranges between 750-1100 mm [8]. However, with the development of extra early and early maturing varieties, cowpea can thrive in Sahel regions where the rainfall ranges between 200-500 mm per year and in dry savannah with annual rainfall ranges between 500-700 mm per year [9].

It has been observed that cowpea growing on the high altitude of Jos plateau is affected by extremely cold weather condition due to the unique climate of the area. According to [10], if temperature falls below 19^{0}C during cowpea cropping season, chilling damage can occur which may result to slow and incomplete emergence of seed.

Germplasm has inherent genetic potential, which when carefully evaluated it is possible to obtained accessions with potentiality and adaptability to such climatic condition, which will help in initiating cowpea breeding programmes with the aim of boosting cowpea production in this agro-ecology.

Assessment of genetic diversity in cowpea germplasm would also facilitate development of cultivars for adaptation to specific production constraints. Better knowledge of the genetic similarities and differences of breeding materials could help to maintain genetic diversity and sustain long term selection gain. Several workers [11,12,13] have calculated genotypic and different components of variance, heritability and genetic advance for different yield characters in cowpea and have revealed that selection was effective for a population with broad genetic variability and character with high heritability.

However [12] stated that heritability estimates together with genetic advance are more useful in predicting the resultant effect for selection of the best individual from a population than heritability alone. Therefore, the present study was initiated to evaluate the extent of genetic variabilities, for different traits in cowpea germplasm collections and to evaluate their performance with the objective of selecting accessions with the best adaptability and potentiality for upgrading grain yield and its component character on the high altitude of Jos.

2. MATERIALS AND METHODS

2.1 Experimental Site Location

The experiment was carried out in Dagwom farm at National Veterinary Research Institute (NVRI)

Vom, Jos South Local Government Area of Plateau State (Lat. 09°44 N, long. 08°47 E. altitude 1293.2 m above sea level) during the 2013 and 2014 cropping seasons.

2.2 Experimental Materials

Eighty (80) cowpea (*Vigna unguiculata* (L.) Walp) accessions obtained from International Institute for Tropical Agriculture (IITA) Ibadan, Nigeria were used for this study.

2.3 Experimental Design

The experiment was laid out in a Randomized Complete Block Design (RCBD) in two replicates. Each accession was planted in a row of 3 m long, with a spacing 70 cm x 30 cm between and within row respectively, covering a total land area of 378 m^2.

2.4 Cultural Practices

Sowing was done second week in august in both 2013 and 2014, three seeds were sown in a hole at 4cm depth. Seedlings were later thinned to two per stand at 2 weeks after sowing. The plot received uniform application of NPK 15:15:15 compound fertilizer at the rate of (7% N, 14% P2O5, 7% K2O) was broadcasted at rate of 60kg per ha on the experimental plots prior to planting. Mechanical weed controls was regularly done using hoe first at three weeks after plant emergence and subsequently during the vegetative stage and close the crop maturity. Cowpea plants were fully protected against insects through regular spray of insecticides (cypermethrin and dimethoate) at the rate of 250ml dissolved in 20 litres of water. The crop was harvested manually after maturity. Matured pods were handpicked 2-3 times from each plot and sundried before post harvest date collected.

2.5 Data Collection and Analyses

Data were collected from five (5) randomly selected plants in the mid row of each accessions on the following characters: plant height, days to flower initiation, days to flower termination, days to maturity, number of primary branches per plant, number of secondary branches per plant, number of pods per plant, pod length, number of seeds per pod, hundred seed weight, seed yield per plant and grain yield kg/ha**.** The data collected was subjected to analysis of variance (ANOVA) using Crop Stat Version 7.2 model software, developed by the crop and soil science Department USA to estimate the level of variability among the accessions. Means separation was performed using (LSD) at $p<0.05$. The phenotypic variation for each trait was partitioned into genetic and non-genetic factors as estimated according to [14] as follows:

$$VG = (MSG – MSE)/r$$
$$VP = VG + MSE$$
$$VE=MSE/r$$

Where; VG, VP, and VE are genotypic, phenotypic and environmental variances, respectively, while MSG, MSE and r are mean squares for accessions, mean squares error and number of replications, respectively.

To compare the variations among characters, phenotypic coefficient of variability (PCV), genotypic coefficient of variability (GCV) and environmental coefficient of variability (ECV) were computed according to the method suggested by [15,16] as follows:

$$GCV = \frac{\sqrt{VG}}{\bar{X}} \text{ X } 100\%$$
$$PCV = \frac{\sqrt{VP}}{\bar{X}} \text{ X } 100\%$$
$$ECV = \frac{\sqrt{VE}}{\bar{X}} \text{ X } 100\%$$

Where; $\bar{X}$ is the grand mean for the studied character. The categorization of phenotypic coefficient of variability (PCV), genotypic coefficient of variability (GCV) and environmental coefficient of variability (ECV) was done as per the scale given by [17] as follows:

Category	Range
Low	<10%
Moderate	11-20%
High	>20%

Broad sense heritability (h^2B) is the ratio of the genotypic variance to the total variance, it denotes the proportion of phenotypic variances that is due to genotypes (heritable) and is calculated according to the formula given by Henson et al. (1956).

$$h^2B = \frac{VG}{VP} \times 100\%$$

Where;

VG = genotypic variance
VP = Phenotypic variance

Chart 1. Broad sense heritability (H^2B) was categorized as proposed by Johnson et al. [14]

Category	Range
Low	<30 per cent
Moderate	30-60 per cent
High	>60 percent

Genetic advance is the improvement in the mean genotypic value of the selected families over the base population it is calculated in percent of mean using the formula given by Johnson et al. [14].

$$GA = h^2B^* K^*\sqrt{VP}$$

$$GA\ (\%\ of\ trait\ mean) = GA/\ \bar{X}^*100\%$$

Where;

k = selection differential at 5% selection intensity
k = 2.06
VP = Phenotypic variances

Chart 2. The range of genetic advance as percentage of mean for various traits was categorized as suggested by [14]

Category	Range
Low	<10 per cent
Moderate	11-20 per cent
High	>20 per cent

3. RESULTS

3.1 Genetic Variability Heritability and Genetic Advance

The result of the Analysis of variance (ANOVA) revealed that accessions exhibit highly significant difference at (P<0.01) for all the yield and related traits accessed (Table 2). There was also significance Genotype × Environment (G × E) interaction for all the yield and related traits accessed except plant height which showed no significant (G × E) interaction (Table 2).

The results of the phenotypic coefficient of variability (PCV), genotypic coefficient of variability (GCV), environmental coefficient of variability (ECV), broad sense heritability (h^2B) and genetic advance as per cent of mean (GAM %) are presented in (Table 3). Generally, the PCV was higher than GCV and ECV was lower in magnitude compared with GCV for all the yield and related traits accessed in this study.

Heritability estimates along with genetic advance are normally more helpful in predicting the gain under selection than heritability alone (Ubi et al., 2001). High heritability with high genetic advance as percentage of mean were recorded for all the characters accessed except days to maturity (DM) which recorded high heritability with low genetic advance. The highest heritability coupled with highest genetic advance was observed for hundred seed weight (100 SW) (Table 3).

3.2 Mean Performance of Accessions

The separation of accessions means for significant difference was done by using Fisher least significant difference (F-LSD) procedure at P<0.05 probability. The mean yield and agronomic performance of eighty cowpea germplasm accession (Table 4).

The highest plant establishment was observed in TVU-2972 (100%) followed by TVU-2174 (76.85%) the least plant establishment was observed in TVU-3007 (9.92%) (Table 4).

Similarly, TVU-3188 recorded the highest plant height of 29.58 cm followed by TVU-2835 with 25.67 cm, while TVU-6863 recorded the least plant height of 8.16 cm (Table 4).

Flower was first observed after 46.25 days in TVU-4578 followed by TVU-3009 (48 days), while TVU-3440 took the longest days to begin flowering which took about 83.50 days (Table 4).

Similar trend was observed in days to flower termination and days to maturity with TVU-4578 (60.5 days) followed by TVU-3009 (66.75 days), longest days to flower termination was observed in TVU-3440 (93.75 days) (Table 4).

The least days to maturity of majority of the pods was observed in TVU-4578 which took 67.75 days, followed by TVU-7707 78.25 days, while the longest days to maturity was observed in TVU-3355 with 101.75 days (Table 4).

The highest number of primary branches per plant was recorded by TVU-3440 (5.85) followed by TVU-3450 (5.00), while the least number of primary branches per plant was recorded by TVU-3185 (1.00) (Table 4).

The highest number of secondary branches was recorded by TVU-3450 (10.38) followed by TVU-6695 (10.14), the least number of secondary branches was recorded by TVU-2793 (3.00) (Table 4).

The mean number of pod varies widely among the accessions, however two genotypes TVU-7918 and TVU-6695 produced the highest number of pods of 24.95 and 19.49, respectively, the least number of pods was produced by TVU-3183 (2.25) (Table 4).

The mean pod length varied widely among the accessions. However, two genotypes TVU-3188 and TVU-985 had longer pods of 18.70 cm and 16.60 cm, respectively compared to others. Both TVU-3188 and TVU-985 produced the same number of seeds per pod of 16.60 and the least number of seeds per pod was produced by TVU-3183 (7.83) (Table 4).

The highest weigh of hundred seed was produced by TVU-10431 (20.85 g), followed by TVU-3188 (11.72 g), the least weight of hundred seeds was produced by TVU-3440 (4.12 g) (Table 4).

The highest seed yield per plant was produced by TVU-3188 (23.73 g), followed by TVU-7918 (19.91 g) and the least seed yield per plant was produced by TVU-2910 (3.10 g). The highest grain yield was produced by TVU-3188 (1129 kg/ha), followed by TVU-7918 (949 kg/ha), the least grain yield was produced by TVU-4578 (155 kg/ ha) (Table 4).

4. DISCUSSION

The high significant difference exhibited for all the yield and related traits accessed indicated the presence of sufficient genetic variability among the cowpea accessions and a scope of improvement in cowpea. The results agreed with the earlier findings by [13], who reported sufficient variability for all the characters observed in this study, [18] also reported significant variability for days to 50% flowering, number of peduncles per plant, number of flowers per plant, number of pods per plant, pod length, number of seeds per pod, hundred seed weight and grain yield. This confirmed our results.

The significant interaction between Accession × Season (G × S) is an indication of non-adaptability of the tested accessions to this area since there performance varies with seasons.

The high PCV compared with GCV coupled with low ECV for all the traits accessed indicated that those characters are mostly controlled by genetic factor with a little environmental influences on the expression of these characters, thus selection of these traits on the basis of phenotypic value may be effective. Our results agreed with the earlier findings by [18] who also reported minimal magnitudenal difference in GCV and PCV coupled with low ECV for days to 50% flowering, number of pods per plant, pod length, number of seeds per pod, hundred seed weight and grain yield. This confirmed our results.

The important of heritability in genetic study of quantitative characters is its predictive role to indicate the reliability of the phenotypic value as a guide to breeding value [19]. Broad sense heritability obtained in this study were generally high for all the yield and related traits accessed. The high broad sense heritability recorded in this research are within the value reported by several published work on cowpea [13,18,20,21]. According to [12] high heritability coupled with high genetic advance are more reliable index for selection of traits than heritability alone. A high heritability coupled with high genetic advance attributed to high additive gene effect was observed for all the characters accessed in this

Table 1. Meteorological data for 2013 and 2014 rainy seasons at Jos Plateau State, Nigeria

Year	Months	Total Rainfall (mm)	Rainy days	Max. air temp°C	Min. air temp°C	Relative humidity (%)
2013	August	273.6	16	24	18	84
	September	277	15	26	18	78
	October	88.9	7	28	15	51
	November	0	0	32	13	34
	December	15.2	1	29	13	36
2014	August	256.1	17	24	17	79
	September	279	19	26	17	71
	October	76.4	6	28	20	54
	November	0	0	31	13	38
	December	0	0	28	14	32

Source: National Root Crops Research Institute Potato Programme Vom Jos south Plateau state

Table 2. Mean squares for eleven traits of cowpea on high altitude of Jos plateau State Nigeria

Sources of variation	Degress of freedom	Plant height	Ddays to 50% flowering	Days to flower termination	Days to 90% maturity	No. of primary branches/plant	No. of secondary branches/ plant	No. of pods/ plant	Pod length (cm)	No. of seeds/pod	100 seed weight (g)	Grain yield (kg/ha)
Accession	79	69.37**	120.6**	155.00**	112.78**	3.37**	7.45**	36.61**	21.40**	14.30**	13.79**	114360**
Year	1	56.56NS	203.2*	845.00**	732.05**	2.19NS	16.89NS	145.36**	15.56**	63.51**	4.26**	691943**
G* year	79	23.86NS	31.49*	24.03**	24.10**	0.98**	4.63**	18.85**	3.61**	4.31**	4.57**	44446.59**
Residual/Error	158	21.74	21.47	13.23	12.96	0.56	2.20	9.21	1.62	2.14	0.70	28827.87

** =significant at p<0.05, **=significant at p<0.01, NS= not significant*

Table 3. Phenotypic, genotypic, environmental variances, heritability and genetic advance for eleven (11) traits of cowpea (*Vigna unguiculata* (L.) Walp) on high altitude of Jos Plateau state, Nigeria

Traits	GCV (%)	PCV (%)	ECV (%)	H^2B (%)	GAM (%)
Plant height (cm)	31.28	37.76	25.15	68.65	53.43
Days to 50% flowering	11.99	13.23	5.48	82.20	22.30
Days to flower termination	11.27	11.78	3.44	91.46	22.20
Days to 90% maturity	8.24	8.77	2.98	88.51	15.98
No. of primary branches/plant	42.96	46.93	19.13	83.43	80.66
No. of secondary branches/plant	33.30	39.71	21.60	70.51	57.60
Number of pods/plant	41.34	47.82	23.91	74.86	73.63
Pod length (cm)	24.47	25.49	7.01	92.40	48.56
Number of seeds per pod	19.37	20.91	8.06	85.03	36.72
100 seed weight (g)	37.59	38.03	8.66	97.76	96.50
Grain yield (kg/ha)	54.10	62.57	31.41	74.79	96.40

GCV=Genotypic coefficient of variability, PCV=Phenotypic coefficient of variability, ECV=Environmental coefficient of variability, H^2B (%) =Broad sense heritability, GAM =Genetic advance as percentage of mean

Table 4. Pooled mean of yield and related traits of eighty cowpea accessions on high altitude area of Jos plateau state, Nigeria

S/N	Accessions	PE	PLH	DFI	DFT	DM	NPB	NSB	NPPP	POL	NSPP	100SW	SYPP	GY (kg/ha)
1	TVU-10390	47.00	16.12	55.50	75.75	88.50	3.03	4.38	6.83	9.12	12.60	4.62	4.01	191.00
2	TVU-1466	56.00	18.41	65.25	80.50	89.50	2.45	4.97	8.22	15.94	14.53	8.53	13.00	618.43
3	TVU-10457	36.90	14.08	55.25	70.50	83.00	2.72	4.85	8.82	13.00	13.10	8.52	39.72	462.40
4	TVU-6432	16.50	12.85	64.25	81.00	92.25	2.50	4.38	8.92	11.85	12.80	6.18	6.20	295.18
5	TVU-3098	10.00	14.88	62.75	81.50	91.50	1.70	5.75	9.00	10.74	9.38	6.37	5.39	256.18
6	TVU-174	24.70	17.30	55.50	69.25	83.00	2.15	3.77	6.38	12.38	12.93	5.99	5.17	245.95
7	TVU-312	36.75	15.60	59.72	76.00	88.00	2.65	4.65	7.25	15.40	15.40	8.48	10.10	480.71
8	TVU-2798	19.15	15.32	60.25	76.00	84.75	2.20	4.18	10.83	11.80	11.43	6.72	6.19	293.71
9	TVU-2815	21.35	15.92	58.00	76.50	88.00	2.90	5.23	9.25	11.63	14.50	5.88	8.18	389.14
10	TVU-41	11.85	10.50	57.25	72.25	82.75	2.55	5.30	9.00	9.24	12.41	4.76	5.31	254.35
11	TVU-7872	28.95	11.65	54.75	70.00	90.50	3.58	6.55	11.18	14.93	12.40	8.91	11.43	544.46
12	TVU-2165	29.00	13.13	55.25	68.25	80.50	1.80	4.40	9.12	10.13	12.39	4.51	5.22	284.56
13	TVU-202	18.50	17.90	67.00	84.00	91.50	3.63	5.64	11.77	15.84	17.50	7.87	16.53	786.60
14	TVU-7705	41.95	14.33	52.50	68.75	78.25	3.70	6.12	11.45	14.62	14.74	7.41	11.27	535.89
15	TVU-4546	57.85	13.48	60.50	81.75	92.50	2.29	3.14	4.10	15.08	14.35	9.62	6.37	291.14
16	TVU-7918	24.07	12.53	56.75	72.75	83.75	4.28	7.93	24.95	14.69	11.33	6.88	15.00	946.91
17	TVU-3166	59.75	18.21	56.50	74.50	84.50	2.62	4.19	5.95	16.87	14.58	8.93	7.77	369.87
18	TVU-296	39.25	9.13	59.00	73.75	86.50	2.49	3.25	5.75	13.62	13.77	7.94	6.32	300.66
19	TVU-10271	45.25	17.23	59.00	72.75	84.00	1.97	4.49	8.70	13.39	13.12	7.61	8.67	412.45
20	TVU-3183	15.98	4.25	73.00	86.75	91.75	1.00	2.13	2.25	7.25	7.32	5.53	4.67	221.92
21	TVU-3080	44.50	15.49	57.25	75.25	85.50	1.95	4.55	9.55	10.73	10.95	4.92	5.19	246.90
22	TVU-7707	40.75	10.33	54.00	66.75	77.25	2.55	3.69	7.92	13.42	14.25	7.87	9.03	429.57
23	TVU-3427	57.95	12.95	58.00	75.50	85.75	2.33	6.03	11.41	10.92	11.53	5.32	9.34	444.32
24	TVU-3219	31.85	15.66	64.00	83.00	90.25	2.28	3.73	4.13	13.72	12.57	9.78	5.00	237.61
25	TVU-6695	48.15	13.55	59.25	70.50	78.75	4.58	10.14	19.49	12.33	12.69	4.53	12.73	605.59
26	TVU-2821	42.20	12.15	53.25	69.75	80.50	1.80	4.10	6.35	11.83	12.34	6.81	5.33	253.56
27	TVU-9397	71.85	14.65	60.75	81.50	90.75	2.95	5.45	11.86	10.91	11.43	4.72	6.79	323.01
28	TVU-9840	44.85	21.69	72.25	84.25	91.25	3.35	3.50	4.38	16.17	15.53	7.22	4.79	228.11
29	TVU-9380	38.15	18.59	59.50	79.00	89.50	3.08	4.95	7.50	15.49	13.75	7.65	7.04	335.14
30	TVU-3060	60.85	17.32	54.50	68.25	82.00	1.55	4.78	10.15	9.99	10.93	5.75	5.88	279.48

S/N	Accessions	PE	PLH	DFI	DFT	DM	NPB	NSB	NPPP	POL	NSPP	100SW	SYPP	GY (kg/ha)
31	TVU-3512	54.35	14.75	59.50	83.25	94.25	3.24	5.58	9.83	11.58	11.47	6.83	8.50	404.36
32	TVU-16598	56.35	13.10	66.75	85.50	97.75	3.78	4.25	4.55	13.13	14.25	5.00	3.88	184.82
33	TVU-16532	45.95	14.27	53.75	65.75	82.25	2.48	4.60	8.59	13.30	14.15	4.40	5.74	273.06
34	TVU-2854	33.10	16.05	55.50	68.00	84.25	3.50	6.10	9.79	12.29	14.10	5.84	8.35	397.46
35	TVU-6346	41.25	14.54	55.50	72.50	87.75	2.27	3.88	7.49	12.70	13.02	6.07	7.26	345.61
36	TVU-4578	37.60	9.53	46.25	60.50	67.75	2.28	5.48	6.78	9.58	9.95	4.77	3.26	155.09
37	TVU3589	60.60	25.07	62.25	83.75	93.50	3.68	4.65	5.95	16.20	14.48	4.91	4.29	203.85
38	TVU-3244	64.00	18.14	53.50	74.75	81.75	1.84	4.07	9.31	13.02	14.25	6.04	7.83	372.48
39	TVU-121	45.95	20.58	54.75	67.50	75.50	4.60	6.73	16.82	13.40	13.29	7.70	11.27	535.90
40	TVU-985	28.00	15.80	56.00	71.00	77.75	3.55	7.00	11.01	17.03	16.60	7.65	15.19	722.61
41	TVU-2835	43.50	25.67	54.75	69.75	82.00	3.93	5.53	10.40	13.50	15.65	6.36	10.05	478.33
42	TVU-16521	45.25	12.23	55.50	67.25	80.00	2.68	4.40	7.50	12.49	14.35	4.41	4.69	223.11
43	TVU-3355	20.85	14.16	52.25	67.00	101.75	1.33	3.70	11.23	9.80	11.45	4.99	6.40	304.70
44	TVU-3440	72.75	19.50	83.50	93.75	87.50	5.85	7.53	13.84	10.83	12.83	4.12	6.36	302.32
45	TVU-6717	24.22	11.62	57.25	77.50	88.75	2.59	3.93	5.40	15.09	14.15	9.94	7.94	377.48
46	TVU-3217	35.60	19.10	65.00	79.25	88.75	2.60	5.18	10.13	14.83	12.55	8.60	10.71	509.25
47	TVU-7176	24.85	13.75	57.50	76.00	82.25	2.83	5.43	9.55	12.14	13.45	5.59	7.27	345.85
48	TVU-15956	60.85	15.00	65.00	81.75	92.25	4.05	6.69	13.63	11.90	12.58	5.07	8.76	416.73
49	TVU-1447	69.60	16.80	59.50	76.25	88.75	3.62	5.09	9.79	15.55	13.04	7.65	10.84	515.68
50	TVU-703	50.50	14.36	59.25	73.00	84.25	2.93	4.38	6.89	15.40	15.78	8.18	8.72	415.06
51	TVU-723	23.97	15.68	57.50	73.25	85.00	2.33	3.69	6.38	15.90	15.22	9.39	9.12	434.09
52	TVU-3012	49.45	17.03	51.00	71.75	82.25	1.70	4.74	11.59	10.27	10.75	5.33	6.59	313.73
53	TVU-2991	50.95	21.60	53.00	68.50	82.00	2.48	3.30	7.20	11.28	11.20	5.93	7.44	353.94
54	TVU-10320	65.10	19.75	68.00	86.50	96.50	3.95	4.85	9.55	11.20	11.03	8.30	8.74	365.78
55	TVU-3009	53.70	14.53	48.00	66.75	80.25	2.00	4.93	9.94	11.10	12.40	5.25	8.18	389.37
56	TVU-2901	18.18	24.40	63.75	82.75	88.50	3.38	5.35	4.48	12.50	10.52	6.53	3.10	147.47
57	TVU-2181	38.10	16.30	67.00	84.00	94.50	4.28	5.03	6.09	10.76	10.16	5.77	4.00	190.05
58	TVU-3188	17.45	29.58	56.50	69.50	84.00	2.65	5.53	11.88	18.70	16.60	11.72	23.73	1129.11
59	TVU-13179	24.20	14.45	55.50	71.50	85.25	2.85	3.75	8.25	13.37	12.13	9.18	9.42	448.60
60	TVU-3295	32.70	14.35	53.25	67.75	81.25	2.40	4.13	8.13	11.35	11.80	5.65	9.01	428.62
61	TVU-3465	23.85	15.30	58.25	74.75	82.00	2.90	4.43	6.36	15.25	13.20	6.98	6.39	303.85
62	TVU-3401	61.85	14.96	52.50	68.00	79.75	2.15	4.32	11.48	11.23	12.38	4.44	6.28	299.70
63	TVU-2829	50.20	11.38	55.75	69.25	78.50	2.89	4.22	8.42	14.71	13.43	6.50	7.32	348.23

S/N	Accessions	PE	PLH	DFI	DFT	DM	NPB	NSB	NPPP	POL	NSPP	100SW	SYPP	GY (kg/ha)
64	TVU-3319	18..50	10.89	62.00	82.25	89.25	2.72	6.95	12.53	10.60	10.05	6.30	8.23	291.28
65	TVU-6139	26.60	15.05	56.75	70.75	84.50	2.19	3.93	9.30	12.43	11.80	7.63	9.28	441.47
66	TV-12015	25.75	20.30	51.50	66.50	78.50	2.08	3.95	7.47	11.71	11.83	6.59	6.35	302.32
67	TVU-2174	76.85	13.50	53.50	69.00	81.00	1.80	3.73	6.67	11.41	12.40	5.81	5.39	256.65
68	TVU-6863	33.60	8.16	46.50	60.00	68.25	2.20	5.22	8.64	10.71	13.52	5.10	5.84	277.82
69	TVU-10170	61.50	23.19	54.50	71.50	83.50	2.99	5.33	11.33	12.61	12.45	6.91	12.07	574.19
70	TVU-10431	58.45	14.16	60.00	78.25	88.00	3.88	4.87	8.34	17.63	12.65	13.77	13.63	684.64
71	TVU-2793	21.00	13.55	54.00	71.50	83.50	1.78	3.00	6.23	11.60	10.65	7.84	5.19	304.52
72	TVU-3007	9.95	12.40	61.25	77.75	91.00	1.25	2.43	7.38	10.08	9.08	8.18	5.53	263.07
73	TVU-7592	27.50	15.55	66.75	80.75	91.50	3.18	4.48	6.05	14.38	11.05	7.46	5.03	199.52
74	TVU-10210	43.70	26.45	58.00	71.75	86.75	2.28	4.22	7.93	14.67	13.23	8.97	9.37	445.75
75	TVU-9882	24.07	15.39	67.50	79.00	89.00	2.63	4.94	6.32	13.98	14.18	10.50	11.61	552.54
76	TVU-3450	28.43	14.68	68.00	81.50	91.00	5.00	10.38	13.75	11.05	12.55	4.78	11.16	531.14
77	TVU-2972	100.00	12.42	53.00	67.50	77.75	2.64	4.43	10.77	9.91	10.03	4.40	5.51	262.36
78	TVU-647	13.45	14.12	60.75	75.50	81.25	2.13	3.75	5.38	16.75	16.29	6.29	5.70	323.00
79	TVU-2561	21.45	12.52	60.75	76.00	86.50	1.95	3.84	8.72	10.43	9.14	5.93	4.68	222.40
80	TVU-10428	39.70	15.79	68.75	81.50	93.50	2.63	4.56	8.50	19.97	12.24	7.52	8.69	413.64
LSD(0.05)		18.43	6.51	6.47	5.08	5.03	1.05	2.08	4.24	1.78	2.04	1.67	4.95	237.10

PE= Plant establishment, PLH=Plant height, DFI=Days to flower initiation, DFT=Days to flower termination, DM=Days to maturity, NPB=Number of primary branches plant^{-1}, NSB=Number of secondary branches plant^{-1}, NPPP=number of pod plant^{-1}, POL=Pod length, NSPP=Number of seed pod^{-1},100SW=Hundred seed weight, SYPP= seed yield per plant, GY= Grain yield (Kg/ha) study, except days to maturity which recorded high heritability with moderate genetic advance. [22] suggested mass selection breeding method as a means of improvement of traits controlled by additive gene action.

The mean performance of accessions is very important in choosing the best individual among population. From the result in this study, TVU-2972 and TVU-2174 were selected as accessions with high establishment capacity based on their high mean performance compared to other accessions. TVU-4578 and TVU-7705 were also selected as the early maturing accessions because it took them lesser days to reach maturity. TVU-10431 and TVU-3188 were selected as the bold seeded genotypes because of their heaviest hundred seed weight. The highest grain yield (kg/ha) was produced by TVU-3188 and TVU-7918.

Selection for these characters were based on their better mean performance coupled with high heritability and genetic advance with low environmental coefficient of variability (ECV).

5. CONCLUSION

The success of genetic improvement in any character depends on the nature of variability present for that character. The present studies have shown that there is sufficient variability coupled with high heritability and genetic advance among the tested accessions for breeders to exploit for further improvement for release of new cowpea variety. The research also identified some promising accessions for high establishment capacity TVU-2972 and TVU-2174, early maturing ability TVU-4578 and TVU-7705, bold seed TVU 10431 and TVU-3188 and high yields TVU-3188 and TVU-7918.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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