



Assessment of Genetic Variability of Some Quantitative Traits of Cowpea (*Vigna unguiculata* [L.] walp) Varieties

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ABSTRACT

The studies on the assessment of genetic variability of some quantitative traits of cowpea (*Vigna unguiculata* [L.] WALP) varieties were conducted at the green house of the Institute for Agricultural Research (IAR), Ahmadu Bello University, Zaria, Nigeria. Completely Randomized Design was used. The Seeds of the three cowpea varieties (IT87D 941-1, IT97K 499-35 and Dankurmi) were sown in Plastic pots and are arranged in six replications. Variations of selected quantitative traits were studied in three cowpea varieties (IT87D941 - I, IT97K 499 - 35 and Dankurmi) and their F₁ and F₂ hybrids. The first two varieties are improved varieties which are tall and photo-insensitive. The latter is a local variety which is short and photo-sensitive. There were improvements in quantitative traits of F₁ hybrids derived from crosses involving Dankurmi. Highly significant differences were observed in many traits such as height at maturity, number of pods per plants, length of pods per plants, number of seed per pod and leaf area in the F₂ population. Positive correlation coefficient was obtained and this will enhance productivity through selection using the two characters positively correlated. It was concluded that hybrid plants were found to be vigorous and intermediate between the parent varieties with respect to many quantitative traits. The seed set data indicated that cross compatibility was lower in crosses involving Dankurmi, which may be due to low pollen content and the high seed set in IT87K 499-35 suggests high receptivity for pollen. This may be due to high fertility and compatibility. This study recommended that cross combination through the use of hybridization would improve the quality and quantity of quantitative traits which would in turn improve the quality and quantity of cowpea genotypes (varieties).

Keywords: Cowpea, F₁ and F₂, Variation, Varieties.

1.0 INTRODUCTION

Cowpea (*Vigna unguiculata*) is one of the most important food legume crops. In Africa, particularly the western and central regions, cowpea is the main source of plant protein (IITA, 1994). The tender leaves, immature pods, soft stem and fresh seeds are eaten as vegetables and the dry grains serve as staple food (Lim, 2012). The protein content ranges from 23 - 38% in the grain and 29 - 43% in the leaves (Ahmed *et al.*, 2009). For this reason, cowpea has been referred to as 'the poor man's meat' (Inaizumi *et al.*, 1999). In addition to the sustainability of cropping systems and soil fertility improvements in marginal lands by providing ground cover and plant residues, fixing atmospheric nitrogen and suppressing weeds (Inaizumi *et al.*, 1999). Several methods were devised in the conventional breeding

programs to improve desirable traits of plants of commercial and agronomic interest. These methods include among others mutation and hybridization. Mutation has been used to study the nature and functions of genes in the genetic improvement of economic crops (Adamu *et al.*, 2004). Characters of agronomic interest such as grain weight, yield, leaf area, seed number, protein contents, plant height, pod sets and biomass were found to be improved through mutation in plants (Adamu *et al.*, 2004). However, despite all the advantages of mutation in the improvement of the traits of economic plants, the mutagens confer lethality of varying degree on to the plants.

Hybridization (cross breeding) involves combining different strains of a species (that is, members of the same species with different characteristics) or

members of different species in an effort to combine the most desirable characteristics of both (Iraqi *et al.*, 2005). Cross breeding is one of the tools for exploiting genetic variation. It uses pure-or line-breeding to improve economic traits through the use of complementarity traits or economic heterosis. Complementarity is often very important to success in crossbreeding programs. Often positive complementarity arises because of a multiplier trait such as reproductive and viability traits (Iraqi *et al.*, 2005). However, as with single trait heterosis, economic heterosis may be negative (Iraqi *et al.*, 2005). Hybridization is therefore a valuable tool for transferring economic characters from one species to another and has been applied widely for the improvement of Brassica crops (Brown *et al.*, 1995). Successful hybrids were achieved only when *Brassica tournefortii* was used as a female parent (Brown *et al.*, 1995). Wild *Cajanus* Species of Indian Origin have been extensively utilized in Pigeon pea improvement (Saxena *et al.*, 1998). Within the genus *Lycopersicon*, *L. peruvianum* Mill, abundant source of Valuable genetic traits were improved through hybridization. These traits include tomato yellow leaf virus (Doganlar *et al.*, 1997) and fusarium root (Doganlar *et al.*, 1997). Ovule culture was successfully used to produce F₁ hybrids between *L. esculentum* and two accessions of *L. peruvianum* (Doganlar *et al.*, 1997). Because the accessions of *L. peruvianum* used contain new nematode resistance genes, the progeny produced may allow the first transfer of these genes to cultivated tomato (Doganlar *et al.*, 1997).

Seed setting in interspecific and intergeneric crosses is a product of the interaction between genotypes used in the hybridization (Bozorgipour and Snape, 1990), which explains the wide range of variation amongst the different *Brassica* genotypes with respect to their ability to set seeds in the interspecific crosses (Choudhary and Joshi, 1999). Hybrid plants were found to be vigorous and intermediate between the parent species with respect to many morphological characteristic (Choudhary and Joshi, 1999). Hybridization barriers between the wild and cultivated varieties as well as cross incompatibility among some existing cultivated genotypes exist. Considerable effort on cowpea improvement is needed to sustain the bright future for the crop. Early maturity is a reflectively

important agronomic characteristic. Typically, the trait is measured by such criteria as days to flowering or days to maturity of such traits that are heritable through hybridization. New Combinations result from crossing varieties which contain new heredity factors. An understanding of the heritability of traits such as early maturity, early flowering, seed setting, pod length, pod setting, plant height is important as crop improvement is related to the magnitude of genetic variability and the extent to which characters are heritable. Most local Cowpea varieties are late maturing and dwarf in height and are generally affected by photoperiod and production rate is at local subsistence level. There is the need for improving these varieties through hybridization of quantitative traits using improved varieties due to the frequent use of the local varieties by farmers. Beside these, the massive increase in price of fertilizer coupled with economic melt-down of the recent years has made the purchase of Nitrogen fertilizer out of the scope of local farmers. Therefore the need for growing economic crops that have less demand for Nitrogen deemed necessary. As a legume fixes its own nitrogen, cowpeas do not need nitrogen fertilizer (Quinn, 1999). Cowpeas do fix nitrogen without the addition of Rhizobium, as long as these bacteria are present in the soil from previous soyabeans cultivation (Quinn, 1999).

This paper aimed at assessing the genetic variability of some quantitative traits of cowpea (*Vigna unguiculata* [L.] WALP) Varieties. The objectives of this paper are to determine the effect of variation in the improvement of some selected quantitative traits in three Cowpea varieties.

2.0 MATERIALS AND METHODS

2.1 Study Site

The quantitative trait studies were conducted at the green house of the Institute for Agricultural Research (IAR), Ahmadu Bello University, Zaria, Nigeria. It is located at the latitude 11° N and longitude 11° 40'E and on altitude 660m above sea level.

2.2 Sources and Description of the Seeds Genotypes

Seeds of three cowpea varieties: IT87D 941-1, IT97K 499-35 and Dankurmi were collected from the Institute for Agricultural Research, Ahmadu

Bello University, Zaria. The first two varieties are improved varieties which are tall and photo-insensitives. The latter is a local variety which is short and photo-sensitive.

2.3 Experimental Design

Completely Randomized Design was used. The Seeds of the three cowpea varieties (IT87D 941-1, IT97K 499-35 and Dankurmi) were sown in Plastic pots and are arranged in six replications.

2.4 Crossability Studies

Crosses were made between three cowpea Genotypes (varieties) in a factorial mating design. Two of the three genotypes (varieties) coded A and B were used as female parents and all the three genotypes (varieties) coded A, B and C were used as male parents in 2 x 3 factorial mating design. Five flowers were hand pollinated per plant for each genotypic combination. The number of genotypic combinations performed for each combination was determined by the synchrony of flowering and the number of flowers available per parental plant. Emasculated (female parent) flowers were (cross) pollinated at anthesis. A small tag listing the cross and date was affixed to the peduncle beneath the pollinated flower bud. Unfertilized flowers drop within 24 hours after anthesis hence crosses were recorded as successful three days after pollination. Parental plants and hybrids were evaluated for plantings. All plants were grown in insect proof screen house. Diseases and insects were controlled by using Bertoline and Justfaxien (spray), weeds were controlled by hand pulling while vertebrate pests were controlled using the appropriate cultural practices. Data recorded were days from sowing to first flower, days from sowing to first pod maturity, plant height at first flower, plant height at first pod maturity, pod length, leaf area, number of successful crosses (percentage), number of pods per plant and number of seeds/pod (Nwofia *et al.*, 2015).

2.4.1 Plant Heights

Plant height was measured from soil level to the growing tip on the main stem (Ishiyaku and Singh, 2001) using a meter rule.

2.4.2 Leaf Area

Leaf area was estimated by measuring the length and width of the selected leaves and multiplied by 2.325 (Ishiyaku and Singh, 2001).

$$A = [(L)(W)(2.325)] \times 2$$

A = leaf area per plant

W = Width of leaves

L = Length of leaves

2.325 is the constant leaf area factor for cowpea.

2.4.3 Number of Pods per Plant

The number of pods produced per plant was counted and recorded.

2.4.4 Length of Pods Per plant

This was determined by the use of a meter rule. The length of the pods per plant from the stalk to the terminal ends of the pods were measured and recorded (Ewa-Ubi, 2001).

2.4.5 Number of Seeds per Pod

This was done by breaking some pods and the number of seeds produced per pod counted and recorded.

2.4.6 Number of Successful Crosses

The number of plants that showed success in the crosses was determined in percentages and recorded. To determine the mode of inheritance of plant height and pod length, 20 parent seeds and 20 of the F₁ seeds of each varietal line were planted in the screen house and part of the plants selfed to produce the F₂ generations. The remaining F₁ plants were used to raise backcrosses and reciprocal backcrosses. Segregation data were evaluated in plantings. Using 20 seeds of each of the parent, 20 seeds of each of the F₁ and reciprocal F₁'s, 10 seeds of the backcrosses and reciprocal backcrosses and 50 seeds of the F₂ populations for traits in plant height, pod length, and days to first flowering for their goodness of fit to the proposed (appropriate) genetic ratios.

2.5 Data Analyses

Data were subjected to one way Analysis of Variance (ANOVA) at 5% level of significance. Duncan's Multiple Range Test (DMRT) was used to separate the means. All tests for relationships were done using Pearson's Product Moment correlation co-efficient statistics. All analyses were performed using SAS V. 9.2 (2008).

3.0 RESULTS AND DISCUSSIONS

3.1 Mean Effects of Variation in Some Quantitative Traits of Parents and Cowpea Hybrids

A comparative account of the morphology of the parents and the F₁ hybrids in three cowpea varieties (IT87D 941-1, IT97K 499-35 and Dankurmi) were presented in Table 1. The results revealed that, the mean values of quantitative traits of IT87D 941-1, IT97K 499-35 and Dankurmi ranges from 6.80 in number of seeds per pods to 66.50 at days to maturity. The highest and lowest mean values of the quantitative traits were obtained in Dankurmi variety, the lowest in crosses involving Dankurmi (as male parent) may be due to low pollen content, this was in line with the findings of Bothmer *et al.* (1995) who reported similar average seed set in crosses involving the three barley varieties as males. The mean value for the crosses between IT87D 941-1 and IT97K 499-35 ranges from 8.30 at number of seeds per pods to 63.30 at days to maturity. crosses between IT87D 941-1 and Dankurmi had the mean values that ranges from 4.70 to 68.0 at number of seeds per pods and at days to maturity respectively, also crosses between IT97K 499-35 and Dankurmi had mean range values of 8.10 at number of seeds per pods and 67.30 at days to maturity respectively. The mean values for days to first flowering in the hybrids were closer to the value of the earlier flowering parent, suggesting partial dominance of the alleles for early flowering. Similar observations were made by Adu – Dapaah *et al.* (1999) in cowpea. Ishiyaku *et al.* (2005) reported that photoperiod sensitivity was partially dominant to insensitivity. Photo sensitive cultivars flower early when day lengths are less than 12.5 hrs (Ishiyaku and Singh, 2001).

3.2 Relationship between Variation in Some Quantitative Traits of the Selected Cowpea Varieties and the F₁ Hybrids

The result from the correlation co-efficient analysis of some quantitative traits of the three cowpea varieties is presented in Table 2. The result indicated that there were significant (negative) correlations between the numbers of days to first flower with plant height at first flower, height at maturity, number of pods/plant, length of pods and number of seeds/pod, but no significant correlations was found between the number of days to first flower with

number of days to maturity, crossability percentages and leaf area, this may be due to the planting dates of February and March due to short day length. However, highly significant correlations were found between plant height at first flower with height at maturity and number of pods/plant. Generally plant height in photo insensitive varieties was less affected by sowing date (Ishiyaku and Singh, 2001).

Significant correlations were also found between the heights at first flower with length of pods and number of seeds/pod. The significant correlation was due to the interaction of the genotypes in the hybridization. The hybrids were intermediate of the parents in number of in days to first flower. The hybrids were also intermediate of the parents in plant height, both at time of first flower and at maturity. These observations are in agreement with work done by Kumari *et al.* (2018) who reported that hybrid plants were found to be vigorous and intermediate between the parent species with respect to many morphological characteristics. More so, significant negative correlations were found between the plants height at first flower with number of days to maturity. No significant correlation was however found between the heights at first flower with crossability percentages and leaf area. A significant correlation was found between the crossability percentages with leaf area and number of days required for maturity, but no significant correlation was found between crossability percentages with height at maturity, number of pods/plant, length of pods and number of seeds. However, no significant correlations were found between crossability percentages with height at maturity, number of pods/plant, length of pods and number of seeds/pod. Significant correlation however exist between the crossability percentages with leaf area and number of days required to maturity. On the other hand, no significant correlation exist between the leaf area and number of days to maturity, height at maturity, number of pods/plant and number of seeds/pod, but significant correlation was found between the leaf area and length of pods/plant.

Furthermore, the number of days required to maturity correlated significantly with height at maturity, number of pods per plant and length of pods. No significant correlation was found with the

number of seeds/pod. More so, a highly significant correlation was found between the height at maturity with number of pods/plant and significantly with the length of the pods and number of seeds/pod. Similarly, the number of pods/plant correlated significantly with the length of the pods and number of seeds/pod. And also, the length of the pods correlated significantly with the number of seeds produced per pod.

3.3 Mean Values of Different Quantitative F₂ Traits in Some Cowpea Hybrids.

The mean values of the different F₂ traits in the hybrids of cowpea are presented in Table 3. The results revealed that, the highest mean values for the crosses between IT87D 941-1 and IT97K 499-35 among the F₂ hybrids ranges 8.67 at number of seeds per pods to 68.83 at days to maturity. Similarly, the mean values for the crosses between IT87D 941-1 and Dankurmi ranges from 6.50 at number of seeds per pods to 68.17 at days to maturity. Also the mean values for the crosses between IT87D 941-1 and Dankurmi revealed mean values of 5.33 at number of seeds per pods to 68.00 at days to maturity. The crosses made with higher mean values than other crosses revealed that there was recorded increase in plant height of hybrids produced from the crosses, it is also affect the pod length with an improvement to the length of the short pods. This findings is in line with the findings of Brown *et al.* (1995) reported the improvement of Brassica crops through the application of widely of inter specific hybridization.

3.4 Relationship between Some Quantitative F₂ Traits of the Selected Cowpea Varieties

The results of the relationships between the yield and growth parameters of the F₂ generations were presented in Table 4. The results revealed the presence of highly significant relationships ($P \geq 0.01$) between the number of pods produced per plants with plant heights, leaf area and height at maturity with significant negative correlations ($P \geq 0.05$) with number of days to flower, the result on leaf area is in agreement with the work of Vaijyanthi and Ramesh (2019) who reported that there were significant differences among cowpea genotypes as for width and length of terminal leaflet and leaf area, while no significant correlation exist between

the number of pods with crossability percentages and days to maturity. Similarly, highly significant correlations exist between the lengths of the pods with plant height and height at maturity, and significantly with crossability percentages, leaf area number of pods/plants and negatively with number of days to flower. No significant correlation was found between the lengths of the pods and days to maturity. However, the number of seed produced per pod correlate highly ($P \geq 0.01$) with plant height, height at maturity, number of pods/plant and length of pods. Furthermore, the number of seeds produced per pod correlates significantly ($P \geq 0.05$) with crossability percentages and negatively with the number of days to flower. These observations are in agreement with work done by Kumari *et al.*, (2018) who reported that hybrid plants were found to be vigorous and intermediate between the parent species with respect to many morphological characteristics. However, no significant correlation was found with the days to maturity.

Table 1: Mean of Variation in Some Quantitative Traits of Selected Cowpea Varieties.

Varieties	No. of Days	Plant Height	Crossability	Leaf Area	Days to Maturity	Height at Maturity	No. of Pods per Plant	Pod Length	No. of Seeds
A									
IT87D941-1	47.20	38.90 ^a	0.00	39.50 ^a	66.50 ^b	40.90 ^a	36.70 ^a	12.50 ^a	10.80 ^a
B									
IT97K499-35	46.00	39.00 ^{ba}	0.00	41.80 ^a	65.80 ^c	41.70 ^a	34.00 ^b	12.90 ^a	12.30 ^a
C									
DANKURMI	50.80	17.80 ^c	0.00	31.80 ^c	69.20 ^a	19.40 ^c	25.20 ^d	7.90 ^b	6.80 ^b
A X B	47.30	39.20 ^a	40.00	40.40 ^a	63.30 ^d	41.30 ^a	34.80 ^{ba}	12.60 ^a	8.30 ⁿ
A X C	49.20	33.60 ^b	33.30	36.00 ^b	68.00 ^a	35.70 ^b	28.50 ^c	8.60 ^b	4.70 ^c
B X A	48.00	39.50 ^a	30.00	36.40 ^b	65.70 ^c	41.10 ^a	32.80 ⁿ	12.80 ^a	8.50 ^b
B X C	49.50	33.10 ^b	26.70	32.90 ^c	67.30 ^b	34.80 ^b	26.70 ^{dc}	8.90 ^b	4.80 ^c
Mean	48.30	34.50	32.50	37.60	66.90	36.90	31.20	10.90	8.10
S.E±	2.50	1.40	11.10	19.90	2.30	1.40	1.80	1.60	1.70

Table 2: Correlation Co-efficient of observed Variation in Quantitative Traits of Selected Cowpea Varieties

Varieties	No. of Days to First Flower	Plant Height at First Flower	Crossability (%)	Leaf Area	Days to Maturity	Height at Maturity	No. of Pods per Plant	Pod Length	No. of Seeds per Pod
No. of Days to First Flower	1								
Plant Height at First Flower	-0.486*	1							
Crossability %	-0.128 ^{ns}	0.135 ^{ns}	1						
Leaf Area	-0.339 ^{ns}	0.144 ^{ns}	0.394*	1					
Days to Maturity	0.149 ^{ns}	-0.399*	-0.381*	-0.338 ^{ns}	1				
Height at Maturity	-0.489*	0.999**	0.176 ^{ns}	0.153 ^{ns}	-0.395*	1			
No. of Pods per Plant	-0.395*	0.758**	0.260 ^{ns}	-0.119 ^{ns}	-0.365*	0.759**	1		
Pod Length	-0.0452*	0.651*	0.327 ^{ns}	0.395*	-0.540*	0.650*	0.687*	1	
No. of Seeds per Pod	-0.419*	0.421*	0.042 ^{ns}	0.055 ^{ns}	-0.209 ^{ns}	0.417*	0.602*	0.559*	1

Ns= not significant * = significant (P ≥ 0.05) ** = Highly Significant (P ≥ 0.01)

Table 3: Mean Values of Different Quantitative F2 Traits

Variety	No. of Days to First Flower	Plant Height at First Flower	Crossability	Leaf Area	No. of Days to Maturity	Height at Maturity	No. of Pods per Plant	Pod Length	No. of Seeds per Pod
A X B	45.83 ^c	38.00 ^{ab}	30.00	38.17 ^a	68.83 ^b	43.17 ^{ab}	35.17 ^a	12.17 ^a	8.67 ^a
A X C	48.00 ^a	30.00 ^b	29.33	30.33 ^c	69.67 ^a	31.67 ^v	27.67 ^d	9.33 ^c	6.50 ^c
B x A	45.67 ^d	38.33 ^a	39.50	30.50 ^b	65.33 ^d	41.33 ^a	32.17 ^b	11.33 ^b	8.33 ^d
B x C	48.33 ^b	29.67 ^c	24.00	28.67 ^c	68.17 ^c	30.00 ^b	28.50 ^c	9.33 ^c	5.33 ^d
Means	46.96	34.00	30.71	31.92	68.00	36.54	30.88	10.54	7.21
S.E ±	2.43	2.70	3.22	2.13	0.94	3.33	1.73	0.72	0.79

Values with the same letter(s) within the column are not significantly different ($P \leq 0.05$).

Key- A: IT 87D 941-1, B: IT97K 499-35, C: Dankurmi. SE : Standard Error

Table 4: Correlation Co-efficient Between Variations in Some F2 Traits of Selected Cowpea Varieties

Varieties	No of Days to Flower	Plant Height	Crossability (%)	Leaf Area	Days to Maturity	Height at Maturity	No. of Pods per Plant	Length of Pods	No. of Seeds per Pod
No. of Days to Flower	1								
Plant Height	-0.580*	1							
Crossability (%)	-0.110 ^{ns}	0.167 ^{ns}	1						
Leaf Area	-0.312 ^{ns}	0.233 ^{ns}	0.330 ^{ns}	1					
Days to Maturity	0.163 ^{ns}	-0.401 ^{ns}	-0.421 ^{ns}	-0.391 ^{ns}	1				
Height at Maturity	-0.691*	-0.630*	0.180 ^{ns}	0.113 ^{ns}	-0.296 ^{ns}	1.000*			
No. of Pods per Plant	-0.460*	-0.866**	0.428 ^{ns}	0.781**	0.162 ^{ns}	0.851**	1		
Length of Pods	-0.470*	0.963**	0.561*	0.690*	-0.141 ^{ns}	0.989**	0.512*	1	
No. of Seeds per Pods	-0.461*	0.954**	0.740*	0.738*	-0.311 ^{ns}	0.982**	0.812**	0.942**	1

^{ns} = Not significant * = Significant ($P \geq 0.05$) ** = Highly significant ($P \geq 0.01$)

4.0 CONCLUSION

It was concluded that hybrid plants were found to be vigorous and intermediate between the parent varieties with respect to many quantitative traits. The seed set data indicated that cross compatibility was lower in crosses involving Dankurmi, which may be due to low pollen content and the high seed set in IT87K 499-35 suggests high receptivity for pollen. This may be due to high fertility and compatibility. There was recorded increase in plant height and pod length in hybrids produced from the crosses involving the variety Dankurmi. This study

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