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Efficacy of Some Cowpea Genotypes Against Major Insect Pests in Southeastern Agro-Ecology of Nigeria

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Abstract: Eight cowpea (*Vignaunguiculata* L. Walp) genotypes under improvement were screened for their efficacy against major insect pests of cowpea in southeastern agroecology of Nigeria in 2011 and 2012 cropping seasons at the Abia State University research farm. Results of the study indicate significant variations amongst the genotypes for the agronomic and damage attributes. The principal component analysis (PCA), PC1, PC2, PC3 and PC4 accounted for 90.13%, 6.51%, 2.37% and 0.69% of the total variation individually and 99.7% combined. while the, Hierarchical cluster analysis conducted grouped the genotypes into four distinct clusters thus; - cluster I – low yield and susceptible (4 genotypes), cluster II – early flowering (2 genotypes), cluster III – late maturing and high leaf area (1 genotype), cluster IV – resistant and high grain yield (1 genotype). Grain yield was significantly and positively correlated with pod number per plant (r = 0.97**) and pod length (r = 0.79*) while it was significantly significantly and negatively related with number of; aphid (r = -0.91**), thrip (r = -0.91**), foliage beetle (r = -0.94**), legume pod borer (r = -0.89**) @ 12 WAE and damaged pod (r = -0.84**). Genotypes; IT89KD-288 (V4) and IT89KD-391 (V2) had the outstanding performance and need to be fully exploited in the ecological zone.

Key words: Cowpea · Genotypes · Host Plant Resistant (HPR) · Insect pests · Efficacy · *Vigna unquiculata* L. walp

INTRODUCTION

The yield of cowpea (*Vigna unguiculata* L. Walp) which is widely grown in all tropical and sub-tropical countries is relatively low averaging < 500kg/ha [1]. The primary production constrain is a diverse and destructive pest complex that sometimes results in total crop failure in the field [2] Kumar [3] estimated that in northern Nigeria, potential loss in yield of cowpea due to insects is over 90%. According to him, it is virtually impossible to obtain any meaningful harvest without the use of insecticides to combat pests. Insect pests can cause serious damage to cowpea by feeding on flowers and leaves thus reducing pods set and pod yield of susceptible varieties. The major field insect pests are Aphid (*Aphis craccivora* Koch), Thrips (*Megalurothrips sjostedti* Trybom), Legume pod borer (*Maruca vitrata* Fab.) and Foliage beetle (*Ceratoma trifurcata*) [4]. In order to control these insect pests, cowpea growers are increasingly using chemical pesticides, cultural control method, biological control which is more popular in developed countries and Host Plant Resistance (HPR). Nevertheless, questions of economic and environmental sustainability and negative impacts on public health have been raised in regard to pesticide use, Similarly, cultural control method may not be sufficiently effective thus it is not always applicable [5]. There is therefore pressing need to develop a suitable alternatives to pesticides and other unwholesome methods of pest control. However, Host Plan Resistance (HPR) is often promoted as an approach for controlling destructive pest populations while simultaneously eliminating the use of chemicals. Insect – resistant plant alter the relationship an insect pest has with its host plant

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and the relationship between the insect and plant depends on the kind of resistance e.g. antibiosis, antixenosis (non-preference), or tolerance [6]. Use of insect- resistant crop varieties is economically, ecologically and environmentally beneficial [3]. In south east agroecology of Nigeria the potential of cowpea production is yet to be attained due to lack of typically improved cowpea ecotypes with wide variation in the abilities to adapt in this insect pest endemic ecology. Sustainable cowpea production intensification will require cowpea varieties that are better adapted to ecologically based production practices than those currently available.The advocacy for gene pool assemblage and evaluation is to identify improved cowpea genotypes that can appropriately fit into the agro-environment which will ensure stability and satisfactory yields in the local area in which insect pest condition vary, hence the need to assess eight cowpea varieties.

The objective of this is to identify 8 improved cowpea genotypes that can appropriately fit into the agro-environment which will ensure stability and satisfactory yields in south east Nigeria.

MATERIALS AND METHODS

Field trial were conducted in 2011 and 2012 to investigate the genotypic performance of some cowpea varieties as influence by major insect pests in southeastern agroecology at the experimental field of the Department of Crop Science, Abia State University, Uturu (Lat. 5°32' N and Long. 7°29' E, 91.44m ASL). The varieties which were obtained from the National Root Crop Research Institute, Umudike (Table 1) were grown in a plot area of 3m × 3m and replicated 5 times using a randomized complete block design. A space of 1.5m was allowed between treatment plots and 2.0m was spaced between blocks to minimize treatment interference due to the spreading nature of cowpea. The seeds were planted at 3 seeds per hill which was later thinned down to 2 seeds per hill two weeks after planting at spacing of 30cm × 75cm which gave plant population density of 88,888plants/ha and 80plants/plot. Weeding was done regularly and manually to reduce inter-species competition.

Table 1: Genotypic code, name of genotype and seed quality

GENOTYPIC CODE	NAME OF GENOTYPE	SEED QUALITY
V1	IR48	Small white
V2	IT89KD-391	Medium to large brown
V3	RCI-28	Medium brown
V4	IT89KD-288	Large white
V5	IT90K-277-2	Medium white
V6	IT97K-499-35	Medium to large brown
V7	IT90K-760	Medium brown
V8	IT90K-82-2	Small brown

Field Sampling and Scouting Frequency: Frequent and regular field inspection was conducted in a prescribed fashion to measure pest levels and to determine the density and development of insect populations since it gives a representative objective assessment of the pest situation in a whole field. This was done from 6.30 – 9.30 am every two weeks interval after crop emergence. Insect pests were sampled by randomly picking 15 plants in each plot and virtually assessing the overall appearance of the leaves, vines, flowers and pods for insects or signs of damage by pest. A hand lens and diagnostic manual for the identification of insect pathogens published by Poinar and Thomas [7] was used for confirmation of insect identity.

Data Analyses: The data for the two years were pooled as there were no significant differences between years Agronomic and insect pests damage parameters collected were subjected to uni- and multi-variate analyses to select promising genotypes. The procedures used include; Pearson Correlation Coefficient used to estimate the relationships between the yield and yield related traits [8] while principal component analysis was used to identify the discriminating morphological traits [9]. Dendrogram and genetic similarity among the genotypes was also generated using the Jaccard's Coefficient of similarity expressed as Euclidean genetic distances [10]. Similarly, cluster analysis was used to sort the genotypes into their appropriate group with minimum error [11]. A Rank Summation Index (RSI) method was introduced to rank the genotypes for their overall performance as proposed by Ngwuta [12]. To obtain the RSI, genotypes were first ranked for each parameter (that is; 1= best genotype and 8 = poorest genotype) and the parameter ranks summed to generate overall performance of each genotype. Hence, the lower the RSI of any genotype, the greater is its resistance and the better is its agronomic performance. Analysis of Variance (ANOVA) was used to compare variables using Genstat [13] and Statistical Package for Social Sciences (SPSS) softwares. Data analysis and interpretation was based on Wahua[14]. Where significant differences are observed Least Significance Difference (LSD) at 5% level of probability was used to separate the test and means for difference.

RESULTS

The means for agronomic and damage traits of eight genotypes evaluated are presented in Table 2. There were significant variations among the genotypes for fourteen of the seventeen parameters assessed.

The coefficient of variation (CV) obtained showed that most of the traits had moderate to high CV estimates. Foliage beetle number at 8WAE had the highest CV (49.8%), followed by aphid number (40.6%) at 8WAE. Lowest CV was recorded in days to 50% flowering (1.7%) and days to maturity (3.4%).

The results of the principal component analysis (PCA) of the parameters measured are presented in Table 3. From the results, PC1, PC2, PC3 and PC4 accounted for 90.13%, 6.51%, 2.37% and 0.69% of the total variation individually and 99.7% combined. The first principal axis had high positive contributing factor loadings from leaf damage at 12WAE, aphid number at 12WAE and foliage beetle number at8WAE. The second principal component had high positive contributing factor loadings from days to 50% flowering and days to pod maturity, while pod length and pod number per plant which recorded high loadings in third principal component axis can be regarded as productive and yield axis since it is highly loaded for yield parameters. The fourth axis had high loadings for leaf area at 8WAE and leaf damage at 12WAE.

Table 4 shows that cluster I comprised of genotypes with fewer seed number per pod which are also susceptible to leaf damage. Cluster II comprised of early maturing, while cluster III is late maturing genotype that

Table 2: Agronomic and damage traits variations of 8 cowpea genotypes

Genotype	50%E	50%F	LA(CM^2) 8WAE	AN 8WAE	TN 8WAE	FBN 8WAE	LBN 8WAE	AN 12WAE	TN 12WAE	FBN 12WAE	LBN 12WAE	LD(%) 12WAE	PN/PT	DTM	DP/PT	SN/P	PL (CM)	GY (t/ha)
IR48(V1)	8.3	62.3	165.9	5.50	2.8	5.3	4.0	10.0	5.0	6.0	6.3	20.8	5.0	105.3	25.6	6.8	16.5	1.53
IT89KD-391(V2)	7.5	59.3	175.9	3.25	1.3	1.0	1.8	5.3	2.3	3.0	2.0	16.5	9.8	98.5	10.5	7.1	18.5	2.05
RCI-28 (V3)	7.5	81.5	236.1	5.00	2.3	2.8	2.8	6.0	3.3	4.5	6.0	16.3	8.8	123.8	21.7	7.0	16.5	1.83
IT89KD-288(V4)	7.3	79.3	202.9	2.25	1.0	0.8	1.3	4.0	2.0	2.3	1.8	14.3	11.0	120.3	9.2	7.5	18.8	2.25
IT90K-277-2(V5)	8.0	72.5	144.6	3.50	1.5	2.0	2.8	6.3	4.0	3.5	2.8	29.3	8.8	121.5	16.0	7.0	18.8	1.94
IT97K-499-35(V6)	8.0	70.8	141.4	4.50	1.8	2.3	3.0	6.8	3.8	5.0	6.8	24.3	6.8	116.0	16.5	6.8	17.3	1.65
IT90K-760 (V7)	7.8	70.3	115.6	4.75	2.0	6.3	3.0	8.0	4.3	6.3	5.8	22.0	6.0	119.3	18.1	5.6	16.5	1.65
IT90K-82-2(V8)	8.0	67.8	123.8	4.50	2.3	3.3	3.8	8.3	3.8	6.0	4.3	20.3	7.0	106.0	21.6	6.8	15.8	1.73
MEAN	7.8	70.4	163.3	4.16	1.8	2.9	2.8	6.8	3.5	4.6	4.4	20.4	7.9	113.8	17.4	6.8	17.3	1.83
$LSD_{(0.05)}$	N.S	1.72	22.3	N.S	0.9	2.2	0.96	1.9	1.4	2.3	1.9	2.5	1.9	5.8	3.7	N.S	N.S	0.38
S.E	0.9	1.17	15.2	1.69	0.64	1.5	0.65	1.3	0.9	1.7	1.3	1.7	1.3	3.9	2.5	1.1	2.6	0.26
CV (%)	12.2	1.7	9.3	40.6	34.8	49.8	23.4	19.1	27.7	34.3	30.4	8.3	16.5	3.4	14.3	15.8	15.3	14.3

WAE = weeks after plant emergence

50%E = days to 50% emergence, 50%F = days to 50% flowering, LA = leaf area at 8WAE, AN = Aphid number per plant at (8 or 12)WAE, TN = Thrip number per plant at (8 or 12) WAE, FBN= Foliage beetle number per plant at (8 or 12)WAE, LPB= Legume pod borer number per plant at (8 or 12)WAE, LD12WAE = Leaf damage at 12WAE (%), PN/PT = Pod number per plant, DTM = Days to pod maturity, DP/PT = Damage pod per plant (%), SN/P = Seed number per plant, PL = pod length, GY = Grain yield.

Table 3: Latent vectors (loadings) for the first four principal components for 8 cowpea genotypes

Trait	PC1	PC2	PC3	PC4
Aphid number at 12WAE	0.0246	-0.0338	-0.2235	-0.0172
Aphid number at 8WAE	0.0053	-0.0040	-0.1495	-0.0111
Days to 50% emergence	0.0045	-0.0020	-0.0298	0.0416
Days to pod maturity	-0.0580	0.8041	-0.0117	0.1236
Damage pod per plant (%)	0.0209	0.0001	-0.8221	-0.0518
Foliage beetle number at 12WAE	0.0205	0.0021	-0.1722	-0.1196
Foliage beetle number at 8WAE	0.0218	0.0167	-0.2018	-0.1259
Grain yield (t/ha)	-0.0029	-0.0888	0.0292	-0.0001
Days to 50% flowering	-0.0937	0.5639	0.0440	-0.3973
Leaf area at 8WAE (cm^2)	-0.9893	-0.0888	-0.0575	0.8930
Leaf damage at 12WAE (%)	0.0770	0.1563	-0.1189	0.8647
Legume pod borer number at 12WAE	0.0083	0.0356	-0.2431	-0.0496
Legume pod borer number at 8WAE	0.0106	-0.0045	-0.1158	0.0067
Pod length (cm)	-0.0072	0.0030	0.1426	0.1681
Pod number per plant	-0.0291	0.0124	0.2281	0.0024
Seed number per plant	-0.0084	-0.0107	0.0268	0.0350
Thrip number at 12WAE	0.0129	0.0107	-0.1174	0.0616
Thrip number at 8WAE	0.00134	0.0132	0.0123	0.0050
Percentage variation (%)	90.13	6.51	2.27	0.69
Latent roots	11936	862	314	92

Table 4: Cluster means for agronomic and damage traits of 8 cowpea genotypes

Plant character	I	II	III	IV
Aphid number at 12WAE	7.00	8.00	6.00	4.00
Aphid number at 8WAE	4.30	4.40	5.00	2.30
Days to 50% emergence	7.90	7.90	7.50	7.30
Days to pod maturity	115.70	101.90	123.30	120.30
Damage pod per plant (%)	18.08	18.03	21.70	9.23
Foliage beetle number at 12WAE	5.00	5.00	5.00	2.00
Foliage beetle number at 8WAE	3.50	3.20	2.80	0.80
Grain yield (t/ha)	1.74	1.79	1.83	2.25
Days to 50% flowering	70.40	60.80	81.50	74.30
Leaf area at 8WAE (cm^2)	131.40	170.90	239.10	202.90
Leaf damage at 12WAE (%)	24.00	18.70	16.30	14.30
Legume pod borer number at 12WAE	4.90	4.20	6.00	1.80
Legume pod borer number at 8WAE	3.00	3.00	3.00	1.00
Pod length (cm)	17.10	17.50	16.50	18.80
Pod number per plant	7.00	7.00	9.00	11.00
Seed number per plant	6.60	7.00	7.00	7.50
Thrip number at 12WAE	4.00	4.00	3.00	2.00
Thrip number at 8WAE	1.90	2.10	2.30	1.00
Proportion (%)	50.0	25.0	12.5	12.5

Table 5: Number of genotype, genotype and seed quality of the 8 cowpea genotypes shown according to the clusters obtained from cluster analysis

Group	Number of genotype	Genotype	Seed quality
CLUSTER I	4	IT90K-277-2(V5)	Medium white
		IT97K-499-35(V6)	Medium to large brown
		IT90K-760(V7)	Medium brown
		IT90K-82-2 (V8)	Small brown
CLUSTER II	2	IR48 (V1)	Small white
		IT89KD-391 (V2)	Medium to large brown
CLUSTER III	1	RCI-28 (V3)	Medium brown
CLUSTER IV	1	IT89KD-288 (V4)	Large white

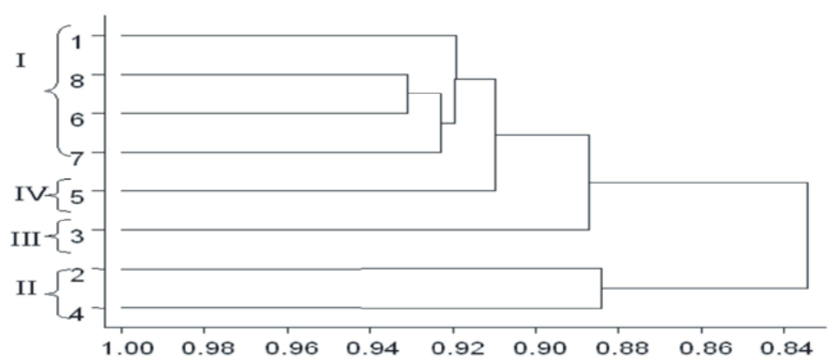

Fig. 1: Dendrogram of 8 improved cowpea genotypes based on some traits

is highly susceptible to pod damage. Genotype in cluster IV is the most resistant and has the highest grain yield. It also exhibited best performance in most of the characteristics measured. The intra-population variability evaluated by hierarchical cluster analysis conducted on the parameters evaluated grouped the genotypes into four clusters (Table 5). Cluster I comprised of four genotypes which were all brown in seed colour except IT90K-277-2 (v5). Cluster II was made up of two genotypes while clusters III and IV comprised of one genotype each. The four clusters maintained same level of distance from each other.

The resultant UPGMA clusters analysis presented in Fig 1 shows the existence of four major clusters at 0.830 similarity of coefficient.

Table 6: Pearson correlation matrix of some agronomic and damage parameters of 8 cowpea genotypes evaluated

Plant trait	1	2	3	4	5	6	7	8	9	10	11	12
1.Days to pod maturity	1											
2.Days to 50% flowering	0.90**	1										
3. Leaf damage at 12WAE (%)	0.20	-0.15	1									
4.Aphid number at 12WAE	-0.32	-0.48	0.38	1								
5.Thrip number at 12WAE	0.01	-0.27	0.65	0.92*	1							
6.Foliage beetle number at 12WAE	-0.13	-0.26	0.30	0.91**	0.83**	1						
7.Legume pod borer number at 12WAE	-0.16	-0.33	0.24	0.67	0.72*	0.80*	1					
8.Pod number per plant	0.20	0.41	-0.44	-0.96**	-0.92**	-0.94**	-0.81*	1				
9.Damage pod per plant (%)	-0.04	-0.10	0.25	0.86**	0.83*	0.83*	0.76*	-0.80*	1			
10.Seed number per plant	-0.09	0.19	-0.34	-0.57	-0.61	-0.75	-0.54	0.69*	-0.38	1		
11.Pod length (cm)	0.12	0.07	0.03	-0.75*	-0.60	0.91**	-0.76*	0.75*	-0.84**	0.54	1	
12.Grain yield (t/ha)	0.14	0.33	-0.43	-0.91**	-0.91**	-0.94**	-0.89**	0.97**	-0.84**	0.65	0.79*	1

•*Correlation is significant at the 0.05 level (2-tailed), **Correlation is significant at the 0.01 level (2-tailed)

Table 7: Plant traits, their ranks and rank summation index (RSI) of 8 cowpea genotypes

Genotype	LD(%)12WAE	R1	DTM	R2	PL(CM)	R3	PN/PT	R4	SN/P	R5	DP/PT(%)	R6	GY(t/ha)	R7	RS1
IT89KD-288 (V4)	14.3	1	120.3	6	18.8	1	11.0	1	7.5	1	9.23	1	2.25	1	12
IT89KD-391 (V2)	16.5	3	98.5	1	18.5	3	9.8	2	7.1	2	10.48	2	2.05	2	15
IT90K-277-2(V5)	29.3	8	121.5	7	18.8	1	8.8	3	7.0	3	16.03	3	1.94	3	28
RCI-28 (V3)	16.3	2	123.8	8	16.5	5	8.8	3	7.0	3	21.70	7	1.83	4	32
IT97K-499-35(V6)	24.3	7	116.0	4	17.3	4	6.8	6	6.8	5	16.53	4	1.65	6	36
IT90K-82-2 (V8)	20.3	4	106.0	3	15.8	8	7.0	5	6.8	5	21.62	6	1.73	5	36
IR48 (V1)	20.8	5	105.3	2	16.5	5	5.0	8	6.8	5	25.57	8	1.52	8	41
IT90K-760(V7)	22.0	6	119.3	5	16.5	5	6.0	7	5.6	8	18.12	5	1.65	6	42

R1 to R7 = Rank 1 to Rank 7, RSI = Rank Summation Index. LD12WAE = Leaf damage at 12WAE (%), PN/PT = Pod number per plant, DTM = Days to pod maturity, DP/PT = Damage pod per plant (%), SN/P = Seed number per plant, PL = pod length(cm), GY = Grain yield(t/ha).

Correlation: The correlation studies of Pearson correlation coefficient (r) revealed significant (P = 0.05) to highly significant (P = 0.01) level of probability among the traits (Table 6). Grain yield was significantly and positively correlated with pod number per plant (r = 0.97**) and pod length (0.79*) and significantly and negatively related with aphid number at 12 WAE (r = -0.91**), thrip number at 12WAE (r = -0.91**), foliage beetle number at 12 WAE (r = -0.94**), legume pod borer number at 12 WAE (r = -0.89**) and damage pod per plant (r = -0.84**) and negatively related with leaf damage at 12 WAE (r = -0.43). Significant and positive correlations were found between damage pod per plant and aphid number at 12 WAE (r = 0.86**), thrip number at 12 WAE (r = 0.83*), foliage beetle number (r = 0.83*) and legume pod borer at 12 WAE (r = 0.76*) and significantly and negatively related with pod number per plant (r = -0.80*). However, the relationships, between the leaf damage at 12 WAE with aphid number at 12 WAE, thrip number at 12 WAE, foliage beetle number at 12 WAE, legume pod borer number at 12 WAE and damage pod per plant were all positive but not significant. Conversely, it recorded negative correlation with pod number per plant (r = -0.44), seeds per pod (r = -o.34) and grain yield (r = - 0.43). Similarly, pod number per plant had significant and negative correlations with aphid number (r = -0.96**), thrip number (r = -0.92**), foliage beetle number (r = -0.94**) and legume pod borer (r = -0.81*) all at 12 WAE. It also recorded positive relationships with days to maturity (r = 0.20) and days to 50% flowering (r = 0.41).

Rank summation index (RSI): Grain yield, because of its strong relationship with insect damage parameters was included in constructing a selection index for selecting insect pest resistant cowpea genotypes. The rankings of the 8 cowpea genotypes (Table 7) using most important agronomic and insect pest damage parameters showed that IT89KD-288 (V4) had the best overall resistant level with a rank summation index (RSI) value of 12. This was followed by IT89KD-391 (v2) and IT90K-277-2 (V5) with RSI values of 15 and 28 respectively. Genotype IT90K-760 (V7) is the least of all the genotypes studied with the RSI value of 42. Selection of the top 25% (2 genotypes in all) include IT89KD-288 (v4) and IT89KD-391 (v2).

DISCUSSION

The highly to very highly significant varietal effect obtained from the agronomic and insect pest damage traits and the level of variability among the varieties observed in this study indicate that enough genetic variability exist among the genotypes to allow identification of genotypes with high level of insect resistance and desirable agronomic characteristics. The non-significant differences recorded in number of days to 50% emergence could be due to the uniformity and resemblance in the thickness of the seed coat and tissue layers among the genotypes. The variation obtained on the days to 50% flowering is in agreement with Thomas and Vince-Prue [15] who reported that many plants flower in response to seasonal changes in daylength and that this response often varies between accessions of a single species base on their genetic constitution. The variation observed in leaf area was largely due to varietal differences among the cowpea varieties evaluated or due to differences in anatomical, morphological and physiological features. This report is in support of Agbawa and Ndukwu [16] findings which believed that leaf sizes and numbers are dependent on the crop genetic endowment.

The significant genotype effect and the variations observed among the genotypes on the number of; aphids, thrips, foliage beetle and legume pod borer per plant was attributed to insect pest preference and non- preference for some genotypes as some plants possess characters that affect the behavior and selection pressure of the insect during orientation for food, shelter and oviposition. This finding is supported by Staedler [17] which reported that biochemical factors to a large extent, affect the behaviour and metabolic processes of the pests while morphological factors mostly influence the mechanisms of locomotion, feeding, oviposition, ingestion and digestion of the pests. According to Painter [18], "heritable characteristics of some crops, race, clone or individual may reduce the probability of successful utilization of that plant as a host by an insect species, race, biotype, or individual". The genotypes, IT89KD-288 (V4) and IT89KD-391 (V2) which recorded the least number of insect pests indicate that they possessed morphological and biochemical factors that made them less preferred by insect pests. Similarly, the variations observed on leaf damage may be due to differences in the genetic constitution of the genotypes is in agreement with Flint [19] who stated that resistant varieties may inhibit pest attack through toxic or repellent compounds or through physical factors such as colour or toughness. Harriman [20] also reported that reasonable silicate deposits in leaves of some crops make them unattractive to leaf feeding insect pests as it slows down the rate of digestion of the pests. This discrepancy obtained among the genotypes in pod number per plant, seed number per plant and pod length indicate that the characteristics are genetically controlled. Abdullah *et al*. [21] reported that crop genotypes produce fruits of various sizes as dictated by the genetic constitution. It is evident that fruits (pods) containing more seeds achieved greater pod length. Genotype IT89KD-288 (V4) had the highest grain yield (2.25 t/ha) and the highest pod length (18.8cm) and seed number per pod (7.5 seeds) when compared with the rest of the genotypes. This result agrees with Decker [22] who experimentally reported that fruits containing more seeds grew faster and achieved greater size. Similarly, the differences observed in days to pod maturity were attributed to genetic differentials. This again supports Fenemore [23] who in his report maintained that a crop may have genes conferring early maturity depending on its genetic diversity. The significant differences in damage pod per plant observed could be attributed to the differences in the genes conditioning resistance. Again, this is supported by Fenemore [23] whose experiment revealed that resistant varieties may have a high tolerance to pest damage. The low grain yield output obtained in IR48 (V1), IT97K-499-35 (V6) and IT90K-760 (V7) could be attributed to their susceptibility to insect pest infestation. This supports Ofuya[24] which emphasized that aphid, a major economic pest of cowpea, while feeding, removes sap from the leaves, pods, seeds and other aerial plant parts causing damage to the plant resulting in yield reduction. Odulaja and Oghiakhe [25] also reported that maruca feeds on tender stems, flower buds, flowers, peduncles, pods and leaves causing yield reduction.

The coefficient of variation (CV) used to compare the degree of variation from one data series to the other indicated that parameters like days to 50% flowering and days to maturity had the lowest CV unlike foliage beetle number at 8WAE that recorded very high CV. From the principal component analysis, traits such as aphid number, damaged pod per plant, leaf damage and foliage beetle number exhibited maximum contribution towards total variation among the genotypes. This observation supported by George [26] who classified cowpea varieties based on their traits. The distribution of the genotypes along the first three principal axes revealed a reasonable agreement with the hierarchical cluster. Most of the characters in the principal component axes were positive, suggesting that the characters made significant contribution in the genetic variability and therefore would provide useful information in the identification of a genetically distinct geographic variety or race. Major genotypic discrimination was observed along the PC1 axis. The intra-population variability evaluated by hierarchical cluster analysis on the parameters, grouped the cultivars into four clusters, indicating sufficient variation that could warrant identification of genotypes with satisfactory yields in a local area in which weather and pests conditions vary from year to year. The genotypes in cluster I are lowest yielding and most susceptible. Similarly, cluster II comprised of early flowering genotypes. The genotype RCI-28 (V3) in cluster III is essentially late flowering, late maturing, had highest leaf area and susceptible to damaged pod per plant. However, genotypes in cluster IV which also alienated itself from others produced the longest pods and had highest grain yield production capacity. It could be adjudged that the genotypes in cluster II and IV showed signs of future success in the production of resistant and high yielding capabilities and therefore, advocated for adoption as improved cowpea cultivars more adapted to the agroecology. The genotypes studied exhibited different degrees of genetic diversity in terms of the traits like leaf area, seeds number per pod, pod length and variation in the infestation of insect pests among the genotypes. These characteristics allowed differentiation among the genotypes in the first four principal axes and were the principal source of discrimination and characterization among the genotypes. The results recorded from dendrogram analysis summarized the intra-genetic relationships observed among the genotypes into four main clusters at 0.830 coefficient of similarity. The genotypes IT97K-499-35 (V6) and IT90K-82-2 (V8) gave the highest coefficient of similarity (0.930) indicating that they are closest affiliate or pair. IT97K-499-35 (V6) and IT90K-82-2 (V8) had Jaccard dissimilarity coefficient of 0.005 with IT90K-760 (V7) and Jaccard dissimilarity of coefficient of 0.010 with IR48 (V1). However, IT89KD-391 (v2) and IT89KD-288 (V4) which had similarity coefficient of 0.887 were clustered in cluster II while 0.889 and 0.910 coefficient of similarity were recorded in cluster III and IV respectively.

Grain yield was observed to be positively correlated with days to maturity, days to 50% flowering, pod number per plant, seed number per pod and pod length which indicate that the positive increase in the mean values of these traits will lead to an increase in grain yield. The positive correlation recorded between the grain yield, days to 50% flowering and seed per pod is in agreement with Picken [27] field experimental results. Positive correlation of grain yield with days to 50% flowering suggested that early flowering would reduce gain yield. The significant and positive correlations between grain yield and pod number per plant and pod length suggest that these characters contributed positively towards yield and should be considered when selecting for resistant and high grain yield in cowpea. This was supported by Ombakho and Tyagi [28]. Conversely, the highly significant negative correlations between grain yield and insect pests population indicates that grain yield was reduced as insect pests population increased, vice versa. This was supported by Ofuya [24] who reported that infestation with *Aphis craccivora* caused significant reductions in seed yield. The positive correlation between number of seeds per pod and pod length indicates that with longer pods more space is provided for seeds. However, the highly negative significant correlation between grain yield and damaged pods per plant showed that with many damaged pods the grain yield was reduced. Similarly, Positive and significant relationships between the damaged pods per plant and the number of aphid, thrip, foliage beetle and legume pod borer is an indication of a linear relationship existing between the damaged pods per plant and the above traits. This means that damaged pods per plant increases with increase in the number of aphid, thrip, foliage beetle and legume pod borer. The correlation between damaged pods per plant and pod number per plant was significant but negative which indicates that higher number of pods per plant were obtained in the genotypes that were less susceptible to pod damage. The negative relationships recorded between the seed number per pod and days to maturity, leaf damage and the number of aphid, thrip, foliage beetle, legume pod borer and damaged pods per plant indicates that the seeds number per pod increased with earliness in maturity and reduced in number as leaf damage incidence increases. Similarly, seeds number per pod become fewer as the number of the different insect pest mentioned before incresed. This is in accordance with Odulaja and Oghiakhe [25] experimental results.

CONCLUSION

There exist significant variations in the different cowpea genotype studied with respect to agronomic and pest damage traits. Selection based on the rank summation index calculated identified two top-ranking lines - IT89KD-288 (V4) and IT89KD-391 (v2) with RSI values of 12 and 15 respectively. This research finding is in agreement with IITA [29] research highlights which reported IT89KD-288 and IT89KD-391 superior over the current improved lines being cultivated and therefore could be recommended for testing on farmer's field since they could be used to overcome the challenges faced by cowpea farmers in the zone.

REFERENCES

1. Adipala, E., J.E. Obuo and D.S.O. Osiru, 1997. A survey of cowpea cropping systems in some districts of Uganda. African Crop Science Conference Proceedings, 3: 665-672.
2. Sabiti, A.G., E.N.B. Nsubuga, E. Adipala and D.S. Ngambeki, 1994. A socio – economic aspect of cowpea production in Uganda; A rapid rural appraisal Uganda Journal of Agricultural Sciences, 2: 59-99.
3. Kumar, R., 1999. Insect Pest Control; with special reference to African Agriculture. Arnold Hodder Headline Group. 338 Euston Road, London NWI. BH.
4. Omongo, C.A., M.W. Ogenga-Latigo, S. Kyamanywa. and E. Adipala, 1997. Effect of Seasons and Cropping Systems on Occurrence of Cowpea Pests in Uganda. African Crop Science Conference Proceedings, 3: 1111-1116.
5. Patel, P.N., 1995. Fungal, Bacterial and Viral Diseases of Cowpea in the USA. Chapter 14 in Cowpea Research, Production and Utilization, S.R. Singh and K.O. Rachie (eds.). John Wiley and Sons Ltd.
6. Uguru, M.I., 2005. Crop Genetic and Breeding. Revised Edition. *Ephrata Press*, 12 Orba Road, Nsukka, pp: 92-93.
7. Poinar, G.C. Jr. and G.M. Thomas, 1978. Diagnostic Manual for Identification of Insect Pathogens. *Plenum Press*, New York, pp: 232.
8. Ofori, I., 1996. Correlation and path-coefficient analysis of components of seed yield in bambara groundnut (*Vigna subterranean*). *Euphytica*, 91: 102-107.
9. Falowo, D.O., 1982. An application of principal component analysis response to F_3 Amazon Cocoa Seedlings to Insecticide Treatments. Nigerian Agricultural Journal, 12/18: 178-188.
10. Hair, J.F., R.F. Anderson, R.L. Tatum and W.C. Black, 1992. Multivariate Data Analysis. 3rdedn. New York: Macmillan Publishing, pp: 544.
11. Daogu, Z. and G.S. Lawes, 2003. Manova and discriminant analyses of phenotypic data as guide for parent selections in Kiwi fruits (*Actinidia deliciosa*) breeding. Euphytica, 114: 151-157.
12. Ngwuta, A.A., 2007. Evaluation of thirteen cultivars of bambara groundnut (*Vigna subterranean* L. Verdc.) in Umudike, rainforest agroecological area of Nigeria. International Journal of Agriculture and Rural Development. 9: 120-122.
13. Genstat. 2007. Genstat for Windows, Discovery, 4th edition. Lawes Agricultural Trust, Rothamsted Experimental Station, UK.
14. Wahua, T.A.T., 1999. Applied Statistics for Scientific Studies. *Afrilink Books*, Ibadan, pp: 60-85.
15. Thomas, B. and B. Vince-Pruce, 1997. Photoperiodism in Plants, 2nd Ed, *Academic Press,* San Diego., pp: 4.
16. Agbagwa, I.O. and B.C. Ndukwu, 2004. The value of morpho-anatomical features in the systematic of *curcurbita* L. Species in Nigeria. Afr. J. Biotechnol. 3(10): 541-546.
17. Staedler, E., 1977. Sensory aspects of insects plant interaction. Proc. XV. International Congr. Ent. Washington D.C, pp: 228-248.
18. Painter, R.H., 1951 Resistance in crop plants. Macmillan, New York, pp: 520.
19. Flint, M.L., 1990. Pests of the Garden and Small Farm. University of California pub, pp: 276.
20. Harriman, J.C., 2012. Evaluation of some maize genotypes for acceptability and performance in stem bore endemic agroecology. A M.Sc. Thesis of the Department of Crop Science, Federal University of Technology, Owerri, pp: 95.
21. Abdullah, A.A., H.H. Hegazi and I.A. Almousa, 2003. Evaluation of locally grown pumpkin Genotypes in the Central Region of Saudi Arabia. J. King Saudi Univ. Agric. Sc., 15(1): 13-24.
22. Decker, D.S., 1988. Origin(s), evolution and systematic of Curcurbita pepo. cucurbitaceae. Econ. Bot., 4(11): 4-15.
23. Fenemore, P.G., 1982. Plant pests and their control. Butterworth, Wellington, New Zealand pp: 271.
24. Ofuya, T.I., 1989. The effect of pod growth stages: In cowpea on aphid reproduction and damage by cowpea aphid. Annals of Applied Biology, 115(3): 63-66.
25. Odulaja, M. and S. Oghiakhe, 1993. A non-linear model describing yield loss in cowpea due to the legume pod borer. Int. J. Pest Management, 39(1): 61-63.
26. George, L.T., 2011. Plant Resistance to Insects: A Fundamental Component of IPM. Department of Entomology, Texas A and M University College Station TX, pp: 843-2475.
27. Picken, A.J.F., 1984. Review of pollination and fruits set in the tomato (*Lycopersiconesculentum* Mill). J. Sc., 59: 1-13.
28. Ombakho, G.A. and A.P. Tyagi, 1987. Correlation and path-coefficient analysis of components for yield and its components in cowpea. East African Agriculture and Forestry Journal, 53: 23-27.
29. International Institute of Tropical Agriculture. 2010. Improved cowpea varieties for Nigeria's Savannas. 29 September, 2010 Research Highlights, pp: 1.