

## ASSESSMENT OF MORPHO-VARIABILITY BETWEEN BRUCHID TOLERANT AND SUSCEPTIBLE COWPEA (*Vigna unguiculata* L. Walp.) ACCESSIONS

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### ABSTRACT

Cowpea bruchid is a major constraint to cowpea production. Easy identification of resistant/tolerant accessions to bruchid infestation has been a major challenge in bruchid resistant breeding programmes. Hence, the study was aimed to evaluate variations in some morphological characters between some bruchid resistant/tolerant and susceptible cowpea accessions, correlating them with their bruchid tolerance status in the hope of identifying a pointer character(s) that can facilitate easy identification of bruchid tolerant among cowpea germplasm. Sixty accessions were collected and evaluated for bruchid tolerance. Accessions were then grouped into bruchid susceptible and bruchid tolerant. These accessions were planted in Randomized Complete Block Design with ten replicates. Morphological differences between groups were evaluated accordingly. Of the sixty accessions evaluated, fifty-two were susceptible while eight were bruchid tolerant. No qualitative differences were observed between bruchid susceptible and tolerant groups, however significant differences were observed in quantitative characters which include terminal leaflet length, terminal leaflet/width ratio, leaf petiole length, terminal leaflet petiole length (TLPL), leaf petiole length, pod length (PDL), pod width, total number of pods per plant, seed length (SDL), seed width (SDW), seed thickness (SDTK) and 100 seed weight (100SDW). Bruchid tolerance was significantly positively correlated with seed characters which include, SDL ( $r = 0.798, p < 0.01$ ); SDW ( $r = 0.798, p < 0.01$ ); SDTK ( $r = 0.758, p < 0.01$ ); 100SDW ( $0.830, p < 0.01$ ) and significantly negatively correlated with TLPL and PDL ( $p < 0.05$ ). These characters can provide easy identification of bruchid tolerant among cowpea germplasm, hence requires further investigations.

**Keywords:** Cowpea, *Vigna unguiculata*, Bruchid, *Callosobruchus maculatus*, Morphology

### INTRODUCTION

Cowpea (*Vigna unguiculata* L. Walp.) is an important crop in Nigeria. Its production and storage are faced with various biotic stresses in countries where they are produced. *Callosobruchus maculatus* Fab., (cowpea beetle, weevil or bruchid), is not a threat on the field though infestation starts on the field, but major havoc is done in storage. It has the potential to cause high grain loss both in the quantity and quality of the stored cowpea seeds. Larvae feed on the seed content and cause about 90% of seed loss due to perforations (Amusa *et al.*, 2014). This reduces the usefulness of the seeds and makes them unsuitable for planting or human consumption, thereby reducing their market value (Amusa *et al.*, 2019).

There have been several attempts to preserve seeds by management practises to reduce the growth, development or reproduction of insects. These include the use of pesticides, physical and cultural control. The use of chemical pesticides has been highly effective and most used against

these storage pests. However, there have been reports that the use of chemical pesticides is not only expensive but sometimes resulted in food poisoning and environmental toxicity (Olakojo *et al.*, 2007; Keneni *et al.*, 2011). Thus, in a collaborative research project, the International Institute of Tropical Agriculture (IITA) and John Innes Centre, UK saw the need for an alternative and better management method for this pest which protects not only the crop, but also the consumers and the environment, and attempted to genetically modify cowpea for insect pests' resistance (IITA, 1990). As a result, several improved cultivars and/or varieties of cowpea seeds with different levels of resistance to infestation by *C. maculatus* have been released to date. However, there have been reports of resistance breakdown in many of these earlier tolerant genotypes identified and/or developed (Amusa *et al.*, 2013, 2014). This is an indication of the insects' polymorphic adaptation to the resistance stress imposed on its infestation capabilities. The identification of new

resistant/tolerant genotypes to fight and/or suppress the menace of this pest is now of paramount importance to cowpea production in combating food insufficiency.

A major constraint in the identification of resistant/tolerant genotypes is the time-consuming process to develop bruchid cultures and the duration of screening. An alternative is to use bruchid resistant associative characters to ease identification and/or prediction of bruchid tolerant genotypes, as this method will facilitate the rapid identification of other potential genotypes that can be used for breeding this valuable trait into the elite germplasm. Both qualitative and quantitative traits are very important in germplasm assessment, and for breeding programs as it allows the identification of available resources for selection. Hence, this study seeks to evaluate the morphological variations among sixty bruchid tolerant and susceptible cowpea accessions, and to correlate them with their bruchid tolerance status with the hope of identifying bruchid tolerant traits among cowpea germplasm.

## MATERIALS AND METHODS

### Collection of Samples

Seeds of sixty cowpea accessions were used in this study including, twenty-nine (29) accessions collected from the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria and thirty-one (31) landraces collected from the Institute of Agricultural Research and Training (IAR&T), Moor Plantation, Ibadan, Nigeria (Table 1).

### Bruchid Tolerance Evaluation

A bruchid tolerance evaluation was carried out to determine the tolerance status of the cowpea accessions according to Amusa *et al.* (2014). Briefly, bruchid infested seeds collected from IAR&T was used to establish a bruchid culture at 20-30 °C and 55-60%. Two pairs of newly emerged adult insects, 1-3 day old, were introduced into petri-dishes containing 10 seeds (oven dried at 60 °C for 5 h) of each cowpea accession. Insects were allowed to mate and oviposit for 3 days before removal. Four replicates of each accession were set up and arranged in a completely randomized design for 60 days. Daily

adult insect's emergence was recorded for the duration of the study. To measure the level of bruchid tolerance (Tol) in cowpea genotypes evaluated, the following parameters were used: Percentage adult emergence (PAE), Percentage seed damaged (PSD) and Host susceptible index (HSI) as shown below:

$$(a) \text{ PAE} = \frac{\text{Number of emerged adult insects}}{\text{Number of eggs laid}} * 100$$

$$(b) \text{ PSD} = \frac{\text{Total number of damaged seeds}}{\text{Total number of seeds}} * 100$$

$$(c) \text{ Tol} = \frac{\text{PAE} + \text{PSD}}{2}$$

$$(d) \text{ HSI} = \log_{10} \frac{\text{PAE}}{\text{MDP}}$$

Where MDP (Mean Development Period in days) is the average time taken for the bruchid insect to develop from egg to adult which is signified by the emergence of the adult from the seed;

$$(e) \text{ MDP} = \frac{x_1 + x_2 + x_3 + x_4}{4}$$

where  $x_i$  is the average development period for cumulative adult insects in each experimental replicate set up.

Data collection was terminated 60 days after insect infestation to avoid counting second-generation of emerging insects. Values from analysis above were used to group the accessions into bruchid tolerant and bruchid susceptible accessions.

### Morphological Evaluation of the Cowpea Lines

Each accession was planted in 2 kg pots replicated 10 times. The pots were arranged at 40 cm equidistance from each other using randomized complete block design. The experiment was conducted in the screen house of IAR&T, Ibadan, Oyo State (Latitude: 7° 22' 35.2" N, Longitude: 3° 50' 34.4" E) between January to April, 2017. General agronomic traits of cowpea were used for morphological characterization of the cowpea accessions as described by the International Board for Plant Genetic Resources (IBPGR, 1983). Data were collected on the qualitative characters (plant habit, terminal leaf shape, terminal leaflet base shape, terminal leaflet top shape, pigmentation, hairiness of plant, pod position with canopy, pod

stripes, flower colour, pod curvature, seed colour, seed coat nature) and quantitative characters (terminal leaflet length, terminal leaflet width, terminal leaflet/width ratio, leaf petiole length, terminal leaflet petiole length, leaf rachis length, number of branches per plant on main stem, pod length, pod width, total number of pods per peduncle, total number of pods per plant, seed length, seed width, seed thickness).

### Data Analysis

Qualitative and quantitative data from the replicates of accessions in the group were pooled together and statistically analysed using IBM SPSS version 25 (IBM Corp., Armonk, NY, USA). Independent sample t-test was used to compare values of the evaluated quantitative characters of the two groups assuming no variation between groups. Differences were considered significant at 5% significant level. Correlation between the characters measured with bruchid tolerance using Spearman's correlation was also done. Differentiating characters were subjected to stepwise multiple regression to determine the predictive ability at  $p < 0.05$ .

## RESULTS

### Bruchid Tolerance Evaluation and Groupings of Accessions

Bruchid tolerance performance and grouping of evaluated cowpea accessions is presented in table 2. A total of 52 accessions of cowpea comprising of all the cowpea accessions (31) collected from IAR&T and 21 accessions collected from IITA were susceptible to bruchid infestation. The susceptible accessions recorded between 80 – 100% emergence of adult bruchid and 80 – 100% seed damage. Only eight accessions (TVu-11953, IT81D-1064, IT99K-429-2, IT81D-1032, IT97K-

499-2, IT97K-1042-8, IT97K-1042 and TVu-2027) showed varied bruchid tolerance levels (Tol = 0 – 65%). Among the least bruchid tolerant, TVu-11953 and IT81D-1064 showed 10.37% and 48.49% adult emergence, respectively. However, MDP for these two genotypes were 44 days and 35 days, respectively making TVu-11953 a better bruchid resistant than IT81D-1064. IT99K-429-2 was observed to have delayed the MDP to 47 days than both TVu-11953 and IT81D-1064 genotypes but showed a higher PAE of 57.88%. Hence, 8 accessions were considered bruchid tolerant (HSI = -0.63 – 0.25) with PSD between 40-66% while the remaining 52 accessions were considered bruchid susceptible (HSI = 0.40 – 0.64) with PSD > 80% after the bruchid tolerance evaluation (Table 2).

### Qualitative and Quantitative Differences between Bruchid Tolerant and Susceptible Cowpeas

Qualitative characters varied moderately within bruchid tolerant groups under study but no unique differences were observed between the bruchid tolerant and susceptible groups (Table 3). However, evaluation of quantitative characters revealed that all characters significantly differ between the two groups except the terminal leaflet width, number of branches per plant on the main stem and total number of pods per peduncle (Table 4). The highest significant variation was observed in the total number of pods per plant (Coefficient of Variation (CV) = 59.10,  $t = 2.89$ ,  $p < 0.01$ ) while total number of pods per peduncle shows the least morphological variation and no significant difference between the two groups (CV = 10.68,  $t = 0.00$ ,  $p > 0.05$ ).

Table 1: Names of Cowpea Accessions used in this Study and where they were sourced from.

Sn	Accessions	Source	Sn	Accessions	Source
1	NG/SA/07/167	IAR&T	31	Ife-98-14	IAR&T
2	NG/SA/07/159	IAR&T	32	IT95K-193-12	IITA
3	NG/SA/01/09/008	IAR&T	33	IT93K-452-1	IITA
4	NG/SA/07/089	IAR&T	34	IT86D-719	IITA
5	Cowpea-2	IAR&T	35	IT98K-205-8	IITA
6	NG/SA/07/155	IAR&T	36	IT97K-499-35	IITA
7	NG/SA/01/09/001	IAR&T	37	IT89KD-288	IITA
8	311109	IAR&T	38	IT95-499-35	IITA
9	NG/SA/01/09/009	IAR&T	39	TVx3236	IITA
10	NG/SA/07/083	IAR&T	40	IT90K-277-2	IITA
11	NG/AO/11/08/084	IAR&T	41	IT84S-2246-4	IITA
12	NGB/06/041	IAR&T	42	IT90K-76	IITA
13	NG/AO/11/08/089	IAR&T	43	IT90K-277-2	IITA
14	NG/SA/07/141	IAR&T	44	IT90K-59	IITA
15	NG/SA/01/09/005	IAR&T	45	IT95K-222-3	IITA
16	NG/SA/07/135	IAR&T	46	IT97K-207-15	IITA
17	304107	IAR&T	47	IT87S-1393	IITA
18	NG/SA/01/09/004	IAR&T	48	IT86D-498	IITA
19	NG/SA/07/132	IAR&T	49	TVu-11979	IITA
20	NG/SA/07/130	IAR&T	50	IT99K-494-6	IITA
21	NGB/06/043	IAR&T	51	IT81D-994	IITA
22	NGB/06/110	IAR&T	52	IT97K-499-8	IITA
23	NG/SA/01/09/015	IAR&T	53	TVu-11952	IITA
24	NG/SA/01/09/011	IAR&T	54	TVu-2027	IITA
25	Ife Brown	IAR&T	55	IT81D-1032	IITA
26	Ife-98-12	IAR&T	56	IT81D-1064	IITA
27	Ife BPC	IAR&T	57	IT97K-1042-8	IITA

IAR&T: Institute of Agricultural Research and Training, Moore Plantation, Oyo State; IITA: International Institute for Tropical Agriculture, Ibadan, Oyo State

Table 2: Bruchid Tolerance Performance among 60 Cowpea Accessions

Sn	Accessions	MDP (days)	PAE (%)	PSD (%)	Tol (%)	HIS	Status
1	NG/SA/07/167	28	100	100	100	0.55	S
2	NG/SA/07/159	34	100	92.5	96.25	0.47	S
3	NG/SA/01/09/008	28	100	90	95	0.55	S
4	NG/SA/07/089	28	100	100	100	0.55	S
5	Cowpea-2	29	100	80	90	0.54	S
6	NG/SA/07/155	28	100	100	100	0.55	S
7	NG/SA/01/09/001	30	100	100	100	0.52	S
8	311109	29	100	100	100	0.54	S
9	NG/SA/01/09/009	30	100	100	100	0.52	S
10	NG/SA/07/083	28	100	100	100	0.55	S
11	NG/AO/11/08/084	30	100	100	100	0.52	S
12	NGB/06/041	28	100	100	100	0.55	S
13	NG/AO/11/08/089	37	100	100	100	0.43	S
14	NG/SA/07/141	29	100	100	100	0.54	S
15	NG/SA/01/09/005	38	100	90	95	0.42	S
16	NG/SA/07/135	32	100	100	100	0.49	S
17	304107	28	100	95	97.50	0.55	S
18	NG/SA/01/09/004	28	100	100	100	0.55	S
19	NG/SA/07/132	33	100	100	100	0.48	S
20	NG/SA/07/130	30	100	97.50	98.75	0.52	S
21	NGB/06/043	38	100	95	97.50	0.42	S
22	NGB/06/110	30	100	92.50	96.25	0.52	S
23	NG/SA/01/09/015	29	100	100	100	0.54	S
24	NG/SA/01/09/011	30	100	100	100	0.52	S
25	Ife-brown	23	100	100	100	0.64	S
26	Ife-98-12	30	100	100	100	0.52	S
27	Ife-BPC	28	100	100	100	0.55	S
28	Oloyin	34	100	100	100	0.47	S
29	Erusu	35	100	100	100	0.46	S
30	Modupe	32	100	100	100	0.49	S
31	Ife-98-14	29	100	100	100	0.54	S
32	IT95K-193-12	33	100	100	100	0.48	S
33	IT93K-452-1	30	100	100	100	0.52	S
34	IT86D-719	35	100	100	100	0.46	S
35	IT98K-205-8	33	100	100	100	0.48	S
36	IT97K-499-35	36	100	100	100	0.44	S
37	IT89KD-288	30	100	100	100	0.52	S
38	IT95-499-35	32	100	100	100	0.49	S
39	TVx3236	26	100	100	100	0.59	S
40	IT90K-277-2	34	100	100	100	0.47	S
41	IT84S-2246-4	35	100	100	100	0.46	S
42	IT90K-76	33	100	100	100	0.48	S
43	IT90K-277-2	34	100	100	100	0.47	S
44	IT90K-59	33	100	100	100	0.48	S
45	IT95K-222-3	33	100	100	100	0.48	S
46	IT97K-207-15	35	100	100	100	0.46	S
47	IT87S-1393	36	100	100	100	0.44	S
48	IT86D-498	34	100	100	100	0.47	S
49	Tvu-11979	34	100	100	100	0.47	S
50	IT99K-494-6	37	100	80	90	0.43	S
51	IT81D-994	33	83.4	100	91.70	0.40	S
52	IT97K-499-8	39	64.88	57	60.94	0.22	MR
53	TVu-11952	32	98.43	100	99.22	0.49	S
54	TVu-2027	42	74.44	66	70.22	0.25	MR
55	IT81D-1032	39	63.35	52	57.68	0.21	MR
56	IT81D-1064	35	48.49	50	49.25	0.14	MR
57	IT97K-1042-8	38	67.33	60	63.67	0.25	MR
58	TVu-11953	44	10.37	40	25.19	-0.63	R
59	IT97K-1042	42	75.00	65	70	0.25	MR
60	IT99K-429-2	47	57.88	50	53.94	0.09	MR

Abbreviations-MDP: media development period; PAE: percentage adult insect emergence; PSD: percentage seed damage; Tol: tolerance; HIS: host susceptibility index; S: susceptible genotype; MR: moderately resistant genotype; R: resistant genotype

Table 3: Qualitative Characters observed in Bruchid Susceptible and Tolerant Cowpea Groups

Characters	Tolerant Group (8)	Susceptible Group (52)	Remark
PHB	Erect	Erect	ns
TLS	Deltoid	Deltoid	ns
TLBS	Acute/deltoid	Acute	ns
TLTS	Attenuate	Attenuate	ns
PIG	Absent	Absent	ns
HPC	Absent	Absent	ns
PPC	Above	Above	ns
PSP	Absent	Absent	ns
FLC	Purple/white	Purple/White	ns
PDC	Curved/straight	Straight	ns
SDC	Mottled red/Red/Brown/White/ Chocolate	Brown/White/Chocolate	ns
SDCN	Rough/Smooth	Rough/Smooth	ns

Number of accessions in group in parenthesis. Abbreviations-PHB: plant habit; TLS: terminal leaf shape; TLBS: terminal leaflet base shape; ditto: terminal leaflet top shape; PIG: pigmentation; HPC: hairiness of plant; PPC: Pod position with canopy; PSP: pod stripes; FLC: flower colour; PDC: pod curvature; SDC: seed colour; SDCN: seed coat nature; ns: no significant difference between groups

Table 4: Quantitative Characters Evaluated on Bruchid Tolerant/Resistant and Susceptible Cowpea Groups

Characters	Tolerant Group (8)	Susceptible Group (52)	CV	t-test
TLL	15.50 ± 1.48	13.51 ± 0.77	17.74	4.88*
TLW	8.51 ± 0.70	8.07 ± 1.11	17.59	1.22
TLR	1.94 ± 0.21	1.59 ± 0.12	13.40	4.07*
LPL	8.82 ± 2.44	11.43 ± 0.82	23.06	2.28*
TLPL	9.62 ± 2.46	12.04 ± 0.84	22.69	2.51*
LRL	18.44 ± 4.90	23.47 ± 1.66	23.70	2.62*
BPS	15.20 ± 4.60	12.75 ± 3.28	29.84	1.33
PDL	7.08 ± 0.29	11.59 ± 0.38	26.83	14.03**
PDW	0.59 ± 0.11	0.80 ± 0.07	21.01	4.19**
PPP	2.00 ± 0.00	2.25 ± 0.46	10.68	0.00
PPPT	5.25 ± 1.14	10.17 ± 5.85	59.10	2.89*
SDL	9.66 ± 1.27	7.46 ± 0.51	17.56	4.87**
SDW	7.57 ± 0.39	5.77 ± 0.24	15.91	12.55**
SDTK	6.24 ± 0.51	4.14 ± 0.53	21.56	9.87**
100-SDWT	26.40 ± 1.63	14.57 ± 1.22	30.74	18.78**

\*  $p < 0.05$ ; \*\*  $p < 0.01$ ; Values are represented in mean ± SD of group; Number of accessions in group in parenthesis. Abbreviations-TLL: terminal leaflet length (cm); TLW: terminal leaflet width (cm); TLR: terminal leaflet/width ratio; LPL: leaf petiole length (cm); TLPL: terminal leaflet petiole length (cm); LRL: leaf rachis length (cm); BPS: number of branches per plant on main stem; PDL: pod length; PDW: pod width; PPP: total number of pods per peduncle; PPPT: total number of pods per plant; SDL: seed length (mm); SDW: seed width (mm); SDTK: seed thickness (mm); 100-SDWT: 100 seed weight (g); CV: coefficient of variation (%); ns: no significant difference between groups

Table 5: Spearman Correlation Coefficient among Quantitative Characters Evaluated between Bruchid Tolerant and Susceptible Groups.

Characters	TLL	TLW	TLR	LPL	TLPL	LRL	BPS	PDL	PDW	PPP	PPPT	SDL	SDW	SDTK	100SDW
TLL	1.000														
TLW	0.565**	1.000													
TLR	0.497*	-0.691**	1.000												
LPL	0.034	0.477**	-0.483*	1.000											
TLPL	0.060	0.553**	-0.447*	0.990**	1.000										
LRL	0.031	0.563**	-0.470*	0.999**	0.995**	1.000									
BPS	0.354	0.178	0.042	-0.304	-0.297	-0.313	1.000								
PDL	-0.587**	-0.266	-0.630**	0.258	0.478*	0.496*	-0.177	1.000							
PDW	-0.147	0.394	-0.445*	0.583**	0.578**	0.585**	-0.141	0.747**	1.000						
PPP	0.221	0.350	-0.150	0.260	0.137	0.125	-0.304	-0.232	0.113	1.000					
PPPT	-0.079	0.251	-0.279	0.574*	0.508*	0.555*	-0.239	0.306	0.127	0.411	1.000				
SDL	0.651**	0.420*	0.438	-0.296	-0.423	-0.425	0.208	-0.590**	-0.420	0.316	-0.099	1.000			
SDW	0.703**	0.321	0.580**	-0.190	-0.258	-0.301	0.292	-0.748**	-0.462*	0.260	-0.455	0.718**	1.000		
SDTK	0.662**	0.371	0.385	-0.165	-0.251	-0.292	0.148	-0.748**	-0.665**	0.336	-0.399	0.675**	0.899**	1.000	
100SDW	0.714**	0.454*	0.528*	-0.254	-0.376	-0.378	0.475*	-0.771**	-0.579*	0.294	-0.290	0.812**	0.804*	0.821**	1.000
PBT	0.731**	0.074	0.724**	-0.677**	-0.727**	-0.727**	0.511*	-0.767**	-0.604*	0.000	-0.572	0.798**	0.798**	0.758**	0.830**

\*, \*\*correlation value is significant at  $p < 0.05$ , 0.01 respectively. Abbreviations- PHT: plant height; TLL: terminal leaflet length; TLW: terminal leaflet width; TLR: terminal leaflet/width ratio; LPL: leaf petiole length; TLPL: terminal leaflet petiole length; LRL: leaf rachis length; BPS: number of branches per plant on main stem; PDL: pod length; PDW: pod width; PPP: total number of pods per peduncle; PPPT: total number of pods per plant; SDL: seed length; SDW: seed width; SDTK: seed thickness; 100SDW: 100 seed weight; PBT: percentage bruchid tolerance

### Relationship with Bruchid Tolerance Status and Morphological Characters

Correlation analysis between all quantitative characters evaluated and bruchid tolerance revealed significant negative correlation between bruchid tolerance and terminal leaflet petiole length ( $r = -0.73, p < 0.01$ ), leaf rachis length ( $r = -0.73, p < 0.01$ ), and pod length ( $r = -0.77, p < 0.01$ ). On the other hand, bruchid tolerance was significantly positively correlated with terminal leaflet length ( $r = 0.73, p < 0.01$ ), terminal leaflet/width ratio ( $r = 0.72, p < 0.01$ ) and seed characters which include seed length ( $r = 0.80, p < 0.001$ ), seed width ( $r = 0.80, p < 0.001$ ), seed thickness ( $r = 0.76, p < 0.01$ ) and seed weight ( $r = 0.83, p < 0.01$ ). However, stepwise multiple regression model analysis showed that no character was found to significantly predict bruchid tolerance from further regression analysis of characters evaluated with regard to bruchid tolerance (Table 5).

### DISCUSSION

The suitability of the food material for pest is determined based on the growth index as measured by HSI, a key parameter for insect growth and development. Genotypes with low HSI are considered as resistant while those with high HSI as susceptible. It was based on the assumption that insect progeny development would take a longer time in the resistant seed than in the susceptible seed (Soumia *et al.*, 2017), thus leading to fewer insect progenies emerging from resistant seeds when compared to the susceptible seeds. It has been reported that susceptibility to pest attack by legumes is related to the rate of insect growth success and time from egg to adult (Kosini *et al.*, 2017). The cowpea accessions evaluated varied in HSI in this study, with TVu-11953 having the lowest HSI, as it showed a lower percentage of emergence periods in adults, whereas Ife brown had the highest HSI showing higher adult emergence over a shorter time interval in the study. This indicates that TVu-11953 was the least bruchid tolerant and Ife brown the highest bruchid tolerant. Kosini *et al.* (2017) in their study reported that varieties with high percentage adult emergence and short developmental period may be severely damaged but those that allow low adult emergence and long generation times may be minimally damaged.

Resistance breakdown is a major problem when using host resistance to pest as an alternative method of pest control. Several of the bruchid tolerant cowpea accessions collected for the study were susceptible after the bruchid bioassay. One of such accession used in the study, TVu-2027, was previously reported by Jackai and Singh (1988) as the only accession in IITA's germplasm collection showing resistance to bruchid infestation. It was discovered almost 30 years ago and has since been used widely for bruchid resistance breeding programmes. Later, Singh and Singh (1990) reported two other accessions to TVu-2027, TVu-11952 and TVu-11953 with moderate tolerance. Ofuya and Credland (1995) in their study evaluated the relative susceptibilities of cowpea varieties including Ife Brown, TVu-2027, and IT84S-2246-4 and found that TVu-2027 showed lower percentage adult emergence while Ife brown was regarded as the most susceptible. These accessions, TVu 2027 and Ife brown, have been used for breeding programmes at IITA as a bruchid resistant and susceptible references, respectively. The tolerance evaluation also showed that IT84S-2246-4 was susceptible to the bruchid infestation. However, this was not in accordance with IITA annual report (IITA, 2004). Dugje *et al.* (2009) also reported that the cowpea accession (IT84S-2246-4) shows moderate tolerance to bruchid infestation. The present study revealed that there was no bruchid resistant accession among samples from IAR&T cowpea accessions (sampled landrace collected from exploration) used in this study, an implication that most of the Nigerian cultivars/landraces were susceptible to bruchid infestation as at the time of this study.

The need to identify and breed alternative sources for bruchid resistance in cowpea cannot be overestimated. Variability in the species selection for insect resistance is an important tool in breeding programs and this depends on the cultivar characteristics which may include a simple phenotypic appearance from the nature of leaf surface to grain or fruit characters which include the nature and/or biochemical factors of the seeds etc (Amusa *et al.*, 2014). Phenotypic descriptors are necessary for assessing the genetic variation of crop species for the adequate investigations of the genetic variability in germplasm collections, thereby providing



valuable information to conservation efforts and breeding programs (Franco *et al.*, 2005; Laurentin, 2009). Although, variations were observed in qualitative characters among sampled accessions, these variations were not significantly different between the bruchid tolerance and susceptible cowpea groups. The absence of discriminating qualitative characters between the tolerant groups implies that bruchid resistance may not be dependable on observable characters in cowpea, example is the seed coat roughness and smoothness theory for bruchid resistance as opined by Magbo *et al.*, (2014), Seram *et al.*, (2016) and Soumia *et al.*, (2017).

Several authors have attributed bruchid tolerance to seed characteristics which include seed coat texture, seed size, seed colour and seed thickness (Messina and Renwick, 1985; Mei *et al.*, 2009; Chakraborty and Mondal, 2016). This does not only affect the tolerance of the seed to developing bruchid larvae but also reduce oviposition preference of the female bruchids (Amusa *et al.*, 2013). This study reported that larger seeds with smooth surface were highly preferred by the pest as they provided more surface area for oviposition, ample food and space for the development of the larvae. Seed characters including seed length, seed width, seed thickness and 100 seed weight showed positive significant correlation with bruchid tolerance of the accessions in this study. The regression analysis however showed that the seed characters were not good predictors or identifiers for bruchid tolerance. This corroborates with previously reported works that bruchid tolerance is not influenced by seed characters (Maina *et al.*, 2012; Cruz *et al.*, 2016). This may be as a result of low genetic variability within the germplasm.

## CONCLUSION

This study evaluated the phenotypic variation in the qualitative and quantitative characteristics of 60 cowpea accessions in relation to their bruchid tolerance status. Such information could be used as a preliminary indication for the identification of cowpea accessions tolerant to bruchid. Although, the study found significant correlations among some characters and bruchid tolerance, the small differences observed between bruchid susceptible and tolerant genotypes were not discriminatory

enough to effectively predict tolerance to bruchids. These traits still need to be further investigated, to explore other options for better identification of bruchid tolerance within the cowpea germplasm.

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