SUSCEPTIBILITY OF SIX LOCAL AND FOUR IMPROVED COWPEA *CULTIVARS TO Callosobruchus maculatus (F.)* (*Coleoptera: Bruchidae*) INFESTATION IN NORTH EASTERN NIGERIA

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ABSTRACT

The susceptibility of seeds of six local (Banjara, Borno brown, Gwallam, Kanannado brown, Kanannado white and Saddam) and four improved (189KD-288, IT89KD-391, IT90K-82-2 and IT97K-499-35) cowpea cultivars that were commonly grown in north eastern Nigeria to infestation by the cowpea storage bruchid, Callosobruchus maculatus (F.) (Coleoptera: Bruchidae) was evaluated in the laboratory at 30^{oC} - 35^{oC} and 60% - 65% RH. Parameters tested include the number of bruchid eggs laid and adults emerged, percentage seed damage, severity of seed damage, seed susceptibility index and bruchid developmental period. All parameters collected were analyzed using the analysis of variance (ANOVA). The mean number of bruchid eggs laid and adults emerged, percentage seed damage, severity of seed damage and seed susceptibility index were generally significantly different amongst the ten different cowpea cultivars. Mean bruchid developmental period, was however, not significantly different amongst the cowpea cultivars tested. The seeds of all ten cowpea cultivars (local and improved) were either moderately or highly susceptible to infestation by C. maculatus. Results obtained in this study indicated the need for breeders to develop high-yielding cowpea cultivars that are well adapted to cultivation in the north eastern region of Nigeria, with relatively high resistance to attack by the bruchid beetle.

Keywords: *Cowpea seeds, cultivars,Callosobruchus maculatus, seed susceptibility*

INTRODUCTION

Cowpea (*Vigna unguiculata (L.) Walp.)* is an important indigenous African grain legume providing millions of people in the tropics and subtropics with dietary protein, vitamins and mineral elements (Bressani, 1985; Rubatzky and Yamaguchi, 1997), and also income for farmers and traders (Langyintuo et al., 2005). Accounting for between 64% and 70% of the global annual production (7.56 million tonnes of dry seed or grain) Nigeria is the world's largest cowpea producer (Singh et al, 2002; FAO 2005). Harvested cowpea seeds are mainly stored for subsequent use as human food or trading product. Cooked cowpea seeds are either eaten plain or as a component of meals made from cereals, root crops or vegetables (Lambot, 2002). The sales of cowpea cake (from mashed or ground seeds either steamed (moi-moi) or deep-fried (*akara*) as fast food along roadsides also provide employment to thousands of urban and rural women that prepare and sell various traditional cowpea snacks. The bruchid beetle, *Callosobruchus maculatus* (*F.*) (*Coleoptera: Bruchidae*), is a major field-to-store pest of cowpea seeds that greatly reduce the quantity and quality of seeds reserved for food, sowing and trading purposes (Lale and Ofuya, 2001). Under poor threshing, cleaning, drying and storage techniques or conditions in the humid tropics, 60% to 100% infestation of cowpea seeds by the bruchid beetle can occur in less than five months of storage (Jackai and Daoust, 1986; Lienard and Seck, 1994). Several local and improved cultivars or varieties of cowpea seeds exist in Nigeria with different levels of resistance to infestation by *C. maculatus* (Lale and Kolo, 1998, Maina et al., 2006). Although, the susceptibility to *C. maculatus* infestation of cowpea seeds of some local and improved cultivars or varieties from different parts of Nigeria have been assessed in the past (Osuji, 1976; Ofuya, 1987; Mbata, 1993; Pessu and Umeozor, 2004), such information for several local and improved cultivars or varieties cultivated in the North Eastern Region of Nigeria remain scarce. This study was therefore designed to screen the susceptibility of ten different cowpea cultivars or varieties available to farmers in the north eastern part of Nigeria to *C. maculatus* infestation in storage.

MATERIALS AND METHOD

Cowpea cultivars and insect culture: Ten cowpea cultivars, comprising six local (Banjara, Borno brown, Gwallam, Kanannado brown, Kanannado white and Saddam) and four improved (189KD-288, IT89KD-391, IT90K-82-2 and IT97K-499-35) were obtained from the local markets in Maiduguri and IITA (PROSAB) in Biu, respectively, in North Eastern Nigeria. *Callosobruchus maculatus* cultures were established on Borno brown seeds in 500ml Kilner jars kept under the prevailing conditions of 30^{oC} - 35^{oC} and 60% - 65% RH in the laboratory.

Physical seed characteristics: Physical inspection was carried out to determine the seed testa colour of each cowpea cultivar. Average individual seed mass per cowpea cultivar was also obtained by dividing the total weight of ten randomly selected seeds by ten. Seed size or diameter was determined as the mean of measurements taken from three positions (the middle and two different ends of the seed) using a venier calliper.

Experimental Procedure: Four replicates of 15g cowpea seeds per 100ml glass jar were prepared per cultivar. Cowpea seeds in all experimental jars were then infested using five pairs of two to three days old adult *C. maculatus.* Three other 15g replicates were prepared per cowpea cultivar and left uninfested to serve as control treatment. Adult bruchids were sieved off from all experimental jars after a five days infestation period. The number of eggs laid per seed was counted in each experimental jar. After which, all experimental jars were left untouched until the emergence of F_1 progeny. The number of adult bruchids of the first filial generation and damaged seeds (seeds bearing adult emergence holes) were counted per experimental jar. The severity of seed damage (number of adult emergence holes per seed) was calculated by dividing the number of emergence holes by the number of damaged seeds. The susceptibility index (SI) of each cultivar was calculated using the formula (Dobie, 1974):

$$\text{Susceptibility index (SI)} = S_1 = \frac{Log_e F_1}{D \times 100}$$

where F_1 = total number of emerging adults and D = median developmental period (time from the middle of oviposition to the emergence of 50% of the F_1 generation). Data obtained were subjected to one-way analysis of variance (ANOVA). Significantly different means at $P < 0.05$ were separated using the Least Significant Different (LSD).

RESULTS AND DISCUSSION

The physical seed characteristics of cowpea cultivars tested are presented on table 1. All ten cowpea cultivars observed had a total of three (white, brown and milky) different testa colours. Seed mass recorded was from 0.17g by the cultivar IT97K-499-35 to 0.44 g by the cultivar Gwallam. Seed size ranged from 0.60 cm by the cultivar IT90K-82-2 to 1.03cm by the cultivar Gwallam. Percent moisture content was lowest (9.7) and highest (13.4) in the seeds of Banjara and Gwallam cultivars, respectively.

Although the mean number of eggs laid by *C. maculatus* were significantly different amongst the cultivars tested, both highest (Borno brown and Saddam) and lowest (Banjara) numbers of eggs laid were recorded on local cultivars (Table 2). The mean number of adult bruchids emerged and percentage seed damage were observed to be significantly higher on some local (Banjara, Saddam or Borno brown) than all the improved cultivars tested. Mean severity of seed damage was significantly higher on mainly local cultivars (Borno brown, Borno white, Gwallam, Kanannado white and Saddam), and the improved (IT97K-499-35) one. Mean susceptibility index was significantly different amongst the ten different cowpea cultivars tested, but developmental period was not significant (Table 2). The highest mean values of both parameters were recorded on local (Borno brown or Banjara) cultivars, while the lowest mean values were observed on their improved (IT89KD-391 or IT90K-82-2) counterparts.

The results of correlation performed between different parameters tested are presented on table 3. Although positive, susceptibility index was generally moderately correlated with the number of bruchid eggs laid or adults emerged, percentage seed damage and severity of seed damage, yet Also, bruchid developmental period was moderately and weakly correlated with the severity of seed damage and susceptibility index, respectively. The strongest positive correlation observed was between percentage seed damage and number of adult bruchids emerged.

Except for Banjara, a local cowpea cultivar that was found to be highly susceptible to infestation by *C. maculatus*, most cowpea cultivars (improved and local) proved to be moderately susceptible to attacks by the bruchid beetle. Fewer bruchid eggs laid on the seeds of Banjara was explained by the absence of strong correlation between the number of eggs laid on cowpea seeds and the susceptibility of these seeds to infestation by *C. maculatus*. Furthermore, due to the very weak correlation between the developmental period of *C. maculatus* and the susceptibility of cowpea seeds to infestation by the bruchid beetle, the developmental period of the bruchids was not necessarily faster on Banjara cultivar compared to others. The higher mean number of adult bruchids emerged, percentage seed damage and severity of seed damage, in spite, of the low number of bruchid eggs laid on the seeds of Banjara suggests one or both of the following: Firstly, a lower level or absence of bruchid feeding deterrent or inhibitor in the seeds of this cultivar. Higher levels of α -amylase inhibitor in the cotyledon (that is, cultivated line: *Vigna unguiculata* TVu 2027 (from Nigeria) and wild species: *Vigna luteola* (Jacq) Bentham (from Brazil, Botswana and Kenya) and *Vigna vexillata* A Richard (from Australia, Costa Rica and Rwanda) and seed coat tannin (Proanthocyanidin) content (Vita 7 seeds from Nigeria) have been reported in cowpea seed with moderate levels of resistance to *C. maculatus* infestation (Lattanzio *et al.*, 2005).

Variant forms of vicilins (7S storage proteins), for example, in the seeds of some *V. unguiculata* cultivars (IT81D-1045, IT81D-1032 and IT81D-1064) are resistant to digestion by midgut proteinases, which limits food supply to *C. maculatus* larvae (Singh and Singh, 1990; Macedo et al., 1993; Sales et al., 2001). In lima bean (Phaseolus lunatus L.), phaseolin (a vicilin-like 7S storage globulin) peptides from the cotyledon and testa tissues were detrimental to *C. maculatus* with ED50 of 1.7% and 3.5%, respectively and LD50 of 2% and >2%, respectively (Moraes et al., 2000). Moreover, the level of phaseolin in the seed coat (16.7%) was found to be sufficient to deter larval development of this bruchid. Secondly, because of the lower number of eggs laid on the seeds of this cowpea cultivar, intraspecific competition by *C. maculatus* larvae within these seeds was very likely also low. Past studies by Giga and Smith (1991) and Hu et al. (1995) on the effects of intraspecific competition in *C. maculatus* under different treatments, such as varied bean sizes and number of larvae per bean revealed larval survivorship and/or emergence weight of the bruchid beetle to be significantly reduced with increased larval density per bean.

Irrespective of the higher mean number of bruchid eggs laid on IT89KD-391 / IT90K-82-2 and severity of seed damage on IT97K-499-35 than other improved cowpea cultivars; all improved cultivars, like most of their local counterparts tested were moderately susceptible to infestation by *C. maculatus*. Also, amongst the moderately susceptible cowpea cultivars, the mean number of bruchid eggs laid and adults emerged, percentage seed damage or severity of seed damage tended to be higher on mainly three local cultivars (Saddam, Borno brown and Gwallam). Since seed properties including seed testa colour, mass, size and moisture content generally do not influence the susceptibility of cowpea seeds and other cereals grains to *C. maculatus* and *Sitophilus* species in storage respectively (Lale and Kolo, 1998; Maina and Lale, 2005; Maina and Dlamini, 2009), the above observed differences were very likely due to variations in the composition or levels of chemical substances that either deter or stimulate bruchid oviposition and/or feeding in these seeds (Gatehouse *et al.*, 1979).

Alternatively, seed properties such as seed coat texture (smooth or rough) and hardness might have contributed to the differences observed. For instance, studies by Messina and Renwick (1985) that evaluated the resistance of selected cowpea lines to infestation by *C. maculatus*, found that rough seed coat was less preferred for oviposition by the bruchid beetle. Landerito *et al.* (1993), in assessing the physiochemical and biochemical factors associated with mungbean (*Vigna radiata* (L.)) and blackgram (*Vigna mungo* (L.) Hepper) resistance to a related bruchid pest, *Callosobruchus chinensis L.*, reported that resistant accessions of both legume crops were harder (20% to 59%, respectively) than the susceptible one.

Table 1: Some physical seed characteristics of ten cowpea cultivars tested

Cultivar	**Type**	**Testa colour**	**Seed mass** (g)	**Seed Size** (cm)	**Moisture content** (%)
Banjara	Local	Brown	0.27	0.91	9.7
Borno brown	Local	Brown	0.38	0.86	10.2
Gwallam	Local	White	0.44	1.03	13.4
Kanannado brown	Local	Brown	0.23	0.86	10.3
Kanannado white	Local	White	0.29	0.89	11.0
Saddam	Local	Milky	0.23	0.71	10.2
189KD-288	Improved	White	0.29	0.77	11.5
IT89KD-391	Improved	Brown	0.18	0.77	13.1
IT90K-82-2	Improved	Brown	0.22	0.61	10.6
IT97K-499-35	Improved	White	0.17	0.78	12.7

Source: Experimentation 2011.

Table 2: Parameters used in evaluating resistance of cowpea cultivars to Callosobruchus maculatus infestation

Cultivar	**Type**	**NEL**	**NAE**	**PSD**	**SSD**	**SI**	**DP**
Banjara	Local	126.25a	101.25b	60.27b	2.35b	14.29b	11.00a
Borno brown	Local	99.50d	40.75ab	22.35a	2.57b	5.57a	22.50a
Gwallam	Local	32.00b	8.25a	8.07a	1.67ab	2.21a	17.75a
Kanannado brown	Local	92.00cd	1.75a	0.78a	0.87a	1.26a	12.00a
Kanannado white	Local	40.25bc	22.25a	15.21a	1.75ab	3.30a	22.50a
Saddam	Local	100.50d	97.75b	59.13b	2.19ab	1.14a	11.00a
189KD-288	Improved	21.50b	7.25a	7.37a	0.65a	2.22a	11.25a
IT89KD-391	Improved	54.75bc	8.75a	8.84a	0.63a	2.16a	10.50a
IT90K-82-2	Improved	81.75c	1.75a	1.87a	0.75a	0.97a	19.00a
IT97K-499-35	Improved	35.50b	33.75a	21.27a	1.66ab	4.60a	22.50a
SED		13.73	30.12	11.82	0.56	2.41	6.43
LSD (0.05)		28.14	61.52	24.15	1.14	4.92	13.25

Source: Experimentation 2011.

Table 3: Correlation of all parameters tested

	NEL	**NAE**	**PSD**	**SSD**	**SI**	**DP**
No. eggs laid	1.0000					
No. adults emerged	0.6172	1.0000				
% seed damage	0.6612	0.9431	1.0000			
Severity of seed damage	0.4947	0.6507	0.6687	1.0000		
Susceptibility index	0.6543	0.5513	0.7028	0.5999	1.0000	
Developmental period	-0.1114	-0.1386	-0.1064	0.5448	0.0773	1.0000

Source: Experimentation 2011. SED = Standard error deviation; LSD = Least significance difference. *NEL = Numberof eggs laid; NAE = Number of adult emerged; PSD = Percent seed damage; SSD = Severity of seed damaged; SI = Susceptibility index; DP = Developmental period*

CONCLUSION

This study was designed to examine the susceptibility of ten different cowpea cultivars, that is, six local (Banjara, Borno brown adobrown, Kanann white and Saddam) and four improved varities (189KD - 288, IT 89KD - 391, IT90K - 82 - 2 and IT97K - 499 - 35). In conclusion, none of the ten cowpea cultivars evaluated showed a strong resistance to attacks by *C. maculatus*, and thus, implying that their seeds can suffer serious damage in storage. These results further challenge crop breeders for increased efforts towards the provision of high yielding cowpea cultivars with nutritionally adequate or balanced seeds that store safely against infestation by the bruchid beetle in North Eastern Nigeria..

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