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Effects of Initial Infestation and Interspecific Competition on the Development of *Callosobruchus subinnotatus* (Pic.) in Bambara Groundnut *Vigna subterranea* (L.) Verdcourt

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ABSTRACT

An investigation was carried out to assess the influence of level of initial infestation with bruchid eggs (2, 3, 4 or 5% of seeds with 2 eggs) on progeny development of *Callosobruchus subinnotatus* and damage to three cultivars (Bakingangala, Ole and Bulmono) of bambara groundnut. In another experiment, the effect of interspecific competition was studied between *C. maculatus* and *C. subinnotatus* on the development of the latter species. Results showed that seed infestation with varying proportion of bruchid eggs significantly increased the number of eggs laid by F_1 female at 5% level of infestation. In Bakingangala or Ole, the number of F_2 adult bruchids that developed in seeds at the 5% level of infestation was significantly higher than the number that developed at the 2% level; so was the case for damage caused to these cultivars The results also showed that the population of *C. maculatus* increased dramatically with successive generations and *C. subinnotatus* began to extinct at the third generation.

Key Words: Field infestation; Damage, Interspecific competition; Scramble type competition; *Callosobruchus subinnotatus; C.maculatus*; Progeny development

INTRODUCTION

Bambara groundnut [*Vigna subterranea* (L.) Verdcourt] has been considered the third most important legume as protein source after cowpea and groundnuts in many regions of sub-Saharan West Africa (Sellschop, 1962). It is now recognized as having immense potential in a wider area because of its high nutritional value (Doku *et al.*, 1978) and adaptability to different environmental conditions.

Callosobruchus subinnotatus (Pic.) is one of the field-to-store pest bruchids infesting grain legumes in tropical Africa and Asia. In West Africa, this pest is restricted to bambara groundnuts (*Vigna subterranea*) (Haines, 1991; Mbata, 1993; Ofuya, 2001). Bambara groundnuts are often infested concurrently by *C. subinnotatus* and *C. maculatus* and interspecific competition is known to occur between these two species (Lale & Vidal, 2001). Being a field-to-store pest, *C. subinnotatus* commences infestation in the field (Prevett, 1966; Dike, 1994) and at harvest seeds are infested with varying levels of eggs. This initial level of infestation considerably influences the bionomics of the bruchid in storage (Haines, 1991). Studies on these aspects of the ecology of this bruchidae are necessary for two reasons. First, they are likely to provide information on the extent of damage to be expected from field infestation. Second, they would also provide information on the relative significance of *C. maculatus* and *C. subinnotatus* as pests of stored bambara groundnut in case of joint infestation (Lale & Vidal, 2001)

MATERIALS AND METHODS

Insect rearing. Two batches of bambara groundnuts infested separately by *C. maculatus* and *C. subinnotatus* were obtained locally from Maiduguri, Nigeria, and used to establish laboratory cultures of the two bruchid species. Insects from the two species were subsequently reared separately on bamabara groundnut seeds (Cv. Bulmono) under fluctuating laboratory conditions (22-34^{o}C and 18-27% R.H.).

Influence of level of initial infestation. A batch of bambara groundnut seeds of each of the three cultivars (Bakingangala, Ole and Bulmono) was infested with *C. subinnotatus* teneral adults of both sexes. Female bruchids were allowed to lay eggs for 3 days after which all insects were removed.

All seeds in the infested batch of each cultivar were inspected individually and seeds bearing 2 bruchid eggs were selected for the experiment. For different levels of initial infestation, 2, 3, 4 or 5 seeds bearing 2 eggs per seed were then admixed with 98, 97, 96 or 95 pristine seeds of each of the three cultivars. The experiment was set up as a completely randomized design with 4 replications.

The F_1 adult progeny that developed from these eggs was allowed to mate and the females were allowed to lay eggs

throughout their life span. The eggs laid by the F_1 adult progeny were subsequently counted. The seeds damaged by *C. subinnotatus* in each batch were also counted.

Interspecific competition. In this experiment, 396 pristine seeds of bambara groundnut (cv. Bulmono) were admixed with 4 seeds with two seeds bearing 2 eggs each of *C. maculatus* and *C. subinnotatus*. The adult progeny of each bruchid species that developed was monitored for 1, 2 or 3 generations. The experiment which was set up as a completely randomized design with 5 replications was terminated at the end of the third filial (F_3) generation.

Data analysis. Data obtained from both experiments were subjected to two–way analysis of variance (ANOVA) and differences between means were determined using Least Significant Difference at 5% level of probability (Gomez & Gomez, 1984).

RESULTS

Influence of level of initial infestation. At 3, 4 or 5% level of infestation, significantly more eggs were laid on Bakingangala seeds than on Ole or Bulmono seeds (Table I). Significantly higher number of F_2 adult progeny were developed at the 5% level of infestation in Bakingangala than at 2, 3 or 4% level in Bulmono or Ole seeds (Table II). There were no significant differences in the numbers of F_2 adult progeny that developed at different levels of infestation in Bulmono seeds. Seeds of Bakingangala or Ole at the 5% level of infestation also suffered significantly more damage than those at the 2% level; however, at 3 or 4% level of infestation there were no significant differences (Table III). In Bulmono damage increased with increasing infestation, although the difference was not significant ($P > 0.05$).

Table I. Mean number of eggs laid by F_1 *Callosobruchus subinnotatus* on seeds of bambara groundnut cultivars initially bearing different numbers of eggs

	Initial level of egg infestation (%)				
Cultivar	2	3	4	5	Mean
Bakingangala	60.8	94.8	103.3	108.8	91.9
Ole	30.5	49.8	46.5	73.5	50.1
Bulmono	26.5	31.8	59.5	65.0	45.7
Mean	39.3	58.8	69.8	82.4	

SED = 16.4; LSD (0.05) = 33.6 (Cultivar)
SED = 18.9; LSD (0.05) = 38.8 (Level of infestation)
SED = 32.9; LSD (0.05) = 67.1 (Interaction)

Table II. Mean number of F_2 *Callosobruchus subinnotatus* adult progeny that developed in seeds of three bambara groundnut cultivars initially infested with different numbers of eggs

	Initial level of egg infestation (%)				
Cultivar	2	3	4	5	Mean
Bakingangala	11.5	20.3	23.8	42.0	24.4
Ole	5.0	17.3	18.5	34.8	18.9
Bulmono	13.5	19.3	29.3	29.3	22.9
Mean	10.0	18.9	23.9	35.4	

SED = 6.1; LSD (0.05) = 12.5 (Cultivar)
SED = 7.1; LSD (0.05) = 14.5 (Level of infestation)
SED = 12.3; LSD (0.05) = 25.1 (Interaction)

Table III. Mean percentage of seeds of three cultivars of bambara groundnut infested initially with different numbers of eggs that were damaged by *Callosobruchus subinnotatus*

	Initial level of egg infestation (%)				
Cultivar	2	3	4	5	Mean
Bakingangala	10.8	17.8	16.3	28.5	18.4
Ole	4.5	16.0	16.0	23.0	14.9
Bulmono	12.3	16.5	24.3	25.3	19.6
Mean	9.2	16.8	18.9	25.6	

SED = 4.0; LSD (0.05) = 8.2 (Cultivar)
SED = 4.7; LSD (0.05) = 9.5 (Level of infestation)
SED = 8.1; LSD (0.05) = 16.4 (Interaction)

Table IV. Mean number of *Callosobruchus maculatus* and *C. subinnotatus* adult progeny that developed in three generations

	Bruchid generation			
Bruchid species	F_1	F_2	F_3	Mean
C.maculatus	32.4	395.4	585.4	337.7
C.subinnotatus	38.2	64.8	43.3	48.8
Mean	35.3	230.1	314.4	

SED = 37.2; LSD (0.05) = 77.5 (Bruchid species)
SED = 45.5; LSD (0.05) = 94.9 (Bruchid generation)
SED = 64.4; LSD (0.05) = 134.3 (Interaction)

Interspecific competition. Table IV shows that *C. maculatus* increased in population significantly with increasing generation but in the case of *C. subinnotatus*, population peaked in F_2 and then declined considerably in F_3. In F_2 and F_3, *C. maculatus* produced a significantly higher number of adult progeny than *C. subinnotatus.*

DISCUSSION

The study showed that at least for two (Bakingangala and Ole) of the three cultivars of bambara groundnut, infested with 2 to 5% levels of bruchid eggs significantly increased the rate of progeny production in *C. subinnotatus* and the damage caused to seeds. This result suggests that batches of field-infested bambara groundnuts with up to 5% infestation are likely to suffer higher losses even after a single generation of the bruchid than with 2% infestation. At the 2% level of infestation and after completing one generation, damage ranged from 4.5% in Ole to 12.3% in Bulmono. These low levels of infestation are known to expand rapidly and thus lead to significant losses under the very conducive environment in the store (Haines, 1991; Ofuya, 2001). It is therefore imperative that steps be taken to protect against this incipient infestation before bambara groundnuts are preserved in storage.

The results have also shown that *C. maculatus* produced significantly higher numbers of adult progeny than *C. subinnotatus* at F_2 and F_3 generations. Lale & Vidal (2001) reported that the form of interspecific competition between these two species is the scramble type. In case of joint infestation, *C. maculatus* is likely to cause more damage to and greater losses of unprotected bambara groundnuts than *C. subinnotatus*. This feature is ascribed to a higher pest status on *C. maculatus*. They also reported that *C. maculatus* is likely to cause the extinction of *C. subinnotatus* in multiple generations of interspecific competition. *C. maculatus* accomplishes this through its ability to lay more eggs and produce more adults than *C. subinnotatus* due to its shorter developmental period (Lale & Vidal, 2001).

CONCLUSIONS

The level of initial infestation, expressed in the form of percentage of seeds in the batches bearing eggs had significant impact on the development of *C.maculatus* and *C. subinnotatus* in stored bambara groundnut. This result implies that percentage of seeds infested with these bruchids may be more likely to provide adequate prediction of seeds damage in stored bambara groundnut than adult progeny.

The results further show that *C.maculatus* is, however, more likely to cause the extinction of *C. subinnotatus* in multiple generation of interspecific competition whenever the crop is infested simultaneously by the two brichuds. Effective protection of bambara groundnuts against infestation by *C.maculatus* and *C.subinnotatus* would therefore require pre-harvest and post-harvest control strategies.

REFERENCES

Dike, M.C., 1994. An annotated checklist and the identity of major storage insect pests in Nigeria, *Samaru Miscellan*., 130: 1–17

Doku, E.V., T.W. Hammonds and B.J. Francis, 1978. On the compositions of Ghanaian bambara groundnuts (*Voandzeia subterranean* (L.) Thouars). *Trop. Sci*., 20: 263–70

Gomez, K.A. and A.A. Gomez, 1984. Statistical Procedures for Agricultural Research, p: 540. 2nd edition, John Wiley and Sons

Haines, C.P., 1991. *Insects and Arachnids of Tropical Stored Products*. p: 246.Their Biology and Identification. Natural Resources Institute, Chatham, Kent, UK

Lale, N.E.S. and S. Vidal, 2001. Intraspecific and interspecific competition in *Callosobruchus maculatus* (F.) and *Callosobruchus subinnotatus* (Pic.) on stored bambara groundnut, *Vigna subterranea* (L.) Verdcourt. *J. Stored Prod. Res*., 37: 329–38

Mbata, G.N., 1993. Evaluation of susceptibility of varieties of cowpea to *Callososbruchus maculatus* (F.) and *Callosobruchus subinnotatus* (Pic.) (Coleoptera: Bruchidae). *J. Stored Prod. Res*., 29: 207–13

Ofuya, T.I., 2001. Biology, ecology and control of insect pests of stored food legumes in Nigeria, In: Ofuya, T.I. and N.E.S. Lale, (eds), *Pests of Stored Cereals and Pulses in Nigeria*. pp: 24–58 Biology, Ecology and Control. Dave Collins Publications, Akure, Nigeria

Prevett, P.F., 1966. Observations on the biology of six species of Bruchidae (Coleoptera) in Northern Nigeria. *Entomologists' Monthly*, 102: 174–80

Sellschop, J.P.F., 1962. Cowpea *(Vigna unguiculata* (L.) Walp.) Field Crop Abstracts 15: 259–66

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