EFFECTS OF POPULATION DENSITY AND STORAGE DURATION ON THE DEVELOPMENT OF *CALLOSOBRUCHUS SUBINNOTATUS* IN STORED BAMBARA GROUNDNUT (*VIGNA SUBTERRANEAN (L.) VERDCOURT*)

Maina, Y. T.
***Degri, M. M.**
Sharah, H. A.
Department of Crop Protection
Faculty of Agriculture, University of Maiduguri, Maiduguri, Nigeria
**Email: michael_degri@hotmail.com*

ABSTRACT

An experiment was conducted in the Entomology Laboratory, Department of Crop Protection, Faculty of Agriculture, University of Maiduguri in 2010. The aim was to determine the effect of Population density and storage duration on the development of Callosobruchus subinnotatus in stored bambara groundnut (Vigna subterranean (L.) Verdcourt) with different levels of infestation (2, 3, 4 and 6 pairs of C. subinnotatus) per 100g of bambara groundnut and stored for three months duration under prevailing tropical storage temperature of 30 - 32°C. The results showed that as the population density of C. subinnotatus increases with increasing storage duration the more the damage done to bambara groundnut. The mean number of eggs laid at different levels of infestation increase with the storage duration indicating a significant difference between the first, second and the third month. Adult emergence in treatments infested with two pairs at the third month has a higher mean number of adults compared to those of first and second month which are also applicable to 3, 4, and 6 pairs. The percentage seed damage of bambara groundnut done infested with two pair of C. subinotatus and stored for three months was higher with mean number of 87.84% while four and six pairs gave 99.66% and 99.33% respectively. The severity of damage caused was more in the third month compared to that of first and second month regardless of the level of infestation. The study submitted that the longer the storage duration, the more economic damage stored produce will suffer due to increase egg laying, increase adult emergence and increase percentage damage of seeds which result to high severity of damage.

Keywords: *Bambara groundnut, Callosobruchus subinnotatus, Levels of infestation, storage duration*

INTRODUCTION

Bambara groundnut (Vigna subterranean (L.) verdcourt) is an indigenous African Leguminous crop cultivated mainly by subsistence farmers. It has been considered the third most important legume as protein source after cowpea and groundnuts in many regions of sub-Sahara West Africa (Sellschop, 1962). Bambara groundnut has a reputation for resisting pests and competes favourable with other legumes such as groundnuts or cowpea in this regard (Ofuya, 2001). It is susceptible to infestation by field-to-store bruchid pests. In West Africa, it is mainly infested by Callosobruchus

subinnotatus in storage (Haines, 1991; Mbata, 1992). The bruchid commences infestation in the field, once bambara groundnut has been harvested and left to dry (Maina et. al., 2011). Although the level of field infestation is usually low (Ofuya, 2001), the bruchid population rapidly increases in storage and causes substantial quantitative and qualitative losses (Maina, Dauda and Degri, 2011). These are manifested by reduction in weight, market value and germination (Dauda, Ayertey and Boateng, 2009).

Control of stored bambara groundnuts pests using chemical pesticides is becoming less popular due to high costs, environmental concerns, development of resistant insect strains and the awareness of the potential dangers of pesticides to consumers of stored products, especially in cases of misapplication (Appert, 1987; Athanassious, 2005). Local farmers stored bambara groundnut seeds with various substances including tobacco, peppers, wood ash, neem leaf powders, onion scales and sand to protect them from storage pests (Oparaeka and Bunmi, 2006). The objective of this study is to determine the effect of population density and different storage durations on the damage of bambara groundnut seeds by C. subinnotatus.

MATERIALS AND METHODS

The experiment was conducted in the Entomology Laboratory of the Department of Crop Protection, Faculty of Agriculture, University of Maiduguri in 2010 under tropical storage temperature of 30^{o} - 32^{o}C. The Bambara groundnut seeds used for this experiment was obtained locally from Maiduguri Monday Market. Clean seeds were sorted out and stored in the refrigerator prior to the setting of the experiment to avoid unwanted infestation. 100g of bambara groundnut seed were weighed into 100 ml of glass jars and were infested with adults of both sexes of C. subinnotatus with different pairs (2, 3, 4 and 6 pairs) with the aid of a porter and stored for three months. The experiment was set-up as a randomized complete block design (RCBD) in which treatments were replicated three times. The female bruchids were allowed to lay eggs throughout their life-span afterward both live and dead insects were removed at the end of the duration of storage.

The parameters taken were the number of eggs laid, total number of adults emerged in each replicate, percentage seed damaged and severity of damaged seeds. The severity of seed damaged was obtained by dividing the number of adult emerged holes by the number of damaged seeds. These parameters were taken at the end of every month within the three months duration. Data obtained from this experiment were subjected to two-way Analysis of Variance (ANOVA) and differences between means were determined using the least significant difference (LSD) at 5% level of probability according to Gomez K. and Gomez A. (1984).

RESULTS AND DISCUSSION

The mean number of eggs laid by *Callosobruchus subinnotatus* at different levels of infestation (pairs) increased with the storage duration, indicating a significant difference among all the pairs (table 1). At the first month storage duration, those infested with three pairs have the lowest mean number of eggs laid. This implies that there is a significant difference between the first and third month of storage duration. Four and six pairs levels of infestation significantly increase the rate of progeny production in *C. subinnotatus* with six pairs at three months attaining the highest mean number of eggs laid. The levels of infestation and storage duration of *C. subinnotatus* had significant impact on the bionomics of the pest. This result showed that as the number of *C. subinnotatus* increase with storage duration, the number of eggs laid also increases. This study agrees with the findings of Maina and Lale (2004a) who reported that C. subinnotatus increase with increasing initial level of infestation and duration of storage in bambara groundnut.

Table 2 shows that the mean number of *C. subinnotatus* adult emerged in bambara groundnut seed infested with three pairs of *C. subinnotatus* has the lowest mean number of adult emergence all through the three months storage duration irrespective of being the lowest in all the pairs. There was significant difference among the first month, second month and third month. This result suggests that bambara ground nut with six pairs infestation are likely to suffer higher loss even after single generation of the bruchid than two pairs infestation. The result showed that the longer the storage duration the more adult emergence was recorded as shown in six pairs infestation for the second and third months. This result indicates that the population density and storage duration of C. subinnotatus in stored bambara groundnut has a significant impact on the development of the pest. This agrees with the findings of Maina and Lale (2004b) and Dauda, Ayertey and Boateng (2009) who reported that higher number of adults emerged after three months of storage. The significantly higher number of adult progeny that emerged in bambara groundnut seeds infested with three pairs of *C. subinnotatus* and stored for three months suggest that bambara groundnut with heavy dose of infestation will suffer serious damage.

Table 3 shows the mean percentage damaged bambara groundnut seeds by adult *C. subinnotatus* infested with different pairs of the insect and stored for three months. Bambara groundnut infested with two pairs of *C. subinnotatus* and stored for one month had the lowest mean percentage damaged of 10.81%, while those infested with two pairs of *C. subinnotatus* and stored for three months had significantly higher mean percentage damaged of 87.84%. Generally, percentage seed damage significantly increased with increasing storage duration and population density. Significantly higher proportion of seeds were damaged in seeds infested with six pairs of *C. subinnotatus* and stored for three months with mean percentage damage of 99.33%. The result shows that the longer the storage duration the more damage done irrespective of the population density. This agrees with the finding of Haines (1991) and Ofuya (2001)

who reported that the low population density are known to expand rapidly and thus lead to significant losses under a very conducive environmental conditions of temperature and relative humidity. This also implies that the longer the storage durations the more economic damage stored produce will suffer (Mbata, 1992).

Table 4 shows the mean severity of damaged bambara groundnut seed infested with different pairs of *C. subinnotatus* and stored for three months. At three pairs level of infestation in one month duration has the lowest mean severity of damaged. There was no significant difference between one, two and three months among three pairs. However, there was significant differences among the different pairs of two, three, four and six in various months but the severity of damaged caused was more in the third month compared to that of first and second month regardless of the population density of the *C. subinnotatus.*

The result also shows that severity of damaged bambara groundnut seeds was generally more in four and six levels of infestation and stored for three months duration. This suggests that as the bambara groundnut seeds are stored for longer period of time the severity of damaged increases. This study agrees with the observation made by Maina (2005), Oparaeka and Bunmi (2006) who reported that *C. subinnotatus* causes severe damage to bambara groundnut seeds when stored for a longer period of time under conducive environmental conditions.

Table 1: Mean number of egg laid by Callosobruchus subinnotatus on bambara groundnut seed infested with different pairs of the insect for three months.

Storage duration (Months)	Population density of C. subinnotatus in pairs/100 g seed				
	2	3	4	6	Mean
1	84.70	14.70	131.00	117.30	86.93
2	1221.30	532.70	2902.00	2861.70	1879.93
3	1644.30	920.70	3143.30	3372.70	2270.25
Mean	983.43	489.37	2058.77	2117.23	

SED = 180.65 LSD (0.05) 372.85 (Duration of storage)
SED = 208.60 LSD (0.05) 430.33 (Population Density)
SED = 361.30 LSD (0.05) 745.70 (Interaction)

Table 2: Mean number of Adult C. subinnotatus emerged in Bambara groundnut seed infested with different pairs for three months

Storage duration (Months)	Population density of C. subinnotatus in pairs/100 g seed				
	2	3	4	6	Mean
1	15.00	4.67	42.00	46.33	25.50
2	101.67	45.33	209.33	258.00	153.58
3	254.33	91.33	459.00	433.00	309.42
Mean	123.67	47.11	236.78	243.78	

SED = 19.46 LSD (0.05) 40.16 (Duration of storage)
SED = 22.47 LSD (0.05) 46.38 (Population Density)
SED = 38.92 LSD (0.05) 80.32 (Interaction)

Table 3: Mean percentage of damaged bambara groundnut seeds infested with different pairs of C. subinnotatus and stored for three months

Storage duration (Months)	Population density of C. subinotatus in pairs/100 g seed (%)				
	2	3	4	6	Mean
1	10.81	4.96	35.02	31.65	20.61
2	66.01	45.82	75.62	87.03	68.87
3	87.84	61.60	99.66	99.33	87.11
Mean	54.89	37.46	70.43	72.67	

SED = 4.49 LSD (0.05) 9.26 (Duration of storage)
SED = 5.18 LSD (0.05) 10.70 (Population Density)
SED = 8.98 LSD (0.05) 18.53 (Interaction)

Table 4: Mean severity of damaged bambara groundnut seeds infested with different pairs of C. subinnotatus and stored for three months

Storage duration (Months)	Population density of C. subinotatus in pairs/100 g seed (%)				
	2	3	4	6	Mean
1	1.26	1.00	1.19	1.30	1.19
2	1.63	1.19	2.79	2.93	2.14
3	3.00	1.21	4.81	4.45	3.37
Mean	1.96	1.13	2.93	2.89	

SED = 0.20 LSD (0.05) 0.41 (Duration of storage)
SED = 0.23 LSD (0.05) 0.48 (Population Density)
SED = 0.40 LSD (0.05) 0.82 (Interaction)

CONCLUSION

The effects of Population density and storage duration on the development of Callosobruchus subinnotatus in stored bambara groundnut (Vigna subterranean (L.) Verdcourt) were examined using three different levels of infestation (2, 3, 4 and 6 pairs of C. subinnotatus) per 100g of bambara groundnut and stored for three months duration under prevailing tropical storage temperature of 30 - 32^{o}C. The study shows that the longer the storage durations the more economic damage stored produce will suffer due to increase egg laying, increase adult emergence and increase percentage damage of seeds which result to high severity of damage.

ACKNOWLEDGMENTS

The authors are grateful to Miss Ruth Onumonu of the Department of Crop Protection, Faculty of Agriculture, University of Maiduguri, Nigeria who assisted in data collection.

REFERENCES

Appert, J. (1987). The storage of Food Grains and seeds. Macmillan Publishers Ltd. London, 146pp.

Athanassiou, C. G. (2005). Insecticidal Effect in Different Grain Commodities. Crop Protection, 24, 703 - 710.

Dauda Z., Ayertey J. N. and **Boateng B. A.** (2009). The Effect of Bambara groundnut (Vigna subterranean (L.) Verdcourt) varieties on Development of Callosbruchus maculatus Fab. (Coleoptera: Bruchidae). *Journal of Arid Agriculture,* 18: 38 - 44.

Gomez, K. A. and **Gomez, A. A.** (1984). Statistical Procedures for Agricultural Research, 2nd edition John Wiley and Sons. New York, 540pp.

Haines, C. P. (1991). Insects and Arachuids of Tropical stored products: Their Biology and Identification. Natural Resources Institute, Chathman Kent, UK. P.246.

Maina, Y. T. (2005). Effects of variety, duration of storage, season and solar radiation on the efficacy of neem (Azadirachta indica A. Juss) Seed oil in the control of storage cowpea bruchid Callosobruchus maculatus (F.). Ph.D. Thesis, University of Maiduguri, Nigeria.

Maina, Y. T. and **Lale, N. E. S.** (2004a). Effect of initial infestation and interspecific competition on the Development of Callosobruchus subinnotatus (Pic) in Bambara groundnut Vigna subterranean Verdcourt. *International Journal of Agriculture and Biology,* 6(6), 1059 - 1061.

Maina, Y. T. and Lale, N. E. S. (2004b). Influence of Varietal Differences on Interspecific Competition between (Callosobruchus maculatus (F.) and Callosobruchus subinnotatus (PIC) on Bambara groundnut. *Journal of Research in Science and Management,* 2 (1), 1 - 6.

Maina Y. T., Dauda Z. and **Degri M. M.** (2011). Effects of Different levels of Infestation and storage Durations on the Development of Callosobruchus maculatus (Fab.) in stored cowpea Vigna unguiculata (L.) Walpers. www.patrisujejournal.net/currentissues. Publication of Nasarawa State University. Keffi 7(1), 49 - 54.

Mbata, G. N. (1990). Studies on the developmental biology of Callosobruchus subinnotatus (PIC.) (Coleoptera: Bruchidae) a pest of bambara groundnuts. *Insect Science and its Application,* 11: 245 - 251.

Mbata, G. N. (1992). Studies on the comparative susceptibility of varieties of Bambara groundnut to infestation by Callosobruchus maculatus. *Tropical Science,* 32: 47 - 51.

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.

Oparaeka, A. M. and **Bunmi, J. O.** (2006). Bioactivity of two powdered species (Piper guineeuse Thonin and schum and Xylopia aethiopia (Dunol) A. Richard) as home made insecticides against Callosobruchus subinnotatus (Pic.) on stored Bambara groundnut.

Sellschop, J. P. F. (1962). Cowpea (Vigna unguiculata (L.) Walp.). *Field Crop Abstracts,* 15: 255 - 266.