**Journal of Agricultural Science and Food Technology**
**Vol. 2 (10), pp. 164-168, December, 2016**
**ISSN: 2465-7522**
**Full Length Research Paper**
**http://pearlresearchjournals.org/journals/jasft/index.html**

# Influence of Seed Size on the Performance of *Callosobruchus maculatus* in Four Cowpea Varieties

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Accepted 30 November, 2016

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**ABSTRACT**

**There have been reports on the factors influencing the performance of cowpea seed beetle, *Callosobruchus maculatus* (F.). Therefore, experiments were conducted on four local cowpea varieties (Oloyin, Drum, Sokoto white small and big) to evaluate the effects of seed size on the performance of *C. maculatus* on the varieties. The study was carried out at the Pest Management Laboratory, Department of Crop, Soil and Pest Management, Federal University of Technology Akure, Ondo State, Nigeria. Ten seeds of the four varieties and two seeds of the varieties mixed served as the control were infested with 3 pairs of 2days old adult's *C. maculatus* in petri dishes (90x150 mm) and replicated three times. The experiments were conducted under prevailing laboratory conditions of 28±2°C temperature and 60±5% relative humidity. Data were collected on initial weight of seeds, number of eggs laid, number of seeds with eggs, number of seeds without eggs, number of emerged adults, number of seeds with holes, number of seeds without holes, weight loss and percentage damage. Results indicated that more eggs (41.00) were laid on Sokoto small variety but had no significant difference (p> 0.05) from the other varieties. Results also indicated that the highest number of adult's *C. maculatus* (9.00) emerged from the Drum variety but this was not statistically different (p> 0.05) from the other varieties. Weight loss (0.41) and percentage damage (56.67%) were highest in the Sokoto small. The study showed that the number of eggs laid was not influenced by the size of the seed but the number of emerged adults was influenced by the seed size.**

**Key words: *Callosobruchus maculatus*, Damage, Influence, Seed size and Weight loss.**

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## INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp) is a warm weather crop that is well adapted to drier regions of the tropics like Nigeria where other food legumes such as soybean, groundnut do not thrive well (Abate et al., 2011). It is one of the most economically and nutritionally important indigenous African grain legumes produced throughout the tropical and subtropical areas of the world (Abate et al., 2011) Nigeria is its largest producer and consumer, accounting for about 45% of its world's production (Ndong et al., 2012). Cowpea seed pods and leaves are consumed in fresh form as green vegetables in some African countries (Ghaly et al., 2010). The rest of the cowpea plant after the pods have been harvested serves as a nutritious fodder for livestock (Abebe et al., 2005) and also a source of cash income when sold to farmers who use them as livestock feed (Dugje et al., 2009). Its nutritive value makes it an extremely important protein source to vegetarian and people who cannot afford animal protein (Adeyemi et al., 2012). Cowpea seeds are also a rich source of minerals and vitamins (Hall et al., 2003). Cowpea is sometimes called "poor man's meat" or "vegetable meat" by researchers due to its high protein

content (Ofuya, 2003). Cowpea grain contains 23.4% protein, 1.8% fat and 60.3% carbohydrates and also a good source of vitamins and phosphorus (Adeyemi et al., 2012).

The major storage pest of cowpea is *Callosobruchus maculatus* (F). It infests cowpea before harvest, the higher the infestation levels before harvest the greater the damage to the seeds in storage. This will result in higher beetle emergence causing a greater weight loss, larger number of holes and consequently loss of economic value (Baidoo et al., 2010). The *C.maculatus* is a cosmopolitan polyphagous pest in the most tropics and subtropics such as USA, European, Mediterranean's areas, Africa, India, Malaysia, China, Japan, Pakistan, Iraq and Iran. This beetle is reported to be the mostdamaging pest of legume seeds and its larvae infests grains such as chickpea, broad bean and green pea (Kawecki, 1995). Since legumes provide the cheapest and richest source of plant protein they are often called poor man's meat. It has been suggested that the growth and development of *C. maculatus* depends on the nutritional value of the seeds (Wijeratne, 1998). Thus various parameters of *C. maculatus* such as oviposition behavior, development period and ability of newly hatched larvae to utilize the host for further growth are affected by host attributes that could exist physically or chemically in nature. Therefore, this study investigated the influence of seed size on the performance of *C. maculatus* on seeds of some local varieties of cowpea.

## MATERIALS AND METHODS

### Study Area

The study was carried out at the Pest Management laboratory of the Department of Crop, Soil and Pest Management, Federal University of Technology, Akure, Ondo State, Nigeria from March to April, 2016. The experiments were conducted under prevailing laboratory conditions of 28±2ºC and 60±5% relative humidity.

### Collection of Materials

Clean uninfested four (4) cowpea varieties (Oloyin, Sokoto big, Sokoto small and Drum) used in the experiment were purchased from Ojo- Oba market, Akure, Ondo State, Nigeria. The varieties were authenticated in the departments by an expert. The adults of *C. maculatus* were derived from already infested culture in the laboratory.

### Culturing of *C. maculatus*

Cowpea seeds collected were sterilized in the laboratory at 70ºC for 2 h to disinfest them of any insect's infestation. Two hundred and fifty (250) grams of each of the four (4) varieties were used for the culturing and was put inside disposable plastic containers covered with netted perforated lids to allow for ventilation and prevent the *C. maculatus* from escaping and were kept on the shelf in the laboratory. Fifty (50) pairs of adult's *C. maculatus* were introduced into the container to lay eggs and produce new set of offsprings. Fresh adults of 2 days old from the culture were subsequently used for further experiment on the influence of seed size on the performance of *C. maculatus.*

### Experiments on The Influence of Seed Size on The Performance of *C. maculatus*

Ten clean uninfested seeds each of the cowpea varieties (Oloyin, Sokoto big, Sokoto small and Drum) were weighed into petri dish with three replicates including control which was the mixture of two seeds each of the four varieties. Each petri dish was infested with 3 pairs (male and female) of *C. maculatus* adults of 2 days old. The insects were left in the petri dish for seven (7) days to allow for mating and oviposition. After seven (7) days adults of *C. maculatus* were sieved out while data on the following parameters were collected; number of eggs laid, number of seeds with egg and number of seeds without egg. The experiment set-up arranged in Completely Randomized Design was left untouched 21 days on the shelf for the emergence adults. Data on the following parameters were then collected; number of emerged adults, number of seeds with holes, number of seeds without holes, weight loss and percentage of damage caused.

### Data Analysis

Prior to statistical analysis, all data in counts and percentages were respectively square root and arcsine transformed and subjected to Analysis of Variance using Statistical Package for Social Sciences (SPSS) version 16. Means were separated using Tukey's test at 95% level of probability.

## RESULTS

The morphological characteristics of the four cowpea varieties used for the experiment are shown in Table 1. The result from this study shows variability in the influence of seed size on the performance of *C. maculatus*. The number of eggs laid, number of seeds with eggs, number of seeds without eggs, number of emerged adults, number of seeds with holes, number of seeds without holes and percentage damage caused were not significantly different except for the weight loss that was statistically different at $P<0.05$ (Table 2). Control (Mixed seeds), Oloyin, Drum Sokoto small and Sokoto big cowpea varieties showed no significant difference (P

**Table 1.** The morphological characteristics of the four cowpea varieties.

| Cowpea Varieties | Size | Colour | Texture | Average Seed Weight (g) | Texture |
|---|---|---|---|---|---|
| Sokoto small | Small | White | Slightly rough | 0.18 | Slightly rough |
| Sokoto big | Big | White | Smooth | 0.32 | Smooth |
| Oloyin | Medium | Light brown | Smooth | 0.26 | Smooth |
| Drum | Big | Brown | Rough | 0.33 | Rough |

Means in the column with the same letter(s) are not significantly different at 5% level of significant using Tukey's test (P < 0.05).

**Table 2.** Means of the number of eggs laid, number of seeds with eggs, number of seeds without eggs and number of emerged adults.

| Treatments (Varieties) | Number OF Eggs Laid | Seeds With Eggs | Seeds Without Eggs | Number Of Emerged Adults |
|---|---|---|---|---|
| Control (Mixed seeds) | 18.00a | 5.67a | 2.33a | 6.00a |
| Oloyin | 29.67a | 7.00a | 3.00a | 2.33a |
| Drum | 19.33a | 7.67a | 2.33a | 9.00a |
| Sokoto small | 41.00a | 10.00a | 0.00a | 8.33a |
| Sokoto big | 14.67a | 6.33a | 3.67a | 6.67a |

> 0.05) in the number of eggs laid. Highest number of eggs laid was observed on the seeds of Sokoto small. There was no significant difference in the four cowpea varieties for number of seeds with eggs recorded although Sokoto small has the highest number of seeds with eggs while the mixed seeds has the lowest number of seeds with eggs. When number of seeds without eggs was considered there was no significant difference (P > 0.05) in the four cowpea varieties, however Sokoto small variety has the least number of seeds without eggs while Sokoto big had the highest mean value of seeds without eggs. Though, no significant difference was observed among the four cowpea varieties for number of emerged adults, the highest number of adults *C. maculatus* emerged from Drum while Oloyin had the lowest number of emerged adults. Table 3 reveals the results obtained for the number of seeds with holes, number of seeds without holes, weight loss (g) and damaged cause (%) was not significantly different (p>0.05) among the varieties though Drum and Sokoto small varieties had highest number of seeds with hole. There was a significant difference (P > 0.05) in weight loss caused by the beetle with the highest weight loss obtained from the Sokoto small. Percentage damage was high (56.67%) in Sokoto small but was not significantly different (P > 0.05) from the value obtained for the Oloyin cowpea (20.00%). The four cowpea varieties showed no significant difference (P > 0.05) in the number of seeds with hole and number of seeds without hole, however, Drum recorded highest mean value of 6.33 in number of seeds with holes followed by the Sokoto small with 5.67 while Oloyin had the highest mean value (8.00) for the number of seeds without hole followed by the Sokoto big with 5.67.

## DISCUSSION

The result of the present study has shown that the four cowpea varieties (Oloyin, Drum, Sokoto small and big) evaluated show various degree of susceptibility to *C. maculatus* attack. The results suggest that female *C. maculatus* evaluate the relative quantity of resources available inside of a seed more accurately than if they compared the ratio of surface area between seeds of varying size. This supports the findings of (Oke and Olajire, 2012) who reported that the cowpea varieties studied exhibited some levels of susceptibility to *C. maculatus*, a major storage insect pest of cowpea. They also opined that seed size is of importance than the surface area of the seeds. Though in this study, eggs laid seems not to be influenced by the size of the seeds. From the results, Drum was found to be more susceptible to *C. maculatus.* It has the highest number of emerged adult followed by Sokoto small variety. It had been reported that variables such as adult emergence and weight loss are the most reliable indicators for susceptibility of cowpea to damage by *C. maculatus* (Redden and McGuire, 1983; Jackai and Asante, 2003). This might be due to large size of the Drum which provides ample supply of food for developing larvae. This present study also showed that Sokoto small which is smaller in size performed better to the *C. maculatus* infestation in weight loss and percentage damage. This is contrary to previous findings where larger seed sizes have been reported to influence susceptible of cowpea seeds to *C. maculatus*. These disparities in this report might be due to the fact that *C. maculatus* perform well in relation to the mass of seeds than seed size. *C. maculatus* evaluate the relative

**Table 3**. Means of number of seeds with hole, number of seeds without hole, weight loss and damaged cause.

| Treatments (Varieties) | NSWH | NSWTH | Weight loss (g) | Damage (%) |
|---|---|---|---|---|
| Control (Mixed seeds) | 3.67a | 4.33a | 0.07b | 45.83a |
| Oloyin | 2.00a | 8.00a | 0.07b | 20.00a |
| Drum | 6.33a | 3.67a | 0.06b | 33.33a |
| Sokoto small | 5.67a | 4.33a | 0.41a | 56.67a |
| Sokoto big | 4.33a | 5.67a | 0.16b | 43.33a |

Means in the column with the same letter(s) are not significantly different at 5% level of significant using Tukey's test ($P < 0.05$). NSWH = Number of seeds with hole. NSWTH = Number of seed without hole.

quantity of resources available inside of a seed more accurately than if they compared the seeds of varying size (Mitchell, 1990). This can also be linked to the environment where the experiment was carried out and variation in the host's characteristics. Differential responses of *C. maculatus* to various seed sizes observed in this study could also be as a result of larval competition within the seeds. This could also be explained that the females disperse their eggs among seeds according to the relative differences in seed mass rather than the relative differences in seed surface area. They not only deposited more eggs on the larger seeds but distributed their eggs according to the relative mass of the seeds available. Females distributed eggs in a manner inconsistent with the hypothesis that they base oviposition decisions on the relative surface area of seeds; they distribute eggs in a manner that reflects relative mass of seeds better than relative seed surface area (Mitchell, 1990). Instead, females must either use cues other than surface area when estimating seed mass or must have the ability to extrapolate non-linearly from surface area to seed mass. Avidov et al. (1965) had also proposed that females identify seed size according to surface curvature. Wilson (1988) documented that female *C. maculatus* spend over a quarter (27%) of their oviposition time inspecting the seeds other than oviposition pheromones and species–specific host plant cues. Most research on optimal oviposition strategies of seed beetles has focused on the frequency of host encounters and the avoidance of super parasitism. For instance, (Mitchell and Thanthianga, 1990) list three reasons that *C. maculatus* oviposition behavior deviates from randomness, none of which include variation in seed size. Not only that seed size is important during oviposition but that it directs oviposition behavior away from a strict uniform dispersion. As have been shown before and now that variation in seed size is important during all oviposition periods and at varying egg loads, but suggest that it may be more important as oviposition time and egg loads increase.

## CONCLUSION

From the results of this study, it was concluded that *C. maculatus* infested all the cowpea varieties presented irrespective of their sizes. However *C. maculatus* performed better on the Drum and Sokoto small varieties than other varieties. Highest number of eggs was laid on Oloyin and Sokoto small varieties. More adults emerged from Drum and Sokoto small. The mean weight loss was highest in Sokoto small and Sokoto big. Percentage damage was highest in the Sokoto small and mixed seeds. It was also concluded that the performance of *C. maculatus* as revealed in this study does not only depend on the size of the seeds but several factors such as seed texture, hardness e.t.c. It is therefore, recommended that further study involving many factors should be conducted to determine their separate and combine effects on the performance of *C. maculatus.*

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