

Residual Effect of Different Temperature Regimes on the Developmental Stages of F₁ Progeny of *Callosobruchus maculatus* (F) (Coleoptera: Bruchidea) on Cowpea Seeds

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Abstract – Residual effect of varying temperature regimes on the developmental stages of F₁ progeny of *Callosobruchus maculatus* (F) was investigated on cowpea seeds at the Biology Laboratory of Federal College of Agriculture, Ibadan. A pair of teneral adults (male and female) of *Callosobruchus maculatus* obtained from 10°C, 20°C, 30°C and 40°C was transferred into separate Kilner jars containing 25 seeds each, the control were from laboratory ambient conditions (29 ± 3°C and 85 ± 5% relative humidity). The experiment was laid out in a completely randomized design and replicated four times. Total number of eggs laid, number of hatched eggs (eclosion) and total number of adults that emerged from each treatment were recorded and analyzed, using analysis of variance while treatment means were separated with the aid of Duncan Multiple Range Test at 5% level of significance. Adults *C. maculatus* obtained from the lower temperatures (10 and 20°C) recorded higher fecundity (64.0 ± 3.4 and 61.0 ± 2.7) and adult emergence (52.8 ± 3.4 and 52.3 ± 3.2) respectively compared to those obtained from higher temperature regimes (30 and 40°C) with 45.5 ± 1.5, 21.5 ± 1.4 and 41.8 ± 4.2, 18.7 ± 2.4 respectively. Similarly F₁ adults of *C. maculatus* obtained from 10°C recorded the longest developmental period of 38 days while the shortest developmental period of 16.2 days was recorded from the F₁ adults reared under the temperature of 40°C. Thus at longer developmental period, the females have the highest fecundity and adult emergence.

Keywords – Eclosion, Oviposition, *Callosobruchus maculatus*, Fecundity, Infestation, Incubation, Emergence.

I. INTRODUCTION

Cowpea, *Vigna unguiculata* (L) Walpers originated in Africa, where it was domesticated in the Neolithic age [15]. The high protein content makes it a good supplement of staple food such as cereals, root, stem, tubers and fruits [3]. Cowpea seeds are eaten locally in a large variety of dishes. The green leaves and pods are sometimes used as vegetables. It is also consumed boiled or cooked or may be ground into flour turned into slurry and fried as cakes or stewed bean cakes especially in the Southern parts of Nigeria [10]. The cowpea weevil, *Callosobruchus maculatus* Fab is a major pest of economically important leguminous grains such as cowpea, lentils, green gram and black grain [11], [9], [14], [12]. It is a holometabolic insect with the egg and adult stage found on the grain and the larval and pupal stages living inside the grain [2]. The larvae bore into the pulse grains and eat up the endosperms

which become unsuitable for human consumption with reduced viability [4].

In Nigeria, losses of 50–100 percent of stored seeds have been attributed to *Callosobruchus maculatus*. Infestation by *Callosobruchus maculatus* damaged seeds during its developmental period, resulting in bored holes on the seeds. This severely reduces the quality and germination potential of the seeds [13].

Previous work has shown that temperature and humidity have marked effects on the duration and viability of different stages of the bean weevil. Similarly, these factors have been shown to affect the rate and total amount of oviposition of the fertile female [5].

Some workers have reported that the numbers of eggs laid on cowpea seeds by female *C. maculatus* varied considerably being 58 – 91 eggs [17], [7], [1]. Reference [16] also reported that adult female of *C. maculatus* laid between 50 to 80 eggs within a period of 5 to 7 days.

Temperature has a profound effect on the developmental period (egg – adult) and survival of *C. maculatus* [6]. Oviposition and developmental period were significantly affected by commodity temperature and their interaction [6]. A detailed knowledge of the life history and some environmental factors affecting the reproductive behaviour of an insect is crucial to understanding its population dynamics and managements. This paper therefore investigated the residual effects of different temperature regimes on the developmental stages of F₁ progeny of *Callosobruchus maculatus* on cowpea seeds.

II. MATERIALS AND METHODS

Four incubators used for this trial were calibrated into temperature regimes viz: 10, 20, 30 and 40 °C. The incubators were left working for about four days before the commencement of the trial. This was to ascertain any possible fluctuations on the temperature condition of each incubator. The untreated cowpea seeds kept in the refrigerator were taken out and allowed to acclimatize for 24 hours under ambient temperature condition before being used. Twenty-five (25) seeds were placed in each of 20 kilner jars grouped into 5 sets. Four sets of these kilner jars were kept in each incubator under a specified temperature regime while the fifth set was kept under ambient temperature in the laboratory as a control. Pair (male and

female) teneral adults of *Callosobruchus maculatus* reared on cowpea seeds from sub-culture was introduced into each kilner jar for all the replicates in all the incubators and the control under ambient laboratory condition. The weevils were left to oviposit on the seed. A week after the adults had died; the total numbers of eggs laid and hatched were recorded. The total number of emerged adults in each replicate at different temperature condition were obtained and immediately used for the experiment.

A pair of virgin adults (male and female) of *Callosobruchus maculatus* from each temperature regime was transferred into kilner jars containing 25 seeds each. This was replicated four times. In each of the four temperature regimes 10, 20, 30 and 40 °C and a control set up under ordinary laboratory condition of 29 ± 3 °C and 85 ± 5 % relative humidity.

The seeds were regularly observed for egg deposition and subsequent adult emergence. Percentage adult emergence and total developmental period from egg to adult were also noted and recorded. Hatched eggs were identified by the presence larval frass which causes egg to turn milky – white as larvae tunnel into the seeds. Percentage numbers of egg hatched was also calculated and recorded. Data collected were analyzed using the Completely Randomized Design followed by the mean separation using the Duncan Multiple Range Test (DMRT) at 5 % level of significant. The study was terminated when no adult emergence was observed for five days.

III. RESULTS AND DISCUSSION

The results of the effect of different temperature regimes on the fecundity and developmental stages of *C. maculatus* are presented in Table 1. There were significant differences in the mean number of eggs oviposited, ecloded and mean number of adults that emerged at different temperature regimes by the insect. The highest mean number of egg laid (46.5 ± 3.7) was recorded at the temperature of 30 °C and was significantly different from the values of 6.3 ± 0.9 , 10.8 ± 1.7 and 39.3 ± 3.5 obtained at the temperature regimes of 10, 20 and 40 °C respectively but was not significantly different when compared with the value of 50.3 obtained at the control experiment (Table 1).

The mean number of egg hatched for *C. maculatus* was significantly different at varying temperature conditions. Table 1 revealed that a temperature regime of 30 °C significantly supported the highest egg hatch of 44.0 ± 4.1 . In *C. maculatus* while the least number of the egg hatch (3.5 ± 1.0) was recorded at 10 °C. However, there was no significant difference in the mean number of egg hatched at 10 and 20 °C respectively.

Table 1 also shows that the number of adult *C. maculatus* that emerged in the control (36.25 ± 3.6) was not significantly different from those obtained at 30 °C. There was a significant reduction in the mean number of *C. maculatus* adults that emerged at 10 and 20 °C when compared to the adults that emerged at 30 °C and the control experiment respectively. The adults that emerged from the temperature of 10 °C have the longest developmental period (38 days) while the fastest developmental period (16.2 days

) was recorded at 40 °C.

The residual effect of different temperature regimes on fecundity and developmental stages of F₁ progeny of *C. maculatus* is presented in Table 2. There was a significant difference in the mean number of eggs laid and adult that emerged at different temperature conditions. The mean number of eggs oviposited and ecloded decreased considerably as the temperature under which the F₁ adults developed increases. For instance, adults obtained from the temperatures of 10°C and 20°C had the mean number of egg laid of 64.0 and 61.0 (82.5 and 85.7 %) respectively while the lowest mean number of eggs laid of 21.5 (60.4 %) was recorded from the F₁ adults obtained at 40 °C. Similarly, the highest percentage of adults that emerged from the F₁ progeny when reared at 20 °C was 85.7 % while the lowest percentage of 60.4 % was obtained from the F₁ progeny that was reared at 40 °C (Table 2).

The F₁ progeny obtained from the temperature of 10 °C has the highest developmental period of 38.0 days while the shortest developmental period of 16.2 days was obtained from the F₁ progeny of 40 °C. The most important components of the environment that affect the development of insects are temperature and relative humidity. The effective manipulation of any or both components will have considerable impact in the management of the insect population.

In this study, temperature has a marked effect on the egg-laying and development of *C. maculatus*. At lower temperatures, 10 and 20 °C, the mean number of eggs laid and hatched were significantly the lowest while a moderate temperature of 30 °C and the control supported the highest mean number of egg laid, ecloded and adult emergence. This confirmed the report of [6] who indicated that *C. maculatus* was unable to breed successfully in temperatures below 20 °C. This also explains the inability of *C. maculatus* to survive in the temperate regions.

The highest fecundity recorded on F₁ adults under low temperature (10 and 20 °C) regimes, with longer developmental periods clearly showed that egg laid by individual female *C. maculatus* depended on the reserves built up during the larval stages. Thus at longer developmental period, the females have the highest fecundity and adult emergence. This also confirmed the report of [8], that the egg a female will lay is proportional to the reserves built up during larval feeding and development.

Table 1. The Effect of Different Temperature Regimes on the Fecundity and Developmental stages of *Callosobruchus maculatus* (F)

Temperature Regime	Mean number of egg laid (\pm SE)	Mean number of egg eclosed (\pm SE)	Mean number of emerged adults (\pm SE)	Total developmental period (days) (\pm SE)
10°C	6.3 \pm 0.9 ^c	3.5 \pm 1.0 ^c	1.25 \pm 0.9 ^c	38.0 \pm 0.4
20°C	10.8 \pm 1.7 ^c	7.8 \pm 0.4 ^c	3.25 \pm 0.5 ^c	29.8 \pm 0.3
30°C	46.5 \pm 3.7 ^a	44.0 \pm 4.1 ^a	35.25 \pm 5.3 ^a	23.0 \pm 0.9
40°C	39.3 \pm 3.5 ^b	15.3 \pm 2.2 ^b	7.00 \pm 0.7 ^b	16.2 \pm 0.3
*Control	50.3 \pm 6.4 ^a	42.3 \pm 5.4 ^a	36.25 \pm 3.6 ^a	23.0 \pm 0.6

* Control temperature = 29 \pm 3°C

* Means followed by the same letters along the column are not significantly different at 5% level of significance (Duncan Multiple Range Test)

Table 2. Residual Effects of Varying Temperature on fecundity, Adult Emergence and Total Developmental Period of F1 Progeny of *Callosobruchus maculatus* (F)

Source of F ₁ Progeny	Mean number of egg laid (\pm SE)	Mean number of egg-hatch (\pm SE)	Mean number of emerged adults (\pm SE)	Percentage Adult Emergence (%)	Total Developmental Period (days)
10°C	64.0 \pm 3.4a	60.5 \pm 2.4a	52.8 \pm 3.4a	82.5	38.0
20°C	61.0 \pm 2.7a	52.3 \pm 1.8b	52.3 \pm 3.2a	85.7	29.8
30°C	45.5 \pm 1.5b	41.8 \pm 4.2c	36.0 \pm 4.3b	79.1	23.1
40°C	21.5 \pm 1.4d	18.7 \pm 2.4d	13.0 \pm 2.4c	60.4	16.2
Control	44.5 \pm 4.3c	43.2 \pm 3.6c	35.0 \pm 2.6b	78.7	23.0

Means followed by the same letters along the column are not significantly different at 5% level of significance (Duncan Multiple Range Test).

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