Effect of Diet and Seed Pretreatment on the Biology of *Bruchidius uberatus* (Coleoptera, Bruchidae)

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Diet significantly ($P < 0.0001$) affected fecundity of *Bruchidius uberatus* Fahraeus. Provision of 1 % sugar solution increased fecundity from 15 eggs/female to 47. Furthermore, sugar solution prolonged significantly the oviposition period of *B. uberatus* from one week to two weeks. Diet also significantly ($P < 0.0001$) increased adult longevity. Mean adult longevity recorded was 3, 7 and 13 days in control, water and sugar treatments, respectively. Seed pretreatment had a highly significant impact on the various developmental stages of *B. uberatus*. Maximum egg hatchability occurred in non-husked *Acacia nilotica* (L.) Willd. ex Del. seeds (83 %), moderate in de-husked seeds (74 %) and least in seeds presoaked in concentrated sulphuric acid (42 %). The frequency of larvae that developed successfully into pupae was greatest in non-husked seeds (72 %), nevertheless in de-husked and acid pretreated seeds, absolutely no larvae developed into pupae and hence the adult stage was not reached in these two treatments. Thus, de-husking and acid pretreatment of *A. nilotica* seeds is highly recommended.

Keywords *Bruchidius uberatus,* Bruchidae, *Acacia nilotica,* seed borer biology
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1 Introduction

Bruchids are universal beetles that infest mainly leguminous plant seeds with their larvae entering the seed and feed on the embryo and/or the endosperm rendering the seeds non-viable (Van Tonder 1985). Usually infested seeds never germinate (Ponnuswamy et al. 1990). In many instances bruchid seed borers were the main obstacle that inhibits the spread and existence of certain tree species in a particular ecosystem. Ernest et al. (1990) reported several *Bruchidius* spp. in seeds of *Acacia tortilis* subsp. *heteracantha* in Botswana, with *B. albosparsus*, *B. aurivillii* and *B. rubicundus* as the most dominant.

Bruchidius uberatus was reported as a serious pest of *Acacia nilotica* seeds in Botswana and is capable of destroying the total amount of stored seeds within a few years (Ernest et al. 1990). In the Sudan, the beetle was first reported by Peake (1952) and it caused 60–70 % or more infertility in *A. nilotica* seeds stored in sacks. The green pods collected off trees were already infested.

Fecundity and longevity of insects were reported to be affected by several factors. Various diets especially sugar, starch and foliage nitrogen content had a significant impact on fecundity and longevity (Ohmart 1991, Carey et al. 1992, Hanks et al. 1993). In general, fecundity was influenced by diet that varied with the variation in tree species (Smock and MacGregor 1988, Sukartana 1989, Augustin et al. 1993, He and Huang 1993).

The aim of the present study was to investigate the effect of seed treatment and diet on fecundity, oviposition, egg hatching, development, and adult mortality of *Bruchidius uberatus*.

2 Materials and Methods

2.1 Stock Culture Preparation

A total of 20 pairs of adult *Bruchidius uberatus* comprising 10 males and 10 females were introduced to 100 g of clean healthy seeds of *Acacia nilotica* (L.) Willd. ex Del. (about 300 seeds) in a glass jar (20 cm high and 20 × 20 cm base). The jar was kept inside an incubator (30 ± 1 °C). Newly emerging adults were collected by means of a camelhair brush and kept in clean petri dishes at room temperature for further experiments.

2.2 Sexing of Adults

Males and females were differentiated using a method described by Southgate (1983). In the female, the 5th sternite is fully extended so that the ventral surface is more or less flat and the 7th tergite is not represented. In the male, the 5th sternite is deeply incurved anteriorly and the 7th tergite is often seen projecting between it and the pygidium.

2.3 Effect of Diet on Fecundity and Longevity of *Bruchidius uberatus*

Ten pairs of newly emerging adults of *Bruchidius uberatus* comprising ten males and ten females, were introduced to 100 g of seeds (about 300 seeds) of *Acacia nilotica* in clean petri dishes (90 mm diameter) for each treatment as follows:

1. Just the beetles and the seeds
2. The beetles, the seeds and 1 % sucrose solution which was supplied by dipping a small piece of cotton into the sugar solution until fully saturated (Mital 1971).
3. The beetles, the seeds and tap water instead of sugar solution (control). Cotton piece and seeds were replaced daily.

Ten petri dishes were replicated for each treatment. The petri dishes were kept inside an incubator at 30 ± 1 °C. Eggs were counted daily, the oviposition period and adult longevity were recorded every 24 hours for one month.

2.4 Effect of Seed Pretreatment

A total of ten pairs of *Bruchidius uberatus* comprising equal numbers of males and females of newly emerging adults were introduced to a clean petri dish containing 100 g of *Acacia nilotica* non-husked seeds (about 300 seeds) and the same was done to 100 g of de-husked seeds and a third petri dish containing 100 g of seeds which were previously soaked in concentrated sulphuric acid for one hour and washed thoroughly in three changes of tap water and left to dry. All treatments were kept inside an incubator at 35 ± 1 °C.

Egg incubation and hatchability %, number of larvae which developed into pupae, the larval period, pupal period and the frequency of pupae that successfully developed into adults were all counted and recorded.

Data were transformed by SQRT (x), Arcsine (SQRT (x / 100)) and Arcsine (SQRT (x + 0.000001) / 100)) according to Sabin and Stafford (1990) before analyses. Then, statistical analyses were carried out using analysis of variance (ANOVA) and Tukey's (HSD) Test.

3 Results

3.1 Effect of Diet on Fecundity of *Bruchidius uberatus*

Diet significantly (P < 0.0001) affected fecundity of females (Table 1). It is evident that provision of 1 % sugar solution increased fecundity by more than threefold. Moreover, provision of sugar solution prolonged significantly (P < 0.0001) the oviposition period to two weeks as compared to ten days and one week in water and control treatments, respectively (Table 2).

Table 1. Effect of diet on fecundity of females of *Bruchidius uberatus.*

Type of diet	Mean number of eggs/female ± S.E.
Sucrose	6.87 ± 0.018a
Water	4.58 ± 0.028b
Control	3.99 ± 0.035c

Data were transformed by SQRT (x).
Means followed by the same letter are not significantly different according to Tukey's (HSD) Test.

Table 2. Effect of diet on oviposition period and adult longevity of *Bruchidius uberatus.*

Type of diet	Mean oviposition period (days) ± S.E.	Mean adult longevity (days) ± S.E.
Sucrose	3.74 ± 0.0053a	3.73 ± 0.037a
Water	3.14 ± 0.063b	2.65 ± 0.046b
Control	2.61 ± 0.0014c	1.90 ± 0.072c

Data were transformed by SQRT (x).
Means followed by the same letter in a column are not significantly different according to Tukey's (HSD) Test.

Table 3. Effect of seed treatment on egg hatchability and larval development of *Bruchidius uberatus*

Seed treatment	Mean egg hatchability % ± S.E.	Mean larvae % developed into pupae ± S.E.
Sugar	1.15 ± 0.003a*	1.02 ± 0.002a**
Water	1.04 ± 0.003b	0.00 ± 0.00b
Control	0.71 ± 0.004c	0.00 ± 0.00b

* Data were transformed by Arcsine (SQRT (x/100)).
** Data were transformed by Arcsine (SQRT (x + 0.000001)/100)).
Means followed by the same letter in a column are not significantly different according to Tukey's (HSD) Test.

3.2 Effect of Diet on Adult Longevity

Adult longevity was significantly (P < 0.0001) affected by diet. The mean maximum adult longevity was recorded in cultures supplemented with sugar solution. Nevertheless in water and control treatments longevity was much less (Table 2).

3.3 Effect of Seed Pretreatment

Seed pretreatment had a significant impact on the various developmental stages of *Bruchidius uberatus*.

3.3.1 Effect on Egg Hatchability and Incubation Period

The maximum egg hatchability % was recorded in non-husked seeds (83 %), moderate in de-husked seeds (74 %) and least in acid pretreated seeds (42 %) and these differences were significant (P < 0.0001) (Table 3). However, the egg incubation was not significantly different between treatments and it was 9.8, 9.9 and 9.7 days in non-husked, de-husked and acid pretreated seeds, respectively.

3.3.2 Effect on Larval Development

The results of the impact of seed pretreatment on larval development were striking. A total of 72 % of larvae developed successfully into pupae inside non-husked seeds. The mean larval period recorded was 27 days. Nevertheless, no single larva developed into pupa in the other two treatments i.e. de-husked and acid pretreated seeds (Table 3).

3.3.3 Effect on Pupal Development

A total of 81 % of the pupae developed successfully into adults inside non-husked seeds. Since no larvae pupated inside de-husked and acid pretreated seeds, zero adults were recorded in these two treatments.

4 Discussion

It is apparent that provision of sugar solution, significantly increased female fecundity of *Bruchidius uberatus* as compared to water and control treatments. Fecundity was tripled and doubled when compared with control and water treatments, respectively. Furthermore, provision of sugar solution also doubled the oviposition period over water and control treatments. Similarly, longevity increased significantly when females were supplemented with sugar solution. It has been well established that diet has a considerable impact on fecundity. As early as 1967, Prevett reported an increase in the number of eggs/female *Caryedon serratus* as a result of water provision. Hanks et al. (1993) reported a greater increase in fecundity of *Phoracantha semipunctata* (Cerambycidae) as a direct result of provision of sucrose. Increasing the concentration of sugar above 5 % didn't benefit beetle performance. Fecundity of *Paropsis attomaria* was directly related to foliar nitrogen concentration of *Eucalyptus blakelyi* (Ohmart 1991). Generally, diet expressed as various tree species affects fecundity and longevity of several insect species (Hamilton and Lechowicz 1991, He and Huang 1992, Augustin et al. 1993). In the present study, seed treatment had a significant impact on egg hatchability. Maximum egg hatchability was recorded in non-husked seeds and it was least in acid pretreated seeds.

An extremely important result in the present study is the fact that in de-husked and acid pretreated seeds, all larvae failed absolutely to pupate, whereas 72 % of larvae pupated inside non-husked seeds. Fortunately, pretreatment of *Acacia nilotica* seeds with concentrated sulphuric acid has been a routine practice in the Sudan to break down the extremely impermeable seed coat to enhance seed germination. It follows that this acid treatment is highly recommended to serve the dual purpose of seed protection and to improve germination. Similarly, newly emerging adults of *Bruchidius uberatus* (81 %) were recorded only in non-husked seeds, whereas no adults emerged from de-husked and acid pretreated seeds. It is probably that the pod might have provided a better microclimate in terms of temperature, humidity, and light intensity, that encouraged the development of larvae into pupae. De-husking and/or pretreatment of seeds with concentrated sulphuric acid might have changed the microclimate inside the seed that made conditions extremely unfavourable for larval development. Added to that is the possibility of desiccation of larvae following de-husking of seeds i.e. pod removal. It may be concluded that de-husking and acid pretreatment of *Acacia nilotica* seeds are recommended as they retard the development of the various developmental stages of *Bruchidius uberatus*.

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