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Population growth and grain loss of *Cathartus quadricollis* (Guerin-Meneville) (Coleoptera: Silvanidae) in different stored grains

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Abstract

In the tropics, insect pests account for large losses of food grains and other commodities. The knowledge of the biological parameters to establish suitable models of growth becomes necessary for programs of integrated pest management. Some insect pests of stored products can attack the grains in the field and in the wharehouse, as it happens with the *Cathartus quadricollis* (Guerin-Meneville). In Brazil, surveys showed the presence of this insect in the field. However, surveys evidencing the presence of this species in grains during the storage are lacking. Due to the occurrence of *C. quadricollis* in stored grains, the determination of their biological parameters such as the population growth becomes necessary. We determined the instantaneous rate of population increase (r_i) of *C. quadricollis*, natural mortality and grain loss in three different stored grains. The experiment on population growth and grain loss was carried out using Petri dishes with 40 g of broken maize, wheat and sorghum grains (13 % moisture content). Ten Petri dishes were infested with 20 non-sexed adults (2-4 weeks old) at 25 ºC and 70 % RH. The number of alive and dead insects was counted after 60 days. Insects on broken maize showed a higher r_i. Insects on wheat and sorghum showed the smallest r_i. The wheat and sorghum grains showed the higher weight loss among the three feeding substrate. The insect natural mortality was higher on wheat grains.

Key words: Squarenecked grain beetle, biological parameters, grain losses, insect growth, stored grains.

Introduction

Squarenecked grain beetle, *Cathartus quadricollis* (Guerin-Meneville) (Coleoptera: Silvanidae), is a common minor pest of a wide range of commodities, including cereals, dried fruit and cacao. In warm temperature and tropical areas, such as the southern United States, Central and South America, and West Africa, it attacks maize in the field and is very common in the tropics as a pest of maize stored on-farm by subsistence producers (Johnston and Oehlschlager, 1986; Rees, 1996).

In Brazil, some studies evidenced the presence of the insect in the field (Picanço et al., 1994). However, surveys evidencing the presence of the insect in grains during the storage are practically absent. Allotey and Morris (1993) showed the biology of *C. quadricollis* in different grains. However, studies that determine other biological parameters of this species, as the grain losses in the different food media and the natural mortality are very few. Differences in the biological

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parameters affecting the growth rate of insect populations are of particular interest to pest control (Faroni et al., 2004). Studies on models of population growth contribute to guide actions to be added to the integrated pest management programs.

The food media are capable of affecting the life cycle and the development time considerably (Allotey and Morris, 1993). Cline and Highland (1985) showed that the survival, reproduction and the development period of stored-product insects in 17 types of food media. The life cycle of *C. quadricollis* was studied under ambient laboratory condition on maize, sorghum, wheat, cowpea and melon, evaluating some basic parameters of your biology, as the number of descendants, in adult and immature forms (Allotey and Morris, 1993).

The occurrence of *C. quadricollis* associated to the stored products in Brazil, become necessary the knowledge of your biological parameters as the population growth and the potential of grain loss of this insect. The aim of our study was (1) to provide information of population growth of *C. quadricollis* on some selected food media such as maize, wheat and sorghum; (2) to verify the grain loss in the food media; and (3) to asses the natural mortality on the same substrates.

Materials and methods

Insects

We used one strain of *C. quadricollis* collected from maize on farm wood store in Aguanil, Minas Gerais, Brazil, in 2004. This strain was reared in glass bottles (1.5 l) in the laboratory (28 ± 2 ºC, 70 ± 5 % r.h.). Broken corn grains were used as food (13 % m.c.). Grains were previously disinfected and kept at -18 ºC to avoid reinfestation.

Instantaneous rate of population increase (r_i)

The instantaneous rate of increase (r_i) was measured in Petri dishes (140x10 mm) with 40 g of broken maize, wheat and sorghum grains (13 % m.c.). Ten dishes were infested with 20 adults (males and females) of 2-4 weeks old, 25 ± 2 ºC and 70 ± 5 % r.h. The number of alive and dead insects was counted after 60 days. The instantaneous rate of increase was calculated as $r_i = \ln(N_f/N_0)/rt$, where, N_f is the final number of insects alive, N_0 is the initial number of insects and rt is the duration of the experiment (Walthall and Stark, 1997).

Grain loss

The grain loss was measured by the difference among the initial mass of grains and the final mass in each Petri dish, discounted the fine particles non-retained in sieve of 1.00 mm.

Natural mortality

The natural mortality was measured by the final number of insects dead in each Petri dish, counted after 60 days.

Statistical analysis

The instantaneous rate of increase (r_i), natural mortality and grain loss were analyzed using ANOVA followed by Tukey tests ($p < 0.05$, PROC GLM; SAS Institute, 1989; SPSS, 2001).

Results

Instantaneous rate of population increase (r_i)

We used the instantaneous rate of population increase (r_i) to evaluate the development of *C. quadricollis* on different grains. There was significant variation in r_i among maize, wheat and sorghum ($F = 25.43$, d.f .= 27, $p < 0.0001$). Insects on broken maize showed a higher r_i. Insects on wheat and sorghum showed the smallest r_i (Figure 1). This indicates that the r_i for this specie was influenced by the different food source.

Grain loss

We used the grain loss to evaluate the consumption of grain by the insects. The grain loss varied significantly within food source ($F = 11.85$, d.f .= 29, $p < 0.0002$). Insects on wheat and sorghum grains showed the higher weight loss among the three feeding substrate (Figure 2).

Natural mortality

The natural mortality varied significantly in the different food source ($F=20.46$, d.f.=29, $p < 0.0001$). Insects that were maintained in wheat grains presented high natural mortality. However, the natural mortality of the insects in maize and sorghum was smaller than in wheat (Figure 3).

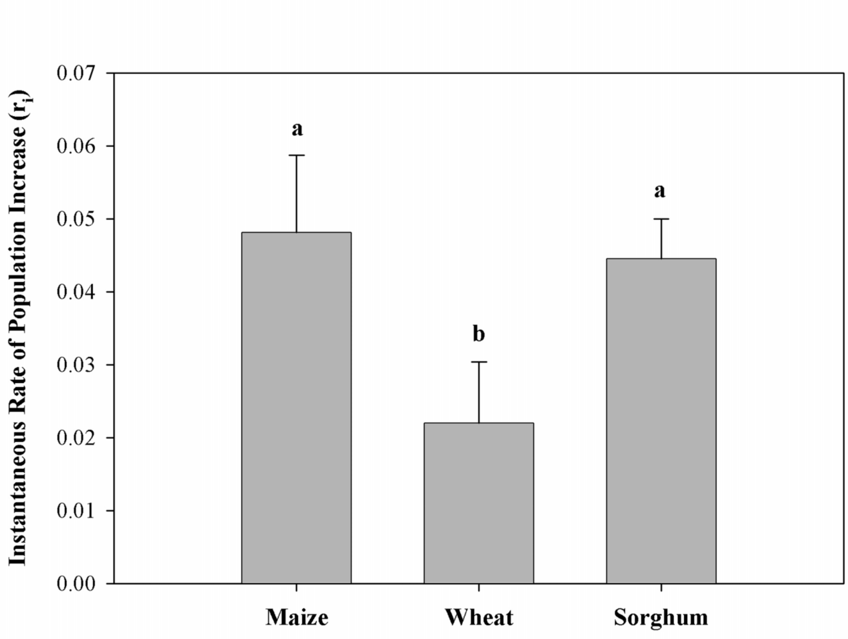

Figure 1. The instantaneous rate of population increase (r_i) for *Cathartus quadricollis* as a function of food source, after 60 days (25 ± 2 ºC and 70 ± 5 % r.h.). The results represent the mean ± standard error from ten replicates. Means followed by the same letter are not significantly different (Tukey test at $p < 0.05$).

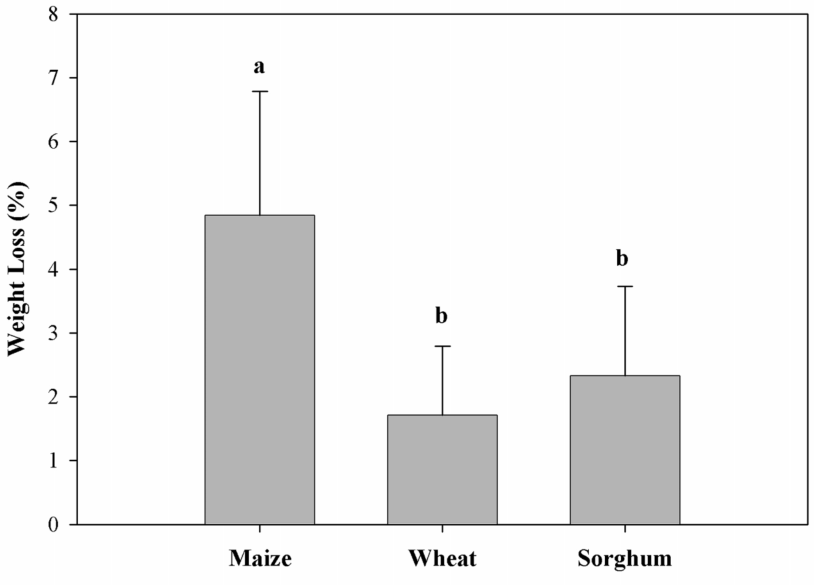

Figure 2. Weight loss (%) of maize, wheat and sorghum as a function of the development of *Cathartus quadricollis*, after 60 days (25 ± 2 ºC and 70 ± 5 % r.h.). The results represent the mean ± standard error from ten replicates. Means followed by the same letter are not significantly different (Tukey test at $p < 0.05$).

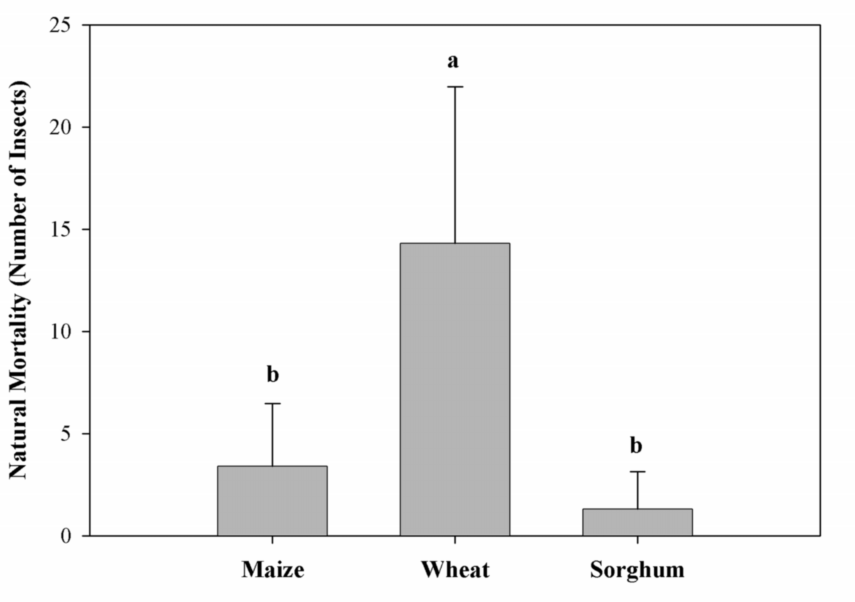

Figure 3. Natural mortality (number of insects) of *Cathartus quadricollis*, after 60 days (25 ± 2 ºC and 70 ± 5% r.h.) on maize, wheat and sorghum. The results represent the mean ± standard error from ten replicates. Means followed by the same letter are not significantly different (Tukey test at $p <$ 0.05).

Discussion

The food media and the environmental conditions affect the time of development of the insects (Gilbert, 1988; Allsopp et al., 1991; Subramanyam and Hagstrum, 1991). According to Munro (1966), the food type and the content of nutrients affect the biological parameters of the insects. LeCato and Flaherty (1973), show that the quantity and quality of the food media are capable of affecting the life cycle of an insect.

Our results indicate the higher instantaneous rate of increase was observed in the assays with maize and sorghum. Our data confirm findings by Osuji (1982) and Allotey and Morris (1993). Osuji (1982), show that these results might be caused by the higher nutritional value of the maize germ. Nation (2002) reported that temperature is particularly important since it governs the rate of increase. However, Howe (1967) stated that temperature is usually a key factor of the environment, but it interacts jointly with others such as humidity, food and light. Allotey (1986) noted that there was not much difference between the internal microclimate of the experimental cultures of insects and ambient conditions. However, the quality and condition of food could be responsible for the differences in the developmental periods (Allotey and Goswami, 1990). It has been observed that the flow of energy (consumption and utilization) through stored product insects during development vary with different food media (Imura and Sinha, 1986; White and Sinha, 1987).

This is the first report of grain loss and natural mortality of *C. quadricollis* in Brazil. These results increase the knowledge of the biological parameters about this species and data on the grain losses caused by this insect are practically absent.

Knowledge of the instantaneous rate of increase, grain loss and natural mortality of *C. quadricollis*, is essential in predicting the number of generations in a given period in the tropics under ambient conditions, especially considering the rising importance of *C. quadricollis* as a pest of stored products. Thus information on these parameters is very useful in the implementation of integrated pest management programs.

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