Available online at www.sciencedirect.com
SCIENCE DIRECT®
Journal of Stored Products Research 41 (2005) 271–281
Journal of STORED PRODUCTS RESEARCH
www.elsevier.com/locate/jspr

Developmental rates and population growth of insecticide-resistant and susceptible populations of *Sitophilus zeamais*

Daniel B. Fragoso[a], Raul Narciso C. Guedes[a,*], Luiz A. Peternelli[b]

[a] *Departamento de Biologia Animal, Universidade Federal de Viçosa, Viçosa MG 36571-000, Brazil*
[b] *Departamento de Informática, Universidade Federal de Viçosa, Viçosa MG 36571-000, Brazil*

Accepted 21 March 2004

Abstract

Two experiments were carried out to assess the developmental rate and population growth of four populations of *Sitophilus zeamais* Motschulsky (Coleoptera: Curculionidae). Two of these populations are resistant to pyrethroid insecticides (Jacarezinho and Juiz de Fora), while the other two are susceptible (Bragança Paulista and Sete Lagoas). The first experiment, with progeny removal and assessment every other day, allowed the estimation of the developmental rates of the four populations. The second experiment, without progeny removal and with monthly assessments, allowed the estimation of population growth and the consequent grain loss caused by each population. Both susceptible populations and the resistant population from Jacarezinho showed similar developmental rates, population growth and grain loss. In contrast, the insecticide-resistant population from Juiz de Fora showed reduced and delayed emergence. This population also had a smaller rate of population growth and high mortality at high densities associated with reduced grain loss. The Jacarezinho population was maintained without insecticide selection for over a decade suggesting that resistance is fixed or nearly so in this population. This explains its good demographic performance as opposed to the Juiz de Fora population, which was recently collected in a grain mill. Pyrethroid resistance in the Juiz de Fora population seems unstable without insecticide selection, which will likely prevent its fixation.

Keywords: Maize weevil; Demography; Fitness; Pyrethroid resistance; Brazil

*Corresponding author. Tel.: +55-31-3899-2006; fax: +55-31-3899-2537.
E-mail address: guedes@ufv.br (R.N.C. Guedes).

0022-474X/$ - see front matter © 2004 Elsevier Ltd. All rights reserved.
doi:10.1016/j.jspr.2004.03.008

1. Introduction

The maize weevil, *Sitophilus zeamais* Motschulsky (Coleoptera: Curculionidae), is a serious cosmopolitan pest of stored cereals, mainly maize, in the tropics (Throne, 1994; Danho et al., 2002). The over-reliance on insecticides for its control has made insecticide resistance a major concern in Brazil (Santos, 1988; Guedes, 1990, 1991; Guedes et al., 1995; Ribeiro et al., 2003). An earlier study of inheritance of deltamethrin resistance and recent efforts in determining the underlying insecticide resistance mechanisms in Brazilian populations of maize weevil suggest the likely existence of cross and multiple resistance in a few populations highly resistant to pyrethroids (Guedes et al., 1994, 1995; Fragoso et al., 2003; Ribeiro et al., 2003).

Insecticide resistance usually becomes widespread as a result of the spreading of resistant phenotypes in response to the selective pressure brought about by the insecticide presence in the environment (Muggleton, 1983). However, pyrethroid resistance in Brazilian populations of the maize weevil was earlier recognized in five different states (Guedes et al., 1995), but such a widespread problem somehow receded based on subsequent reports (Lorini and Beckel, 2002; Ribeiro et al., 2003). There is little doubt that insecticide resistance positively contributes towards an individual's fitness under conditions of insecticide use; the doubts begin when insecticide use is stopped or drastically modified—circumstances in which insecticide resistance may no longer be useful. In other words, the insecticide resistance trait may place resistant individuals at a biological disadvantage in the absence of the insecticide since it may be associated with a fitness cost, which can be exploited to halt or slow down the spread of resistance (Muggleton, 1982, 1983; Roush and McKenzie, 1987; Roush and Daly, 1990; Coustau et al., 2000).

A range of physiological costs of practical importance have been associated with insecticide resistance (Foster et al., 1996, 1997; Coustau et al., 2000; McCarroll and Hemingway, 2002). The diversity of resistance patterns in insecticide-resistant populations may impose differential costs favoring the fixation of some resistant phenotypes under certain environmental conditions, but not others. Demographic studies are useful in providing preliminary information on fitness disadvantages associated with insecticide resistance because they transpose individual effects on population-level responses (Stark and Wennergren, 1995). Therefore, such an approach was emphasized in the present investigation aiming to provide evidence of fitness costs associated with insecticide resistance in Brazilian populations of maize weevil for future assessment of the physiological costs involved.

2. Material and methods

2.1. Insects

Four populations of *S. zeamais* were used in this study. Two of them, from the counties Bragança Paulista (State of São Paulo, Brazil) and Juiz de Fora (State of Minas Gerais, Brazil), were field-collected in February and April of 1999, respectively, and at least 500 individuals were used to establish each population in the laboratory (Fragoso et al., 2003; Ribeiro et al., 2003). The population from Bragança Paulista is susceptible to insecticides, while the population from Juiz de Fora is highly resistant to pyrethroids (60–100% survival under discriminating concentrations)