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RESEARCH ARTICLE

# Effects of *Aschersonia aleyrodis* on the life table and demographic parameters of *Bemisia tabaci*

**ZHANG Can[1], SHAO Zhen-fang[2], HAN Yue-ye[3], WANG Xing-min[1], WANG Ze-qing[2], Peter Dennis Musa[1], QIU Bao-li[1], Shaukat Ali[1]**

[1] *Key Laboratory of Bio-pesticide Innovation and Application of Guangdong Province, Department of Entomology, South China Agricultural University, Guangzhou 510642, P.R.China*

[2] *Guangdong Engineering Research Centre of Microbial Pesticides, Guangdong New Scene Biological Engineering Co., Ltd., Yangjiang 529932, P.R.China*

[3] *Huai'an Entry-Exit Inspection & Quarantine Bureau, Huai'an 223001, P.R.China*

**Abstract**

The present study reports the sublethal effects of the entomopathogenic fungus, *Aschersonia aleyrodis* (Webber) on *Bemisia tabaci* (Gennadius) (Homoptera: Aleyrodidae). A fungal suspension of *A. aleyrodis* isolate Aa005 containing $1\times10^7$ conidia $mL^{-1}$ was sprayed against *B. tabaci* on eggplant leaves under greenhouse conditions. The effects of fungal application on survival as well as life table parameters of the whitefly were observed at different post inoculation periods. The results indicated that *A. aleyrodis* can significantly affect the survival of 1st, 2nd, and 3rd nymphal instars of *B. tabaci*. Developmental periods of different instar nymphs were not affected by fungal application. *A. aleyrodis* spores persisted well and significantly affected the survivorship of young instar nymphs of *B. tabaci* at different post incubation periods. Life table results suggested that *A. aleyrodis* has no impact on general fecundity and longevity of *B. tabaci*. When the pathogen was exposed to the open environment and maintained for a relatively longer period, a reduction in the reproductive rate and intrinsic rate of increase was caused by the fungal spores, though the sublethal effects were not as good as the control treatment. The results suggest that the ability of spores to suppress an increase in whitefly population persists well after incubation of spores to the external environment (up to 9 days).

**Keywords:** entomopathogenic fungi, *Aschersonia aleyrodis*, *Bemisia tabaci*, life table

## 1. Introduction

The sweet potato whitefly, *Bemisia tabaci* (Gennadius) (Homoptera: Aleyrodidae) is a worldwide pest of economically important crops (Naranjo *et al.* 2010). Since the 1980s, *B. tabaci* Middle East-Asia Minor 1 (MEAM1) cryptic species (formerly 'B biotype') has caused significant damage to host plants through defoliation, stunting and yield losses (Toscano *et al.* 1994; Cahill *et al.* 1995). *B. tabaci* feeds on the phloem sap of plants and produces honeydew,

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ZHANG Can, E-mail: zhangcanmail@163.com; Correspondence Shaukat Ali, E-mail: aliscau@scau.edu.cn


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which can lead to sooty mould production. Moreover, it is a competent vector for more than 150 different plant viruses (Stansly and Naranjo 2010). In China, MEAM1 *B. tabaci* is well distributed across 31 provinces or municipalities where it causes huge economic crop losses (Liu and Liu 2012). Management of heavy whitefly infestations is a difficult task, with synthetic pesticides still being the main control option available to suppress populations (Liang *et al.* 2012). However, injudicious use of chemical pesticides has resulted in the development of insecticide resistance by *B. tabaci* (He *et al.* 2013). In addition, the harmful effects of these chemicals on non-target organisms and increasing public environmental awareness has promoted the need to replace chemical insecticides with sustainable and environmentally safer pest control strategies, which includes biological control (Cuthbertson and Murchie 2005; Huang *et al.* 2010). Biological control using bacteria, viruses, fungi, nematodes and protozoa has been suggested to offer alternative means for control of *B. tabaci* (Huang *et al.* 2010; Cuthbertson *et al.* 2011).

Entomopathogenic fungi are widely distributed throughout the fungal kingdom. Some insect-pathogenic fungi have restricted host ranges, others have wide host ranges, while some individual isolates are very specific (Maia *et al.* 2001). Several species of fungi are potent biocontrol agents of plant pathogenic fungi and arthropods. Isolates of *Zoophthora radicans* (Brefeld), *Paecilomyces fumosoroseus* (Wize) Brown & Smith, *Fusarium solani* (Mart.) Sacc, and *Beauveria bassiana* Vuill can infect different insect species in greenhouse or field condition (Ibrahim and Low 1993; Pell *et al.* 1993; Vandenberg *et al.* 1998; Maia *et al.* 2001). The entomopathogenic fungus, *Aschersonia aleyrodis* (Webber), is well known for its pathogenic potential against whitefly (Meekes *et al.* 2000, 2002). In a previous study, *A. aleyrodis* was shown to have great potential for control of *B. tabaci* under laboratory and greenhouse conditions (Zhang *et al.* 2017). Previous investigations have also shown that sub-lethal effects of fungal infection are important indicators in evaluating the potential effects of fungal application on population dynamics of a target pest (Blanford and Thomas 2001). Quesada-Moraga *et al.* (2004) found that egg production, hatching, and the number of nymphs of the German cockroach, *Blatella germanica* (Linnaeus), declined when exposed to *Metarhizium anisopliae* (Metschnikoff). Therefore, knowledge concerning the sub-lethal effect of *A. aleyrodis* against *B. tabaci* populations is required before the application of *A. aleyrodis* in the field.

The general aim of this study was to assess the sub-lethal effects of *A. aleyrodis* on development and survival of *B. tabaci*. Furthermore, the pathogen persistence was assessed by incubation experiments. It is hoped that this research will contribute to a further understanding of the factors influencing the demographic parameters of MEAM1 *B. tabaci*.

## 2. Materials and methods

### 2.1. Cultivation of fungal isolate

The research was carried out at the Key Laboratory of Bio-pesticides Innovation and Application, South China Agricultural University (SCAU), Guangzhou, China. The strain *A. aleyrodis* Aa005 was maintained on potato dextrose agar (PDA) plates under laboratory conditions ((26±1)°C, (70±10)% RH). The inoculum for the experiment was produced following the method of Ali *et al.* (2010).

### 2.2. Insects and host plants

A stock of MEAM1 whiteflies were collected in Guangzhou from cotton plants and reared at SCAU. The MEAM1 *B. tabaci* was identified by using the mitochondrial COI sequence as described by Ahmed *et al.* (2010) and was maintained on eggplants (approximately 8 weeks old) in a greenhouse. The plants were cultured in 18.0-cm pots and kept in isolation cages to avoid any premature infestation from whiteflies or other insects until required. The rearing conditions were set at (26±1)°C, (70±10)% RH, and a photoperiod of 12 h L:12 h D.

### 2.3. Bioassay on life table and demographic parameters

In the evaluation of the pathogen using life table analysis, the leaves were treated with *A. aleyrodis* and incubated for different time periods prior to rearing of the cohort eggs. Female fecundity, viability of eggs, and reproductive ability were used for life table analysis to evaluate the potential of *A. aleyrodis* to be an effective natural enemy of *B. tabaci*. The essence of incubation was to test the persistence and survival of spores on the plant leaves.

**Effect of pathogen on development and survival parameters** The development and survival of *B. tabaci* from egg to adult emergence was investigated on eggplant leaves treated with a conidial suspension of *A. aleyrodis* ($1\times10^7$ conidia $mL^{-1}$). A cohort of 50 *B. tabaci* eggs was reared for development and survival trials. For homogenous production of eggs, a micro-cage (3.5 cm in diameter, 3 cm high) was clipped to the undersurface of eggplant leaves and two pairs of *B. tabaci* adults collected from the stock colony were released into the cage to initiate egg production. The micro-cages were removed after 24 h and the numbers of eggs on each leaf was adjusted to 10 individuals per leaf. The experimental set up consisted of 5 leaves, with each leaf having 10 eggs, making a total of 50