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A simple rearing technique for *Zeugodacus cucurbitae* Coquillett, 1899 (Diptera: Tephritidae), a melon pest in Senegal

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Abstract

Zeugodacus cucurbitae (Diptera: Tephritidae) is a major pest of cucurbit crops, and its laboratory rearing typically relies on expensive methods requiring artificial diets and specialized infrastructure. In resource-limited settings, these requirements represent a substantial barrier to establishing stable colonies, which are nevertheless essential for bioecological studies and integrated pest management programs. This study describes a simple, low-cost, and reproducible rearing technique adapted to local conditions in Senegal. Naturally infested watermelon fruits were collected and incubated at ambient temperature (26-32 °C), relative humidity of 47-72%, and a 12L: 12D photoperiod. Larvae developed within the fruit pulp and subsequently pupated in a sterilized sand substrate. Pupae were collected daily, incubated in ventilated containers, and monitored until adult emergence. Adults were maintained in simple cages and provided with a diet consisting of watermelon juice, sugar, water, and yeast. Oviposition was induced by offering pieces of fresh watermelon, enabling the production of a new generation without the need for artificial diets. This method provides a reliable and easily implementable alternative for maintaining *Z. cucurbitae* colonies in the laboratory, thereby supporting entomological research and the assessment of sustainable management strategies.

Keywords: *Zeugodacus cucurbitae*, rearing technique, watermelon, oviposition

Introduction

Agriculture is a pivotal sector for global food security and the sustainability of food systems in the context of population growth and increasing environmental constraints (Islam, 2025) [12]. However, crop productivity is frequently undermined by biotic factors, particularly insect pests, which constitute a major threat by reducing both yield and quality (Dhillon *et al*., 2005) [5]. Fruit flies (Diptera: Tephritidae) rank among the most destructive pests of horticultural crops, especially cucurbits, citrus, and various tropical fruits (White & Elson-Harris, 1992; Virgilio *et al*., 2015; Doorenweerd *et al*., 2018) [23, 21, 6]. *Zeugodacus cucurbitae* is one of the most damaging fruit fly species, capable of causing substantial economic losses due to its high reproductive potential, broad host range, and strong ability to adapt to diverse environments (Dhillon *et al*., 2005; De Meyer *et al*., 2015) [5, 4]. Understanding the biology and behavior of this species is essential for developing effective integrated pest management strategies. Studies by Vargas *et al*. (2015) [19] highlight that the implementation of modern control approaches such as the sterile insect technique, the evaluation of biopesticides, and the use of biological control agents requires well-established laboratory colonies, which are indispensable for producing high-quality individuals and conducting reliable biological assays. The *Z. cucurbitae* rearing techniques described in the literature rely primarily on standardized protocols developed for the mass production of Tephritidae (Cáceres *et al*., 2014; Maset *et al*., 2022) [2, 13]. These methods depend on complex artificial diets composed of balanced mixtures of proteins, sugars, fibers, and vitamins, often optimized to enhance the survival, fecundity, and overall quality of the flies produced (Cáceres *et al*., 2014; Pascacio-Villafán *et al*., 2017; Negm, 2020; Maset *et al*., 2022) [2, 16, 15, 13]. They also require specialized infrastructure, including climate-controlled chambers, sterile containers, artificial oviposition substrates, and strict colony management procedures to prevent microbial contamination (Dyck *et al*., 2005; Cáceres *et al*., 2014) [7, 2]. Although these protocols have proven effective, particularly in

Specialized facilities, their implementation remains costly and technically demanding, making them difficult to apply in laboratories with limited resources (Walker *et al*., 1997; FAO, 2007; FAO/IAEA/USDA, 2019) [22, 9, 10]. In light of these logistical, material, and financial constraints, it is necessary to explore ways of maintaining reliable *Z. cucurbitae* colonies in settings where access to specialized equipment is limited. This study addresses this challenge by proposing a simpler, lower-cost rearing method adapted to local conditions.

Presentation of *Zeugodacus cucurbitae*

The melon fly, *Zeugodacus cucurbitae* (Coquillett, 1899) [3], is a Tephritidae species of major agricultural importance, occurring across temperate, tropical, and subtropical regions (Dhillon *et al*., 2005) [5]. Formerly classified within the genus *Bactrocera*, phylogenetic analyses conducted by Doorenweerd *et al*. (2018) [6] led to its reassignment to the genus *Zeugodacus*. Native to Asia, *Z. cucurbitae* is now widely distributed throughout Asia, the Pacific region, East and West Africa, and Madagascar (De Meyer *et al*., 2015; Doorenweerd *et al*., 2018) [4, 6]. Its geographical expansion has been largely driven by the intensification of international trade in fruits and vegetables, which constitutes the main pathway for the dissemination of invasive Tephritidae (Dhillon *et al*., 2005; De Meyer *et al*., 2015) [5, 4]. The melon fly infests a wide range of fleshy fruits and vegetables but is particularly associated with cucurbits, including watermelon (*Citrullus lanatus*), melon (*Cucumis melo*), cucumber (*Cucumis sativus*), squash (*Cucurbita maxima*), and certain related wild plants (Dhillon *et al*., 2005; De Meyer *et al*., 2015) [5, 4]. Adult *Z. cucurbitae* measure on average 6-8 mm in length and exhibit a characteristic yellow-orange coloration, with a bright yellow scutellum and dark abdominal bands (White & Elson-Harris, 1992) [23]. The wings are hyaline with slightly shaded veins, typical of Tephritidae [6] (Doorenweerd *et al*., 2018). Females are distinguished by a tapered ovipositor at the posterior end of the abdomen, adapted for fruit penetration, whereas males possess a rounded abdominal tip (De Meyer *et al*., 2015; Singh *et al*., 2019) [4, 18]. Its life cycle comprises four stages: egg, larva, pupa, and adult (White & Elson-Harris, 1992) [23]. Under tropical conditions, the development of *Z. cucurbitae* varies according to temperature and humidity, with immature stages developing more rapidly at higher temperatures. This results in shorter life cycles and multiple generations per year in warm regions, contributing to the species' invasive potential and its significant economic impact on tropical horticultural systems (Vayssières *et al*., 2008) [20].

Fig 1: Dorsal view of *Zeugodacus cucurbitae*

Collection and establishment of the breeding colony

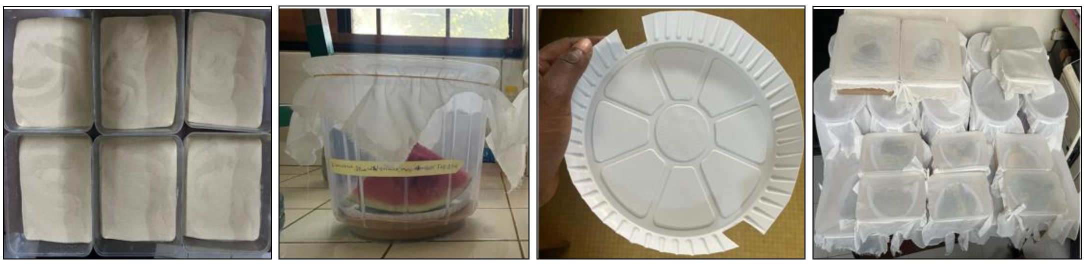
The laboratory colony was established in October 2025, corresponding to the transition period between the rainy and dry seasons in Senegal. Sampling was conducted in the botanical garden of Cheikh Anta Diop University in Dakar. Watermelon fruits (*Citrullus lanatus*) showing signs of infestation (softened or discolored areas, visible oviposition punctures, exudates on the fruit surface, etc.) were harvested directly from the plants by hand and placed in clean plastic bags. The samples were transported the same day to the Entomology and Acarology Laboratory of Cheikh Anta Diop University for incubation.

Rearing conditions

The samples were incubated under ambient laboratory conditions (temperature: 26-32 °C; relative humidity: 47-72% RH) and exposed to a photoperiod of 12 hours of light and 12 hours of darkness (12L: 12D). These values fall within the thermal and hygrometric ranges commonly used for rearing *Zeugodacus cucurbitae*. Experimental studies have shown that the melon fly achieves optimal development and survival within temperatures of approximately 20-30 °C and moderate relative humidity levels of 50-70% (Dhillon *et al*., 2005; Vayssières *et al*., 2008; Mkiga & Mwatawala, 2015; Ahn *et al*., 2022) [5, 20, 14, 1]. In contrast, 32 °C appears to represent the upper threshold of the species' tolerable range under constant environmental conditions (Ahn *et al*., 2022; Walker *et al*., 2023) [1, 22].

Incubation of infested fruits

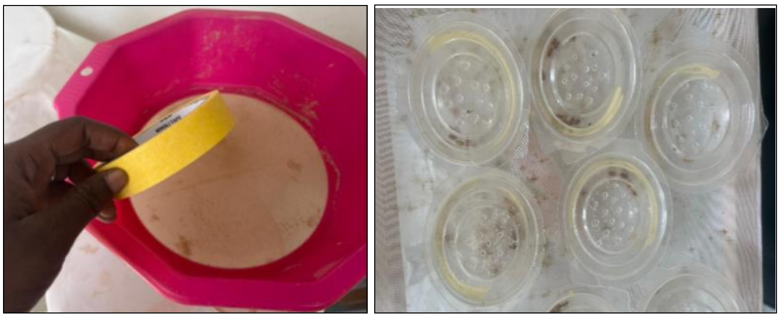
Disposable trays were placed on sifted and sterilized sand (heated to 70 °C for 30 minutes), which had been evenly distributed in plastic buckets used for the incubation setup. Using scissors, the edges of each tray were trimmed, and small openings were cut on two opposite sides to allow the larvae to drop onto the sand for pupation. Whole watermelons were then placed on the trays. Each bucket was covered with a fine-mesh white cloth securely fastened around the opening, allowing adequate air circulation while preventing the entry of gnats and ants. All buckets were placed on a table for incubation.



A B C D

Fig 2: Incubation setup for infested fruits. A: Sifted and sterilized sand; B: Cut tray; C: Incubation bucket; D: Incubation apparatus

Harvesting the pupae
After fruit incubation, the sand in each bucket was sifted daily using a fine-mesh sieve to check for the presence of pupae. Pupae were collected using soft tweezers and placed in plastic containers (diameter: 10 cm) labeled with the collection date and the number of pupae. Small holes were made in the lids of each container using a De Buyer pin or perforating tool to ensure adequate aeration. The sand in each bucket was replaced when necessary.



A **B**

Fig 3: Sieving and incubation of pupae in containers. A: Sieve and adhesive tape; B: Plastic containers holding pupae

Incubation of pupae
The containers holding the pupae were placed on a table at ambient room temperature. Temperature and relative humidity were monitored daily using a thermo-hygrometer. The containers were observed each day to record any adult emergence.

Adult Emergence and Maintenance
Upon emergence, the containers were opened to release the flies into cages (50 cm × 30 cm) covered with fine-mesh white fabric featuring two openings: one resealable and the other tied, allowing access for handling the insects. For feeding, three Petri dishes were placed in each cage: the first containing watermelon juice, the second a solution of water and granulated sugar, and the third a mixture of water, yeast, and granulated sugar to promote mating. Cotton was soaked in each solution to prevent the flies from drowning during feeding. The food was renewed every two days.

A B C

Figure 4: Adult maintenance setup for *Zeugodacus cucurbitae*. A: Rearing cage; B: Pupae containers with emerging adults; C: Feeding apparatus

Oviposition
To induce oviposition, freshly cut pieces of watermelon were placed in the adult breeding cages for 24 hours. Eggs were laid naturally within the watermelon pulp, which served as a natural oviposition substrate. The watermelon pieces were then incubated following the previously described protocol to allow egg hatching and larval development.

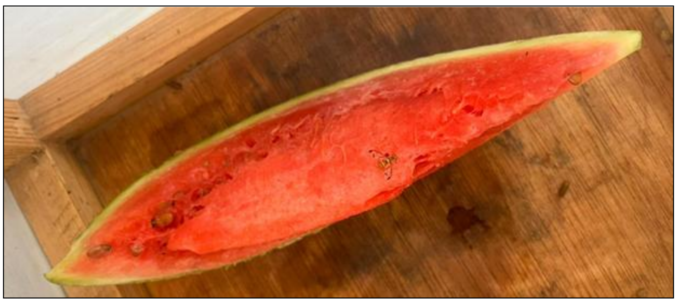


Fig 5: *Zeugodacus cucurbitae* on a piece of watermelon fruit

Larvae

Larval development occurred exclusively within the pulp, progressively destroying the fruit.

Fig 6: Third-instar larvae (L3) of *Zeugodacus cucurbitae*

Pupae

Upon reaching maturity, larvae exit the fruit and move to the ground to pupate. The sand is sifted to collect the pupae, which are then incubated to allow adult emergence, facilitating the production of a second generation.

Fig 7: Pupae of *Zeugodacus cucurbitae*

Conclusion

The simple rearing technique presented in this study provides a robust methodological framework for establishing reliable *Z. cucurbitae* colonies, which are essential for entomological research and the development of more sustainable management strategies. Further evaluation of alternative oviposition substrates could enhance understanding of the species' biology and behavior and improve the effectiveness of control measures.

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