




UDC: 632.937:632.7

DEVELOPMENT OF A LABORATORY REARING SYSTEM FOR WHITEFLY AS A HOST FOR *ENCARSIA FORMOSA*

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Abstract. The article presents the technology for effective laboratory rearing of whiteflies (Aleyrodidae), particularly *Bemisia tabaci* Genn., and investigates their biological characteristics. During the study, optimal microclimatic conditions were maintained to ensure stable development of the whitefly population, including a temperature of $25 \pm 2^\circ\text{C}$, relative humidity of 60-70%, and a 16:8 h photoperiod regime. Tomato (*Solanum lycopersicum*), cucumber (*Cucumis sativus*), and tobacco (*Nicotiana tabacum*) plants were used as host plants. The formation of the whitefly population, larval developmental stages, survival rate, and population density dynamics were analyzed. The results demonstrated that stable microclimatic conditions, high-quality host plants, and strict sanitary-hygienic control make it possible to obtain high-density whitefly populations within a short period under laboratory conditions. In addition, a biological basis was established for the development of the parasitoid entomophagous insect *Encarsia formosa*, and morphological changes in parasitized larvae were observed.

Keywords: Whitefly, *Bemisia tabaci*, *Encarsia formosa*, laboratory conditions, biological control, entomophagous insect, host plant, population density, microclimate, tobacco plant, larva, phytosanitary control.

Annotatsiya. Mazkur maqolada oqkanotlar (Aleyrodidae), xususan *Bemisia tabaci* Genn. ni laboratoriya sharoitida samarali ko'paytirish texnologiyasi hamda ularning biologik xususiyatlari o'rganilgan. Tadqiqot davomida oqkanot populyatsiyasining barqaror rivojlanishini ta'minlash maqsadida optimal



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mikroiqlim sharoitlari yaratildi: harorat $25\pm 2^{\circ}\text{C}$, nisbiy namlik 60-70% va 16:8 soatlik fotoperiod rejimi saqlandi. Xo'jayin o'simlik sifatida pomidor (*Solanum lycopersicum*), bodring (*Cucumis sativus*) va tamaki (*Nicotiana tabacum*) o'simliklaridan foydalanildi. Oqkanot populyatsiyasining shakllanishi, lichinka rivojlanish bosqichlari, yashab qolish darajasi va populyatsiya zichligi dinamikasi tahlil qilindi. Tadqiqot natijalari barqaror mikroiqlim sharoiti, sifatli xo'jayin o'simliklari va qat'iy sanitariya-gigiyena nazorati laboratoriya sharoitida qisqa muddat ichida yuqori zichlikdagi oqkanot populyatsiyasini olish imkonini berishini ko'rsatdi. Shuningdek, parasitoid entomofag hasharot *Encarsia formosa* ni rivojlantirish uchun biologik asos yaratildi va parazitlangan lichinkalardagi morfologik o'zgarishlar kuzatildi.

Kalit so'zlar: oqkanot, *Bemisia tabaci*, *Encarsia formosa*, laboratoriya sharoiti, biologik nazorat, entomofag hasharot, xo'jayin o'simlik, populyatsiya zichligi, mikroiqlim, tamaki o'simligi, lichinka, fitosanitar nazorat.

Аннотация. В статье представлена технология эффективного лабораторного разведения белокрылок (Aleyrodidae), в частности *Bemisia tabaci* Genn., а также изучены их биологические особенности. В ходе исследования для обеспечения стабильного развития популяции белокрылки поддерживались оптимальные микроклиматические условия: температура $25\pm 2^{\circ}\text{C}$, относительная влажность 60-70% и фотопериод 16:8 часов. В качестве растений-хозяев использовались томат (*Solanum lycopersicum*), огурец (*Cucumis sativus*) и табак (*Nicotiana tabacum*). Были проанализированы формирование популяции белокрылки, стадии развития личинок, уровень выживаемости и динамика плотности популяции. Полученные результаты показали, что стабильные микроклиматические условия, качественные растения-хозяева и строгий санитарно-гигиенический контроль позволяют за короткий период получать высокоплотные популяции белокрылки в лабораторных условиях. Кроме того, была создана биологическая основа для развития паразитоидного энтомофага *Encarsia formosa*, а также отмечены морфологические изменения у паразитированных личинок.

Ключевые слова: белокрылка, *Bemisia tabaci*, *Encarsia formosa*, лабораторные условия, биологический контроль, энтомофаг, растение-хозяин, плотность популяции, микроклимат, табак, личинка, фитосанитарный контроль.

INTRODUCTION

Laboratory rearing of whiteflies (Aleyrodidae) is considered one of the most important stages in biological control research, since the effective mass production of parasitoid entomophagous insects, including *Encarsia formosa*, first requires stable and sufficient populations of the host pest *Bemisia tabaci*. Therefore, this study comprehensively describes the theoretical foundations and practical aspects of whitefly rearing under artificial conditions.





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The process of whitefly rearing under laboratory conditions was organized in strict compliance with biological, agrotechnical, and sanitary-hygienic requirements. The experiments were conducted in 2026 under the conditions of the Tashkent region, where laboratory microclimatic parameters were continuously monitored. Temperature was maintained at $25\pm 2^{\circ}\text{C}$, relative humidity at 60-70%, and the photoperiod at 16:8 h (light:dark). These conditions were considered optimal for all developmental stages of whiteflies and promoted their rapid reproduction.

Vegetable crops were selected as host plants for whitefly rearing. In practice, tomato (*Solanum lycopersicum*), cucumber (*Cucumis sativus*), and in some cases tobacco (*Nicotiana tabacum*) proved to be the most effective host plants. These plants possess high nutritional value for whiteflies and support rapid pest development. The plants were cultivated in special containers or pots, and their phytosanitary condition was regularly monitored.

To establish the whitefly population in the laboratory, adult insects collected from natural environments were initially transferred into laboratory conditions. They were placed in special entomological cages together with host plants. Female whiteflies laid eggs on the underside of leaves, and the emergence of a new generation was observed within several days. Considering that one female whitefly can lay from 100 to 300 eggs, conditions were created for rapid population increase.



Figure 1. Cultivation of tobacco plants in the laboratory for whitefly rearing.



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Larvae hatched from the eggs were initially mobile, but later attached themselves to the leaf surface and began feeding. Larval development consisted of four instar stages, and the physiological condition and feeding activity of the larvae were monitored at each stage. Depending on temperature and humidity conditions, the developmental period lasted from 18 to 25 days. During this period, the population growth rate was regularly recorded.

Special attention was paid to sanitary and hygienic requirements during the laboratory rearing of whiteflies. All working areas were disinfected to prevent contamination by foreign pests or pathogenic microorganisms. In addition, each experimental variant was maintained in separate isolation, which ensured the reliability of the obtained results.



Figure 2. Establishment of a tobacco plantation in the laboratory for whitefly mass rearing.

To maintain a stable whitefly population, new host plants were periodically replaced. This was necessary because populations maintained on the same plants for a long time may experience nutritional deficiency or physiological weakening. Therefore, new plants were introduced every 10-15 days, which allowed the maintenance of high population density.

Under laboratory conditions, whitefly population density was evaluated using special counting methods. The numbers of larvae and adults on each leaf were counted, and their average values were determined. Based on these data, the dynamics of population growth were analyzed. In addition, the percentage of infested leaves was calculated to assess the overall infestation level.



During the whitefly rearing process, developmental rate and survival were also studied. These indicators are of great importance for evaluating the effectiveness of entomophagous insects in biological control programs. Developmental rate was calculated separately for each developmental stage, and the total developmental period was determined. Survival rate was evaluated based on the number of individuals surviving from egg to adult stage.

The light regime also played an important role in laboratory whitefly rearing. Under a regime of 16 hours of light and 8 hours of darkness, increased whitefly activity and higher egg-laying intensity were observed. Fluorescent lamps were used as light sources, and their intensity was maintained at a stable level.



Figure 3. Whitefly pests reared on tobacco leaves under laboratory conditions.

In the present study, a “conveyor method” was applied for the continuous rearing of whitefly populations. In this method, populations of different developmental stages were maintained simultaneously, ensuring the constant availability of individuals required for research purposes. This approach provided continuity in experiments involving entomophagous insects.

During laboratory rearing, the response of whiteflies to environmental factors was also investigated. It was determined that an increase in temperature accelerated developmental rate, whereas excessively high temperatures reduced survival. Low



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humidity levels were observed to cause egg desiccation. Therefore, maintaining optimal microclimatic conditions was proven to be of great importance.

The results of the study demonstrated that effective laboratory rearing of whiteflies requires stable microclimatic conditions, high-quality host plants, and strict sanitary control. Under such conditions, it is possible to obtain high-density whitefly populations within a short period of time. Whiteflies were mainly observed on the abaxial (lower) surface of leaves. Adult insects were small, white-colored, and covered with a waxy coating on their wings. Numerous small yellowish eggs were distributed in groups on the leaf surface. In addition, larval stages of different ages were also observed on the leaves.

A. Whitefly rearing process in the biolaboratory



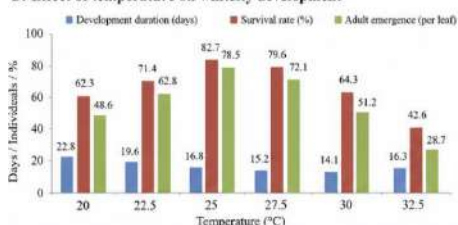
B. Mass rearing of Encarsia formosa



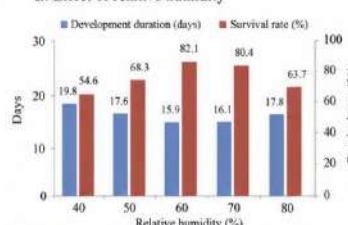
C. Life cycle of Bemisia tabaci (at 25±1°C, 65±5% RH)



D. Effect of temperature on whitefly development

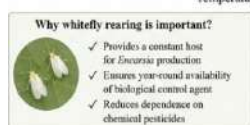


E. Effect of relative humidity



F. Optimal conditions for whitefly rearing in laboratory

Parameter	Optimal range	Remarks
Temperature	25 ± 1°C	Optimal for development and reproduction
Relative humidity	60-70 %	High survival and fecundity
Photoperiod	16L : 8D	Supports active oviposition
Host plant	Cotton (<i>Gossypium hirsutum</i> L.)	Provides suitable leaf surface and nutrition
Leaf age	15-25 days old	Preferred for oviposition



- Why whitefly rearing is important?**
- ✓ Provides a constant host for *Encarsia* production
 - ✓ Ensures year-round availability of biological control agent
 - ✓ Reduces dependence on chemical pesticides



- Advantages of the developed technology**
- ✓ Simple and cost-effective
 - ✓ High reproduction rate
 - ✓ Suitable for mass production
 - ✓ Ensures quality and quantity of *Encarsia*



- Application**
- ✓ Mass production of *Encarsia formosa*
 - ✓ Integrated pest management (IPM)
 - ✓ Sustainable and eco-friendly agriculture

Figure 1. Technology for laboratory rearing of whitefly for mass production of Encarsia formosa.

Some larvae turned black in color, indicating possible parasitism by natural enemies, particularly *Encarsia formosa*. This characteristic is considered an important visual indicator for evaluating the effectiveness of biological control.

CONCLUSION

The study results demonstrated that whitefly (*Bemisia tabaci* Genn.) populations can be effectively and continuously reared under laboratory conditions. The optimal conditions for whitefly rearing were determined to be a temperature of



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25±2°C, relative humidity of 60-70%, and a 16:8 h photoperiod regime. Tomato, cucumber, and especially tobacco plants proved to be highly suitable host plants with high nutritional value for whiteflies. The application of the “conveyor method” in the laboratory enabled continuous maintenance of populations at different developmental stages, thereby supporting uninterrupted experiments with entomophagous insects.

The study also confirmed that strict sanitary-hygienic measures, stable microclimatic conditions, and regular replacement of host plants ensure high population density. Signs of parasitism by *Encarsia formosa* were observed in whitefly larvae, confirming the important role of this entomophagous insect in biological control. The obtained results provide a scientific basis for improving biological control systems against whiteflies and for developing technologies for the mass rearing of entomophagous insects in the future.

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