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Research Article

# Do the parasitism parameters of *Trichogramma brassicae* change when *Tuta absoluta* feeds on resistant and susceptible tomato cultivars?

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**Abstract:** Integrated application of compatible methods is the most reliable strategy for sustainable management of phytophagous pests in different agroecosystems. In the current study, parasitism parameters of *Trichogramma brassicae* Bezdenko were determined on eggs of *Tuta absoluta* (Meyrick) reared on a susceptible "Infinity" and a resistant "Goldy" tomato cultivar. All experiments were carried out under laboratory conditions at 25 ± 1 °C, 65 ± 5% RH, and a photoperiod of 16:8 (L:D) h. Our results showed that the maximum number of parasitized hosts per parasitoid was 25.94 and 23 eggs in "Goldy" and "Infinity" cultivars, respectively. The cultivars tested had no significant effects on the net parasitism rate ($C_0$), and the values of this parameter were 7.87 and 6.67 hosts on the mentioned cultivars, respectively. Similarly, the cultivar impact on the finite ($\omega$) and stable parasitism rates ($\psi$) of *T. brassicae* was not significant. The parasitoid needed approximately one egg host to produce an egg on both cultivars for the simple reason that this parasitoid nearly always lays one egg in each host. In other words, the transformation rate ($Q_p$) of the parasitoid on the "Goldy" did not differ from that estimated on the "Infinity". Our findings revealed that the resistant tomato cultivar, "Goldy", did not compromise *T. brassicae*-based biocontrol of *T. absoluta*. Therefore, these two control procedures could be combined for the integrated management of this pest.

**Keywords:** Finite parasitism rate, Host plants, Integrated pest management, Net parasitism rate, Tomato leaf miner

## Introduction

Tomato leaf miner, *Tuta absoluta* (Meyrick) (Lep.: Gelechiidae), is a ubiquitous serious pest of tomato both in outdoor and greenhouse conditions; it causes severe damage throughout the growing season (Uchoa-Fernandes *et al.*, 1995; Colomo *et al.*, 2002). Although tomato *Solanum lycopersicum* L. is its preferred host, other plants such as potato *Solanum tuberosum* L., pepper *Capsicum annum* L., eggplant *Solanum melongena* L., wild solanaceous *Solanum* spp. and *Datura* spp., some weeds *Datura stramonium* L., *Nicotiana glauca* G. and

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some other non-solanaceous plants like green beans *Phaseolus vulgaris* L. have also been attacked by this pest (Korycinska and Moran, 2009; Desneux *et al*., 2010). The larval stage is the only damaging stage that feeds on the mesophyll tissue of leaves and stems. They form irregular mines in the leaves and extensive galleries in the stems. Furthermore, they can also attack the fruits, and their entryways may attract secondary pathogens, causing fruit rot (Pereyra and Sánchez, 2006). This pest can lead to up to 50-100% yield losses in tomatoes, especially in cases where management strategies are not efficiently developed (EPPO, 2005; Desneux *et al*., 2010). However, the extent of infection partly depends on the plant cultivar (Pereyra and Sánchez, 2006; Desneux *et al*., 2010).

Neurotoxic and insect growth regulator pesticides have been extensively used to control this pest. However, chemical control is not effective enough because of the concealed feeding manner of larvae and the rapid development of insecticide resistance (Siqueira *et al*., 2000; Lietti *et al*., 2005). Tomato producers have to increase pesticide use to overcome this obstacle, which leads to an increase in total pest management and production costs (Desneux *et al*., 2011). This widespread and drastic application will lead to adverse impacts on the environment and human health and disturb natural enemy populations (Lietti *et al*., 2005). Consequently, other control approaches are urgently needed to ensure effective, thrifty, and environmentally safe management of *T. absoluta*. Biological control using the predators, parasitoids, and entomopathogens of this pest is an alternative procedure worth studying (van Lenteren, 2008).

Different types of predators, parasitoids, and entomopathogens can be used for biological control of leaf miners. *Trichogramma* parasitoids are known as one of the most important biological control agents of various Lepidopterous pests (Chailleux *et al*., 2013). *Trichogramma brassicae* Bezdenko (Hym.: Trichogrammatidae) has been reported to be the most critical and dominant species of *Trichogramma* in different parts of Iran (Ebrahimi *et al*., 1998) commercially reread and inundatively released against several major crop pests including *Chilo suppressalis* Walker, *Ostrinia nubilalis* (Hübner), *Helicoverpa armigera* (Hübner), and *T. absoluta* (Ebrahimi *et al*., 1998; Ahmadipour *et al*., 2016).

One of the best control strategies for highly damaging pests is the simultaneous application of compatible control methods (Khanamani *et al*., 2015; Torres and Torres, 2018; Alipour *et al*., 2019). Combining different control procedures, especially biological control and resistant host plants, reduces insecticide use, keeps *T. absoluta* population below its economically injurious level (EIL), and finally results in effective management (Nderitu *et al*., 2020). Because the population growth of a pest species is slower on resistant hosts, resistance is often assumed to increase the capacity of a biological control agent to keep the pest population under the economic damage threshold (Khanamani *et al*., 2015). It has been found that the interaction between predatory bug *Macrolophus pygmaeus* (Rambur) (Hem.: Miridae) and resistant tomato cultivar resulted in a considerable control of *T. absoluta* by decreasing insecticide applications and production costs and enhancing environmental compatibility with biological control agents (Nderitu *et al*., 2020).

Plant quality in herbivores' diet may affect the parasitism capacity of their parasitoids. Tomato cultivars differ largely in resistance to leafminer (Safaeeniya *et al*., 2017a). In our previous studies, the susceptibility of five tomato cultivars to *T. absoluta* was evaluated. Regarding the population parameters of *T. absoluta*, "Infinity" and "Goldy" were determined as the most susceptible and resistant cultivars, respectively (Safaeeniya *et al*., 2017a). Therefore, it is essential to investigate their compatibility with natural enemies such as *T. brassicae* for integrated management of *T. absoluta* in tomato cropping systems. As a consequence, the present study was designed to evaluate the biological efficacy of *T. brassicae* in parasitizing and controlling *T. absoluta* on two susceptible and resistant tomato cultivars.

## Materials and Methods

### Plant cultivation

The seeds of the resistant ("Goldy") and susceptible ("Infinity") tomato cultivars were obtained from the Plant Protection Organization, Yasouj, Iran, and after treatment with a fungicide (carboxin-thiram [Vitavax-Thiran®] 75% WP, Gyah Co., Iran), were sown in plastic pots (20 cm diameter and 25 cm height) filed with fertilized field soil (1: 1: 1 mix of sand: clay: sheep manure). Under the greenhouse conditions, the plants were kept in the fine mesh cages (100 × 100 × 100 cm) at 27 ± 5 ˚C, 65 ± 20 % RH, and natural photoperiod. During the experiments, planting of the tomato cultivars was continued to ensure an adequate number of plants for both pest rearing and experimentations (same-sized plants with ≈ 35 cm height). All plants were synchronically irrigated. No additional fertilizers or chemical pesticides were used.

### Stock colony of tomato leaf miner

The leaves infested with different life stages of *T. absoluta* were collected from the tomato greenhouses in Kohgiluyeh and Boyer-Ahmad province, Iran. The leaves were gathered in the sampling bags and transferred to the laboratory conditions. The leaves were carefully checked using a stereomicroscope, and all unwanted organisms (pests and natural enemies) were removed. After this, the samples were transferred onto each tomato cultivar separately and kept in the mesh cages (eight plants per cage). The dead plants were replaced with healthy ones every week. Before the experiments, the pest was reared on each cultivar for at least three generations. *Tuta absoluta* adults were collected using a mechanical aspirator when necessary.

### Stock colony of parasitoid wasp *T. brassicae*

All rearing processes of *T. brassicae* were performed on nonviable eggs (50 min under UV light) of Angoumois grain moth, *Sitotroga cerealella* (Olivier) (Lep.: Gelechiidae). The fresh eggs (≤ 24 h old) of grain moth were obtained daily from Green Field Insectary of Plant Protection Organization, Yasouj, Iran. *Trichogramma brassicae* were collected from apple orchards in Kohgiluyeh and Boyer-Ahmad province, Iran, using egg traps (blue pieces of cardboard covered with fresh eggs of *S. cerealella*). For this, the fresh eggs were sprinkled on blue cardboard (20 × 15 cm) and hung on apple tree branches. To fix the fresh eggs of *S. cerealella* onto the sheets, a thin layer of Arabic glue (5%) was applied to the card surface using a paintbrush. The collected samples were transferred to the laboratory and placed in cylindrical plastic containers (25 cm in height and 10 cm in diameter). Parasitized eggs were incubated in a growth chamber until the adult's emergence. One hundred and fifty newly emerged pairs of *T. brassicae* were introduced to each container. The adult wasps were supplied with diluted honey on cotton rolls as a carbohydrate source during oviposition. Several samples were sent to the Iranian Research Institute of Plant Protection, Tehran, Iran, to identify the species.

### Preparation of parasitoids for experiments

The pots of tomato cultivars infested with *T. absoluta* were placed separately in a cage (90 × 90 × 100 cm), then adult wasps were randomly selected from the stock colony and released into the cage of each cultivar. To adapt the parasitoid to experimental conditions, they were reared for three generations in cages of each cultivar on *T. absoluta* moth eggs as host. Honey droplets were used to feed the adult wasps. During this period, in order to provide sufficient eggs for parasitoid wasps, newly emerged adult moths were collected daily from the colonies on the related cultivars and released into parasitoid cages.

### Experimental design

One hundred parasitized eggs (age ≤ 24 h) from each cage for each cultivar were randomly chosen and were individually kept in a glass cylinder (1.60 cm in diameter and 10 cm in height) until the emergence of adult wasps. The emerged female was confined with a male who had been raised under the same conditions. The pairs were then placed in the new glass cylinders. Paper traps (10 × 50 mm) containing about 150 eggs of *T. absoluta* reared on the resistant and susceptible tomato cultivars were offered daily to each pair of *T. brassicae* until the death of the females. The egg cards were removed from the glasses and kept in separate glass tubes to check for parasitism based on the symptoms of a color change in the egg. Therefore, the number of parasitized eggs was recorded daily as the parasitism rate. The adult wasps were supplied with paper strips impregnated with 20% honey-water solution as a carbohydrate source during oviposition. If a male died, it was replaced by a newly emerged one (< 24 h old) from the same colony. All experiments were performed in an incubator set at 25 ± 1 °C, 65 ± 5% RH, and a photoperiod of 16:8 (L: D) h.

## Data analysis

The daily parasitism rate of *T. brassicae* on *T. absoluta* reared on the two different tomato cultivars was analyzed according to Chi and Yang (2003) using the CONSUME-MSChart computer program (Chi, 2021a).

The data obtained from daily parasitism of the total cohort were used to calculate the age-stage specific parasitism rate ($c_{xj}$). This is the mean number of *T. absoluta* eggs parasitized by individual *T. brassicae* at age *x* and stage *j*. The age-specific parasitism rate ($k_x$) is the mean number of *T. absoluta* eggs parasitized by *T. brassicae* at age *x* and according Chi and Yang (2003) was calculated as follows:

$$k_x = \frac{\sum_{j=1}^{\beta} s_{xj} c_{xj}}{\sum_{j=1}^{\beta} s_{xj}} \quad (1)$$

where $\beta$ is the number of life stages, and $s_{xj}$ (age-stage specific survival rate) is the probability that a newborn will survive to age *x* and develop to stage *j*. The age-specific net parasitism rate ($q_x$) was calculated as follows:

$$q_x = l_x k_x \quad (2)$$

The net parasitism rate ($C_0$) gives the mean number of host parasitized by an average individual parasitoid during its entire life span, and is calculated as:

$$C_0 = \sum_{x=0}^{\infty} \sum_{j=1}^{\beta} s_{xj}\, c_{xj} \quad (3)$$

According to these, the total number of hosts parasitized by a cohort of size *N* is calculated as $NC_0$.

The transformation rate from host population to parasitoid offspring ($Q_p$) is the proportion of the net parasitism rate to the net reproductive rate, and is calculated as:

$$Q_p = \frac{C_0}{R_0} \quad (4)$$

The stable predation rate ($\psi$) is the total parasitism capacity of a stable population whose total size is one and is calculated as follows:

$$\psi = \sum_{x=0}^{\infty} \sum_{j=1}^{\beta} a_{xj}\, c_{xj} \quad (5)$$

where $a_{xj}$ is the proportion of individuals belonging to age *x* and stage *j* in a stable age-stage distribution (SASD). Because the parasitoid population itself will increase at the finite rate $\lambda$, the total number of hosts parasitized will increase as $\lambda\psi$. The finite predation rate ($\lambda\psi = \omega$) describes the parasitism potential of a parasitoid population by combining its growth rate ($\lambda$), age-stage parasitism rate ($c_{xj}$), and stable age-stage structure ($a_{xj}$), and is calculated as follows:

$$\omega = \lambda\psi = \lambda \sum_{x=0}^{\infty} \sum_{j=1}^{\beta} a_{xj}\, c_{xj} \quad (6)$$

Considering this, the intrinsic parasitism rate is calculated as $ln(\omega)$. In other words, the parasitism capacity will increase exponentially ($\omega = e^{(\text{intrinsic parasitism rate})}$) (Chi *et al.*, 2011).

The variances and standard errors (*SE*) of the parasitism parameters were calculated by the bootstrap method using 100,000 resamplings (Huang and Chi, 2012). The paired bootstrap test was used for mean comparison between the two treatments using TWOSEX-MSChart (Chi, 2021b).

## Results

### Age-stage-specific parasitism rate

The average number of the age-stage-specific parasitism rate ($c_{xj}$), which reflects the average number of *T. absoluta* parasitized by parasitoid wasp at age *x* and stage *j*, of *T. brassicae* on the susceptible ("Infinity") and resistant ("Goldy") tomato cultivars are shown in Figure 1. Because only adult females can parasitize their host, only one diagram can be seen. Therefore, for the other stages (*e.g.,* egg, larva, pupa and male), their parasitism rates were zero. As can be seen, females began to parasitize the host on the 12th day of their lives in both cultivars studied (Fig. 1). The maximum number of parasitized hosts per parasitoid was 25.94 and 23 eggs in "Goldy" and "Infinity" cultivars, respectively, indicating that the resistant cultivar could provide better conditions for parasitism activity (Fig. 1).

The total parasitism of females, displaying the number of parasitized hosts at the female stage of parasitoid as long as the females are alive, is shown in Fig. 2. When the parasitoid wasp reached the adult stage, the maximum total parasitism capacity of the cohort was observed on both studied cultivars. Then, it was reduced sharply and reached zero when the wasp died. Furthermore, the highest rate of total parasitism was observed on "Infinity" (susceptible cultivar) (Fig. 2).

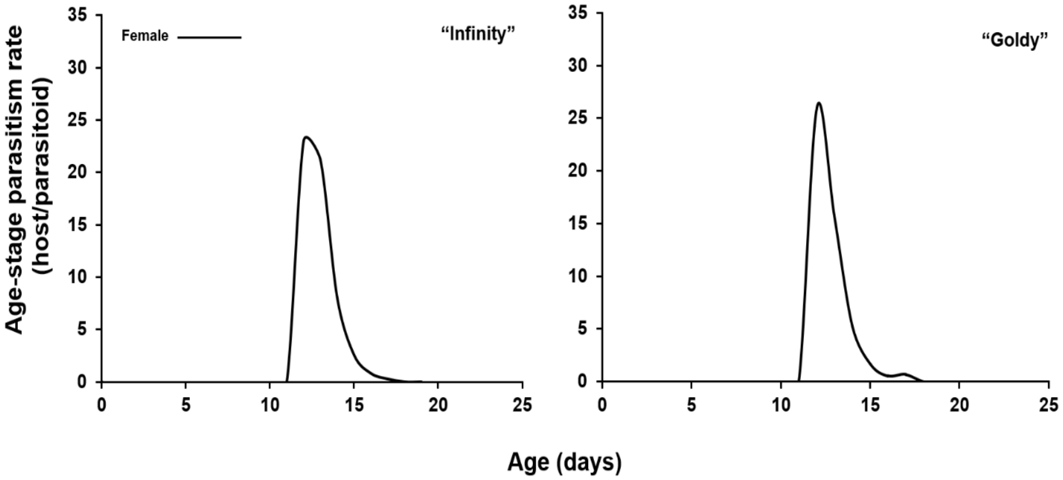

**Figure 1** Age-stage-specific parasitism rate ($c_{xj}$) of *Trichogramma brassicae* when reared on *Tuta absoluta* on susceptible ("Infinity") and resistant ("Goldy") tomato cultivars.

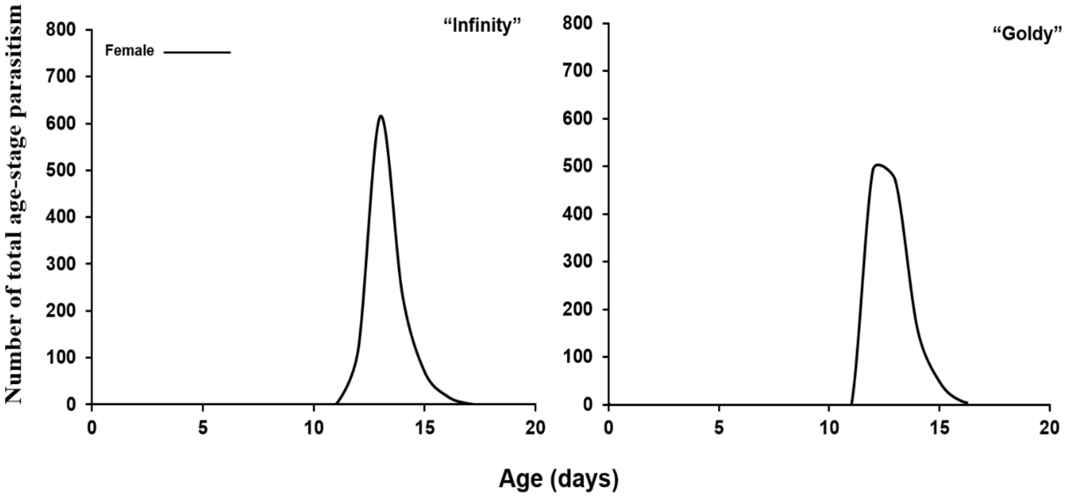

**Figure 2** Total host parasitism of *Trichogramma brassicae* females when reared on *Tuta absoluta* on susceptible ("Infinity") and resistant ("Goldy") tomato cultivars.

## Age-specific parasitism rate and age-specific net parasitism rate

The age-specific parasitism rate ($k_x$) and age-specific net parasitism rate ($q_x$) of *T. brassicae* on two tomato cultivars are depicted in Fig. 3. The age-specific parasitism rate is the mean number of *T. absoluta* eggs parasitized by *T. brassicae* at age $x$. By considering survivorship, the age-specific net parasitism rate ($q_x = l_x k_x$) is defined as the weighted number of hosts parasitized by a parasitoid of age $x$. The former indicates the average number of hosts parasitized by the surviving parasitoids at age $x$, and its highest value was 9.25 and 12.55 hosts/parasitoids on "Goldy" and "Infinity" cultivars, respectively, which occurred at the age 13 d. Fig. 3 shows that the values of these parameters were similar to each other until the age of 13 d, where the age-specific survivorship ($l_x$) differs from 1. The $q_x$ reached its peak at age 12 (3.49 hosts/parasitoid) and 13 d (4.27 hosts/parasitoid) on "Goldy" and "Infinity" cultivars, respectively.

## Parasitism parameters

Table 1 shows the effects of different tomato cultivars on the parasitism parameters of *T. brassicae* on *T. absoluta*. The net parasitism rate ($C_0$) was 7.87 and 6.67 hosts/parasitoids on "Goldy" and "Infinity" cultivars, respectively. As it is apparent, no significant effect on the net parasitism rate ($C_0$) was found. Similarly, the effects of the resistant cultivar on the finite parasitism rate ($\omega$) and stable parasitism rate ($\psi$) of the parasitoid were not significant (Table 1). A parasitoid female needed approximately one egg host to produce an egg on both cultivars for the simple reason that this parasitoid nearly always lays one egg in each host. In other words, the transformation rate of the parasitoid on "Goldy" did not differ from those on "Infinity" (Table 1).

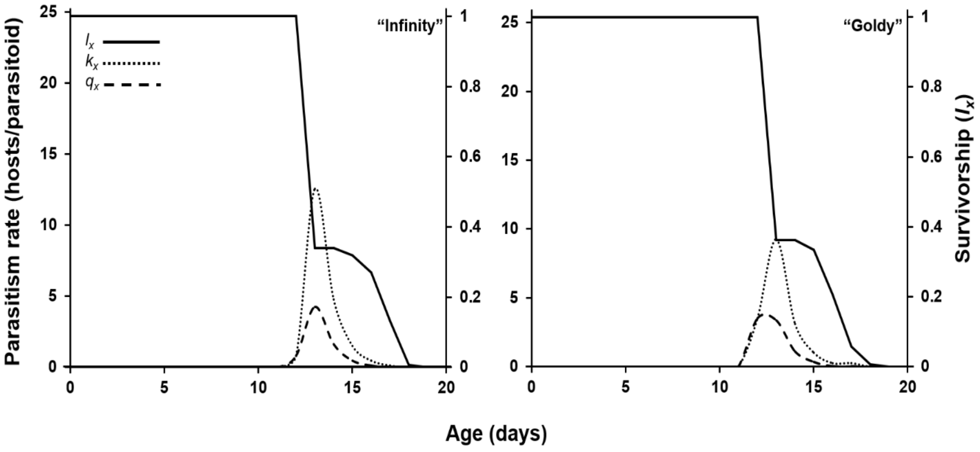

**Figure 3** Age-specific survival rate ($l_x$), age-specific parasitism rate ($k_x$), and age-stage-specific net parasitism rate ($q_x$) of *Trichogramma brassicae* when reared on *Tuta absoluta* on susceptible ("Infinity") and resistant ("Goldy") tomato cultivars.

**Table 1** Parasitism parameters (Means ± SE) of *Trichogramma brassicae* when reared on *Tuta absoluta* on susceptible and resistant tomato cultivars.

| Cultivars | Net parasitism rate ($C_0$) (hosts/parasitoid) | Transformation rate ($Q_p$) | Stable parasitism rate ($\psi$) (hosts/parasitoid) | Finite parasitism rate ($\omega$) (day$^{-1}$) |
|---|---|---|---|---|
| Resistant ("Goldy") | 7.868 ± 1.327$^a$ | ≈1 | 0.173 ± 1.506$^a$ | 0.199 ± 1.984$^a$ |
| Susceptible ("Infinity") | 6.666 ± 1.472$^a$ | ≈1 | 0.188 ± 1.601$^a$ | 0.219 ± 2.148$^a$ |

*Means followed by the same letters within the same column are not significantly different based on paired bootstrap test (with 100,000 resampling, $P < 0.05$).

## Discussion

A pest population can be rapidly ascended if no appropriate control strategy is present (Hashemi *et al*., 2021; Kadkhodazadeh *et al*., 2021). On the other hand, the simultaneous application of two or more compatible strategies may be more effective in keeping the pest population below the economically injurious level (EIL) than one strategy (Cherif and Lebdi-Grissa, 2013; Saeidi and Raeesi, 2020). Under experimental conditions, we investigated the effects of the combination of resistance plant and biological control on the parasitism parameters of *T. brassicae* against the tomato leaf miner. According to our findings, the combination of a resistant cultivar with *T. brassicae* did not significantly affect its parasitism rate. Conversely, the significant effects of the host plant on the parasitism of other parasitoids were reported. It has been proved that when a parasitoid was fed on the pest reread on the susceptible host, its parasitism rate was higher than when its host was raised on the resistant plant (Gowling and van Emden, 1994). These researchers designed cage experiments in which the population increase of the *Metopolophium dirhodum* (Walker) was measured either in the absence or presence of the parasitoid wasp *Aphidius rhopalosiphi* de Stefani-Perez, and their results showed a reduction in peak population in the presence of the parasitoid wasp on the susceptible cultivar. Similar findings were also reported by Bayhan *et al*. (2007). In another study, host plant resistance ascended the parasitism of *Sitobion avenae* (F.) by *Aphidius* spp. (Cai *et al*., 2009). By contrast, the combination of biological control with host-plant resistance had an antagonistic effect. It adversely affected the parasitism success of *Cotesia vestalis* (Haliday) against *Plutella xylostella* (L.) (Karimzadeh *et al*., 2013). A study on other biocontrol agents also indicated that the combination of resistant plant with the selective insecticide and the combination of susceptible plant with biological control using *Macrolophus pygmaeus* (Rambur) considerably progressed the management of *T. absoluta* (Nderitu *et al*., 2020).

The transformation rate ($Q_p$) describes the connection between predation (or parasitism) and reproduction rate (Chi and Yang, 2003). If a parasitoid lay only one egg in its host body and that egg can reach maturity, the rate of parasitism is equal to the rate of reproduction ($C_0 = R_0$). By contrast, if the mentioned egg cannot reach the adult stage despite parasitizing its host, the amount of parasitism rate will be different from the fertility rate ($C_0 \neq R_0$) (Ebrahimi *et al*., 1998; Chi and Yang, 2003). Our results showed that this parameter was equal to one on both resistant and susceptible cultivars. Similarly, other studies revealed a value close to one ($R_0 \approx C_0$) for this parasitoid on *S. cerealella* (Negahban *et al*., 2016) and *Ephestia kuehniella* Zeller (Ghaemmaghami *et al*., 2021). In addition, the same result was found for other trichogrammatid wasps such as *Trichogramma principium* (Sugonjaev & Sorokina) (Salehi *et al*., 2019) and *Trichogramma evanescens* Westwood (Tabebordbar *et al*., 2020). This can be explained by the fact that if a parasitoid lays only one egg in its host body ($R_0 = C_0$), $Q_p$ will be one or very close to it, but if the number of eggs laid in its host is more than one ($R_0 > C_0$), $Q_p$ will be less than one (Chi and Yang, 2003). For a predator, the age-specific predation rate can be defined as the number of prey killed by an individual predator of a specific age. Whereas, age-specific fecundity is the offspring produced by an individual female predator of that age. Therefore, the predation rate of a predator usually differs from its fecundity (Chi and Yang, 2003).

According to Chi *et al*. (2011), population growth parameters cannot solely describe a parasitoid's parasitism potential. As a consequence, a standard parameter, the finite parasitism rate ($\omega$), which takes both the increase rate of parasitoid ($\lambda$) and the age-stage-specific parasitism rate ($c_{xj}$) into consideration, was introduced by Chi *et al*. (2011). This parameter is a good criterion for comparing different parasitoids under equal conditions or one parasitoid under different conditions (Chi *et al*., 2011). We found that the finite parasitism rate was 0.199 and 0.219 day$^{-1}$ on the resistant and susceptible cultivars, respectively, which is lower than those estimated for this parasitoid by Ghaemmaghami *et al*. (2021) on *E. kuehniella* and Negahban *et al*. (2016) on *S. cerealella*. The values of finite parasitism rate of other Trichogrammatidae wasps, such as *T. evanescens* (Tabebordbar *et al*., 2020) was considerably higher than those estimated in the current study for *T. brassicae*. Furthermore, our study showed that the difference between two resistant and susceptible cultivars was not significant. In contrast to our findings, Karami *et al*. (2018) found that the finite parasitism rate of *Diaeretiella rapae* McIntosh on *Brevicoryne brassicae* (L.) was significantly lower on the resistant canola cultivar than on the susceptible one.

Shaping tri-trophic interactions is dependent on planting quality. Although some plant chemical compositions could accord host immune responses, other metabolites could have direct antagonistic impresses on one or both interacting insects (Weber *et al*., 2020). Surprisingly, plant properties conferring resistance against the herbivorous insect do not necessarily influence the parasitoid adversely. Conversely, it is generally accepted that some plant resistance metabolites participated in successful parasitism (Weber *et al*., 2020). Accordingly, we found that the parasitism attributes of *T. brassicae* were not affected by the plant resistance chemical compounds. The life table of this parasitoid on *T. absoluta*, when reared on "Infinity" and "Goldy" cultivars, was investigated by Safaeeniya *et al*. (2017b). They found that although the parasitoid development time varied on these cultivars, adult longevity, survival, and life table parameters, including net reproductive rate ($R_0$), intrinsic rate of increase ($r$), and finite rate of increase ($\lambda$) did not differ significantly on the tested cultivars. Similar to our findings, Weber *et al*. (2020) reported that differences in plant resistance to *Galerucella tenella* L. was not reflected in the survival of *Asecodes parviclava* Thompson. From a plant protection perspective, this shows that even plant cultivars with high resistance to herbivorous pests can facilitate the successful implementation of biocontrol programs. It can be concluded that the resistant tomato cultivar, "Goldy" does not interfere with the *T. brassicae*-based biocontrol of *T. absoluta*, so that these two control methods could be combined for the integrated management of this pest.

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## Statement of Conflicting Interests

The authors declare no conflict of interest.

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# آیا پارامترهای پارازیتیسم زنبور پارازیتوئید *Trichogramma brassicae* در صورت تغذیه از شب‌پره مینوز گوجه‌فرنگی *Tuta absoluta* روی ارقام مقاوم و حساس گوجه‌فرنگی تغییر می‌کنند؟

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**چکیده:** استفاده تلفیقی از روش‌های سازگار با یک‌دیگر قابل اطمینان‌ترین شیوه مبارزه با آفات گیاه‌خوار در سامانه‌های کشاورزی می‌باشد. در مطالعه حاضر، پارامترهای پارازیتیسم زنبور پارازیتوئید *Trichogramma brassicae* Bezdenko با تغذیه از تخم‌های شب‌پره مینوز گوجه‌فرنگی *Tuta absoluta* (Meyrick) روی ارقام مقاوم "Goldy" و حساس "Infinity" گوجه‌فرنگی تعیین شد. تمامی آزمایش‌ها در شرایط آزمایشگاهی با دمای ۱ ± ۲۵ درجه سلسیوس، رطوبت نسبی ۵ ± ۶۵ درصد و دوره نوری ۱۶ ساعت روشنایی و ۸ ساعت تاریکی انجام شد. نتایج نشان داد که حداکثر تعداد تخم پارازیت شده به‌ازای هر پارازیتوئید روی ارقام "Goldy" و "Infinity" به‌ترتیب برابر با ۲۵/۹۴ و ۲۳ (تخم) بود. ارقام مورد مطالعه تأثیر معنی‌داری بر نرخ خالص پارازیتیسم ($C_0$) نداشته و مقدار محاسبه شده این پارامتر روی ارقام مورد مطالعه به‌ترتیب برابر با ۷/۸۷ و ۶/۶۷ (میزبان) بود. اثرات میزبان‌های مورد مطالعه روی دو پارامتر نرخ متناهی ($\omega$) و پایدار ($\psi$) پارازیتیسم زنبور پارازیتوئید *T. brassicae* نیز معنی‌دار نبود. از آن‌جا که هر پارازیتوئید در هر تخم میزبان یک تخم می‌گذارد، این زنبور قادر به تکمیل رشد مراحل نابالغ خود در یک تخم شب‌پره مینوز گوجه‌فرنگی بود. نرخ تبدیل از جمعیت میزبان به جمعیت پارازیتوئید ($Qp$) روی دو رقم "Goldy" و "Infinity" از نظر آماری تفاوت معنی‌داری نداشت. نتایج پژوهش حاضر نشان داد که رقم مقاوم "Goldy" اثرات نامطلوبی بر پارامترهای پارازیتیسم زنبور پارازیتوئید *T. brassicae* نداشت و برهمین اساس، این دو روش کنترلی می‌توانند در تلفیق با یک‌دیگر برای مدیریت شب‌پره مینوز گوجه‌فرنگی مورد استفاده قرار گیرند.

**واژگان کلیدی:** نرخ متناهی پارازیتیسم، میزبان‌های گیاهی، مدیریت تلفیقی آفات، نرخ خالص پارازیتیسم، شب‌پره مینوز گوجه‌فرنگی