J. Crop Prot. **2025, 14 (3): 327-343**

Research Article

Does superparasitism affect fitness of *Ooencyrtus telenomicida*, an egg parasitoid of *Eurygaster integriceps*?

Ashkan Rafat[1], Seyed Ali Safavi[1*] and Shahzad Iranipour[2]

1. Department of Plant Protection, Faculty of Agriculture, Urmia University, Urmia, Iran.
2. Department of Plant Protection, Faculty of Agriculture, University of Tabriz, Tabriz, 51666-14888, Iran.

Abstract: *Ooencyrtus telenomicida* Vassiliev (Hym.: Encyrtidae) is an important and broadly distributed egg parasitoid of sunn pest *Eurygaster integriceps* Puton (Hem.: Scutelleridae) in Iran. Few studies have been carried out on this species. In this research, the life history of *O. telenomicida*, was studied on *E. integriceps* eggs under laboratory conditions. All parameters were compared between two levels of parasitism, i.e., superparasitized (SP = two progenies per host egg) and non-superparasitized (NSP = one progeny per host egg). The developmental time of the whole immature stages within the host eggs was 13-17 days. The longevity of adult males and females also ranged between 25-35 and 23-41 days, respectively. The number of eggs was recorded to be 43-191 per female. Moreover, the mean number of daily per capita eggs was 5.3-19.12 per female. The pre-adult survival rate of the two cohorts was 100%, i.e., all wasps from the two cohorts hatched successfully from the host eggs. Superparasitism was observed in all female wasps. Observed sex ratio of the emerged broods was 0.437-0.898 females/total offspring. The intrinsic rate of increase (*r*) of NSP and SP wasps was estimated 0.224 ± 0.004 and 0.234 ± 0.004 per day, respectively. Net reproductive rate was 76.13 ± 7.55 and 81.6 ± 9.66 females/female/generation for the same cohorts, respectively. The mean generation time was also estimated to be 19.36 ± 0.41 and 18.84 ± 0.40 days for the same treatments, respectively. No significant difference was observed in life table parameters of the two parasitoid cohorts. Therefore, our results showed that superparasitism had no negative effects on the reproductive fitness of *O. telenomicida*.

Keywords: Intrinsic rate of increase, Life history, Sunn pest, Fecundity

Introduction

Sunn pest, *Eurygaster integriceps* Puton, is the most important insect pest of wheat in Central and West Asia (Radjabi, 1994; Javahery, 1995; Parker *et al.,* 2011). The current strategies for sunn pest management rely mainly on chemical and cultural control (Miller and Morse, 1996; Islamoglu and Karacaoglu, 2018). Chemical measures are costly and may induce resistance in populations with a long history of exposure to pesticides. Therefore, they may be considered as temporary solutions (Alexandrescu *et al.,* 1990; Golmohammadi and Dastranj, 2020; Javadipouya *et al.*, 2023). Current

Handling Editor: Yaghoub Fathipour

[*]Corresponding authors: a.safavi@urmia.ac.ir
Received: 30 October 2024, Accepted: 26 October 2025
Published online: 08 November 2025

studies are focused on resistant wheat varieties, insect pathogens, predators, and parasitoids (Moore, 1998; Najafi-Mirak, 2012; Davari and Parker, 2018; Iranipour, 2021). Different natural enemies attack the sunn pest, which plays an important role in its control; in some years, they even prevent the need for spraying in certain countries (Kartavtsev, 1974; Udovitsa, 1998). *Trissolcus grandis* (Thomson), *T. vassillievi* (Mayr), and *Ooencyrtus telenomicida* (Vassiliev) are the most common egg parasitoids of *E. integriceps* (Radjabi and Amirnazari, 1989; Iranipour *et al.*, 1998; Nouri and Asgari, 2000; Iranipour, 2021). Seasonal activities of these parasitic wasps begin before their host, *E. integriceps* (Safavi, 1973; Radjabi, 2000; Iranipour, 1996, 2021). Egg parasitoids kill their hosts before any feeding damage to the crop. This makes them very attractive in practical biological control programs against insect pests. Therefore, utilization of these beneficial insects can decrease control costs and prevent environmental damage. Ecological studies on natural enemies are required before implementing inundative release or conservation programs (van Lenteren *et al.*, 2003).

Ooencyrtus telenomicida (Hymenoptera: Encyrtidae) is a generalist, cosmopolitan, gregarious, idiobiont endoparasitoid of cereal bugs present across Europe, Asia, and Sub-Saharan Africa (Zhang *et al.*, 2005; Japoshvili and Noyes, 2006; Triapitsyn *et al.*, 2020). Several herbivorous insects from Heteroptera (families Coreidae, Pentatomidae, Scutelliridae) and Lepidoptera (families Lymantriidae, Notodontidae, and Thaumetopoeidae) have been recorded as hosts for this species. This encyrtid wasp, as well as related species *O. fecundus* Feniere & Voegele, are also reported as facultative secondary parasitoids of parasitic wasps from the family Scelionidae (Japoshvili and Noyes, 2006), particularly *T. basalis* (Catalan and Verdu, 2005) and *T. grandis* (Nassiri *et al.*, 2020; Hatami-Sadr *et al.*, 2024). Intra-guild interaction between *Trissolcus* spp. (or other scelionid species) and *Ooencyrtus* spp. has been reported in several crop-pest systems around the world (Corrêa-Ferreira, 1986; Shepard *et al.*, 1994; Ehler, 2002; Mohammadpour *et al.*, 2014; Peri *et al.*, 2014; Cusumano *et al.*, 2012, 2022; Faca *et al.*, 2021; Fusu and Andreadis, 2023).

Superparasitism is a common phenomenon in nature, defined as repeated attacks by conspecific female parasitoids on a single host (conspecific superparasitism) or by an individual female alone (self-superparasitism) (van Alphen and Visser, 1990; Ahmadpour *et al.*, 2013; Iranipour *et al.*, 2020). When a female parasitoid encounters a parasitized host, it may respond in different ways: (1) rejects the host and searches for subsequent hosts; (2) feeds on the host's haemolymph to produce additional eggs and/or enhance her energy reservoirs; (3) superparasitizes i. e. oviposit an additional egg in the host, or (4) kills one or more eggs or larvae initially laid in the host (infanticide) and replace them with one or more of her own (Strand and Godfray, 1989; Mayhew, 1997; Netting and Hunter, 2000; Goubault *et al.*, 2004; Tunca *et al.*, 2016; Chen *et al.*, 2020). The effects of superparasitism differ between koinobiont and idiobiont parasitoids. In koinobionts, the host continues to feed, grow, and undergo metamorphosis while the parasitoid progeny develops. On the other hand, idiobionts develop in non-developing or paralyzed hosts. In endoparasitoids, superparasitism may be a mechanism of overcoming encapsulation (van Alphen and Visser, 1990; Blumberg and Luck, 1990; Luna *et al.*, 2016). Consequently, such parasitoids should tend to oviposit in a recently parasitized host because their larvae have a higher chance of surviving (van Lenteren, 1981; Mackauer, 1990). Some endoparasitoids leave an external cue to avoid superparasitism (Netting and Hunter, 2000), for example, a spin-like egg stalk protruding from the host's cuticle, in some Encyrtidae (Maple, 1954). Superparasitism might be an adaptive strategy at least in some situations (van Alphen and Jervis, 1996; Rosenheim and Hongkham, 1996; White and Andow, 2008). The trade-off between the benefits and costs of laying an additional egg in a parasitized host will determine the relative advantage of this behavior. Recent studies have shown that an additional clutch may be beneficial under certain conditions (van der Hoeven and Hemerik, 1990; Visser *et al.*, 1990; Gandon *et al.*, 2006).

Over the past few decades, life tables have been the main tool for ecological studies of populations and species from different origins, under various climate conditions and nutritional states (Lewis, 1942; Leslie, 1945; Birch, 1948; Carey, 1993; Ebert, 1999; Chi *et al.*, 2022). Life history parameters also provide useful criteria for evaluating the relative performance of a predator/parasitoid against a prey/host. Development, reproduction, and survival are life history components that are influenced by both the physiological state of an organism and environmental conditions (Harbison *et al.*, 2001; Uçkan and Ergin, 2003). The intrinsic rate of increase combines those components into a single parameter, making it the most comprehensive life table parameter for comparing species, populations, and their physical conditions (Southwood and Henderson, 2009). Life table studies were initiated approximately 25 years ago in Iran and have since been increasingly developed to study both pest and natural enemy populations (Asgari and Kharrazi Pakdel, 1998; Amir-Maafi, 2000; Asgari, 2001; Iranipour *et al.*, 2003). Such demographic data can be very useful for preliminary screening of the most effective biocontrol agents, performing mass rearing programs, and timing inundative releases.

Numerous life history studies have been conducted on egg parasitoids of the sunn pest and other stink bugs, both from Scelionidae (mainly *Trissolcus* spp.; Asgari, 2004, Kivan and Kiliç, 2006b; Abdel-Salam *et al.*, 2007; Laumann *et al.*, 2008; Nozad-Bonab *et al.*, 2014; Bazavar *et al.*, 2015; BenaMolaei *et al.*, 2015a, b; Abdi *et al.*, 2017; Teimouri *et al.*, 2019) and Encyrtidae (*Ooencyrtus* spp.; Bazavar, 2013; Ahmadpour *et al.*, 2013; Ganjisaffar and Perring, 2020; Giovannini *et al.*, 2020). To our knowledge, the life history of *O. telenomicida* has never been studied on *E. integriceps*. In this paper, we studied the life history of *O. telenomicida* on *E. integriceps* eggs using a traditional female cohort age-specific life table for two levels of parasitism: *O. telenomicida* developed as singletons (non-superparasitized, NSP) and twins (superparasitized, SP) in *E. integriceps* eggs.

Materials and Methods

Insect cultures

A stock culture of *E. integriceps* was established in the laboratory using materials collected in the spring of 2012 from wheat fields in West Azerbaijan, Iran (geo: lat = 45.071810, geo: lon = 37.791190). The adults were reared in plastic containers (24 × 17 × 10 cm) with fine mesh covered to provide ventilation and prevent insects from escaping. Containers were placed in a growth chamber (28 ± 1 °C, 60 ± 5% RH, and 16:8 h L: D), and a diet of soaked wheat grains (*Triticum aestivum*) and water was daily supplied. A few pieces of folded paper were placed in each container as egg-laying substrates. Parts of papers with egg masses were cut, labeled by date, and kept in the fridge at 8 °C.

The colony of *O. telenomicida* was established by female wasps that emerged from *E. integriceps* egg masses, which were placed on delta-shaped traps mounted around wheat fields. They were reared in glass tubes (10 × 1.5 cm diameter) in an incubator with previously mentioned conditions, feeding on a 20% honey solution.

Life table studies

All experiments were conducted under the same laboratory conditions. To obtain a female cohort, one host egg mass (14 eggs per mass, 1-3-day old) per female was exposed to 20 females *O. telenomicida* for 24 h. Then, the wasps were removed, and the parasitized egg masses were held in the same incubator until emergence. Emerged wasps were divided into two groups: 1) super-parasitized cohort in which two wasps developed per a single host egg, and 2) cohort with a single wasp developed per host. Each group was replicated with 15 randomly selected females, which were kept separately in glass tubes in the incubator. Each female was engaged with a male of the same age and same group of parasitism level on the first day of her life. The wasps were fed with a 20% honey solution renewed weekly.

To estimate life table parameters, each female wasp was daily supplied with two clutches of host eggs (each consisting of 14 eggs) up to death.

These eggs were removed the next day, labeled by recording date and replication number, and kept in similar glass tubes until emergence. Longevity of males and females, per capita number of parasitized eggs, age-specific number of offspring emerged per parasitized eggs, and sex ratio of them were evaluated separately for each group. In addition, the influence of female age on reproductive parameters (proportion of parasitized eggs and sex ratio of offspring) was assessed. Female age (x: estimated by including development time of larvae + 0.5), daily fecundity (m_x: number of female progeny/female in each day) and female survivorship (l_x: proportion of females surviving in each day) were computed.

Data analysis

Stable population growth parameters including net productive rate (R_0), gross reproductive rate (GRR), intrinsic rate of increase (r), mean generation time (T), doubling time (DT), finite rate of increase (λ), instantaneous birth rate (b) and instantaneous death rate (d) were calculated for two cohorts of *O. telenomicida* using female cohort age-specific life table (Carey, 1993; Iranipour *et al*., 2025a). The intrinsic rate of increase (r) was calculated by using a Macro in Excel (Iranipour, 2018). A comparison between male and female longevity, as well as a comparison between the fecundity of the two cohorts, was carried out using a paired t-test. The intrinsic rate of increase, net reproductive rate, mean generation time, doubling time, and finite rate of increase have been compared using 95% confidence intervals of the differences between randomly paired bootstrap replicates of the two cohorts.

Results

Overall, 29,512 host eggs were offered to females of the two cohorts, from which 1,873 eggs successfully parasitized, and 3,180 wasps emerged, resulting in 74.12% and 25.88% of the progeny being female and male, respectively. The development time of the immature stages of wasps did not differ significantly ($t = 1.20$, df = 1, 28, $P = 0.12$) between the two treatments, as it took 14.28 ± 0.06 and 14.19 ± 0.05 days for wasps to emerge from non-superparasitized (NSP) and superparasitized (SP) cohorts, respectively. Female adults of *O. telenomicida* lived for 33.67 ± 1.15 and 36.6 ± 0.93 d in NSP and SP cohorts, respectively, which was significantly different ($t = 1.98$, df = 1,28, $P = 0.03$), and longer than those of the males that took 28.6 ± 0.79 and 29.47 ± 0.74 d, for the same cohorts ($t = 0.80$, df = 28, $P = 0.21$). The mean oviposition period of both cohorts was the same ($t = 1.31$, df = 1, 28, $P = 0.10$), at 16.67 ± 1.52 and 17.27 ± 1.10 days, respectively. The longest oviposition period was 26 d.

Life time fecundity was 104.2 ± 10.34 and 107.8 ± 10.16 eggs per female in NSP and SP cohorts, respectively ($t = 0.25$, df = 1,28, $P = 0.40$). Superparasitism was recorded in all female wasps with an average of 1.73 ± 0.06 and 1.69 ± 0.06 broods per host egg for the same cohorts. The maximum number of wasps that emerged from a host egg was four, which were from one or both sexes. The mean superparasitism rate of *O. telenomicida* was the same between the SP and NSP cohorts ($t = 0.41$, df = 1, 28, $P = 0.34$).

No stable population growth parameter was significantly affected by superparasitism (Table 1). This means that both wasp groups had similar performance on the host eggs. Intrinsic rate of increase (r) of the two cohorts was 0.224 ± 0.004 and 0.234 ± 0.004 d^{-1} in NSP and SP cohorts, respectively. No difference was observed between GRR and R_0 values in any cohort. All mortality occurred during the senescence period after oviposition, resulting in convex survivorship curves. On the other hand, age-specific fecundity exhibited a somewhat triangular shape in both cohorts, reaching its peak between the 19th and 20th day of the experiment (Figs. 1A and 1B). The sex ratio of offspring was 0.73 and 0.75 in NSP and SP cohorts, respectively. Life expectancy (e_x) of adult females at commencement of emergence was estimated to be 23.44 and 21.6 d for SP and NSP cohorts, respectively. Mean number of daily eggs showed no significant difference between NSP and SP cohorts ($t = 1.05$, df = 1,28, $P = 0.43$). The values were 6.58 ± 0.58 and 6.42 ± 0.55 in the cohorts mentioned above, respectively.

In the NSP cohort, the mean daily number of male offspring was more than in the SP cohort (Fig. 2A), while the number of female offspring was lower (Fig. 2B). However, no significant difference was observed between the sex ratios (t = 0.08, df = 1,28, P = 0.47).

Table 1 Stable population growth parameters of two cohorts of *O. telenomicida* singleton (NSP) and twin (SP).

Parameters	Unit	Mean ± SE		*p*-value
		NSP	SP	
GRR	females/female/generation	76.13 ± 7.55	81.6 ± 9.66	0.33
R_0	females/female/generation	76.13 ± 7.55	81.6 ± 9.66	0.33
r	day^{-1}	0.224 ± 0.004	0.234 ± 0.004	0.07
λ	day^{-1}	1.251 ± 0.005	1.264 ± 0.005	0.07
b	day^{-1}	0.224 ± 0.004	0.234 ± 0.004	0.07
d	day^{-1}	$0.0004 \pm 2.57 \times 10^{-5}$	$0.0005 \pm 3.11 \times 10^{-5}$	0.07
DT	day	3.09 ± 0.06	2.96 ± 0.06	0.07
T	day	19.36 ± 0.41	18.84 ± 0.40	0.19

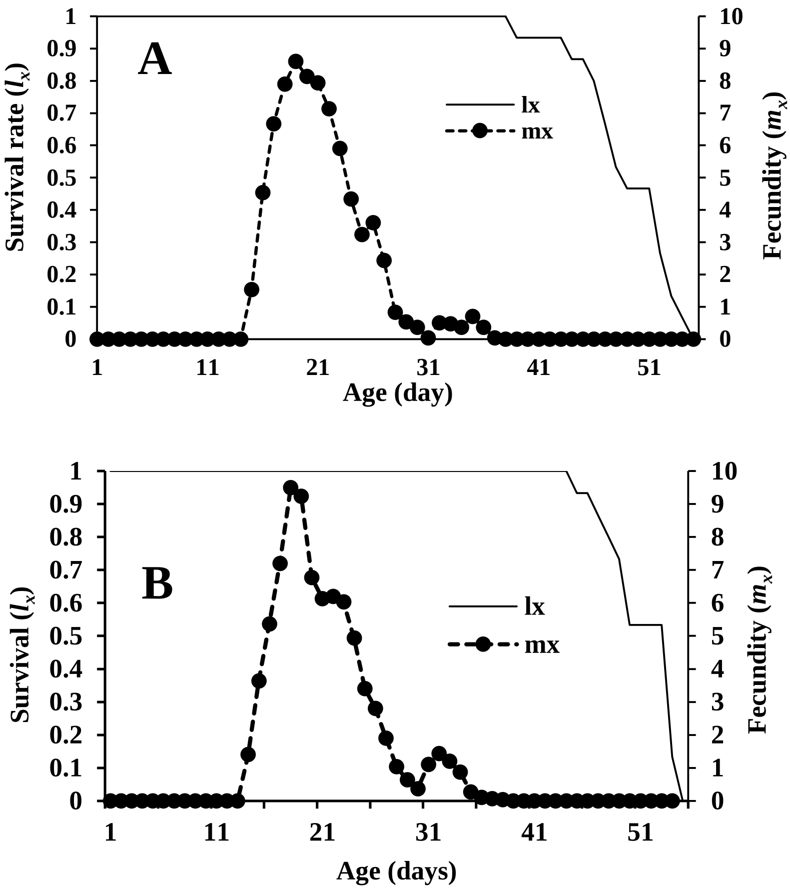

Figure 1 Age-specific survival rate (l_x), and age-specific fecundity (m_x) of *O. telenomicida*, developed on *E. integriceps* eggs at 25°C. A) singleton wasps; B) twin wasps.

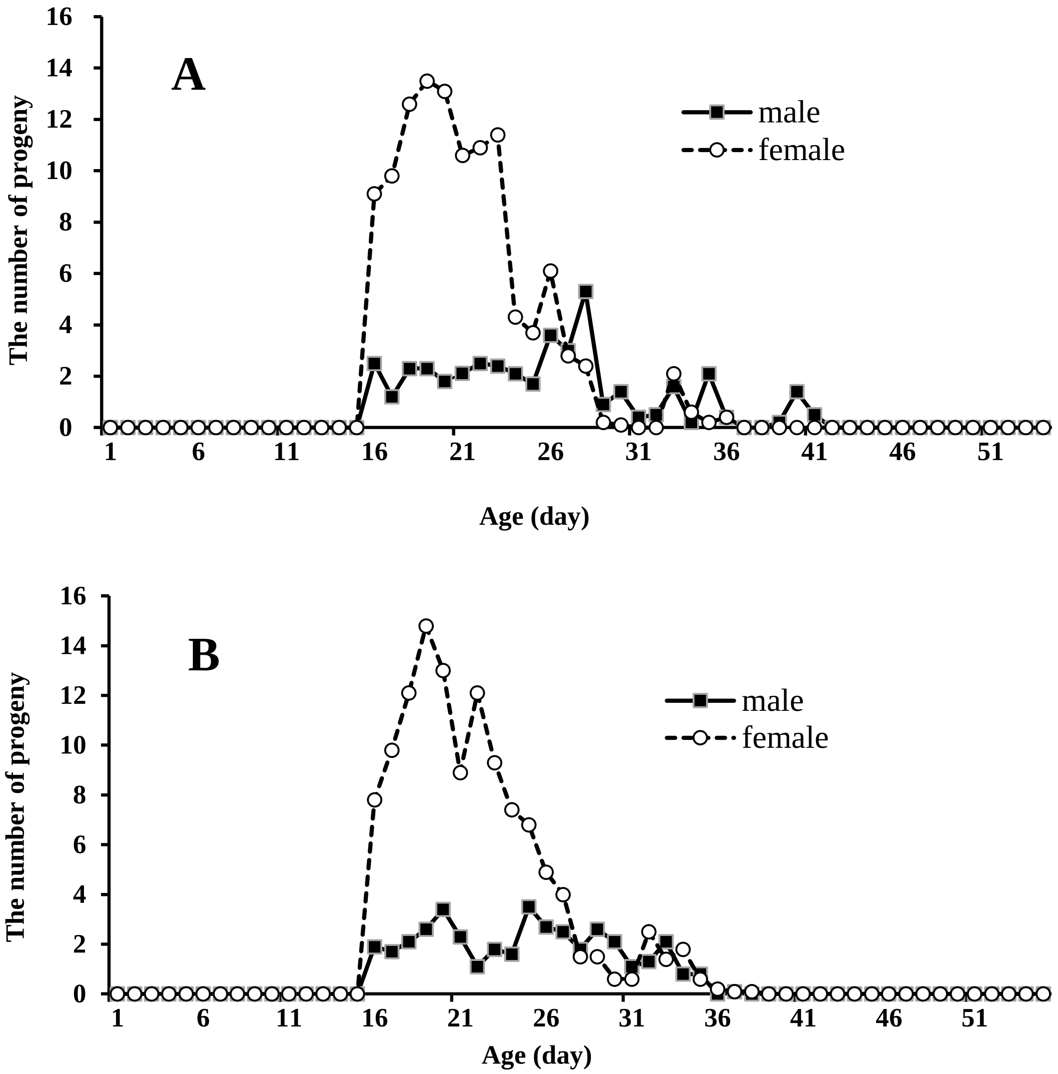

Figure 2 Age-specific progenies of *O. telenomicida* on *E. integriceps* egg at 25 °C. A) singleton wasps; B) twin wasps.

Females laid no eggs on the first day of their emergence. Oviposition continued for 7 days until death. The majority of eggs did not fertilize at senescence, leading to an increasing proportion of male progeny. The maximum and minimum number of host eggs parasitized by a female parasitoid was 103 and 26 eggs, respectively, and the maximum and minimum number of progenies per host egg was 2.13 and 1.16 per female, which were both recorded in NSP eggs. The maximum attack rate was 21/d.

No significant difference was observed between the NSP and SP cohorts regarding the daily number of eggs (11.07 ± 0.71 and 9.83 ± 0.65, respectively; t = 1.10; df = 1, 28; P = 0.36). Results showed that the daily fecundity was negatively related to total fecundity. Reproduction interval of *O. telenomicida* had no significant difference between the two test groups of wasps (t = 1.06, df = 1,28, P = 0.41). The durations were 5.12 ± 0.49 and 3.98 ± 0.39 days in the SP and NSP cohorts, respectively.

Discussion

Theoretically, *O. telenomicida* should be able to control E. integriceps adequately, given its more rapid population growth rate compared to the target host, *E. integriceps* (Iranipour *et al.*, 2010). However, this may not be the case in natural settings, where insects are not confined and access to hosts is difficult (Iranipour *et al.*, 2011; Koutsogeorgiou *et al.*, 2024). Nonetheless, the high contribution of *Ooencyrtus* spp. to the parasitoid complex in egg traps is promising (Nozad-Bonab and Iranipour, 2010; Shafaei *et al.*, 2011). Nozad-Bonab and Iranipour (2010) recorded the highest percentages of parasitism by *T. grandis*, *O. fecundus*, and *O. telenomicida* in wheat fields of Bonab County (respectively 33.33%, 30.61%, and 25.03% of the species), which represents a high potential for *O. telenomicida*. Of course, success of the *O. telenomicida* in sunn pest control, depends on many other factors such as its competition potential in presence of the other egg parasitoids (Nassiri *et al.*, 2020; Hatami-Sadr *et al.*, 2024; Jalal-Kor *et al.*, 2024), ability to detect and find the hosts as well as their habitats (van Driesche and Bellows, 1996), density dependence (Hassell, 1978; Iranipour *et al.*, 2011), presence of the alternative hosts particularly preferable ones (Iranipour and Vaez, 2021), relative profitability of the hosts and suitable synchrony between the parasitoid and the host (Jervis and Kidd, 1996; Iranipour, 2021). Fortunately, *O. telenomicida* has proven to be a superior competitor to other parasitoids, such as *Telenomus costalimai*. This is apparently due to a physical attack of competing larvae within the host egg (Conde and Rabinovich, 1979). Moreover, *O. telenomicida* can parasitize all stages of *Trissolcus* spp. (*i.e.*, pupae, larvae, and eggs), and eliminate them inside the host egg (Safavi, 1973). *T. grandis* is the most tolerant species against weather changes (Iranipour *et al.*, 2024); however, *O. telenomicida* has been adapted to harsh winters and dry summers or springs (Zatyaina and Klechkovskii, 1974). Despite the relatively good capacity of *O. telenomicida* for pest control and its ability to overcome other competitors via hyperparasitism, it actually plays a minor role in sunn pest control (Iranipour *et al.*, 2011; Iranipour and Kharrazi Pakdel, 2012). A possible reason is the lack of proper synchronization with the host (Iranipour and Vaez, 2021).

In this study, it was found that superparasitism has no adverse effect on the efficacy and vitality of *O. telenomicida*, as both singleton and twins presented the same performance. This finding aligns with the results of Ahmadpour *et al.* (2013) and Iranipour *et al.* (2020) on *O. fecundus*. However, they observed some negative impacts at higher superparasitism levels (i.e., triplets and quadruplets). This may suggest that superparasitism has only minor negative impacts on these species and cannot be considered a significant factor in preventing biological control. The *O. telenomicida* can distinguish between parasitized and healthy eggs. Nevertheless, some females choose parasitized eggs for further oviposition, even when there are still a few healthy eggs (Ahmadpour *et al.*, 2013). The reason may be that the wasp does not lose a considerable advantage by superparasitism. Recognition of parasitized eggs has already been reported for *O. nezarae*, which is realized by leaving an egg stalk on the surface of the host eggs. Wasps can distinguish these physical cues for eight days (Takasu and Hirose, 1988). Safavi (1973) suggested that females of *O. telenomicida* prefer non-parasitized eggs over parasitized ones. Ahmadpour *et al.* (2013) also showed that superparasitism occurs at a lower rate than expected from a random search, which may imply partial avoidance. It seems that *Ooencyrtus* species avoid laying their eggs only partially in hosts that are already clutched.

A comparison between the population growth parameters of *O. telenomicida* in this study and those of other egg parasitoids on the target pest *E. integriceps* may reveal their relative potential in controlling the sunn pest. The developmental time, longevity, generation time, net replacement rate (R_0), and intrinsic rate of increase (r) are often considered significant criteria for ranking a species' competitive potential. Still, in such a comparison, one must take sufficient care to ensure that the comparison was conducted under similar physical conditions, because variables such as host quality and temperature may have a profound effect on the parameter values. Overall, *r* is the most comprehensive parameter that summarizes all information in a single parameter. In terms of *r*, *T. grandis* (Amir-Maafi, 2000; Nozad-Bonab *et al.*, 2014; Teimouri *et al.*, 2019) and *T. vassilievi* (Iranipour et al., 2025b) are potentially more efficient control agents than *O. telenomicida*. The highest value for *r* was 0.368 and 0.367 d^{-1}, as recorded by Nozad-Bonab *et al.* (2014) and Teimouri et al. (2019) for *T. grandis* at 29 °C and 26 °C, respectively. On the other hand, *O. fecundus*, with a population growth rate of 0.252 (Ahmadpour *et al.*, 2013), and *T. djadetshkoe* Rjachovskii, with a growth rate of 0.212 d^{-1} (Abdi *et al.*, 2017), are close to *O. telenomicida*. The difference in life history parameters refers primarily to the inherent differences among the species; however, the other factors such as physical conditions in which the wasps are reared (see Abdi *et al.* 2017 for a comprehensive discussion on intra-specific variation at different studies), size and quality of the host eggs (Asgari, 2004; Nozad-Bonab and Iranipour, 2013; BenaMolaei *et al.*, 2015 a, b) and the number of generations may also be effective.

Both total fecundity and net replacement rate have been found to vary strongly in different studies. The highest total fecundity among the egg parasitoids of the sunn pest was 355.5 eggs, and the corresponding R_0 was 198 daughters per generation, as recorded for *O. fecundus* (Ahmadpour *et al.*, 2013). Total fecundity was recorded as 200, 140-187, and 128 for *T. grandis* by Amir-Maafi *et al.* (2001), Teimouri *et al.* (2019), and Bazavar *et al.* (2015), 217-280 for *T. vassilievi* (Iranipour *et al*., 2025b), and 69.4 for *T. djadetshkoe* (Abdi *et al.*, 2017). The corresponding R_0 values for those species were 158, 105-141, 85, 168-216, and 40, respectively. In addition, R_0 value for *T. semistriatus* was 130 (Asgari, 2004). Except for *T. djadetshkoe* (Abdi *et al.*, 2017), the other species were more fecund than *O. telenomicida* in this study.

Among other parameters, the population growth rate is deeply sensitive to developmental time. A rapid development leads to a higher population growth rate. Additionally, generation time corresponds to developmental time. Hence, a comparison among developmental and/or generation times can provide valuable insight into the performance of a species. Furthermore, a parasitoid that develops faster may possess all resources before the delayed ones. However, the developmental rate of an insect is primarily influenced by temperature, as a slight rise in temperature can shorten developmental time by a few days. Therefore, any comparison must be done at the same temperature. Among the egg parasitoids of the sunn pest, *T. grandis* has a shorter developmental time compared to *O. telenomicida*. For example, in different studies, Amir-Maafi *et al.* (2001) recorded 10.9 days at 25 °C, Nozad-Bonab and Iranipour (2013) 11.7 days at 26 °C, and Teimouri *et al.* (2019) 10.8-11.1 days at 26 °C. In addition, the developmental time of *Trissolcus rufiventris* (Mayr) and *T. simoni* (Mayr) was 10.2 and 12.2 days for males and 10.5 and 12.4 days for females at 26°C, respectively (Kivan and Kiliç, 2006a), which are both shorter than those of *O. telenomicida*. The developmental time of relative species of *O. fecundus* at 26 °C (Ahmadpour *et al.*, 2013), and *T. vassilievi* females at 25°C (Iranipour *et al.*, 2015, BenaMolaei *et al.*, 2015b) has been similar to *O. telenomicida*, however, in contrast to *O. telenomicida*, *T. vassilievi* is a protandrous species, hence, the developmental time of males lasted one day shorter. The mean developmental time of *O. pityocampae* was 21.4 days from egg to adulthood (Tiberi *et al.*, 1991) which is the longest among the *Ooencyrtus* species. The generation time of *T. grandis* was shorter than that of *O. telenomicida* in all studies (Amir-Maafi, 2000; Nozad-Bonab *et al.*, 2014; Teimouri *et al.*, 2019), except for Bazavar *et al.* (2015), which reported a similar value. That of the *T. vassilievi* (Iranipour *et al*., 2025b) and *T.*

djadetshkoe (Abdi *et al.*, 2017) was close but slightly shorter, *T. semistriatus* close (Asgari, 2004), and *O. fecundus* (Ahmadpor *et al.*, 2013) and *T. vassilievi* close but slightly longer than *O. telenomicida* in similar conditions. The differences arose from the developmental time and/or oviposition period of the species.

Lifetime is considered an effective factor in biological control. Often, it is believed that a parasitoid's longer longevity controls a pest population more effectively. Of course, it will be critical if the vulnerable stage of a host overlaps sufficiently with the duration of parasitism. The average lifespan of the female *O. telenomicida* was over a month, which is longer than 25.6 days recorded for female *O. pityocampae* (Safavi, 1973). The adult lifespan of *T. grandis* has been recorded as 38.5 d by Amir-Maafi (2000) and 38.6-41.1 d by Teimouri *et al*. (2019), which is slightly longer than that of *O. telenomicida*. It is 55.6 d for *T. djadetshkoe* (Abdi *et al.*, 2017), and 26-32 d for females and 18-21 d for males of *T. vassilievi* (Iranipour *et al*., 2025b), although there are records up to 66 d for females, and 58 d for males of the latter species (BenaMolaei *et al.*, 2015a; b). The high variability of longevity in different studies may reflect the effects of environmental conditions, such as host quality, temperature, and others. Therefore, it appears that longevity is not a suitable scale for comparing species, populations, and experimental treatments.

The observed sex ratio in the progeny of the two cohorts in this experiment was strongly female-biased (75%), whereas Safavi (1973) and Ahmadpour *et al.* (2013) recorded 50 and 55% female progeny for *O. telenomicida* and *O. fecundus*, respectively. Safavi (1973) and Tiberi *et al.* (1991) reported a temperature-dependent telytoky in *O. pityocampae*, such that females reproduced parthenogenetically (without the contribution of males) at temperatures below 25 °C, and males appeared only above 28-30 °C. Hatami-Sadr *et al.* (2024) and Jalal-Kor *et al.* (2024) observed the same phenomenon in *O. fecundus*, while a decreasing trend in the percentage of female progeny by age was observed in *O. telenomicida*, so that an initial 65-70% female progeny finally balanced to achieve an identical sex ratio.

In conclusion, *O. telenomicida* appears to be a promising egg parasitoid of the sunn pest, with the potential to prevent outbreaks of the sunn pest in augmentative release programs when released at suitable timing. Furthermore, superparasitism has no considerable adverse effect on it. However, in comparison to other egg parasitoids, it may be ranked as an inferior species due to a longer developmental and generation time, and lower parasitism and reproductive capacity compared to the majority of the egg parasitoids of the target pest. However, it is still capable of controlling sunn pest, because it has a higher population growth rate than its host.

Conflict of Interest

The authors state that there is no conflict of interest.

Acknowledgements

This research was supported financially by Urmia University as the MSc thesis of the first author, which is acknowledged hereby.

References

Abdel-Salam, A. H., El-Serafi, A. K., El-Naggar, M. E. and Twafik, W. A. 2007. Development, longevity, fecundity, and life table parameters of *Trissolcus basalis* (Wollaston), egg parasitoid of the stink green bug, *Nezara viridula* (L.) in relation to temperature. Journal of Plant Protection and Pathology, 32(5): 3809-1821. https://doi.org/10.21608/jppp.2007.219535.

Abdi, F., Iranipour, S. and Hejazi, M. J. 2017. Reproductive-life table studies on *Trissolcus djadetshkoe* (Hym.: Scelionidae). Applied Entomology and Phytopathology, 85(1): 1-9. https://doi.org/10.22092/jaep.2017.109568.

Ahmadpour, S., Iranipour, S. and Asgari, S. 2013. Effects of superparasitism on reproductive fitness of *Ooencyrtus fecundus* Ferriere & Voegele (Hym. Encyrtidae), egg parasitoid of sunn pest, *Eurygaster integriceps* Puton (Hem. Scutelleridae). Biological Control of Pests and Plant Diseases, 2(2): 97-105. https://doi.org/10.22059/jbioc.2014.51477.

Alexandrescu, S., Savu, M. and Hera, E. 1990. Resistance of some insect species to insecticides (In Romanian with English Summary). Analele Institutului de Cercetari pentru Protectia Plantelor, Academia de Stiinte Agricole si Silvice, 23: 229-244.

Amir-Maafi, M. 2000. An investigation on the host-parasitoid system between *Trissolcus grandis* Thomson (Hym.: Scelionidae) and sunn pest eggs. PhD thesis, University of Tehran, Iran.

Amir-Maafi, M. and Parker, B. L. 2011. Biological parameters of the egg parasitoid *Trissolcus grandis* (Hym.: Scelionidae) on *Eurygaster integriceps* (Hem.: Scutelleridae). Journal of Entomological Society of Iran, 30(2): 67-81.

Amir-Maafi, M., Kharrazi Pakdel, A., Sahragard, A. and Rasoulian, G. 2001. Study on the biology of *Trissolcus grandis* Thomson (Hym.: Scelionidae) under laboratory condition. Applied Entomology and Phytopathology, 68(2): 29-41.

Asgari, S. 2001. Comparative study of fitness of sunn pest egg parasitoid *Trissolcus semistriatus* Nees on *Graphosoma lineatum* L. and *Eurygaster integriceps* Puton. Ph.D. Thesis, Tarbiat Modares University, Tehran, Iran.

Asgari, S. 2004. Comparing population parameters of egg parasitoid, *Trissolcus semistriatus* on the host egg, *Graphosoma lineatum* and *Eurygaster integriceps* for host fitness determination. In: Proceedings of the 16th Iranian Plant Protection Congress, p. 38.

Asgari, S. and Kharrazi Pakdel, A. 1998. Evaluation of some biological parameters affecting sunn pest egg parasitoid, *Trissolcus grandis* (Thom.) (Hym.: Scelionidae). In: Proceedings of the 13th Iranian Plant Protection Congress, August 1998. Karaj, Tehran, Iran, p. 28.

Bazavar, A. 2013. Effect of host unavailability durations on parasitism behavior of *Trissolcus grandis* (Hymenoptera: Scelionidae) and *Ooencyrtus fecundus* Ferriere & Voegele (Hym.: Encyrtidae) egg parasitoids of sunn pest. MSc Thesis, Faculty of Agriculture, University of Tabriz, 67 pp.

Bazavar, A., Iranipour, S. and Karimzadeh, R. 2015. Effect of host unavailability durations on parasitism behavior of *Trissolcus grandis* (Hymenoptera: Scelionidae) egg parasitoid of sunn pest. Applied Researches in Plant Protection, 4(1): 41-56.

BenaMolaei, P., Iranipour, S. and Asgari, S. 2015a. Biostatistics of *Trissolcus vassilievi* (Hym., Scelionidae) developed on sunn pest eggs cold-stored for different durations. Munis Entomology and Zoology, 10(1): 259-271.

BenaMolaei, P., Iranipour, S. and Asgari, S. 2015b. Effect of the host embryogenesis on efficiency of *Trissolcus vassilievi*. Biocontrol in Plant Protection, 3(1): 83-100.

Birch, L. C. 1948. The intrinsic rate of natural increase of an insect population. Journal of Animal Ecology, 17: 15-26. https://doi.org/10.2307/1605.

Blumberg, D. and Luck, R. F. 1990. Differences in the rates of superparasitism between two strains of *Comperiella bifasciata* (Howard) (Hymenoptera: Encyrtidae) parasitizing California red scale (Homoptera: Diaspididae): an adaptation to circumvent encapsulation? Annals of the Entomological Society of America, 83: 591-597. https://doi.org/10.1093/aesa/83.3.591.

Carey, J. R. 1993. Applied Demography for Biologists. Oxford University Press, New York.

Catalan, J. and Verdu, M. J. 2005. Evaluacion de dos parasitoides de huevos de *Nezara viridula* (in Spanish). Boletin de Sanidad Vegetal Plages, 31: 187-197.

Chen, W. B., Vasseur, L., Zhang, S. Q., Zhang, H. F., Mao, J., Liu, T. S., Zhou, X. Y., Wang, X., Zhang, J., You, M. S. and Gurr, G. M. 2020. Mechanism and consequences for avoidance of superparasitism in the solitary parasitoid *Cotesia vestalis*. Scientific Reports, 10: 11463. https://doi.org/10.1038/s41598-020-67050-1.

Chi, H., Güncan, A., Kavousi, A., Gharakhani, G., Atlihan, R., Özgökçe, M. S., Shirazi, J., Amir-Maafi, M., Maroufpoor, M. and Taghizadeh, R. 2022. TWOSEX-MSChart: the key tool for life table research and education. Entomologia Generalis, 42(6): 845-849. https://doi.org/10.1127/entomologia/2022/1851.

Conde, J. and Rabinovich, J. 1979. Larval competition between *Telenomus costalimai* (Hymenoptera: Scelionidae) and *Ooencyrtus trinidadensis* Venatorius (Hymenoptera: Encyrtidae) after simultaneous oviposition in *Rhodnius prolixus* eggs (Hemiptera: Reduviidae). Journal of Mediterranean Entomology, 16(5): 428-431.

Corrêa-Ferreira, S. B. 1986. Natural occurrence of the egg parasitoid complex of stink bugs on soybean in Parana, Brazil. Anais da Sociedade Entomologica do Brasil, 5: 189-199.

Cusumano, A., Peri, E., Alınç, T. and Colazza, S. 2022. Contrasting reproductive traits of competing parasitoids facilitate coexistence on a shared host pest in a biological control perspective. Pest Management Science, 78(8): 3376-3383. https://doi.org/10.1002/ps.6965.

Cusumano, A., Peri, E., Vinson, S. B. and Colazza, S. 2012. Intraguild interactions between two egg parasitoids exploring host patches. BioControl, 56(2): 173-184. https://doi.org/10.1007/s10526-010-9320-z.

Davari, A. and Parker, B. L. 2018. A review of research on sunn pest *Eurygaster integriceps* Puton (Hemiptera: Scutelleridae) management published 2004-2016. Journal of Asia-Pacific Entomology, 21(1): 352-360. https://doi.org/10.1016/j.aspen.2018.01.016.

Ebert, T. A. 1999. Plant and Animal Populations, Methods in Demography. Academic Press, San Diego, California.

Ehler, L. E. 2002. An evaluation of some natural enemies of *Nezara viridula* in northern California. BioControl, 47: 309-325. https://doi.org/10.1023/A:1021262931608.

Faca, E. C., Pereira, F. F., Fernandes, W. C., Silva, I. F., Costa, V. A. and Wengrat, A. P. G. S. 2021. Reproduction of *Ooencyrtus submetallicus* (Hymenoptera: Encyrtidae) and *Trissolcus* sp. aff. *urichi* (Hymenoptera: Scelionidae) in eggs of *Nezara viridula* (Hemiptera: Pentatomidae) of different ages. Journal of Agricultural Science, 13(10): 96-106. https://doi.org/10.5539/jas.v13n10p96.

Fusu, L. and Andreadis, S. S. 2023. *Ooencyrtus mirus* (Hymenoptera, Encyrtidae), discovered in Europe parasitizing eggs of *Halyomorpha halys* (Hemiptera, Pentatomidae). Journal of Hymenoptera Research, 96: 1045-1060. https://doi.org/10.3897/jhr.96.109739.

Gandon, S., Rivero, A. and Varaldi, J. 2006. Superparasitism evolution: adaptation or manipulation? The American Naturalist, 167: E1-E22. https://doi.org/10.1086/498398.

Ganjisaffar, F. and Perring, T. M. 2020. Life history evaluation of *Ooencyrtus lucidus*, a newly described egg parasitoid of *Bagrada hilaris*. Insects, 11: 292. https://doi.org/10.3390/insects11050292.

Giovannini, L., Mazza, G., Binazzi, F., Simoni, S., Marianelli, L., Guerrieri, E., Roversi, P. F. and Peverieri, G. S. 2020. Biological parameters of the egg parasitoid *Ooencyrtus gonoceri*. Bulletin of Insectology, 73(2): 313-319.

Golmohammadi, G. and Dastranj, M. 2020. Comparison of the susceptibility of two populations of sunn pest, *Eurygaster integriceps* to deltamethrin and fenitrothion. Applied Entomology and Phytopathology, 88(1): 53-59. https://doi.org/10.22092/jaep.2020.128278.1310.

Goubault, M., Fourrier, J., Krespi, L., Poinsot, D. and Cortesero, A. M. 2004. Selection strategies of parasitized hosts in a generalist parasitoid depend on patch quality but also on host size. Journal of Insect Behavior, 17: 99-113. https://doi.org/10.1023/B:JOIR.0000025135.94296.8d.

Harbison, J. L., Legaspi, J. C., Fabritius, S. L., Sadan, R. R., Legaspi, B. C. and Enkegaard, A. 2001. Effects of age and host number on reproductive biology of *Allorhogas pyralophagus* (Hymenoptera: Braconidae) attacking the Mexican rice borer (Lepidoptera: Pyralidae). Environmental

Entomology, 30(1): 129-135. https://doi.org/10.1603/0046-225X-30.1.129.

Hassell, M. P. 1978. The Dynamics of Arthropod Predator-Prey Systems. Princeton University Press, Princeton, NJ.

Hatami-Sadr, N., Iranipour, S. and Karimzadeh, R. 2024. Parasitism of *Ooencyrtus telenomicida* (Hymenoptera: Encyrtidae) on common sunn pest's eggs: effect of host age and previous parasitism by *Trissolcus grandis* (Hymenoptera: Scelionidae). Journal of Applied Researches in Plant Protection, 13(1): 97-109.

Iranipour, S. 1996. Population fluctuations of egg parasitoids of sunn pest (*Eurygaster integriceps* Put.) (Heteroptera: Scutelleridae) in Karaj, Kamalabad and Fashand. M.Sc. thesis, University of Tehran, Karaj, Iran, 187 pp.

Iranipour, S. 2018. A microsoft excel program for bootstrap estimates of reproductive-life table parameters. Journal of Crop Protection, 7(3): 247-258.

Iranipour, S. 2021. Superfamily Platygastroidea: Natural enemies of true bugs, moths, other insects, and spiders. In: Karimi, J. and Madadi, H. (Eds.), Biological Control of Insect and Mite Pests in Iran: A Review from Fundamental And Applied Aspects, Springer Nature, pp. 293-332. https://doi.org/10.1007/978-3-030-63790-3_12.

Iranipour, S. and Kharrazi Pakdel, A. 2012. Relationship between parasitism rates in egg traps and natural egg populations of sunn-pest *Eurygaster integriceps* Put. Journal of Agricultural Science and Sustainable Production, 22(4): 45-55.

Iranipour, S. and Vaez, N. 2021. Egg parasitoids: chalcidoidea with particular emphasis on Trichogrammatidae. In: J. Karimi and H. Madadi (Eds.). Biological Control of Insect and Mite Pests in Iran, pp. 197–231. Springer Nature. https://doi.org/10.1007/978-3-030-63790-3_9.

Iranipour, S., Ahmadpour, S. and Asgari, S. 2020. Gregarious development alters host utilization by the egg parasitoid *Ooencyrtus fecundus* (Hymenoptera: Encyrtidae). Journal of Crop Protection, 9(3): 523-535.

Iranipour, S., Benamolaei, P. and Asgari, S. 2025b. Fitness enhancement by crosses between two populations of *Trissolcus vassilievi* (Hym., Scelionidae). Journal of Agricultural Science and Technology, 27: 1395-1408.

Iranipour, S., BenaMolaei, P., Asgari, S. and Michaud, J. P. 2015. Reciprocal crosses between two populations of *Trissolcus vassilievi* (Mayr) (Hymenoptera: Scelionidae) reveal maternal effects on thermal phenotypes. Bulletin of Entomological Research, 105(3): 355-363. https://doi.org/10.1017/S0007485315000164.

Iranipour, S., Kharrazi Pakdel, A., Esmaili, M. and Radjabi, G. R. 1998. Introduction of two species of egg-parasitoid of pentatomid bugs from Genus *Trissolcus* (Hym.: Scelionidae) for Iran. Proceedings of the 13th Iranian Plant Protection Congress, Tehran, Iran, p. 4.

Iranipour, S., Kharrazi Pakdel, A., Radjabi, G. and Michaud, J. P. 2010. Life history parameters of the sunn pest, *Eurygaster integriceps*, held at four constant temperatures. Journal of Insect Science, 10: 106. https://doi.org/10.1673/031.010.10601.

Iranipour, S., Kharrazi Pakdel, A., Radjabi, G. and Michaud, J. P. 2011. Life tables for sunn pest, *Eurygaster integriceps* (Heteroptera: Scutelleridae) in northern Iran. Bulletin of Entomological Research, 101(1): 33-44. https://doi.org/10.1017/S0007485310000155.

Iranipour, S., Kharrazi Pakdel, A., Radjabi, G. R., Rasoulian, G. and Karim Modjeni, H. 2003. Age specific mortality and temperature dependent development of immature stages of sunn pest (*Eurygaster integriceps* Put.) (Heteroptera: Scutelleridae) in four constant temperatures. Applied Entomology and Phytopathology, 70: 1-6.

Iranipour, S., Mahmoodi-Arabi, S. and Michaud, J. P. 2025a. Does the two-sex life table for sexual populations invalidate those based solely on female cohorts? Annals of the Entomological Society of America, 118(3): 189-205. https://doi.org/10.1093/aesa/saaf001.

Iranipour, S., Michaud, J. P., Najafipour, M. and Khaghaninia, S. 2024. Interspecific competition and comparative cold tolerance in two egg parasitoids of sunn pest, *Eurygaster integriceps*. BioControl, 69: 103-114. https://doi.org/10.1007/s10526-024-10246-5.

İslamoglu, M. and Karacaoglu, M. 2018. Efficacy of the some insecticide used in the sunn pest *Eurygaster* spp. (Het; Scutelleridae) struggle on the adults of *G. monspeliensis* (Picard) (Hymenoptera: Scelionidae) parasitoid. Entomology and Applied Science Letters, 5(1): 21-26.

Jalal Kor, E., Iranipour, S. and Asgari, S. 2024. Multiparasitism and competition between *Ooencyrtus telenomicida* and *Ooencyrtus fecundus* (Hymenoptera: Encyrtidae) two species of sunn pest *Eurygaster integriceps* egg parasitoids. Applied Entomology and Phytopathology, 91(2): 173-184. https://doi.org/10.22092/jaep.2024.363255.1486.

Japoshvili, G. O. and Noyes, J. S. 2006. New data on the European fauna of Encyrtid wasp (Hymenoptera: Chalcidoidea: Encyrtidae). Entomological Review, 86: 298-304. https://doi.org/10.1134/S0013873806030067.

Javadipouya, H., Valizadegan, O. and Sheikhigarjan, A. 2023. Susceptibility of sunn pest in overwintered adults and new generation to eight insecticide groups of IRAC. Journal of Entomological Society of Iran, 43(3): 247-257. https://doi.org/10.61186/jesi.43.3.5.

Javahery, M. 1995. A technical review of sunn pests (Heteroptera: Pentatomoidea) with special reference to *Eurygaster integriceps* Puton. FAO/RNE, 80.

Jervis, M. and Kidd, N. 1996. Insect Natural Enemies: Practical Approaches to their Study and Evaluation. Chapman and Hall, London.

Kartavtsev, N. I. 1974. Studying the role of naturally occurring Telenomines. Zashchita Rastenii, 4: 31. (in Russian with English abstract).

Kivan, M. and Kiliç, N. 2006a. A comparison of the development times of *Trissolcus rufiventris* (Mayr) and *Trissilcus simoni* Mayr (Hym.: Scelionidae) at three constant temperatures. Turkish Journal of Agriculture, 30: 383-386.

Kivan, M. and Kiliç, N. 2006b. Age-specific fecundity and life table of *Trissolcus semistriatus*, an egg parasitoid of the sunn pest, *Eurygaster integriceps*. Entomological Science, 9: 39-46. https://doi.org/10.1111/j.1479-8298.2006.00152.x.

Koutsogeorgiou, E. I., Moysiadis, T., Fifis, G. T., Gogolashvili, N. E., Chatzimpalasis, D. and Andreadis, S. S. 2024. Age- and density-dependent parasitism rate and development time of the generalist egg-parasitoid *Ooencyrtus telenomicida* (Hymenoptera: Encyrtidae) on eggs of the brown marmorated stink bug, *Halyomorpha halys*. Insects, 15(1): 14. https://doi.org/10.3390/insects15010014.

Laumann, R. A., Moraes, M. C. B., Pareja, M., Alarcão, G. C., Botelho, A. C., Maia, A. H. N., Leonardecz, E. and Borges, M. 2008. Comparative biology and functional response of *Trissolcus* spp. (Hymenoptera: Scelionidae) and implications for stink bugs (Hemiptera: Pentatomidae) biological control. Biological Control, 44: 32-41. https://doi.org/10.1016/j.biocontrol.2007.10.003.

Leslie, P. H. 1945. On the use of matrices in certain population mathematics. Biometrics, 33: 183-212.

Lewis, E. G. 1942. On the generation and growth of a population. Sankhya, 6: 93-96.

Luna, M. G., Desneux, N. and Schneider, M. I. 2016. Encapsulation and self-superparasitism of *Pseudapanteles dignus* (Muesebeck) (Hymenoptera: Braconidae), a parasitoid of *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae). PLoS One, 11(10): e0163196. https://doi.org/10.1371/journal.pone.0163196.

Mackauer, M. 1990. Host discrimination and larval competition in solitary endoparasitoids. In: M. Mackauer, L. E. Ehler and J. Roland (Eds.). Critical issues in biological control, pp. 41-62. Intercept/VHC Publishers, Andover, UK.

Maple, J. D. 1954. The eggs and first instar larvae of Encyrtidae and their morphological adaptations for respiration. University of California Publications in Entomology, 8: 25-122.

Mayhew, P. J. 1997. Fitness consequences of ovicide in a parasitoid wasp. Entomologia Experimentalis et Applicata, 84: 115-126. https://doi.org/10.1046/j.1570-7458.1997.00206.x.

Miller, R. H. and Morse, J. G. 1996. *Sunn pest and their control in the near East*. FAO plant production and protection paper 138. FAO, Rome, p. 165.

Mohammadpour, M., Jalali, M. A., Michaud, J. P., Ziaaddini, M. and Hashemirad, H. 2014. Multiparasitism of stink bug eggs: competitive interactions between *Ooencyrtus pityocampae* and *Trissolcus agriope*. BioControl, 59: 279-286. https://doi.org/10.1007/s10526-014-9565-z.

Moore, D. 1998. Control of sunn pest particularly *Eurygaster integriceps* Put. (Hemiptera, Scutelleridae) the role of mycoinsecticides in managment schemes. In: FAO PPCRI. Integrated sunn pest control meeting, 6–9 January 1998, Ankara.

Najafi-Mirak, T. 2012. Evaluation of resistance to sunn pest (*Eurygaster integriceps* Put.) in wheat and triticale genotypes. Crop Breeding Journal, 2(1): 43-48.

Nasiri, R., Iranipour, S. and Karimzadeh, R. 2020. Host preference of *Ooencyrtus fecundus* Feniere & Voegele (Hym. Encyrtidae) egg parasitoid of sunn pest and hyperparasitoid of *Trissolcus* spp. Biological Control of Pests and Plant Diseases, 8(2): 59-74.

Netting, J. F. and Hunter, M. S. 2000. Ovicide in the whitefly parasitoid, *Encarsia formosa*. Animal Behaviour, 60: 217-226. https://doi.org/10.1006/anbe.2000.1463.

Nouri, H. and Asgari, S. 2000. Study and identification of sunn pest egg parasitoid in Qazvin Province. Proceedings of the 14th Iranian Plant Protection Congress in Iran, 5-8 September 2000, Isfahan, Iran, p. 218.

Nozad Bonab, Z. and Iranipour, S. 2013. Development of *Trissolcus grandis* (Thomson) (Hymenoptera: Scelionidae) on two factitious hosts *Graphosoma lineatum* (L.) and *G. semipunctatum* (F.) (Hemiptera: Scutelleridae) at three constant temperatures. Journal of Applied Researches in Plant Protection, 1(1): 41-54.

Nozad-Bonab, Z. and Iranipour, S. 2010. Seasonal fluctuations in egg parasitoid fauna of sunn-pest *Eurygaster integriceps* Puton in wheat fields of New Bonab country, East Azarbayjan province, Iran. Agricultural Science and Sustainable Production, 20(2): 73-83.

Nozad-Bonab, Z., Iranipour, S. and Farshbaf Pourabad, R. 2014. Demographic parameters of two populations of *Trissolcus grandis* (Thomson) (Hymenoptera: Scelionidae) at five constant temperatures. Journal of Agricultural Science and Technology, 16: 969-979.

Parker, B. L., Amir-Maafi, M., Skinner, M., Kim, J. S. and El Bouhssini, M. 2011. Distribution of sunn pest, *Eurygaster integriceps* Puton (Hemiptera: Scutelleridae), in overwintering sites. Journal of Asia-Pacific Entomology, 14(1): 83-88. https://doi.org/10.1016/j.aspen.2010.10.005.

Peri, E., Cusumano, A., Amodeo, V., Wajnberg, E. and Colazza, S. 2014. Intraguild interactions between two egg parasitoids of a true bug in semi-field and field conditions. PLoS One, 9(6): e99876. https://doi.org/10.1371/journal.pone.0099876.

Radjabi, G. 1994. Analysis of sunn pest periodic outbreaks in Iran. Applied Entomology and Phytopathology, 61: 1-10.

Radjabi, G. 2000. *Ecology of Cereals' Sunn-Pests in Iran*. Ministry of Jihad and Agriculture, Agricultural Research, Education and Organization Publication, Tehran, Iran.

Radjabi, G. and Amirnazari, M. 1989. Egg parasites of sunn pest in the central part of Iranian plateau. Applied Entomology and Phytopathology, 56: 1-12.

Safavi, M. 1973. *Etude Bio-Ecologique des Hymenopteres Parasites des Oeufs des Punaises des Cereales en Iran*. Institut de Researches Entomologiques et Phytopathologiques Publication, Tehran, Iran, 159 p.

Shafaei, F., Iranipour, S., Kazemi, M. H. and Alizadeh, E. 2011. Diversity and seasonal fluctuation of sunn pests egg parasitoids (Hym.: Scelionidae) in central regions of West Azarbayejan province, Iran. Field Crop Entomology, 1(1): 39-54.

Shepard, B. M., Elsey, K. D., Muckenfuss, A. E. and Justo, H. D. Jr. 1994. Parasitism and predation on egg masses of the southern green stink bug, *Nezara viridula* (L.) (Heteroptera: Pentatomidae), in tomato, okra, cowpea, soybean, and wild radish. Journal of Agricultural Entomology, 11: 375-381.

Southwood, T. R. E. and Henderson, P. A. 2009. Ecological Methods, 3rd Edn. Methuen, London.

Strand, M. R. and Godfray, H. C. J. 1989. Superparasitism and ovicide in parasitic Hymenoptera: theory and a case study of the ectoparasitoid *Bracon hebetor*. Behavioral Ecology and Sociobiology, 24: 421-432.

Takasu, K. and Hirose, Y. 1988. Host discrimination in the parasitoid *Ooencyrtus nezarae*: The role of the egg stalk as an external marker. Entomologia Experimentalis et Applicata, 47: 45-48.

Teimouri, N., Iranipour, S. and Benamolaei, P. 2019. Effect of light intensity and photoperiod on development, fecundity and longevity of *Trissolcus grandis* (Hym.: Platygastridae), egg parasitoid of sunn pest, *Eurygaster integriceps* Puton (Hem.: Scutelleridae). Journal of Applied Researches in Plant Protection, 8(3): 77-93.

Tiberi, R., Niccoli, A., Roversi, P. F. and Sacchetti, P. 1991. Laboratory rearing of *Ooencyrtus pityocampae* (Mercet) on eggs of *Nezara viridula* (L.) and other Pentatomids. In: 4th European Workshop, Perugia, pp. 467-469.

Triapitsyn, S. V., Andreason, S. A., Power, N., Ganjisaffar, F., Fusu, L., Dominguez, C. and Perring, T. M. 2020. Two new species of *Ooencyrtus* (Hymenoptera, Encyrtidae), egg parasitoids of the bagrada bug *Bagrada hilaris* (Hemiptera, Pentatomidae), with taxonomic notes on *Ooencyrtus telenomicida*. Journal of Hymenoptera Research, 76: 57-98. https://doi.org/10.3897 /jhr.76.48004.

Tunca, H., Buradino, M., Colombel, E. and Tabone, E. 2016. Tendency and consequences of superparasitism for the parasitoid *Ooencyrtus pityocampae* (Hymenoptera: Encyrtidae) in parasitizing a new laboratory host, *Philosamia ricini* (Lepidoptera: Saturniidae). European Journal of Entomology, 113: 51-59. https://doi.org /10.14411/eje.2016.006.

Uçkan, F. and Ergin, E. 2003. Temperature and food source effects on adult longevity of *Apanteles galleriae* Wilkinson (Hymenoptera: Braconidae). Environmental Entomology, 32(3): 441-446. https://doi.org /10.1603/0046-225X-32.3.441.

Udovitsa, M. I. 1998. The situation may change. Zashchitai Karantin Rastenii, 3: 15. (in Russian with English abstract).

van Alphen, J. J. M. and Jervis, M. A. 1996. Foraging behaviour. In: Jervis, M. and Kidd, N. (Eds.), Insect Natural Enemies: Practical Approaches to Their Study and Evaluation, Chapman and Hall, London, UK. pp. 1-62.

van Alphen, J. J. M. and Visser, M. E. 1990. Superparasitism as an adaptive strategy for insect parasitoids. Annual Review of Entomology, 35: 59-79. https://doi.org/10. 1146/annurev.en.35.010190.000423.

van der Hoeven, N. and Hemerik, L. 1990. Superparasitism as an EES: to reject or not reject, that is the question. Journal of Theoretical Biology, 146: 467-482. https: //doi.org/10.1016/s0022-5193(05)80373-x.

van Driesche, R. G. and Bellows, J. T. 1996. Biological Control. Chapman and Hall Publication.

van Lenteren, J. C. 1981. Host discrimination by parasitoids. In: Nordlun, A. D. Jones, R. L. and Lewis, W. J. (Eds.), Semiochemicals: Their Role in Pest Control, John Wiley & Sons, pp. 153-179.

van Lenteren, J. C., Babendreier, D., Bigler, F., Burgio, G., Hokkanen, H. M. T., Kuske, S., Loomans, A. J. M., Menzler-Hokkanen, I., van Rijn, P. C. J., Thomas, M. B., Tommasini, M. G. and Zeng, Q. Q. 2003. Environmental risk assessment of exotic natural enemies used in inundative biological control. BioControl, 48: 3-38. https://doi.org/10.1023/A:1021262931608.

Visser, M. E., van Alphen, J. J. M. and Nell, H. W. 1990. Adaptive self superparasitism and patch time allocation in solitary parasitoids: the influence of the number of parasitoids depleting a patch. Behaviour, 114: 21-36. https://doi.org/10.1163/156853990X00031.

White, J. A. and Andow, D. A. 2008. Benefits of self-superparasitism in a polyembryonic parasitoid. Biological Control, 46: 133-139. https://doi.org/10.1016/j.biocontrol.2008.04.005.

Zatyaina, V. V. and Klechkovskii, E. R. 1974. Telenomines of the Voronezh region. Zashchita Rastenii, 4: 32.

Zhang, Y. Z., Wie, L. and Huang, D. W. 2005. A taxonomic study of Chinese species of *Ooencyrtus* (Insecta: Hymenoptera: Encyrtidae). Zoological Studies, 44: 347-360.

آیا سوپرپارازیتیسم شایستگی *Ooencyrtus telenomicida*، زنبور پارازیتوئید تخم *Eurygaster integriceps* را متأثر می‌کند؟

اشکان رفعت[1]، سیّدعلی صفوی[1*] و شهزاد ایرانی‌پور[2]

۱- گروه گیاه‌پزشکی، دانشکده کشاورزی، دانشگاه ارومیه، ارومیه، ایران.
۲- گروه گیاه‌پزشکی، دانشکده کشاورزی، دانشگاه تبریز، تبریز، ایران.
پست الکترونیکي نویسنده مسئول مکاتبه: a.safavi@urmia.ac.ir
دریافت: ۹ آبان ۱۴۰۳؛ پذیرش: ٤ آبان ١٤٠٤

چکیده: زنبور *Ooencyrtus telenomicida* Vassilie (Hym.: Encyrtidae) پارازیتوئید مهم تخم سن گندم، *Eurygaster integriceps* Puton (Hem.: Scutelleridae) با انتشار وسیع در ایران است. مطالعه‌های کمی روی این‌گونه صورت گرفته است. در این پژوهش، تاریخچه زیستی*O. telenomicida* روی تخم‌های *E. integriceps* در شرایط آزمایشگاهی مطالعه شد. تمامی فراسنجه‌ها بین دو سطح پارازیتیسم، یعنی سوپرپارازیته شده (SP = دو نتاج در هر تخم میزبان) و غیرسوپرپارازیته (NSP = یک نتاج در هر تخم) مقایسه شدند. دوره رشد ونموی تمام مراحل نابالغ در داخل تخم‌های میزبان ۱۳–۱۷ روز طول کشید. دوره زندگی حشرات کامل نر و ماده نیز به‌ترتیب بین ۲۵-۳۵ و ۲۳-۴۱ روز متغیر بود. تعداد تخم به‌ازای هر ماده ۴۳-۹۱ عدد ثبت شد. به‌علاوه، تعداد متوسط سرانه تخم، ۵/۳–۱۹/۱۲ عدد بود. نرخ بقای مراحل پیش از حشره کامل در هر دو گروه ۱۰۰ درصد بود، یعنی همه زنبورهای دو گروه به‌طور موفقیت‌آمیزی از تخم‌های میزبان تفریخ شدند. نسبت جنسی مشاهده شده در گروه خارج شده از تخم‌ها ۰/۴۳۷–۰/۸۹۸ ماده به‌ازای تمام نتاج بود. نرخ ذاتی افزایش جمعیت زنبورهای غیرسوپرپارازیته و سوپرپارازیته به‌ترتیب ۰/۰۰۴ ± ۰/۲۲۴ و ۰/۰۰۴ ± ۰/۲۳۴ در هر روز برآورد شد. نرخ جایگزینی خالص به‌ترتیب برای همان گروه‌ها ۷/۵۵ ± ۷۶/۱۳ و ۹/۶۶ ± ۸۱/۶ ماده به ازای هر ماده در هر نسل بود. متوسط زمان یک نسل نیز ۰/۴۱ ± ۱۹/۳۶ و ۰/۴۰ ± ۱۸/۸۴ روز به‌ترتیب برای هر دو تیمار تخمین زده شد. هیچ تفاوت معنی‌داری در فراسنجه‌های جدول زیستی در دو گروه پارازیتوئیدها مشاهده نشد. بنابراین، نتایج ما اثبات نمود که سوپرپارازیتیسم هیچ تأثیر منفی در شایستگی تولیدمثلی*O. telenomicida* نداشت.

واژگان کلیدی: نرخ ذاتی افزایش جمعیت، تاریخچه زیستی، سن گندم، زادآوری