Effect of host and parasite density on *Trichogramma ostrinae*

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Abstract: The effects of host and parasite density on the efficiency of the egg parasite, *Trichogramma ostrinae* Pang et Chen were studied in the laboratory under controlled conditions. In the first experiment, females of *T. ostrinae* of one day old were exposed at different densities i.e. 1, 2, 4, and 8 heads to the 400 eggs of *Corcyra cephaloica*. Total parasitism was significantly higher at the highest parasite density, but the parasitism per ♀ decreased almost more than double, when the parasite density increased from 1 to 8. Also in the same way more than 3-fold increase in the number of female progenies was recorded, when the parasite density decreased from 8 ♀ per unit to 1 ♀ per unit. In the second experiment the effect of host densities on parasitism by *T. ostrinae* was studied by exposing groups of 50, 100, 200 and 400 eggs of *Corcyra cephaloica* to a single couple of parasite of one day old. Here the parasitism by *T. ostrinae* exhibited the opposite trend than the 1st experiment. In this case when the host density was raised from 50 to 400 eggs, significantly high parasitism was recorded. Almost more than 2-fold increase in female progeny per ♀ was recorded with the host density. It was concluded that increasing host density had beneficial effect on parasite efficiency of *T. ostrinae*.

Key words: *Trichogramma ostrinae*; *Corcyra cephaloica*; parasite density; host density; parasite efficiency
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蜂密度和寄主卵密度对玉米螟赤眼蜂寄生效能的影响

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摘要:在实验室内以米蛾卵作寄主研究了蜂密度和寄主密度对玉米螟赤眼蜂寄生效能的影响. 在第一个试验中,1、2、4和8头1日龄的玉米螟赤眼蜂雌蜂被分别接入400粒米蛾卵上,结果表明,卵的总寄生率在最高蜂密度(8头)时显著高于其他蜂密度,但平均每头雌蜂的寄生率却随蜂密度的增加而减少,当蜂密度从1增加到8头时,平均每头雌蜂的寄生率几乎减少了近一半,同时每雌产后代数也随蜂密度的增加而减少,说明蜂密度的增加降低了玉米螟赤眼蜂的寄生效能. 另一试验中,50、100、200和400粒米蛾卵上分别接入1头1日龄的赤眼蜂雌蜂,结果表明,随寄主卵密度的增加,卵的总寄生率也显著增加,寄主卵密度每增加1梯度,每雌产后代数平均增加了2倍,由此可以看出,寄主卵密度的增加对玉米螟赤眼蜂的寄生效能有增强作用.

关键词:玉米螟赤眼蜂; 米蛾; 蜂密度; 寄主卵密度; 寄生效能

Egg parasitoids of the genus *Trichogramma* have long been used in biological control[1] and have been mass-reared and field released for almost 80 years[2,3]. They are the currently the most widely augmented arthropod natural enemy with more than 32 million hectares of agricultural and forest land worldwide treated annually[3].

Over the last decade there has been an increased awareness that quality of laboratory-reared natural enemies is critical to the success of augmentation programs. In the context of augmentation, quality can be broadly defined as the reproductive capacity of a natural enemy in the field after release[4,5]. The quality of laboratory-reared *Trichogramma* can be affected by 29 specific factors[6]. It is common practice in laboratories for *Trichogramma* to be

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reared at high densities in mass cultures although several effects from overcrowding have been recorded in other parasitic Hymenoptera, including a reduction in searching efficiency[7], a reduction in fecundity[8], and a pronounced shift towards a preponderance of males in the eggs laid[9,10]. The effect of different natural and artificial host has also been studied by different scientists for the mass production of *Trichogramma*[11,12]. No specific work has been conducted up till now on the effect of host and parasite density on the over all quality (parasitism capacity) of *Trichogramma ostrinae* Pang et Chen.

The following study was conducted to determine the efficient combination of host and parasitoids and to assess the effect of host and parasite density on the parasitism (fecundity), emergence and sex ratio of *T. ostrinae*.

1 Materials and methods

1.1 The effect of fluctuating parasite density under fixed host density, on *T. ostrinae* efficiency

400 fresh eggs of *Corcyra cephaloica* were glued on each paper card. These egg cards were exposed for 1-hour to UV-sterilization treatment and then were placed individually into small vials of size 12 mm × 55 mm. The number of replicates was 20 but these were divided in two lots for easy handling.

After sexing, 1, 2, 4 and 8 heads of one-day-old *T. ostrinae* were released in the vials individually. Then the vials were plugged with cotton. These vials were placed in an incubator at 25 ℃ and 75 % relative humidity, for 24 hours in continuous illumination. After 24 hours the adult *T. ostrinae* were removed and the vials were placed again in the incubator. About a week after oviposition, the developing parasites reached to the pupal stage, and the number of parasitized eggs (black eggs) was recorded. The eggs left for several more days at 25 ℃, and after parasites emerged completely, they were counted and then sexed.

1.2 The effect of fluctuating host density on *T. ostrinae* efficiency

C. cephaloica fresh eggs were glued on the paper cards at densities of 50, 100, 200 and 400 eggs with the help of non-toxic glue. These egg cards were exposed to UV-sterilization treatment for 1 hour. The cards were placed into small vials of size 12 mm × 55 mm. The number of replicates was 20 but these were handled 10 at a time for convenience.

One-day-old *Trichogramma* couple was released in each vial containing egg card. Then the vials were plugged with cotton. These vials were placed in an incubator at 25 ℃ and 75 % relative humidity, for 24 hours in continuous illumination. After 24 hours the adult *Trichogramma* were removed and the vials were placed again in the incubator. About a week after oviposition, the developing parasites reached to the pupal stage, and the number of parasitized eggs (black eggs) was recorded. The eggs were left for several more days at 25 ℃, and after parasites completed their emergence, they were counted and then sexed.

SAS 6.12 version was used for data analysis. Duncan's multiple range test (DMRT) was used for means separation[13].

2 Results and discussion

2.1 The effect of parasite density

Table 1 shows an increase in the total and percent parasitism when the parasite density increased from 1 to 8, but the parasitism per ♀ and also percent parasitism per ♀ decreased almost in a ratio of more than double. So increasing the parasite density had an adverse effect on the performance of the parasite individually, which parasitized fewer host per ♀ of parasite. A possible explanation for such type of study may be that at less parasite density, less mutual interference may be occurred between the searching ability of parasites and parasitized more hosts per ♀ as compared with higher densities of parasites. The percentage of emergence from parasitized host was high, but not affected by parasite density (Table 1).

Tab. 1 The effect of parasite densities on *T. ostriniae* in the host eggs of *C. cephaloica*[1)]

items	1 head	2 heads	4 heads	8 heads
total parasitism	32.0±1.2 d	54.0±1.2 b	60.0±1.0 c	118.8± 2.7c
parasitism per ♀	32.0±1.2 a	27.0±0.6 b	15.0±0.2 c	14.8±0.3c
parasitism/%	8.0±0.3 d	13.5±0.3 c	15.0±0.2 b	29.5±0.7 a
parasitism per ♀/%	8.0±0.3 a	6.8±0.1 b	3.8±0.1 c	3.7±0.1 c
emergence/%	79.7±1.5 a	80.5±1.0 a	82.2±1.7 a	80.5±1.4 a
total female progeny	19.0±1.0 c	30.0±1.0 b	32.0±1.5 b	42.0±2.1 a
female progeny per ♀	19.0±1.0 a	15.0±0.5 b	8.0±0.4 c	5.3±0.3 d
female progeny/%	72.6±1.9 a	68.7±2.1 ab	65.0±2.6 b	44.2±1.9 c
female progeny per ♀/%	72.6±1.9 a	34.4±1.1 b	16.2±0.6 c	5.5±0.2 d

1) Means ± SE followed by the same letter within a row are not significantly different from each other ($P < 0.05$; DMRT)

Table 1 shows that female progeny, the number of which is of great importance to the survival of species, was severely affected by the parasite density. Female progeny per ♀ fell from 19.00 to 5.25, percent female progeny from 72.62% to 44.22% and also percent female progeny per ♀ parent from 72.62% to 5.52%, when parasite

density was increased from 1 to 8 heads. Although total female progeny was increased from 19 to 42.

This study clearly shows that increasing the parasite density had an adverse effect. Parasite efficiency dropped. It parasitized fewer hosts and the percentage as well as number of female progeny fell down.

2.2 The effect of host density

By increasing the host densities total parasitism increased, while their percentage decreased (Table 2). So increasing host densities had a beneficial effect. The parasites become more active and efficient and parasitized more hosts. Although high percent emergence was recorded for all host densities, but statistically no difference was recorded ($P > 0.05$) (Table 2).

Tab. 2 The effect of different host densities of *C. cephaloica* on *T. ostriniae*[1)]

items	50	100	200	400
total parasitism	12.3±0.6b	20.8±1.0a	21.4±1 0a	22.9±0.8a
parasitism/%	24.6±1.39a	20.8±1.0b	10.7±0.5c	5.7±0.2d
emergence/%	83.8±1.8a	86.5±1.8a	85.2±1.8a	86.2±2.2a
total female progeny	7.9±0.7c	13.0±0.9b	16.0±1.1a	16.7±0.8a
female progeny/%	75.7±3.4b	71.8±3.4b	85.2±1.9a	84.2±1.9a

1) Means ± SE followed by the same letter within a row are not significantly different from each other ($P < 0.05$; DMRT)

About a 2-fold increase in the total number of female progeny was recorded when the host density increased from 50 to 200 and 400 (Table 2). Also the percent female progeny increased by increasing the host density from 50 to 200 and 400 ($P < 0.05$) (Table 2). So increasing the host density had a positive effect, the parasite become very effective produced more female progeny.

3 Conclusion

The present whole work showed that increasing the parasite density had an adverse effect on the efficiency of the parasite. It parasitized few hosts and showed less number of female progeny per ♀ parent. On the other hand, increasing host density had beneficial effect on parasite efficiency. The parasite parasitized more hosts and produced more female progeny. These finding support the previous work[14-16].

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