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## Studies on Host Preference and Oviposition Behaviour of *Trichogramma aurosum* Sugonjaev and Sorokina Strains in Choice and Non-Choice Tests

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### Abstract

Samara, R., J.C. Monje, T. Qubbaj and C.P.W. Zebitz. 2011. Studies on Host Preference and Oviposition Behaviour of *Trichogramma aurosum* Sugonjaev and Sorokina Strains in Choice and Non-Choice Tests. Arab Journal of Plant Protection, 29: 259-266.

Oviposition behaviour and host selection of different German strains of the egg parasitoid *Trichogramma aurosum* Sugonjaev and Sorokina (Hymenoptera: Trichogrammatidae) were examined on eggs of five Lepidopteran hosts (*Cydia pomonella* (L.), *Spodoptera littoralis* (Boisd.), *Helicoverpa armigera* (Hübner), *Agrotis segetum* (Schiff.) and *Lobesia botrana* (Den. and Schiff.)). The parasitization behaviour of individual female wasps was examined in choice and non-choice tests. Single female wasps were observed for 90 min. using a rectangular grid. Results from the choice test revealed that 75–90% of *C. Pomonella* eggs attacked by *T. aurosum* strains were successfully parasitized. Values for *L. Botrana* and for *A. segetum* ranged between 40–80% and 40–70%, respectively. No significant preference was found between *C. Pomonella* eggs and host eggs of both *L. botrana* and *A. segetum*. Time needed by the female wasps to drill on eggs of *L. Botrana* was shorter than the time needed for drilling on *C. Pomonella* eggs. This could be due to differences in egg chorion thickness and, presumably, differences in chorion hardness. During direct observation of the parasitism behaviour it was noticed that all strains spent about 20% of the observation time for drilling on either *C. Pomonella* or *L. Botrana* eggs, 30–60% on resting, 4–15% on cleaning, < 4% on walking and < 1% on feeding. Results from the non-choice test showed that a significantly higher number of *C. pomonella* and *L. botrana* eggs were parasitized in comparison to the other hosts offered. The presence of hair-like structures deposited on eggs of *S. littoralis* and a thick egg chorion in *H. armigera* seems to represent a physical barrier that impedes successful parasitization.

**Keywords:** *Trichogramma aurosum*, *Cydia pomonella*, *Spodoptera littoralis*, *Helicoverpa armigera*, *Agrotis segetum*, *Lobesia botrana*, host acceptance, host selection, parasitization behaviour.

### Introduction

The codling moth, *Cydia pomonella* (L.), is a key pest of apple distributed world-wide, with exception of both Japan and China (16). Damage caused by this pest on apple trees could reach 95% when no control methods were applied (1). Insecticides are widely used to control this pest. Though, the increase of resistance has prompted interest in alternative control methods such as inundative biological control. *Trichogramma* spp. are egg parasitoids used worldwide for this control strategy against lepidopterous pests in forestry, orchards, and row crops (15, 23, 29). However, not only inoculative releases (classical biological control) but also inundative releases failed to reveal successful control of the target pest(s) (19, 30). In more than 10% of the reported cases, failing biocontrol could be traced back to selection of either the wrong species or inappropriate or unsuitable strains (31). Thus, biological control programmes require pre-introductory basic research on the performance of potential candidates (20, 21, 27, 28).

One of the most important aspects of the parasitoid-host relationship is research done on host selection process (33). Selection process is usually based on *Trichogramma* biological characteristics, which includes fecundity, emergence rate, sex ratio, longevity, host preference for the target species, host searching activity and tolerance to local climatic conditions. According to Flanders (9); Gordh *et al.* (11) and Vinson (35), successful parasitism is divided into 5 steps: host habitat location, host location, host acceptance, host suitability and host regulation. The first three steps are

referred to as aspects of the host selection process, which can be by selecting between hosts of different ages and or species (34). Host suitability is concerned with factors affecting the development of a parasitoid within potential hosts. Following the host finding and host selection process, host suitability is a final step in the host-parasitoid relationship toward successful parasitism (23), while host preference under controlled conditions is important in the risk assessment of biological control agents (14, 17).

Host selection can be affected by environmental conditions or by host factors such as host chemical or physical cues, shape, size and host age. For biological control programs host preference tests were carried out on *Trichogramma* species/strains between its target pest and its factious host eggs (3, 4, 12, 13, 32, 33). This assessment of the host preference showed to be insufficient while various host eggs may not occur together in the field on the same crop and at the same time (32).

Host preference tests should include a native *Trichogramma* species/strain found in the field with the target pest. These wasps may have adapted to the field conditions and synchronized with the presence of the pest. Since host preference tests are difficult to be carried out under field conditions, this study aimed at examining the host preference of five strains of *T. aurosum* for eggs of different lepidopterous host species in the laboratory. Van Dijken *et al.* (33) suggested that observation of the wasp behavioural performance using the rectangular grid is the most suitable method for determining host preference. Two experiments were designed for determining host preference: 1) choice tests, where female wasps have to choose between

eggs of two host species, thus providing information on its status in the environment. 2) non choice tests, experiment was carried out to determine the wasps host range. These experiments were expected to provide more information of this *Trichogramma* species the parasitization behaviour and host preference.

## Materials and methods

### Insect rearing

Stock rearing of the Codling moth *Cydia pomonella* L. (abbr. CP), the Cotton leaf worm, *Spodoptera littoralis* Boisd. (abbr. SL), the African bollworm *Helicoverpa armigera* Hübner (abbr. HA), the Turnip moth *Agrotis segetum* Schiff. (abbr. AS), the Grapevine moth *Lobesia botrana* Den. and Schiff. (abbr. LB), and the Mediterranean flour moth *Ephestia kuehniella* Zeller (abbr. EK) were reared and maintained according to the methods described by Cerutti *et al.* (6) and Bathon *et al.* (2). The parasitoids were obtained by collecting parasitized (blackened) eggs of *Nematus tibialison* leaves of *Robinia pseudoacacia* trees in five locations in the Federal German Republic (Table 1). After the emergence of the parasitoids, laboratory colonies were started and maintained on eggs of *E. kuehniella*. Males of each collection were slide-mounted following Platner *et al.* (25), and identified using the terminology of Pinto (24). Voucher specimens of all strains are deposited in the collection of the Dept. of Applied Entomology, Institute of Phytomedicine, University of Hohenheim. A strain is thereafter defined as the progeny emerged from all eggs collected at the same site on the same day. Strains were placed in culture tubes (70 x 20 mm) closed with a plastic lid, which had a small hole for aeration. The tubes were kept in a climatic cabinet at ca. 25 ± 0.5 °C, 85 ± 5% RH and 18:6 h L:D photoperiod during pupal development of the parasitoids. To feed emerged adults, a droplet of honey was placed in the tube prior to or upon their emergence. Emerged parasitoids were provided with fresh host eggs on an 'egg card'. Egg cards were prepared by sprinkling host eggs on a drop of Arabic gum on a piece of paper index card (ca. 50 x 15 mm).

### Experimental design

**Choice test** - van Dijken *et al.* (33) found that the best method for studying the parasitoid parasitism behaviour is by direct observation using a rectangular grid. According to them, the distance between the eggs offered should not exceed 2-4 mm. Newly hatched *T. aurosum* test females were placed singly in small tubes with a droplet of honey

for 10 min. Subsequently they were transferred singly into the side of a Petri-dish with eight host eggs of *L. botrana*, or *A. segetum*, in combination with eight eggs of *C. pomonella*. Eggs were arranged in a grid in alternative manner. The distance between single eggs was ca. 4 mm to ensure that females could not perceive adjacent eggs. Every behavioural event was recorded for 90 min by direct observation with The Observer® software 3.0 (22), i.e. walking, cleaning, resting (handling time), contact (touching the egg with part of the wasps body), drumming (touching the host egg with the antennae), acceptance (by starting drilling), or rejection (by leaving the host and walking away), drilling, and oviposition (movement of the abdomen can be clearly seen). Each treatment was replicated 20 times. The observation time started after the first contact with an egg. The second part of the experiment was by indirect observation. Eight eggs of *C. pomonella* were arranged in a Petri-dish in combination with eight eggs of *S. littoralis*, or *H. armigera* in the same manner as described above and test females were allowed to parasitize them for 90 min. (no refer to the statistical method that you used for analysis of the results that you obtained, please refer to it in each comparison or analysis you have done)

**Non-choice test** - Non-choice tests are sufficient for an initial evaluation of both the physiological host range and host preference of *Trichogramma* spp. Therefore, 16 eggs of each host species (*C. pomonella*, *S. littoralis*, *H. armigera*, *A. segetum*, *L. botrana*) were arranged as described above. A single newly hatched female wasp was allowed to parasitize them for 90 min. Each treatment was replicated 20 times.

## Results

In the choice test, no significant differences in the number of parasitized eggs in both host combinations were detected for all tested strains of *T. aurosum* (Table 2). The average number of parasitized eggs ranged from 3.2-4.6 CP eggs, and 2.7-3.9 LB eggs. The values in the combination CP vs. AS ranged from 1.1-2.7 eggs of CP and 0.8-1.8 eggs of AS. In contrast, all strains parasitized a significant higher number of LB and CP eggs in comparison to the other hosts in the non-choice tests (Table 3). The average number of parasitized eggs ranged from 4.4-7.5 in CP, and from 5.3-9.3 eggs in LB. The average number of parasitized eggs of SL, HA, and AS ranged from 0.3-1.4, 2.1-4.1 and 2.1-4.1 eggs, respectively.

**Table 1.** List of the collected *T. aurosum* strains, their locations, latitude, longitude and time of collection.

| Code | Location                                 | Latitude      | Longitude    | Time of collection |
|------|--|---------------|--------------|--------------------|
| Ta4  | Baden-Württemberg, Stuttgart (Southwest) | 48° 42' North | 9° 13' East  | July 2001          |
| Ta10 | Hesse, Worms (West)                      | 49° 39' North | 8° 21' East  | August 2001        |
| Ta13 | Bavaria, Munich (Southeast)              | 48° 08' North | 11° 35' East | July 2002          |
| Ta19 | Low Saxony, Göttingen (North)            | 51° 32' North | 9° 55' East  | August 2002        |
| Ta20 | Berlin, Schöneberg (Northeast)           | 52° 28' North | 13° 22' East | August 2002        |

**Table 2.** Host selection expressed as number of parasitized eggs of *A. segetum*, *L. botrana*, and *C. pomonella* by female wasps of *T. aurosum* strains in choice tests at room temperature (n = 20).

|                     | Ta4           | Ta10          |  | Ta19          | Ta20          |
|---------------------|---------------|---------------|--|---------------|---------------|
| <i>C. pomonella</i> | 3.22 ± 0.97 a | 3.50 ± 1.76 a |  | 3.41 ± 1.94 a | 4.59 ± 2.60 a |
| <i>L. botrana</i>   | 2.78 ± 1.99 a | 3.17 ± 0.98 a |  | 2.71 ± 1.93 a | 3.93 ± 2.41 a |

|                     | Ta4           | Ta10          | Ta13          | Ta19          | Ta20          |
|---------------------|---------------|---------------|---------------|---------------|---------------|
| <i>C. pomonella</i> | 2.69 ± 1.60 a | 1.13 ± 0.74 a | 2.08 ± 1.12 a | 1.27 ± 0.80 a | 1.25 ± 0.87 a |
| <i>A. segetum</i>   | 1.77 ± 1.42 a | 1.00 ± 1.00 a | 1.62 ± 1.67 a | 0.80 ± 0.77 a | 1.08 ± 0.79 a |

Within a column, means followed by the same letter are not significantly different (P > 0.05, Student Newman Keuls (SNK) test)

**Table 3.** Host selection expressed as number of parasitized eggs of *S. littoralis*, *H. armigera*., *A. segetum*, *C. pomonella*, and *L. botrana* by female wasps of *T. aurosum* strains non-choice tests at room temperature (n = 20).

|                      | Ta4                     | Ta10                    | Ta13                     | Ta19                    | Ta20                    |
|----------------------|-------------------------|-------------------------|--------------------------|-------------------------|-------------------------|
| <i>S. littoralis</i> | 0.65 ± 0.93 c<br>(n=20) | 0.31 ± 0.48 c<br>(n=16) | 1.40 ± 0.91 c<br>(n=16)  | 0.50 ± 0.22 d<br>(n=20) | 0.75 ± 0.97 d<br>(n=20) |
| <i>H. armigera</i>   | 3.35 ± 3.28 b<br>(n=20) | 2.13 ± 1.41 b<br>(n=15) | 4.10 ± 3.29 b<br>(n=20)  | 2.06 ± 2.82 c<br>(n=18) | 4.05 ± 3.26 c<br>(n=19) |
| <i>A. segetum</i>    | --                      | 4.13 ± 2.45 a<br>(n=16) | 3.00 ± 2.08 bc<br>(n=13) | 2.13 ± 1.41 c<br>(n=16) | 2.92 ± 1.93 c<br>(n=15) |
| <i>C. pomonella</i>  | 5.32 ± 2.06 a<br>(n=20) | 4.37 ± 2.34 a<br>(n=20) | 7.53 ± 2.65 a<br>(n=20)  | 5.15 ± 2.96 b<br>(n=20) | 5.93 ± 2.63 b<br>(n=20) |
| <i>L. botrana</i>    | 5.75 ± 4.49 a<br>(n=16) | 5.25 ± 1.91 a<br>(n=15) | 7.59 ± 3.97 a<br>(n=20)  | 6.77 ± 3.65 a<br>(n=15) | 9.27 ± 3.41 a<br>(n=15) |

Within a column, means followed by the same letter are not significantly different (P > 0.05, Student Newman Keuls (SNK) test)

Host acceptance contact ratio (a/c ratio) was higher for CP across all strains when two different hosts were offered in the choice test (Table 4). The a/c ratio for the strains Ta4, Ta10, Ta19, and Ta20 ranged from 0.76-0.93 on CP eggs and from 0.44-0.91 on LB eggs. In the second test, the a/c ratios for Ta4, Ta10, and Ta13 ranged from 0.77-1.00 for CP and from 0.60-0.82 on AS eggs. Significant differences in the a/c ratios were detected for both Ta4 and Ta10 in the combination CP vs. LB and for Ta10 in the combination CP vs. AS eggs. Here the females preferred eggs of CP over the other offered eggs in the choice test. In all other tests, no preference was observed for any of the strains to contact and to accept one of the hosts offered. The female wasps were able to parasitize 75-90% of the attacked eggs of CP compared with 40-98% of the attacked eggs of LB in the choice test (Figure 1). Also, they were able to parasitize 70-80% of the attacked eggs of the CP compared with 40-77% of the attacked eggs of AS.

Handling time was calculated in the choice test experiment between *C. pomonella* and *L. botrana*: Ta19 and Ta4 spent 23.7 and 25.4% of the observed time for drilling on eggs of CP and 16.3, 17.6% on LB eggs, respectively (Figure 2). In contrast, Ta20 and Ta10 spent 16.6, 18.1% of the observed time for drilling on eggs of CP and 24, 15.2% on LB eggs, respectively. Drumming time did not differ between the two hosts. Resting behaviour dominated the handling time in all strains. It was 29.5, 36.8, 40.0 and 60.0% for Ta20, Ta19, Ta4 and Ta10,

respectively. It was followed by cleaning, walking and feeding, which always made out less than 1% of the total observation time (Figure 2).

Average drilling and ovipositing time spent on the first egg continuously decreased up to the last egg in most of the wasps strains, suggesting that wasps could have learned to differentiate and to inspect the egg content and to reach a faster decision of parasitising the eggs or not (Figure 3). Ta4 and Ta19 needed significantly longer time for drilling and ovipositing when the first egg encountered was an egg of CP, while this was the case in Ta10 and Ta20 when the first egg encountered was an egg of LB.

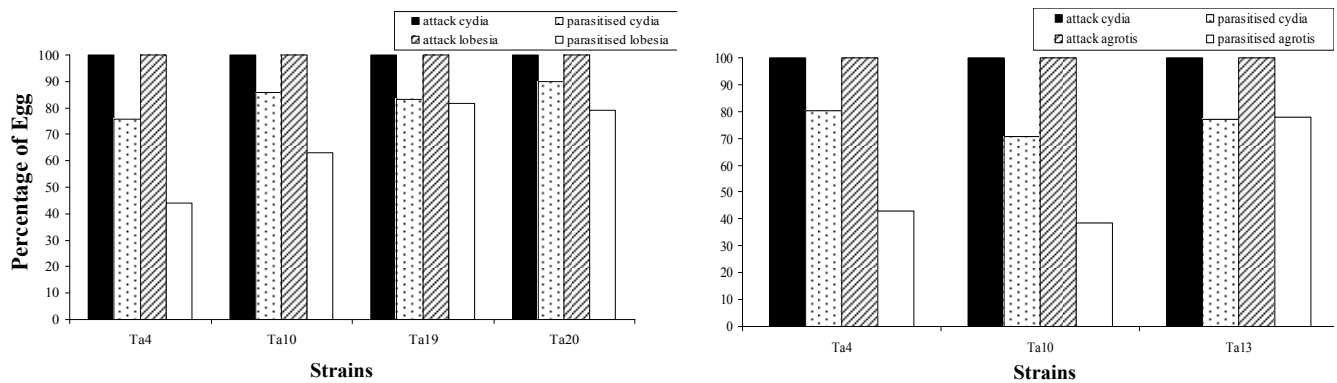
## Discussion

Preference for a certain host can be expressed as the total number of accepted hosts divided by the total number of contacts made with these hosts before the first acceptance occurs compared with other host species for the same strain of the parasitoid. A highly preferred host would have the a/c ratio near to 1. A host egg can be encountered several times, and it can be rejected after have being accepted in the first time. Hosts can be rejected by the parasitoids during different phases of the host inspection, e.g. after approaching at a distance of 1-2 mm, or after contact with the antennae, or after drumming the host surface, or after internal inspection with the ovipositor (33).

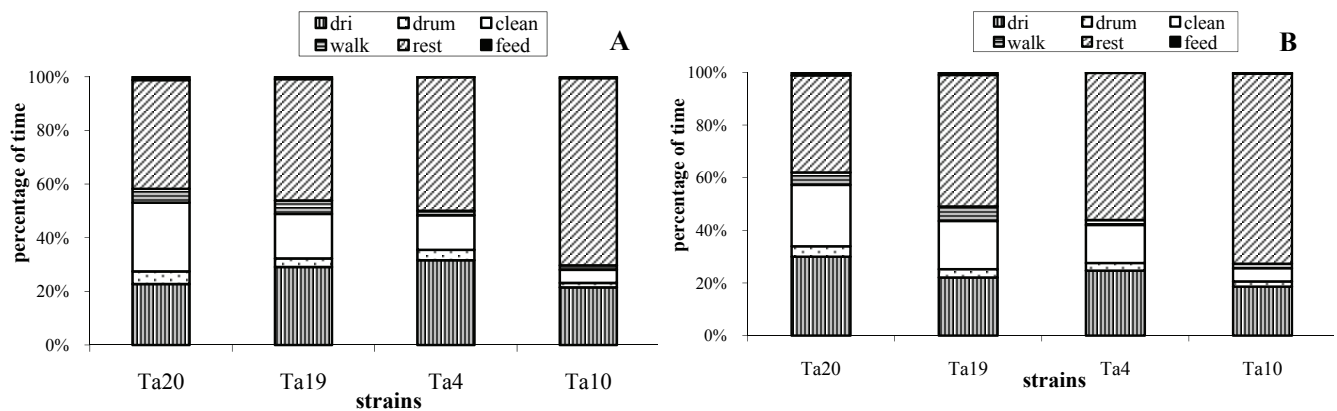
**Table 4.** Number of contacts and acceptances for *C. pomonella*, *L. botrana* and *A. segetum*, eggs by five *T. aurosum* strains in choice tests and statistical analysis of host preference (n = 20).

| Strain |                     | No. Contacts | No. Acceptances | a/c ratio | Chi square | Df | P     |
|--------|---------------------|--------------|-----------------|-----------|------------|----|-------|
| Ta4    | <i>C. pomonella</i> | 58           | 44              | 0.76      | 11.47      | 1  | 0.001 |
|        | <i>L. botrana</i>   | 50           | 22              | 0.44      |            |    |       |
| Ta10   | <i>C. pomonella</i> | 42           | 36              | 0.86      | 5.14       | 1  | 0.020 |
|        | <i>L. botrana</i>   | 38           | 24              | 0.63      |            |    |       |
| Ta19   | <i>C. pomonella</i> | 58           | 54              | 0.93      | 0.12       | 1  | 0.730 |
|        | <i>L. botrana</i>   | 46           | 42              | 0.91      |            |    |       |
| Ta20   | <i>C. pomonella</i> | 78           | 70              | 0.90      | 3.17       | 1  | 0.080 |
|        | <i>L. botrana</i>   | 67           | 53              | 0.79      |            |    |       |
| Ta4    | <i>C. pomonella</i> | 40           | 35              | 0.88      | 0.377      | 1  | 0.540 |
|        | <i>A. segetum</i>   | 28           | 23              | 0.82      |            |    |       |
| Ta10   | <i>C. pomonella</i> | 9            | 9               | 1.00      | 4.8        | 1  | 0.028 |
|        | <i>A. segetum</i>   | 15           | 9               | 0.60      |            |    |       |
| Ta13   | <i>C. pomonella</i> | 26           | 20              | 0.77      | 0.004      | 1  | 0.947 |
|        | <i>A. segetum</i>   | 18           | 14              | 0.78      |            |    |       |

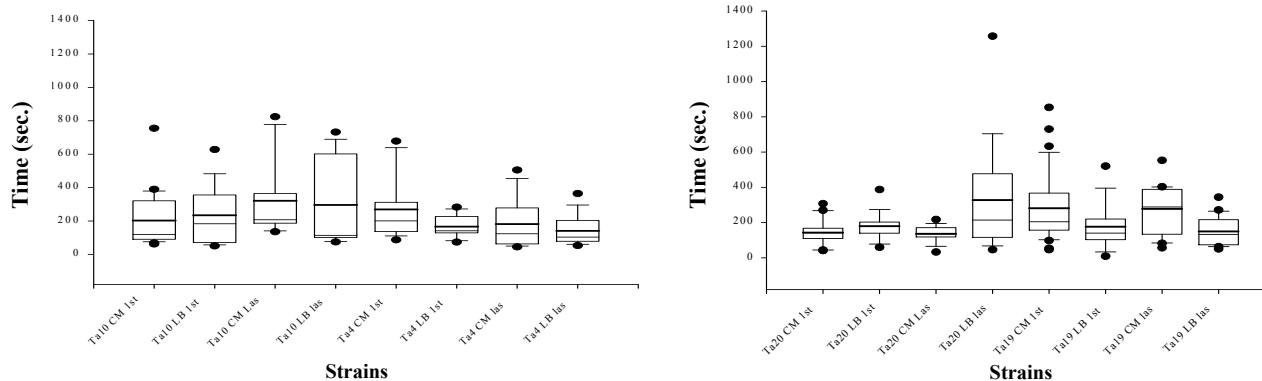
P values lower than 0.05 indicate significant differences



**Figure 1.** Host selection expressed as percentage of eggs of *A. segetum*, *L. botrana*, and *C. pomonella* attacked and parasitized by female wasps of *T. aurosum* in choice tests at room temperature (n = 20)



**Figure 2.** Percentage handling times for four strains of *T. aurosum* parasitizing eggs of *C. pomonella* (A) and *L. botrana* (B) at room temperature in choice test (n = 20). Dri = drilling, drum = drumming, clean = cleaning, walk = walking, rest = resting, feed = host-feeding.



**Figure 3.** Box-Whisker-Plots of time consumed for drilling on the first and the last egg of *C. pomonella* and *L. botrana* by four strains of *T. aurosum* at room temperature in choice test (n = 20)

No significant differences in the number of parasitized eggs in both host combinations were detected for all tested strains of *T. aurosum* in the choice tests. This suggests that no preference for any host species was present (Table 2) from the tested hosts. Interestingly, the total number of parasitized eggs was consistently higher when CP and LB were offered simultaneously compared with the number of parasitized eggs in the combination CP and AS. This suggests that host acceptance may be influenced when hosts of similar shape and size (i.e. CP and LB) are available for parasitization. Offering hosts of different shape and size (i.e. CP and AS) apparently had a negative effect on host acceptance. Chorion thickness and hardness may also have played a role (7). The number of contacts and acceptances of the hosts also provide additional indication (Table 4). In general, hosts in the combination CP and LB were more frequently contacted and accepted than in the combination CP and AS. It could be hypothesized that the presence of a less attractive host (i.e. AS) has a negative impact on overall parasitism activity, but additional work is necessary to verify this in detail. For instance, shape and texture of the host has been shown to play a major role in host acceptance (35).

In contrast to the choice tests, all strains parasitized a significant higher number of *L. botrana* and *C. Pomonella* eggs in comparison to the other hosts in the non-choice tests (Table 3). For example, the average number of parasitized eggs of CP and LB by strain Ta4 was 8 times higher than the parasitized eggs of SL and 2 times higher than the parasitized eggs of HA (Table 4). The results suggest that *T. aurosum* has a higher affinity for members of the Tortricidae as for Noctuidae when offered alone (see also explanations below). Host size had a obvious effect on choice of the first host in *T. galloi* (20), while the probability of ovipositional probing after the antennal contact increases with increasing size of the host (26). The shape and texture of the host is very important in host acceptance. It was found that odour played a key role while shape and texture have secondary effect on acceptance of a host (35).

Morphological characters reflect the adaptation of the species to their habitats (7). *Trichogramma aurosum* was collected from eggs of the locust sawfly *N. Tibialis*

(Hymenoptera: Tenthredinidae), who lay its eggs on the leaves and stem of *R. pseudoacacia*. The eggs are oval in shape (ca. 1000-1500 µm in length and 500-700 µm in width). *C. Pomonella* and *L. botrana* belong to the family Tortricidae with different egg shapes. Eggs of *C. Pomonella* belong to the lying flat type (1.350 µm in length and 1.050 µm in width). The upper face of the shell is convex, the surface finely structured (8). Eggs of *L. botrana* are circular, of a diameter of 600 to 700 µm, slightly convex, whitish green with a rainbow hue. The factitious host eggs of *E. kuehniella* have both ends rounded (520.7 µm long x 289.8 µm wide). Egg sculpture is homogenous, the surface has a granular texture and it is marked by a regular polygonal pattern. Eggs of *H. armigera* are cylindrical in shape (551.8 µm long x 499.5 µm wide). The chorion shows a well-defined sculpturing with 9-10 conspicuous ridges crossing the egg longitudinally. The chorion has a rough surface due to the presence of many tiny concaves. Egg of *S. littoralis* have a dense layer of hairy-like material that covers them when laid by young females and is less frequent on eggs of older females. Eggs are spherical in shape (454.9 µm long x 390.2 µm wide). The presence of hairy-like structures on egg clusters of *S. littoralis* reduces the parasitism rate by *Trichogramma* in field and laboratory conditions, thus representing a physical barrier (7). These findings suggest that shape of the host can affect the degree of acceptance by *T. aurosum*, where the natural host is oval in shape and large in size. This is also the case in CP and LB. Mansfield and Mills (18) reported that *Trichogramma* spp. could not penetrate a chorion thicker than 20 µm. Drilling time spent on LB eggs was noticeably lower but with no significant differences than drilling time on CP (25-130 sec.), independent on whether it was the first or the last egg. Consoli *et al.* (7) found that the thickness of the exochorion might result in different drilling time by *T. galloi* and *T. Pretiosum* when drilling on eggs of the same chorion thickness. Additionally, the structural integrity of the chorion was an important factor limiting successful oviposition by *T. Platneri* in larger host eggs (18). The chorion of *C. Pomonella* eggs have 4 layers and it varies in thickness (8), while the chorion of *E. kuehniella* eggs is 2.63-3.23 µm thick with four layers. In contrast, the chorion of *H. virescens* eggs has 5 layers with 4.00-13.15 µm

thickness and the chorion of *S. frugiperda* eggs is 2.50-4.44 µm thick. This may explain the wasp host preference for eggs of *E. kuehniella* (factitious host), *C. pomonella*, *L. botrana* over eggs of *S. littoralis* and *H. armigera*. As a result, many factors could have affected the selection process and *T. aurosum* strains host preference such as host shape, structure, texture, chorion thickness and structural integrity.

Both average mean drilling and oviposition time for the first egg of CP and or LB spend by Ta4, Ta19 and Ta20 were noticeably reduced compared with the mean drilling time of the last egg. This might be an indication that the wasp test females learn to differentiate and to inspect the egg content so as to reach a faster decision whether to parasitise the hosts or not (Figure 3). Godfray (10) related learning behaviour with switching behaviour and pointed out that the first contact made by the wasp is very important. *Trichogramma evanescens* strains tended to parasitise the host species that was initially encountered although it was the less preferred host (33). Our results showed that host switching from CP to LB eggs for Ta4 and Ta20 was relatively high (> 55%) compared with host switching from LB to CP (34%). In contrast, host switching from CP to LB eggs for Ta10 and Ta19 was relatively low (30%) compared with switching from LB to CP (20 and 50%, respectively). Host switching is a fundamental part of the parasitoid biology, allowing it to attack a variety of different hosts (3), and to regulate the pest population (33). The parasitoids tend to switch to the most abundant host type (type in the meaning of species and its age) when presented with a range of different species. It is believed that parasitoid tendency to switch is correlated with innate host preference (33). This behaviour can be explained as a type of learning or host preference. When a parasitoid prefers a host species over another, they tend to switch to the preferred host (10). Host switching is a fundamental component of mass rearing programmes for *Trichogramma* spp. Normally, parasitoids are mass-reared on a relatively small factitious host and then released to attack a larger target host (3).

Percentage of parasitized eggs from attacked eggs of CP was higher than those of LB and AS. This showed that *T. Aurosum* examine all eggs it comes in contact with, but that does not mean that the females accept them for oviposition. Our results showed that host acceptance: contact ratio was higher for CP across all strains when offered together with eggs of LB or AS in the choice test. Although the number of the contacts made by a female to the latest host eggs was high, it seems that the females rejected many of the eggs they examined after drumming or drilling. This agrees with the finding of Godfray (10), who reported that the parasitoids frequently insert their ovipositor into a host without laying eggs. Castañeda-Samayoá *et al.* (5) reported that *T. dendrolimi* continue drilling and ovipositing in eggs of *Eupoecilia ambiguella* Hb. and *L. botrana* before rejecting the eggs.

*Anaphes iole* Girault (Hymenoptera: Mymaridae) females use chemicals derived from host eggs or adults in host recognition (31). Godfray (10) found that the wasps would attempt to oviposit on glass beads coated with the chemical if they were about the same size as a host egg, but they would refuse to oviposit either on uncoated glass beads or on flat surfaces smeared with accessory gland extract. Therefore, laboratory behavioural observations of the relative time spent handling different host species can provide at least an indication towards preference for any host, but it does not give obvious indication of their field efficiency (5). They may be useful to assess the host range by non-choice test before the choice test (18).

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## المخلص

سمارة، رنا، خ.ك. مونجي، ت. قبح وك.ف.و. زبيبت. 2011. دراسات عن التفضيل العوائل وسلوك وضع البيض عند سلالات من المتطفل *Trichogramma aurosum* Sugonjaev and Sorokina في اختبارات الاختيار وعدم الاختيار. مجلة وقاية النبات العربية، 29: 259-266. تم فحص سلوك الإباضة واختيار العائل عند سلالات مختلفة ألمانية المصدر من متطفل البيض *Trichogramma aurosum* Sugonjaev and Sorokina (رتبة غشائيات الأجنحة وفصيلة Trichogrammatidae) على بيوض 5 عوائل من رتبة حرشفيات الأجنحة (*Agrotis segetum* (Schiff.)، *Cydia pomonella* (L.)، *Lobesia botrana* (Den. and Schiff.)، *Spodoptera littoralis* (Boisd.)، *Helicoverpa armigera* (Hübner)). تم فحص السلوك التطفلي للدبابير إناث مفردة في اختبارات الاختيار وعدم الاختيار. إذ تم مراقبة دبابير أنثوية مفردة لمدة 90 دقيقة باستخدام شبكة مستطيلة. أظهرت النتائج من اختبار الاختيار أن 75-90% من بيوض *C. pomonella* التي هاجمتها سلالات المتطفل *T. aurosum* حدث فيها التطفل بنجاح. وتراوحت القيم لكل من *L. botrana* و *A. segetum* ما بين 40-70%، على التوالي. ولم توجد فروق معنوية ما بين بيوض *C. pomonella* وبيوض العائلين *L. botrana* و *A. segetum*. كان الوقت اللازم لإناث الدبابير لحفر بيوض *L. botrana* أقصر من الوقت اللازم لحفر بيوض *C. pomonella*. وقد يعزى ذلك إلى الاختلاف في سماكة كوريون البيضة أو اختلاف صلابة الكوريون. ولقد لوحظ أثناء الملاحظة المباشرة للسلوك التطفلي أن كافة السلالات أمضت 20% من وقت الملاحظة لحفر بيوض كل من *C. pomonella* أو *L. botrana*، 4-15% على التنظيف وأكثر من 4% للمشي وأكثر من 1% للتغذية. كما أظهرت نتائج اختبار عدم الاختيار أن هناك عدداً كبيراً

وبفارق معنوي من بيوض *C. pomonella* و *L. botrana* تم التطفل عليها مقارنة بالعوائل الأخرى المقدمة. يبدو أن وجود أشكال تشبه الشعر متوضعة على بيوض كل من *S. littoralis* و سماكة كوريون بيض *H. armigera* يشكلان حاجزاً فيزيائياً يمنع التطفل عليهما بنجاح.

كلمات مفتاحية: *Lobesia*, *Agrotis segetum*, *Helicoverpa armigera*, *Spodoptera littoralis*, *Cydia pomonella*, *Trichogramma aurosom* *botrana*, تقبل العائل، اختيار العائل، السلوك التطفلي

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