DEVELOPMENT OF THREE *TRICHOGRAMMA* SPP. ON EGGS OF TWO FACTITIOUS LEPIDOPTEROUS HOSTS, *PHTHORIMAEA OPERCULELLA* ZELLER AND AGROTIS IPSILON (HUFNAGEL)

A.F. LUTFALLAH AND R.H.G. MIKHAEL

Plant protection Research Institute, Agricultural Research Centre, Dokki, Giza, Egypt.

(Manuscript received 15 February 1998)

Abstract

Three species of *Trichogramma; T.pretiosum, T.minutum* and *T.evanescens* have been tested in order to study their development on factitious host eggs of two important pests in Egypt (black cutworm and potato tuberworm) as an initial step for the use in IPM programs.

Several biological parameters were evaluated such as, parasitism %, emergence rate, dévelopment duration, longevity, sex ratio and number of embryos/egg. *T.evanescens* was very promising as a biocontrol agent for both pests.

INTRODUCTION

The heavy use of pesticides is causing a large environmental pollution. This encourages the use of biological control methods, particularly by natural enemies, which are playing an important role among others through integrated pest management programs.

Trichogramma spp. are the most important egg parasitoids of several lepidopterous pests and other pest in the world (King, 1991). Several authors reported the important role of using *Trichogramma* spp. for controlling insect pests, such as potato tuberworm, *Phthorimaea operculella* in storage (Harwalkar *et al.*, 1987), as parasitoid for stored product pests (Brower, 1984 and Prozell *et al.*, 1994), and for controlling insect pests in vegetables, cotton, maize, rice and sugar cane (Hassan, 1981; Abbas *et al.*, 1990; El-Heneidy *et al.*, 1990; Pham *et al.*, 1994).

The present work was carried out in order to study the development of three *Trichogramma* spp. on two important pests in Egypt (the black cutworm and the potato tuberworm) as an initial step for the use in integrated pest management programs.

MATERIALS AND METHODS

Two species, *Trichogramma pretiosum* Riley and *Trichogramma minutum* Riley, were obtained from collection of the Department of Entomology at California University, Riverside, USA (Origins, Riverside & Chula Vista, CA, respectively). While the third local species *T.evanescens* Westw. is the common species in Egypt, which is used in the programs of the biological control for the lesser sugar-cane borer, *Chilo agamemnon* Bles. in Upper Egypt. This species was obtained from the mass rearing Lab., Dept. of Biological Control, ARC, Egypt (Origin, Giza, Egypt).

The following parameters were evaluated on eggs of each of the mentioned host species:

Parasitism % (the capacity of parasitization), emergence rate, development duration, longevity, sex ratio and the number of embryos/egg.

Factitious hosts

1. ***Agrotis ipsilon*:** Larvae were reared on freshly cut leaves of castor oil plant, *Ricinus communis* L. Black cutworm larvae have been reared successfully on freshly cut leaves (Satterthwait, 1933).

2. ***Phthorimaea operculella*:** Larvae were reared on potato tubers in wire cages (40 x 70 x 50 cm) to get newly emerged moths daily (El-Shereif, 1966 and Abul Nasr *et al.*, 1971).

For both species, eggs were deposited on brownish paper toweling strips by newly emerged moths placed into 2 kg egg-laying jars (procedure of Hendrix *et al.*, 1991), provided with a moistened cotton of a honey solution 7% to serve as a food source (Reese *et al.*, 1972). Eggs were deposited by the colony of mated females over several days. Eggs were taken daily and kept in cool storage at 5-6^{o}C until sufficient number were available for the study. Cooling of some lepidopterous eggs were used to delay hatching or to stop the embryonic development temporarily until needed (Lutfallah and Awadallah, 1984). Harwalkar *et al.* (1987) mentioned that *T.brasiliensis* (Ashmead) was multiplied by using *P.operculella* eggs killed by exposing them for 24 h to freezing temperature (-4^{o}C). *T.cordubensis* was reared on cold stored eggs (at 7^{o}C) of Mediterranean flour moth for seven generations (Vieira and Tavares, 1994).

In order to determine the development duration, emergence rate, longevity

and sex-ratio, the paper strips of the cold stored host eggs were introduced to the checked species (less than 24 hours old mated females) at rate of 5 eggs/female into corked vials (1.5 x 4 cm) placed at 26±1°C, 70±5% RH and 14: 10 L:D photoperiod (Parra and sales, 1994). Four replicates with two groups of 10 pairs each were used. Host eggs were changed every 24 hours for three days. The parasitized eggs were removed and recorded (as evidenced by black host eggs) then kept at the same conditions, as well as the average of embryos/egg was determined by dissecting the black parasitized host eggs (with the aid of dissecting stereomicroscope) counting the number of surviving immature stages. The development duration (egg to adult), the total adult emergence (emergence rate), sex ratio and longevity of males and females were also recorded. Sex-ratio was defined, based on the various between male and female antennae. The values presented are the average of four successive generations.

RESULTS AND DISCUSSION

Percentages of parasitism by different egg parasitoids on eggs of two factitious hosts under the offered number of host eggs

On *A.ipsilon*, the highest percentage of parasitism (91.56%) was recorded by exposing eggs to *T.minutum*. The same parasitoid gave also the highest percentage of parasitism on *P.operculella* eggs (87.31%). The local egg parasitoid, *T.evanescens* came the next as the percentages of parasitism on BCW and PTW (89.44 and 84.75%), respectively. While, the lowest percentage of parasitism (87.44 and 82.13%, respectively) occurred by using the third parasitoid, *T.pretiosum*, Table 1.

It could be also noticed from the same table that the percentages of parasitism were generally higher on *A.ipsilon* eggs (89.44, 91.56 and 87.44%) for *T.evanescens, T.minutum* and *T.pretiosum*, respectively, while, those recorded on the eggs of *P.operculella* were 84.75, 87.31 and 82.13%, respectively1.

Production of *Trichogramma* adults from eggs of the two hosts

As shown in Table 1, although *T.minutum* showed the highest parasitism on eggs of the two host species (i.e. BCW and PTW) , it produced the lowest number of adults from 100 eggs of the BCW (107.44 adults). This rate of adults production was found, statistically lower than that produced from 100 eggs of the same host by using the two remaining parasitoids, *T.evanescens* and *T.pretiosum* (157.06 and

148.31 adults, respectively). The differences in the average number of adults produced from 100 BCW eggs parasitized by *T.evanescens* or *T.pretiosum* were, statistically, insignificant. In case of parasitization on PTW eggs, the differences between adults reproductivity by the three egg parasitoids were insignificant, although the sequence of average productivity of adults were *T.evanescens* (90.19), *T.minutum* (88.56), and *T.pretiosum* (87.50 adults/100 eggs). However, the mean production of the emerged adults (from 100 eggs) for the three *Trichogramma* spp. were significantly higher when they were reared on BCW eggs compared with PTW eggs. This is due to the size of the host egg which affected the emergence rate and the size of the emerged wasps. This is in harmony with Bai *et al.* (1992) who reported that the size of *T.pretiosum* female depends on two factors; the size of the host eggs and the number of individuals that emerge from it. The results complied in Table 2 showed that BCW eggs were more favorable than PTW eggs for reproducing all the tested *Trichogramma* species. The number of embryos per 100 eggs was higher in BCW host eggs because of its bigger size where it averaged 171.25, 150 and 170 embryos, respectively compared with 108, 111.25 and 101.25 embryos in PTW eggs for *T.evanescens, T.minutum and T.pretiosum*, respectively. This is clear that the emergence rate is not related completely for the adaptation of the parasitoid to the factitious host eggs as mentioned by Parra and Sales (1994), but the size of the host eggs is considered one of the main factors in this respect.

Sex ratio

By using either for the three parasitoid species on *A.ipsilon* or *P.operculella*, the sex ratio was nearly 1:1, although higher numbers of females were slightly produced on the PTW eggs than BCW eggs, Table 1. This agrees with results obtained by Harwalkar *et al.* (1987) when they developed *T.brasiliensis* on PTW eggs. Games *et al.* (1994) mentioned that a high percentage of females were produced when *T.pretiosum* was reared on *Diatraea indigenella* eggs, about 2.3 females: 1 male. They added that this higher percentage of females may be due to the adaptation to the host eggs. However, this is in disagreement with Parra and Sales (1994) who related that sex ratio was affected in some *Trichogramma* spp. with the rearing temperature, where a higher number of males were observed at 32^{o}C.

Development duration and longevity

Life cycle duration was shorter on BCW eggs as it averaged 9.44, 8.22 and 9.31 days compared with 10.37, 9.09 and 10.12 days on PTW eggs for

T.evanescens, T.minutum and T.pretiosum, respectively, Table 2. These differences may be due to the adaptation and the size of the host eggs. Normally, the development period was negatively related to rearing temperature as noticed by Babi (1994) who mentioned that the shorter development time of some *Trichogramma* species was obtained at 30°C and the longer development time was at 20°C. BCW prolonged the female and male longevity periods, where they averaged 5.34 and 5.07 days for *T.evanescens*, 4.81 and 4.46 days for *T.minutum* and 6.32 and 6.15 days for *T.pretiosum* compared with (4.55 and 4.41), (4.27 and 4.31) and (4.76 and 4.62) days on PTW eggs for the same mentioned species of *Trichogramma*, respectively. In general, most of the *Trichogramma* female longevity differs according to the host availability. There was a negative correlation between longevity and fecundity, i.e. ovipositing females lived shorter. Manickavasagam *et al.* (1994) found that the longevity of *T.pretiosum* females decreased to 6.9 days when they were offered unlimited number of host eggs, compared with 9.1 days when no host eggs were available.

The present study showed that, although the experiments were conducted under less than ideal conditions because of the limited number of PTW host eggs that were available every day, there is no parasitism differences among the three *Trichogramma* species, the local species *T.evanescens* seems to be a promising biocontorl agent for both pests (BCW & PTW). The reasons of that are, its presence on natural hosts in Egypt and they can be trapped easily from the nature on eggs of lepidopterous pests. *T.evanescens* has been used in controlling rice and sugar-cane borer *Chilo agamemnon* Bles. in Egypt since 1987. A field survey and a potato store release studies would also be necessary in order to test the efficiency of using this egg parasitoid through the integrated pest management programs.

ACKNOWLEDGMENT

We wish to express our gratitude to professor N.Tompson, Department of Entomology, University of California, Riverside, USA, for his valuable contribution and suggestions which he gives concerning this manuscript and also for providing the US materials.

Table 1. Success of parasitization (parasitism %), emergence rate and sex ratio of three *Trichogramma* spp. reared on potato tuberworm (PTW) and black cutworm (BCW) eggs.

Trichogramma sp.	% of parasitism		Mean No. of adult parasites emerged from 100 eggs		Sex ratio			
	PTW	BCW	PTW	BCW	PTW		BCW	
					Male*	Female	Male	Female
T.evanescens	84.75	89.44	90.19	157.06a	1	1.05	1.08	1.00
T.minutum	87.31	91.56	88.56	107.44b	1	1.04	1.00	1.02
T.pretiosum	82.13	87.44	87.50	148.31a	1	1.05	1.02	1.00
F. 0.05	0.7179	1.5957	0.1219	26.9701**				
L.S.D.				13.4503				

Means in the same column followed by the same letter or without are not significantly different at 5% level according to F test.

Table 2. Development duration (egg to adult), embryos/100 eggs and longevity of three *Trichogramma* spp. reared on potato tuberworm (PTW) and black cutworm (BCW) eggs. (Range/mean (X-) ± standard deviation).

Parameters	Host	*T.evanescens*		*T.minutum*		*T.pretiosum*	
		Range	M($\bar{X}$)±S.D.	Range	M($\bar{X}$)±S.D.	Range	M($\bar{X}$)±S.D.
Mean no. of embryos/100 eggs	PTW	100-120	108±6.660	100-140	111.25±12.1660	100-110	101.25±3.328
	BCW	140-220	171.25±23.296	130-170	150.00±14.2310	150-190	170.00±13.3122
Development duration (days)	PTW	10.0-11.50	10.37±0.3453	9.0-9.5	9.09±0.1541	9.5-10.5	10.12±0.2764
	BCW	9.0-10.50	9.44±0.3856	8.0-8.5	8.22±0.1608	9.0-10.2	9.31±0.3752
Female longevity (days)	PTW	4.0-5.5	4.55±0.4647	3.5-5.0	4.27±0.4000	3.5-5.5	4.76±0.5174
	BCW	5.0-6.0	5.34±0.3258	4.0-5.5	4.81±0.3699	4.5-7.0	6.32±0.5642
Male longevity (days)	PTW	3.5-5.5	4.41±0.4965	3.5-5.0	4.31±0.5214	3.5-5.5	4.62±0.5956
	BCW	4.0-6.0	5.07±0.3575	4.0-5.5	4.46±0.3663	4.0-7.0	6.15±0.5121

REFERENCES

1 . Abbas, M.S.T., M.M. Embaby, A.R. Hamed and M.A. Ewaise. 1990. On utilization of *Trichogramma evanescens* West. to control the lesser sugar-cane borer *Chilo* agamemnon Bles. in sugar-cane fields in Egypt. 4-Release in 410 feddans. Egypt. J. Appl. Sci., 5 (1): 220-224.

2 . Abul-Nasr, S., H.S.M. Fahmy and Amal El-Sherif. 1971. Studies on the potato tuberworm *Phthorimaea operculella* (Zeller) (Lepidotera: Gelechiidae). Bull. Soc. ent. Egypt, 55: 185-192.

3 . Babi, A. 1994. Effect of temperature on strains of *Trichogramma cacoeciae* Marchal and *T.daumalae* Dugast & Veogele (Hym., Trichogrammatidae). "*Trichogramma* and other egg parasitoids". 4th International Symposium", Les Colloques de l'INRA, 73: 95-99.

4 . Bai, B., R.F. Luck, L. Forster, B.Stephens and J.A.M. Janssen. 1992. The effect of host size on quality attributes of the egg parasitoid, *Trichogramma pretiosum*, Entomol, exp. appl. 64: 37-48.

5 . Brower, J.H. 1984. *Trichogramma* : Potential new biological control method for stored-product Lepidoptera. Proceeding of the 3rd Int. Conf. Stored-Product Entomol. Kansas State Univ., Manhattan: 454-470.

6 . El-Heneidy, A.M., M.S.T. Abbas, M.M. Embaby and M.A. Ewaise. 1990. Utilization of *Trichogramma evanescens* West. to control the lesser sugar cane borer, *Chilo agamemnon* Bles. in sugar cane fields in Egypt. 5-An approach towards large scale release. "Trichogramma and Other Egg Parasitoids:. 34 th International Symposium", Les Colloques de l'INRA, 56: 187-189.

7. El-Shereif, A.R. 1966. Studies on the morphology and biology of potato tuberworm, *Phthorimaea operculella* (Zeller). M.Sc. Thesis, Fac. Agric., Cairo Univ., 147 pp.

8. Games, L.L.A., A.E. Diaz and L.A. Lastra. 1994. Selection of strains of *Trichogramma exiguum* for controlling sugarcane borers (*Diatraea* spp.) in the Cauca Valley, Colombia. "*Trichogramma* and Other Egg Parasitoids". 4th International Symposium", Les Colloques de l'INRA, 73: 75-78.

9. Harwalkar, M.R., H.D. Rananavare and G.W. Rahaikar. 1987. Development of *Trichogramma brasiliensis* (Hym. : Trichogrammatidaae) on eggs of radiation sterilized females of potato tuberworm, *Phthorimaea operculella* (Lep.: Gelechiidae). Entomophaga, 32 (2): 159-162.

10. Hassan, S.A. 1981. Mass production and utilization of *Trichogramma.* Four years of successful biological control of the European corn borer. Med. Fac. Landouww Rijksuniv, Gent., 46: 417-427.

11. Hendrix, H.W., D.F. Gunnaron and W.B Showers. 1991. Modification of a Meridic diet for rearing black cutworm (Lepidoptera: Noctuidae) larvae. J. Kansas Entomol. Soc., 64 (1): 45-50.

12. King, E.G. 1991. Introduction talk in "*Trichogramma* and Other Egg Paraitoids". 3rd International Symposium", Les Colloques de l'NRA, 56: 17-18.

13. Lutfallah, A.F. and W.H. Awadallah. 1984. Effect of cooling *Sesamia cretica* and *Ostrinia nubilalis* eggs for different periods on their viability. Agric. Res. Rev., 62 (1): 53-57.

14. Manickavasagam, S., P. Baskaran and B.Ramesh. 1994. Does the host availability regulates the fecundity and longevity of *Trichogramma*? *Trichogramma* and other Egg Parasitoids". 4th International Symposium", Les Colloques del'INRA, 73: 75-78.

15. Parra, J.R.P. and O.Jr. Sales. 1994. Biology of *Trichogramma galloi* Zucchi reared on natural and factitious hosts under different temperatures and relative humidities. "*Trichogramma* and Other Egg Parasitoids". 4th International Symposium", Les Colloques de l'INRA, 73: 95-99.

16. Pham, B.Q., V.S. Nguyen and T.D. Nguyen. 1994. Natural hosts of *Trichogramma* spp. and selection of factitious hosts for mass production. "*Trichogramma* and Other Egg Parasitoids". 4th International Symposium", Les Colloques del'INRA, 73: 165-167.

17. Prozell, S., G. Wiedenman and S.A. Hassan. 1994. The egg parasitoid *Trichogramma evanescens* (Hym.: Trichogrammatidae) as a potential biological control agent against the Indian meal moth *Plodia interpunctella* (Lep.: Pyralidae). "*Trichogramma* and Other Egg Parasitoids". 4th International Symposium:, Les Colloques de l'INRA, 73: 131-132.

18. Reese, J.C., L.M. English, T.R. Yonke and M.L. Fairchild. 1972. A method for rearing black cutworms. J. Econ. Entomol., 65: 1047-1050.

19. Satterthwait, A.F. 1933. Larval instars and feeding of the black cutworm *Agrotis ipsilon* (Rott.) J. Agric. Res., 46: 517-530.

20. Vieira, V. and J. Tavares. 1994. Rearing of *Trichogramma cordubensis* Vargas & Cabell (Hym.: Trichogrammatidae) on Mediterranean flour moth cold-stored eggs. "*Trichogramma* and Other Egg Parasitoids". 4th International Symposium", Les Colloques. de l'INRA, 73: 177-180.

تربية ثلاثة انواع من الترايكوجراما علي بيض فراشتي درنات البطاطس والدوده القارضة

عادل فوزي لطف الله ، رفعت حسني جندي ميخائيل

معهد بحوث وقاية النباتات – مركز البحوث الزراعية، الدقي – الجيزه – القاهرة.

في هذه الدراسة تم اختبار ثلاثة انواع من طفيل الترايكوجراما *Trichogramma pretiosum, Tri-chogramma evanescens, Trichogramma minutum* للوقوف علي امكانية تربيتهم علي بيض حشرتين من الحشرات الهامة في مصر (الدوده القارضه وفراشة درنات البطاطس) كخطوه اولي لمعرفة امكانية استخدامها في برامج المكافحة المتكامله.

وقد تم التقيم من خلال القياسات الاتيه:

نسبة التطفيل ٪ ، نسبه خروج الحشرات الكامله، فترة تطور الاعمار اليرقيه، طول فترة حياة الحشره الكاملة، النسبة الجنسية وعدد افراد الطفيل داخل كل بيضه.

وقد اظهرت نتائج هذه الدراسة الاولية ان طفيل *T.evanesces* يمكن استعماله كاحد عوامل المكافحة الحيوية ضمن برامج المكافحة المتكاملة للحشرتين.