INTERNATIONAL JOURNAL OF SCIENCE AND NATURE
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PARASITIZATION CAPACITY OF *TRICHOGRAMMA CHILONIS* ISHII (HYMENOPTERA: TRICHOGRAMMATIDAC) ON THE EGGS OF *HELICOVERPA ARMIGERA* (LEPIDOPTERA: NOCTUIDAE) UNDER LABORATORY CONDITIONS

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ABSTRACT
The pod borer, *Helicoverpa armigera* is considered to be the most important pest of several crops such as cotton, tomato, tobacco, chick pea, pigeon pea etc. *Trichogramma chilonis*, the tiny wasp, which are the major parasitoids of lepidopteran eggs are used to control plant pests and are used widely in augmentative biological control. In the present laboratory study, infestation capacity of the parasitoid on the eggs of *H. armigera* was undertaken at Mysore, India. Also, the hatchability rate, developmental period and longevity of the biocontrol agent were studied. The results revealed that the *T. chilonis* exhibited 58.54% parasitization and 93% hatchability on the pod borer. It took an average of 8.28 days to develop under laboratory conditions and lived for 6.7 days. These findings will be helpful in employing *T. chilonis* in the control of *H. armigera* on the agricultural crops in the field.

KEYWORD: Biological control, Pest control, Parasitization rate, Emergence rate.

INTRODUCTION

Trichogramma species are the most studied group world wide of egg parasitoids for biological control due to their efficiency and easy maintenance under laboratory conditions (Parra and Zucchi, 1997). As this parasitoid attacks the egg stage of the pest, the damage done by the larvae of the pests is avoided. These natural enemies are employed in more than 30 countries in biological control programs against insect pests (Wajnberg and Hassan, 1994). Thus, knowing biological characteristics such as parasitization rate and longevity is very important in achieving success in biological control programs (Oliveira *et al*., 2003). Successful parasitism by these parasitoids is preceded by several phases of probing that takes the females into the close vicinity of their potential host (Gingras *et al*., 2002; Grieshop *et al*., 2007). Light, temperature and humidity play vital role in the length of the development cycle, parasitization rate, longevity, and sex ratio of an egg. The success of such biological control depends on the efficiency of the parasitoid in controlling the targeted pest, which is determined by the interaction of the parasitoid with the specific target host (Broucheir and smith, 1996). *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) has been known by different names such as cut worm, fruit borer, leaf feeder, gram pod borer, shoot borer and bollworm. It is a widely distributed polyphagous pest causing year round damage. It attacks a variety of agricultural crops such as cotton, tomato, tobacco, sunflower, legumes etc., and is a major pest in India as well especially in the larval stage. The key pest status of *H. armigera* is due to several factors including its migratory activity, high fecundity, facultative diapauses and polyphagy (Fitt, 1989). In India, more than 180 plant species from 45 families have been reported as hosts of the pest (Majunath *et al*., 1989). These pests are generally controlled by insecticides that can cause negative impacts, such as pest resistance and environmental imbalance (Soares *et al*., 2009; Barrera *et al*., 2011; Gassmann *et al*., 2009; Daane and Johnson, 2010). In addition, insecticides are harmful to human health and have multiple potential side effects on beneficial arthropods (Desneux *et al*., 2007; Hong *et al.*, 2009; Vianna *et al.*, 2009 and Saber, 2011). Thus the researchers now focus on the alternative method such as biological control under the integrated pest management (IPM) program (Bueno *et al*., 2010; Shanower *et al*., 1997). So, biological control is a key component of IPM programs as an alternative to pesticides, but knowledge on interaction between natural enemies, hosts and abiotic factors is required to select biocontrol agents optimally (Pratissoli *et al*., 2005, 2007; Desneux *et al*., 2010; Ragsdale *et al*., 2011). One such biocontrol agent is *Trichogramma* which has short generation time and can be easily multiplied with highly efficient and cheaper methodologies has been experimented for the present study in the Vector Biology Research Laboratory, Department of Studies in Zoology, University of Mysore, Mysore.

MATERIALS & METHODS

Trichogramma chilonis colony

T. chilonis strain was procured from National Bureau of Agriculturally Important Insects (NBAII), Bangalore and the successive generations were maintained in the Vector Biology Research Laboratory, University of Mysore, Mysore using the eggs of *Corcyra cephalonica* (Lepidoptera : Pyralidae) which is also being maintained

as the laboratory host following the method of Singh *et al*. (1994).

***Helicoverpa armigera* colony**

The pupae of *H. armigera* were obtained from NBAII, Bangalore and the colony was maintained in the Vector Biology Research Laboratory, of the department. The male and female pupae were placed in the plastic containers with inner walls covered by a sheet of paper. The emerged adults were provided with 50% honey solution. The eggs laid on the paper were collected for conducting the experiments and also to maintain the colony. The larvae were reared on an artificial diet following the method of Ballal *et al*. (1998) under the laboratory conditions (25±2°C temperature 70±10% Relative Humidity, 12:12 L: D photoperiod). The parasitization capacity of *T. chilonis* was analyzed on the freshly laid eggs of *H. armigera.* Around 60-80 eggs were glued to the card and inserted in to a glass vial (5x2cm), where the male and female adult parasitoids were allowed to mate earlier. The adults were fed with 50% honey solution. After four days, the egg cards were taken out form the vial and observed for parasitization. Those eggs turned into black color were considered as parasitized eggs.

The percent parasitization was calculated using the formula:

$$\% \text{ Parasitization} = \frac{\text{No. of eggs parasitized}}{\text{Total No. of Eggs}} \text{X } 100$$

In order to study the emergence of *T. chilonis* adults from the parasitized eggs, the eggs were placed individually into separate vials and observed for the emergence. The adults were supplied with 50% honey solution as a food source. The longevity of the emerged adults was also observed. The emergence rate was expressed in percentage and it was calculated using the formula:

$$\% \text{ Emergence} = \frac{\text{No. of } Trichogramma \text{ emerged}}{\text{No. of Parasitized eggs}} \text{X } 100$$

The developmental period of the *Trichogramma* adult was observed by noting the time taken to develop from the egg stage to the adult. Ten replicates were used for each experiment and the experiment was repeated for seven times. The data obtained were subjected to one sample T-test by using SPSS software version 20.

RESULTS & DISCUSSION

Table 1 reveals the results of the present investigation with *T. chilonis* showing 58.54 ± 11.8% of parasitization capacity on *Helicoverpa armigera.* The eggs hatched were found to be 93 ± 1.6% and the developmental period taken by the *Trichogramma* to emerge out as an adult was observed to be 8.28 ± 0.28 days. The longevity of the adults emerged was found to be 6.7 ± 1.64 days. The t-value obtained are shown in the table 1 and the values obtained are significant at the level of 0.05 ($p<0.05$). Earlier studies made by Ballal and Singh (2003) revealed that *T. chilonis* could parasitize 66.7% *Helicoverpa armigera* eggs. Romeis *et al*. (1999) have reported that 65% of *H. armigera* eggs were parasitized by *T. chilonis* at room temperature. Our results at Mysore are nearer to the results obtained by these researchers. But, in contrast to our results, the studies done by Aganon and Adhikari (2000) have shown that, it could parasitize up to 81.48% of *H. armigera* eggs at Philippines. Similarly, Harrison *et al*. (1985); Nadeem and Hamed (2008), too have reported the parasitization rate up to 90.6% and the percentage of emergence as 94.4% at 25°C.

TABLE 1: The biological parameters of *T. chilonis* parasitized on *H. armigera* eggs under laboratory conditions.

	Mean Values	Standard Deviation	Standard Error	t- Value	p value *
Parasitization rate (%)	58.54	31.2	11.80	4.95	0.003
Hatchability rate (%)	93	4.4	1.6	55.48	0.001
Development Period (days)	8.28	0.75	0.28	29	0.001
Longevity (days)	6.7	4.35	1.64	4.07	0.007

* p value is significant based on the non overlapping of 95% fiducial limits ($p<0.05$)

The percentage emergence rate correlates with our results. The difference in the result at different places may be due to strain variations. The longevity of *T. chilonis* emerged from the parasitized *H. armigera* eggs was found to be nearly seven days which is contradictory to the results of Nadeem amd Hamed (2008) where the adults survived only upto 3-4 days. Many reports indicate that not only the type of host eggs, but also the factors such as intra and inter specific interactions with biotic components, climatic conditions etc interfere in the performance of the parasitoids. In this regard, temperature is one of the most important environmental factors influencing physiology and behaviour of insects including the parasitoids (Reznik and Vaghina, 2006; Reznik *et al*., 2009; Moezipour *et al*., 2008; Ratte, 1985). An efficient biological control program with *Trichogramma* needs selection of strains with high efficiency against a target pest in a given set of environmental conditions (Hassan, 1994). Pak and Lenterene (1988) have reported that the *Trichogramma* strains performed well in laboratory also have the ability to adopt in field conditions.

CONCLUSION

From the present study, it is evident that parasitization efficiency and rate of development of *T. chilonis* may be variable at different places. Inspite of such differences, it remains as a potent biological control agent for the control of gram pod borer, *Helicoverpa armigera*. The laboratory studies can serve as baseline information prior to the field application at Mysore. Further studies in a widescale are needed to determine the efficiency of *Trichogramma* on field trials.

ACKNOWLEDGEMENTS
The authors are thankful to NBAII, Bangalore for the supply of cultures and to The Chairman, Department of Studies in Zoology, University of Mysore, Mysore for the facilities provided.

REFERENCES

Aganon, T. M. and Adhikari, D. R. (2000) Utilization of *Trichogramma* parasitoid as biological control agent against sunflower headworm *H. armigera* Hubner. J. KMITL Sci & Tech. 4(1).

Ballal, C. R., Singh, S. P., Joshi, S. and Rao, N. S. (1998) Multicellular tray for rearing the larvae of *Helicoverpa armigera* Hubner Lepidoptera: Noctuidae. Entomon. 234, 307-312.

Ballal, C. R. and Singh, S. P. (2003). The effectiveness of *Trichogramma pretiosum* and *Trichogramma brasiliense* (Hymenoptera: Trichogrammatidae) as parasitoids of *Helicoverpa armigera* (Lepidoptera: Noctuidae) on Sunflower (*Helianthus annus*) and Redgram (*Cajanus cajan*). Bio. Sci. Tech. 13, 231-240.

Barrera, G., Simon, O., Villamizar, L., Williams, T. and Caballero, P. (2011) *Spodoptera frugiperda* multiple nucleopolyhedrovirus as a potential biological insecticide: genetic and phenotypic comparison of field isolates from Colombia. Biol Control. 58, 113-120.

Bourchier, R. S. and Smith, S. M. (1996) Influence of environmental conditions and parasitoid quality on field performance of *Trichogramma minutum*. *Entomol.* Exp. Appl. 80, 461-468.

Bueno, R. C. O. F., Bueno, A. F., Parra, J. R. P., Viera, S. S. and Oliveira, L. J. (2010). Biological characteristics and parasitism capacity of *Trichogramma pretiosum* Riley (Hymenoptera: Trichogrammatidae) on eggs *Spodoptera frugiperda* J. E. Smith (Lepidoptera: Noctuidae). 54(2), 322-327.

Daane, K. M. and Johnson, M. W. (2010). Olive fruit fly: managing an ancient pest in modern times. Annu. Rev. Entomol. 55, 151–169.

Desneux, N., Decourtye, A. and Delpuech, J. M. (2007) The sublethal effects of pesticides on beneficial arthropods. Annu. Rev. Entomol. 52, 81–106.

Desneux, N., Wajnberg, E., Wyckhuys, K. A. G., Burgio, G., Arpaia, S., Narva´ez-Vasquez, C. A., Gonza´lez-Cabrera, J., Catala´n Ruescas, D., Tabone, E., Frandon, J., Pizzol, J., Poncet, C., Cabello, T. and Urbaneja, A. (2010) Biological invasion of European tomato crops by *Tuta absoluta*: Ecology, history of invasion and prospects for biological control. J. Pest. Sci. 83,197–215

Fitt, G.P. (1989) The ecology of Heliothis in relation to agro ecosystems. Annu. Rev. Entomol. 7, 685- 688.

Gassmann, A. J., Carriere, Y. and Tabashnik, B. E. (2009) Fitness costs of insect resistance to *Bacillus thuringiensis*. Annu. Rev. Entomol. 54,147–163.

Gingras, D., Dutilleul, P. and Boivin, G. (2002) Modeling the impact of plant structure on host-finding behaviour of parasitoids. Oecologia. 130, 396–402.

Grieshop, M. J., Flinn, P. W., Nechols, J. R. and Schöller, M. (2007) Host-foraging success of three species of *Trichogramma* in a simulated retail environment. Econ. Entomol.100, 591–598

Harrison, W. W., King, E. G. and Ouzts, J. D. (1985) Development of *Trichogramma exiguum* and *T. pretiosum* at five temperature regimes. Environ. Entomol. 14, 118–121.

Hassan, S. A. (1994) Strategies to select *Trichogramma* species for use in biological control, pp. 55-71. *In* E. Wajnberg and S. A. Hassan (eds.), Biological control with egg parasitoids.CABInternational, Willingford, Oxon, United Kingdom.

Hong, S. Y., Jeong, D., Gil, H.W., Yang, J. O. and Lee, E. Y. (2009) The estimation of pesticide exposure in depression scores: in case of Lorean orchard farmers. J. Pest. Sci. 82, 261-265.

Manjunath, T. M., Bhatnagar, V. S., Pawar, C. S. and Sithanantham, S. (1989) Economic importance of *Heliothis* spp. in India and an assessment of their natural enemies and host plants. In: E. G. King & R. D. Jackson (eds), Proceedings of the Workshop on Biological Control of *Heliothis*: Increasing the Effectiveness of Natural Enemies, 11–15 November 1985, New Delhi. Far Eastern Regional Research Office, United States Department of Agriculture, New Delhi. 197–228.

Moezipour, M., Kafil, M. and Allahyari, H. (2008) Functional response of *Trichogramma brassicae* at different temperatures and relative humidities. Bull. Insect. 61(2), 245-250.

Nadeem, S. and Hamed, M. (2008) Comparitive development and parasitization of *Trichogramma chilonis* Ishii and *Trichogrammatoidea bactrae* Nagaraja under different temperature conditions. Pak. J. Zool. 40(6), 431-434.

Oliveira, H.N., Zanuncio, J. C., Pratissoli, D. and Picando, M. C. (2003) "Biological characteristics of *Trichogramma maxacalii* (Hym.: Trichogrammatidae) on eggs of *Anagasta kuehniella* (Lep.: Pyralidae)". Braz. J. Biol. 63(4), 647-653.

Pak, G. A. and Van Lenteren, J. C. (1988) Criteria and methods for the pre-release evaluation of different *Trichogramma* spp. strains, in: *Trichogramma* and other egg parasites, 2nd International Symposium on *Trichogramma*, Guangzhou, PR China, No. 43

(VOEGELE, J., WAAGE, J. & van LENTEREN, J.C., Eds.). Les Coloques de l' INRA, Paris. 433- 442.

Parra, J. R. P. and Zucchi, R. A. (1997). *Trichogramma e o controle biológico aplicado*. FEALQ, Piracicaba. 324.

Pratissoli, D., Zanuncio, J. C., Vianna, U. R., Andrade, J. S., Pinon, T. B. M. and Andrade, G. S. (2005). Thermal requirements of *Trichogramma pretiosum* and *Trichogramma acacioi*(Hym: Trichogrammatidae), parasitoids of the avocado defoliator *Nipteria panacea* (Lep: Geometridae), in eggs of two alternative hosts. Braz. Arch. Biol. Technol. 48 (4), 523-529.

Pratissoli, D., Polanczyk, R. A., Andrade, G. S., Holtz, A. M., Silva, A. F. and Pastori, P. L. (2007). Tabela de vida de fertilidade de cinco linhagens de Trichogramma pretiosum Riley (Hym.: Trichogrammatidae) criadas em ovos de Tuta absoluta (Merick) (Lep.: Gelechiidae), sob temperaturas constantes e alternadas. Cienc Rural. 37, 618–622

Ragsdale, D. W., Landis, D. A., Brodeur, J., Heimpel, G. E. and Desneux, N. (2011). Ecology and management of the soybean aphid in North America. Annu. Rev. Entomol. 56, 375–399

Ratte, H. T. (1985). Temperature and insect development. In: Hoffmann KH (ed) Environmental physiology and biochemistry of insects. Springer. 33–66

Reznik, S. Y. and Vaghina, N. P. (2006). Temperature effects on induction of parasitization by females of Trichogramma principium (Hymenoptera: Trichogrammatidae). Ent. Rev. 86(2), 261-265.

Reznik, S. Y., Voinovich, N. D. and Vaghina, N. P. (2009). Effect of temperature on the reproduction and development of *Trichogramma buesi* (Hymenoptera: Trichogrammatidae). Eur. J. Entomol. 106, 535–544.

Romeis, J., Shanower, T. G. and Peter, A. J. (1999). Trichomes on pigeonpea (*Cajanus cajan* (L.) Millsp. and two wild *Cajanus* spp. Crop Sci. 39, 564–569.

Saber, M. (2011). Acute and population level toxicity of imidacloprid and fenpyroximate on an important egg parasitoid, Trichogramma cacoeciae (Hymenoptera: Trichogrammatidae). Ecotoxicol. 20(6), 1476-1484.

Shanower, T. G., Kelley, T.G. and Cowgill, S. E. (1997). Development of effective and environmentally sound strategies to control *Helicoverpa armigera* in Pigeon pea and Chickpea production systems. In: R.K.Saini (ed), *Trop. Entomol.* 255-276.

Singh, S. P., Jalali, S. K., Bhumannavar, B. S., Bakthavatsalam, N. and Pushpalatha, N. A. (1994). Production and use of Trichogrammatid egg parasitoids. Technical Bulletin No. 11, Project Directorate of Biological Control, Bangalore, 16.

Soares, M. A., Zanuncio, T. V., Zanuncio, J. C., Mielke, O. H. H. and Serrão, J. E. (2009). *Euselasia mys lara* (Stichel, 1919) (Lepidoptera: Riodinidae) a potential pest on *Eucalyptus* in Brazil. J. Res. Lepid. 41, 76-83.

Vianna, U. R., Pratissoli, D., Zanuncio, J. C., Lima, E. R., Brunner, J., Pereira, F. F. and Serrao, J. E. (2009). Insecticide toxicity to *Trichogramma pretiosum* (Hymenoptera: Trichogrammatidae) females and effect on descendant generation. Ecotoxicol. 18, 180–186

Wajnberg, E. and Hassan, S.A. (1994). Biological control with egg parasitoids. *CAB Intl.* Oxon, UK. 286.