http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 5(5): 563-565, 2002

Comparative Study Between *Trichogramma evanescens* Westwood and *Trichogrammatoidea bacterae* Nagaraja as Biological Control Agents Against Two Irradiated and Non-irradiated Stored Product Pests

Mona B.R. El-Mandarawy and [1]Salwa A. Rizk
Plant Protection Research Institute, A.R.C., Dokki, Giza, Egypt
[1]National Research Center for Radiation Research and Technology, Atomic Energy Authority, Egypt

Abstract: Studies on the effect of substerilizing doses of gamma radiation on the stored product insects *Callosobruchus maculatus* (Fabricius) and *Corcyra cephalonica* (Stainton) eggs before parasitization by *Trichogramma evanescens* Westwood and *Trichogrammatoidea bacterae* Nagaraja were carried out. *C. maculatus* and *C. cephalonica* eggs were exposed to the respect calculated LD_{25} level 92.48 Gray and 1.39 Gray as substerilizing doses. The percent of parasitization and fecundity differed significantly between the two parasitoid species and the two hosts. They were higher in *T. evanescens* than in *T. bacterae*. However, the percent of parasitization and fecundity were insignificantly differed between the irradiated host eggs as compared to the non-irradiated ones. Highest emergence rate was recorded from irradiated and non-irradiated *C. cephalonica* eggs that parasitized with *T. evanescens*. Radiation had no effect on the developmental period (days) and adult longevity of the two parasitoids reared from the two hosts.

Key words: *Trichogramma evanescens*, *Trichogrammatoidea bacterae*, *Callosobruchus maculatus*, *Corcyra cephalonica*, Irradiation.

Introduction

Stored product insects usually damage grains by developing inside kernels and feed on the inner endosperm causing serious economic damage in the stored leguminous seeds. In order to avoid the chemical problem in controlling the grain pests, the use of gamma radiation as safe control measures has been suggested. Irradiation of insects has many advantages that concluded in no residues, uniform penetration into grains and no development of resistance. Also, exposing the insects to low doses can be more affective (Cornwell and Bull, 1960; Hussain and Imura, 1989).

Trichogramma spp. are absolutely the most commonly used egg-parasitoids for insect pests control in many parts of the world (Abdel-Hafez and Nada, 2000). Recently the tiny parasitoid wasps, *Trichogramma* spp. was used in stores; and repeated their releases in certain intervals in order to ensure a long-term effect. Many investigators studied *Trichogramma spp.* as a biological control agent against the stored product insects for example Navarajan Paul *et al.*, 1975; Van Huis and De Roy 1998).

All the biological characters (life-cycle, production of eggs, percent of successful emergence, percent of mortality inside the host eggs, etc.) of *Trichogramma* spp. vary by rearing on different host species. Research with different species of *Trichogramma* has shown that the size and species of the host egg in which the parasitoid develops may alter its efficiency (Navarajan Paul *et al.*, 1975; Kazmer and Luck, 1991).

Callosobruchus maculatus (Fabricius) (Coleoptera: Bruchidae) is one of the most damaging pest of stored legume seeds especially cowpea, *Vigna unguiculata* (Decella, 1981; Jackai & Daoust, 1986). Also, *Corcyra cephalonica* (Stainton) (Lepidoptera: Pyralidae) is the major pest of stored grains of pearl millet, *Pennisetum glaucum* and sorghum (Locatelli and Limonta, 1998). So, this study aims to compare between *T. evanescens* and *T. bacterae* against the irradiated and non-irradiated *C. maculatus and C. cephalonica* eggs.

Materials and Methods

Rearing technique

Hosts species: The stored legume seeds *Callosobruchus maculatus* (Fabricius) (Coleoptera: Bruchidae) was reared (in laboratory conditions of 28 ± 1°C and 60 ± 10%R.H.) in glass jars (capacity = 1 Kg) on cowpea seeds, *Vigna unguiculata*. The adults permitted to oviposit on this culture throughout their life span (Strong *et al.*, 1968). The rice bran moth *Corcyra cephalonica* (Stainton) (Lepidoptera: Pyralidae) was reared in the jars containing rice bran as food until pupation. The nutrition source were sterilized at 60°C, scattered in a fine layer on trays and then kept until used.

Parasitoid species: The egg parasitoid, *Trichogramma evanescens* Westwood and *Trichogrammatoidea bacterae* Nagaraja were reared in glass cylinders (25 cm long and 10 cm diameter) under controlled laboratory conditions (28 ± 1°C and 60 ± 10%R.H.). In order to obtain adults of *Trichogramma* at uniform age for the experiments, stripes from the Angoumois grain moth, *Sitotroga cerealella* (Olivier) eggs were exposed to *Trichogramma* rearing and were taken 24 hours later. Parasitized eggs were kept in separate containers, under the same laboratory conditions, for parasitoid development. Days before emergence black eggs containing pupae of the parasitoid were taken for the experiment.

Tests

Irradiation technique: Gamma cell irradiation unit 220 located at "The National Center for Radiation Research and Technology (NCRRT), Atomic Energy Authority, Nasr city Cairo, Egypt" was the irradiation source used in the present study with a dose rate of 2.6 Rad/sec.

Host treatments: *C. maculatus* (sample of cowpea seeds containing eggs) and *C. cephalonica* eggs < 24 hr. old were collected and exposed to gamma radiation. Three replicates of 100 eggs were irradiated using doses of 1, 3, 5 and 7 Gray for *C. maculatus*, but in case of *C. cephalonica* were exposed to 10, 30, 60, 90 and 120 Gray. Samples of non-irradiated eggs were used as control. Each replicate of eggs was kept individually in glass tubes until hatch. As mortality percentages (unhatched eggs) in the control ranged from 5-20%, obtained data were corrected according to Abbott's formula (1925). The LD_{50} values and LD_{25} values were determined using the statistical method of Finney (1952).

Parasitoid test: A sheet of eggs (< 24 hours old) from each of *C. cephalonica* eggs (about 100 irradiated or non-irradiated eggs/sheet) or seeds of cowpea containing about 100 of *C. maculatus* eggs were offered daily to ten of the mated female parasitoids in glass vials (10.5 x 4.0cm) until the parasitoid death. *C. maculatus* and *C. cephalonica* irradiated eggs were exposed to gamma radiation at LD_{25} level (the sublethal dose). Droplets of honey were added directly to the wall of the vial as food for the adult parasitoids. The percent fecundity of the parasitoid, during

its life, was measured by the number of beetle eggs that turned black or brown due to parasitism per female. Percent mortality among the immature stages of parasitoids was calculated from the number of emerged adults from the coloured eggs. Developmental time of *Trichogramma* spp. was measured by counting the number of parasitoids emerged twice daily. Also, the rate of adult emergence was estimated. Data were statistically analyzed by T-test.

Results and Discussion

On *C. maculatus* and *C. cephalonica* eggs irradiated with different gamma radiation doses: The corrected mortality percentages after 24 hours (at which LD_{50} were estimated) for the irradiated *C. maculatus* eggs ranged between 27.3-83.06% at doses of 1-7 Gray, respectively. These percentages in case of *C. cephalonica* eggs were ranged between 19.42-97.33% at doses of 10-90 Gray, respectively. However, the LD_{50} value was 1.88 Gray for *C. maculatus* eggs, while this value in case of *C. cephalonica* eggs was 23.96 Gray, (Table 1). The calculated LD_{25} level of *C. maculatus* and *C. cephalonica* eggs were 1.33 Gray and 13.90 Gray, respectively.

Walder and Wiendl (1973) reported that 10Krad from a radioactive ^{60}Co source was sufficient to prevent egg hatchability of *C. maculatus*. Also, on the same pest Abbassy (1997) stated that irradiation of 3-day-old eggs with 5, 10, 15 and 20Gray led to highly reduction in hatchability. Hassaballa *et al.* (1985) showed that eggs of *C. cephalonica* exposed to gamma radiation at an early stage of embryonic development were considerably more susceptible to radiation, where the percent hatching decreased from 90.3% in the non-irradiated one day old eggs to 7.3% in those irradiated at 8 Krad. Shenishen and El-Zanaty (1987) who decided that eggs of *Sitotroga cerealella* had been treated with various doses of radiation (50-250 Gr.) hatched in 0-21.8% (where the mortality increased with increasing dose) as compared with 94.1-95.7% of untreated eggs.

The comparison between the percent of parasitization, mortality of immature parasitoids and emergence rate of *T. evanescens* & *T. bacterae* reared from non-irradiated and irradiated *C. maculatus* & *C. cephalonica* eggs: As indicated in Table 2 the percent of parasitization by *T. evanescens* & *T. bacterae* were 52.00 and 49.50& 47.20 and 44.30% for the non-irradiated and the irradiated *C. maculatus*, respectively. While in the case of the non-irradiated and the irradiated *C. cephalonica*, the respect parasitization percent were 92.00 and 90.40 & 82.30 and 79.80% for the two *Trichogramma* spp.. The comparisons between the mortality percent of the immature parasitoids (*T. evanescens* & *T. bacterae*) were 14.02 and 15.55 & 21.02 and 23.51% for non-irradiated and irradiated *C. maculatus* eggs, respectively. Also, these values were 3.04 and 4.43 & 15.76 and 18.02% for non-irradiated and irradiated *C. cephalonica* eggs, respectively. Data showed more emergencies of *T. evanescens* than *T. bacterae* from the non-irradiated & irradiated *C. maculatus* eggs (85.60 & 84.45 and 78.98 & 76.49%, respectively). While the percent of emergencies were 96.96 & 95.57 and 84.84 & 82.10% for the non-irradiated & irradiated *C. cephalonica* eggs, respectively.

Table 1: The effect of gamma radiation against *C. maculatus* and *C. cephalonica* eggs

C. cephalonica		*C. maculatus*	
Doses (Gray)	% Mortality	Doses (Gray)	% Mortality
0.00	0.00	0.00	0.00
10	19.42	1	27.30
30	47.28	3	60.82
60	85.08	5	74.50
90	97.33	7	83.06
LD_{50}	23.96	LD_{50}	1.88
Slope	2.83	Slope	1.72

The comparison between fecundity, the developmental period and the adult longevity of *T. evanescens* & *T. bacterae* reared from the non-irradiated and irradiated egg hosts: Table 3 shows that the fecundity of *T. evanescens* was decreased from 26.00 or 46.00 in the non-irradiated *C. maculatus* and *C. cephalonica* eggs to 24.75 or 45.20 individuals/female for the irradiated egg hosts, respectively. Where *T. bacterae* fecundity was 23.60 & 22.15 and 41.15 & 39.90 individuals/female for non-irradiated & the irradiated *C. maculatus* and *C. cephalonica*, respectively. The adult longevity of the *T. evanescens* and *T. bacterae* reared from the non-irradiated & irradiated *C. maculatus* eggs (1.8 and 1.8 & 1.5 and 1.4 days, respectively) was less than those reared in *C. cephalonica* eggs (6.2 and 5.8 & 6.2 and 6.2 days, respectively). *T. evanescens* and *T. bacterae* life spans (developmental time of parasitoid) spent less time in the non-irradiated *C. maculatus* & *C. cephalonica* eggs (13.1 & 8.2 and 13.3 & 8.4 days, respectively) than the irradiated egg of hosts (13.4 & 8.3 and 13.6 & 8.6 days,

Table 2: The percent of parasitization, mortality of immature stages and emergence of parasitoids *T. evanescens* & *T. bacterae* reared from non-irradiated and irradiated *C. maculatus* & *C. cephalonica* eggs.

Hosts	% parasitization	% mortality of immature parasitoids	% emergence
T. evanescens			
Non-irradiated *C. maculatus*	52.00± 2.54	14.02± 1.73	85.60± 1.46
C. cephalonica	92.00± 1.89	3.04± 0.98	96.96± 0.98
Irradiated *C. maculatus*	49.50± 2.92	15.55± 1.21	84.45± 1.21
C. cephalonica	90.40± 1.58	4.43± 1.98	95.57± 1.98
T. bacterae			
Non-irradiated *C. maculatus*	47.20± 3.97	21.02± 4.14	78.98± 4.14
C. cephalonica	82.30± 2.00	15.76± 3.09	84.84± 3.07
Irradiated *C. maculatus*	44.30± 1.95	23.51± 2.59	76.49± 2.59
C. cephalonica	79.80± 3.46	18.02± 2.75	82.10± 2.77

Table 3: Fecundity, adult longevity and the life span of the parasitoids *T. evanescens* and *T. bacterae* reared from non-irradiated and irradiated hosts.

Hosts	*T. evanescens*			*T. bacterae*		
	Fecundity /female	Longevity (days)	Developmental period (days)	Fecundity /female	Longevity (days)	Developmental period (days)
Non-irradiated						
C. maculatus	26.00± 1.27	1.8± 0.63	13.1± 0.32	23.6± 1.98	1.8± 0.43	13.3± 1.06
C. cephalonica	46.00± 0.94	6.2± 0.79	8.2± 0.63	41.15± 1.00	5.8± 0.42	8.4± 0.70
Irradiated						
C. maculatus	24.75± 1.46	1.5± 0.53	13.4± 0.52	22.15± 0.97	1.4± 0.52	13.6± 0.84
C. cephalonica	45.20± 0.79	6.2± 1.49	8.3± 1.49	39.90± 1.73	6.2± 1.14	8.6± 0.52

respectively). From the obtained results we conclude that the percent of parasitization, fecundity and the percent mortality of immature stages of parasitoids differed significantly between the two tested parasitoids and between the two hosts. However, these parameters differed insignificantly between irradiated host eggs and the non-irradiated ones. They were higher in *T. evanescens* than in *T. bacterae*. The emergence rate significantly differed in between the two parasitoids and between the two hosts. The highest percentages were recorded from non-irradiated and irradiated *C. cephalonica* eggs that parasitized with *T. evanescens*. Radiation had no effect on the developmental time (days) and adult longevity of each of the two parasitoids reared from *C. cephalonica* or *C. maculatus*.

Our data are in agreement with Farghaly *et al.* (1980) and Shalaby *et al.* (1999) who mentioned that *T. evanescens* female was significantly higher than that of *T. bacterae* which reared from *C. cephalonica* and other different hosts. Bourarach and Hawlitzky (1989) noticed that females of *T. evanescens* laid more eggs than those of *T. lutea* and the mean numbers of parasitoid adults that emerged from eggs of *Helicoverpa armigera* were similar for the two parasitoid species. Shenishen and El-Zanaty (1987) who found that the treated *Sitotroga cerealella* eggs with radiation slightly reduced the likelihood of the eggs being parasitized, but had no effect on the embryonic mortality and longevity of the parasitoid. Therefore, irradiation is suggested as a method of preserving host eggs to allow parasitoid mass production in laboratory. Cheng *et al.* (1999) decided that irradiation of the host eggs *Ostrinia furnacalis* did not significantly influence parasitism, the emergence rate or the number of offspring per female of each of the two parasitoids *T. ostriniae* and *T. chilonis*.

References

Abbassy, S.A., 1997. Biochemical composition of dimorphic adults of the southern cowpea weevil *Callosobruchus maculatus* F. with reference to its control. Ph.D. Thesis, Fac. Sci., Ai. Shams Univ.

Abbott, W.S., 1925. A method of computing the effectiveness of an insecticide. J. Econ. Entomol., 18: 265-267.

Abdel-Hafez, A. and M.A. Nada, 2000. Augmentation of *Trichogrammatoidea bacterae* Nagaraja in the IPM programme for the control of pink bollworm *Pectinophora gossypiella* (Saund,) in Egypt. Cotton Insect Beltwide Cotton Conferences-Resesrch and Conferences, Jan. 2000. 1009-1014.

Bourarach, K. and N. Hawlitzky, 1989. Etude comparative des potentialities biologiques de deux Trichogrammes: *Trichogramma evanescens* et *Trichogrammatoidea lutea* (Hym.: Trichogrammatidae). Entomophaga, 34: 95104.

Cheng, W.Y., S.M. Chen and Z.T. Wang, 1999. Parasitism of *Trichogramma ostrinae* on different host eggs. Report of the Taiwan Sugar Research Institute, 166: 19-34.

Cornwell, P.P. and J.O. Bull, 1960. Insect control by gamma radiation. An appraisal of potentialities and problems involved. J. Sci. Food and Agric., 11: 757-768.

Decella, J., 1981. Bruchidae related to grain legumes in the Afro-Tropical area. Series Entomologica, 19: 193-198.

Farghaly, H.T., Z.A. Ragab and M.F.S. Tawfik, 1980. Effects of different hosts on some biological criteria of *Trichogramma evanescens* West.. Proceedings of the First Conference on Plant Protection Research, 13-15 December 1980. Cairo, Egypt, 2: 261-265.

Finney, D.J., 1952. Probit Analysis, Cambridge University Press, Cambridge, pp: 333.

Hassaballa, Z.A., M.Y.Y. Ahmed and M.A. Rizk, 1985. Effects of gamma radiation on the immature stages of *Corcyra cephalonica* (Staint.). Assiut Journal of Agric. Sci., 16: 291-298.

Hussain, T. and O. Imura, 1989. Effects of gamma radiation on survival and reproduction of *Callosobruchus chinesis* (L.) (Coleoptera : Bruchidae). Appl. Entomol. Zool., 24: 273-280.

Jackai, L.E.N. and R.A. Daoust, 1986. Insect pests of cowpeas. Annual Review of Entomology, 31: 95-119.

Kazmer, D.J. and R.F. Luck, 1991. Female body size, fitness and biological control quality: field experiments with *Trichogramma pretosium*. Les Colloques de L'INRA, 56: 37-40.

Locatelli, D.P. and L. Limonta, 1998. Development of *Ephestia kuehniella* (Zell.), *Plodia interpunctella* (Hbn.) and *Corcyra cephalonica* (Staint.) (Lepidoptera:Pyralidae) on kernels and wholemeals of *Fagopyrum esculentus* Moench and *Triticum aestivum* L. J. Stored Prod. Res., 34: 269-276.

Navarajan Paul, A.V., M. Mohanasundaram and T.R. Subramaniam, 1975. Studies on the effects of larval diets of rice meal moth on its egg parasite *Trichogramma australicum* Gir. and *T. japonicum* Ashm. Madras Agricultural Journal, 62: 190-198.

Strong, R.G., G.J. Partidae and D.V. Warner, 1968. Rearing stored product insects for laboratory studies. Bean and Cowpae weevils. J. Econ. Entomol., 61: 747-751.

Shalaby, F.F., A.M. Abd-El-Hafez, E.F.El-Kayat, M.A.A. El-Sharkawy, 1999. Some biological parameters of *Trichogramma* spp. (Hymenoptera: Trichogrammatidae) reared on different hosts. Proceeding of the first regional symposium for applied biological control in Mediterranean countries 25th-29th Oct., 1998, Cairo, Egypt, 223-227.

Shenishen, Z. and E.M. El-Zanaty, 1987. Differential effects of radiation on the egg parasitoid *Trichogramma evanescens* Westwood, (Hymenoptera: Trichogrammatidae) and its host *Sitotroga cerealella* Olivier, (Lepidoptera: Gellichiidae). Bull. Entomol. Soc. Egypt, 16: 143-150.

Strong, R.G., G.J. Partidae and D.V. Warner, 1968. Rearing stored product insects for laboratory studies: Beans and cowpea weevils. J. Econ. Entomol., 61:747-751

Van Huis, A. and M. De Roy, 1998. The effect of leguminous plant species on *Callosobruchus maculatus* (Coleoptera: Bruchidae) and its egg parasitoid *Uscana lariophaga* (Hymenoptera: Trichogrammatidae). Bulletin of Entomological Res., 88: 93-99.

Walder, J.M.M. and E.M. Wiendl, 1973.Influence of gamma radiation on the oviposition and length of life of *Callosobruchus maculatus* anois de scociedade. Entomologic de Brasil, 2: 102-108.