APPLICATION OF *Trichogramma embryophagum* HTG. IN DENSITY CONTROL OF THE PLUM-MOTH PEST (*Grapholitha funebrana* TR.) AT PLUM TREES

GAVRILIŢA Lidia

Abstract. During the period 2011-2012, research studies with *Trichogramma embryophagum* HTG. were conducted in laboratory conditions and in the field. There were determined different biological indices of *T. embryophagum*; then, it was applied on plum cultures in AGRO BRIO farm from rep. Moldova on a surface of 5.4 hectares against the pest *Grapholitha funebrana* TR. In the plum orchard, there were performed 6 launches with *T. embryophagumma.* During the development of two generations of the plum moth (*G. funebrana*), it was determined the dynamics of pest eggs laying and there were constructed digital maps of the spatial distribution of eggs of *G. funebrana* TR. in the field, as well as the biological efficacy of *T. embryophagum*, which varied from 66.6% up to 75.0%.

Keywords: biological indices, prolificacy, effectiveness, *T. embryophagum* HTG., *G. funebrana* TR.

Rezumat. Aplicarea entomofagului *Trichogramma embryophagum* HTG. în reglarea densităţii dăunătorului viermelui prunelor (*Grapholitha funebrana* TR.) la cultura de prun. În perioada 2011-2012 s-au efectuat cercetări cu *T. embryophagum* în condiţii de laborator şi în câmp. S-au determinat indicii biologici a *T. embryophagum,* apoi s-a efectuat aplicarea la prun în combaterea dăunătorului *G. funebrana* în Gospodăria „AGRO BRIO", Băcioi, rep.Moldova pe suprafaţa de 5,4 hectare. În livada de prun, s-au efectuat 6 lansări cu *T. embryophagum.* În perioada dezvoltării a două generaţii a viermelui prunelor (*G. funebrana*) la prun, s-a determinat dinamica depunerii ouălor dăunătorului, s-au construit hărţile digitale de repartizare spaţială în câmp a ouălor de *G. funebrana* şi eficacitatea biologică a *T. embryophagum*, care a variat pe variante de la 66,6% până la 75,0%.

Cuvinte cheie: indicii biologici, prolificitatea, eficacitatea, *T. embryophagum* HTG., *G. funebrana* TR.

INTRODUCTION

During the period 2011-2012, research studies with *Trichogramma embryophagum* HTG., 1838. were conducted in the field and in laboratory conditions. There were determined different biological indices of *T. embryophagum*; then, it was applied on plum cultures in AGRO BRIO farm from rep. Moldova on a surface of 5.4 hectares against the pest *Grapholitha funebrana* TR.

The following harmful species were found on plum trees: the mealy plum aphid (gray louse of plum) (*Hyalopterus pruni* GEOFFR.), San José Scale (*Quadraspidiotus perniciosus* COMST.), black plum sawfly (plums' wasp) (*Hoplocampa minuta* CHRIST), plum moth (*Grapholitha funebrana* TR.), Oriental fruit moth (*Grapholitha molesta* BR.) and mites (*Pannonichus ulmi* KOCH and *Bryobria rubrioculus* SCHEUT.) and so on, with attack frequency between 3 and 20%.

The plum moth (*Grapholitha funebrana*) differs among all the rest of the plum pests because of the degree of damage it provokes. Chemical treatments do not have high efficiency because of the closed life cycle of the *Grapholitha funebrana* larvae. These pests can be treated essentially by applying active biological substances and entomophagous.

The pest *G. funebrana* winters at mature larvae stage in a silky cocoon under the peeling bark of trees or other shelters and has two generations per year. Eggs are deposited in the proportion of 70 - 90% on the lower cap of the fruits. Attacked plum fruit no longer develops, acquires a violet colour and falls before the larvae reach full development. *G. funebrana* eggs are parasitized by *T. embryophagum.* The larvae attack the fruit of wild and cultivated plum (Monfor, green gage, Malivazinca) and cherry fruit, raspberries, grapes, peach and apricot. Attacked fruits can be identified by the presence of the gummy drops which drain through the penetration of the whole larvae. The fruit matures in early fall and often rot. Losses are recorded in Generation II, amounting to 50-80% of the harvest. Prevention and control measures: collecting wormy fruits, scraping bark, traps, biological control using *T. embryophagum* wasp against the pest *G. funebrana* for plums (ZIMMERMANN, 2004; MARCU, 1999; MARCU & DIACONESCU, 2003; KNUTSON, 2001). In case of plum crops, there are also several other pests *Grapholitha molesta* (Lepidoptera: Tortricidae) against which *Trichogramma embryophagum* was applied by the following authors (MATHEVS et al., 2011). *Trichogramma cacoeciae* MARCHAL and *Trichogramma dendrolimi* MAT. were applied by the author (BARBARA & STAATL, 2007) on a surface of 2.5 hectares in Germany against pest *G. funebrana* TR. In KNUTSON, 2001, representing a guide for plant protection, is specified that *Trichogramma* is applied to over 32 hectares annually worldwide against the pest *G. funebrana* at plums with an efficacy of 70%.

Yearly big amount of capital is invested for plum crops protection against the pest *G. funebrana* with entomophagous *Trichogramma* application. *Trichogramma* species parasitize many species of pests and is used for biological protection of plants. Data states that annual launches with *Trichogramma* worldwide amounts to a total area of 45 million hectares of agricultural crops (LENTEREN, 2000). Proposed procedures and methods will allow consecutive application of various biological agents - sex pheromones in fighting against imago phases, entomophagous *Trichogramma* against egg phase, the parasite *Bracon* against larvae phase and nectariferous plants will be used to attract beneficial insects.

MATHERIALS AND METHODS

During the period 2011-2012, research studies with *T. embryophagum*. were conducted in laboratory conditions and in the field. Field experiments were performed in the plum orchard Stenlei on a surface of 5.4 hectares in the household "Agro Brio", Bacioi, Republic of Moldova.

The collection, determination, maintaining and accumulation of the species of *Trichogramma* sp. were performed according to the author (DIURICI, 2008) methods, to be recommended in practice. Rearing the laboratory host grain moth (*Sitotroga cerealella* OL.), determining biological indices of *T. embryophagum*, determination of the numerical density of the pest eggs - plum moth (*G. funebrana*), biological efficacy of *Trichogramma* were performed according to the traditional methods of the authors (ABAȘCHIN et al*.,* 1979). Breeding of grain moth and *Trichogramma*, evaluation of biological effectiveness of entomophagous and the extent of fruit damage by pest and mathematical data processing were conducted according to the relevant procedures and guidelines for the mass breeding and use of *Trichogramma* (ABAȘCHIN et al*.,* 1979; MENCER & ZIMERMAN, 1986).

The determination of the release norms of the entomophagous *T. embryophagum* in combating against the plum moth (*G. funebrana*) on plum was performed applying different rules in the field: 450,000, 350,000, 250,000/ha in small bags, depending on the density of harmful eggs. As a result of researches there have been constructed digital maps (spatial distribution) of the egg density of *G. funebrana* on plum crops. The plan of the experiments is shown in Fig. 1.

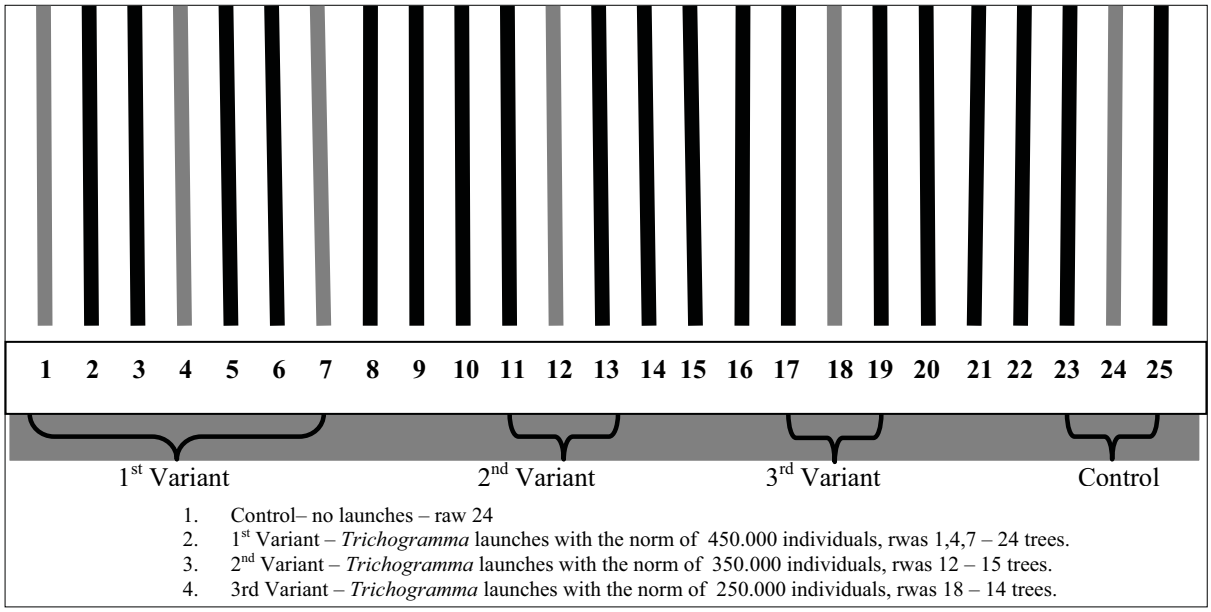

Figure 1. Scheme of experiments in plum orchard, Băcioi, 2012.

RESULTS AND DISCUSSIONS

1. Determination of species, biological indices and conservation of collected populations of *Trichogramma* for plum crop protection.

During the year 2011-2012, under laboratory conditions after prolonged storage (diapauses) for 6 months, *Trichogramma* was multiplied for 3 generations and there were determined the biological indices of *T. embryophagum* bred on the grain moth eggs - prolificacy, the share of females, hatching individuals.

T. embryophagum biological indices (collected from plum) were: prolificacy - 25.0 eggs per female, individuals hatching - 87.0%, the share of females - 100%, static criterion of quality – 21.7.

For research conducting reason, entomophagous *Trichogramma* was collected from the nature. The reason for this was to have and work with species that dominate the plum crop and for gene pool population renewal, because the multiplication under laboratory conditions of many generations in a row (years) leads to the decrease of the entomophagous quality. In the plum orchard from Agro Brio "Bacioi farm", where experiments were conducted, 12 records were performed. Entomophagous *Trichogramma* presence in nature was reported at a 6.0% quote. The most common species of *Trichogramma* collected from plum crop are: *T. embryophagum* - 50%, *T. dendrolimi* - 30%, and 20% of *T. evanescens*. From these three species, *T. embryophagum* predominates. These species were collected and were induced in diapauses for further research.

We determined the pest (*G. funebrana*) dynamics of eggs lay during the development period to optimize pest terms and rules of launches. In Băcioi plum orchard 12 records were carried out for the determination of egg density of *G. funebrana* on plum, before and after the release of *Trichogramma*. In the first pest generation the average density of

plum moth eggs ranged from 1 to 8 eggs per 100 fruits, on variants. During the development of the second generation, pest average density of plum moth eggs ranged from 10 to 16 eggs per 100 fruits, on variants (Fig. 2).

2. Determining the spatial distribution of the pest *G. funebrana* density in the field, to optimize terms and rules of entomophagous *T. embryophagum* launch in pest control during the development of the plum crop.

During the pest (*G. funebrana*) development period, worm eggs laying dynamics was determined to optimize the launch terms and conditions. Density determination of the pest eggs (*G. funebrana*), was done by the traditional method. In Bacioi farm plum orchard 6 launches and 12 records were performed to determine egg density (*G. funebrana*) in plum, before and after the launch with *Trichogramma*. In each variant, records of the number of pest eggs were taken, with 100 fruits per tree, where pheromone traps were installed. The first variant includes rows 1, 4, 7 recording a total of 27 trees and 2700 fruits. The second variant includes row number 12, for a total of 15 trees and 1500 fruits. Third variant (raw 18) comprises a total of 14 trees and 1400 fruits. Fourth variant (Witness -control) contains row 24 in total 4 trees recorded for 500 fruits. Experiments scheme for the plum orchard from Bacioi farm is presented in figure 1. Records were conducted at 60 plum trees uniformly distributed in the field.

During the first generation of the pest, the average density of plum worm eggs ranged from 1 to 8 eggs per 100 fruits per variants. Pest eggs density was lower than the economic damage threshold (2-5 eggs/100 fruits, or 2-3% damage). During the development of the second generation of the pest, average density of plum worm eggs ranged from 1 up to 16 eggs per 100 fruits per variants (Fig. 2). With the "Bio Class" program – multi-classification system criteria of information optimization regarding the initial density in the field of *G. funebrana* there were built digital maps of the spatial distribution of eggs of *G. funebrana* during the development of two generations of this pest and where the uneven distribution was determined and outbreaks detected locations.

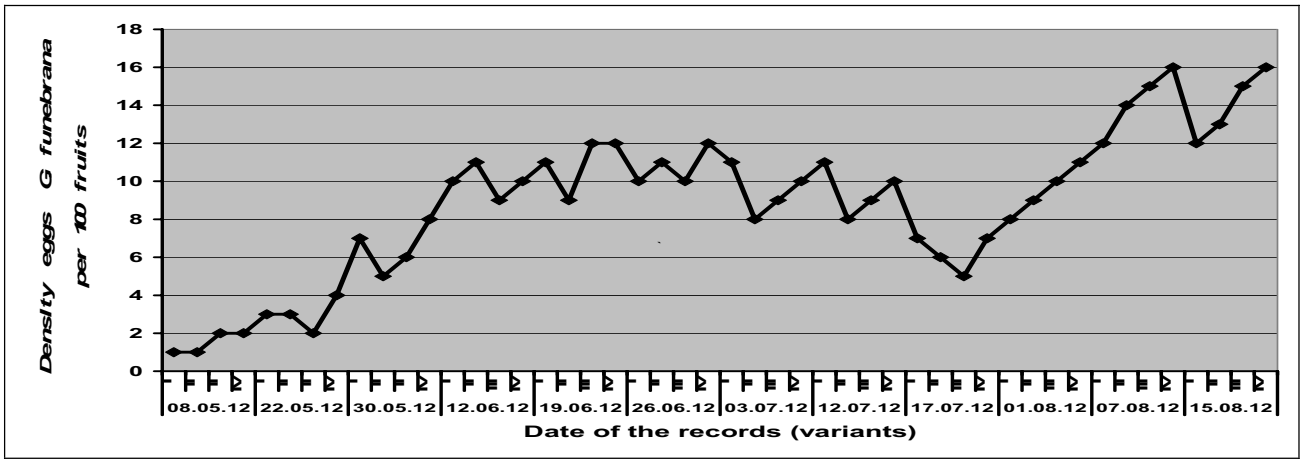

Figure 2. *G. funebrana* eggs density on plum crop, Băcioi, 2012.

3. Determination of the release norms of entomophagous *T. embryophagum* in combating plums worm (*G. funebrana*) at plums.

For the determination of the optimal norms of the launch of the entomophagous *Trichogramma* against plum moth *G. funebrana* at plums, several variants were analyzed as it follows: 450 thousand eggs per hectare in the first variant, 350 thousand/ha in the second variant and 250 thousand individuals per hectare in the third variant. In the fourth variant (witness) there were no launches performed. The number of parasitized eggs was determined on variants and witness.

4. Determination of the parasitic capacity of the plum moth eggs (*G. funebrana*) by the entomophagous *T.embryophagum* at plum crops.

The launch of the entomophagous *T. embryophagum* was conducted after the accumulation, determination of the biological indices and monitoring with pheromone traps of the plum moth butterfly in the field. The launch scheme of *T. embryophagum* in the field in small bags is represented in Fig. 5. In the plum orchard from Bacioi farm 6 launches were conducted for (*G. funebrana*) egg density determination. Evidences were performed before and after each the launch with *Trichogramma*. The density of the pest eggs was initially small and this is the reason why two launches were prophylactic.

In the first generation – eggs parasitized by *T. embryophagum* varied on variants from 16.6% to 25.0 %, after the first two launches. During the second generation 4 launches were conducted up to the date of August 15, 2012 in dependence on the pest presence in the field. Later on the number of eggs parasitized by *T. embryophagum* was determined on variants and it oscillated between 25.0% and 70% (Table 1, Fig. 3). During the two generation development of the pest *G. funebrana*, biological efficacy of *T. embryophagum* in the field varied from 25% to 70% in first variant and from 20% to 69.2% in the second variant. In the third variant efficacy in the field varied from 16.6% to 66.6%. Plum fruit protected by *T. embryophagum* in the plum orchard from Bacioi is shown in Fig. 6). In case of the control plot the parasitized eggs during the entire period varied from 3.8% to 6%.

Table 1. Percentage of parasitisation of *G. funebrana* eggs by *T. embryophagum* as a result of the release of entomophagous on plum crop, Băcioi, 2012.

Date of the record	Variant	Percentage of parasitized eggs, %	Date of the record	Variant	Percentage of parasitized eggs, %
08 May	I	0	03 July	I	42.8
	II	0		II	37.5
	II	0		III	30.5
	IV	0		IV	3.5
22 May	I	0	12 July	I	45.5
	II	0		II	37.5
	II	0		III	33.3
	IV	0		IV	3.8
30 May	I	22.4	17 July	I	57.1
	II	20.0		II	50.0
	II	16.6		III	40.0
	IV	0		IV	4.0
12 June	I	25.0	01 August	I	62.0
	II	22.2		II	55.5
	III	20.0		III	50.0
	IV	0		IV	4.5
19 June	I	30.0	07 August	I	66.6
	II	26.3		II	64.2
	III	22.7		III	60.0
	IV	2.4		IV	5.0
26 June	I	34.6	15 August	I	75.0
	II	28.0		II	69.2
	III	25.0		III	66.6
	IV	3.5		IV	6.0
Td=1.36-5.79 > tb o.o5=1.96					

During the two generation development period of the pest *G. funebrana* in the plum orchard the pest attack was determined as it follows: in the first generation on variants it varied from 1.8 to 2.2% (Fig. 4); during the second generation on variants it varied from 1.3% up to 2.2%. In case of the control plot, the pest attack on fruits varied from 3.0% to 4.4%. On variants, fruit attack ranged from 0.6 to 2.0% in the first variant; in the second variant ranged from 0.9 to 2.3%, in the third attack it ranged from 1.0 to 2.5%. In control, fruit attack ranged from 1.8 to 4.4%. Fig. 7 summarizes *G. funebrana*'s eggs on fruits parasitized by entomophagous *T. embryophagum* in the plum orchard. When comparing the results of the first with the third variant and third with the witness - the difference in biological effectiveness of the mean values (DEM) is essential.

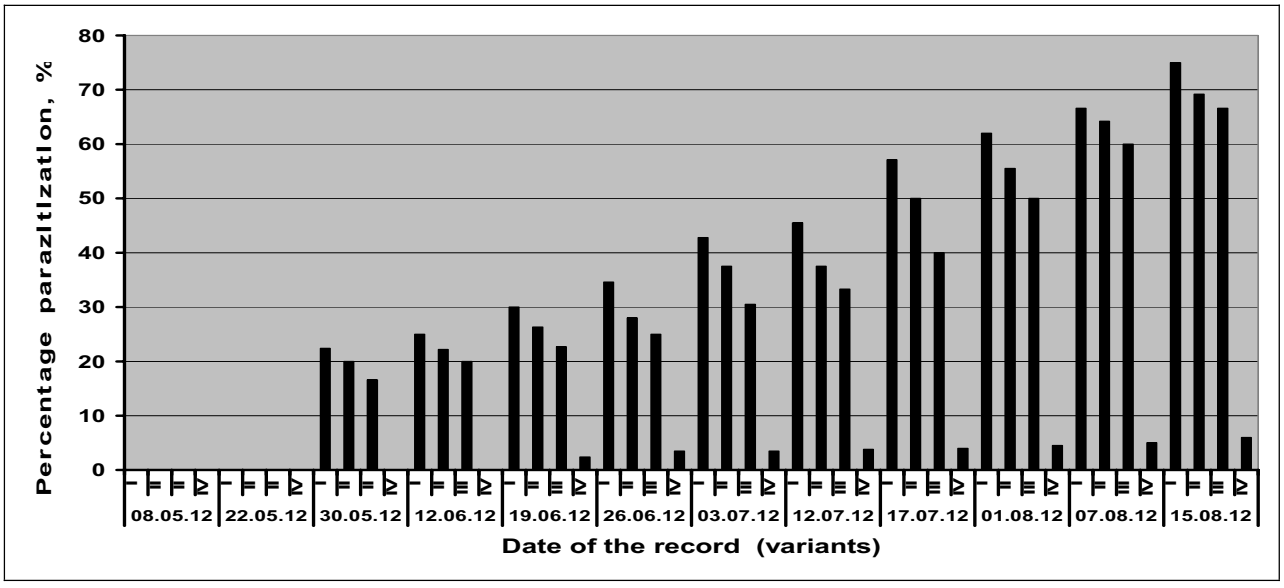

Figure 3. Percentage of parasitisation of *G. funebrana* eggs by *T. embryophagum* as a result of the release of the entomophagous on plum crop, Băcioi, 2012.

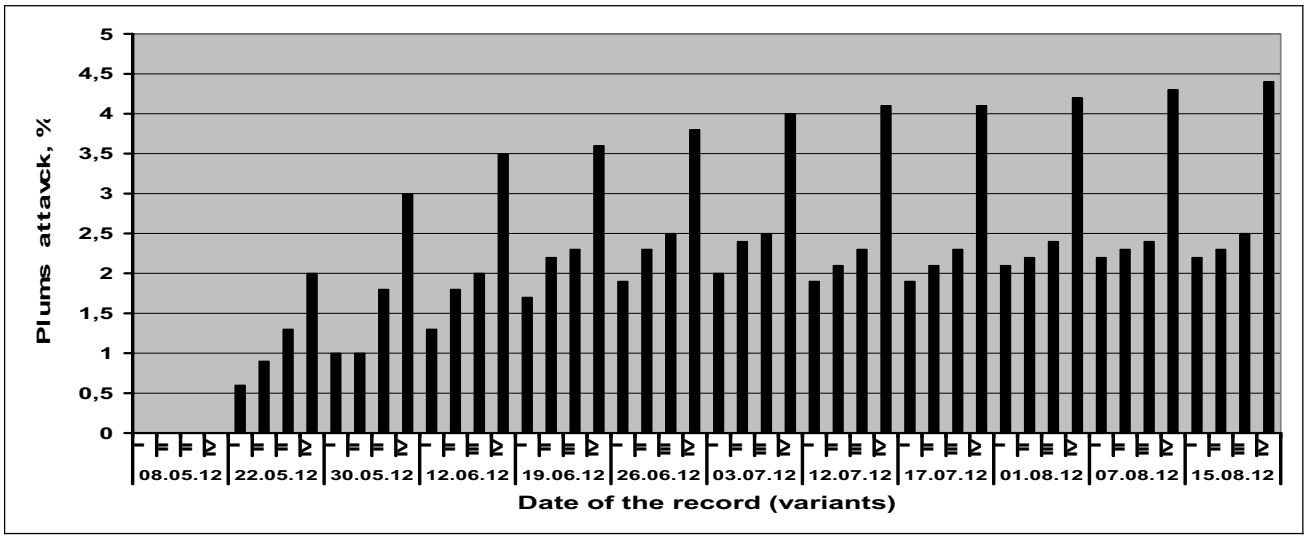

Figure 4. Plums attack by *G. funebrana*, in the plums tree orchard from Băcioi, 2012.

Figure 5. *T. embryophagum* launch in Băcioi plum orchard (original).

Figure 6. Plums protected by *T. embryophagum* in the plum orchard from Băcioi (original).

Figure 7. *G. funebrana* eggs parasitized by *T. embryophagum* at plum in Băcioi farm plum orchard, 2012 (original).

CONCLUSIONS

As a result of the researches, it was achieved a complete data base regarding the laid eggs on the basis of which it was rendered the spatial distribution (digital maps were built in time) of the pest *Grapholitha funebrana* eggs density, for norms and terms optimization of entomophagous *T. embryophagum* launch in the field against pest density reduction at plum crop.

Digital maps were created (spatial distribution) of *G. funebrana* eggs density at plum crop.

Parasitizing capacity of plum moth eggs (*G. funebrana*) by *T. embryophagum* was determined by applying different norms of launch (450.000, 350.000, 250.000), where efficacy per variants varied from 66.6% to 75%.

The immediate results of the research were the elaboration of methodological principles of application of entomophagous *T.embryophagum* for diminishing the pest *G. funebrana* density.

As final result, the application procedures for entomophagous *T. embryophagum* were implemented, as an important element in the integrated protection meant to reduce the pest population density of *G. funebrana* in the plum orchard from Bacioi farm on a surface of 5.4 ha in 2012.

REFERENCES

ABAŞCHIN A., GRINBERG A., DIURICI GALINA, MENCER Ă. 1979. *Rucovodstvo po massovomu razvedeniu i primeneniu Trichogramma Westw.* Metodicescoe rucovodctvo. Edit. Moscva Vasihnil. 133 pp. [In Russian].

BARBARA & STAATL. 2007. *Evaluierung und Optimierung biologischer Verfahren zur Regulierung des Pflaumenwicklers (Cydia funebrana) und der Monilia-Krankheit im ökologischen Steinobstanbau*. Runs. Project Leader. Project ID:FKZ 06OE198 Location: Traubenplatz 5, 74189 Weinberg. http://www.bundesprogramm.de/fkz: 117-122. (Accesed: September 28, 2012).

DIURICI GALINA. 2008 *Sbor, opredelenie i poderjanie jivîh culitur vidov roda Trichogramma Westw. (Hymenoptera, Trichogrammatidae)*. Metodicescoe rucovodctvo. Edit. CEP Chişinău-Prim: 36 pp. [In Russian].

KNUTSON A. 2001. *The Trichogramma manual*. A guide to the use of *Trichogramma* for Bilogical Control with Special Reference to Augmentative Releases for Control of bollworm and Budworm in Cotton. The Texas A & M University System: 33-40.

LENTEREN J. 2000. *How Can Entomology Contribute to Sustainable Crop Production*. Course reader, 3rd International Course on Agroecology "Biodiversity, food and sustainable development". Edit. Tropical Field Crops. Perugia. Italy: 1-10.

MARCU FLORENTINA. 1999. *Cercetări privind utilizarea paraziţilor oofagi din genul Trichogramma, (Hymenoptera-Trichogrammatidae) în combaterea moliilor piersicului (Cydia molesta BUSCK şi Anarsia lineatella ZEII., Lepidoptere*). Teză de doctorat, Universitatea „Al. I. Cuza" Iaşi. Rezumat.

MARCU FLORENTINA & DIACONESCU A. 2003. *Eficacitatea unor mijloace biologice în combaterea dăunătorului Cydia funebrana TR. (Viermele prunelor) din plantaţiile de prun de pe solurile nisipoase de la Dăbuleni.* A 6-a Conferinţa Naţională de Protecţia Plantelor. Principiul Mijloace Biologice şi Biotehnice. Edit. Universităţii Transilvania din Braşov: 32-36.

MATHEWS CLARISSA, BOTTRELL G. DALE, BROWN W. MARK. 2011. *Interactions between Extrafloral Nectaries, Ants (Hymenoptera: Formicidae), and Other Natural Enemies Affect Biological Control of Grapholita molesta (Lepidoptera: Tortricidae) on Peach (Rosales: Rosaceae*), Environmental Entomology: Edit. Entomological Society of America. **40**(1): 42-51.

MENCER A. & ZIMERMAN F. 1986. *Osnovî planirovania experimenta s elementami matematicescoi statistichi vissledovaniah po vinogradarstvu.* Metodicescoe rucovodctvo. Edit. „Ştiinţa".Chişiniev: 235 pp. [In Russian].

ZIMMERMANN O. 2004. *Der Einsatz von Trichogramma-Schlupfwespen in Deutschland: Zum aktuellen Stand der Forschung und Nutzung von Eiparasitoiden gegen Schadlepidopteren im biologischen Pflanzen- und Vorratsschutz*. Use of Trichogramma wasps in Germany. Present status of research and commercial application of egg parasitoids against lepidopterous pests for crop and storage protection Journal Title, Gesunde Pflanzen. Editeur / Publisher Springer, Heidelberg, Allemagne: **56**(6): 157-166.

Gavriliţa Lidia
Institute for Plant Protection and Ecological Agriculture of the Academy of Science of Moldova
Chişinău, Str. Pădurii 26/1, Republic of Moldova.
E-mail: lidia_gavrilita@yahoo.com

Received: March 13, 2013
Accepted: May 01, 2013