During the 2000 to 2017 years average biological efficacy after 4 and respectively 6 treatments with Trichogramma on annual crops such as cabbage, corn, tomatoes, peas, sugar beet and soybean varied in the first variant from 74% to 90.0% whereas in the second variant varied from 60% to 76%. Pests attack on agricultural crops researched varied from 2% to 10%, after Trichogramma launching. In the untreated field, the same index varied from 16% to 90%.

*T. evanescens, T. pintoi, H. armigera, S. cerealella Ol.*, experiments, biological efficacy.

A very important role in integrated plant protection belongs to biological measure for plant protection. Conservation and activation of the natural mechanisms in harmful organisms density regulation must be based on profound knowledge of all the factors and biocoenotic bounding. In general it is noticed a very notable trend in ambient protection in the activities that depend on environment.

The basic principle of the biological control is the biocenotic balance through which the population of a species (prey, host) is conditioned by other species (predators, parasites and pathogens). But this balance is swinging, has dynamic character and can be disrupted by agro technical practices as well as of plant protection. Therefore it is necessary to create favorable conditions to entomophage organisms for their development.

*Trichogramma* species parasitize many species of pests and are used in biological plant protection. Considering [1]. data from year 2000, annually 45 million hectares are being treated with *Trichogramma* sp. in the world. Considering, Knutson, 2001 [2]. information, *Trichogramma* is the most used entomophage in the world, which was launched annually on approximate 32 million hectares on agricultural cultures and forests in 30 different countries.

A pest example against which *Trichogramma* is used is *Helicoverpa armigera Hb*, which brings harm to a vast gamma of cultures. *Helicoverpa armigera Hb* is a polyphagous species, attacking over 120 species of crops.
and wild, causing significant damage to nature. Annual harvest losses of vegetables, corn and other crops are 15—80%. Correct and appropriate time launching of Trichogramma spp. entomophage in combating (controlling) these pests helps reduce the number of pest’s density from 60 to 80% [3].

Pest Helicoverpa armigera Hübner (Lepidoptera: Noctuidae) control with Trichogramma evanescens Westwood (Hymenoptera: Trichogrammatidae) in cotton cultures (Malvaceae) in Turkey. Helicoverpa armigera H. has 5 generations per year. Trichogramma launching was done twice for each of the three generations of H. armigera in 2004 and 2005 years. For every release of Trichogramma in field, 120,000 parasitoids were used per hectare. Percentage of parasitized eggs was — 62.9% and 71.6%. The percentage of larvae of H. armigera was reduced to 76.8 % and 80.6 %, respectively [4].

The “Biotop” Company from Europe produces and sells the Trichogramma entomophage, which is used against Lepidoptera pests. Trichogramma is produced for farmers in biological protection against Ostrinia nubilalis (corn) and Tuta absoluta (tomatoes) and is used yearly on 100,000 hectares in France, Germany, Switzerland and Czech Republic, Frandon, 2012 [10]. About Trichogramma brassicae’s use as parasite on pests eggs in Germany, which was reared in laboratory conditions and applied in field against Ostrinia nubilalis for corn and other cultures like apple, plum, grapes and some crops in greenhouses, on a total surface of 11,000 hectares, several papers were written by the author, Zimmermann, 2004 [11]. In Ukraine, in present time, biological methods are used on an overall area of about 1.2 million hectares, where 65 laboratories are functioning and where 35—40% inclusively of the reared material is Trichogramma, Fiodorenco et al., 2009 [9]. Use of the biological methods for agricultural cultures protection, inclusively with Trichogramma in Latin America (Brazil, Colombia, Costa Rica, Cuba, Ecuador, Panama, Venezuela) emerged to a total area of about 9 million hectares in 2002 [5].

In the Republic of Moldova, as well as in other countries, specialists’ goal is to minimize yield losses caused by illnesses and pests without influencing negatively the fauna in biocenosis and to obtain ecologically pure yield.

Within the Institute of Genetics, Physiology and Plant Protection of the Republic of Moldova, in 1976 was created the “Trichogramma laboratory”, under the initiative of the academician Popusoi Ion, directed by Dr. habilitat Grinberg Alexandru and succeeded by Dr. Lidia Gavrilita. The main goal of the laboratory is to research, analyze, elaborate data in rearing and application of the Trichogramma entomophage in pest’s control.

In order to apply Trichogramma in plant protection, profound knowledge in Ecology, Biology of entomophage and phytophagous organisms is required. There are several factors to be considered which influence the
efficacy in field. Obtaining satisfactory results in the *Trichogramma* application for pest’s control leads to variables continuous analysis and results driven focuses knowing the role and place of entomophage for regulating pest’s density.

**Materials and methods.** Researches were done in field and laboratory conditions during various institutional and state projects with the Innovation and Technological Transfer Agency. Implementation took place in various farms in the Republic of Moldova and on the Institute’s agricultural territory along the 2006—2010 years. *Trichogramma* has been collected from annual cultures (cabbage, tomatoes, maize, peas, sugar beet and soybean). *Trichogramma* evanescens was reared on different host eggs preliminarily irradiated and non-irradiated with gamma rays.

Collecting, identification, storage and accumulation of *Trichogramma* species were done according [6]. Rearing of the laboratory host — grain moth for *Trichogramma* production was done by Abaschin et al., 1979, [7] author’s methods. Mathematical data elaboration was done according to Mencer & Zimerman, 1986 [8].

**Steps to obtaining maternal cultures of entomophage:** 1. For the reason that the *Trichogramma* entomophage is applied several times at different stages of pest’s maturity for agricultural production protection, it is necessary to collect annually from the natural environment the entomophage for its geophone renewal, because from reared several generations in laboratory conditions, it is known that *Trichogramma* looses from its qualities; 2. The annual natural collecting is done from the same cultures to which it is going to be applied afterwards; 3. It follows: identification, rearing and maintenance along the year of the species collected from nature; 4. Use of different procedural methods for quality increase during rearing process of the *Trichogramma* entomophage before launching it in the field; 5. Biological indexes (quality) analysis before launching in field for protection of crops.

**Steps and periods for entomophage field application:** 1. To make accurate assessment of pest density in field, records necessary to determine the specific pest for each species and crop, which depend largely on their biocological peculiarities, must be taken. Field pest monitoring with pheromone traps; 2. Deciding the rules and terms of release of *Trichogramma* entomophage, which have to be taken depending on the pest density at different developmental stages (egg, larvae, pupae, adults), also must take into account the damaging Economic threshold for each pest and crop; 3. Determination of the biological efficacy in field, made after each launching of *Trichogramma*, based on the period of pest development (1—3 generations), to which 4—6 launches can be made with entomophage in different cultures; 4. During the launch of the *Trichogramma* a strict record of the “control” (no launches) takes place which gives knowledge about the natural density of the entomophage, which helps in tracking and taking decisions for further
launches; 5. Entomophage releases in our experiments were performed in capsules, to be protected by various predators.

In the Republic of Moldova, it was organized and functioned until recently an integrated system for producing biological resources for biological plant protection. For some years now the system is stationary, currently working partly, only two biological laboratories (Cahul, Soroca) out of 14. *Trichogramma* spp. is one of the most important biological agents in plant protection. In the Republic of Moldova, the volume of utilization of *Trichogramma* in field constituted 80% to 85% of the agricultural territory (1984—1992 years). Nowadays, the volume of production decreased considerably, which covered only 30 to 663 thousands hectares.

From 1994 to 2002, in the Republic of Moldova, the biological agent *Trichogramma* has not been produced. Starting from 2002 the production process had been reinitiated. Protected crops areas with *Trichogramma* spp, in Moldova, during the 2002—2011 years constituted a total of 47.7 thousands hectares at different annual crops (cabbage, tomatoes, corn, peas, sugar beet and soybean), from 2002 to 2008 years, and ranged from 2—9 thousand hectares.

*Trichogramma* spp. entomophage is one of the most important biological agents in biological plant protection and in integrated plant protection, which rears easily in the laboratory conditions and accumulate fatly because of its short development period of a generation. *Trichogramma* entomophage is used at its initial development stage (eggs). One of the most significant problems in mass rearing of *Trichogramma* is its quality which decreases easily while rearing several generations consecutively on host laboratory eggs, respectively its field efficacy decreases. For this reason several researches were made for augmenting its efficacy. One of the procedures with high success is rearing *Trichogramma* on preliminarily gamma rays irradiated eggs. The results are presented in the following Table 1.

In the Research Institute for of Genetics, Physiology and Plant Protection of Repub. Moldova, to increase the quality and effectiveness of *Trichogramma*, different rearing methods were used on various hosts for plant protection. *T. evanescens*’ prolificacy reared on *Mamestra brassicae* *L.* eggs treated with different factors, ranged from 33.1 to 60.4 eggs/female. In untreated host eggs the results were the following: 23.2 eggs/female. Reared on *Ostrinia nubilalis*’ eggs, the results ranged from 21.3 to 26.6 eggs/female whereas in untreated host eggs — 13.3 eggs/female. Reared on *Éphestia kuhniella*’s eggs the results ranged from 24.8 to 50.8 eggs/female, whereas in untreated eggs the results were — 25.3 eggs/female. Reared on *Sitotroga cerealella*’s eggs the results ranged from 25.0 to 50.0 eggs/female, whereas in untreated eggs — 20.3 eggs/female. Biological indexes: prolificacy, individual hatching, rate of females are higher in the variants where *Trichogramma* was reared on treated hosts eggs rather than
1. Methods for increasing the quality of Trichogramma evanescens W. grown on different hosts eggs

| Hosts                          | Mamestra brassicae L. | Ostrinia nubilalis H. | Ephestia kuhniella Z. | Sitotroga cerealella Ol. |
|-------------------------------|-----------------------|-----------------------|-----------------------|--------------------------|
| Procedures                    | Prolificacy, eggs/female |                        |                        |                          |
| 1. Passages in natural hosts  | 40.4±1.8              | 23.0±1.0              | 30.8±1.3              | 30.0±2.0                 |
| 2. Supplementary feeding with honey | 34.5±1.8          | 26.6±1.5              | 32.3±1.7              | 32.5±1.5                 |
| 3. Supplementary feeding with 20% sugar syrup | 33.1±1.8        | 25.5±1.5              | 32.6±1.8              | 33.4±1.9                 |
| 4. Gamma rays, grei           | 60.4±2.9              | 23.1±1.6              | 50.8±2.9              | 50.0±2.5                 |
| 5. Ultraviolet, hours         | 46.0±2.8              | 21.3±1.5              | 29.3±1.8              | 27.6±1.3                 |
| 6. Fe₃O₄ magnetic fluid       | —                     | —                     | 30.3±1.5              | 37.0±1.7                 |
| 7. „In vitro” medium          | —                     | —                     | 24.8±1.6              | 25.0±1.6                 |
| 8. Untreated hosts (martor)   | 23.2±2.9              | 13.3±1.0              | 25.3±1.4              | 20.3±1.2                 |

untreated eggs having a 1.5 to 2.5 times higher results and effectiveness in field increased from 7% to 10%.

Static criteria of the quality (including: prolificacy, individual hatching, female rate) in the variant where Trichogramma was reared on Mamestra brassicae L. constituted 23.4; on non treated eggs — 17.8. On Ephestia kuhniella Z. irradiated beforehand with gamma rays — 14.4, whereas non-treated eggs 11.4. On Sitotroga cerealella Ol. treated eggs — 13; untreated 8.7. On Ostrinia nubilalis H. treated eggs — 11; untreated — 6. Comparing the variants of the treated and untreated eggs under the T-Student criteria, statistical data are veridical at a 95% level (Tₙ = 2.4 − 3.3 > T₀.₀₅ = 1.96).

Determination of biological indexes of the Trichogramma spp.: During the 2006 to 2017 years, in laboratory conditions, after prolonged storage (diapause) — 6 months, Trichogramma was reared for 3—4 generations each year. Later on, the biological indexes were determined for Trichogramma grown on grain moth irradiated beforehand with gamma rays (I Variant) and non — irradiated (II Variant) — prolificacy, number of female individuals hatching at the temperature of 26 ± 1°C and relative humidity of 80—85%. Results are presented in Table 2.

For T.evanescens, T. pintoi (tomato, corn), biological indicators in the first variant varied as follows: female prolificacy — from 30.9 to 36.8 eggs/female, individuals hatching from 88.3% to 94%, female number — 56.7 to 60.0%, static criteria of quality — from 16.2 to 19.6. In the second variant these indices ranged as follows: Prolificacy of females — from 18.0 to 21.5 eggs/female, individuals hatching from 79.6% to 86.0%, female number — 53.5 to 56.0%, static quality criteria — 8.4 to 9.4.

During the development period of 2—3 generations of the annual re-
searched crops (cabbage, corn, tomatoes, peas, sugar beet and soybean),
average biological efficacy of \( T.\) evanescens in pests control during the
2000—2017 years, the percentages varied from 74 to 90% in the first variant
and from 60- to 76.0% in the second one (Table 2).

Pest density of the researched annual crops during the 2006—2017
years varied from 1 to 8 eggs/plant. Pests’ attack on agricultural cultures in
2006—2017 years varied from 2 to 10% in \( T.\) evanescens applied variant,
whereas in “control” (non treated crops by \( T.\) evanescens) the same index
varied from 16 to 90%. The percentage of different pests’eggs parasitized
by \( T.\) evanescens in nature on different cultures in the same period of time
varied from 1 to 9%. (at the end of vegetation period).

The role of entomophages’ application as an element in integrated plant
protection is the following:

Economic effect: Cost reduction for plant protection by 3—4 times
relative to chemical treatments. Ecological effect: Preservation of useful

| Farms                      | Culture      | Pests’ name          | Area, (hectares) | \( T.\) evanescens species | Variants | Parasitized eggs, (%) |
|---------------------------|--------------|----------------------|------------------|-----------------------------|----------|-----------------------|
| Gura Bacului, Sărata Galbena, Bacioc, Sangera Chetrosu | Cabbage | \( Mamestra brassicae L. Helicoverpa armigera\) Hb. | 55.5 | \( T.\) evanescens | I II | 74.0 — 90.0, 60.0 — 81.0 |
| Sarata Galbena, Bacioc, Coșnița, Marandeni, Balți, Caușeni | Corn | \( Helicoverpa armigera\) Hb. \( Ostrinia nubilalis\) Hb. | 1615 | \( T.\) evanescens | I II | 80.0 — 88.0, 73.0 — 80.0 |
| Sarata Galbena, Chișinău, Gura Bacului, Sangera | Tomatoes | \( Helicoverpa armigera\) Hb. | 290 | \( T.\) evanescens | I II | 83.0 — 90.0, 74.0 — 80.8 |
| Sarata Galbena, Chișinău | Peas | \( Helicoverpa armigera\) Hb. | 210 | \( T.\) evanescens | I II | 80.0 — 86.0, 75.0 — 80.0 |
| Pohoarna, Marandeni | Sugar beet | \( Helicoverpa armigera\) Hb. | 450 | \( T.\) evanescens | I II | 84.0 — 85.0, 76.0 — 77.0 |
| Marandeni Chișinău | Soya | \( Helicoverpa armigera\) Hb. | 336 | \( T.\) evanescens | I II | 83.0 — 86.0, 75.0 — 76.0 (Td=1.0—1.90, 1.96=To.05) |

\( I\) variant — reared on irradiated host eggs,
\( II\) variant — reared on different non irradiated host eggs.
organisms in nature, minimizing the number of chemical treatments in integrated system, creating conditions to reduce environmental pollution and the production of organic farming.

CONCLUSIONS

1. During the 2006 to 2010 years, the average biological efficacy after 4 and respectively 6 treatments with *Trichogramma*, on annual crops such as cabbage, corn, tomatoes, peas, sugar beet and soybean, varied from 74% to 90% in the first variant, whereas in the second one from 60% to 81%. Pests attack on agricultural crops researched varied from 2% to 10% after *Trichogramma* launching. The same index varied from 16% to 90% in the untreated field.

2. During the development period of 2—3 pest’s generations on annual crops (cabbage, tomatoes, corn, sugar beet, peas, soy, etc.), a very important role in reducing pest’s density belongs to entomophage. For this reason the following steps have to be performed in crop protection:

- In the adult stage, pheromone traps are mounted to monitor and capture in mass butterflies;
- In the pest’s egg stage, 5 to 6 *Trichogramma* releases must be applied, having the norm of 200.000 to 300.000 individuals per hectare;
- In the larval stage of pests, other entomophage can be released — Bracon, Apanteles;
- Treatments with biological compositions in pest control can be applied;
- 1—2 treatments with fungicides to be carried in combating diseases;
- 1—2 treatments with selective insecticides to be carried in combating the complex of pests (if necessary);
- Mechanical and physical means, crop’s rotation;
- Preservation of useful organisms in nature;
- Minimizing (or avoiding) the number of chemical treatments in integrated protection;
- Creating conditions to reduce environmental pollution;
- Getting organic ecological and qualitative products.

REFERENCES

1. Lenteren J. *How Can Entomology Contribute to Sustainable Crop Production*. Course reader, 3rd International Course on Agroecology “Biodiversity, food and sustainable development”, 2000. Perugia. Italy. P. 1—10.

2. Knutson A. *The Trichogramma manual*. A guide to the use of *Trichogramma* for Biological Control with Special Reference to Augmentative Releases for Control of bollworm and Budworm in Cotton, The Texas A&M University System. 2001. P. 33—40.

3. Mureșean Felicia, Mustea D. *The Biological Control of the European Corn Borer (Ostrinia nubilalis H.) With Trichogramma sp.* At A.R.S. Turda.
Proceedings of the XVIII Conference of the International Working Group on Ostrinia Nubilalis H. Turda, România. 1995. P. 97—104.

4. Oztemiz S., Karacaoglu M., Yarpuzlu F. Parasitization Rate of Helicoverpa armigera Hübner (Lepidoptera: Noctuidae) Eggs After Field Releases of Trichogramma evanescens Westwood (Hymenoptera: Trichogrammatidae) in Cotton in Cukurova Region of Turkey. Plant Protection Research Institute. 01321. Adana Turkey. Journal of the Kansas Entomological Society. 2009. 82(2). P. 183—193.

5. Bueno V., Lenteren J., 2002. The Netherlands the popularity of augmentative biological control in Latina America. Department of Entomology. Federal University Lavras. Brazil. Laboratory of Entomology, Wageningen University. P. 67—72.

6. Diurici G. Sbor, opredelenie i poderjanie jivoh cultur vidov roda Trichogramma Westw. (Hymenoptera, Trichogrammatidae). Metodicescoe rucovodctvo. Chişiniev. 2008. P. 16—27.

7. Abaşchin A., Grinberg A., Diurici G., Mencer Ă. Rucovodstvo po massovomu razvedeniiu primeneni Trichogramma Westw. Metodicescoe rucovodctvo. Chişiniev: 1979. P. 20—38.

8. Mencer A., Zimerman F. 1986. Osnovo planirovania āxperimenta s ālementami matematicески statistich s issledovaniah po vinogradarstvu. Metodicescoe rucovodctvo. Chişiniev. P. 20—27.

Гаврилита Л.Ф. Ентомофаг трихограма в інтегрованому захисті рослин як засіб зниження щільності популяції шкідників однорічних культур

Протягом 2000—2017 рр. у досліджуваних однорічних культурах (ка-пуста, кукурудза, томати, горох, цукровий буряк і соя) після 4—6 по-льових випусків трихогріами середня біологічна ефективність ентомофага в першому варіанті була в межах від 74 до 90%, а в другому варіанті — від 60 до 76%. Пошкодженість однорічних культур шкідниками протя-гом цього періоду варіювала від 2 до 10% у варіантах з Trichogramma. У контрольні пошкодженість рослин становила 16—90%.

Гаврилита Л.Ф. Энтомофаг трихограмма в итегрированной защите растений как средство снижения плотности популяции вредителей однолетних культур

В течение 2000—2017 гг. в исследуемых однолетних культурах (ка-пusta, кукуруза, томаты, горох, сахарная свекла и соя) после 4—6 по-левых выпусков с трихограммой средняя биологическая эффективность энтомофага в первом варианте колебалась в пределах от 74 до 90%, а во втором варианте — от 60 до 76%. Поврежденность однолетних культур от вредителей, в течение этого периода, варировала от 2 до 10% в вариантах с Trichogramma. В контроле поврежденность растений составляла 16—90%.