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TRICHOGRAMMA SPP - AN ENTOMOPHAGOUS INSECT IN SPACE AND TIME (50 YEARS - 1976–2026)

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This publication presents the history and current status of the mass rearing and application of the entomophagous parasitoid *Trichogramma* at the Institute of Genetics, Physiology and Plant Protection during the period 1976–2026. It summarizes the achievements of researchers who have contributed and continue to contribute to the biological protection of plants through the use of *Trichogramma* for pest control.

The excessive use of pesticides has created serious and complex problems against the backdrop of worsening environmental conditions. This situation necessitated a comprehensive approach to plant protection issues, focused on the development of alternative, non-chemical methods for controlling harmful organisms and on the establishment of a specialized institution dedicated to this field.

From the perspective of more than four decades of activity, the importance of establishing in Moldova the world's second institute dedicated to biological methods of plant protection has become increasingly evident. The institute has served as a coordinator of research related to the development of integrated crop protection systems and the implementation of environmentally sustainable agriculture.

A retrospective analysis of its development, considering its major achievements and their practical implementation, clearly demonstrates the necessity of establishing a new laboratory focused on integrated plant protection. Particular emphasis was placed on biological control methods, especially on the use of the entomophagous parasitoid *Trichogramma*.

The validity of this decision has been repeatedly confirmed through scientific achievements, valuable practical applications, collaboration with numerous international organizations, international recognition, and successful solutions to various problems related to the biological protection of plants.

Species of *Trichogramma* parasitize a wide range of pest species and are extensively used in biological and integrated plant protection programs. According to van Lenteren (2000) [2], this entomophagous parasitoid is released annually worldwide over a total area of approximately 45 million hectares of agricultural crops. Accord-

ing to Knutson (2001) [3], *Trichogramma* is the most widely used biological control agent in the world, being released annually in agricultural and forest ecosystems across 30 countries.

The European company Biotop produces and commercializes *Trichogramma* for the control of lepidopteran pests. The parasitoid is supplied to growers for biological control programs targeting *Ostrinia nubilalis* in maize and Tuta absoluta in tomato crops. It is used annually on more than 100,000 hectares in France, Germany, Switzerland, and the Czech Republic (Frandon, 2012) [1].

In the Republic of Moldova, during the period 1984–1994, the biological control agent *Trichogramma* spp. was applied on large agricultural areas ranging from 20.000 to 663.000 hectares across various crops. During this period, a comprehensive system for the production of biological plant protection agents was established and operated until 1994. Since 1994, this system has largely ceased functioning, and currently only two biological laboratories (located in Cahul and Soroca) remain partially operational out of the original fourteen. During the active period, annual production of *Trichogramma* spp. ranged from 29 to 41 billion individuals.

Between 1994 and 2002, *Trichogramma* spp. was not produced in the Republic of Moldova. Production activities were resumed only in 2002, when biological laboratories restored the mass-rearing process of this beneficial parasitoid. During the period 2002–2011, agricultural areas protected with *Trichogramma* spp. totaled 47.7 thousand hectares and included various annual crops such as cabbage, tomato, maize, pea, sugar beet, and soybean. The treated area varied between 0.6 and 9.3 thousand hectares annually.

The scientifically substantiated application of *Trichogramma* spp. in regions favorable for its activity ensures the destruction of up to 60–80% of pest eggs and contributes significantly to increased crop yields, enhanced agricultural production, and improved economic returns.

Trichogramma belongs to the family *Trichogrammatidae,* order *Hymenoptera*, genus *Trichogramma*. The most widespread species include: *T. evanescens* Westw., *T. pintoi* Vog., *T. semblidis* A., *T. leucaniae* P. & Ch., *T. sibiricum* Sor., *T. dendrolimi* Mats., *T. aurosum* Sug., *T. piceum* Dj., *T. embryophagum* Hb., *T. sorokina* Kost., and *T. telengai* Sor. (Dyurich, 2008) [4].

The entomophagous parasitoid *Trichogramma* spp. plays a crucial role as a key component of integrated pest management (IPM) systems for both annual and perennial crops.

Biological Control of Lepidopteran Pests Using *Trichogramma*

Trichogramma is the principal biological control agent used against complexes of lepidopteran pests affecting cereal, legume, industrial, vegetable, forage, viticultural, fruit, forestry, ornamental, aromatic, and medicinal crops.

1. Vegetable Crops

Cabbage, tomato, pepper, eggplant, etc. — controlled pests include:

- Cabbage moth (*Mamestra brassicae* L.)
- Cotton bollworm (*Helicoverpa armigera* Hbn.)
- Heart-and-dart moth (*Agrotis exclamationis* L.)
- Dark sword-grass (*Xestia c-nigrum* L.)
- Black cutworm (*Agrotis ipsilon* Huf.)
- Diamondback moth (*Plutella xylostella* L.)
- Large white butterfly (*Pieris brassicae* L.)
- Small white butterfly (*Pieris rapae* L.)

2. Grain Legumes

Pea, soybean, lentil, bean, etc. — pest complexes include:

- *Mamestra brassicae*, *Helicoverpa armigera*, *Agrotis exclamationis*
- *Xestia c-nigrum*, *Agrotis ipsilon*, *Various moth species*.

3. Industrial Crops

Sugar beet, sunflower, tobacco, etc. — pests include:

- *Mamestra brassicae*, *Helicoverpa armigera, Agrotis exclamationis, Xestia c-nigrum*;
- *Agrotis ipsilon*, Beet moth (*Scrobipalpa ocellatella* Boyd).

4. Cereals

Maize, wheat, barley, oats, triticale, etc. — pests include:

- Cotton bollworm (*Helicoverpa armigera*)
- Beet webworm (*Loxostege sticticalis* L.)
- European corn borer (*Ostrinia nubilalis* Hbn.)
- Various maize moth species

5. Fruit Crops

Apple: Codling moth (*Cydia pomonella* L.)

- Oriental fruit moth (*Grapholita molesta* Busck)

Plum: Plum fruit moth (*Grapholita funebrana* Treitschke)

Other noctuid pest complexes.

6. Vineyards

Grapevine:

- European grapevine moth (*Lobesia botrana* Denis & Schiffermüller)

7. Ornamental and Floricultural Crops

Flowers and ornamentals:

- *Mamestra brassicae*, *Helicoverpa armigera*, *Agrotis exclamationis*
- Rose tortrix (*Archips rosana* L.), Vapourer moth (*Orgyia antiqua* L.)

8. Medicinal Plants

Main pests include: *Helicoverpa armigera, Agrotis exclamationis,* Various moth species

9. Forest Plantations

The most widespread pests include: Cabbage moth (*Mamestra brassicae*),

- Cotton bollworm (*Helicoverpa armigera*), Heart-and-dart moth (*Agrotis exclamationis*),

Rose tortrix (*Archips rosana*), Vapourer moth (*Orgyia antiqua*), Green oak tortrix

(*Tortrix viridana*)

- Plum fruit moth (*Grapholita funebrana*)
- Gypsy moth (*Lymantria dispar*)
- Fall webworm (*Hyphantria cunea* Drury)
- Horse-chestnut leaf miner (*Cameraria ohridella* Deschka & Dimić)
- Codling moth (*Cydia pomonella*)

As a result of extensive international research on the application of *Trichogramma* in pest management, a substantial body of scientific literature has been accumulated.

The primary objective of plant protection specialists is to reduce crop losses caused by pests without negatively affecting beneficial fauna within agroecosystems and to obtain environmentally friendly agricultural products.

In response to the national need for biological plant protection and the production of ecologically sustainable agricultural products, and at the initiative of Academician Ion S. Popușoi, the *Trichogramma* Laboratory was established on March 1, 1976, at the Institute of Genetics, Physiology and Plant Protection of the Academy of Sciences of Moldova (currently part of USM).

The laboratory was initially headed by Dr. Ala P. Adașcheevici (1976–1977), followed by Dr. Habil. A. M. Grinberg (1977–1992). From 1995 to 1999, the laboratory was directed by Dr. Vladimir A. Șleahtici, and from 1999 to 2003 by Dr. Lidia T. Gavrilita. Research on *Trichogramma* has continued to the present day (2026) within the Laboratory of Phytopharmacy and Ecotoxicology of the Institute of Genetics, Physiology and Plant Protection.

Now, fifty years after the establishment of the *Trichogramma* Laboratory, and having passed through periods of profound institutional, social, and political restructuring, the necessity of conducting both fundamental and applied research on *Trichogramma* for pest control within integrated crop protection systems remains evident. These developments have further expanded the prospects for research and practical applications involving this important biological control agent.

Senior Research Scientists

1. Boris Vasile Pânzaru, PhD in Agricultural Sciences (1976–1996)
2. Ana Tudor Rusnac, PhD in Biological Sciences (1976–1988)
3. Miron Pavel Teşler, PhD in Biological Sciences (1981–1993)

4. Ion Nicolae Boubătrân, PhD in Agricultural Sciences (1976–1988)
5. Victoria Vasile Orlovscaia, PhD in Biological Sciences (1988–1992)
6. Mihail Valentin Palii, PhD in Biological Sciences (1978–1984)
7. Constantin Victor Tărâţă, PhD in Biological Sciences (1976–1978)
8. Nicolai Ion Serâi, PhD in Agricultural Sciences (1976–1980)
9. Alexandra Tudor Vorotânţeva, PhD in Biological Sciences (1976–1987)
10. Emanuel Marc Mencer, PhD in Mathematical Sciences (1978–1982)
11. Natalia Vladimir Răileanu, PhD in Biological Sciences (2002–2009)

Research Scientists

1. Galina Tudor Diurici (1976–1992, 1998–2000)
2. Natalia Petru Bradovscaia (1995–2003)
3. Nina Nicolae Cudreavţeva (1986–1992)

Junior Research Scientists (Research Trainees)

1. Ana Crucinina (1976–1982)
2. Galina Gluşcova (1993–2003)
3. Lidia Şchiopu (1977–1998)
4. Ludmila Podberezcaia (1977–1984)
5. Ala Nesterova (1981–1983)
6. Eleonora Negru (1984–1985)
7. Nelea Voronţova (1977–1983)
8. Natalia Pşenicica (1977–1983)
9. Tatiana Bogoutdinova (2003–2004)

Entomologist

1. Galina Feodor, Category I Entomologist (1990–1991)

Agronomists

1. Elizaveta F. Moisei, Category II Agronomist (1967–2003)
2. Ana Buzatu, Category I Agronomist (1995–2003)
3. Elizaveta Zaiţeva, Category I Agronomist (1976–1982)
4. Ala Rudac, Category I Agronomist (1987–1997)

Technicians

1. Maria Florica, Category II Technician (1978–1983)
2. Elena Florica, Category II Technician (1976–1977)
3. Vera Scrob, Category II Technician (1980–1982)
4. Maria Butucea, Category II Technician (1980–1983)
5. Olga Balaclav, Category I Technician (2006–2007)
6. Vasile Anton Gavriliţa (2006–2015)

Doctoral and Habilitated Doctoral Theses Related to *Trichogramma* Defended within the "Trichogramma" Laboratory

1. Grinberg Sh. M. *Scientific Foundations of the Biotechnology for the Production and Application of Trichogramma*. Leningrad. Abstract of the Doctor of Biological Sciences Dissertation, 1991.

2. Boubătrân I. N. *Biological Justification for the Use of Trichogramma in the Control of the European Corn Borer on Maize under Intensive Cultivation Technology*. Abstract of the Candidate of Agricultural Sciences Dissertation. Tbilisi, 1988.

3. Pânzaru B. V. *Development of Technologies for the Application of the Entomophagous Insect Trichogramma in the Control of the Cabbage Armyworm on Cabbage*. Dissertation Abstract for the Degree of Doctor of Agricultural Sciences. Chișinău, 1989.

4. Şleahtici V. A. *Ecological and Physiological Characteristics of Trichogramma Diapause under Mass-Rearing Conditions*. Abstract of the Candidate of Biological Sciences Dissertation. Chișinău, 1991.

5. Gavriliţa L. T. *Biological Substantiation of Procedures and Methods for Increasing the Vitality of Trichogramma*. Dissertation Abstract for the Degree of Doctor of Biological Sciences. Chișinău, 1993.

6. Palii M. V. *Biological Justification for the Use of Trichogramma in Limiting the Population of Noctuid Moths (NOCTUIDAE) in the Forest-Steppe Zone of Ukraine*. Abstract of the Candidate of Biological Sciences Dissertation. Chișinău, 1983.

7. Teşler M. P. *Biological Justification and Optimization of the Application of Trichogramma and Biological Preparations in the Biological Control of the European Grapevine Moth in Vineyards*. Leningrad, 1985.

8. Orlovscaia V. V. *Agrocenotic Justification for the Application of Trichogramma in the Control of the Pest Ostrinia nubilalis H. in Maize Crops*. Dissertation Abstract for the Degree of Doctor of Biological Sciences. Chișinău, 1993.

9. Tărâţă C. V., Doctor of Biological Sciences (1976–1978).

10. Răileanu N. V. *Bioecological Justification of Methods and Techniques for the Multiplication and Application of Trichogramma Against the Complex of Cutworm Species*. Dissertation Abstract for the Degree of Doctor of Biological Sciences. Chișinău, 2008.

Laboratory Personnel

A total of **36 people** worked in the ***TRICHOGRAMMA***

Laboratory, including:

- Moldovans – 18; Ukrainians – 6; Russians – 9; Jews – 3

As of **2026**, only **two staff members** continue to work in the laboratory:

- **Dr. L. Gavriliţa**
- **Maria Butucel**.

CONCISE RESULTS OBTAINED DURING THE PERIOD 1976–2026

During the period 1976–2026, fundamental and applied research was carried out on the entomophagous insect *Trichogramma* spp.

Within this laboratory, various research directions were studied by the laboratory team.

The entomophagous insect *Trichogramma* spp. plays a very important role as a key element in the integrated protection of annual and perennial crops against pests.

- Identification, accumulation, and maintenance of collected *Trichogramma* spp. species from different agricultural crops for recommendation in plant protection.

Researchers: Grinberg Ș. M., Diurici G., Gavrilița L., Șchiopu L., Rudac A., Răileanu N.

The identification, accumulation, and maintenance of *Trichogramma* species were carried out according to the methodological guidelines of the author G. F. Diurici: "Collection, Identification and Maintenance of Live Cultures of Species of the Genus *Trichogramma* Westw. (*Hymenoptera, Trichogrammatidae).*" Methodological Guide, 2008.

The research direction focused on studying the fauna and systematics of the genus Trichogramma and other genera used in biological plant protection, with the general objective of studying the fauna and systematics of the genus *Trichogramma*, family Trichogrammatidae (Hymenoptera), and other related genera.

In the works of the author Diurici, G. 14 species of *Trichogramma* distributed throughout the Republic of Moldova are described. The species *T. evanescens, T. pintoi, T. semblidis*, and *T. principium* prefer field agricultural crops. The species *T. cacoeciae, T. embryophagum*, and *T. dendrolimi* prefer perennial crops such as apple, plum, and grapevine plantations.

- Study of interspecific competition among *Trichogramma* species.

Researchers: Gavrilița L., Grinberg Ș. M., Diurici G., Șchiopu L.

One of the important research issues in the mass rearing and field release of *Trichogramma* is interspecific competition. Due to the relatively specialized trophic behavior of *Trichogramma*, competitive ability directly influences the effectiveness of the entomophagous insect.

Experiments were conducted in five laboratory variants using different ratios of the indicated Trichogramma species:

T. evanescens – 100%; *T. pintoi* – 100%; *T. evanescens* + *T. pintoi* – 50% + 50%;

T. evanescens + *T. pintoi* – 10% + 90%; *T. evanescens* + *T. pintoi* – 90% + 10%.

Laboratory experiments established that over four generations of development within mixed Trichogramma populations, a gradual replacement of T. evanescens by T. pintoi occurs.

The mechanism of substitution of one species by another is explained by the different reactions of *T. evanescens* and *T. pintoi* to temperature and humidity conditions during mass rearing.

- **Development of mechanized procedures and biotechnical requirements for equipment complexes used in the production of the laboratory host *Sitotroga cerealella* Ol. and *Trichogramma*.**

Researchers: Grinberg Ș. M., Vorotânțeva A., Gavrilița L., Pâzaru B., Palii M., Boubătrân I., Orlovscaia V., Șleahtici V., Crucinina A., Mencer E., in collaboration with the mechanization group.

The purpose of this research was the modernization and testing of certain elements of the production line for *Sitotroga cerealella* eggs required for the production of the entomophagous insect Trichogramma spp.

Elements of the cereal moth egg production line were tested, T. evanescens of different ages released in capsules was verified under field conditions, and *Trichogramma* release using modern technology was evaluated.

The research direction of the *Trichogramma* laboratory included the development of methods and procedures for applying *Trichogramma* in pest control for annual and perennial agricultural crops.

In collaboration with the mechanization group, research was carried out on mechanized application of the entomophagous insect *Trichogramma* (using airplanes, helicopters, and tractors), in cooperation with institutes from Moscow, Krasnodar, Kyiv, Tashkent, and Odessa for the protection of agricultural crops. From Romania: Turda, ClujnaPoca, Timisoara, Craiova, Iasi, Arad, Bucharest.

Another research direction focused on optimizing the timing and release rates of Trichogramma in the field for pest control.

Different types of equipment were developed for the production line of the laboratory host *Sitotroga cerealella* O. used in the production of *Trichogramma* spp.

Techniques for the use and release of the entomophagous insect *Trichogramma* in controlling pest complexes in agricultural crops were developed. The technologies elaborated by the working group, together with the mechanization team, were implemented in the Republic of Moldova and in various regions of the former USSR.

Improvement and completion of the equipment (production line) for producing the laboratory host — the grain moth (*Sitotroga cerealella*) — for the multiplication of the entomophagous insect *Trichogramma* spp.

Researchers: Grinberg Ș., Gavrilița L., Boubătrân I., Pânzaru B., Vorotânțeva A.

Different types of equipment were developed for the production line of the labo-

ratory host Sitotroga cerealella O. used for the production of *Trichogramma* spp. in the protection of agricultural crops against pests.

Techniques for the use and release of the entomophagous insect *Trichogramma* in controlling pest complexes in agricultural crops were developed. The technologies elaborated by the working group, together with the mechanization group, were implemented in the Republic of Moldova and in different regions of the former USSR.

- A special device for storing *Trichogramma* spp. was constructed.
- Storage periods for *T. evanescens* in special devices were determined (together with the mechanization and design group).

Development of methods for the production and maintenance of laboratory hosts — the grain moth (*Sitotroga cerealella* O.) and the flour moth (*Ephestia kuehniella*) — for the multiplication of different *Trichogramma* spp. species.

Researchers: Grinberg Ș., Gavrilița L., Șleahtici V., Tărânță C., Palii V., Răileanu N., Moisei E., Negru E., Buzatu A., Gavrilița V., Crucinina A., Voronțova N., Bogoutdinova T., Nesterova A., Pșenicica N., Florica M., Florica E., Scrob V., Butucea M., Butucel M., in collaboration with the mechanization group.

The biological indices of *Trichogramma* are directly dependent on the laboratory host species on which the entomophagous insect is reared, as well as on the age and quality of the eggs laid.

Each species has a high capacity for host selection on which it develops. Differences are also observed among individuals of the same *Trichogramma* species emerging from different host eggs. The larger the host eggs, the larger the entomophagous insect becomes.

In the *Trichogramma* laboratory, the laboratory host *Sitotroga cerealella* O. was produced in different quantities for carrying out various research activities.

- **Development and implementation of new methods and procedures for the production of *Trichogramma* spp. with enhanced qualities for the protection of agricultural crops against pests**.

Researchers: Gavrilița L., Grinberg Ș., Rusnac A., Podberezcaia L., Mencer Ă., Răileanu N.

Within the "Trichogramma" laboratory, a Trichogramma Quality Standard was developed, according to which the entomophagous insects were classified into quality classes.

New methods and procedures were developed for the production and application of Trichogramma spp. with enhanced qualities for the protection of agricultural crops against pests.

The traditional laboratory host — the grain moth — does not correspond, in terms of biochemical composition and size, to the nutritional requirements of the parasite. During long-term rearing of *Trichogramma* on grain moth eggs, a reduction

in the size of the entomophagous insect, decreased prolificacy, reduced searching capacity of females, and lower field effectiveness were observed.

In order to increase the vitality of laboratory populations, it is recommended to annually renew the parent culture by collecting egg masses of Lepidoptera parasitized by Trichogramma from nature, carrying out 1–2 spring passages on natural host eggs, and rearing the entomophagous insect on *Sitotroga cerealella* Ol. eggs previously irradiated with gamma rays, ultraviolet rays, magnetic fluid, and other sources.

Under these conditions, the biological indices of Trichogramma increase significantly.

- To improve biological indices, supplementary feeding of adults with sugar and honey solutions was applied.
- Preservation of the gene pool of the initial colony plays a very important role during mass rearing and release of the entomophagous insect in various agrocenoses, where uncontrolled environmental humidity and temperature conditions have different effects in nature.
- **The relationship between the general quality criterion and the predicted biological efficiency of the entomophagous insect in the field under optimal hydrothermal environmental conditions was established.**

Dr. Gavrilița L. developed the following methodological guidelines:

"Methodological Guidelines for the Production of T. embryophagum with Enhanced Qualities for Apple Crop Protection";

"Methodological Guidelines for the Production and Application of T. evanescens with Different Qualities for Maize Crop Protection";

"Methodological Guidelines for the Rearing and Application of *Trichogramma evanescens* with Enhanced Qualities for Cabbage Crop Protection";

"Methodological Guidelines for the Rearing and Application of *Trichogramma evanescens* with Enhanced Qualities for Tomato Crop Protection".

- **Development and implementation of methods for applying the entomophagous insect Trichogramma spp. in the integrated protection of annual crops.**

Researchers: Gavrilița L., Grinberg Ș., Boubătrân I., Pânzaru B., Vorotânțeva A., Orlovscaia V., Răileanu N., Adașcheevici A., Palii M.

Application of the entomophagous insect *Trichogramma* spp. in the integrated protection of cabbage, maize, pea, tomato, soybean, and sugar beet crops, reared on *Sitotroga cerealella* O. eggs for the control of cutworms, moths, and whiteflies, demonstrated that in the variant where methods for improving biological indices were applied, the biological efficiency was significantly higher than in the variant where *Trichogramma* was reared on *Sitotroga cereal*ella Ol. eggs using the traditional method.

- A linear relationship between the general quality criterion of the parasite and its biological efficiency in the field was established.
- Based on the experiments carried out, models were developed describing the Host: Parasite (H:P) relationship according to pest egg density, as well as the dependence of *Trichogramma* quality on temperature (T) and humidity (W).

New methods and procedures for the production and application of Trichogramma spp. were implemented for the protection of annual agricultural crops (vegetable, industrial, cereal, and leguminous crops).

- **Development and implementation of technologies for the multiplication and application of the entomophagous insect *Trichogramma* spp. in the integrated protection of perennial crops**.

Researchers: Gavrilița L., Cudreavțeva N., Diurici G., Vorotânțeva A., Serâi N. I., Moisei E., Feodor G.

The entomophagous insect *Trichogramma* was applied in the integrated protection of perennial crops such as apple, plum, and grapevine plantations, reared on Sitotroga cerealella O. eggs for controlling pest complexes.

"Methodological Guidelines for the Production and Application of the Entomophagous Insect Trichogramma spp. for the Protection of Annual and Perennial Agricultural Crops against Pests" were developed.

- **Development of technologies for the storage of the entomophagous insect Trichogramma for the protection of agricultural crops against pests.**

Researchers: Șleahtici V., Gavrilița L., Grinberg Ș., Negru E.

Research activities within this direction focused on developing methods for long-term and short-term storage (diapause) and production of the entomophagous insect Trichogramma for plant protection.

- "Methodological Guidelines for the Production and Application of *T. evanescens* with Different Storage Periods" were developed.
- Development of technologies for the use of the entomophagous insect *Trichogramma pintoi* in grain storage facilities for the control of moth complexes.

Researcher: Gavrilița L., 2009–2010.

As a result of research carried out in the grain storage facility in Chișinău, a technology was developed for the use of *Trichogramma pintoi* V. for the protection of cereal products (flour, wheat, barley) against moth complexes in storage facilities.

"Methodological Recommendations for the Use of the Entomophagous Insect Trichogramma pintoi in Grain Storage Facilities for the Control of Moth Complexes" were developed.

- **Development of technologies for the multiplication and use of the entomophagous insects *Bracon hebetor, Choioia cunea, Uscana senex, and Podizus maculiventris* for the integrated protection of agricultural crops.**

Researchers: Bradovscaia N., Glușcova G., Buzatu A., and the mechanization group.

The main research direction focused on the development of technologies for the multiplication and use of entomophagous insects in plant protection against agricultural crop pests.

The principal field of activity is biological plant protection, with the general theme:

"Development and Improvement of Methods and Technologies for the Production and Application of Beneficial Insects for Plant Protection" (*Bracon hebetor, Podizus maculiventris, Uscana senex, Choioia cunea*), reared on laboratory hosts such as *Aphis fabae*, *Galleria mellonella*, and others.

These entomophagous insects are maintained, produced, and utilized for controlling pest complexes in agricultural crops within plant protection systems.

Development of technologies for the multiplication and use of the entomophagous insect *Trichogramma* spp. for the integrated protection of agricultural crops.

Researchers: Gavrilița L., Răileanu N., Gavrilița V., Butucel M.

Studying the basic principles underlying integrated plant protection systems, the author emphasized the enhancement of beneficial organism circulation and the necessity of reducing harmful organisms.

As a fundamental principle, a transition was proposed from total pest eradication toward methods for regulating pest population density through a systemic approach to the problem as a whole.

For this purpose, biological plant protection methods were promoted through the application of the biological agent *Trichogramma* in assessing pest population status and regulating populations at the Economic Threshold Level (ETL).

Over many years, the biology, phenology, and systematics of *Trichogramma* species collected from different regions of the Republic of Moldova and from various agricultural crops were studied and maintained for further research.

Within the fundamental research directions, new procedures and methods for producing the entomophagous insect were substantiated, developed, and implemented, including rearing *Trichogramma* on eggs of the laboratory host *Sitotroga cerealella* treated with gamma rays, ultraviolet rays, magnetic fluid, and deuterium-depleted water, in order to improve quality and field efficiency.

Within the applied research directions, procedures and methods for using the biological agent in regulating the population density of the main agricultural crop pests were substantiated, developed, and implemented.

During the period 2000–2016, the total implementation area reached 3000 hectares of vegetable, leguminous, fruit, industrial, cereal, and forestry crops through

the use of *Trichogramma* spp. with enhanced qualities for crop protection against complexes of cutworms, moths, and whiteflies.

The biological efficiency of the entomophagous insect in field conditions was significantly higher compared to the variant where *Trichogramma* was reared on traditional *Sitotroga cerealella* eggs.

Using the BioClass program — a multicriteria spatio-temporal classification and optimization system — together with initial information regarding egg density per plant during the vegetation period, digital spatial distribution maps of pest eggs were created for the development period of two to three generations.

These maps identified uneven distribution patterns and localized pest outbreak centers, enabling optimization of the release rates and timing of the entomophagous insect *Trichogramma* spp.

These developments were tested under production conditions and recommended by the Scientific Council of IGFPP for practical implementation.

"Methodological Guidelines for the Production and Application of the Entomophagous Insect Trichogramma spp. for the Protection of Agricultural Crops against Pests" were developed in 2008 and 2015.

CONCISE RESULTS OBTAINED DURING THE PERIOD 1916–2026

During the period 1916–2026, fundamental and applied research was carried out on the entomophagous insect *Trichogramma* spp.

- **Technologies for the multiplication of *Sitotroga cerealella* as a laboratory host for obtaining the entomophagous insect *Trichogramma* spp. and its application in integrated biological protection systems for various agricultural crops.**

Researcher: Dr. Gavrilița L.

- **Efficiency of certain methodological procedures for increasing the vitality of the entomophagous insect *Trichogramma* spp. reared on eggs of different hosts.**

Development of technological procedures for increasing the vitality of the entomophagous insect *Trichogramma evanescens* West. in order to enhance the reduction rate of pest population density in agricultural crops.

Researchers: Dr. Gavrilița L., Dr. habil. Nastas T., Technician Butucel M.

- **Assessment of the efficiency of biologically active substances with kairomonal properties under field conditions (sunflower crop) in increasing the pest egg parasitism potential of the entomophagous insect *T. evanescens* W.**

Researchers: Dr. Gavrilița L., Dr. habil. Nastas T., Technician Butucel M.

- **Assessment of the efficiency of biologically active substances with kairomonal properties on the behavior of the entomophagous insects *Trichogram-***

***ma evanescens* West. *Trichogramma dendrolimi* Mats., and *Trichogramma pintoi* Voeg. aimed at increasing the pest egg parasitism potential.**

Researchers: Dr. Gavrilița L., Dr. habil. Nastas T., Technician Butucel M.

- **Detection, identification, maintenance, and accumulation of *Trichogramma* species collected from agricultural crops, maintenance of live cultures, and accumulation of the laboratory host Sitotroga cerealella Ol.**

Researchers: Dr. Gavrilița L., Dr. habil. Nastas T., Technician Butucel M.

Methodological recommendations for plant protection.

Researcher: Dr. Gavrilița L.

1. During the development of 2–3 generations of pests on annual and perennial plants, entomophagous insects play a very important role in reducing pest density. For this purpose, the following integrated protection measures should be implemented:

2. During the adult stage of pests, pheromone or light traps should be installed for monitoring and mass capture of butterflies/moths (males);

3. During the pest egg stage, 5–6 releases of *Trichogramma* should be carried out at a rate of 100,000–600,000 individuals per hectare (depending on pest density);

4. During the larval stage, other entomophagous insects such as *Bracon, Apanteles*, etc., may be released;

5. Biological preparations should be applied for pest control;

6. One or two fungicide treatments should be carried out for disease control;

7. One or two selective insecticide treatments should be carried out against pest complexes if necessary;

8. Mechanical and physical measures should be applied;

9. Agrotechnical measures and crop rotation should be implemented for the respective crops.

As a result:

- Plant protection costs can be reduced by 3–4 times compared to chemical preparations;
- Beneficial organisms in nature are preserved;
- The number of chemical treatments in integrated protection systems is minimized;
- Conditions are created for reducing environmental pollution;
- Ecological and high-quality agricultural products are obtained.

Advantages of biological plant protection using the entomophagous insect *Trichogramma* spp.

Researcher: Dr. Gavrilița L.

The priorities of applying the entomophagous insect *Trichogramma* include:

- Reduction of financial costs for crop protection;
- Preservation of beneficial organisms in nature;
- Increased biological efficiency in the field;
- Reduction of agricultural production costs;
- Improvement of agricultural product quality;
- Increased agricultural yield in the field;
- Low cost;
- Establishment and maintenance of natural biological balance;
- Assurance of food product quality;
- Minimization of chemical treatments within integrated protection systems;
- Prevention of environmental pollution;
- Safety and harmlessness;
- Good quality; Ease of application; Ecological purity.

Pest eggs fresh and parasitized with Trichogramma

The developed procedures and methods enabled the integration of the obtained results into integrated agricultural plant protection practices, reducing costs by 3–4 times compared to chemical protection.

Integrated protection aims to minimize or avoid the use of polluting chemical products and to promote the use of biological methods without harmful effects on humans and beneficial entomofauna, in order to maintain an appropriate phytosanitary condition and obtain ecological agricultural production.

Results of Dr. L. Gavrilița's activity during the period 1967–2026:

1.Published articles – 350

2.Patents for inventions – 15

3.National and international projects – 10

4. Participation in conferences (national and international) – 185

5. Participation in seminars – 167

6. Participation in various exhibitions – 108

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Doctor of biology, associate research professor, coordinating scientific researcher – Lidia Gavrilița, 2026.

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