

USE OF THE BIOLOGICAL CONTROL TECHNOLOGY OF PRODUCTS STORED IN TACKLING COMPLEX GRAIN MOTHS

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INTRODUCTION

The damage caused by the insects to the agricultural products has a great economic importance. There have been undertaken numerous and various investigations, relating to this issue, therefore, a series of synthesis papers of general and systematic nature concerning this group of insects were realized. Studies on the biology and ecology of the insect pests of the stored cereal products have been published by Evans, 1987.

A major concern in the protection of the stored agricultural products is the biological control of the pests. Scientific papers have been elaborated by many authors on the use of the parasitic hymenoptera in the biological control of the insect pests of the stored agricultural products. To control the complex of flour pests there have been performed the experiments with three species of *Trichogramma* - *T. deion*, *T. ostrinia*, *T. pretiosum* in the laboratory conditions for control of *Plodia interpunctella* (Mattheew, 2008).

The researches on application of the biological protection of stored pests control with the different species of entomophagous - *Trichogramma pretiosum* and *Bracon hebedor* have been realized by (Browe, 1988; Brower & Press, 1990). The works of these authors demonstrated the real possibility of application of the entomophagous (*Trichogramma* and *Bracon*) in the control of the moth product pests as one of the main elements of the integrated protection of the stored food products.

The approach to the integrated protection strategy of the stored food products is well reflected in the work of the authors (Todiras et al., 2009). There is a large complex of the pests in the warehouses: *Calandra granaria* L., *Sitophilus granarius* L., *Acarus siro* L., *Sitotroga cerealella* Ol., *Tinea granella* L., *Plodia interpunctella* Hubn., *Ephestia elutella* Hubn., *Ephestia kuhniella* Zell., etc.

Against these pests different control methods are used: biological, chemical controls, fumigation, the use of pheromones, acoustic methods, thermal methods, application of plant products, gamma radiation, animal pests etc.

The objective of the studies: Evaluation of the application technology of *Trichogramma pinto* V. and other elements of biological protection in control of the moths in the stored products.

MATERIAL AND METHODS

The objects of research during the 2009-2010 were entomophagous *Trichogramma pinto* and the hosts *S. cerealella* Ol., *P. interpunctella* L. and *E. kuehniella* Zell. The researches were conducted in the laboratory conditions in the Institute of Genetics Physiology and Plant Protection and in the grain warehouse from Chisinau. Biological indices of entomophagous *Trichogramma pinto* were determined with the goal of using the entomophagous in the warehouse against a complex of moths. The collection, determination, maintaining and accumulation of the species of *Trichogramma* sp. were performed according to the author methods (DIURICI, 2008), which are to be recommended.

Rearing the laboratory host grain moth (*Sitotroga cerealella* Ol.), determining biological indices of *T. pinto*, determination of the biological efficacy of *Trichogramma* were performed according to the traditional methods of the authors (Abaschin, et al 1979).

Breeding of grain moth and *Trichogramma*, evaluation of biological effectiveness of entomophagous by pest and mathematical data processing were conducted according to the relevant procedures and guidelines for the mass breeding and use of *Trichogramma* (ABASCHIN Et Al., 1979; MENCER & ZIMERMAN, 1986).

The biological efficacy of *T. pinto* after each launch was determined taking into consideration the number of moth larvae from the samples of wheat flour. The biological efficacy of *T. pinto* was determined by the formula: $E = 100 - B/A \times 100$, where: E - biological efficacy expressed in % compared with the control; A - the average number of pest in control; B - the average number of pest in experiments („Îndrumări metodice pentru testarea produselor chimice și biologice, 2002).

RESULTS AND DISCUSSIONS

1. Evaluation of the percentage of infestation and biological effectiveness of *T. pinto* as a result of different tests conducted at different cereal products' substrates in the warehouse

Experiences were held in the thermostat at the temperature of $25\pm 1^\circ\text{C}$ and relative humidity of the air of 80-85 %, with a repetitively of 5 times. Experiments were mounted in a glass desiccator with a cereal product substrate of a thickness of 5-6 cm, in an amount of 1 kg of each substrate on: wheat, barley, maize, and that has been beforehand infested with grain moth (for each kg of cereals' substrate a gram of moth eggs were used).

The period of development of a grain moth generation substrates lasted 32-34 days after which the butterflies started flying and precisely 5 days after (during which butterflies laid their eggs) *T. pinto* was launched with a report of parasite: host of 1:10 (100 females to 1000 eggs) to combat grain moth. Five days after the launch of *Trichogramma*, biological effectiveness was determined of *T. pinto* (number of eggs parasitized) on each substrate of

cereal product. In Control, the experiments were carried out without substrates (Table 1, Fig. 1).

Analyzing the number of infested grains on variants, it has been revealed that the substrate of barley grains was infested up to 90.8%. Number of parasitized eggs by the *T. pinto* on the barley substrate was of 78.2%. The infestation on the wheat substrate has achieved 82.4 % and on corn the infestation percentage was of 78.4%. Parasitizing percentage on the wheat layer has achieved 72.5%, on corn though it was of 70%. In Control experiment the researches were conducted without substrates, where the number of parasitized eggs achieved the 86.7% level.

Determination of the biological efficiency of *Trichogramma pinto* in the ecologic space room and within the warehouse.

With the goal of elaboration of utilization the technology of *T. pinto*, for integral protection of the cereal products, and control over the moth complex in the warehouses, artificial conditions were created, but similar to the ones in warehouses, where preliminary results have been estimated for later *Trichogramma* control technology implementation and examination.

Table 1. The biological efficacy of *T. pinto* at different layers of cereal products in the warehouse

Nr. of variants	Layers types	% of the invested grains	% of <i>S. cerealella</i> parasitized eggs on layers
1	barley	90,8 \pm 3.1	78,2 \pm 2.6
2	wheat	82,4 \pm 2.9	72,5 \pm 2.1
3	corn	78,4 \pm 2.8	70 \pm 2.0
5	Control (no layers)	0	86,7 \pm 2.9

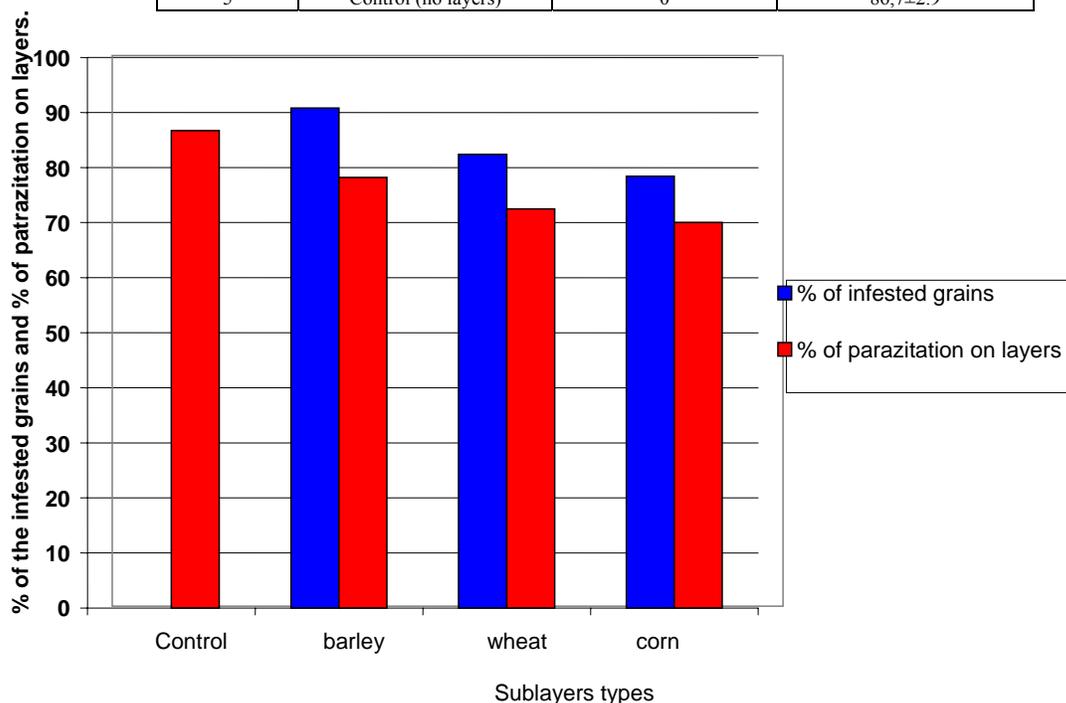


Figure 1. Percentage of the grains infested by grain moth *S. cerealella* and brown moth *T. pinto*

Laboratory experiments were carried out in the ecological room at the temperature of $25\pm 1^{\circ}\text{C}$ and relative humidity of 80-85%, in 50 repetitions (50 cards). Thermostat's volume is $2\text{m} \times 2\text{m} \times 2\text{m} = 8\text{m}^3$, where eggs of *S. cerealella* and *E. kuhniella* were placed on small sized cards. In the given space, *T. pintoii* was launched in 10 capsules with the launch norm of 1000 females at 20.000 eggs of *S. cerealella* and *E. kuhniella* with the rate of parasite: host of 1:20. After 7 days we conducted the tracking of the number of host eggs parasitized (blackened) on cards by entomophage *T. pintoii*, where the biological effectiveness in combating hosts by *T. pintoii* varied from 60.4 to 80%.

Under the same laboratory conditions of ecologic room, experiences with the same hosts were carried out with the optimal rate of 1:1 (parasite: host). Number of parasitized eggs of *S. cerealella* and *E. kuhniella* in the area of 8m^3 varied from 62,5 to 88,6%. The entomophagous searched for the moth eggs in the given area and parasitized them. In a warehouse, which is much bigger hosts eggs can be searched and parasitized by *Trichogramma*, but with a smaller rate of parasite:host.

2. Determination of the percentage of parasitized eggs by *T. pintoii* in the grain warehouse from Chisinau.

Before launch, in the warehouse the biological indexes were determined of *T. pintoii*. The indexes were: a prolific female 31.9-a female egg, exclusion of the individuals 91.6%, female share 60.4%, static criterion of the quality 17.4. With the scope of determination of the moth's parasitized eggs number by *T. pintoii*, in the warehouse from Chisinau, an artificial fond has been created to have a more precise evidence, by fixing 120 cards on the walls of the warehouse, window, machinery, with an amount of 12.000 eggs of *S. cerealella* preliminarily irradiated with gamma rays. In this warehouse *Trichogramma T. pintoii* has been launched in capsules, with a rate of 1:1 (host: parasite), meaning 12.000 moth eggs to 12.000 *Trichogramma* females. The cards have been later on gathered and analyzed in depth, this way being examined the number of parasitized and exhibited eggs. The results were 61,8 to 80,24% of parasitization. It can be affirmed that in the grain warehouses the entomophagous *Trichogramma* can be used as one of the main elements in integral protection.

During the years 2009-2010 the experiments were carried out in grain warehouse from Chisinau. The evidence of the pests in storage was carried out on the entire surface of the investigated territory by means of application of the main techniques for monitoring inspections: inspections, sampling, temperature monitoring, and usage of pheromone traps. In order to determine the presence and numerical density of the various species of moths in

the grain store were mounted the pheromone traps for: *E. kuhniella* Zell., *P. interpunctella* Hubn. and *E. elutella* Hubn. The monitoring of the moths by using of the pheromone traps (Fig. 4) during the storage of cereal products was carried out from 18th of May till 20th of May 2010. As a result of records of moths from traps, the following species were found out in the warehouse: *E. kuhniella*, which vary from 8.0 till 80.0 individuals and *P. interpunctella* from 1.0 till 5.0 individuals in a pheromone trap at the Mill No.1. At the mill No. 2 *E. kuhniella* from 7.0 till 86.0 individuals were caught in a trap, *P. interpunctella* varied from 1.2 till 3.0 individuals. In the elevator (grain store) *E. kuhniella* were caught in a trap in average from 2.0 till 10.0 individuals, *P. interpunctella* varied from 5.0 till 79.0 individuals. In the flour storage were caught in a trap from 17.7 to 109.0 *E. kuhniella* individuals, but the *P. interpunctella* varied from 3.0 till 7.0 individuals. In elevator No. 2 - wheat warehouse, which served as a control – were caught in a trap from 3.0 till 9.0 *E. kuhniella* individuals, *P. interpunctella* varied from 19.0 till 139.0 individuals. The difference of the average is essential. *E. elutella* was not captured in the pheromone traps. In the flour mills predominate *E. kuhniella*, but in the elevator – *P. interpunctella*. The average temperature from the 18th of May till the 20th of august 2010, varied from 18.5°C to $T = 28^{\circ}\text{C}$.

3. Determination of the numerical density of moths in the cereal products storehouse.

To identify the strategies that would ensure the protection of the stored cereals stocks, the first requirement is the knowledge of the diversity of the pests existing in storehouse. To realize this program of the moths control with *T. pintoii* was necessary to determine the species and numerical density of moths' complex from the grain storehouse from Chisinau.

To determine the density of moths' complex (number of larvae) within the grain warehouse and the wheat elevators were collected of 9 samples from the different places in each store for every record. Determination of the numerical density of moths in the grain mill was made according to (Todirach V. et al., 2009).

After determining of the pest density it was determined the biological efficacy of *T. pintoii* in the control of moths *E. kuhniella* and *P. interpunctella* in storehouses. The entomophage *T. pintoii* was used as one of the important elements in the integrated protection of cereal products. (Fig. 2). Entomophage *T. pintoii* was launched in capsules. The records of the bags of cereal products, walls, windows, equipment in the warehouse were realized, and then *T. pintoii* launched. During experiments, *T. pintoii* has been launched six times and were realized seven records before and after the launch of the moths *Ephestia kuhniella* and *Plodia interpunctella*.

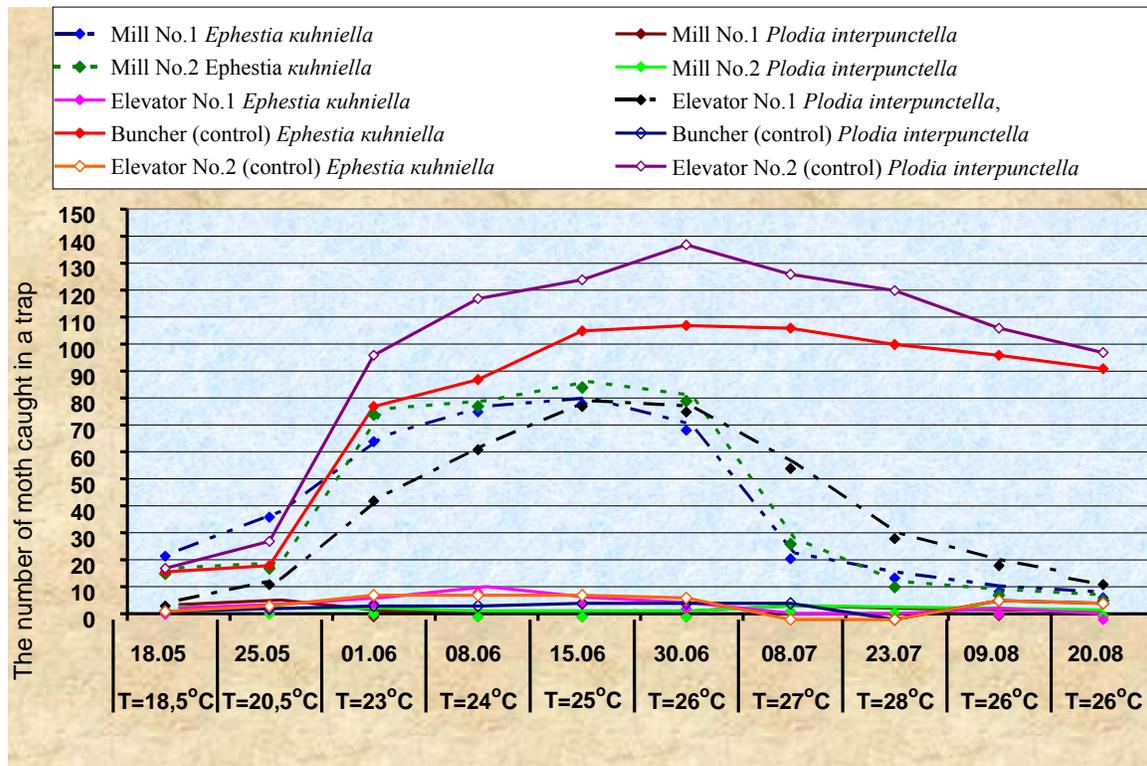


Fig. 2. The dynamic of moths caught in the traps and the temperature

The biological efficacy after six launches of *T. pinto* varied from 16.67% to 71.4% within the Mill No.1. The biological efficacy of *T. pinto* varied from 20.0% to 68.5% within the, Mill No. 2. Within the elevator No.1 (grain store), the biological efficacy of *T. pinto* varied from 27.50% to 73.3%.

In the control (flour mill and elevator No.2), where the entomophage has not been launched, the efficacy was not reported. The biological efficacy of *T. pinto* increased after each start until the end of the experiments. When comparing the efficacies of *T. pinto* at the mill No.1, N2, Elevator No.1 and control (where the entomophage has not launched), the difference of the average was significant: $(T_d = 2.88-10.40) > (T_{0.05} = 2.12)$ after sixth launches. Our results demonstrate that the release of *T. pinto* into commodity storages could play an important role in population suppression of stored product moth populations, especially as part of an integrated control program.

CONCLUSIONS

As a result of the evaluation of the percentage of infestation, of *Sitotroga cerealella* and *Ephestia kuhniella* Z, in laboratory conditions in different sublevels of barley, wheat, corn warehouses, the values of infestation varied from 70% to 90.8%.

The density of larvae in the warehouse varied from 2 to 3. 4 individuals at mill Nr. 1 and mill Nr. 2.

In the control (warehouse) larvae density varied from 3 to 7.5 individuals. In the elevator Nr.1 (wheat storage), the larvae density varied from 2.7 individuals to 4.4 individuals. In control at elevator Nr. 2 the number of larvae varied from 4 to 10,2 individuals. There is a very big difference with comparison to the control. The most encountered pests at the cereal warehouses from Chisinau were *E. kuhniella* and *P. interpunctella* against these *T. pinto* has been launched six times.

We determined the biological effectiveness of *T. pinto* in the ecologic rooms and grain storages against the moth complex. The number of eggs of *S. cerealella* and *E. kuhniella* parasitized by *T. pinto* in the area of 8 m³ where the optimal ratio (P:H) is 1:1 ranged from 60.4 to 88.6%. The number of eggs parasitized in the deposit by *T. pinto* were 61.8%-80.24%.

We determined the norms for launching and biological effectiveness of *T. pinto*. As a result of the launch of entomophage *T. pinto* in the ecologic room and storage spaces on the cards, it was determined – the biological effectiveness of *T. pinto*. Analyzing range parasite:host relationships, it was found that the optimum ratio (P:H) is 1:1, where the maximal effectiveness in combating moths complex in the ecological room is 88.66% and 80.24% in deposits.

In the control option from bunker, which was held in the elevator Nr.1 (flour warehouse), Nr. 2

(wheat warehouse) and where the entomophagous has not been launched, the effectiveness has not been reported. The mean differences is critical, (DEM), (Td = 2.88 to 10.40 > 2.12 = T0.05), after the second - the sixth release.

Larvae density in the storage ranged from 2.0 to 3.4 individuals, mill N1, N2 flour storage, the control – bunker (flour storage), larval density ranging from 3 to 7.5 individuals. The elevator N1 (wheat storage) larval density ranged from 2.7 to 4.4 individuals, in the control - (Elevator N2 - storage of wheat) larval density ranged from 4.0 to 10.2 individuals. The difference is essential in comparison to the control.

The results obtained from the 2009-2010 years, were used for elaboration of the technology used for *T. pintoi*, for integral protection of the cereal products used against moth complex in the warehouses.

ABSTRACT

Before launch, in the warehouse the biological indexes were determined of *Trichogramma pintoi*. The indexes were: a prolific female 31.9-a female egg, exclusion of the individuals 91.6%, female share 60.4%, static criterion of the quality 17.4. With the scope of determination of the moth's parasitized eggs number by *T. pintoi*, in the warehouse from Chisinau, an artificial fond has been created to have a more precise evidence, by fixing 120 cards on the walls of the warehouse, window, machinery, with an amount of 12.000 eggs of *Sitotroga cerealella* preliminarily irradiated with gamma rays. In this warehouse *T. pintoi* has been launched in capsules, with a rate of 1:1 (host: parasite), meaning 12.000 moth eggs to 12.000 *Trichogramma* females. The cards have been later on gathered and analyzed in depth, this way being examined the number of parasitized and exhibited eggs. The results were 61.8 to 80.24% of parasitization.

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