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POPULATION CONTROL OF THE COTTON BOLLWORM (*HELICOVERPA ARMIGERA* HÜBNER) ON TOMATOES IN GREENHOUSE

КОНТРОЛЬ ЧИСЕЛЬНОСТІ БАВОВНИКОВОЇ СОВКИ НА ТОМАТАХ У ЗАКРИТОМУ ГРУНТІ

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Abstract. *Helicoverpa armigera (Hübner), commonly known as the cotton bollworm, is one of the most destructive pests affecting tomato (Solanum lycopersicum Mill.) cultivation worldwide. Its polyphagous nature, high reproductive potential, and resistance to insecticides present significant challenges for pest management. This study aimed to evaluate the efficacy of biological control using two entomophagous agents—Trichogramma spp. (egg parasitoid) and Habrobracon spp. (larval ectoparasitoid)—against H. armigera in greenhouse-grown tomato crops. Monitoring of pest flight activity was conducted using pheromone traps at a density of one trap per hectare, while pest population assessments were based on fruit inspections of 100 plants across four replicates. Biological agents were released in two applications targeting different pest generations. Trichogramma was applied at 1.5 g/ha during peak moth activity and again at 1.0 g/ha after five days. Habrobracon was released at 500 individuals/ha upon detection of third-instar larvae and repeated after three days. The combined application of these biological agents led to a significant reduction in H. armigera populations—by 4 to 6 times compared to pre-treatment levels. The average biological efficacy reached 73.5% for the second generation and 82.9% for the third. These findings confirm the high potential of integrated biological control strategies for effective and environmentally sustainable management of Helicoverpa armigera in protected tomato cultivation.*

Key words: *Helicoverpa armigera, tomato, biological control, Trichogramma, Habrobracon, greenhouse, integrated pest management, pheromone monitoring*

Introduction.

Tomato (*Solanum lycopersicum* Mill.) is among the most widely cultivated solanaceous vegetable crops globally and holds the second position in significance after potato in numerous countries. Identified thirteen insect pests associated with tomato crops, predominantly from the orders *Lepidoptera*, *Coleoptera*, and *Hemiptera*.

The major insect pests affecting tomatoes include the fruit borer (*Helicoverpa armigera* Hübner), whitefly (*Bemisia tabaci*), jassid (*Amrasca devastans* Ishida), leafminer (*Liriomyza trifolii* Blanchard), and the potato aphid (*Myzus persicae*). The fruit borer, *Helicoverpa armigera* (Hübner), is recognized as the most damaging pest of tomato. Commonly referred to as the gram pod borer, American bollworm, or tomato fruit borer, it can inflict crop losses of up to 40–50% [3]. Early instar larvae primarily feed on foliage, flower buds, and blossoms, while later instars bore into developing fruits, making them unfit for market [4]. Its broad host range, capacity for multiple generations per season, migratory behavior, high reproductive potential, and resistance to many insecticides make this pest particularly challenging to manage [5, 6]. Globally, *H. armigera* is responsible for annual agricultural losses estimated at around 5 billion USD [7]. In tomato production, it contributes to significant reductions in yield, ranging from 20% to 60% depending on infestation levels [8–10].

Helicoverpa armigera belongs to the order *Lepidoptera*, family *Noctuidae*. The adult moth is 18–20 mm long, with a wingspan of 3.5–4.0 cm (Figure 1). Males are generally larger than females. Eggs are small (up to 0.6 mm in diameter), hemispherical, and turn nearly black when parasitized by *Trichogramma* spp. Larvae vary in color, most commonly yellowish-green (Figure 2).. The pupa is 16–20 mm in length, with two slightly curved spines at the posterior end of the abdomen [11].

Figure 1 – Adult moth of the cotton bollworm

Figure 2 – Tomato fruit damaged by cotton bollworm larvae

Monitoring populations of lepidopteran pests is most effectively and efficiently carried out using pheromone traps. These allow for the assessment of seasonal population dynamics and provide accurate timing for the implementation of targeted control measures. The economic threshold for *H. armigera* on tomato is 20 males per trap over a 3-day period (or 5 larvae or 15–20 eggs per 100 plants during the budding stage, and 40–90 eggs during fruit setting).

The use of pheromone and chromotropic (colored sticky) traps enables precise detection of pest hotspots, prediction of infestation timing and intensity, assessment of seasonal activity, and thus optimization of control measures to increase their efficacy [12].

Although natural enemies (entomophagous insects) play a role in regulating pest populations, their natural impact is often insufficient. One component of integrated pest management (IPM) is the seasonal augmentation of biological control agents, which allows manipulation of agroecosystem dynamics during periods of low natural enemy abundance. A key beneficial group in this context is *Trichogramma* spp. (Hymenoptera: Trichogrammatidae), which enrich agrocenoses with effective parasitoids [13].

The release of *Trichogramma* can reduce *H. armigera* populations by 60%–80%, especially when combined with regular pest monitoring and appropriate cultural practices [14]. Findings from the article *"Biological control of Spodoptera spp. with Trichogramma spp. in tomato crops"* confirm the high efficacy of *Trichogramma* species in suppressing *H. armigera* infestations in tomato fields, particularly under organic farming systems [15].

Main text.

The success of biological pest control using entomophagous insects can depend significantly on the timing of their release and the population density introduced into the field. In modern tomato production systems—as well as in other agricultural crops—particular attention is given to the safety of plant protection strategies while maintaining high levels of efficacy. It is well established that many chemical control agents contain potent active substances that may adversely affect human health and agrobiocenoses. Their use contributes to environmental pollution, accumulation of pesticide residues in agricultural products, and, consequently, poses a serious threat to human health.

The objective of the present study is to assess the efficacy of applying the egg parasitoid *Trichogramma* spp. and the larval ectoparasitoid *Habrobracon* spp. for population control of the cotton bollworm (*Helicoverpa armigera*) in greenhouse-grown tomato crops.

To monitor the flight dynamics and seasonal activity of the pest on tomato plantations, pheromone traps were deployed at a density of one trap per hectare. Population assessments of *Helicoverpa armigera* were conducted by inspecting tomato fruits on 100 plants, selected from different locations within the field, with observations replicated four times.

Due to the extended flight period of the pest, biological control agents were applied twice. *Trichogramma* spp. were released at a rate of 1.5 g/ha during the peak flight of *Helicoverpa armigera* adults, followed by a second application at 1.0 g/ha five days later. *Habrobracon* spp. were introduced at the initial appearance of third-instar larvae, at a density of 500 individuals per hectare, with a repeated release at the same

rate three days later. *Trichogramma* was utilized to parasitize pest eggs, while *Habrobracon* targeted the later larval instars.

The implementation of control measures against the cotton bollworm (*Helicoverpa armigera*) is often complicated by the pest's biological characteristics. The larvae exhibit a concealed lifestyle, burrowing into tomato fruits, which limits the effectiveness of most contact insecticides. As a result, pest management strategies often rely solely on systemic insecticides. An effective alternative is the use of entomophagous insects capable of reaching the larvae inside the fruit. Among these, *Trichogramma* spp. are particularly effective, parasitizing the pest's eggs and preventing larval emergence.

The first generation of *H. armigera* is typically low in number and develops mainly on wild host plants; therefore, its impact on cultivated tomato crops is generally minimal and often not taken into account in control planning. To determine the timing of adult emergence for the second and third generations, pheromone traps were used (Figure 3). These traps were installed in early June. The capture of 2–3 male moths per trap per day signaled the onset of oviposition and served as the basis for the timed release of *Trichogramma* spp. for biological control of the pest population.

Figure 3 – Pheromone trap-based monitoring and control of cotton bollworm (*Helicoverpa armigera*)

To control the phytophagous pest, two biological releases of entomophagous agents—*Trichogramma* spp. and *Habrobracon* spp.—were carried out targeting two generations of the cotton bollworm (*Helicoverpa armigera*). This approach resulted in a significant reduction of pest population—by 4 to 6 times compared to the initial levels.

The use of *Trichogramma* and *Habrobracon* on tomato plantations demonstrated high efficacy. The average biological control efficiency reached 73.5% for the second generation and 82.9% for the third generation of the pest.

The obtained results confirm the effectiveness of biological control in reducing *H. armigera* populations and support its feasibility as a sustainable strategy for the protection of agricultural crops.

Summary and conclusions.

Damage caused by the cotton bollworm (*Helicoverpa armigera*) is undoubtedly one of the key limiting factors in global tomato production.

Ukrainian tomato producers have access to a wide range of both chemical and biological pest management methods, including the use of synthetic insecticides, biological control agents, and agronomic practices aimed at conserving and enhancing populations of natural enemies.

In this context, excessive reliance on a single control strategy is considered ineffective. It is advisable to implement an Integrated Pest Management (IPM) approach, which involves the combination of complementary methods to effectively suppress pest populations below the economic threshold level.

References:

1. Клечковський Ю. Є., Глушкова С. О., Могилюк Н. Т., Ігнатьєва О. В. Шкідливість популяції бавовникової совки та мікробіоконтроль її чисельності на посівах томатів. *Агробіологія*. 2017. №1, с. 52–58.

2. Коваленко О. В. Біологічні методи боротьби з совкою на овочевих культурах. *Захист рослин і карантин*. 2020. №3, с. 14–18.

3. Ткачук М. І., Станкевич С. В. Інтегрований захист овочевих культур у закритому ґрунті. *Вісник аграрної науки Причорномор'я*, №2, с. 21–26.

4. Дрозда В. Ф. Бавовникова совка. Захист рослин. 2002. № 12. С. 17–18.

5. Bagheri A., Seyahooei M. A., Fathipour Y. Eco-friendly managing of *Helicoverpa armigera* in tomato field by releasing *Trichogramma evanescens* and *Habrobracon hebetor*. *Journal of Crop Protection*, 8(1). 2019. 11–19.

6. Трибель С. О., Федоренко В. П., Лапа О. М. Совки (Найпоширеніші види в Україні). К.: Колобіг, 2004. 72 с.

7. Байдик Г. В. Бавовняна совка – багатоїдний шкідник сільськогосподарських культур [Електронний ресурс]. Syngenta Україна. 2017. Режим доступу: https://www.syngenta.ua/news/sonyashnik/bavovnikova-sovka-bagatoyidniyshkidnik-silskogospodarskih-kultur

8. Довгань С. В. Бавовняна совка – небезпечний шкідник [Електронний ресурс]. – Режим доступу: http://golovderzhzahist.com.ua [in Ukrainian].

9. Горяінов О. М., Станкевич С. В. Біоінсектицидний захист томатів у закритому грунті від основних шкідників. *Захист і карантин рослин у XXI столітті: проблеми і перспективи. Матеріали II Міжнародної науково-практичної конференції, присвяченої ювілейним датам від дня народження видатних вчених-ентомологів докторів біологічних наук, професорів О. О. Мігуліна та О. В. Захаренка* (м. Харків, ДБТУ, 19–20 жовтня 2023 р.). Житомир: Видавництво «Рута». С. 52–54.

10. Stankevych S., Horiainov O., Horiainova V. The common tomato insect pests in greenhouses. *Integration vectors of sustainable development: economic, social and technological aspects. Monograph. Edited by Aleksander Ostenda and Oleksandra Mandych.* The University of Technology in Katowice Press. 2023. 359–369 P. DOI: 10.54264/M019

11. Liu Z., Li D., Gong P., Wu K. Life table studies of the cotton bollworm, *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae), on different host plants // *Environmental Entomology*. – 2004. – Vol. 33, No. 6. – P. 1570–1576. https://doi.org/10.1603/0046-225x-33.6.1570

12. Облік шкідників та хвороб сільськогосподарських культур / В.П. Оме- Всеукраїнська науково-практична конференція, 21 березня 2023 р. 21 люта, І. В. Григорович, В. С. Чабан та ін. Под ред. В. П. Омелюти. К.: Урожай, 1986. 296 с.

13. Міністерство аграрної політики України. Методичні рекомендації щодо застосування феромонних пасток у системі захисту овочевих культур. Київ: НААН. 2021.

14. Моніторинг лускокрилих шкідників світловими і феромонними пастками на полях агрохолдингу AGR Group. *SuperAgronom.com*. URL: https://superagronom.com/blog

15. Huang J., Hao H. Effects of climate change and crop planting structure on the abundance of cotton bollworm, *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae). *Ecology and Evolution*. 2020. Vol. 10, № 3. P. 1324–1338. https://doi.org/10.1002/ece3.5986

Анотація. *Helicoverpa armigera (Hübner), більш відома як бавовникова совка, є одним із найбільш шкідливих фітофагів, що уражають Solanum lycopersicum Mill. (томат) у світовому масштабі. Її поліфагізм, висока репродуктивна здатність та резистентність до інсектицидів створюють суттєві труднощі в реалізації ефективних заходів контролю. Метою даного дослідження було оцінити ефективність біологічного контролю чисельності Helicoverpa. armigera у тепличних насадженнях томата шляхом застосування двох ентомофагів: яйцеїда Trichogramma spp. та личинкового ектопаразита Habrobracon spp.. Моніторинг льоту імаго шкідника здійснювали із застосуванням феромонних пасток із нормою розміщення одна пастка на гектар. Облік чисельності совки проводили шляхом візуального огляду плодів на 100 рослинах у чотирьох повтореннях. Біологічні агенти випускали дворазово, орієнтуючись на фенофази розвитку шкідника. Trichogramma застосовували у нормі 1,5 г/га під час піку льоту імаго та повторно — 1,0 г/га через п'ять діб. Habrobracon випускали в кількості 500 особин/га при виявленні гусениць третього віку, з повторенням через три доби. Комбіноване застосування ентомофагів забезпечило значне зниження чисельності H. armigera — у 4–6 разів порівняно з початковими показниками. Середня біологічна ефективність склала 73,5 % для другого покоління та 82,9 % — для третього. Отримані результати підтверджують високий потенціал інтегрованих біологічних стратегій захисту для ефективного та екологічно безпечного контролю бавовникової совки в умовах захищеного ґрунту.*

Ключові слова: *Helicoverpa armigera, томат, біологічний контроль, Trichogramma, Habrobracon, теплиця, інтегрований захист рослин, феромонний моніторинг.*

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