Infestation of cabbage white with *Apanteles glomeratus* in the Zeravshan Valley

Dilafruz Sattarova[1*], *Nuriniso* Rajamuradova[2], and *Mehrubon* Xurramova[2]

[1]Samarkand State University named after Sharof Rashidov, Samarkand, Uzbekistan
[2]Uzbek-Finnish Pedagogical Institute, Samarkand, Uzbekistan

Abstract. The cabbage white butterfly (*Pieris brassicae*) is a dominant species among cabbage pests, and the role of natural enemies in regulating the population of this pest is quite large. Two species of parasite were found on the larvae of the cabbage white butterfly - *Apanteles glomeratus* L. and *Eulophus larvarum* (L), and one species of pupae - *Pteromalus puparum* (Linnaeus, 1758). Infestation of larvae with the parasite Eulophus larvarum was 1.9%, and infestation of pupae with Pteromalus puparum was 9.1%. The most effective parasite is *Apanteles glomeratus*, infesting from 34.6% to 42.1% of larvae. Infestation of larvae of different generations of the cabbage white butterfly with parasites varies significantly. The lowest degree of infestation was noted in the larvae of the first generation - 12.0-17.3%. During the growing season, the effectiveness of the parasite gradually increases and the highest degree of infection of the pest larvae is observed in the 5th generation larvae - 51.5-60.0%. From one infected pest larva, an average of 17.5 parasite larvae emerged. The survival rate of Apanteles glomeratus pupae was 80.8%.

1 Introduction

The Zarafshan Valley is a large intermountain depression located on the territory of Uzbekistan and Tajikistan. It covers the Samarkand, Navain and Bukhara regions of Uzbekistan. The invertebrate fauna of the Zarafshan Valley is very diverse and is currently being intensively studied [1-4]. In recent years, the study of the entomofauna of this region has been carried out mainly in natural ecosystems [5-10]. However, there are very few modern studies on the study of the beneficial entomofauna of agrocenoses that are important in biological regulation [11].

Among the cultivated vegetable crops in this region, white cabbage occupies a special place. There are many factors limiting the yield of this crop, among which the largest share falls on insect pests. The most harmful in the region are *Pieris brassicae, Plutella xylostella, Brevicoryne brassicae* and others [12].

In the fight against cabbage white butterfly, special attention is paid to environmentally friendly control methods. The effectiveness of bioinsecticides against this pest has been studied [13, 14].

* Corresponding author: balikulov87@gmail.com

Natural enemies – entomophagous insects – play a significant role in reducing the numbers of cabbage whites. According to researchers, there are more than 50 species of entomophages of cabbage whites [12,15], among which the most effective are *Apanteles glomeratus* and *Pteromalus puparum* [12].

The infestation rate of the cabbage white *Apanteles glomeratus* larvae ranges from 15-20% to 50%, depending on weather conditions, and the infestation rate of the *Pteromalus puparum* puparia ranges from 3% to 40% [15]. In some years, natural enemies reduce the cabbage white population by up to 90% [16].

The most common, significant, and well-studied entomophages of the cabbage white, depending on the region, are *Apanteles glomeratus, Pteromalus puparum* (Khalimov, 2016), and *Cotesia glomerata* [17].

2 Material and methods

The study was conducted during 2022-2024 in cabbage fields of the Samarkand region of Uzbekistan. Three experimental plots of 0.5 hectares each were allocated for the study, with a total volume of 1.5 hectares. To study the phenology of *Pieris brassicae* development, 20 model plants were isolated from each plot and the timing of pest development was strictly taken into account. Observations of the phenology of development were also carried out in laboratory conditions. The infestation of larvae was determined in laboratory conditions. For this, the collected larvae of different ages were placed in special glass containers along with cabbage leaves (Fig. 1). The parasites that flew out of them were fixed with ethyl acetate and a collection was made. In this case, the larva of each age, as well as each generation, were placed in separate vessels to make it possible to determine the infestation with entomophages at each stage of development. In 2022, 1,320, in 2023 1,231, and in 2024 1,286 cabbage white butterfly larvae were collected and tested.

Fig. 1. Cabbage white butterfly larvae in glass containers.

3 Results and discussion

The first *Pieris brassicae* butterflies appeared on cabbage at the end of March and the beginning of April. The first eggs appeared already in the first ten days of April. In general, in the region of the research the cabbage white butterfly produces 4-5 generations. The most numerous are the 4th and 5th generations of the pest.

Two species of parasite were bred from cabbage white butterfly larvae: *Apanteles glomeratus* L. and *Eulophus larvarum* (L), and one species - *Pteromalus puparum* (Linnaeus,

1758) - from pupae. The parasite of *Eulophus larvarum* larvae is rare and out of all 3837 larvae collected over three years, only 74 (1.9%) were infected with this parasite. The infection rate of cabbage white butterfly pupae by *Pteromalus puparum* was 9.1%.

The most effective parasite is Apanteles glomeratus. Of the 3837 larvae collected over three years, 1454 were infected with the parasite, i.e. the infection rate was 37.9%. However, the infection rate of larvae of different generations of cabbage white butterfly varied significantly (Fig. 2). The lowest degree of infection was noted in the first generation larvae. During the season, the degree of infection of larvae gradually increases and the maximum is noted by the fifth generation. So in 2024, the infection rate of first generation larvae with parasites was 12%, the second generation - 20.8%, the third generation - 34%, the fourth generation - 39.02%, and the fifth generation - 51.3%. The same trend was observed in the previous 2022 and 2023.

Larval infestation also varied across the years of study. In 2022, the average larval infestation was 42.1%, in 2023 - 36.8%, and in 2024 - 34.6%.

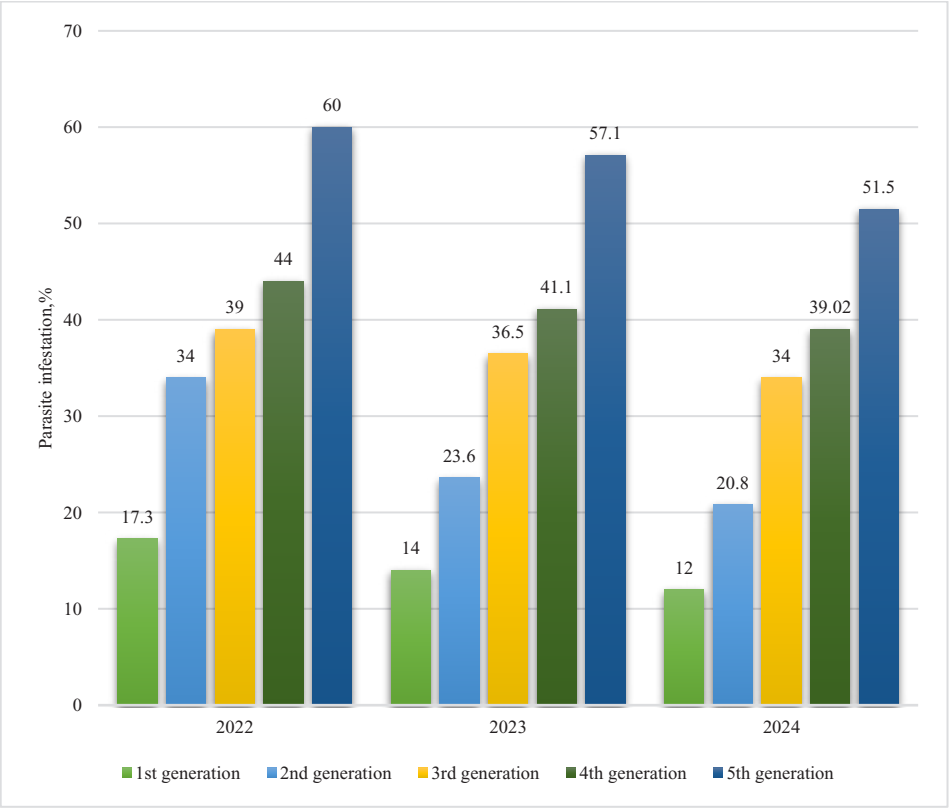

Fig. 2. Infection of larvae of different generations of cabbage white butterfly by the parasite *Apanteles glomeratus* (%)

As noted in some studies [18, 19], Apanteles glomeratus prefers to infect second-instar larvae of the cabbage white butterfly. Therefore, in the 2022 experiments, larvae of different instars collected in the field were placed in separate dishes. The results obtained are shown in Table 1.

Table 1. Infection of larvae of different ages of cabbage white butterfly by the parasite *Apanteles glomeratus*

Age of the larva	Number of larvae	Number of infected larvae	Degree of infestation
I	50	-	0
II	50	6	13,3
III-V	100	11	14,7
Total	200	17	11,3

However, based on the data obtained, it is impossible to draw an exact conclusion about the preference of a particular age of host larvae by parasites. Because it is impossible to establish the time of infection of older larvae collected from cabbage fields. Since the difference between the degree of infection of larvae of the second age and III-V ages is not very high, it can be assumed that the majority of larvae were infected in the second age.

From 15 to 35 parasite larvae emerged from the infected larvae, on average this was 17.5 parasite larvae per pest. The emergence of parasite larvae is observed in the fifth instar of cabbage white butterfly larvae (Figure 3). The yellowish parasite larvae immediately after emerging from the host pupate in yellowish cocoons, and the host dies.

Fig. 3. Pupation of uninfected cabbage white butterfly larvae (A), emergence and pupation of *Apanteles glomeratus* parasite larvae from infected host larvae (B), emergence of parasite adults from pupae (C), emerged parasites in test tubes (D) (Laboratory experiments, 2024)

After pupation, the emergence of parasite imagoes was observed on the 15th day and lasted for 4-5 days.

In 2024, 7787 parasite larvae hatched from 445 infected cabbage white butterfly larvae and all of them formed a pupa. However, only 6290 pupae produced parasite imagoes, i.e. the survival rate of the pupae was 80.8% (Table 2).

Table 2. Survival of Apanteles glomeratus pupae in laboratory experiments

Number of infected larvae	Number of hatched parasite larvae	Average number of parasite larvae per host	Number of parasite imagoes emerging from pupae	Pupae survival rate, %
445	7787	17,5	6290	80,8

Thus, Apanteles glomeratus is the most effective parasite reducing the number of cabbage white butterfly, a dangerous pest of cabbage in Uzbekistan. The infestation of the pest larvae with this parasite varies significantly both by years and by generations of the pest. The infestation of the 1st generation of cabbage white butterfly larvae is 12-17.3%, 2nd generation - 20.8-34.0%, 3rd generation - 34.0-39.0%, 4th generation - 39.0-44.0%, and 5th generation - 51.5-60.0%. These data show that Apanteles glomeratus plays an important role in reducing the number of cabbage white butterfly during the season, but also significantly reduces the wintering stock of the pest.

References

1. Narzullayev S.B., Mirzaev U.N., Mavlyanov O., Khakimov N., Jabborov A.R., Khamidova A.B., Tursunova Sh.Sh., Khujamov Sh., Baysarieva Ch., Ashrapov A.A., Nurmatova D.M. (2024) Acta Biologica Sibirica, **10:** 1147–1164. https://doi.org/10.5281/zenodo.13937701
2. Alimova L.K., Umurzakova M.S., Zokirova D.F., Khamzaev R.A., Normuradova G., Otakulov B., Pazilov A., Kudratov J.A., Urazova R.S., Khalimov F.Z. (2024). Biosystems Diversity, **32(1),** 73–82. doi:10.15421/012407
3. Kudratov J., Pazilov A., Zokirova D., Otakulov B., Jalilov J., Urinova X., Khalimov F., Izzatullaev Z. (2024). Acta Biologica Sibirica **10**: 349–359. https://doi.org/10.5281/zenodo.11160044
4. Fomichev A.A., Shodmonov F.A. (2024) Acta Arachnologica, **73 (2):** 75–80, https://doi.org/10.2476/asjaa.73.75
5. Rakhimov M.R. (2023) Acta Biologica Sibirica **9:** 167–193. https://doi.org/10.5281/zenodo.7835401
6. Romantsov P.V., Rakhimov M.R. (2023). Entomological Review **103(6):** 639–646. https://doi.org/10.1134/S0013873823060052
7. Mamanov S.S., Rakhimov M.R., Khalimov F.Z., Khamzaev R.A., Abdullayev E.N., Jabborov A.R., Khamidova A.B., Shodmonov F.A., Ashrapov A.A., Ochilbekova S. (2024) Acta Biologica Sibirica **10:** 1543–1557. https://doi.org/10.5281/zenodo.14303122
8. Khalimov F. (2020) Biosystems Diversity **28 (3):** 265–271. http://dx.doi.org/10.15421/012035
9. Khalimov F. (2023) Acta Biologica Sibirica **9:** 113–125. https://doi.org/10.5281/zenodo.7725474
10. Khalimov F., Rakhimov M., Khamzaev R., Abdullaev E., Usanov U. (2023) Journal of the Entomological Research Society **25(2):** 275−286. https://doi.org/10.51963/jers.2023.86

11. Halimov F. (2020) Travaux du Muséum National d'Histoire Naturelle "Grigore Antipa" **63 (2):** 175–187. https://doi. org/10.3897/travaux.63.e54116
12. Adashkevich B.P., Biological protection of cruciferous vegetable crops from harmful insects (Tashkent, Fan, 1983)
13. Kour R, Gupta RK, Kour S, Ganai SA, Sharma S, Ibrahim S., Journal of Pharmacognosy and Phytochemistry **7(4):** 3322-3327 (2018)
14. Cheema R.S., Sandhu I.S., *Efficacy of microbial biopesticides to manage Pieris brassicae (Linnaeus) and Plutella xylostella (Linnaeus) in cauliflower.* Int. J. Trop. Insect Sci. (2024). https://doi.org/10.1007/s42690-024-01296-4
15. Adashkevich B.P., Shukuraliev B.T., Cabbage pests and their entomophages in Uzbekistan. Biological method of pest control of vegetable crops (Moscow, 1989)
16. Bondarenko N.V., Biological protection of plants (Moscow: Agropromizdat, 1986)
17. Pervez A., Adhikari A., Chandra Mishra A. (2024) Annals of Science and Allied Research, **2 (2):** 52-56. https://doi.org/10.5281/zenodo. 14674469
18. Shapiro V.A., Relationships between the cabbage white butterfly and its parasite Apanteles glomeratus in ontogenesis and factors determining resistance to insecticides. Bulletin of VIZR, **2(14),** 3-7 (1970)
19. Shapiro V.A., Collection of scientific papers. Leningrad **74:** 5-17 (1983)