SCIENTIFIC HORIZONS

Journal homepage: https://sciencehorizon.com.ua
Scientific Horizons, 27(7), 97-106

UDC 632.7.018.72-79:635.1/8.64
DOI: 10.48077/scihor7.2024.97

Species composition of the main pests of aubergine in open soil conditions of the Right Bank Forest-Steppe of Ukraine

Serhii Shchetyna*
PhD Agricultural Sciences, Associate Professor
Uman National University of Horticulture
20305, 1 Instytutska Str., Uman, Ukraine
https://orcid.org/0000-0001-8504-2944
Ivan Mostoviak
Doctor of Agricultural Sciences, Professor
Uman National University of Horticulture
20305, 1 Instytutska Str., Uman, Ukraine
https://orcid.org/0000-0003-4585-3480
Vitalii Fedorenko
Doctor of Biological Sciences, Professor, Academician of National Aacademy of Agrarian Sciences of Ukraine
Institute of Plant Protection of National Academy of Agrarian Sciences of Ukraine
03022, 33 Vasylkivska Str., Kyiv, Ukraine
https://orcid.org/0000-0002-7783-1617
Svitlana Mostoviak
PhD Agricultural Sciences, Associate Professor
Uman National University of Horticulture
20305, 1 Instytutska Str., Uman, Ukraine
https://orcid.org/0000-0001-8322-8710
Halyna Slobodianyk
PhD Agricultural Sciences, Associate Professor
Uman National University of Horticulture
20305, 1 Instytutska Str., Uman, Ukraine
https://orcid.org/0000-0003-3419-9751

Article's History:
Received: 15.02.2024
Revised: 26.05.2024
Accepted: 24.06.2024

Abstract. In the context of climate change and excessive anthropogenic pressure, the adverse effects of pests in agrocenoses are increasing, leading to considerable losses of crop production and economic damages. During the growing season, it is necessary to conduct phytosanitary monitoring to identify and control the number, spread, and intensity of pests, followed by determining the level of danger and

Suggested Citation:
Shchetyna, S., Mostoviak, I., Fedorenko, V., Mostoviak, S., & Slobodianyk, H. (2024). Species composition of the main pests of aubergine in open soil conditions of the Right Bank Forest-Steppe of Ukraine. *Scientific Horizons*, 27(7), 97-106 doi: 10.48077/scihor7.2024.97.

*Corresponding author

developing relevant plant protection measures. For this, from 2008 to 2022, the species composition of pests in aubergine plantations in open ground conditions in the central part of the Right-Bank Forest-Steppe of Ukraine was studied. The study was conducted using conventional entomological methods. In aubergine plantations, 73 species of phytophagous insects from 25 families of 8 orders were found, which accounted for 93% of the pest structure, 2 species of mites (3%), 2 species of nematodes (3%), and one species of slugs (1%). The species diversity of insect phytophages was represented by insects from the orders: *Coleoptera* (20 species from 6 families), *Lepidoptera* (19 species from 5 families), *Homoptera* (14 species from 3 families), *Diptera* (9 species from 4 families), *Orthoptera* (5 species from 4 families), *Thysanoptera* (3 species from 1 family), *Hemiptera* (2 species from 1 family), *Hymenoptera* (1 species from 1 family). Among the ticks, the greatest damage was caused by the red spider mite (*Tetranychus urticae* Koch.), which on average was inhabiting 10-50% of the area. The average number of *Tetranychus urticae* Koch. was 8.5 specimens/plant, with up to 35-44% damage, which exceeded the EWP by 3.5-4.4 times. The colonisation of aubergine areas by naked slugs was not significant (up to 12%), but plant damage reached 10-14%. Among the insect phytophages, the largest area of plantations was infested with the Colorado potato beetle, larvae of the maybeetle, and gnawing scoops, which averaged 35-100%. The most harmful during the growing season were the Colorado potato beetle and the European mole cricket

Keywords: *Solanum melongena* L.; pests; phytophagous insects; phytosanitary condition; harmfulness; pest population density

INTRODUCTION

In the context of climate change and excessive anthropogenic pressure, the negative impact of pests in agrocenoses is increasing, leading to significant losses in crop production and economic damages. This forces agricultural producers to use even more chemical plant protection products, which leads to new environmental problems, including disruption of biological balance, changes in dominant pest species, their number and harmfulness, contamination of products with pesticide residues, etc. Furthermore, there are prohibitions and restrictions on the use of chemical pesticides in vegetable cultivation. Therefore, it is important to conduct phytosanitary monitoring to identify and control the number, spread, and intensity of pests, with the subsequent determination of their level of danger and development of relevant plant protection measures.

Harmful organisms are the primary causes of worldwide crop yield losses, and pest control plays a crucial role in ensuring food security, the efficient operation of agriculture, and it also impacts biodiversity (Alansary *et al.,* 2021; Skendžić *et al.,* 2021; Shah *et al.,* 2023). On average, globally, 10-28% of crop production is lost to pests (IPPC Secretariat, 2021). Phytophagous insects have an important economic value among harmful organisms in agrocenoses of vegetable crops. The main significant obstacles to increasing the volume of vegetable production in open ground conditions, including aubergine fruits, are global climate changes and extreme weather events, along with harmful organisms that create additional challenges for agricultural producers (Anuar *et al.,* 2023).

S. Kumar *et al.* (2019), I. Mostoviak and O. Demyanyuk (2020) noted that the harmful effects of phytophages and phytopathogens have increased. This increase is associated with the neglect of agrotechnologies for growing agricultural crops, violations of crop rotation, excessive use of chemical plant protection agents, or non-compliance with the technologies of their introduction, leading to the formation of resistance in harmful organisms to pesticides. Additionally, climate changes contribute to these challenges. The key factors that influence the diversity and abundance of pest arthropods in an agroecosystem are the landscape context and farming practices. All these factors collectively contribute to the deterioration of the phytosanitary condition of agrocenoses, an increase in biological and ecological risks in agroecosystems, and a decrease in plant productivity (Flores-Gutierrez *et al.,* 2020; Jaworski *et al.,* 2023).

FAO (n.d.) also estimates annual global vegetable losses due to insect damage alone at 15-20% during cultivation and 18-20% during storage. The harmful effect of phytophagous insects on agricultural crops is manifested in the damage to above-ground and underground organs of plants, the transmission of diseases, which leads to a violation of the physiological status and a decrease in yield, losses during storage of the grown crop, which ultimately affects economic indicators. The natural and climatic conditions of Ukraine are favourable for cultivating most vegetable crops in open ground, allowing for the expansion of their range and the introduction of innovative technologies to provide the population with useful and high-quality vegetables. According to O. Zakharchuk (2021), if innovations in the production and development of the food industry are used, Ukraine can considerably improve its position in world markets. In addition, vegetable growing is a highly profitable and competitive branch of the domestic agricultural sector of economy, which, in recent years, has also become one of the leaders in increasing the export of domestic products. However, Ukraine still has an extremely insufficient range

and variety of high-vitamin products. Furthermore, as a result of the hostilities, there is a shortage of vegetable and melon products, which affects the country's food and environmental security, and the food problem needs to be addressed with due regard to the possibilities of domestic production.

Aubergine (*Solanum melongena* L.) is one of the essential vegetable crops in domestic and global vegetable production and nutrition of the population. It also serves as as the main raw material for the canning industry. Aubergine fruit is a nutritious product with minimal calories, but maximum biological value. In Ukraine, aubergines are cultivated in open ground on an area of about 5.1 thsd ha, primarily at small farms and personal homesteads of the population (State Statistics Service of Ukraine, n.d.). Ukraine ranks fourth in aubergine production among European countries and 25th globally (AtlasBig, n.d.).

However, the level of yields of open-air vegetable crops in Ukraine is insufficient compared to European countries, due to a series of technological problems and the critical phytosanitary condition of agrocenoses (Shchetina *et al.*, 2023). At the same time, the irrational use of pesticides has a powerful impact on the environment, specifically on natural enemies of pests, destroys ecological balance, and causes outbreaks of secondary pests. All these issues are exacerbated by climate change, when new ecological niches are created that allow insect pests to establish and spread in new geographical regions and move from one region to another. That is why the purpose of this study was to investigate the species composition of pests in aubergine (*Solanum melongena* L.) plantations under open field conditions in the central part of the Right-Bank Forest-Steppe of Ukraine.

MATERIALS AND METHODS

The study was conducted at Uman National University of Horticulture. During 2008-2022, the phytosanitary state of aubergine plantations was monitored on the territory of Cherkasy Oblast as representative of the Right Bank Forest-Steppe. Each year route inspections of more than 70 ha of aubergine plantations were conducted on the household plots and farms in Cherkasy Oblast. Recording of pests was performed during route inspections in the growing season of the crop in the main phases of their development using the BBCH scale (international scale of plant growth and development phases (phenological phases)): shoots (BBCH 0-10), first true leaf (BBCH 11-12), 5 leaves (BBCH 13-15), stem growth (BBCH 21-29), budding (BBCH 50-59), flowering (BBCH 60-69), fruit formation and growth (BBCH 70-79), fruit ripening (BBCH 81-89), technical ripeness (BBCH 97-99).

For this, the methods generally accepted in entomology were used. Insects were caught at 07:00 am to 10:00 am using nets. These included visual inspection of plants, sweep-net method, soil excavation, Petliuk's box, and Barber's traps. Petliuk's box, resembling a truncated pyramid without a bottom and a top, with a layer of cotton wool attached to the inner surface of its walls, was employed to catch and record small jumping insects. The surface area was 0.1 m^2 (with the size of the side wall at the bottom being 316 mm, at the top 800 mm, and with a height of 350 mm).

For the study of terrestrial entomofauna, Barber's traps were used – polyethylene glasses, filled to one-third with a fixative (ethylene glycol) and buried so that their upper part was at the level of the soil and tightly adjoined to it. The diameter of the upper part of the glass was 7 cm, and its height was 9.5 cm. Pests were removed from the traps once every 10 days, placed on cotton mattresses and labelled. The species of insects were identified using binoculars and markers. The taxonomic affiliation of the entomological material was analysed in the laboratory using modern insect keys, atlases, and available online electronic versions of keys to different groups of invertebrates (Royal Entomological Society, n.d.). The study was conducted following the standards of the Convention on the Protection of Biological Diversity (1992). Damage screening was also performed in between the active sampling. The infestations were monitored thoroughly from roots, branches, small branches, leaves, fruits, flowers, and shoots of the plants. The damage was surveyed, documented, and photographed for future reference.

RESULTS AND DISCUSSION

According to the results of monitoring studies on the phytosanitary state of aubergine agrocenoses, it was established that plants are damaged by 73 types of insects, two types of mites, two types of nematodes, and one type of slugs. The structure of the harmful complex in the aubergine agrocenosis is presented in Figure 1.

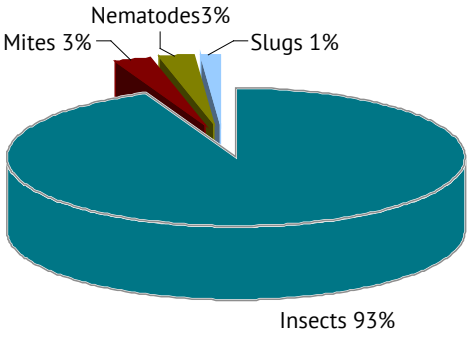

***Figure 1**. The structure of the harmful complex of aubergine agrocenosis, Cherkasy Oblast (average for 2008-2022), %*
***Source:** developed by the authors of this study*

Two members of the Heteroderidae family were discovered among the nematodes (order Tylenchida): golden potato nematode (*Meloidogyne marioni* Woll.) and root-knot nematode (*Globodera rostochiensis* Woll.).

Naked slugs (*Kailie gliemeži*) are among slug species. Phytophagous mites from the order Acariformes (acariform mites) were represented by red spider mite (*Tetranychus urticae* Koch.) from the family Tetranychidae and tomato russet mite (*Aculops lycopersici* Massee) from the family Eriophyidae.

Red spider mite caused the most significant damage, occupying an area ranging from 10% to 50% during the years 2008-2022. The average number of spider mites was 8.5 individuals per 1 plant, and plant damage was recorded at the level of 35-44%. During the research period, the maximum number of mites was 18 individuals/plant, and plant damage was recorded at the level of 50%. Exceeding of economic threshold was 3.5-4.4 times. The most massive infestation of aubergine plantings by the red spider mite was in 2015 and made up 50%, and in 2019 it was 30%. A high number of phytophagous individuals was recorded at the level of 5, 6, and 8 individuals/plant in 2018, 2009, and 2012, respectively. The exceeding of the economic threshold ranged from 2.5 to 5.0 times, with the economic threshold set at 3-5 individuals per leaf and affecting 10% of inhabited plants.

Over the years of research, naked slugs (*Kailie gliemeži*) were also discovered in the aubergine agrocenosis. The percentage of inhabited areas was not significant on average and amounted to 1-12% (max 15%), while the average number of pests was 1-4 specimens/m^2. However, plant damage was 10-14%. It was noted that the number and distribution of slugs depended not only on weather conditions, but also on certain agricultural measures. Thus, the use of plant residues, which are often used for fertilisation in private farms, contributed to the development and reproduction of slugs. Favorable weather conditions, specifically warm winters, and moderately warm, wet weather in the spring-summer period caused an outbreak of mass reproduction of these pests, up to 7 specimens/m^2 were detected in aubergine plantations, and plant damage reached 22%. Among aubergine pests, class Insecta has the greatest variety of species, which accounted for 93% of the pest structure (Fig. 1). The harmful entomofauna includes representatives of:

Order Coleoptera:

- Chrysomelidae – *Leptinotarsa decemlineata* Say., *Phyllotreta cruciferae* Goeze, *Phyllotreta undulata* Kutsch., *Psylliodes affinis* Payk., *Phyllotreta vittata* Redt., *Phyllotreta nemorum* L., *Phyllotreta atra* F., *Phyllotreta crucifera* Goeze., *Phyllotreta armoraciae* Koch., *Entomoscelis adonidis* Pallas;
- Coccinellidae – *Coccinella septempunctata* L.;
- Curculionidae – *Baris coerulescens* Scop., *Baris carbonaria* Boh., *Baris chlorizans* Germ., *Ceutorrhynchus quadridens* Panz., *Ceuthorrhynchus assimilis* Payk.;
- Elateridae – *Agriotes lineatus* (L.), *Agriotes sputator* L.;
- Nitidulidae – *Meligethes aeneus* F.;
- Scarabaeidae – *Melolontha melolontha* L.

Order Diptera:

- Agromyzidae – *Linomyza bryoniae* Kalt., *Delia platura* Mg.;
- Anthomyidae – *Delia brassicae* Bouche, *Delia floralis* Fallen;
- Sciaridae – *Bradysia brunnipes* Mg., *Pnyxia scabiei* Hop.;
- Tipulidae – *Tipula oleracea* L., *Tipula paludosa* Mg., *Tipula vernalis* Mg.

Order Hemiptera:

- Pentatomidae – *Eurydema ventralis* Kol., *Eurydema oleracea*.

Order Homoptera:

- Aleyrodidae – *Trialeurodes vaporariorum* Westw., *Aleurodes proletella*;
- Aphididae – *Myzodes persicae* Sulz., *Aphis gossypii* Glov., *Macrosiphum euphorbiae* Thom., *Rhopalosiphum padi* L., *Schizaphis graminum* Rondani, *Macrosiphum (Sitobion) avenae* F., *Brachycolus (Cuernavaca) noxius* Mordv., *Brevicoryne brassicae* L.;
- Cicadinea – *Hyalesthes obsoletus* Sign., *Laodelphax striatella* L., *Psammotettix striatus* L., *Macrosteles laevis* L.

Order Hymenoptera:

- Tenthredinidae – *Athalia rosae* L.

Order Lepidoptera:

- Gelechiidae – *Phthorimaea operculella* Zell., *Plutella maculipennis* Curt., *Tuta abcoluta* Meyr.;
- Noctuidae – *Scotia segetum* Denis&Schiff., *Lacanobia oleracea* L., *Mamestra brassicae* L., *Helicoverpa armigera* Hub., *Hydraecia micacea* Esp., *Laphygma exigua* Hb., *Euxoa agricola* B., *Euxoa tritici* L., *Autographa gamma* L.;
- Pieridae – *Aporia crataegi* L., *Pieris brassicae* L., *Pieris rapae* L., *Pontia edusa* Fabr.;
- Pyralidae – *Evergestis forficallis* L., *Evergestis extimalis* Scop.;
- Sphingidae – *Manduca quinquemaculata* Haworth.

Order Orthoptera:

- Acrididae – *Locusta migratoria* L.;
- Gryllidae – *Gryllus campestris* L.;
- Gryllotalpidae – *Gryllotalpa gryllotalpa* L.;
- Tettigoniidae – *Tettigonia viridissima* L., *Decticus verrucivorus* L.

Order Thysanoptera:

- Thripidae – *Thrips tabaci* Lindeman, *Heliothrips haemorrhoidalis*, *Haplothrips tritici* Kurd.

Thus, phytophagous insects, which comprise members of 73 species from 25 families and 8 orders, are present in the structure of the harmful entomocomplex of aubergine. The taxonomic structure of the harmful entomocomplex is dominated by representatives of the orders Coleoptera (20 species), Lepidoptera (19 species), and Homoptera (14 species) (Fig. 2). In total, the representatives of these orders made up 73% of the structure of the harmful entomocomplex.

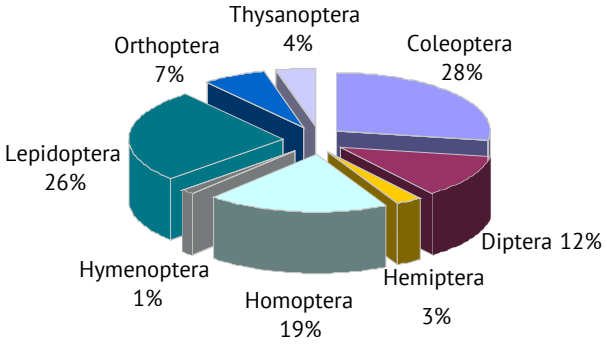

***Figure 2**. Taxonomic structure of the harmful entomocomplex of aubergine agrocenosis, Cherkasy Oblast, 2008-2022, %*
***Source:** developed by the authors of this study*

The order Coleoptera was found to have a large diversity of species, with 20 species belonging to 6 families: leaf beetles (Chrysomelidae), click beetles (Elateridae), dung beetles (Scarabaeidae), ladybird beetles (Coccinellidae), snout beetles (Curculionidae), and nitidulid beetles (Nitidulidae). Their share in the structure of the entomocomplex was 28%. The families of leaf beetles and snout beetles were represented by the largest number of species – 10 and 5, respectively. Notably, the seven-spot ladybird (*Coccinella septempunctata* L.) from the family Coccinellidae (coccinellids), being entomophagous, can form large clusters and damage the fruits under certain weather conditions, which were recorded during the monitoring.

The order of lepidopterans (Lepidoptera) is represented by 5 families: noctuid moths (Noctuidae), gelechiid moths (Gelechiidae), pyralid snout moths (Pyralidae), Sulphur butterflies (Pieridae), and hawk moths (Sphingidae). Their share in the structure of the harmful entomocomplex was 26%. The Noctuidae family exhibited the highest species diversity (9 species), with two dominant and highly destructive species: *Scotia segetum* Denis&Schiff. (turnip moth) and *Lacanobia oleracea* L. (bright-line brown eye). The order of homopterans (Homoptera) included 14 species from 3 families: true aphids (Aphididae), leafhoppers (Cicadellidae), and whiteflies (Aleyrodidae). Their share in the structure of the complex of harmful phytophagous insects is 19%. The Aphididae family has the largest number of species (8).

Representatives of two-winged (Diptera) and orthopterous insects (Orthoptera) were represented by species from 4 families and made up 12% and 7%, respectively, in the structure of the entomocomplex. The order Diptera, which included about the same number of species as the crane fly family (Tipulidae), had a greater diversity of species in the agrocenosis of aubergine: 3 species and 2 species each – families of dark-winged fungus gnats (Sciaridae), flower flies (Anthomyidae) and leaf miner flies (Agromyzidae). Similarly, the order of Orthoptera was also represented by the same number of species (1-2) from the families of mole crickets (Gryllotalpidae), bush crickets (Tettigoniidae), crickets (Gryllidae), and true grasshoppers (Acrididae).

The order Thysanoptera, represented in the entomocomplex, comprised only two species from the thrips family (Thripidae), constituting 4% of the overall entomocomplex structure. The lowest species diversity, consisting of only one family with one to two species each, was observed in the representatives of the Hymenoptera and Hemiptera orders. Together, these orders accounted for 4% of the harmful entomocomplex structure within the aubergine agrocenosis. Specifically, the families represented were true sawflies (Tenthredinidae) and stink bugs (Pentatomidae).

During the growing season in the aubergine agrocenosis, eight dominant phytophagous insect species were identified, causing significant damage as the most common pests: *Leptinotarsa decemlineata* Say., *Trialeurodes vaporariorum* Wstw., *Agriotes sputator* L., *Myzodes persicae* Sulz., *Scotia segetum* Denis&Schiff., *Lacanobia oleracea* L., *Thrips tabaci* Lindeman and *Gryllotalpa gryllotalpa* L. The results of the monitoring showed that the largest area of aubergine plantations was inhabited by Colorado potato beetle and the larvae of click beetles and cut worms (on average from 35 to 100%) (Table 1). The common cabbage leafhopper and cotton thrips were found to occupy the smallest area of plantings, on average between 5% and 30%.

Leptinotarsa decemlineata Say. and its larvae caused the highest level of damage to aubergine plants, occurring both at the early stages of development and throughout the entire vegetation period – 33-90% (max 100%), which exceeded the economic threshold by 1.3-4.0 times. At the same time, the pest population averaged within 15-45 specimens/m^2 over the years of research, with some years recording up to 70 specimens per 1 m^2. The green peach aphid also exhibits a relatively high abundance (24-36 specimens/plant) and causes substantial plant damage, ranging within 38-52%, with a maximum recorded damage of 86%. This species serves as a dangerous carrier of numerous viruses, forming large colonies on plant leaves. By sucking out the juice from the plants, it leads to leaf deformation, delays in plant growth, and underdeveloped fruits.

It was observed that the population of the greenhouse whitefly was 1.2-2.2 times higher than that of the economic threshold, with an average of 12-22 specimens per plant. In years with the maximum number of pests (40 specimens per plant), the greenhouse whitefly population was four times higher. Consequently, plant damage was recorded at levels ranging within 15-22%, with a maximum of 30%.

***Table 1**. Dominant species of phytophagous insects in aubergine agrocenoses, average for 2008-2022*

Pest	Populated area, %	Average number of pest per 1 plant or m²	Damaged plant, %
Leptinotarsa decemlineata Say.	75-100 (100)*	15-45 (70)	33-90 (100)
Myzodes persicae Sulz.	46-100 (100)	24-36 (42)	38-52 (86)
wireworms – larvae of dark click beetle (*Agriotes* spp)	35-57 (94)	1-6 (10)	8-16 (20)
Cut worms: *Scotia segetum* Denis&Schiff.; *Lacanobia oleracea* L.	40-75 (85)	1-6 (8)	8-15 (30)
Trialeurodes vaporariorum Wstw.	10-25 (70)	12-22 (40)	15-22 (30)
Gryllotalpa gryllotalpa L.	5-30 (45)	1-3 (5)	9-17 (25)
Thrips tabaci Lindeman	10-20 (40)	2-8 (12)	7-10 (15)

***Note:** *in brackets – the maximum (max) value of the indicator*
***Source:** developed by the authors of this study*

Among beetles from the family click beetles (Elateridae), the dark beetle (*Agriotes sputator* L.) caused significant damage, with populations damaging up to 20% of plants. On average, the economic threshold exceedance was recorded at 1.2 times, doubling in years with the highest pest numbers. Notably, one of the primary factors influencing outbreaks of this phytophagous population is the weather conditions of the year. A high density of cutworm populations was also observed, causing damage to 8-15% of the plants, with a maximum recorded damage of 30%.

In certain years, the population levels of turnip moth and bright line brown-eye significantly surpassed the economic threshold (by 6-8 times), reaching up to 6-8 specimens/m². The thrips complex in the aubergine agrocenosis was dominated by cotton thrips (*Thrips tabaci* Lindeman) with an average number of 2-8 specimens/m² (max 12). This species caused damage to 7-10% of plants (max 15%). Importantly, the level of the economic threshold was not exceeded over the years of research. The mole cricket population ranged within 1-3 specimens/m² (max 5), resulting in plant damage reaching up to 25%. Notably, the exceedance of the the economic threshold was observed at 2-5 times. This polyphagous insect has a two-year development cycle and causes significant damage to many agricultural crops. Long-term monitoring studies have shown that each stage of vegetation of aubergine plants is characterised by a certain composition of pests (Fig. 3).

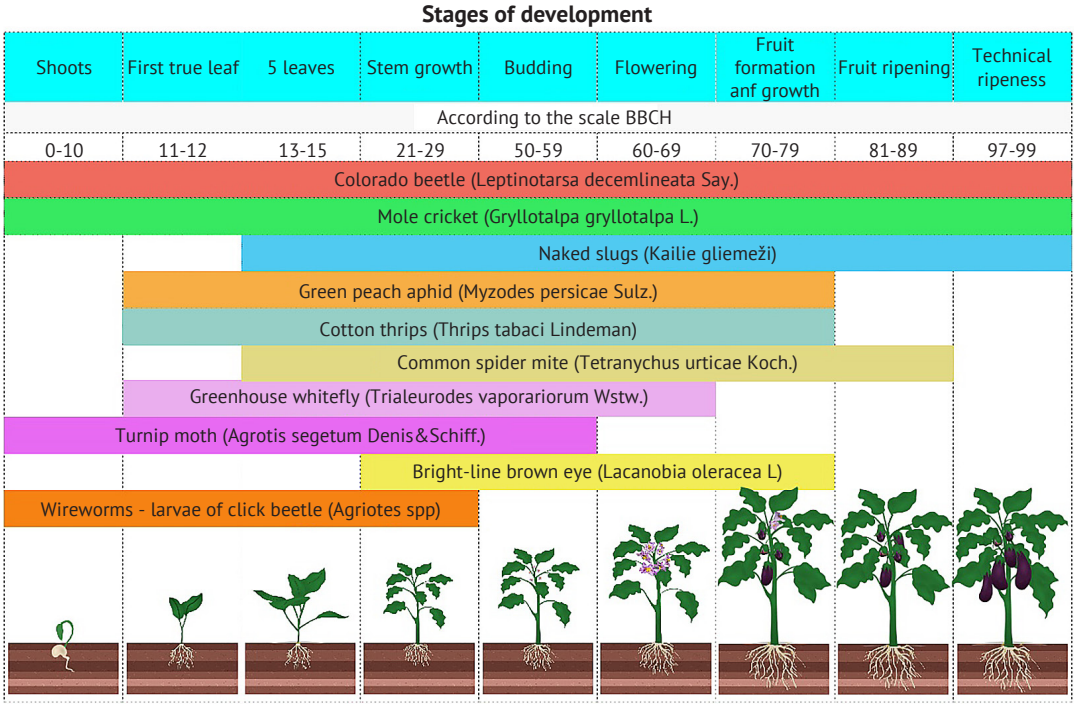

***Figure 3**. The periods of harmful activity of the main phytophages (insects, mites, slugs) according to the development phases of aubergine plants*
***Source:** developed by the authors of this study*

It was found that *Leptinotarsa decemlineata* Say. and *Gryllotalpa gryllotalpa* L. were dominant and most harmful species throughout the entire growing season from germination to the technical ripeness of the fruits. *Leptinotarsa decemlineata* Say. is a phytophagous insect that causes considerable damage to plants of the nightshade family (Solanaceae) in all phases of development both in the Right Bank Forest Steppe and throughout Ukraine. It was proved that as the population of the *Leptinotarsa decemlineata* Say. increases, the assimilation surface of plant leaves is more extensively damaged, leading to greater potential yield losses, which can reach up to 80% (Kroschel *et al.,* 2020; Islam *et al.,* 2020). It was established that warm winters contributed to the overwintering of the pest in the soil, with an average mortality rate of 7-10%. During the research, colonisation of aubergine plants was observed as early as the stage of planting seedlings in open ground in the beginning of the second decade of May. At the end of the third decade of May, the beginning of egg laying by the pest was recorded. Phytophage became widespread during the phases of stem growth (BBCH 21-29), budding (BBCH 50-59), and flowering (BBCH 60-69).

Gryllotalpa gryllotalpa L. is an extremely dangerous polyphagous pest. The greatest harmfulness of this insect is observed at the end of May-mid-July. During this period, the phytophagous insects damage young aubergine plants by gnawing the stem and roots, causing the plants to quickly wither, turn yellow, and dry up. The next active period of mole cricket harmfulness was observed from mid-August to the end of September, during which the pests prepare for wintering and feed mostly on fruits and stems of plants.

Additionally, during the initial stages of aubergine plant development, the larvae of the dark click beetle (*Agriotes sputator* L.) and the turnip moth (*Scotia segetum* Denis & Schiff.) were active, causing significant damage. Their activity persisted until the budding phase (BBCH 50-59) and flowering (BBCH 60-69), respectively. Throughout the years of research, the number of larvae of the dark click beetle and caterpillars of the turnip moth in the soil during spring (first decade of April) remained mostly constant, ranging within 0.6-0.9 specimens/m^2. The second generation of turnip moth in summer was observed in the second decade of August. During the initial stages, specifically the first true leaf phase (BBCH 11-12), cotton thrips (*Thrips tabaci* Lindeman), green peach aphid (*Myzus persicae* Sulz.), and greenhouse whitefly (*Trialeurodes vaporariorum* Wstw.) were detected on the plants.

The greenhouse whitefly (*Trialeurodes vaporariorum* Wstw.) is a polyphagous insect that feeds on 128 plant species from 48 families and causes significant economic damage to vegetable and ornamental crops in greenhouses (Wenda-Piesik & Piesik, 2021). Nevertheless, throughout many years of research, authors observed the presence of this pest from the emergence of the first true leaf to the flowering phase (BBCH 11-12 to BBCH 60-69). This pest reduces both the quality and quantity of plant productivity by feeding on plant sap, producing honeydew, and transmitting plant-pathogenic viruses. During the period of active plant growth and before the phase of fruit formation, the bright line brown eye (*Lacanobia oleracea* L.) caused significant damage. Caterpillars of the first generation damaged 6-8% of plants, while the second generation caused damage to up to 18%.

Aubergine (Solanum melongena) is the third most important vegetable in Asia and is of particular importance in the Mediterranean belt. Although global production of aubergine fruit has been increasing in recent years, productivity is limited due to insect and pathogen damage and abiotic stresses (Alam & Salimullah, 2021). Each region has its own dominant pest species due to specific conditions, and their impact on plants and harmful effects depend on a series of environmental and technological factors (Subedi *et al.*, 2023; Asni *et al.*, 2024).

In Bangladesh, 488 insects were collected from an aubergine field. The collected insects belonged to 20 species of 21 families and 10 orders. The percentage of insects in different taxonomic orders ranged within 0.4-33.6. Among the taxonomic orders, Hemiptera (33.6) was the most dominant, followed by Coleoptera (28.3%), Hymenoptera (12.7%), Diptera (8.8%), Lepidoptera (7.6%), Odonata (2.6%), and Dermaptera (2.5%). Other orders, namely Orthoptera (2%), Dictyoptera (1.2%) and Thysanoptera (0.4%), showed an extremely low percentage of abundance (Amin et al., 2018). Thus, in Indonesia, 10 species of insects from 8 families were found on green aubergine plants: *Epilachna* sp., *Paracoccus marginatus*, *Empoasca* sp., *Atractomorpha crenulata*, *Cassida circumdata*, *Stenocatantops angustifrons*, *Oxya japonica*, *Phlaeoba fumosa*, *Bemisia tabaci*, and *Bactrocera dorsalis*. Among them, *Bemisia tabaci* has the highest dominance index of 1.41 (Rahayu, 2022).

F. Sánchez-Bayo (2021), M. Mohammed *et al.* (2023) identified seven insect orders associated with Solanum lasiocarpum. Diptera had the largest number of species (31.4%), Coleoptera – 26.9%, Hymenoptera – 23.1%. Current studies also show a significant diversity of insect phytophages in aubergine plantations and a wide range of insect species from the orders Coleoptera, Lepidoptera, Homoptera Diptera and Orthoptera. The greatest damage was caused by the red spider mite (*Tetranychus urticae* Koch.). *Leucinodes orbonalis* is a key pest of aubergine in the Indian subcontinent and occurs throughout most of southern Asia with records mostly from India and Bangladesh (EFSA Panel on Plant Health, 2024). The the aubergine fruit and shoot borer (EFSB), *Leucinodes orbonalis* larvae (especially third- and fourth- instars) bore into tender shoots, resulting in the plant ultimately wilting and becoming unable to bear fruits. In addition, the larvae bore into fruits, making them unmarketable. The occurrence of the pest

inside the plant body saves them from insecticidal contact. Escaping from insecticides and a lack of natural resistance in cross-compatible species make EFSB the major aubergine pest. Furthermore, aubergine fruit borers (*Helicoverpa armigera*), stem borers (*Euzophera perticella*), hadda beetles (*Epilachna vigintiopunctata*), as well as some sucking aphids and parasitic nematodes (*Meloidogyne* spp), are important pests affecting aubergine cultivation.

F. Taiwo *et al*. (2020), A. Ekholm *et al*. (2022) focus on insect pests of aubergine at three growth stages (vegetative, flowering, and fruiting), with peak activity observed in the fourth week after planting in open ground. It was observed that *Z. variegatus* and *Epilachna* spp. destroyed the leaves, while *S. litoralis* and *L. ornabolis* severely damaged flowers and fruits, with about 70% of the fruits destroyed by the harvesting stage. The colonisation of aubergine plants by *S. litoralis* and *L. ornabolis* began five weeks after planting. Therefore, when developing measures to control insect pests of aubergine, it is necessary to consider the biological characteristics of both the target plant and the pest, which was done in the present study.

CONCLUSIONS

Thus, a considerable biodiversity of harmful entomofauna was found in the aubergine agrocenosis, which is of great economic significance at all stages of plant development during the growing season. On the territory of the Cherkasy Oblast (central part of the Right Bank Forest Steppe of Ukraine) 73 species of phytophagous insects, two species of phytophagous mites, two species of nematodes and one species of slugs were found on aubergine plants. Insects from 25 families from 8 orders constitute the structure of the harmful entomocomplex of aubergine. The taxonomic composition is predominantly represented by members of the orders Coleoptera (20 species), Lepidoptera (19 species), and Homoptera (14 species), collectively occupying 73% of the harmful entomocomplex structure.

Representatives of the orders Diptera and Orthoptera were represented by species from 4 families and occupied 12% and 7%, respectively, in the structure of the entomocomplex. The order Thysanoptera (thrips) was represented by only two species from the thrips family (Thripidae), accounting for 4% of the entomocomplex structure. Among representatives of the Hymenoptera and Hemiptera orders, the least species diversity (1 family, 1-2 species) was observed, collectively occupying 4% of the harmful entomocomplex structure. The dominant species that caused significant damage to aubergine plants throughout the growing season were: *Leptinotarsa decemlineata* Say., *Trialeurodes vaporariorum* Wstw., *Agriotes sputator* L., *Myzodes persicae* Sulz., *Scotia segetum* Denis&Schiff., *Lacanobia oleracea* L., *Thrips tabaci* Lindeman, *Gryllotalpa gryllotalpa* L. Exceeding of the economic threshold was 1.2-8 times. It stays important to constantly monitor the number and spread of certain dominant species of pests in aubergine plantations in open ground conditions and, if necessary, apply environmentally friendly plant protection methods.

ACKNOWLEDGEMENTS

The authors of the study would like to express their sincere gratitude to the staff of the Main Department of the State Production and Consumer Service and the State Inspectorate for Plant Quarantine in the Cherkasy Oblast for the materials provided for the study.

CONFLICT OF INTEREST

The authors of this study declare no conflict of interest.

REFERENCES

[1] Alam, I., & Salimullah, M. (2021). Genetic engineering of aubergine (*Solanum melongena* L.): Progress, controversy and potential. *Horticulturae,* 7(4), article number 78. doi: 10.3390/horticulturae7040078.
[2] Alansary, R.E., Taher, A.S., & Elmabruk, A.H. (2021). Survey of global crop loss. *Balance Journal – in Applied and Humanities,* 2, 9-19.
[3] Amin, M.R., Miah, M.S., Rahman, H., Nancy, N.P., & Bhuiyan, M.K.A. (2018). Functional and group abundance of insects on aubergine. *Bangladesh Journal of Agricultural Research,* 43(4), 647-653. doi: 10.3329/bjar.v43i4.39163.
[4] Anuar, M.S.K., Hashim, A.M., Ho, C.L., Wong, M.Y., Sundram, S., Saidi, N.B., & Yusof, M.T. (2023). Synergism: Biocontrol agents and biostimulants in reducing abiotic and biotic stresses in crop. *World Journal of Microbiology and Biotechnology,* 39(5), article number 123. doi: 10.1007/s11274-023-03579-3.
[5] Asni, J., Nazilatun, R., Tia, W., Muswita, & Naswir, M. (2024). Investigating insect pest diversity and feeding preferences on aubergines in Jambi, Indonesia. *Journal of Entomological Research,* 48(2), 152-156. doi: 10.5958/0974-4576.2024.00031.X.
[6] AtlasBig. (n.d.). Retrieved from https://www.atlasbig.com.
[7] Convention on the Protection of Biological Diversity. (1992). Retrieved from https://zakon.rada.gov.ua/laws/show/995_030#Text.
[8] EFSA Panel on Plant Health (PLH), *et al.* (2024). Pest risk assessment of *Leucinodes orbonalis* for the European Union. *EFSA Journal,* 22(3), article number e8498. doi: 10.2903/j.efsa.2024.8498.

[9] Ekholm, A., Faticov, M., Tack, A.J.M., & Roslin, T. (2022). Herbivory in a changing climate-Effects of plant genotype and experimentally induced variation in plant phenology on two summer-active lepidopteran herbivores and one fungal pathogen. *Ecology and Evolution,* 12(1), article number e8495. doi: 10.1002/ece3.8495.
[10] FAO. (n.d.). Retrieved from https://www.fao.org.
[11] Flores-Gutierrez, A.M., Mora, F., Avila-Cabadilla, L.D., Boege, K., & del-Val, E. (2020). Assessing the cascading effects of management and landscape on the arthropod guilds occurring in papaya plantations. *Agriculture, Ecosystems & Environment,* 293, article number 106836. doi: 10.1016/j.agee.2020.106836.
[12] IPPC Secretariat. (2021). *Scientific review of the impact of climate change on plant pests*. Rome: FAO on behalf of the IPPC Secretariat. doi: 10.4060/cb4769en.
[13] Islam, W., Noman, A., Naveed, H., Alamri, S.A., Hashem, M., Huang, Z., & Chen, H.Y.H. (2020). Plant-insect vector-virus interactions under environmental change. *Science of The Total Environment,* 701, article number 135044. doi: 10.1016/j.scitotenv.2019.135044.
[14] Jaworski, C.C., Thomine, E., Rusch, A., Lavoir, A.-V., Wang, S., & Desneux, N. (2023). Crop diversification to promote arthropod pest management: A review. *Agriculture Communications*, 1(1), article number 100004. doi: 10.1016/j.agrcom.2023.100004.
[15] Kroschel, J., Mujica, N., Okonya, J., & Alyokhin, A. (2020). Insect pests affecting potatoes in tropical, subtropical, and temperate regions. In *The potato crop*. Cham: Springer. doi: 10.1007/978-3-030-28683-5_8.
[16] Kumar, S., Layek, S., & Upadhyay, A. (2019). Potential impact of climate changes on quality, biotic and abiotic stresses in vegetable production: A review. *International Journal of Chemical Studies,* 7, 636-643.
[17] Mohammed, M.A., Aman-Zuki, A., Buang, M.G., Ossen, A.A.R., Che, Pa N.I., & Yaakop, S. (2023). Insects compositions at different growing phases of the sarawak indigenous aubergine, Terung Asam (*Solanum lasiocarpum* Dunal.) with the first report of a ladybug species, Henosepilachna kaszabi (Coleoptera: Coccinellidae) as major foliage pest. *Malaysian Applied Biology,* 52(5), 19-28. doi: 10.55230/mabjournal.v52i5.cp2.
[18] Mostoviak, I.I., & Demyanyuk, O.S. (2020). Factors of destabilization of the phytosanitary state of agrocenoses of grain crops in the Central Forest Steppe of Ukraine. *Balanced Nature Using,* 2, 73-84. doi: 10.33730/2310-4678.2.2020.208812.
[19] Rahayu, S. (2022). Identification of insect pests of green aubergine (*Solanum melongena* L) in generative phase at agricultural zone of Pandak, Bantul, Yogyakarta. *Proceeding International Conference on Religion, Science and Education*, 1, 589-593.
[20] Royal Entomological Society. (n.d.). Retrieved from https://www.royensoc.co.uk/.
[21] Sánchez-Bayo, F. (2021). Indirect effect of pesticides on insects and other arthropods. *Toxics,* 9(8), article number 177. doi: 10.3390/toxics9080177.
[22] Shah, F.M., Razaq, M., Ahmad, F., ur Rehman, A., & ud Din Umar, U. (2023). Crop protection under climate change: The effect on tri-trophic relations concerning pest control. In *Climate change impacts on agriculture*. Cham: Springer. doi: 10.1007/978-3-031-26692-8_19.
[23] Shchetina, S., Mostoviak, I., & Fedorenko, V. (2023). Phytosanitary state of open-field vegetable crop agroecosystems of the genus Solanum, Raphanus, Brassica in the central part of the Right-Bank Forest-Steppe of Ukraine. *Quarantine and Plant Protection,* 4, 32-38. doi: 10.36495/2312-0614.2023.4.32-38.
[24] Skendžić, S., Zovko, M., Živković, I.P., Lešić, V., & Lemić, D. (2021). The impact of climate change on agricultural insect pests. *Insects,* 12(5), article number 440. doi: 10.3390/insects12050440.
[25] State Statistics Service of Ukraine. (n.d.). Retrieved from http://www.ukrstat.gov.ua.
[26] Subedi, B., Poudel, A., & Aryal, S. (2023). The impact of climate change on insect pest biology and ecology: Implications for pest management strategies, crop production, and food security. *Journal of Agriculture and Food Research,* 14, article number 100733. doi: 10.1016/j.jafr.2023.100733.
[27] Taiwo, F.J., Olaitan, A.F., Abiodun, A.T., & Abiodun, O.O. (2020). Population density of insect pests associated with aubergine varieties (*Solanum* species) in Ogbomoso, Nigeria. *Journal of Entomology and Zoology Studies,* 8(5), 979-982.
[28] Wenda-Piesik, A., & Piesik, D. (2021). Diversity of species and the occurrence and development of a specialized pest population - A review article. *Agriculture,* 11(1), article number 16. doi: 10.3390/agriculture11010016.
[29] Zakharchuk, O. (2021). Development of agri-food products export in Ukraine. *Ekonomika APK,* 28(1), 28-33. doi: 10.32317/2221-1055.202101028.

Видовий склад основних шкідників баклажана в умовах відкритого ґрунту Правобережного Лісостепу України

Сергій Щетина
Кандидат сільськогосподарських наук, доцент
Уманський національний університет садівництва
20305, вул. Інститутська, 1, м. Умань, Україна
https://orcid.org/0000-0001-8504-2944
Іван Мостов'як
Доктор сільськогосподарських наук, професор
Уманський національний університет садівництва
20305, вул. Інститутська, 1, м. Умань, Україна
https://orcid.org/0000-0003-4585-3480
Віталій Федоренко
Доктор біологічних наук, професор, академік Національнох академії аграрних наук України
Інститут захисту рослин аціональнох академії аграрних наук України
03022, вул. Васильківська, 33, м. Київ, Україна
https://orcid.org/0000-0002-7783-1617
Світлана Мостов'як
Кандидат сільськогосподарських наук, доцент
Уманський національний університет садівництва
20305, вул. Інститутська, 1, м. Умань, Україна
https://orcid.org/0000-0001-8322-8710
Галина Слободяник
Кандидат сільськогосподарських наук, доцент
Уманський національний університет садівництва
20305, вул. Інститутська, 1, м. Умань, Україна
https://orcid.org/0000-0003-3419-9751

Анотація. В умовах змін клімату та надмірного антропогенного навантаження посилюється негативна дія шкідників в агроценозах, що призводить до значних втрат продукції рослинництва і економічних збитків. Протягом вегетаційного періоду необхідно проводити фітосанітарний моніторинг для виявлення та контролю чисельності, поширення та інтенсивності розвитку шкідливих організмів з подальшим визначенням рівня небезпеки та розробкою відповідних заходів захисту рослин. З цією метою з 2008 по 2022 рік досліджували видовий склад шкідників у насадженнях баклажана в умовах відкритого ґрунту в центральній частині Правобережного Лісостепу України. Дослідження проводили з використанням загальноприйнятих ентомологічних методів. У насадженнях баклажана виявлено 73 види комах-фітофагів із 25 родин із 8 рядів, що в структурі шкідників становило 93 %, 2 види кліщів (3 %), 2 види нематод (3 %) і один вид слимаків (1 %). Видове різноманіття комах-фітофагів було представлено комахами з рядів: *Coleoptera* (20 видів із 6 родин), *Lepidoptera* (19 видів із 5 родин), Homoptera (14 видів із 3 родин), Diptera (9 видів із 4 родин), *Orthoptera* (5 видів із 4 родин), Thysanoptera (3 види з 1 родини), Hemiptera (2 види з 1 родини), *Hymenoptera* (1 вид з 1 родини). Серед кліщів найбільшої шкоди завдавав кліщ павутинний звичайний (*Tetranychus urticae* Koch.), яким у середньому було заселено 10-50 % площ. Середня чисельність *Tetranychus urticae* Koch. становила 8,5 особин/рослину, за їх пошкодження до – 35-44 %, що перевищувало економічний поріг шкодочинності у 3,5-4,4 раза. Заселення площ баклажана голими слимаками було не значним (до -12 %), проте пошкодження рослин сягало 10-14 %. Серед комах-фітофагів найбільшу площу насаджень було заселено жуком колорадським, личинками коваликів, совками підгризаючими, що в середньому становило 35-100 %. Найбільш шкідливими впродовж вегетації були колорадський жук і капустянка звичайна

Ключові слова: *Solanum melongena* L.; шкідники; комахи-фітофаги; фітосанітарний стан; шкідливість; щільність популяції шкідників