THE BIOLOGICAL AND ENVIRONMENTAL FEATURES OF REPRODUCTION AND DISTRIBUTION OF DOMINANT HARMFUL ORGANISMS IN MODERN CONDITIONS

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Abstract

The article presents research on the features of reproduction of dominant pests of species of organisms in agrobiocenoses growing cereals, leguminous crops, sunflowers and flowers. The article describes the latest ways to control a complex of soil harmful insect species in short-rotation field crop, as well as aerogenic harmful organisms in the integrated use of plant protection products of nutrition systems. In addition, we have identified individual levels of biologically oriented mechanisms of self-regulation of harmful organisms with measures to stabilize the functioning of agrocenoses, which are supplied with natural adaptive reactions in trophic chains.

In the region of observations, the complex of pests is controlled by spiders, nematodes, mites, pathogens, predators and parasites. A variety of causative agents of bacterial, fungal, viral and protozoal diseases of phytophagous insects deserve special attention.

Parasites and predators appear everywhere with trophic chains in 16 rows of the insect class. In recent years, predatory species of ground beetles from a number of Hymenoptera insects that feed on aphids on corn crops with unreasonable intensive use of nitrogen fertilizers have acquired significant importance.

The use of compositions of insecticide + UAN, 32 % for seed treatment of grain crops, allows to save mineral nutrition and get an increase in grain yield up to 27 %. This helps to optimize the state of cenoses and obtain high-quality grain while reducing the cost. Measures have been developed to realize the productivity potential of field crops and flowers through low-cost plant protection measures and to determine the mechanisms for controlling the number of phytophages and the development of dominant types of diseases according to the characteristics of their biology and ecology.

Keywords: pests, diseases, winter wheat, flowers, rusty diseases, false wireworms, armyworms, darkling beetles, click beetles, agrocenoses.

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1. Introduction

In modern conditions of development of agricultural production, obtaining high and constant yields is impossible without a comprehensive, scientifically based, highly effective biologically orienting system for protecting field crops from soil pests. It was developed on the basis of studying the species composition and patterns of their development and reproduction. In Ukraine, about 30–35 % of agricultural crops are lost annually from harmful organisms [1–3].

Particularly dangerous are the larvae of click beetles, scarab beetles, darkling beetles, as well as caterpillars of armyworms and others that damage seedlings of cereals, legumes, industrial and other crops on which it is necessary to ensure the control of phytophages as limited as possible and at the same time using compositions for dressing seeds and highly effective [4].

It is known that in the modern features of the formation of arthropods, insects occupy a special place, being just one of the relatively functionally viable classes of animals. In terms of their role in agrocenoses and their impact on agricultural crops, few groups of animals, even of a higher taxonomic rank, can be compared with phytophage insects [5, 6].

The purpose of the work is to clarify the ecological and phenological features, as well as the structure of the colonization of phytophages in agrocenoses of modern chains of field crop rotations [7–10].

2. Materials and methods

The research was carried out on production, temporary experimental plots laid down in the farms of Kyiv, Poltava and other regions.

The objects of research were the main representatives of the complex of soil-cultivating phytophages, larvae of click beetles, scarab beetles, darkling beetles, as well as caterpillars of armyworms. Monitoring and accounting of pests was carried out according to generally accepted methods in the autumn period by taking soil samples 50×50 cm (0.25 m^2) in size and 30–45 cm deep.

In addition to soil excavations, to determine the population density of soil-living pests, the degree of liquefaction of crops of winter wheat, chickpea, wintering peas, and corn was taken into account.

Plants were dug up on crops of wheat, chickpea and peas, on row crops, 16 samples each, which is conventionally taken as an area of 1 m, and on corn crops, 5 plants were examined in 20 places and during the inspection, the intensity of damage to seeds, the root system was determined.

3. Results and discussion

In 2019–2022, wireworms larvae, as well as scarab beetles and other coleoptera beetles, prevailed in the structure of soil harmful insect species under modern technologies for growing winter wheat, which formed the structure of an entomocomplex with features of biology, migration and survival in the soil seedlings of wheat (**Fig. 1**).

The embryonic development, depending on the conditions, lasts from 3 to 5 weeks, the sum of effective temperatures above +10 °C is necessary – for the identified species it is in the range of 290–370 °C.

Consequently, the larvae of the sowing piece of the first year of life, of course, did not migrate in the thickness of the soil, but were localized near the places of their rebirth. In the first year, young larvae reached a length of 3.5–4.2 mm and during this time they molted 3–5 times. It is characteristic that on seedlings of both winter wheat and chickpea and corn, the larvae of the sowing piece were found at the sowing depth, which indicates the importance of controlling phytophage insects using insecticides for dressing seeds.

It was noted that 5–7 days before the molt, the larvae stopped feeding and moving and stayed in the places of migration for a short time. It is known that during this period the mass of the larva sharply increases (by 20–30 %) due to the absorption of strongly bound water in the body.

The size of the body of the larvae during this period also increases due to the stretching of the pleural and sternal sutures, which become wide and noticeable, the body of the larva swells and rounds.

The old chitin exfoliates, breaks through in the area of the thoracic segments along the median line and is thrown back by the undulating movements of the larva.

The molting process lasts from 4 to 8–14 hours. After that, the larvae stay in the places of migration for 3–7 days and hardly move. Chitin is white, very soft and fragile.

The period of intensive feeding after molting. When migrating in the surface layer of the soil to the root system of plants from 6 to 25 or more days with an increase to older ages.

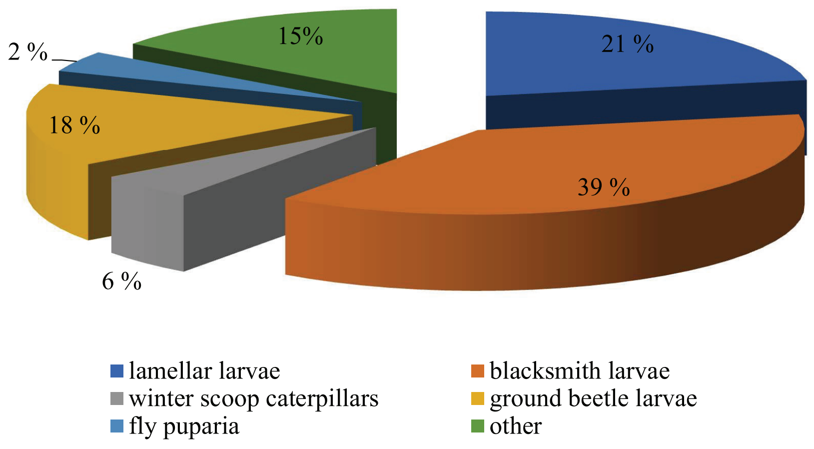


Fig. 1. The structure of soil pests in the crop rotation chain (legumes – winter wheat, 2019–2022)

As on crops of chickpea, pea, corn - in spring, and winter wheat – in autumn for 15 days, larvae actively migrate in a layer of 5–15 cm in search of favorable conditions for development. Nutrition intensity decreased significantly in 2020–2022 due to drought and the negative impact of relatively high soil temperature on phytophages.

An increase in air temperature affects the timing of molting, and with insufficient nutrition, the duration of development is extended by 2–3 days. It is worth noting that the development from egg to pupa under laboratory conditions in larvae of the genus Agriotes spp. ends in 230–335 days, while the sum of effective temperatures +10 °C necessary for development ranges from 3010 to 4030 °C, which deserves special attention for developing forecast models.

With an unfavorable diet, the period between molts in middle and older ages increases by 9–18 days. However, these terms are not yet limits, since the larvae remain viable even during the transition to fluctuations in nutrition during changes in development.

The migration of larvae of the sowing piece, as well as other species in the soil, occurs in the horizontal and vertical directions, which correlates with the search for food resources, changes in soil moisture and temperature. In the studied complex of soil species, both seasonal and diurnal migrations were observed.

The soil moisture is of no small importance in the migration of blacksmith larvae. So, with modern systems of soil cultivation, when the top layer dries up, soil-living insect species migrate to more humid layers, which reduced the harmfulness in recent years of research (**Fig. 2**).

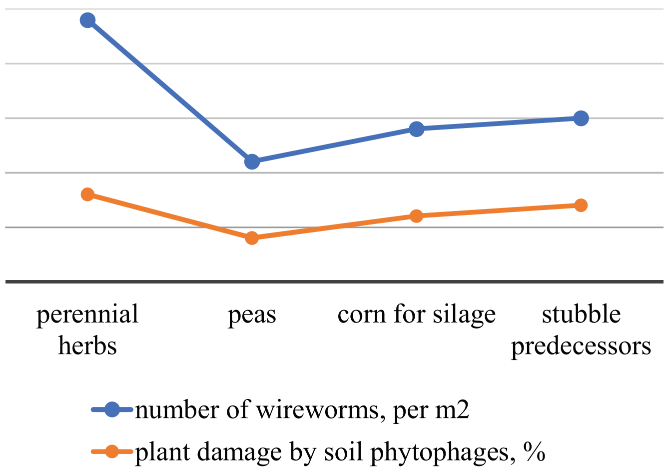
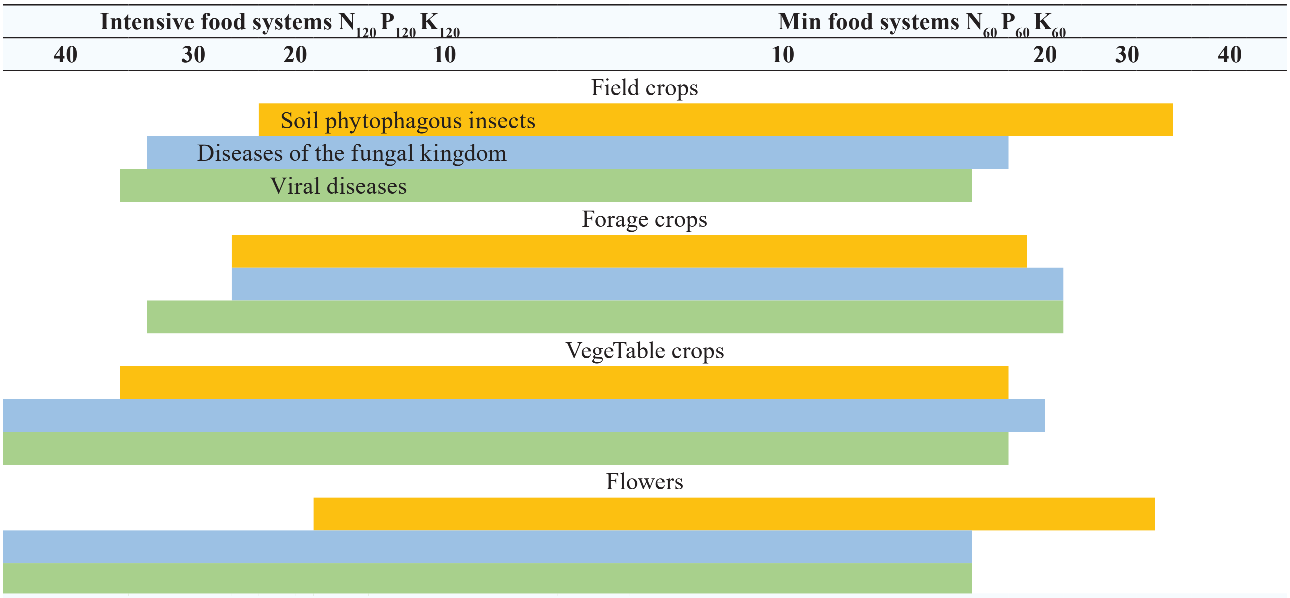


Fig. 2. The influence of wireworms on damage to winter wheat, depending on the predecessor (average for 2019–2022)

In different soil-climatic zones of Ukraine, the harmfulness of wireworms on arable land and at the same time their ability to saprophagy, since the initial type of feeding of wireworms was saprophagy, but in the process of evolution there was a transition to feeding on living plant tissues. Pieces are one of the most dangerous pests of agricultural plants. According to the nature and dynamics of damage, wireworms are divided into two groups. One of them includes most species of the genus Agriotes, the formation of foci of which is associated with cereal vegetation, mainly with cereal perennial grasses. The larvae of these species feed on germinating seeds and roots of various cereals (**Table 1**).

Table 1

Distribution and survival of the main types of pests in modern cenoses (2015–2022), **%**



During the years of observations, the vertical movement of these insects in the soil occurred during the spring-autumn period and was associated mainly with the search for food and relatively optimal conditions for development. At moderate temperatures and high soil moisture, wireworms develop in a layer of 5–7 cm and intensively feed on cereals, legumes, and industrial crops. during the period of spring vertical migration of blacksmith larvae, it is necessary to estimate the average ten-day temperature of the soil in a thickness of 20 cm was +6.5 °C, and in 40 cm +4.7 °C. For the mass movement of wireworms from deeper soil layers to the upper ones, an average ten-day temperature at a depth of 20 cm is +8.1 °C, at a depth of 40 cm, +8.5 °C (**Fig. 3**).

During the years of observation, the dependence of the effectiveness of the action of insecticides for the treatment of sugar beet seeds on the rate of spring warming of the soil was noted. With early warm spring and rapid warming of the soil, wireworms are already in its upper layers when sowing cereals, legumes and sunflowers. If the toxicity of crop plants with systemic insecticides is slow, there is a high probability of damage to them by soil-living pests in the most vulnerable phases of growth and development. One of the measures to protect germinating seeds is its premature treatment with a mixture of insecticides. In late cold spring, blacksmith larvae slowly migrate to the upper layers of the soil and begin to damage plants weakened by adverse weather conditions, which are now largely losing their acquired toxicity. This indicates the importance of seed treatment with insecticides with prolonged action. In summer, as the topsoil dries up and its temperature rises, wireworms move to deeper, moister soil layers. The adaptation of these insects facilitates the search for food, as the root system of plants deepens into places with higher soil moisture.

In autumn, the vertical migration of wireworms to deeper layers begins due to a decrease in soil temperature below +10 °C. Already at a temperature of +6 °C, the movement of the larvae slows down, and when it drops to +4 °C, it becomes sluggish, at 0 °C, they become numb depth of

20 cm to +7.8–8.3 °C, at 40 cm to +9.4–9.8 °C. Vertical migration of wireworms to the upper soil layers does not occur when a high amount of precipitation occurs with a sharp decrease in soil temperature to +11.4–13.1 °C at a depth of 5 cm. Slow increase in soil temperature at a depth of 20 cm with + 7.7 to 9.4 °C, and at a depth of 40 cm from 9.9 to 10.1 °C causes the migration of wireworms to the upper layers.

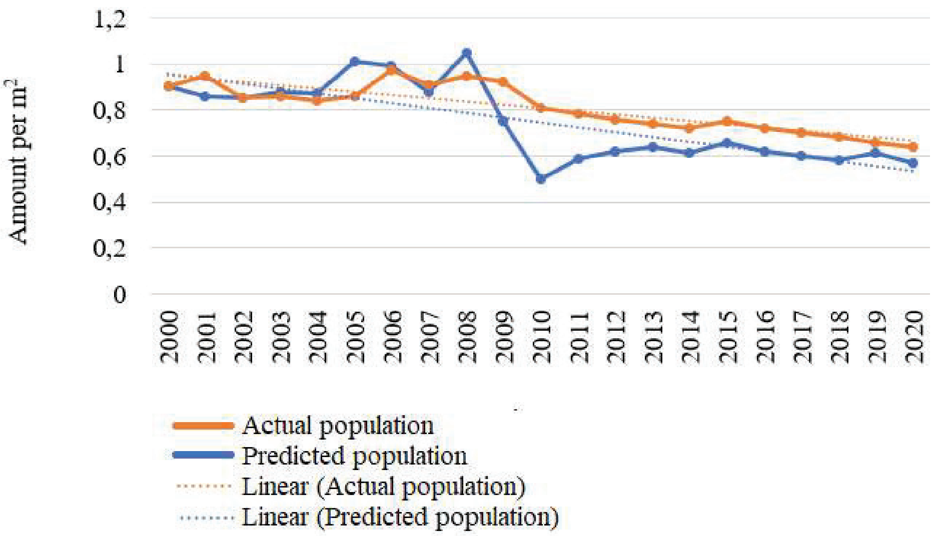


Fig. 3. Estimated and actual dynamics of the settlement of agrocenoses by phytophage insects (2000–2020)

Chemical etching was based on four components:

– cost-effectiveness (a small amount of active substance is used in comparison with continuous processing);

– environmental friendliness (seed treatment minimizes the effect of a chemical disinfectant on soil biota);

– accuracy (compared to continuous processing, accurate application of the active substance to the soil is ensured: the risk of redistribution is minimal);

– high efficiency, since the active substances gradually penetrate from the surface of the treated seeds into the soil, while a protective zone is formed around each seed (**Table 2**).

Table 2

Efficiency of seed dressing of winter wheat against soil-living phytophage insects in winter wheat crops

No.	Variant, l/t	Before processing	After processing, days, ind./m²					After processing, days, %				
			0.5	3	7	14	21	0.5	3	7	14	21
1	Control	7.3	7.5	7.5	8.3	7.8	7.8	0	0	0	0	0
2	Imidacloprid (300 g/l), 0.5	7.5	5.5	3.5	2.5	2.3	2.0	28.1	52.8	67.2	67.5	70.9
3	Imidacloprid (300 g/l), 0.75	8.3	3.8	2.3	1.8	1.3	0.5	54.3	72.2	77.2	84.9	93.1
4	Imidacloprid (300 g/l), 1.0	8.3	2.5	1.5	0.8	0	0	65.5	81.0	91,8	100.0	100.0
–	LSD_{05}	–	1.26	1.03	0.94	0.78	0.52			–		

Note: Option Drug consumption rate, ml/0.1 ha, number of adults and larvae ind./m², reducing the number to the initial one (adults or larvae), %.

According to generally accepted methods, it is planned to establish the peculiarities of the biology and ecology of the complex of harmful species of organisms under the factors of intensification of cultivation of field crops, chrysanthemums and other plants with the definition of mechanisms of self-regulation and viability at the species and population levels. Calculate indicators of plant resistance by periods of their growth and assess the impact of a complex of pests on the formation of generative organs and crop quality.

4. Conclusions

The studied factors of intensification of cultivation, in particular the use of nutrition and protection systems for field crops and chrysanthemums, influenced the development and reproduction of soil and aerogenic pests. It was established that the structure of soil insects-phytophages is formed depending on the number of applied fertilizers in field crop rotations with a characteristic feature of the vital processes of the identified species in chrysanthemum cultivation technologies, which should be taken into account in the systems of forecasting and application of pest control measures.

Phenological observations have shown that the complex of pests is formed under the influence of both weather fluctuations and gross reserves of nutrients of their mobile forms in the soil.

The potential reduction of soil pests with relatively high forms of fertilizers and the increase in the development and reproduction of pests that migrate before and during the formation of generative organs has been established. The dynamics of the number of harmful soil phytophagous species depending on the application of disinfectants, as well as mixtures of fungicides and insecticides used during the growing season of winter wheat is presented. It was found that the effectiveness of the application of the insecticide imidacloprid (300 g/l), with a rate of use of 0.75–1, l/t of seeds helps to reduce the number of harmful soil insects-phytophages by 93.1 % compared to the control.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

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Data availability

Manuscript has no associated data.

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