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# INFLUENCE OF THE PROTECTION SYSTEM ON LIMITATION OF THE NUMBER OF MAIN PESTS IN CORN CROPS

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*This article highlights the theoretical generalization and solution of the problem, which consists in the development and substantiated elements of the system of protecting corn from a complex of pests and controlling their number in the conditions of the Vinnytsia district, which is based on the clarification of the species composition of phytophages in corn crops, their harmfulness and limiting the number when applied insecticides for seed treatment and spraying of crops with chemical preparations.*

*The species composition of the harmful entomofauna of corn was clarified and 32 species of insects from 7 orders and one species of mites were identified. The order was dominated by Coleoptera – 45,2% and Lepidoptera – 15,2%. Diptera and thrips were the least numerous in corn crops – 5,3%. The most numerous families in corn crops are determined to be weevils, weevils, lamellae, and leaf-eaters. It was established that the biggest threat to the seeds and seedlings of corn was the larvae of weevils (Elateridae) and the larvae of plate-bearded beetles (Scarabaeidae), and the most dangerous pest of generative organs during the years of corn research was the cotton bollworm (Helicoverpa armigera Hbn.). Therefore, the corn crop protection system was implemented to limit the number of the above-mentioned phytophages.*

*The effectiveness of modern insecticides against the dominant pests of corn and optimized methods of their application were evaluated. It was established that the highest technical efficiency of insecticide poisons was noted in variants with poisoners Force Zea 280 FS (5,5 l/t) and Poncho 600 FS (2,5 l/t). 82,2% and 81,1% for whitefly larvae; Poncho 600 FS – 81,8% and 82,6%, respectively, while the density of pest larvae was almost 4.5 times higher than in the control, and the yield preservation was at the level of 0,69–1,19 t/ha .*

*When testing insecticides against cotton bollworm caterpillars on corn crops, the highest technical efficiency was provided by the insecticides: Koragen 20 hp. (0,15 l/ha) – 86,0% and Ampligo 150 ZC, FC (0.2 l/ha) – 80,5%. With the use of the investigated insecticides, the yield of corn exceeded the control. The saved yield was 0,23–0,32 t/ha.*

***Key words**: corn, phytophages, harmfulness, insecticides, effectiveness, yield*
***Table 6. Fig 1. Lit. 20.***

**Introduction.** Corn is one of the most valuable fodder and food crops in world agriculture. Among cultivated crops, it ranks first in terms of gross grain collection and second in terms of sown areas, second only to wheat. Corn grain is characterized by high nutritional qualities. A kilogram of it contains 1,34 feed units, barley – 1,2 feed units. Corn grain is a good and economically profitable fodder for all types of livestock and poultry. Corn plays a significant role in providing livestock with juicy fodder. In terms of collection of feed units per hectare, it is somewhat inferior to sugar beet and prevails over all silage crops [1].

Corn grain is used for food purposes (20%), technical purposes (15–20%) and fodder (60–65%). Corn kernels contain 65–70% carbohydrates, 9–12% protein, 4–8%

vegetable oil (up to 40% in the germ) and only about 2% fiber. Contains vitamins A, $B_1$, $B_2$, $B_6$, E, C, essential amino acids, mineral salts and trace elements. The protein content is low, it is deficient in some essential amino acids, especially in the content of lysine [1].

As a precursor, corn has great agrotechnical importance in crop rotation. The almost complete absence of pests and diseases common to grain crops contributes to the construction of a rational rotation of crop rotation fields. Harvested at full ripeness, corn is a good precursor for spring grain and leguminous crops, and when harvested for silage – for winter crops as well. It is one of the best and most productive crops in busy pairs, post-harvest and post-harvest crops. As a row crop, corn, with proper agricultural techniques, helps to clear fields of weeds.

In world agriculture, including in Ukraine, corn is used as a universal crop – for livestock feed, for food and technical needs – for the production of cereals and flour, food starch and vegetable oil, honey and sugar, dextrin and ethyl alcohol, etc. [2].

In the current conditions, corn is one of the main grain crops both in Ukraine and in the world, and its cultivation makes it possible to make a stable profit. Therefore, the areas of its cultivation are increasing. If in 2000 corn in Ukraine (when grown for grain) occupied about 1,4 million hectares, then in 2021 it was already grown on an area of about 4,97 million hectares, which is 8,6% more than in 2019 Currently, corn production already accounts for more than 50% of the total volume of grain production in the country, and this figure has been growing gradually for 20 years. In Ukraine, Poltava oblast (541,8 thousand ha), Kirovohrad oblast (368,3 thousand ha) and Cherkasy oblast (330,9 thousand ha) take first place in Ukraine by region [3].

The crop is damaged by numerous omnivorous and specialized pests throughout the growing season, so it is necessary to monitor and control their number.

Among a number of factors that limit the realization of the potential productivity of modern hybrids in the range of 80–85%, the share of harmful organisms accounts for 33–35%, or losses on average reach about 3 t/ha of grain.

This convincingly shows that even partial prevention of losses is an important factor in increasing crop productivity.

In order to increase the effectiveness of protective measures and avoid possible negative consequences when using insecticides during the formation of milky-waxy maturity of corn grain, it is necessary to widely study the safe use of insecticides [5].

**Analysis of recent research and publications**. According to meteorological observations, it has been established that the air temperature in Ukraine has risen by 0,3–0,6 $^{o}$C, over the past ten years, while over the past hundred years – by 0,7 $^{o}$C. Due to the fact that Ukraine is located in different climatic zones and is characterized by a great diversity of ecosystems, climate changes at the global level can manifest themselves differently at the regional level, indirectly affecting other interconnected factors of the ecosystem [4]. Climatic zones, which are slowly moving to the north, change the entire natural configuration and lead to the destruction of natural ecosystems.

Simultaneously with warming, the number of pests increases. Many insects, with rising temperatures, quickly settle in those regions that were previously unsusceptible to them due to insufficient heat. In warmer climatic conditions, pests begin to develop in early periods and damage plants that have not had time to strengthen, which leads to significant crop losses [4].

Almost 200 species of insects damage corn in Ukraine, but among them, about 20 species are of economic importance.

Among the pests that cause the most damage to corn are seedling pests: soil and terrestrial. From the soil – the larvae of Elateridae, Tenebrionidae, Scarabaeidae beetles and cabbage beetles; terrestrial – larvae of swedish flies. Pests of vegetative organs are bread fleas, caterpillars of the meadow moth, leaf-gnawing bollworms, adults of the western corn beetle, aphids and pests that damage the inner part of stems and cobs – corn stem moth, bollworms (cotton, meadow, caradrina) [5].

The biggest danger for corn crops in the early stages of development is a complex of soil pests, the number of which has increased significantly in recent years and almost everywhere exceeds the economic thresholds of harmfulness by two or three times [18].

Losses of the corn crop due to pests amount to 1,33 t/ha, or 14,3%. The indicator of the harmfulness of wireworms in the phase of seedlings-4 leaves is 1,03; in the phase of 5–7 leaves: swedish fly – 0,79, winter snowdrop – 0,4; in the panicle shedding phase: aphids – 0,98, stem butterfly – 2,47.

Blacksmith beetles (family Elateridae, a number of Coleoptera). On the territory of Ukraine, V. G. Dolin notes 171 species from the Elateridae family, of which 82 are common in the forest-steppe. Among them, 23 species are pests of agricultural crops. The greatest damage to corn crops is caused by larvae of the following species: *Agriotes sputator* L., *Agriotes gurgistanus* Fald., *Agriotes lineatus* L., *Agriotes obscurus* L. [7].

The cycle of development is the same for almost all blacksmiths beetles. A characteristic feature of larval development is their seasonal vertical migrations, which are closely related to the hydrothermal regime of the arable soil layer.

For corn, damage in the seedling phase due to slowing down of plant growth during rainy and cold spring, which often happens in Polissia and Forest Steppe, is very dangerous. Therefore, soil pests for which favorable ecological conditions are created are of primary importance in these zones.

Larvae of the first year of life grow slowly, feed mostly on overgrown roots and humus. In subsequent years, they damage the sown seeds, seedlings, seedlings, root neck and large roots, root crops. On corn, their harmfulness is associated with two calendar and phenological periods. After sowing, they eat the embryo and endosperm of the seed, later they gnaw the underground stem and roots of corn seedlings, as a result of which the density of seedlings decreases, especially with a high number of larvae (wireworms) [6].

From the first half of the 19th century to the present day, the interest of domestic and foreign entomologists and soil scientists in the lifestyle of beetles of the Elateridae family has grown significantly. U.V. Bilayvska developed and proposed the taxonomy of blacksmith beetles, which attracted the considerable attention of many scientists. In her publications, the author describes species that have supplemented the fauna composition of Ukraine [7].

The study of the biology and distribution of blacksmith beetles was carried out in Ukraine dedicated to research in the field of protection of agricultural crops from woodpecker larvae, presented by the following researchers: O.M. Dovgelya., T.V. Girka., N.V. Gulyak [11].

A number of researchers have testified that wireworms cause the greatest harm to corn from sowing to the beginning of tillering. According to N.O. Rudska, with an average number of these pests of 7,7 ekz./$m^2$, seed damage varied from 5,9 to 30%, plants – from 8,6 to 14,0% [8].

According to V.P. Fedorenko and N.V. Hulyak in the Central Forest-Steppe of Ukraine, the average number of weevil larvae on corn crops was 13,8 specimens/m2, which exceeded the standard limit for this crop [11].

Larvae of Scarabaeidae. *Melolontha melolontha* L. is widespread. *Amphimallon solstitialis* L. is numerous in the forest-steppe near fallows and non-arable lands.

The US Department of Agriculture estimates crop yield losses from insect pests alone at $4 billion. Such losses are borne by the country's agriculture, which consumes more than 160,000 tons of pesticides with a total cost of 560 million dollars. The most dangerous pest of the root system is the beetle, whose eggs, larvae, and pupae develop only in the soil [13].

There are 250 species of insects of this family on the territory of our country, among which 70 are pests of agriculture and forestry.

Larvae of these species feed on corn roots, causing crop stunting, wilting, or plant death beginning in the seedling stage. A similar harmfulness is observed from the larvae of bread beetles: cuttlefish and whitefly. According to O.O Bahmyt., Drozda, and V.P. Fedorenco [6, 10, 11] the greatest threat to plants is caused by the larvae of roaches, which have reborn from eggs laid during the period of mass oviposition. Eggs laid in a layer up to 30 cm have the highest viability, but in general, in the surface layer (10 cm) and layer (31–40 cm), eggs are more vulnerable to the influence of abiotic and biotic factors.

According to V.F. Drozda, and V.P. Fedorenko the greatest threat to plants is caused by the larvae of roaches, which have reborn from eggs laid during the period of mass oviposition. Eggs laid in a layer up to 30 cm have the highest viability, but in general, in the surface layer (10 cm) and layer (31–40 cm), eggs are more vulnerable to the influence of abiotic and biotic factors. Distribution of larvae in the soil: in April, 90% of larvae are concentrated at a depth of 50–75 cm, in May, 75% of larvae − 10–30 cm, in June–July, almost 100% of phytophages are in the surface horizons (20 cm), in early August in dry weather, the larvae migrate to a depth of 20–40 cm –

up to 88%, but at the end of August and throughout September, if the soil is sufficiently moist, the larvae are kept in layers up to 30 cm – 60–88% of their total number, at the end of September and in October – in November, the main number of larvae – up to 85% is concentrated at the wintering depth of 50–75 cm. These are very important data for the implementation of effective protective measures against roach larvae [6, 11].

In the fall of 2017, the population of agricultural land with roach larvae was 44% of the surveyed areas with an average density of 1,2 ekz./$m^2$, which is at the level of last year. In Forest steppe and Polissia, the winter stock of *Melolontha melolontha* L is 0.9–1,2 ekz./$m^2$. Taking into account the rather high population density of the wintering larvae of the May and June beetle, in 2020 it is possible to predict the mass appearance of the adults of the May beetle and the threat of a focal increase in the number and harmfulness of larvae and beetles in perennial fruit, forest plantations and crops of agricultural crops bordering forests. forest strips and non-arable lands, mainly in the forest-steppe region [12].

Among terrestrial pests, corn seedlings are harmed by the following: family Scarabaeidae, southern gray or corn weevil (family Curculionidae), larvae of swedish flies (family Oscinella), which gnaw through shoots and stems at the base, gnaw longitudinal ulcers in the stem, gnaw leaves and damage the central leaf, which leads to thinning of the sowing density, suppresses the growth and development of the plant, provokes excessive bushiness, and also contributes to the penetration of the plant and the development of the causative agent of blistering soot [8].

**Pests of vegetative organs.** Bread fleas (Chrysomelidae), caterpillars of the meadow butterfly (Pyraustidae), leaf-gnawing scoops (Noctuidae), locusts (Acrididae), aphids (Aphididae), leafhoppers (Cicadellidae) – six-spotted, striped, imago of the *Diabrotica virgifera virgifera* Le Conte. These pests skeletonize leaves, stems, panicles on the outside, suck juices, discolor the leaves, which later turn yellow, dry up, are affected by viruses, threads damaged by bugs dry up, flowers on panicles die, gnaw anthers, threads, grains on the tops of cobs, which leads to disruption of processes assimilation, the occurrence of through-grain and empty-grain cobs, short-grainedness, a decrease in the marketable quality and seed quality of grain, cobs are affected by bacteriosis, and productivity decreases [9].

In the conditions of Ukraine, corn is damaged by the following species of aphids: monoecious species – *Schizaphis graminum* Rond., *Ryngsia maydis* Pass., *Rhopalosiphum maidis* Fitch.; dioecious species – *Rhopalosiphum padi* L., *Aphis solanella* Theob., which is one of the first (at the end – beginning of June) to colonize corn.

In the last five years, during the growing season of cereals, aphids occupied more than 30%, and in cells 50–70, in some places up to 100% of plants, with the number of 5–18, maximum 30–60 individuals per plant. Some studies have described that in corn crops in the phase of panicle shedding, the number of aphids (mainly genera Sitobion and Rhopalosiphum ranges from 35 to 62 ekz./plant [14].

Another dangerous pest in the forest-steppe and steppe zones is *Ostrinia nubilalis* Hbn. order Lepidoptera, family Pyraustidae.

In Polissia and Forest Steppe, mainly one generation develops, in certain favorable years there is a second optional one. In the steppe zone, the development of two generations is completed. Caterpillars overwinter in the stems of damaged plants, pupation occurs in early June. The summer of butterflies of the overwintering generation mostly coincides in time with the beginning of the shedding of panicles, the second - from the end of August to the middle of September. The fecundity of females, depending on the conditions during the development period, ranges from 100 to 1200 pieces, on average 250–400 pieces. [5].

The nature of crop damage by phytophage is very diverse and varies depending on the morphological and physiological characteristics of plants, the age of the caterpillar, its behavior and environmental conditions. After rebirth, the goose lives for some time on the surface of leaves, gnaws them, and also feeds on male flowers in panicles. Later, through the axils of the leaves, it penetrates into petioles, tops of stems and panicles. Caterpillars of younger ages prefer tender parts of leaves, spikelets of panicles, which contain an increased amount of proteins, caterpillars, damage to panicles and leaves does not lead to significant losses. More negative are the consequences of feeding the goose with stalks and cobs. Stems heavily infested with it easily break, as a result of which plant nutrition is disrupted and the grain yield is reduced. Due to damage to the leg in the early period of development, the cob dies or does not develop; later – the grain in the cob ripens prematurely and becomes thin. As a result, the mass of the crop decreases, its quality deteriorates, it becomes difficult to collect the crop, the causative agents of fungal and bacterial diseases penetrate into the plant [7].

The distribution zone of the butterfly on the territory of the CIS covers the forest, forest-steppe and steppe zones of the European part, as well as the south of the Taiga zone, the southern part of Siberia, Kazakhstan and the Far East, the foothills of the Caucasus. It is known that the distribution of *Ostrinia nubilalis* Hbn. within Ukraine is more stable than other corn phytophages. The largest population of corn crops and the harmfulness of *Ostrinia nubilalis* Hbn. the vegetation period is observed, according to 15-year data, in the forest-steppe zone of Ukraine [4].

The phenology of the *Ostrinia nubilalis* Hbn. is closely related to the phenology of the main forage crop. Thus, butterflies lay eggs on corn and hemp plants that are in the flowering phase [18].

According to the data of the Main State Inspection of Plant Protection of the Ministry of Food and Agriculture of Ukraine, over the last decade, the spread of the corn stem butterfly in the agrocenoses of Ukraine has reached more than 80%. At the same time, its harmfulness is constantly increasing. If at the end of the nineties, the productivity of corn agrocenoses could decrease by 5–7, at most – by 12–15%, now the losses can amount to 20–25, and sometimes more than 50%. According to S.O.

Tribelia colonization of cobs with this phytophagous reaches 11–14%, and stems – 22–28%. The zone of the highest danger covers the Chernivtsi, Vinnytsia, Cherkasy, Poltava, Kirovohrad and Kharkiv regions, where the most favorable hydrothermal conditions for the development and reproduction of the phytophagous are found. Grain yield losses from damage by this pest are currently high [18]. In many countries, on average, they make up 12–15% of the harvest, and in years of mass reproduction, they can reach 25% or more [14].

It should be noted that since 1995, along with the *Ostrinia nubilalis* Hbn., the *Helicoverpa armigera* Hbn., has also been breeding on the ears of corn, the caterpillars of which damage more than 45% of the cobs in some places.

*Helicoverpa armigera* Hbn. order Lepidoptera, family Noctuidae.

The phytophagous goose can feed on more than 120 types of plants. The main damaged crops are corn, sunflower, soybeans, chickpeas, tomatoes, and alfalfa.

After hatching from the egg, the cotton bollworm caterpillars feed on the pistillate threads of the cob. Due to the damage of threads on flowering cobs by caterpillars of older ages, normal pollination does not occur, as a result of which grains are not formed. But, most often caterpillars *Helicoverpa armigera* Hbn. feed on grains of milk and milk-wax maturity. They gnaw their way to the grain through the densely packed pistillate threads (stigmas), feeding on the grain of the cob, making their way through it, filled with a wormhole. Accumulation of excrement of caterpillars and residues after their feeding contribute to the development of fungal diseases, which leads to additional crop losses [14].

Currently, *Helicoverpa armigera* Hbn. is considered an economically important pest. Crop yield losses are very significant. For example, in India, cotton losses in 2015–2016 reached 30–40%. In Brazil, damage by caterpillars of the cotton bollworm of corn led to a crop shortage of 12–25% as of 2016. In the United States, the cotton bollworm is considered one of the most dangerous pests of agricultural plants.

This invasive pest also causes considerable damage in Europe. Losses from corn damage reach 15–18%, and in some years up to 30% [16].

In 2018, *Helicoverpa armigera* Hbn. caterpillars damaged up to 35% of sunflower plants, corn cobs, and vegetable crops in Kirovohrad Oblast in Zaporizhzhya, Cherkasy, and Kharkiv regions during the growing season. In the centers of the Kharkiv, Zaporizhzhya, and Donetsk regions, sunflower and corn phytophagous damage reached 84% [14].

According to Yu.V. Bilyavsky, in the north of the Poltava region. in 2017, significant damage to the cobs of most mid-ripening and late-ripening corn hybrids up to 70% was recorded.

Analogous data are given by O.O. Bahmut, Yu. M. Lyaska a clear tendency to increase (by 3,0–9,8%) damage to plants of corn hybrids by the cotton boll when harvested late was observed only in 2017, which was favorable for the development of the pest, when wet autumn conditions promoted development. The pest penetrated even into the legs of the cobs, so they often broke off in places of damage. Long-term feeding of caterpillars negatively affected the level of grain yield and its quality [4, 10]

The annual losses of the crop of agricultural products in the world from the cotton bollworm on cotton, corn, vegetables, legumes, etc. exceed 2 billion USD, and the cost of protective measures is about 1 billion. In China and India, about 50% of all insecticides are used against the *Helicoverpa armigera* Hbn. Here, farmers spend up to 40% of their earnings on purchasing insecticides to control *H. armigera* Hbn. [14].

Without cotton bollworm protection on corn, protection of other crops becomes problematic. Therefore, the harmfulness of this phytophagous is underestimated.

Currently, corn producers should pay special attention to the quarantine object – the *Diabrotica virgifera virgifera* Le Conte., or Western Corn Rootworm. In 1992, it was first discovered in Yugoslavia. Thanks to its ability to fly, this pest quickly spread across the territory of Western Europe. It appeared in Ukraine in 2001 and initially settled in Zakarpattia in six districts: Berehivskyi, Vynogradivskyi, Irshavskyi, Mukachivskyi, Khustskyi, Uzhhorodskyi. 1657 hectares of land were declared under quarantine.

In 2006, this pest was detected in all agro-climatic zones of Transcarpathia, and the presence of all soil stages of its development (egg, larva, pupa) on corn crops was established. It was also found in the Lviv region. The spread of the pest to the territory of neighboring regions is facilitated by vehicles and the ability of the beetles themselves to fly 40 km per day, which is facilitated by the wind [15].

The revival of larvae begins with the emergence of seedlings and active growth of corn roots from the second half of May – June and continues until the end of July. The survival of larvae is affected by soil moisture: the lower the moisture, the higher the mortality. Beetles appear in the third decade of June (and until August-September), at the beginning of the shedding of panicles in corn. They live for five to six weeks.

Beetles start laying eggs in July and en masse in August and September at temperatures of +18...+26 °C. The females burrow into the soil near corn plants and lay eggs in several batches. The depth of egg deposition depends on the density of the soil and its humidity. On dry dense soils, the main mass of eggs is placed in the soil layer up to 15 cm, and on well-moistened (under irrigation conditions) almost 80% of eggs are stored at a depth of 35–40 cm. One female can lay 400–1000 eggs.

Corn is damaged by larvae and adults. Larvae of the western corn beetle are obligate monophagous and are able to feed and develop only on corn roots, which distinguishes them from other Diabrotica species.

Larvae gnaw the roots of young corn plants from the outside or gnaw through them, gnaw into the parenchyma of thick roots, sometimes into the underground part of the stems, gnawing the passages in them. The gnawed roots die, the plants wither, lie down, bending in the form of a «goose neck», and do not form cobs or die completely. Lying down and dying is observed when 50% of the roots are damaged in plants. Such damage, depending on soil moisture conditions, is caused by larvae in numbers of more than 25 ekz./$m^2$. Damaged roots are a gateway for root rot pathogens to enter. The impact of *Diabrotica virgifera virgifera* Le Conte., on corn yield can be significant, and in extreme cases can cause up to 80% yield loss. Ultimately, the level of crop loss depends on the level of damage and the degree of effectiveness of protective measures.

Symptoms of corn damage by beetles vary depending on the feeding site. On the leaf, they gnaw strips of parenchyma between the veins. On the panicles of plants, beetles eat anthers, which significantly reduces the amount of pollen, and on cobs they eat or gnaw the threads of the receptacles. Due to the damage of the threads, pollination does not take place, and the cobs remain hollow-grained or have a pinnate grain. In the period of pouring – the milky ripeness of the grain, beetles gnaw through the shells of the bare heads of grain and eat their contents [16].

Consequently, the phytosanitary condition of corn fields requires increased attention and compliance with clear zonal systems of plant protection against pests [9].

***Control of the number of the main pests of corn***. To protect corn, integrated protection systems have been developed and used in production, which include organizational, economic and agrotechnical measures, the introduction of resistant varieties, and the use of biological and chemical preparations. So far, the dominant position in these systems is occupied by the chemical method. In 2021, according to the State Statistics Service of Ukraine, the total area treated with pesticides last year amounted to 16.1 million hectares [17].

Modern plant protection is a complex of organizational and technical measures and diagnostics, based primarily on the rational use of pesticides. That is, modern plant protection is mainly chemical. Scientific and technical progress makes it possible to synthesize new and more advanced pesticides. Their level of toxicity to warm-blooded organisms, and in particular to humans, decreases. Per-hectare rates of pesticide consumption are also decreasing.

In the middle of the 20th century with the appearance of new insecticides (Phosfamide, Heptachlor, Hexachloran, etc.), their technical effectiveness against blackfly larvae was studied using different methods of application: seed treatment, application of granules in rows during crop sowing, inter-row cultivation, cultivation. Such studies were conducted by many domestic and foreign scientists, and a large number of scientific works are devoted to this topic [16].

In the 1980s and 1990s, two methods of using carbofuran insecticides were studied: the introduction of granular preparations into the soil after sowing crops and the poisoning of seeds. Despite the high efficiency of the method of pre-sowing treatment of seeds to protect against harmful insects, it is rarely used in production, since it is very difficult to choose insecticides that would meet modern requirements. An important indicator of the technical efficiency of systemic insecticides is the rate of poisoning of young seedlings from the moment of sowing treated seeds, as well as the high initial toxicity of seedlings to pests. During the rapid spring warming, wireworms are concentrated in the upper layers of the soil. If the poisoning of crop plants by systemic insecticides occurs slowly, then there is a high probability of their damage by soil pests in the most vulnerable phases of growth and development. One of the measures to protect seedlings is their treatment with contact insecticides [18].

In countries where corn is grown en masse, the larvae of Elateridae were and remain the most harmful phytophages of corn in the early stages of organogenesis of the crop. According to the results of the research of O.S. Trybela the death of plants during the «seedlings-full maturity» period was on average 9,5–24,0%. During the next period («seedlings – fifth leaf»), 4,0–19,5% died, which was 40,2–76,7% of the number of dead plants during the entire vegetation period. On the world market there is a wide range of drugs with different active substances, which belong to two groups: neonicotinoids and synthetic pyrethroids. Every year, chemical companies update and improve the assortment of insecticide poisons, because protection of corn at the initial stages makes it possible to ensure a high yield [9].

Goose *Helicoverpa armigera* Hbn. and *Ostrinia nubilalis* Hbn. leads a hidden way of life, therefore the protection of corn from these pests becomes difficult. Crops should be sprayed twice. The first spraying is during the mass revival of the caterpillar, the second is after 10 days [16].

As for *Helicoverpa armigera* Hbn., it is known that it is resistant to many insecticides. Resistance of Helicoverpa armigera Hbn. to synthetic pyrethroids was first discovered in Australia in 1983, then in North Africa, Asia and Europe. It is believed that a decrease in the permeability of the cuticle is the main factor in the development of resistance of the cotton bollworm to 19 synthetic pyrethroids. Alternating insecticides from different chemical groups makes it possible to prevent resistance [19].

In 2011–2012, tests of pyrethroids and biological preparations against the cotton bollworm were conducted on corn crops. The insecticide Arrivo, KE (250 g/l), 320 g/ha was more effective than the mixture of bacterial preparations Lepidocide and Bitoxybacillin. Two-time treatment with an insecticide ensured less loss of grain yield from the pest than a one-time treatment [19].

For the timely implementation of control measures against the main pests of corn, it is necessary to systematically carry out phytosanitary control, which makes it possible to assess the situation, which consists of the prevalence, number and harmfulness of all types of phytophages.

From the analysis of literature data, it follows that the larvae of the weevil, the caterpillars of the *Ostrinia nubilalis* Hbn. and the *Helicoverpa armigera* Hbn. are the most dangerous and economically important pests of corn in Ukraine. In terms of research on the study of the biological features of the cotton boll, not enough has been conducted. Therefore, clarifying the biological features of these phytophages and improving the elements of the culture protection system in modern ecological conditions is very relevant.

**The aim of our research**. To improve the system of protecting corn from the main pests, taking into account the peculiarities of the biology of the dominant species and the modern technology of crop cultivation to improve the phytosanitary condition of agrobiocenoses and preserve the crop.

**Materials and methods of research.** The research was conducted at the «Savynetsk» PAE in the Vinnytsia region, during 2021–2022, the species composition of the harmful entomocomplex of corn and the control of their number were studied.

Corn was grown in accordance with the cultivation technology recommended for the right-bank forest-steppe zone of the Vinnytsia region – husking at 10–12 cm, plowing at 23–25 cm, pre-sowing cultivation at a depth of 8–10 cm, sowing was carried out with a seed drill «KINZE 3000» with simultaneous application of nitroammofoska at the rate of $N_{90}P_{48}K_{48}S_{48}$. After the emergence of corn in the phase of 2–5 leaves, it was treated with the herbicide Task Extra 0,44 kg/ha. When planning and conducting experiments, we were guided by the methodology of S.O. Trybel [20].

The size of the experimental plots is 50 $m^2$. Experiments were laid out in a single-tier arrangement of repetitions using a randomized method. For field experiments, medium-ripe high-yielding hybrid of corn DKS 3511, FAO – 330, whose seeds were pre-treated at the plant with the fungicide Maksym XL 035 FS (fludioxanil, 25 g/l, metaloxyl-M, 10 g/l) was used for field experiments. 1 l/t.

The species composition of the entomofauna and the determination of the number of dominant species of pests were determined by the following methods:

- by the soil excavation method: 8 pits arranged in a checkerboard size of 50×50 cm, up to 80 cm deep were dug on each plot. The soil from each pit was sifted layer by layer by hand or sifted through sieves and the pests found in it were counted;

In addition to counting the number, the damage of sown hybrid corn seeds during the period of full germination was also determined. For this purpose, 5 seedlings were dug up in 20 places of the field and the number of damaged and dead seedlings and seeds was determined.

Modified Barber traps were used to study terrestrial entomofauna.

- visual inspection of 10 plants in 10 places of the option;
- digging up crops with ditches and wells;
- Petlyuk's device on 25x25 cm platforms;
- using poisoned lures (1 lure per 100 $m^2$);
- mowing with an entomological net (10 sweeps in 10 places);

The intensity of flight of *Helicoverpa armigera* Hbn. and was determined using pheromones from Biochem Tech.

The degree of damage to the above-ground part of vegetative plants by the striped bread flea, leaf-gnawing sawfly, and the southern gray weevil was determined by examining 100 plants according to the 9-point scale of S.O. Tribel. [20].

Determination of the technical efficiency of insecticides for seed treatment and spraying of corn crops was carried out in field experiments. Seed treatment with insecticides was carried out the day before sowing. Norms and terms of use of drugs were determined based on the goal and task of research.

Records were made from the emergence of seedlings to the phase of 3-5 leaves, by the method of soil excavation and plant inspection (Table 1). The technical efficiency of insecticides-protozoans was determined by the formula:

$$Te = 100\ (K_k - K_v)\ /\ K_k \qquad (2.1)$$

where $T_e$ – is technical efficiency, %;

$K_к$ – occupancy rate in control;

$K_v$ is the occupancy rate in the experimental version.

*Tabl 1*

**The scheme of the experiment on the evaluation of the effectiveness of poisoners for processing corn grain against soil pests (average 2021–2022)**

| № p/p | Variant | Consumption rate, kg (l) / t |
|---|---|---|
| 1 | Control (without insecticides) | Water |
| 2 | Cruiser 350 FS, t.k.s. (thiamethoxam, 350 g/l) | 1,0 |
| 3 | Poncho 600 FS, TH (clothianidin 600 g/l) | 2,5 |
| 4 | Gaucho plus 70 WS, z.p. (imidacloprid, 233 g/l, clothianidin 233 g/l) | 6,0 |
| 5 | Force Zea 280 FS, t.k.s. (thiamethoxam, 200 g/l, tefluthrin, 80 g/l) | 5,5 |

During the growing season of corn plants, the effectiveness of using chemical insecticides for spraying crops against lepidopteran pests was investigated. Processing was carried out during the period of mass flight of the pest, which are listed in Table 2.

The effectiveness of insecticides was determined by the degree of plant damage. Records of damage by pests were carried out during the period of intensive corn settlement and 3, 7, 14 days after the first records.

The technical efficiency of insecticides was calculated by formula 2.2

*Table 2*

**Scheme of the experiment for evaluating the effectiveness of chemical preparations for spraying corn crops on grain against** *Helicoverpa armigera* Hbn. (average 2021–2022)

| № p/p | Variant | Consumption rate, l/ha |
|---|---|---|
| 1 | Control (without insecticides) | Water |
| 2 | Karate Zeon (lambda-cyhalothrin, 50 g/l), (standard) | 0,2 |
| 3 | Ampligo 150 ZC, FC (chlorantraniliprole 150 g/l, lambda-cyhalothrin 50 g/l) | 0,2 |
| 4 | Koragen 20 K.S. (chloranthraniprole, 200 g/l) | 0,15 |
| 5 | Belt 480 SC, CS (flubendiamide, 480 g/l) | 0,15 |

The source is formed on the basis of own results of researches

$$Te = 100\,(Ab - Ba) / Ab \qquad (2.2)$$

where *Te* – is the technical efficiency of the action adjusted for control, %;

*Ab* – the number of phytophages in the experimental version before treatment, ekz./m$^2$; *Ba* – the number of phytophages in the experimental version after treatment, ekz./m$^2$.

We calculated the sum of score frequencies ∑(a × c) the sum of products of the number of plants by the corresponding damage score. Next, the average score (B) of plant damage was calculated according to formula 2.2:

$$B = \sum(a \times b) / n, \qquad (2.2)$$

where n – is the total number of plants in the sample.

Crop losses from pests were calculated by formula 2,3:

$$Q = \frac{100(A - a)}{A} \qquad (2,3)$$

where Q is the yield loss, %; A – yield of intact plants, g / m2; a – the harvest of damaged plants.

Economic efficiency was determined according to the generally accepted method [14].

Statistical processing was performed taking into account the number of pests on variants and replicates, the yield was calculated according using computer programs Excel.

**Research results.** The formation of the species composition of pests in corn crops occurred during the growing season of the plants. In different periods of plant development, the complex of phytophages consisted of species that migrated from other biotopes and those that overwintered in the fields where the crops were placed.

According to the results of the monitoring of harmful entomological entomofauna in corn crops in Vinnytsia region in 2021–2022, 32 species of insects from 7 orders were found (Fig. 1).

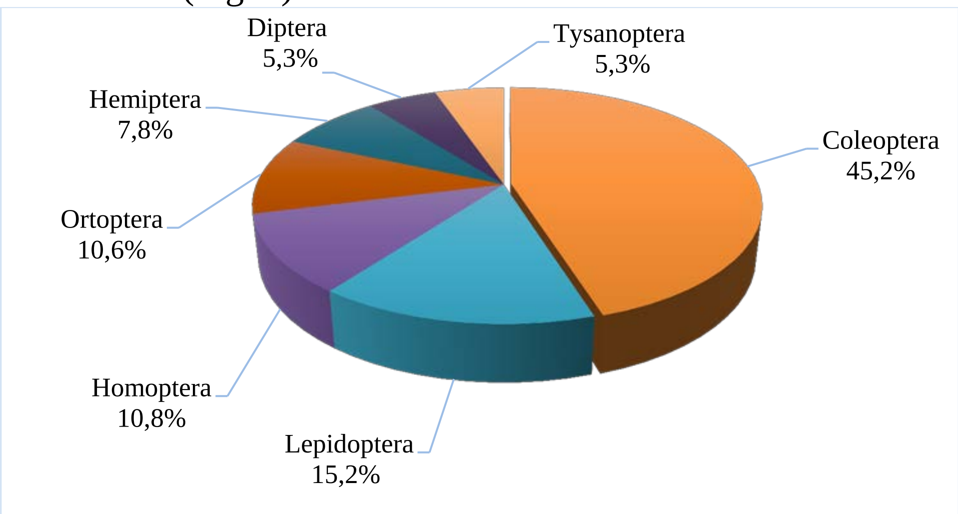


**Fig. 1. Taxonomic structure of the harmful entomocomplex of corn in the Vinnytsia region (on average for 2021–2022).**

The source is formed on the basis of own results of researches

The analysis of their species composition shows that, systematically, the largest number of pest species from the total number of phytophagous insects belongs to the Coleoptera – 45,2%.

The order of Coleoptera is represented by 18 species of harmful insects, the largest share (45,2%) of which belongs to the families of Elateridae and Scarabidae (22,2%). *Agriotes sputator* L. and *Agriotes ustulatus* Schall. turned out to be the most numerous species from the family of Elateridae and *Melolonta melolonta* L. from the family of Scarabaeidae. Lepidoptera belong to the second group with the largest number of species – 15.2%. The order of Lepidoptera is represented by 6 species of phytophages, of which 66,6% belong to the family of Noctuidae.

The dominant phytophagous species from the Noctuidae family was *Helicoverpa armigera* Hbn. Representatives of Orthoptera and Homoptera occupy 10,6% and 10,8% respectively, Hemiptera – 7,8%. Diptera and thrips were the least numerous in corn crops, accounting for 5,3% each. The seven ranks include 17 families. The following families are the most numerous: Elateridae – 20,5%, 10,5% each Noctuidae and Scarabaeidae, and the Chrysomelidae family occupies 7,7% of the total number of all pest families. The rest of the families are represented by one or two species (2,5–5,1%).

Therefore, according to the results of observations, it was established that during the years of research, a significant number and harmfulness of soil-dwelling phytophages belonging to the Elateridae and Scarabaeidae families was observed in corn crops, and during the growing season of the crop, *Helicoverpa armigera* Hbn., caused significant damage. It is from these phytophages that during the years of research, the corn crop protection system was used.

As a result of the research, it was established that the most dangerous soil pests of corn are the larvae of black beetles (Elateridae) and the larvae of beetles (Scarabaeidae). Their damage in the early phases of crop development leads to a decrease in stand density, contributes to the penetration of pathogens, lower productivity, and complicates crop cultivation technology. Since the protection against these phytophages is complicated by the insufficient forecast of their abundance in the soil, there is a need to apply operational protection measures against them in the most vulnerable phases of crop development. The most effective way to protect against soil phytophages is to treat grain with insecticidal poisons.

The effectiveness of modern insecticide poisons was evaluated in 2021–2022. Insecticides were used for seed treatment against soil phytophagous larvae: Cruiser 350 FS, t.c.s. (thiamethoxam, 350 g/l), Poncho 600 FS, TN (clothianidin, 600 g/l), Gaucho Plus 466 FS, TN (imidacloprid 233 g/l, clothianidin 233 g/l), Force Zea 280 FS, t. k.s. (thiamethoxam, 200 g/l, tefluthrin, 80 g/l). The density of soil phytophages was determined based on the results of soil excavations, which were carried out in two stages – before sowing (first decade of May), the density of Elateridae larvae in 2021–2022 averaged 7,3 ekz./m$^2$, and larvae of the Scarabaeidae family – 5, 8 ekz./m$^2$, which exceeded the standard for these types of pests (3–5 ekz./m$^2$) by 30% (Table 3).

According to the result of seed treatment with insecticidal poisons, the density of soil phytophagous larvae significantly decreased in all variants, compared to the control. The lowest number of larvae of soil phytophages over the years of research was noted in variants with poisoners Force Zea 280 FS, (5,5 l/t), the density of larvae of woodpeckers was 1,3 ekz./m$^2$, larvae of roaches – 1,0 ekz./m$^2$ and Poncho 600 FS., the density of woodpecker larvae is 1,4 ekz./m$^2$, and the density of roach larvae is 1,4 ekz./m$^2$. Accordingly, the technical efficiency of Force Zea 280 FS was 82,2% and 81,1% for roach larvae; Poncho 600 FS – 81,8% and 82,6%, respectively, while in the control, the density of larvae of these types of pests was almost 4,5 times higher. The lowest technical efficiency was noted in the version with Gaucho Plus 466 FS, TH poisoner. against woodpecker larvae – 59,0% and roach larvae – 60,0%.

*Table 3*

**Technical effectiveness of insecticides of etching against larvae of click beetles (Elateridae) and larvae of *Melolontha melolontha*** (average 2021–2022)

| Variant | Rate of consumption, l/t | larvae of click beetles (Elateridae) | | larvae of *Melolontha melolontha* | |
|---|---|---|---|---|---|
| | | The number of larvae, ekz./m$^2$ | Technical efficiency, % | The number of larvae, ekz./m$^2$ | Technical efficiency, % |
| Control (without insecticides) | - | 7,3 | 0 | 5,8 | 0 |
| Cruiser 350 FS | 7,5 | 2,1 | 71,0 | 1,8 | 69,4 |
| Poncho 600 FS, TH | 2,5 | 1,4 | 81,8 | 1,4 | 82,6 |
| Gaucho plus 466 FS,TH | 6,0 | 3,0 | 59,0 | 2,2 | 60,0 |
| Force Zea 280 FS, t.k.s. | 5,5 | 1,3 | 82,2 | 1,0 | 81,1 |

The source is formed on the basis of own results of researches

When determining the effect of insecticide poisons on the percentage of damaged plants, stand density (preharvest) and yield of corn plants. it was established that the percentage of damaged plants in the control reached 19,3%, while in the versions with the poisoners Force Zea 280 FS and Poncho 600 FS, TN this indicator was much lower – 0,9% and 2,8%, respectively. A slightly higher percentage of damaged plants was noted in the variant with Cruiser 350 FS – 5,9%, the largest in the variant Gaucho Plus 466 FS, TN – 7,5% (Table 4).

When studying the effect of treating corn seeds with insecticides, it was established that, on average, over the years of research, the pre-harvest plant stand density in the control was 52,4 thousand pcs./ha, which is 12,6 thousand pcs. pcs./ha less, compared to Force Zea 280 FS and by 11,6 thousand pcs./ha – compared to Poncho 600 FS, TH. In the version with Cruiser 350 FS, the pre-harvest plant stand density exceeded the control by 10,2 thousand pcs./ha, and in the version with Gaucho plus 466 FS, TH – by 1,8 thousand pcs./ha. After the harvest of corn, a significant effect of seed treatment with insecticidal poisons against soil pests on the productivity of the crop was revealed.

Thus, as a result of the use of the drugs Force Zea 280 FS, Poncho 600 FS, TH, Cruiser 350 FS and Gaucho plus 466 FS, TH, the value of the saved grain yield compared to the control was: 1,19, 1,09, 1,07 and 0,69 t/ha.

*Table 4*

**Economic efficiency of using insecticides of etching against soil pests of corn (on average 2021–2022)**

| Variant | Rate of consumption, l/t | Damaged plants, % | Pre-harvest density of plants thousand ekz./ha | Yield, t/ha |
|---|---|---|---|---|
| Control (without insecticides) | - | 19,3 | 52,4 | 6,83 |
| Cruiser 350 FS | 7,5 | 5,9 | 62,6 | 7,92 |
| Poncho 600 FS, TH | 2,5 | 2,8 | 64,0 | 7,90 |
| Gaucho plus 466 FS,TH | 6,0 | 7,5 | 56,0 | 7,52 |
| Force Zea 280 FS, t.k.s. | 5,5 | 0,9 | 65,0 | 8,02 |

*The source is formed on the basis of own results of researches*

Therefore, the poisoning of the seed material with chemical poisons provides reliable protection of corn plants from soil phytophages, preserves the optimal pre-harvest density of plant stands, as a result of which the yield is preserved at the level of 0,69–1,19 t/ha.

**Population control of *Helicoverpa armigera* Hbn. for spraying corn crops.** The modern plant protection system is an integration of various methods to reduce the number of harmful species to economically insignificant levels. An integral part of the protection of corn from *Helicoverta armigera* Hb.), which during the years of research was the most numerous and harmful, is the chemical control method for spraying crops, which is characterized by high technical efficiency, the most mobile and economically profitable.

In the development of a corn protection system against *Helicoverpa armigera* Hbn. in 2021–2022, the effect of chemical preparations was studied: Karate Zeon 050 μs (lambda-cyhalothrin, 50 g/l), Ampligo 150 ZC, FK (150 g/l chlorantraniliprole, 50 g/l lambda-cyhalothrin), Koragen 20 K.S. (chloranthraniprole, 200 g/l), Belt 480 SC, KS (flubendiamide, 480 g/l).

Crops were sprayed during the period of mass emergence of *Helicoverpa armigera* Hbn larvae.

The results of the calculations revealed that in the conditions of 2020–2022, the number of *Helicoverpa armigera* Hbn. caterpillars in corn crops before processing in the experimental variants was 28,6–30,7 ekz./100 plants and exceeded the standard limit (20–30 per 100 plants). After treatment on the 3rd day, in the control version, the number of cotton bollworm caterpillars was at the level of 32,1 ekz./100 plants, while in the areas where insecticides were used, the number of phytophages decreased to 8,3–9,4 ekz./100 plants (Table 5).

The highest technical efficiency (78,9%) was noted when using the drug Koragen 20 hp. for consumption norms of 0,15 l/ha. Ampligo 150 ZC, FC with a consumption rate of 0,2 l/ha (73,7 %), Karate Zeon 050 SC with a consumption rate of 0,2 l/ha and Belt 480 SC, k.s., provided slightly lower efficiency. (0,15 l/ha) was at the level of 72,4 and 70,7%, respectively.

*Table 5*

**Technical efficiency of insecticides against** *Helicoverpa armigera* Hbn. **caterpillars in corn crops (average 2021-2022)**

| Variant | Consumption rate, g l/t | before spraying, ekz./100 plants | in ... days after spraying, ekz./100 plants | | | Technical efficiency per day…after germination, % | | |
|---|---|---|---|---|---|---|---|---|
| | | | 3 | 7 | 14 | 3 | 7 | 14 |
| Control (without insecticides) | - | 30,7 | **32,1** | **43,1** | **64,3** | **0** | **0** | **0** |
| Karate Zeon 050 SC | 0,2 | 30,2 | 8,4 | 10,0 | 16,8 | 72,4 | 76,4 | 74,1 |
| Ampligo 150 ZC | 0,2 | 29,7 | 8,3 | 7,4 | 10,6 | 73,7 | 82,4 | 80,5 |
| Koragen 20 k.s. | 0,15 | 28,6 | 6,6 | 5,1 | 9,2 | 78,9 | 88,0 | 86,0 |
| Belt 480 SC, k.s. | 0,15 | 30,2 | 9,4 | 8,7 | 16,1 | 70,7 | 79,5 | 72,9 |

*The source is formed on the basis of own results of researches*

When conducting calculations on the 7th day after spraying, it was found that the number of phytophagous larvae increased (on control 43,1 ekz./100 plants), reducing the technical effectiveness of the preparations in all variants of the experiment. The most effective in controlling the larvae of the *Helicoverpa armigera* Hbn. (88,0%) was the use of the drug Koragen 20 hp. normally 0,15 l/ha. A slightly lower technical efficiency (82,4%) was provided by Ampligo 150 ZC at a rate of 0,2 l/ha. A lower indicator of the effectiveness of controlling cotton bollworm caterpillars (79,5%) was noted when using the drug Belt 480 SC, k.s. with a consumption rate of 0,15 l/ha and Karate Zeon 050 SC (0,2 l/ha), which was at the level of 76,4%.

Records conducted on the 14th day after spraying revealed that the highest level of pest control was provided by the drug Koragen 20 hp. for consumption norms of 0,15 l/ha, the technical efficiency of which was at the level of 86,0%. It was slightly inferior to Ampligo150 ZC, FC with a consumption rate of 0,2 l/ha – 80,5%. The lowest technical efficiency of control of *Helicoverpa armigera* Hbn. caterpillars (74,1%) was found when using the drugs Karate Zeon 050 SC with a consumption rate of 0,2 l/ha and Belt 480 SC, hp. with a consumption rate of 0,15 l/ha 72,9%, respectively.

Consequently, it should be noted that the use of insecticides that were studied showed high efficiency in controlling *Helicoverpa armigera* Hbn. caterpillars. The most effective was the use of the studied drug Koragen 20 k.s. for consumption norms of 0,15 l/ha – 86%. The drug Ampligo150 ZC, FC at the consumption rate of 0,2 l/ha – 80.5%. The variants with Karate Zeon 050 SC – 74,1% and Belt 480 SC, KS – 72,9% were somewhat less effective, however, it should be noted that the studied drugs ensured a high level of phytophagous control throughout the entire period of crop cultivation.

In addition to the technical effectiveness of the insecticide, we also determined the intensity of grain damage in the cobs themselves (with and without treatment), the percentage of damaged cobs, and the amount of the saved crop after insecticide treatment.

From the data of the research results in 2021–2022, it follows that the percentage of cobs with damaged grain in the control (48,6%) was 39,8–38,0% higher compared to the variants treated with chemical insecticides (6,9– 10,6%) (Table 6).

*Table 6*

**Economic effectiveness of insecticide applications against**
*Helicoverpa armigera* Hbn**. caterpillars in corn crops** (average 2021-2022)

| Variant | Rate of consumption, l/ha | Cobs with damaged grain, % | Grains in the cob are damaged, pcs./cob | Grains in the cob, % | Yield, t/ha | |
|---|---|---|---|---|---|---|
| | | | | | Actual | Saved |
| Control (without insecticides) | - | 48,6 | 26,5 | 4,7 | 7,32 | - |
| Karate Zeon 050 SC | 0,2 | 10,1 | 12,8 | 2,2 | 7,57 | 0,25 |
| Ampligo 150 ZC | 0,2 | 8,8 | 12,0 | 2,1 | 7,60 | 0,28 |
| Koragen 20 k.s. | 0,15 | 6,9 | 8,5 | 1,2 | 7,64 | 0,32 |
| Belt 480 SC, k.s. | 0,15 | 10,6 | 12,9 | 2,2 | 7,55 | 0,23 |

*The source is formed on the basis of own results of researches*

The intensity of the damaged grain in the cobs also varied greatly, for example, in the control, an average of 26,5 grains per cob were damaged, and in the version with chemical poisoners, 8,5–12,9 pcs./cob. The smallest number of grains eaten by *Helicoverpa armigera* Hbn**.** caterpillars was noted in the version using Koragen 20 K.S. – 8,5 pcs./cob, or 1,2%.

Table 6 shows that when all insecticides were used, the yield of corn was higher compared to the control. For processing by Koragen K.S. and Ampligo 150 ZC, FC yield increased by 0,28 and 0,32 t/ha compared to the control (7,32 t/ha). For processing Karate Zeon 050 SC per – 0,25 t/ha,

**Conclusions.** As a result of the conducted research, the species composition of pests in corn crops was established, the peculiarities of their number and harmfulness were studied, the elements of the corn protection system against the most dangerous seedling pests and phytophages that harm during the growing season of the crop were substantiated.

In 2021–2022, 32 species of pests belonging to 7 families were found in corn crops in the Vinnytsia region. The analysis of their species composition shows that, systematically, the largest number of pest species from the total number of phytophagous insects belongs to the Coleoptera – 45,2%. Lepidoptera belong to the second group with the largest number of species – 15,2%. The order of Lepidoptera is represented by 6 species of phytophages, of which 66,6% belong to the family of Noctuidae. Representatives of Orthoptera and Homoptera occupy 10,6% and

10,8% respectively, semi-anthopterans – 7,8%. Diptera and thrips were the least numerous in corn crops, accounting for 5,3% each.

The most numerous species from the Elateridae family were *Agriotes sputator* L. and *Agriotes ustulatus* Schall. and *Melolonta melolonta* L. from the Scarabaeidae family. Lepidoptera – *Helicoverpa armigera* Hbn. belong to the second largest group of species.

1. According to the result of seed treatment with insecticidal poisons, the density of soil phytophagous larvae significantly decreased in all variants, compared to the control. The lowest number of larvae of soil phytophages over the years of research was noted in variants with poisoners Force Zea 280 FS, (5,5 l/t), the density of larvae of woodpeckers was 1,3 ekz./m$^2$, larvae of roaches – 1,0 ekz./m$^2$ and Poncho 600 FS., the density of woodpecker larvae is 1,4 ekz./m$^2$, and the density of roach larvae is 1,4 ekz./m$^2$. Accordingly, the technical efficiency of Force Zea 280 FS was 82,2% and 81,1% for roach larvae; Poncho 600 FS – 81,8% and 82,6%, respectively, while in the control, the density of larvae of these types of pests was almost 4,5 times higher. The lowest technical efficiency was noted in the version with Gaucho Plus 466 FS, TH poisoner. against woodpecker larvae – 59,0% and roach larvae – 60,0%, and yield preservation at the level of 0,69–1,19 t/ha.

2. When testing insecticides against the caterpillars of Helicoverpa armigera Hbn., the most effective was the use of the study drug Koragen 20 hp. for consumption norms of 0,15 l/ha – 86,0%. The drug Ampligo150 ZC, FC at the rate of consumption of 0,2 l/ha – 80,5%. The variants with Karate Zeon 050 SC – 74,1% and Belt 480 SC, KS – 72,9% were somewhat less effective, however, it should be noted that the studied drugs ensured a high level of phytophagous control throughout the entire period of crop cultivation.

3. The percentage of cobs with damaged grain in the control (48,6%) was 39,8–38,0% higher than in the insecticide treatment (6,9–10,6%). The intensity of the damaged grain in the cobs varied: in the control, an average of 26,5 grains per cob were damaged, and in the variant with chemical preparations, 8,5–12,9 pcs./cob. The smallest number of grains eaten by caterpillars *Helicoverpa armigera* Hbn., noted in the variant using Koragen 20 K.S. – 8,5 pcs./cob. With the use of the investigated insecticides, the yield of corn exceeded the control. The saved yield was 0,23–0,32 t/ha.

4. It was found that when all insecticides were used, the yield of corn was higher compared to the control. For processing by Koragen K.S. and Ampligo 150 ZC, FC yield increased by 0,28 and 0,32 t/ha compared to the control (7,32 t/ha). For processing Karate Zeon 050 SC per – 0,25 t/ha, respectively.

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***АНОТАЦІЯ***

***ВПЛИВ СИСТЕМИ ЗАХИСТУ НА ОБМЕЖЕННЯ ЧИСЕЛЬНОСТІ ОСНОВНИХ ШКІДНИКІВ У ПОСІВАХ КУКУРУДЗИ***

*У даній статті висвітлено теоретичне узагальнення і вирішення проблеми, що полягає у розробці і обґрунтовані елементів системи захисту кукурудзи від комплексу шкідників та контролю їх чисельності в умовах Вінницького району, яка ґрунтується на уточнені видового складу фітофагів у посівах кукурудзи, їх шкідливості та обмеження чисельності при застосуванні інсектицидів за обробки насіння і обприскування посівів хімічними препаратами.*

*Уточнено видовий склад шкідливої ентомофауни кукурудзи та виділено 32 види комах із 7 рядів. Серед рядів домінували твердокрилі – 45,2 % та лускокрилі – 15,2 %. Найменш чисельними у посівах кукурудзи виявилися двокрилі та трипси – 5,3 %. Найчисленнішими родинами в посівах кукурудзи визначено коваликових, совок, пластинчастовусих та листоїдів.*

*Встановлено, що найбільшу загрозу насінню та сходам кукурудзи становили личинки коваликів (Elateridae) та личинки пластинчастовусих (Scarabaeidae), а найнебезпечнішим шкідником генеративних органів у роки досліджень кукурудзи виявилась бавовникова совка (Helicoverpa armigera Hbn.). Тому, систему захисту посівів кукурудзи проводили для обмеження чисельності від вище зазначених фітофагів.*

*Оцінено ефективність сучасних інсектицидів проти домінуючих шкідників кукурудзи та оптимізовані способи їх застосування. Встановлено, що найвища технічна ефективність інсектицидних протруйників відмічена у варіантах з протруйниками Форс Зеа 280 FS (5,5 л/т) та Пончо 600 FS (2,5 л/т). Для личинок коваликsd – 82,2 % та для хрущів – 81,1 %; Пончо 600 FS – 81,8 % та 82,6 % відповідно, в той час, як на контролі, щільність личинок шкідників, перевищувала майже в 4,5 разів, а збереження врожаю на рівні 0,69–1,19 т/га.*

*При випробуванні інсектицидів проти гусениць бавовникової совки на посівах кукурудзи найвищу технічну ефективність забезпечили інсектициди: Кораген 20 к.с. (0,15 л/га) – 86,0 % та Амплiго 150 ZC, ФК (0,2 л/га) – 80,5 %.*

*За використання досліджуваних інсектицидів, урожайність кукурудзи перевищувала контроль. Збережений урожай становив 0,23–0,32 т/га.*



***Ключові слова:*** *кукурудза, фітофаги, шкідливість, інсектициди, ефективність, урожай*

***Табл. 6. Рис. 1. Літ. 20.***


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