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## **PHYTOPHAGES IN THE AGROCENOSIS OF SPRING WHEAT IN THE PAVLODAR REGION**

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### **Abstract**

To prevent losses of wheat yield from pests, it is necessary to update information on the patterns of formation of the phytosanitary situation in agrobiocenoses, according to which protective measures are planned and organized. In order to assess the phytosanitary situation of spring wheat crops, studies were carried out in the Pavlodar region, as one of the main regions of the republic for the production of grain of this crop. The paper reflects monitoring data on the phytophages population of spring wheat crops in the main grain-sowing areas of the Pavlodar region. The species composition of cereal crop pests that have a direct effect on productivity, qualitative and quantitative indicators of agricultural crops has been established. The obtained results showed that starting from the germination and up to the stem elongation phase, cereal crops were colonized by latent-stem pests and *Phyllotreta vittula*. *Haplothrips tritici*, *Psammotettix striatus* and *Trigonotylus ruficornis* dominated in the stem elongation and heading phases. *Schizaphis graminum*, *Haplothrips tritici* in two forms (larvae and adults) and *Laodelphax striatella* dominated in the phase of grain formation-filling and milk development phase. The study showed that during

the initial phases of wheat development, the majority of pests develop and feed on wild weed plants, subsequently migrating to the cereals.

**Key words:** wheat, phytophages, agrobiocenosis, phases of wheat development, Pavlodar region.

### **Introduction**

Wheat (*Triticum*) is the main food grain crop [1]. According to the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan in 2020 the total gross harvest of agricultural crops amounted to 19508.5 thousand tons, 14258 thousand tons of which accounted for wheat, which amounted to almost 73 % [2]. Pavlodar region is one of the main grain-sowing regions of the Republic of Kazakhstan.

Cultivation of crops is accompanied by a number of problems. The most common of these is insect infestation of grain crops [2]. Phytophagous insects are permanent components of agroecosystems. The degree of plants productivity is determined by the population of phytophages. A high number of insects indicates a decrease in the quality and harvest volume [3]. Most of the potential harvest of food crops in the world is lost annually due to pests and diseases of plants [4]. Protective measures are organized to prevent losses of wheat yield from phytophages, the implementation of which is carried out by updating

information on the phytosanitary situation in agrobiocenoses [5].

Spring wheat fields (according to the predecessor of pure fallow) in five districts of the Pavlodar region (Uspenka, Sherbakty, Irtyshsk, Zhelezinka and Terenkol) were selected as objects of the study. The number of cereal crop pests in these fields was the subject of the study.

There is no information gathered from previously conducted phytosanitary monitoring in the conditions of the region, and therefore it became necessary to collect data and analyze the abundance and species composition of wheat pests, taking into account cultivation techniques.

The aim of the study is monitoring and control of spring wheat phytophages in the main grain-sowing areas of the Pavlodar region. In order to achieve the goal of the study, studies of phytophages in agrocenoses of spring wheat (according to the predecessor of pure fallow) were carried out. As a result of the study, the prevalence of cereal crop pests in the main grain-sowing areas of the Pavlodar region was analyzed.

### **Materials and methods**

Monitoring the number of phytophages in five districts of the Pavlodar region formed the basis of the study. Spring wheat was used as a grain crop. The monitoring of the fields no. 65 (Uspenka district –

53°08'14"N, 77°40'55"E), no. 51a (Sherbaky district – 52°43'17"N, 78°04'46"E), no. 85 (Irtysk district – 53°27'15"N, 74°14'29"E), no. 13(2) (Zhelezinka district – 53°32'28"N, 75°18'52"E) и no. 25 (Terenkol district – 53°04'03"N, 76°06'13"E) demonstrates the number of cereal crop pests at different phases of crop development.

Insect monitoring is carried out on the basis of quantitative methods for accounting in order to assess the phytosanitary state of spring wheat agroecosystems [7]. The registration of pests inhabiting plants was carried out by using an entomological net

### **Results**

The studies were carried out in typical agricultural organizations of the districts on the predecessor of pure fallow. Phytomonitoring was carried out in spring wheat agroecosystems according to the main phases of crop development.

(mowing method). This method is used to identify number of pests which inhabiting upper layer of the grass stand. A standard entomological net (hoop diameter 30 cm, bag depth 60 cm, handle length 1 m) is used. The mowing method involves performing 10 sweeps of the entomological net over the grass. 10 series of sweeps are made in succession [8]. Their total number should reach 100. Insects trapped in the entomological net are extracted and counted. A phytosanitary assessment of the agroecosystem is carried out according to the number of different groups of insects.

Field no. 65 (Uspenka district), area – 516 ha (Figure 1). Sowing began on May 18, wheat variety – Omskaya 35. The seeds were treated with Dividend Extreme (fungicide) and Caliber (insecticide). The treatment of seeds before sowing with an insecticide protects them from germination until tillering-stem elongation phases. The protective effect is manifested within 30 days and more during the germination period (depending on the type of pest and weather conditions). The effect is directed against sucking insects, including insects from the Coleoptera, Homoptera and Diptera families. This explains the low number of phytophages during the period of initial phases of cereal crop development.

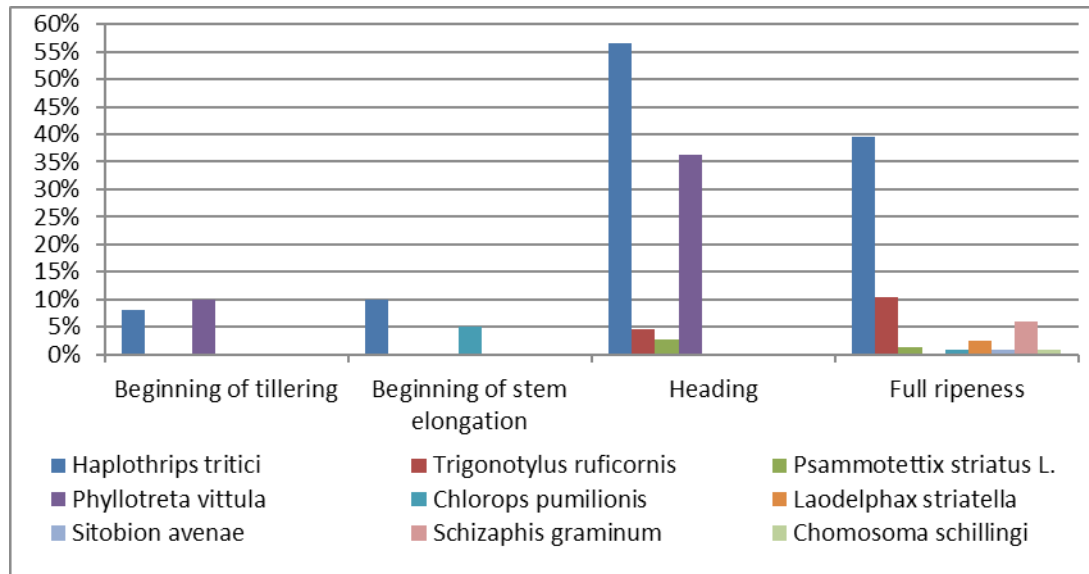


Figure 1 – Cereal crop pests` distribution – field no. 65 (Uspenka district – 53°08'14"N, 77°40'55"E)

Beginning of tillering phase. Flea damage on the leaves (10 %) was observed. Cereal crop pests were found in small numbers: only *Haplothrips tritici* (Kurdjumov, 1912) and *Phyllotreta vittula* (Redtenbacher, 1849).

Beginning of stem elongation phase. Pest damage on the leaves was insignificant. There were imago of *H. tritici* 2–3 pcs. per 1 stem. During the monitoring period, there were unfavorable weather conditions (rain, strong wind), which did not allow working with the entomological net.

Heading phase. Plant damage by *H. tritici* was noted and its larvae were found in ears in the amount of 3–5 pcs. for 1 ear. There was a predominance of the number of cereal crop pests in comparison with other groups of insects – 96.7 %. The dominant species were *Ph. vittula* – 36.2 % and *H. tritici* – 56.5 %.

Full ripeness phase. Plants in dough development phase were found

separately. Plant height varies from 52 to 60 cm, spike length is 6.5–7 cm, grain`s size is medium. *Schizaphis graminum* (Rondani, 1852) (8–9 pcs. per 1 ear) and *H. tritici* larvae (9 pcs. for 1 ear) were found on green wheat plants. There was a decrease in the number of grain phytophages to 61.7 % of the total number of all studied insects, at the same time an increase in the number of entomophages to 26.9 % is observed, among which *Coccinellidae* (47 %) and *Miridae* (47 %) were distinguished. *Trigonotylus ruficornis* (Geoffroy, 1785) (10.3 %), *H. tritici* (39.5 %) and *Sch. graminum* (5.9 %) fed on green parts of wheat and prevailed among the cereal crop pests.

Field no. 51a (Sherbakty district), area – 106 ha (Figure 2). Sowing began on May 15. The main treatment was tilling to a depth of 10–12 cm. Off-grade wheat was used, and its seeds were not treated before sowing

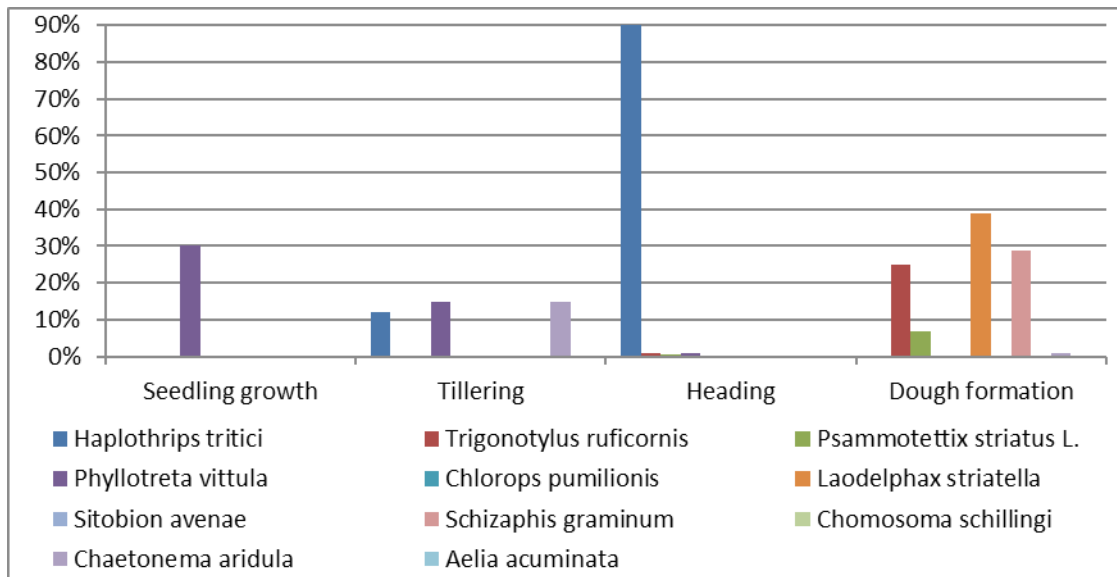


Figure 2 – Cereal crop pests` distribution – field no. 51a (Sherbakty district – 52°43'17"N, 78°04'46"E)

Seedling growth phase. The leaves were damaged by the *Ph. vittula* (25–30 %). The absence of other species of phytophages is associated with the early development of wheat.

Tillering phase. There are small damages of the leaves by sucking insects, the presence of *H. tritici* imago on plants on average (4–5 pcs. per stem), which is below the threshold of economic damage (8–10 adults per stem).

Heading phase. Plants were damaged by *H. tritici* and *Ph. vittula*, as well as gnawing insects. The largest number of identified insects is represented by cereal crop pests (92.6 %), while the dominant species in this phase was *H. tritici* (97.7 % of the total number of crop phytophages, its number also exceeds the threshold of economic damage (8–10 adults stem or 40–50 larvae per 1 ear). This situation indicates the need to treat

crops with insecticides against the pests. Other species were found in single specimens.

Dough formation phase. The height of plants varies from 50 to 65 cm, which have small ear and medium sized grains. There was a *Sitobion avenae* (Fabricius, 1775) on plants (15–20 pcs. per 1 plant), but the percentage of damaged plants is low 2% (per 100 plants). The number of *H. tritici* (adults) was identified as 1–3 pcs. for 1 ear. Most of the insects were represented by cereal crop pests (58.3 %), where the largest part falls on *Laodelphax striatella* (Fallen, 1826) – 39 %, *Sch. graminum* - 28.6 %, *T. ruficornis* – 24.8 %, at the same time *Psammotettix striatus* (Linnaeus, 1758) and *Chaetonema aridula* (Gyllenhal, 1827) were found in small numbers.

Field no. 85 (Irtysk district), area – 367 ha (Figure 3). Sowing began on May 19. The main

processing was tilling to a depth of 20 cm. Off-grade wheat was used and seeds were not treated before sowing.

Germination phase. At the time of observation cereal crop pests were not visually observed. Due to the early development of the wheat, the colonization by phytophages had not yet begun.

Tillering phase. The crops are visually clean, but the leaves of crops were damaged by *Ph. vittula* (5–8 %).

Milk development phase. *H. tritici* and *Ph. vittula* damages are noted on the leaves of wheat. The number of cereal crop pests increased significantly to 54.6 %, where *H. tritici* (50.8 %), *Ch. aridula* (19.8 %), *Ph. vittula* (26.4 %) were dominated. There is also an increase in the number of entomophages *Chrysoperla carnea* (Stephens, 1836) – 98 % of all entomophages

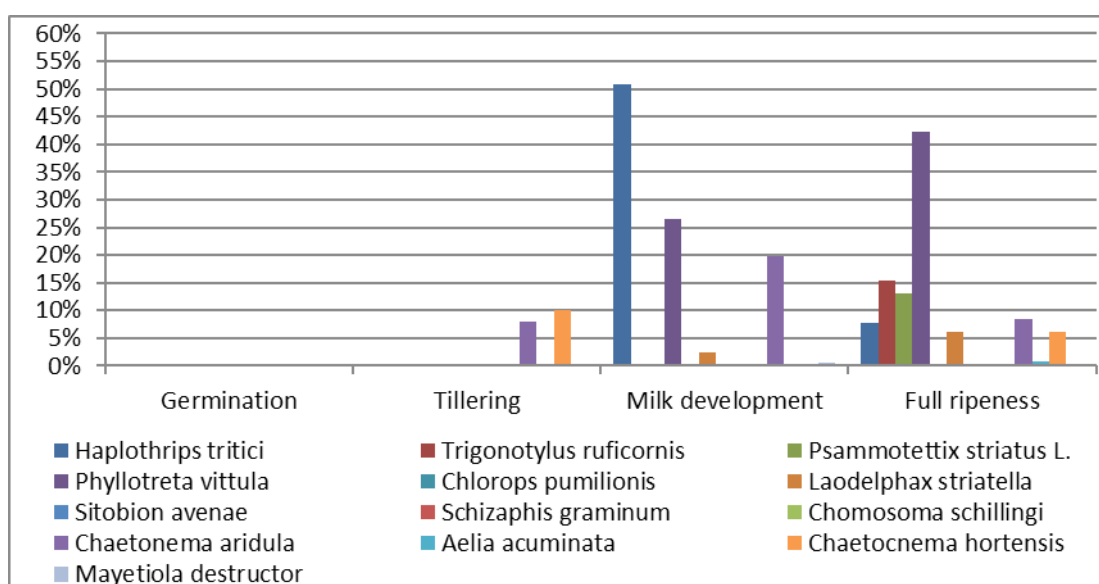


Figure 3 – Cereal crop pests` distribution – field no. 85 (Irtysk district – 53°27'15"N, 74°14'29"E)

Full ripeness phase. The cultures were undersized (height – 20–30 cm) with small ears and small, unformed grains. The crops were heavily infested by weeds, because of it plants were completely dry. The number of cereal crop pests slightly decreased to 48.5 % and *Ph. vittula* became the dominant species (42.3 %).

Field no. 13(2) (Zhelezinka district), area – 354 ha (Figure 4). Sowing began on May 24 on the

depth of 5–6 cm. Agricultural technology – basic tilling to a depth of 20 cm. Wheat variety – Omskaya 35, seeds of which were not treated before sowing.

Seedling growth phase. The leaves have slight damage by *Ph. vittula* (5 %). According to the early development of crops, cereal crop pests were not observed in large numbers.

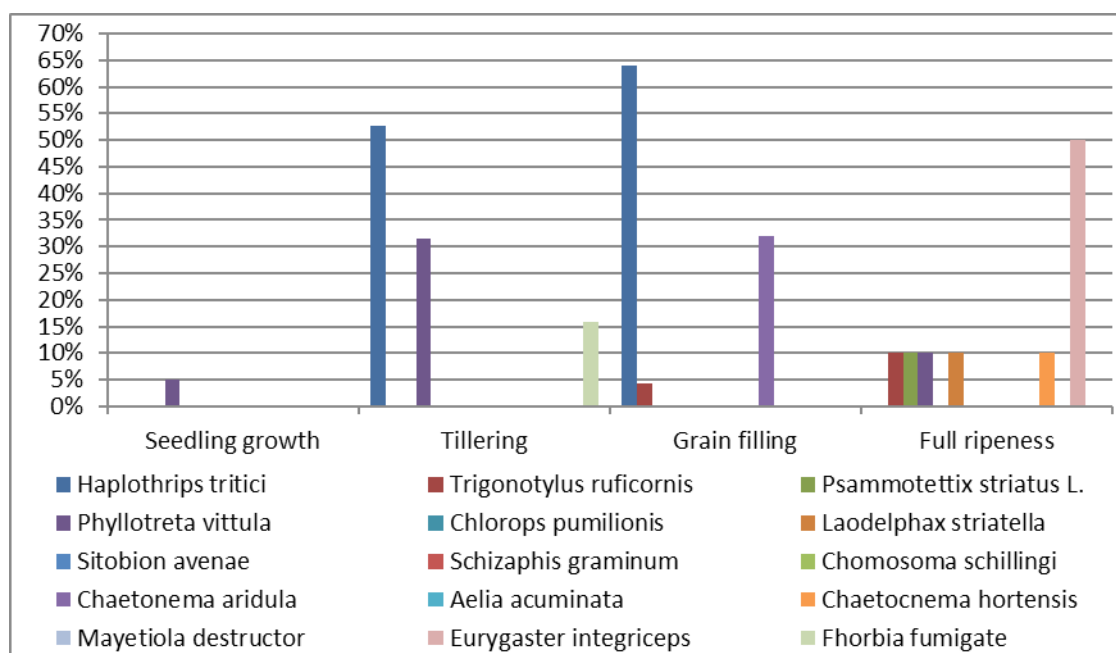


Figure 4 – Cereal crop pests` distribution – field no. 13(2) (Zhelezinka district - 53°32'28"N, 75°18'52"E)

Tillering phase. There are small lesions of the *Ph. vittula* on the leaves (5 %) and significant number of *H. tritici* (5–10 pcs. for 1 stem). The number of cereal crop pests prevails in comparison with other groups – 61.3 % (*H. tritici* (52.6 %) was dominant).

On July 13, 2021, crops were treated against weeds, pests and diseases by compound substance: Propicon 250 (fungicide) + Clorid 200 (insecticide) + Galantny + Efir Extra.

Filling grain phase. Plant leaves are damaged by *H. tritici*. The number of cereal crop pests has increased significantly up to 92.9 % (*H. tritici* – 63.9 %, *Ch. aridula* – 31.9 % were dominated species).

Full ripeness phase (beginning). Plants` height – 70–75 cm, spike

length – 5–7 cm, grain – medium-sized. The number of cereal crop pests has significantly decreased to 15.1%, which is associated with the migration of phytophages to other plants in search of food. At the same time a dangerous pest of cereal crops *Eurygaster integriceps* (Puton, 1881) (50 %) has been recorded. There is also an increase of entomophages number up to 42.4 % (92.9 % of them were *Coccinellidae*).

Field no. 25 (Terenkol district), area 489 – ha (Figure 5). Sowing began on May 18. The main treatment was tilling to a depth of 25 cm. Wheat variety – Omskaya 38, seeds of which were treated with the Akiba insecticide and fungicide Raxon.



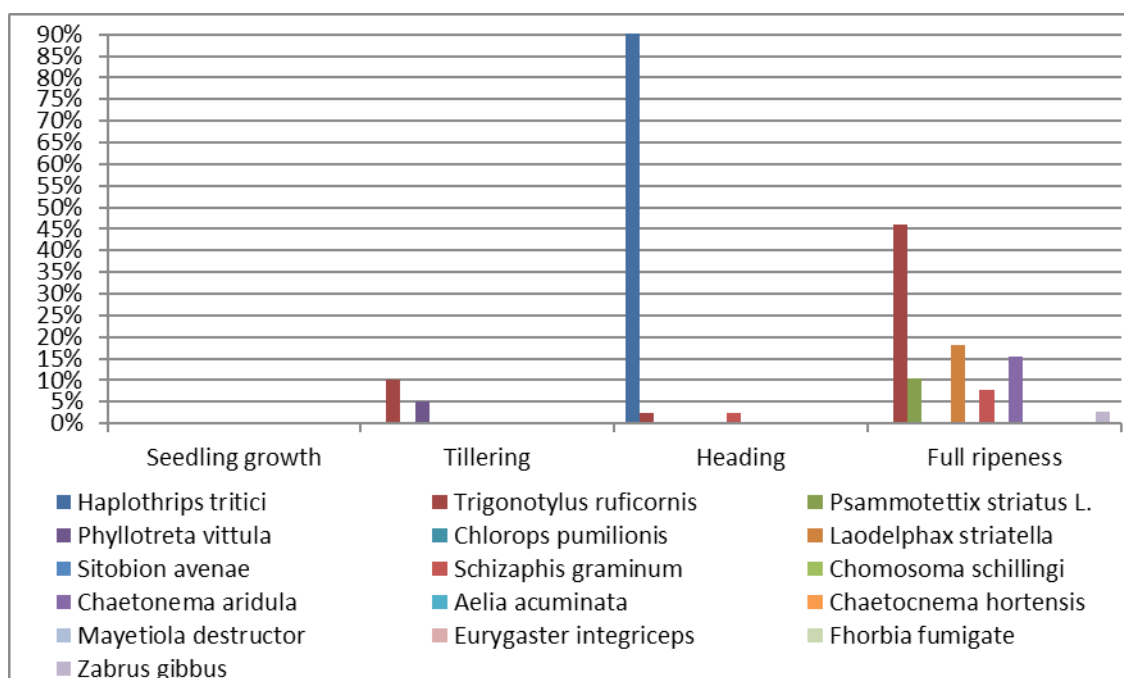


Figure 5 – Cereal crop pests` distribution – field no.25 (Terenkol district – 53°04'03"N, 76°06'13"E)

Seedling growth phase. Due to the high temperatures, yellowing of the leaves was observed, and due to the early stage of culture development, visual pests were not identified.

Tillering phase. The leaves have slight damage by the *Ph. vittula* (about 5 %) and partially turn yellow because of influence of high temperatures.

Heading phase. The leaves of wheat were damaged by *Ph. vittula* (about 5 %) and turn partially yellow. The number of grain phytophages in this period was significant – 81.7 % (*H. tritici* – 94.3 %).

Full ripeness phase. Plants` height is 70–80 cm, spike length is 7–9 cm, grain is large and filled. There is a decrease in the number of all groups of insects, cereal crop pests to

### Discussion

The life cycle of *H. tritici* is closely related to the stages of crop

73.6 % (*T. ruficornis* was dominated (46.1 %)). The decrease in the number of insects is explained by the fact that the culture has completed its development and they migrate to wild cereals for additional feeding.

In addition to these pests, there were small numbers of species of Chrysomelidae, Pentatomidae, Curculionidae, Mylabris, various species of Blaps, adults and larvae of *Autographa gamma* (Linnaeus, 1758), Tettigonioidea, Elateridae, *Lygus pratensis* (Linnaeus, 1758), etc.

In the studies conducted in 2021, the complex of dominant pests of spring wheat crops in the conditions of the North-East of Kazakhstan was represented by: *H. tritici*, *Ph. vittula*, *T. ruficornis*, *Ch. aridula*, *L. striatella*, *P. striatus*, *Sch. graminum*.

development (phenological adaptation). The first imagoes of the



phytophage can be observed already in the phase of stem elongation in the fields no. 65 and 13(2) in the Zhelezinka district and no. 51a in the Sherbakty district. Since the culture in heading phase is most suitable for the reproduction of *H. tritici* species, the largest number of them is observed in the heading phase (field no. 51a – Sherbakty district) – up to 8-10 adults per stem or 40–50 larvae per 1 ear. Adults accumulate at the base of the leaf and feed on plant sap, resulting in appearing of whitish spots on these places.

Wheat plants were also damaged at the initial stages of development by *Ph. vittula* (field no. 51a – Sherbakty district). In the conditions of the North-East of Kazakhstan, the appearance of early seedlings of wheat coincides with the mass exit of beetles from the wintering and colonization of the crop by them. The beetles first damaged the tops of the leaves of seedlings, and then the entire leaf blade, which leads to drying and falling of the leaves, thus reducing the assimilation surface of the leaves and productivity of the culture. Crops are formed incomplete and different in height, which affects the shortage of grain crops. In addition, damaged plants become susceptible to diseases and less resistant to damage by corn-flies.

*T. ruficornis*, due to its plasticity, is found in large numbers in spring wheat crops. It harms the culture throughout the vegetation period. Characteristic damage is discoloration of the puncture sites of the bug, as it sucks out the cell sap of plants, which leads to a decrease in assimilation tissue and grain

deformation. The harmfulness of bugs increases during dry years, when wheat crops are weakened due to the lack of moisture and high air temperatures. The weather conditions of May and the summer months of 2021 in the region were characterized by high temperatures and lack of precipitation during the wheat vegetation period, which contributed to an increase in the number of grain bugs, which was the largest during the grain ripening period.

Number of *Ch. aridula* in all areas was not numerous: in the Sherbakty district (field no. 51a) their number in the tillering phase was 15 %, in the Irtyshsk district (field no. 85) their number in the phase of milk development was 19.8 %. It is explained by the proximity to the fields of forest edges and flea beetles' wintering places. During the tillering, stem elongation and heading phases stem fleas cause significant damage to spring wheat. The stems damaged by the larvae do not form ears, the plants stop growing, thereby reducing the yield. Injuries during the heading phase lead to white spike and stem lodging.

*P. striatus* is trophically closely related to grass vegetation. Their number increases in the first half of summer, during the tillering and stem elongation. The number of leafhoppers is also significant in the period of formation and maturation of grain. Their number increases in the first half of summer, during the tillering and stem elongation. During the formation and maturation of the grain, the number of leafhoppers is also significant. Both adults and larvae are harmful because of feeding

on the cell sap of leaves and stems. Furthermore, whitish spots appear at the bite sites, giving the damaged organs a marble color. The largest number of *P. striatus* was recorded in the phase of full ripeness in the Irtyshsk, Terenkol and Zhelezinka districts.

Cereal aphids pose a great danger to wheat crops, as they can populate leaves and ears with numerous colonies in a short period, feeding on cell sap they significantly reduce the grain yield. During the observation period *Sch. graminum* was found. It belongs to non-

### **Conclusions**

Studies of spring wheat crops showed that the complex of dominant cereal crop pests in the Pavlodar region was represented by *H. tritici*, *Ph. vittula*, *T. ruficornis*, *Ch. aridula*, *L. striatella*, *P. striatus*, *Sch. graminum*.

Comparison of the development phases of spring wheat with the abundance of the phytophagous complex during these periods showed that, from seedling growth to stem elongation phases plants were not actively inhabited by cereal crop pests, but at the same time, decline of density of seedlings and productive bushiness of plants were present. Crops were highly inhabited by sucking pests (adults of wheat thrips, cereal leafhoppers, grain bugs and cereal aphids) during stem elongation and heading phases. This period in the development of the culture is characterized by intensive growth and formation of an ear, therefore, insects reduce the yield of the crop.

The most dangerous period for the formation of the wheat is the

migratory species, development of which occurs completely on the leaves of cereal crops without changing fodder plants. The harmfulness of aphids increases in dry years (low air humidity), since due to a lack of moisture, turgor and resistance to damage are reduced. The weather conditions of the vegetation period in 2021 contributed to an increase in the number of aphids in July-August in the Uspenka (full ripeness phase) and Sherbakty districts (dough formation phase), and during this period the aphids fed on plants lagging behind in development.

period from grain formation-filling to milk development phases. Sucking phytophages (larvae and adults of wheat thrips, aphids) mainly harm. During this period a mass of caryopses is formed. Because of a high number of cereal crop pests, deformed grain is formed, while the qualitative and quantitative indicators of grain, as well as their further productivity, decrease.

Since there is no information on the phytosanitary situation in the wheat agrocenoses of the North-East of Kazakhstan, the data obtained make a significant contribution to the study of insect complexes living in crops and provide comparative material for similar studies in other regions.

Knowledge of the main crop phytophages in the region and their harmfulness in the vulnerable phases of wheat vegetation will help to purposefully organize protective measures, taking into account the abundance of a particular species, and apply agrotechnological methods

more efficiently in order to reduce the number of phytophages in the most dangerous periods of crop development.

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### **Түйін**

Бидай дақылының зиянды ағзалар әсерінен жойылуын болдырмау үшін агробиоценоздардағы фитосанитарлық жағдайдың қалыптасу заңдылықтары туралы ақпаратты жаңарту қажет. Мұның басты себебі-фитосанитарлық жағдайдың заңдылықтары туралы алынған ақпарат негізінде белгілі бір қорғаныс шараларын жоспарлау және ұйымдастыру. Жаздық бидай егістіктерінің фитосанитарлық жағдайын бағалау мақсатында Павлодар облысында республиканың негізгі өңірлерінің бірі ретінде осы дақылдың астығын өндіру бойынша зерттеулер жүргізілді. Осы мақалада Павлодар облысының астық егілетін негізгі аудандарының жаздық бидай егістіктерінің фитофагтармен қоныстануы бойынша мониторинг деректері көрсетілген. Ауыл шаруашылығы дақылдарының шығымдылығына, сапалық және сандық көрсеткіштеріне тікелей әсер ететін астық дақылдарының зиянкестерінің түрлік құрамы белгіленді. Алынған нәтижелер көшет кезеңінен бастап сабақтану кезеңіне дейін дәнді дақылдар сабақты жасырын зиянкестер мен жолақты астық бүргесі (*Phyllotreta vittula*) толтырғанын анық көрсетті. Сабақтану және басының масақтануы кезеңінде бидай трипсі (*Haplothrips tritici*), астық жегі (*Psammotettix striatus*) және астық қандалас (*Trigonotylus ruficornis*) деген сияқты астық дақылдары зиянкестері басым болды. Дәннің қалыптасу-толысу және сүттеніп пісуі кезеңдерінде астық бітесі (*Schizaphis graminum*), бидай трипсі (*Haplothrips tritici*) екі формада

(личинкалар мен ересектер) және астық жегілер (*Laodelphax striatella*) басым болатыны анықталды. Зерттеу көрсеткендей, зиянкестердің көпшілігі бидай дамуының бастапқы кезеңдерінде дамып, сол кезде станцияларда өсетін арамшөптермен қоректеніп, кейіннен дәнді дақылдарға көшеді.

**Кілт сөздер:** бидай, фитофагтар, агробиоценоз, бидайдың даму фазалары, Павлодар облысы.

## **ФИТОФАГИ В АГРОЦЕНОЗЕ ЯРОВОЙ ПШЕНИЦЫ ПАВЛОДАРСКОЙ ОБЛАСТИ**

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### **Аннотация**

Для предотвращения потерь урожая пшеницы от вредных организмов необходимо обновление информации о закономерностях формирования фитосанитарной ситуации в агробиоценозах, на основе которой планируются и организовываются определенные защитные мероприятия. С целью оценки фитосанитарной обстановки посевов яровой пшеницы были проведены исследования в Павлодарской области, как одного из основных регионов республики по производству зерна этой культуры. В настоящей статье отражены данные мониторинга по заселенности фитофагами посевов яровой пшеницы основных районов зерносеяния Павлодарской области. Установлен видовой состав вредителей зерновых, напрямую влияющих на урожайность, качественные и количественные показатели сельскохозяйственных культур. Полученные результаты показали, что начиная с фазы всходов и до выхода в трубку злаковые культуры заселяли скрытостеблевые вредители и хлебная

полосатая блошка (*Phyllotreta vittula*). В фазе трубкования и колошения преобладали пшеничный трипс (*Haplothrips tritici*), цикадки (*Psammotettix striatus*) и хлебные клопики (*Trigonotylus ruficornis*). В фазе формирования-налива зерна и молочной спелости доминировали злаковая тля (*Schizaphis graminum*), пшеничный трипс (*Haplothrips tritici*) в двух формах (личинки и имаго) и злаковые цикадки (*Laodelphax striatella*). Исследование показало, что большинство вредителей в период начальных фаз развития пшеницы развиваются и питаются на сорных дикорастущих растениях, произрастающих на станциях, мигрируя в последующем на сами злаки.

**Ключевые слова:** пшеница, фитофаги, агробиоценоз, фазы развития пшеницы, Павлодарская область.