https://doi.org/10.31489/2024BMG1/67-78

UDC 595.7:632.7 Received: 16 September 2023 | Accepted: 12 December 2023

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Monitoring of phytophages in spring wheat agrocenoses in view of applying different agrotechnological methods in the conditions of the North-East of Kazakhstan

The article discusses issues related to the impact of agrotechnical practices (sowing time and preceding crop) on the number and species diversity of pests in spring wheat varieties of foreign and Kazakhstan breeding in the conditions of the North-East of Kazakhstan. In order to increase plant resistance to pests and identify the impact of various preceding crops the research in 2022 was conducted in agricultural organizations located in the regions of North-Eastern Kazakhstan. The spring and summer of the vegetation period of 2022 were characterized by high temperatures and a lack of moisture in the soil, impact of which is seen in the form of turgor decrease in plant organisms and their resistance to various damages. In the course of early sowing of Triso wheat, the plants were more affected at the initial stage of development by the lack of moisture in the soil and high temperatures, which identified in the form growth retardation and increased plant susceptibility to pest damage. The sowing of other varieties was carried out at the optimal time recommended by the scientific institutions of the region — in the period of May 15–24. This allowed the culture to develop normally and avoid the most vulnerable phases during the maximum level of summer precipitation, which is typical for North-Eastern Kazakhstan in the third decade of June. The practical significance of the work is in the possibility of effective implementation of protective measures and optimization of the agricultural technology used in accordance with the soil and climatic conditions of crop cultivation and species diversity of phytophages.

Keywords: phytophages, abundance, species composition, spring wheat, foreign and Kazakhstan breeding varieties, sowing time, climatic conditions, preceding crop.

Introduction

Wheat (*Triticum*) is the main food grain crop in the Republic of Kazakhstan. According to the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, the total gross harvest of agricultural crops in 2021 was 16 375.9 thousand tonnes, with wheat accounting for 11 814.1 thousand tonnes, or about 73% [1].

Pests and plant diseases destroy more than 25% of the potential yield of food crops each year. Thus, during pest mass reproduction years, spring wheat yield drops to 23.2%; during epiphytoty years, disease output falls to 40.0–60.0% [2].

Human activity has created unfavourable conditions for entomofauna on agricultural lands, resulting in a decrease in the number of insects and an increase in the number of phytophagous species adapted to the specific conditions developing in spring wheat agrocenoses.

Since phytophages do not need to expend much energy while seeking food, agricultural intensification has accelerated the adaptive diversity of pests and their rapid reproduction. In addition, grain crops (such as spring wheat) are more nutritious than wild cereals. As a result, the natural balance between harmful and beneficial insects is disturbed, and herbivorous species multiply rapidly. Thus, the transition in steppe environments to resource-saving strategies such as crop residue preservation and crop saturation, mostly with spring wheat, provides circumstances for the development and dominance of pest populations with a long biological cycle [3].

As a result, improving the phytosanitary condition of agricultural crops is important for achieving high production and profitability of spring wheat crops. The patterns of creation of the phytosanitary situation in agrobiocenoses, on the basis of which measures for protection are planned and organized, must be regularly updated in order to prevent losses of the spring wheat harvest due to pests [4].

Correctly chosen crop cultivation techniques, such as crop rotation, varieties, sowing and harvesting schedules, etc., also play an important role in improving plants' pest resistance [5–7]. One perspective method for combating pests is to choose wheat varieties that are resistant to their impacts, because varieties react differently to insect damage: some significantly decrease yield, while others do not. For instance, sucking insects like aphids and bugs clearly exhibit this. Sun pests are less damaging to rapidly ripening varieties [8].

Furthermore, local producers sow not only wheat varieties of Kazakhstan breeding but also promising highly productive varieties of foreign breeding, which are not adapted to the region's unfavourable soil and climatic conditions, as well as to local phytophages, necessitating further research.

Crop rotation and sowing dates are two agricultural practices that can be used to efficiently control pests' life conditions, minimising crop losses and quality reductions from phytophages. Additionally, the effects of various agricultural practices will appear differently in various agro-climatic areas [9]. As a result, agricultural technology techniques must be chosen with the soil and climatic features of a specific area, or even an individual farm, as well as taking into account the commonly prevalent forms of wheat phytophages.

The purpose of the scientific research is to conduct phytosanitary monitoring of agrocenoses of spring wheat varieties of foreign and Kazakhstan breeding, taking into account the influence of agrotechnical practices on the species composition and pest number in agricultural crops in the North-East of Kazakhstan (using the example of the Pavlodar region) as one of the main regions of the republic for grain production.

Experimental

The Pavlodar region is characterized by a considerable diversity of natural conditions. It is located mainly within two natural areas: steppe and desert steppe [10].

For phytosanitary monitoring, we selected the main wheat cropping areas in different parts of the region (Zhelezin District, Uspen District, and Ertis District), which differ in climatic conditions, vegetation, and geological structure, which determine the corresponding diversity of soil cover.

The studies were carried out during the growing season of 2022 in typical agricultural organizations for various preceding crops.

Zhelezin District is located in the northern part of the Pavlodar region. The area is characterized by low rainfall and low relative humidity in spring and the first half of summer, maximum rainfall in midsummer, high summer and winter temperatures, late spring and early fall frosts, and high wind activity during the year. The minimum temperature is in January-February, where the average temperature in January is minus 18-19°C. The maximum temperature is in June-July, where the average temperature in July is plus 19-20°C. The average annual rainfall is 275.5 mm, sometimes more than 300 mm.

Vegetation is represented by forb-feather associations; there are some aspen and birch forest outliers. Soil covering is represented by southern black soil, more often they are solonetzic and solodised, forming complexes and combinations with solonetz and meadow-chernozem solonetzic soils, occurring in depressions. The presence of complexes with solonetzic soils creates heterogeneity and spotting of the fields, which leads to the uneven appearance of seedlings and thinning of crops.

In this district, the following fields were examined: 17, field area 215 ha, the preceding crop is complete fallow (2021) and 35, field area 298 ha, the preceding crop is spring wheat (2021).

Sowing on the field 17 was carried out on May 18; seed placement depth 5-6 cm, seeding rate 110 kg/ha, agricultural technology is generally accepted for this region, row spacing — 15 cm; the variety is “Likamero”. The seeds were treated with the fungicide Citizen before planting (240 g of active component tebuconazole per 1 l).

“Likamero” variety breeder is Secobra Recherches (France); its parentage is (Hanno × Devon) × (STRU689 × Quattro). The variety is lutescens. This variety is characterized by rapid development in the early phases, good resistance to lodging, very high resistance to spikelet fusariosis, root rot, powdery mildew, and brown rust is affected poorly, high protein content in the grain. This is a compensatory type, which forms its harvest by having a high ear and 1000 grains weight, the vegetation period is 72–97 days, it is moderately drought-resistant. Baking qualities are good, can be sown in early terms, not afraid of early spring frosts.

Sowing on the field No. 35 was carried out on May 23; seed placement depth 5-6 cm, seeding rate 120 kg/ha, direct sowing on a stubble background, row spacing — 15 cm; the variety is “Uralosibirskaya”, the seeds were not treated before sowing.

The breeder of the “Uralosibirskaya” variety is Federal State Budgetary Scientific Institution “Siberian Research Institute of Agriculture” and LLC “Agrocomplex “Kurgan Semena”” (Russia). Variety is lutescens. The vegetation period is 78–93 days, drought tolerance is good. It is moderately susceptible to leaf rust, powdery mildew, and root rot. In the field conditions, it is strongly affected by dust bunt and septoriosis.

“Uralosibirskaya” variety has increased resistance to adverse environmental factors, thanks to the thick straw, has a high resistance to lodging, a high percentage of preservation of the stem.

Uspen District is located in the north-eastern part of the Pavlodar region. The climate of the area is marked by a sharply arid spring and the first half of the summer. The average January temperature — 19.6°C, July +19.6–21.4°C, the amount of rainfall averaged 260–310 mm per year, most of which falls in the second half of summer, so growth and development of culture are largely determined by the amount of moisture stored before sowing.

Soils of the district are dark-chestnut soils of light granulometric composition in the complex with solonetz and meadow-chestnut soils. It has fescue-feather, vermouth, and vermouth-feather vegetation.

In this district, the following fields were examined: 56, field area 425 ha, the preceding crop is spring wheat (2021) and 68, field area 520 ha, the preceding crop is complete fallow (2021).

Sowing on the field No. 56 was carried out on April 30; seeding rate 110 kg/ha, agricultural technology is generally accepted for this region, row spacing — 15 cm; the variety is “Triso”.

The breeder of the “Triso” variety is Deutsche Saatveredelung AG (Germany); its parentage is Kadett × Weihenstephan Stamm. Variety is lutescens. This variety is characterized by good lodging resistance, the vegetative period is 85–90 days, baking quality is good, moderately susceptible to brown rust, powdery mildew, strongly susceptible to smut. Variety intensive type, double-root, that is, when sown in the fall, develops as a winter form, when sown in spring as spring, which provides the variety with high adaptive properties. It can be sown as early as possible to achieve high tillering, the variety is not afraid of frost.

Sowing on the field No. 68 was carried out on May 20; seeding rate 110 kg/ha, agricultural technology is generally accepted for this region, row spacing — 15 cm; the variety is “Omskaya 35”.

Before sowing, the seeds were treated with the fungicide Dividend Extreme (active ingredient: difenoconazole (92 g/l) + mefenoxam (23 g/l)) and the insecticide Caliber (active ingredient: clothianidin (600 g/l)).

The breeder of the “Omskaya 35” variety is Federal State Budgetary Scientific Institution “Omsk Agrarian Scientific Center” (Russia). The variety is lutescens. Its vegetation period is 87–90 days; resistant to lodging, moderately drought tolerant. Moderately susceptible to brown rust, susceptible to dusty mildew, strongly susceptible to hard knotweed, stem rust, powdery mildew, root rot.

The “Omskaya 35” variety has a high potential yield and forms high-quality heavy grains. Thanks to the high productivity in combination with resistance to diseases and lodging, this variety can successfully compete with varieties of similar ripeness groups.

Ertis District is located in the north-western part of the Pavlodar region. Features of the climate are a short spring and autumn, with extremely unstable temperature, with sharp fluctuations from warm to cold, and often from hot to freezing, hot and dry summer, the amount of rainfall averages 250–310 mm. The average temperature of January is 18°C, July is +20°C.

Soils are chernozemic and chestnut, loamy, sandy loam, and sandy in granulometric composition, solonetzic complexes are also widespread. It has fescue-feather-vermouth vegetation.

In this district, the following fields were examined: 37, field area 368 ha, the preceding crop is spring wheat (2021) and 53, field area 317 ha, the preceding crop is flax (2021).

Sowing on the field No. 37 was carried out on May 6; seeding rate 110 kg/ha, agricultural technology is generally accepted for this region, row spacing — 15 cm; the variety is “Triso”. Sowing on the field No. 53 was carried out on May 20; seeding rate 110 kg/ha, agricultural technology is generally accepted for this region, row spacing — 15 cm; the variety is “Kazakhstanskaya 15”. Before sowing, the seeds were treated with Inshur Perform fungicide (active ingredient: triticonazole (80 g/l) + pyraclostrobin (40 g/l) + Seed Start growth stimulator.

Seed Start growth stimulator increases germination energy and field germination of seeds, increases the viability of seedlings, provides them with initial nutrition, stimulates the growth and development of the root system, and increases plant resistance to drought, frost, and diseases.

The breeders of the “Kazakhstanskaya 15” variety are LLP “Kazakh Research Institute of Agriculture and Crop Production” and LLP “Pavlodar Research Institute of Agriculture” (Kazakhstan). Variety is lutescens. The vegetation period is 85–90 days. It is resistant to lodging, preharvest germination of grain. The variety is resistant to drought and brown rust.

The study period included phenological observations of crop development stages, the recording of meteorological data, determining the biometric parameters of the crop, and the number and species composition of insects in wheat crops. Pests were counted using quantitative methods [11-12].

Pests living on plants were enumerated at discount areas. A light frame 50 cm in length and 50 cm in width was placed on the soil surface to count the number of species that were on plants and fell on the soil (within the area bounded by the frame). This method was used for counting sun pests, cereal leaf beetle, cereal chafers, corn ground beetles, pea leaf weevils, meadow moth caterpillars, and many others.

We used an aerial insect net to count pests according to the mowing method. This method helps to count pests in the upper layer of the grass stand. A standard net (hoop diameter 30 cm, receiving bag depth 60 cm, and handle length 1 m) was used. The net was swung 10 times over the upper part of the grass stand without interruption. Then its contents were transferred from the net and the number of insects was counted. Ten series of sweeps were made so that their total number reached 100.

Infestation of plants by the grain flea beetle was evaluated in each field in ten places by checking ten plants and evaluating the degree of leaf surface devouring by the fleas on a five-point scale: 0–5% was scored as 1 point; 6–25% as 2 points; up to 50% as 3 points; up to 75% as 4 points; 76–100% as 5 points [11].

Insect Keys were used to assess the species composition of insects.

Statistical data processing was carried out using Microsoft Excel 2007. Pearson correlation coefficients, errors, and criteria for the significance of the correlation coefficient were calculated to assess the relationship between climatic factors during the growing season and the number of plant-feeding species in wheat crops. Differences were considered statistically significant at the $p < 0.05$ level.

Results and Discussion

In the ongoing research in 2022, wheat thrips (*Haplothrips tritici*), grain flea beetles (*Phyllotreta vittula*), stem flea beetles (*Chaetonema aridula*), bugs (*Trigonotylus ruficornis*), and wheat aphids (*Schizaphis graminum*) were among the dominant pests for crops of spring wheat varieties of foreign and Kazakhstan breeding. However, their distribution over the research locations and for different preceding crops is uneven. Other pests were identified in small numbers, and there was no significant damage to plants.

In the Zhelezin District, field No. 17 is characterized by the beginning of wheat tillering in the first ten days of June and slight damages (less than 7%, 1 point) on the leaves by the grain flea beetle (*Phyllotreta vittula*). The colonization of crops by the main grain phytophages was not seen due to the early development stage of wheat.

In the second ten days of June, the stem elongation stage was observed: there were some damages (10-12%, 2 points) by the grain flea beetle (*Phyllotreta vittula*). Active colonization of plants by wheat thrips (*Haplothrips tritici*) was revealed (ranging from 3 to 7 insects per 1 stem).

On July 15, 2022, crops were treated with a tank mixture of pesticides against weed monocotyledons and dicotyledons, pests and diseases. Clorid 200 insecticide was used for treatment against pests (active ingredient: imidacloprid — 200 g/l). The protective period of this insecticide is 18–25 days. Thus, at the time of the field study (July 21, 2022), only small numbers of wheat thrips (*Haplothrips tritici*) and grain flea beetles (*Phyllotreta vittula*) were observed.

In the second decade of July, a period of grain ripening was identified. Imagoes of wheat thrips (*Haplothrips tritici*) (5-6 per 1 plant) with their signs of ears and leaves damage were identified. During this time, the number of grain pests increased significantly, accounting for 93% of all insect groups. It is possible that the effectiveness of the Clorid 200 insecticide was lower as part of a multi-component tank mixture. In addition, the duration of protection was 18–25 days. Wheat thrips (*Haplothrips tritici*) and stem flea beetles (*Chaetonema aridula*) larvae and imagoes reached their maximum number (33.2% and 56.8%, respectively).

The crop entered the full maturity stage in the second ten days of August. The plant height averaged 77 cm, the ear length was 7-8 cm, the grain was heavy and large. At the end of the wheat vegetation there was a 50.3% decrease in the number grain pests associated with the migration of many species to nearby stations in search of food.

Field No. 35 entered the complete shoots stage in the beginning of June; no insect infestation of the crops was noted.

The second decade of June was characterized by the tillering stage of crops, while there was slight damage by grain flea beetle on the leaves (6%, 1 point), and the presence of wheat thrips on the plants was noted (4-5 species per 1 stem). The number of polyphagous and associated pests was insignificant.

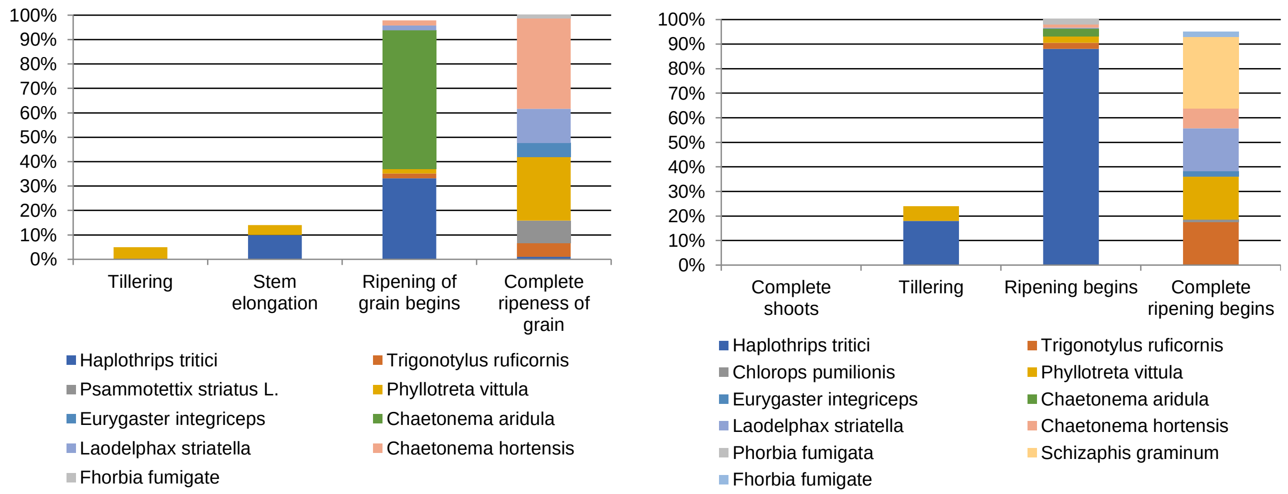
The number of thrips on one plant increased to 5-6 species by the grain-ripening stage. Areas of damage from thrips were recognized on the leaves and ears of plants. During this period, there was an increase in the number of grain pests up to 92.7%, with wheat thrips (*Haplothrips tritici*) dominating among them.

At the beginning of full maturity, the height of plants varied from 62 to 91 cm, the ear length was 5–8 cm, the grain was small and incomplete. The majority of phytophages were found on individual plants during the dough stage, but their quantity dropped to 42.3% when crop development was complete. The main share of pests accounted for: wheat aphid (*Schizaphis graminum*) (29.1%), grain flea beetle (*Phyllotreta vittula*) (17.4%), small brown planthopper (*Laodelphax striatella*) (17.4%), leaf bug (*Trigonotylus ruficornis*) (18.6%).

Figure 1 illustrates the results of collecting phytophages of spring wheat by stages of crop vegetation and several preceding crops in the Zhelezin District.

In the Uspen District (field No. 56) in the first ten days of June, the tillering-beginning of stem elongation phase was observed, which resulted in the yellowing of leaves due to high temperatures and lack of moisture in the soil, as well as damage by the grain flea beetle (*Phyllotreta vittula*) (5–10%, 2 points). In the course of field inspection, pests were found in small numbers, which is associated with the treatment of seeds before sowing with the contact insecticide Caliber (active ingredient: clothianidin (600 g/l), which has a long period of protective action.

The plants entered the heading phase in the third decade of June; the ear was heavily damaged by the imago of wheat thrips (*Haplothrips tritici*) (10–15 species per 1 ear), which indicates the necessity for extra insecticidal treatment of plants. The crops were stunted (up to 30 cm), and the leaves were characterized by signs of grain flea beetle (*Phyllotreta vittula*) damage (10%, 2 points). At the same time, damages by *Haplothrips tritici* (15–20%) were seen on the leaves and ears. Grain pests outnumber other insect groups by nearly twice (51.8%), with wheat thrips (Haplothrips tritici) accounting for 96.5% of this total.



a b

Figure 1. Results of spring wheat phytophages collection using an entomological net (Zhelezin District, field No. 17): preceding crop – complete fallow (a); field No. 35: preceding crop – spring wheat (b). The ordinate axis is the number of insects, and the abscissa axis is the development stage

Damage to the ear and foliage by wheat thrips (*Haplothrips tritici*) (15–20%) and grain flea beetle (*Phyllotreta vittula*) (10%, 2 points) was also observed during the milky ripeness stage. Thrips are found on the plant (3-4 species per 1 ear). Grain pests outnumber other insect groups by more than four times (51.8%), with grain flea beetles (*Phyllotreta vittula*) accounting for 73.8% of this total.

At full maturity, the height of plants varied from 30 to 37 cm, spike size averaged 4-5 cm, the grain was small and incomplete. Wheat thrips larvae (*Haplothrips tritici*) (8 species per 1 ear) and wheat aphids (*Schizaphis graminum*) (7-8 species per 1 ear) infested crops at the dough stage. Wheat aphids (*Schizaphis graminum*) (39.2%), leaf bugs (*Trigonotylus ruficornis*) (25.6%), leafhoppers (*Psammotettix striatus* L.) (14.4%), grain flea beetle (*Phyllotreta vittula*) (18.4%) were also observed in the crops; the other species were found in single specimens.

In the early stages of crop vegetation, a low number of phytophages were detected in field No. 68, but at the beginning of the tillering phase, damage to leaves by flea beetles was seen up to 10% (2 points), while wheat thrips and grain flea beetles were found in small quantities.

In the beginning of the stem elongation phase, a small number of wheat thrips (*Haplothrips tritici*) imagoes (about 2-3 pieces per 1 stem) were found.

The heading phase is characterized by the prevalence of grain pests in contrast to other groups of insects (96.7%), with the grain flea beetle (*Phyllotreta vittula*) accounting for 36.2% and wheat thrips (H*aplothrips tritici*) accounting for 56.5%.

Several plants were in the dough stage during the grain's full maturity period. The plant height was 52–60 cm, the ear length was 6.5–7 cm, the grain was medium-sized, and the field was heavily clogged with sunflowers. There was a decrease in the number of grain phytophages to 61.7% of the total number of studied insects and an increase in the number of entomophages to 26.9%, including *Coccinellidae* and *Miridae*, each accounting for 47%. Leaf bug (*Trigonotylus ruficornis*) amounted to 10.3%, wheat thrips (*Haplothrips tritici*) to 39.5% and wheat aphid (*Schizaphis graminum*) to 5.9%; they fed on plants and green parts of wheat.

Figure 2 reveals information on the results of collecting phytophages of spring wheat by stages of crop vegetation and several preceding crops in the Uspen District.

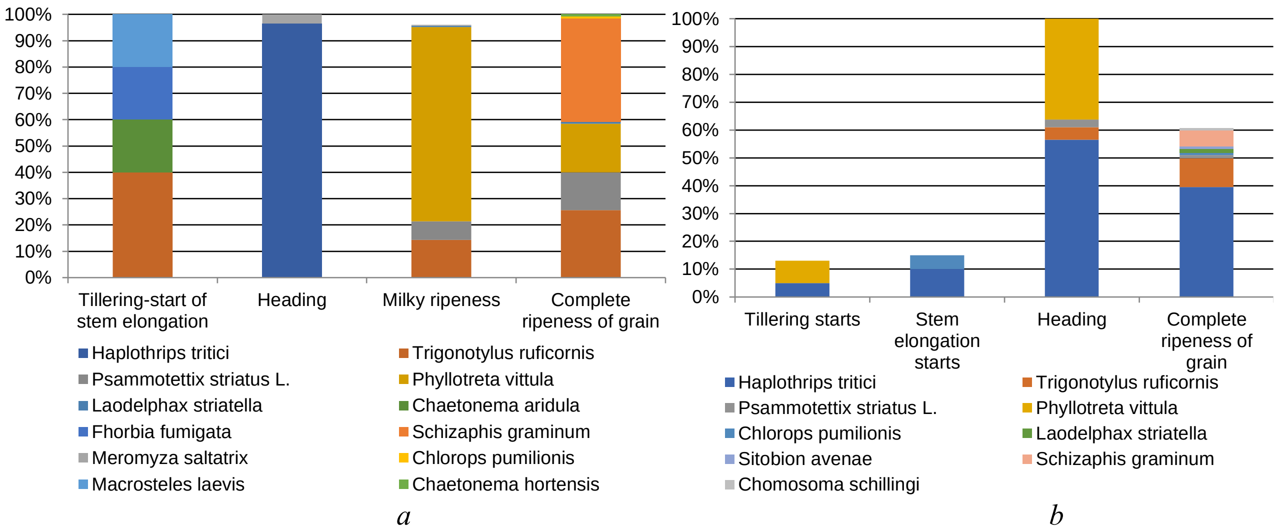


Figure 2. Results of spring wheat phytophages collection using an entomological net (Uspen District, field No. 56): preceding crop – spring wheat (a); field No. 68: preceding crop – complete fallow (b).
The ordinate axis is the number of insects, and the abscissa axis is the development stage

Tillering was observed in the Ertis District (field No. 37) during May`s third decade, when the leaves were severely damaged by the grain flea beetle (*Phyllotreta vittula*) (up to 50%, 3 points). On May 20, the crops were sprayed with Fobos insecticide (active ingredient: alpha-cypermethrin, 200 g/l), which has a protective activity period of 1–3 weeks; no visible pests were noticed at the time of observation.

The third decade of June was defined by the heading phase. Imagoes of wheat thrips (*Haplothrips tritici*) were observed in the axils of the leaves (2–4 species per 1 stem).

The grain-filling phase was determined in the second ten days of July, with plant damage caused by wheat thrips (*Haplothrips tritici*) and grain flea beetles (*Phyllotreta vittula*). High temperatures and low air humidity cause plant leaves to turn yellow. The grain flea beetle (*Phyllotreta vittula*), which made up a large portion of the 92.7% rise in grain pests, was observed.

Full maturity of the grain was noted in the second ten days of August. Plants` height varied from 10 to 30 cm, ear size averaged 6 cm, the grain was small, and plants were completely dry. The number of grain pests decreased significantly to 23%, but the grain flea beetle (*Phyllotreta vittula*) remained dominant among them (54%).

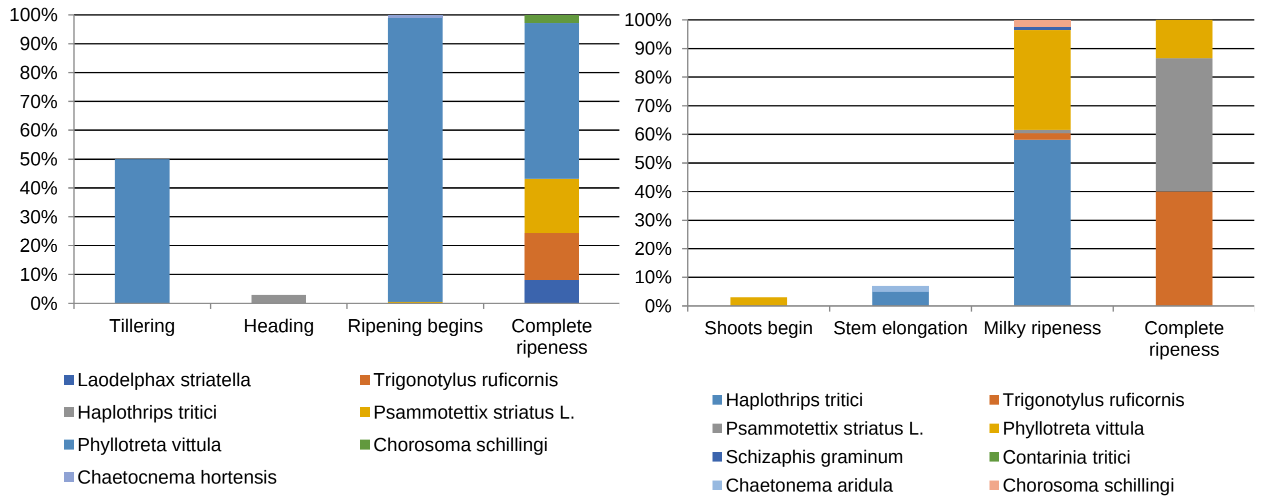
At the beginning of the germination phase (field No. 53), grain flea beetle (*Phyllotreta vittula*) (7 species per 1 m^2) was observed, and due to the early stage of crop development, pest infestation of crops had not occurred.

At the end of tillering and the beginning of stem elongation, leaves with up to 5% (1 point) flea beetle damage were noted. Wheat thrips (*Haplothrips tritici*) were discovered in amounts ranging from 2 to 7 species per 1 stem. Chemical treatment with an insecticide was performed on June 25, 2022, resulting in a low number of grain pests.

The number of grain pests was highest for all time during the milky ripeness stage (83.5%); there was also an increase in the number of meadow moths up to 11.6%.

At the full-ripe stage, plant height varied from 60 to 76 cm, ear length was 6.0–7.5 cm, the grain was medium-sized; there are thrips larvae in the ear 5–10 species per 1 ear (on plants at the middle dough stage or lagging in development). The number of grain pests declined significantly to 9.6%, with leaf bugs (*Trigonotylus ruficornis*) and leafhoppers (*Psammotettix striatus*) dominating among them. There was also an increase in entomophages up to 21%, of which 97% were coccinellids (*Coccinellidae*). Since the preceding crop was oilseed flax, which led to the accumulation of its specialized pests on the field, a considerable number of flax flea beetles (*Aphthona euphorbiae*) (51% of the total number of insects) were also detected.

Figure 3 illustrates the results of collecting phytophages of spring wheat by stages of crop vegetation and several preceding crops in the Ertis District.



a *b*

Figure 3. Results of spring wheat phytophages collection using an entomological net (Ertis District, field No. 37): preceding crop – spring wheat (a); field No. 53: preceding crop – oilseed flax (b).
The ordinate axis is the number of insects, and the abscissa axis is the development stage

Analysis of phytomonitoring demonstrated dominance of wheat thrips (*Haplothrips tritici*) in all studied fields with spring wheat. The vegetation period of 2022 represented high air temperatures in spring and summer: in May maximum air temperature reached 35–38°C without rainfall; the number of days with relative humidity below 30% was 7–9 days; all this indicates that May characterized as an arid month. In June, the peak of air temperature reached 34–36°C, rainfall was registered only in the second half of June. Thereby, lack of moisture resulted in decrease of plant turgor and resistance to damage, which contributed to active reproduction and development of thrips in wheat crops.

Determining the correlation between air temperature during the growing season and number of phytophages demonstrated that the values of correlation coefficients are quite high. This indicates a very strong direct relationship between these indicators; for Zhelezin District the correlation coefficient is $r = 0.92 \pm 0.25$, for Uspen District $r = 0.84 \pm 0.30$, and for Ertis District $r = 0.87 \pm 0.35$, respectively, indicating that temperature rise contributes to an increase in the number of pests, as seen in the example of wheat thrips. Determining the correlation coefficient between the amount of rainfall and number of phytophages demonstrated that there is a strong inverse connection between these indicators, so on Zhelezin District $r = –0.75 \pm 0.45$, on Uspen District $r = –0.84 \pm 0.30$, on Ertis District moderate correlation $r = –0.75 \pm 0.30$, that is, lack of moisture results in an increase in the number of phytophages and vice versa. These correlation relationships are statistically significant ($p<0.05$), since the criteria for the significance of correlation coefficients exceed the values of the Student’s t-test.

However, Ivantsova E.A., in the period of the Lower Volga region conditions’ investigations, argues that dry hot weather in summer contributes to an increase in the number of wheat thrips in the current year, but accelerated development of wheat shortens the duration of larval feeding and dooms them to death in winter, so their number drops the following year [13]. Saratov Agrarian University`s researchers discovered that increasing rainfall to 10–15 mm reduced the quantity of wheat thrips by two times [14].

Wheat thrips (*Haplothrips tritici*) in wheat crops demonstrate phenological adaptation, which means that their life cycles are closely associated with crop development stages. The first plant feeders’ imagoes can be seen during the stem elongation phase in field No. 17 (Zhelezin District: up to 2–7 species per 1 stem), while the most thrips were found during the heading phase in field No. 56 (Uspen District: up to 10–15 species per 1 ear), since the crop in this phase is most suitable for species reproduction. Adult insects accumulate at the leaf base, feeding on plant sap, and these results in the appearance of whitish spots in the feeding places.

Larvae begin to hatch with the progress of flowering and grain-forming phases. Young larvae begin feeding in the flowering part of the spikelet under the flower scales. The choice of feeding site is not random; there is a flow of organic compounds that produce caryopses in the blossoming area. The larvae's feeding intensity increases in the course of grain filling and milky ripeness phase progression. During this time, lipids and proteins in the aleurone layer are emulsified and accessible to the larvae. In the period of dough maturity, when the process of converting organic substances into reserve substances begins, some of the larvae stop feeding and leave the ear. In the case of larvae feeding, damaged flowers die off, so the spike develops through grains, resulting in lower yield (weight of damaged grains declines from 1 to 14%) and lower quality of seeds (laboratory germination rate falls from 98 to 72%). It was established that their harmfulness is 1.71 mg of yield per year from the feeding of one species [15].

Damage to wheat plants by the grain flea beetle (*Phyllotreta vittula*) was also observed in early development (particularly in field No. 37, Ertis District), which was related to early wheat sowing (May 6). In the conditions of North-East Kazakhstan, early wheat sprouts appear at the same time as a large number of beetles emerge from their winter hibernation and begin to infest the crop. The beetles initially damaged leaf tips and then the entire leaf plate, causing the leaves to dry and fall, limiting their assimilation surface and crop productivity. Crops were formed partly thinned and not aligned in height, resulting in a lack of grain output. Furthermore, damaged plants become susceptible to disease and less resistant to grain fly damage. The degree of damage to plants depends on the location of crops; the closer they are to the pest’s habitat, the more severe the damage. Insects frequently overwinter under plant residues that remain on the fields after harvesting (without plowing), and this causes an accumulation of insects in the fields. The most dangerous grain flea beetle (*Phyllotreta vittula*) develops in years with early spring droughts, which were common during the 2022 growing season.

Timoshenkova T.A., in the steppe conditions of the Orenburg region, established that the weather conditions identify the predominance and harmfulness of the grain flea beetles at the sprouting and tillering phases. Low-temperature background contributed to a decrease in the prevalence of the flea almost twice compared with the years with hotter weather during this period [16].

The quantity of large stem flea beetles (*Chaetonema aridula*) was low by regions as a whole; only in field No. 17 in Zhelezin District their number at the grain filling stage was 56.8%, which was explained by proximity to the fields of forest patches and glades, places of flea overwintering. Stage of spring wheat growth during which stem flea beetles cause major damage: tillering, stem elongation, and heading stages. Since larvae-damaged stems do not form ears, the plants cease growing, thereby reducing production. Damage during ear emergence causes white spike and lodging of stems. Plant damage is uncommon in the later stages of wheat development and does not significantly lower yield. Plant damage is uncommon in the later stages of wheat development and does not significantly reduce yield [17]. The severity of damage caused by stem flea rises in dry years with warm early springs because imagoes leave their wintering places earlier and fly to wheat seedlings.

Grain bug (*Trigonotylus ruficornis*) was found in great numbers in spring wheat fields because of its plasticity. It was harmful during the whole crop's vegetation period; typical damage includes discoloration of the bug's puncture sites as it sucks out the plant cell sap, resulting in a reduction of assimilating tissue and deformation of grain. Bugs are more dangerous in dry years when wheat crops are impacted by a lack of moisture and high air temperatures. Weather conditions of May and summer months of 2022 in the region as a whole were characterized by high temperatures and a lack of precipitation during the wheat vegetation period. This increased the number of grain bugs, which was highest during the period of grain ripening.

Wheat crops are greatly endangered by wheat aphids, which can quickly colonise leaves and ears with multiple colonies, feed on cell sap, and drastically reduce grain yield. Wheat aphids (*Schizaphis graminum*) were found in wheat crops during the observation period. It is a non-migratory species that develops solely on the leaves of cereal crops without changing feeding plants. Aphids are more dangerous in dry years (with low air humidity) because plants' turgor and resistance to damage are weakened due to a lack of moisture. In the Uspen District, the number of aphids increased from the heading phase to the full ripeness of the grain in

July-August as a result of the weather conditions of 2022's growing season. During this period the aphids fed on underdeveloped plants.

Leafhoppers (*Psammotettix striatus* L.) are trophically closely related to cereal vegetation. Their numbers increase in the first half of summer, during the period of wheat tillering and stem elongation; the quantity of leafhoppers also rises in the course of grain formation and ripening. Both adults and larvae cause damage by feeding on the cell sap of leaves and stems; whitish spots form at bite locations, giving the affected organs a marble colour.

Examination of the biometric indicators of wheat and crop condition revealed that the plants in the stage of full maturity of the “Triso” wheat variety in both Uspen (No. 56) and Ertis Districts (No. 37) were undersized, with small spikes and puny grain. On the other hand, other varieties had better indicators in terms of plant biometry and grain weight.

We believe this is more related to crop timing because the “Triso” variety was sown earlier, when there was enough moisture in the soil following snowmelt, which is the key limiting factor in our region (April 30 to May 6). However, May was characterized by higher air temperatures and lack of rainfall, which led to slower growth of the crop, poor bushiness, and formation of a weak secondary root system, which subsequently affected the productivity of wheat.

“Triso” variety is also characterized by slow growth after the sprouts emergence, reduced assimilation abilities of the root system, thinning of seedlings because of moisture lack in the upper soil layer, the possibility of severe damage by Oscinella fly, wireworms, and flea beetles. All these factors could also contribute to a drop in crop productivity in unfavourable conditions of the vegetation season.

There are recommendations on the timing of sowing spring wheat at various locations in the Pavlodar region that boost potential productivity and prevent phytophage damage.

The remaining wheat varieties were sown from 15 to 24 May in the optimal conditions, recommended by scientific institutions. Thereby, the most vulnerable stages got under the summer maximum of rainfall, typical for the third ten days of June in the North-East of Kazakhstan, which allowed the crop to develop optimally.

“Likamero” variety is distinguished by the rapid plant development in the early phases of growth, plenty of kernels, and mass of thousands of seeds, well tolerates early spring frosts, but is susceptible to fungal diseases. In the conditions of the region with a lack of moisture in the soil, the main point in growing this variety is the timely implementation of fieldwork targeted at the accumulation and rational use of soil moisture.

In the conditions of Zhelezin District, plants of the “Uralosibirskaya” variety (field No. 35) formed a good stem and optimal parameters of grain quality, which appear to be related to the variety's strong adaptability to the region's adverse weather conditions. Wheat thrips and wheat flies (*Fhorbia fumigate, Chlorops pumilionis*) were found in larger numbers in this variety's crops. The fact that the wheat was planted directly on the wheat stubble background from the previous year enables us to explain it. Due to the wintering of these species in the root and plant residues of plants, in the vegetation year, there was an increase in their population according to the preceding crops, in comparison with the complete fallow preceding crop in field No. 17 (Zhelezin District).

At the same time, the opposite picture was observed in the Uspen District: in field No. 68 in crops of “Omskaya 35” wheat with the complete fallow preceding crop more intense invasion of phytophages was determined, although there were few crop residues and straw on the field, besides, the last main tillage was done at greater depth, which worsens conditions of wintering for thrips than in the field No. 56, where insects can overwinter in straw and stubble additionally. This might be a result of the fact that plants grown in complete fallow have a large aboveground mass, and they are more attractive to insects because of the favourable conditions generated by this preceding crop.

“Kazakhstanskaya 15” variety was brought out by local breeders and well adapted to the adverse soil and climatic circumstances of the region, which allows for an optimal sowing period to obtain a good harvest of high-quality grain. In general, according to the preceding oilseed flax, a considerable overabundance of grain phytophages was not registered by stages of crop growth (field No. 53, Ertis District).

Conclusions

The analysis of the vegetation season's meteorological conditions, sowing time, and preceding crop revealed that all this had a great impact on species composition and the number of spring wheat pests in crops of foreign and Kazakh breeding. Early sowing of the “Trizo” variety resulted in high temperatures and a lack of moisture in the soil during the initial stages of development, which slowed the plants' growth and made them more susceptible to pest attacks. Furthermore, during early sowing, grain flea beetles (*Phyllotreta vittula*) were characterized by a massive emergence from wintering grounds and attacks on sensitive plants. The following factors should be considered when choosing the sowing time: the correlation between the wheat development phase and the period when phytophage activity and abundance are at their peak; the age of the damaged plant, which determines the type of damage, and the formation of tissues that hinder pest penetration.

The climatic circumstances of 2022's growing season primarily affected the domination of specific types of pests, for which the dry conditions of the vegetation period were favourable for reproduction and feeding. For example, the main pest in wheat crops of different varieties, starting from stem elongation until milky maturity, was wheat thrips (*Haplothrips tritici*). It is defined by trophic and phenological attachment to the crop (the phytophage's primary feeding source).

Since there is no information on the phytosanitary situation in wheat agrocenoses of the North-East of Kazakhstan, the data obtained contribute significantly to the study of insect complexes inhabiting the crops and provide comparative data for similar investigations in other areas.

Data on the main phytophages of the crop in the region and their harmfulness during vulnerable phases of wheat vegetation will help to organize protective measures purposefully and apply more effective agrotechnological techniques in cultivation technology, considering the number of a particular species. It will help to reduce the number of phytophages during the most dangerous periods of crop development.

Acknowledgements

This research is funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. AP09058450 “Development of an ecological system of phytosanitary control of destructive biota (phytophages and phytopathogens) of spring wheat in the North-East of Kazakhstan)”.

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Р.М. Уалиева

Қазақстанның солтүстік-шығысындағы түрлі агротехнологиялық әдістерді есепке алумен жаздық бидайдың агроценоздарындағы фитофагтардың мониторингі

Өсімдіктердің зиянкестердің әсеріне төзімділігін арттыру мақсатында мақалада Қазақстанның солтүстік-шығысы жағдайында шетелдік және қазақстандық селекцияның жаздық бидай сұрыптарын егудегі зиянкестердің саны мен түрлік алуандығына агротехникалық әдістердің (себу мерзімі және бұрынғы егісті таңдау) әсері туралы мәселелер қарастырылған. Зерттеулер 2022 жылы әртүрлі бұрынғы егілген егістер бойынша Қазақстанның солтүстік-шығыс аудандарының типтік ауыл шаруашылығы ұйымдарында жүргізілді. 2022 жылдың вегетациялық кезеңі ауа температурасының жоғарылауымен және көктем мен жазда топырақта ылғалдың болмауымен ерекшеленді де, бұл өсімдіктердегі тығыздықтың төмендеуіне және олардың зақымдануға төзімділігіне ықпал етті. Тризо бидай өсімдіктері ерте себу кезінде дамудың бастапқы кезеңінде жоғары температура мен топырақта ылғалдың жетіспеушілігіне тап болып, бұл олардың өсуін кешіктірді және зиянкестердің зақымдалуына бейім болды. Қалған сұрыптар аймақтың ғылыми мекемелері ұсынған оңтайлы мерзімде (15-24 мамыр) егілді, осылайша дақылдың ең осал кезеңдері Қазақстанның солтүстік-шығысында маусымның үшінші онкүндігіне тән жазғы жауын-шашынға ұшырады, бұл дақылдың қалыпты дамуына мүмкіндік берді. Жұмыстың практикалық маңыздылығы мынада: фитомониторинг нәтижелері жергілікті топырақ-климаттық жағдайларды және фитофагтардың түрлік алуандылығын ескере отырып, қорғау шараларын тиімдірек жүргізуге және ауыл шаруашылығы дақылдарын өсірудің қолданбалы агротехнологиясын оңтайландыруға көмектеседі.

Кілт сөздер: фитофагтар, саны, түрлік құрамы, жаздық бидай, шетелдік және қазақстандық селекция сұрыптары, себу мерзімі, климаттық жағдайлары, бұрынғы егіс.

Р.М. Уалиева

Мониторинг фитофагов в агроценозах яровой пшеницы с учетом разных агротехнологических приемов в условиях Северо-Востока Казахстана

С целью повышения устойчивости растений к воздействию вредителей в статье рассмотрены вопросы влияния агротехнических приемов (срок посева и выбор предшественника) на численность и видовое разнообразие вредителей в посевах сортов яровой пшеницы иностранной и казахстанской селекции в условиях Северо-Востока Казахстана. Исследования проводились в 2022 году в типичных сельскохозяйственных организациях районов Северо-Востока Казахстана по разным предшественникам. Вегетационный период 2022 года отличался высокими температурами воздуха и недостатком влаги в почве в весенний и летний периоды, что способствовало снижению тургора у растений и их сопротивляемости к повреждениям. Растения пшеницы сорта «Тризо» при раннем сроке посева испытывали действие высоких температур и недостаток влаги в почве на начальном этапе развития, что привело к задержке их роста и сделало более восприимчивыми к повреждениям вредителями. Остальные сорта высевались в оптимально рекомендованные научными учреждениями региона сроки (15–24 мая), тем самым наиболее уязвимые фазы культуры попали под летний максимум осадков, характерный для третьей декады июня в условиях Северо-Востока Казахстана, что позволило культуре нормально развиваться. Практическая значимость работы состоит в том, что результаты фитомониторинга помогут эффективнее проводить защитные мероприятия и оптимизируют применяемую агротехнику выращивания культуры с учетом местных почвенно-климатических условий и видового разнообразия фитофагов.

Ключевые слова: фитофаги, численность, видовой состав, яровая пшеница, сорта иностранной и казахстанской селекции, срок посева, климатические условия, предшественник.

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