Species diversity and abundance of aphids in triticale crops in North-West Russia

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Abstract. The aphid complex of triticale crops in the Leningrad region was characterized by a large species diversity (20 species), but low abundance (1.6 specimens/trap), which, under the influence of weather conditions, varied 2.4–3.8 times depending on the crop. Winter triticale crops were inferior to spring triticale in terms of species diversity (9 vs. 18 species) and abundance of aphids (1.2 vs. 1.9 specimens/trap). The numerical majority were species whose food specialization is related to cereal vegetation (53.8%-71.4% of individuals). The mass species were *Rhopalosiphum padi* L. and *Sitobion avenae* F., which accounted for 25.7% and 23.0% of the total number of individuals. The presence of other aphid species in grain crops is due to the presence of weeds (25.7%-26.9% of individuals), the growth of other crops nearby (2.9%-10.3%), woody and shrubby vegetation (0%-9.0%). The greatest species diversity and abundance of aphids in crops of both winter and spring triticale was noted in the second decade of June, when the stage development of the former corresponded to the earing phase, and the latter to the tube exit phase.

1 Introduction

Aphids are among the dangerous pests of grain crops in Russia and abroad. Their widespread distribution and great economic importance is indicated in Kazakhstan [1], South Asia [2], North America [3] and Australia [4].

The harmfulness of aphids is manifested in a decrease in the quantitative and qualitative parameters of the crop, as well as the sowing characteristics of seeds [5]. In addition, aphids are carriers of viral diseases of cereals, including such a dangerous disease as the yellow dwarfism virus of barley [6].

In Russia, the objects of study were most often aphid complexes characteristic of widespread crops – wheat and barley. Triticale, both winter and spring, has certain prospects among grain crops for the Northwestern region of Russia. To expand the acreage of this relatively new crop, knowledge on the species composition of aphids, the abundance of mass species, their long-term and seasonal population dynamics is in demand. The data obtained will be used in the development of an integrated triticale protection system in this region, designed to minimize crop losses from harmful organisms.

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2 Materials and Methods

The research was conducted in 2021–2022 at the experimental base of the Menkovsky branch of the Agrophysical Research Institute located in the Leningrad Region of the North-Western Region of Russia [7]. The study included triticale crops – winter (Nemchinovsky 56 variety) and spring (Ukro variety).

Yellow water traps were used in the research, which are water containers (diameter – 22 cm, height – 10 cm), half filled with water. They were placed on the soil surface at an equidistant distance from each other. Aphids were collected at intervals of 7-8 days. During the accounting, all trapped insects, including aphids, were passed through gauze along with water, then placed in a separate tightly sealed container, where alcohol was later added. Sampling, determination of the species and numerical composition of aphids was carried out in laboratory conditions by Berim M.N., senior researcher at the All-Russian Institute of Plant Protection.

In addition to the yellow traps, visual records of the number of aphids on triticale plants were carried out on permanent sites of 0.1 m2, placed in crops in the amount of 36 pieces each. In addition, regular route surveys of crops were carried out, during which the species composition and abundance of aphids on both cultivated and weed plants were determined.

To compare crops of winter and spring triticale for the presence of common aphid species and the abundance ratio between them, the index of pairwise species similarity of Sorensen [8] and the coefficient of generality of specific abundance of Shorygin were calculated [9].

3 Results

According to the results of the research, it was determined that the aphid complex in triticale crops consisted of 20 species, including 9 species in winter and 18 species in spring. At the same time, the presence of 6 species was revealed in 2021, and 18 species in 2022 (Table 1). The similarity of the species composition was 44%, the commonality of specific abundance was 54.5%.

The abundance of aphids in triticale crops was low during the years of research. In 2021, it was higher in winter triticale crops (1.7 vs. 0.8 copies/trap), and in 2022 – spring (3.0 vs. 0.7 copies/trap). This turned out to be due to the fact that in 2021 favorable conditions were created for the reproduction of aphids *Rhopalosiphum padi* L., which, in a situation of late sowing of spring crops, more strongly populated winter cereals, including triticale. Thus, in the sowing of winter triticale in the stalking phase, there were 735 individuals / m^2, and in the earing phase – 2113 individuals / m^2. In 2022 there was a massive reproduction of aphids *Sitobion avenae* F. on spring crops, including triticale. The number of individuals of this species in yellow traps turned out to be 5 times higher than in the previous year (Table 1). In terms of unit area of sowing in the grain filling phase, there were 25 and 113 individuals/m^2, respectively, in 2021 and 2022.

The numerical core of the aphid complex in triticale crops consisted of species whose food specialization is associated with cereal vegetation (71.4% and 53.8% of individuals). First of all, these are *Rhopalosiphum padi* L. and *Sitobion avenae* F., which accounted for 25.7% and 23.0% of the total number of individuals. Other aphid species specializing in feeding on cereal vegetation are *Metopolophium dirhodum* Walk., *Anoecia corni* F., *Rhopalosiphum insertum* Walker. The relative abundance of these aphid species was 4.4, 3.5, 2.7%.

Table 1. Species diversity and abundance of aphids in triticale crops in North-West Russia (Leningrad region, 2021–2022).

Species	Abundance of aphids, specimen of individuals			
	Winter triticale		Spring triticale	
	2021 year	2022 year	2021 year	2022 year
Acythosiphon pisum Harr.		1		3
Anoecia corni F.			3	1
Aphis craccae L.				1
Aphis fabae Scop.	1			5
Aphis grossulariae Kalt.				1
Aphis nasturtii Kalt.				3
Brachycaudus cardui L.				2
Capitophorus elaeagni Guerc.				3
Cavariella aegopodii Scop.				1
Hyperomyzus lactucae L.		4		
Lipaphis erysimi Kalt.	2			
Macrosiphoniella artemisiae B.d.F.	1		1	
Macrosiphoniella tanacetaria Kalt.		1		6
Macrosiphum rosae L.				1
Metopolophium dirhodum Walk.		2		3
Myzus persicae Sulz.				4
Rhopalosiphoninus ribesinus Goot.				5
Rhopalosiphum insertum Walker				3
Rhopalosiphum padi L.	12	3		14
Sitobion avenae F.	4	4	3	15
Total species	**5**	**6**	**3**	**17**
Total individuals, specimen	**20**	**15**	**7**	**71**
Total individuals, specimen/trap	**1.7**	**0.7**	**0.8**	**3.0**

The second most widely represented group of aphids were species whose presence in triticale crops is due to growing weeds. They accounted for 25.7% and 26.9% of individuals (Table 2). 10 species of aphids most likely got into crops of grain planting randomly, which feed on other crops (potatoes, vetch, red clover, spring rape) located nearby, or on woody and shrubby vegetation. These are *Acyrthosiphon pisum* Harr., *Aphis craccae* L., *Aphis grossulariae* Kalt., *Aphis nasturtii* Kalt., *Capitophorus elaeagni* Guerc., *Cavariella aegopodii* Scop., *Macrosiphoniella tanacetaria* Kalt., *Macrosiphum rosae* L., *Myzus persicae* Sulz., *Rhopalosiphoninus ribesinus* Goot. They were found in triticale crops in single specimens.

Table 2. The structure of the aphid complex in triticale crops in North-West Russia.

Food specialization	Share, %	
	Winter triticale	Spring triticale
Cereal vegetation	71.4	53.8
Weeds	25.7	26.9
Other agricultural crops	2.9	10.3
Trees and shrubs	0.0	9.0

The dynamics of species diversity and abundance of aphids in winter and spring triticale crops looked different during the years of research. In 2021, the maximum number of aphids in winter triticale crops was observed in the second decade of June, which was associated with the mass reproduction of aphids *Rhopalosiphum padi* L. The most representative species composition of aphids was recorded in the third decade of June, when *Rhopalosiphum padi*, *Sitobion avenae*, *Aphis fabae* Scop., *Macrosiphoniella artemisiae* B.d.F. were detected. In the sowing of spring triticale, there was a consistently low diversity and abundance of aphids in yellow traps throughout the entire observation period (Table 3).

Table 3. Dynamics of species diversity and abundance of aphids in triticale crops in North-West Russia (Leningrad region, 2021).

Culture	Date of registration						
	June 8	June 16	June 23	June 30	July 7	July 15	July 23
Winter triticale	0 0	2 3.3	4 2.3	1 1.0			
Spring triticale					2 0.7	2 0.7	3 1.0

Note: top line – number of species; bottom line – number of individuals, specimen/trap

In 2022, the settlement of winter triticale crops occurred in the first decade of June, when exclusively cherry-grass aphids were detected. Abundance peaked at the beginning of the third decade of June, whereas in spring triticale crops in the second decade of this month. At the same time, a higher species diversity of aphids was noted, which was noticeably removed later. In spring triticale crops, the second wave of aphid number rise was recorded, coming at the end of July and the beginning of August. At that time, the award of the *Sitobion avenae* F., *Anoecia grateful* F., *Aphis fabae* Scop., *Acyrthosiphon pisum* Harr., *Macrosiphoniella tanacetaria* Kalt. was canceled (Table 4).

Table 4. Dynamics of species diversity and abundance of aphids in triticale crops in North-West Russia (Leningrad region, 2022).

Culture	Date of registration									
	May 30	June 7	June 14	June 21	June 27	July 4	July 12	July 19	July 26	August 3
Winter triticale	0 0	1 0.3	2 1.0	2 1.3	2 0.7	1 0.7	2 1.0			
Spring triticale			10 9.3	5 3.0	4 2.0	3 1.3	2 1.0	1 1.0	2 2.7	5 3.3

Note: top line – number of species; bottom line – number of individuals, specimen/trap

4 Discussion

Through the use of yellow water trap, a diverse composition of aphids was identified in triticale crops in Northwestern Russia. To a large extent, it depended on weather conditions, contamination of crops and surrounding biotopes. At the same time, winter triticale crops were inferior to spring triticale in terms of species diversity and abundance of aphids. Taking into account the phenological timing of crop development, the mass reproduction of aphids *Rhopalosiphum padi* L. it usually occurs in the sowing of spring triticale, which can have economically tangible consequences in the form of loss of a certain part of the crop. The remaining aphid species, given their low abundance, do not pose a threat to the triticale crop.

5 Conclusion

The aphid complex on triticale crops was characterized by high species diversity and low abundance. The basis of the complex was composed of cereal aphids, represented by 5 species, among which *Rhopalosiphum padi* L. and *Sitobion avenae* F. were widespread. The development of these species determined the seasonal dynamics of the number of aphids in triticale crops. The presence of other aphid species in triticale crops is due to the presence of weeds, the growth of other crops nearby, woody and shrubby vegetation.

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