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Diversity and sex ratio of thrips (*Thysanoptera*) species in winter wheat in Lithuania

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Abstract

A study on the variation of species diversity and sex ratio of thrips in winter wheat (*Triticum aestivum* L.) was conducted at the Lithuanian Institute of Agriculture (currently – Lithuanian Research Centre for Agriculture and Forestry). Assessments of thrips abundance were carried out from the beginning of tillering (growth stage (GS) 21) until complete maturity (GS 89). Thirteen thrips species belonging to the three families were identified: 10 thrips species belonged to *Thripidae*, 2 to *Phlaeothripidae* and 1 to *Aeolothripidae* families. In terms of the feeding group, one species (*Aeolothrips intermedius*) belonged to zoophagous, the rest of the species were phytophagous. *Frankliniella intonsa*, *F. tenuicornis*, *Haplothrips aculeatus* and *Limothrips denticornis* were the earliest thrips species identified on winter wheat in spring. The dominating species were *L. denticornis* (41.3%), *H. aculeatus* (25.8%) and *F. tenuicornis* (20.5%). An average sex ratio of *L. denticornis* was 84.7%, and of *H. aculeatus* – 68.2%, and of *F. tenuicornis* – 71.1% and of *F. intonsa* – 60.9%.

Key words: cereal thrips, *Frankliniella tenuicornis*, *Haplothrips aculeatus*, *Limothrips denticornis*, *Triticum aestivum*.

Introduction

Wheat (*Triticum aestivum* L.) is a worldwide cultivated cereal crop. Globally, wheat production exceeds that of all other cereal crops (Varshney et al., 2006). In Lithuania, winter wheat also is one of major crops and their importance has been increasing over the past years. If in 2008 the area under winter wheat was 290 thousand hectares, by 2009 it had increased to 397.2 thousand hectares. Many pest species can damage winter wheat and none of winter wheat variety has been found to be fully immune to any of the species (Gaafar et al., 2011) Thrips are very important in the ecosystem. Most of the lately described species are herbivorous and thrips are among the major pests of wheat. On the global scale thrips fauna can cause serious damage to winter wheat (Schröder, 2009), and current methods of control are not fully sufficient to prevent crop damage. About 90 thrips species are economically important. Nine of them (in the genus *Tospovirus*) are plant viruse vectors (Ullman et al., 1997). The dominating species of thrips in winter cereals are more or less the same; however, the data of different authors about the species composition are diverse. According to Zawirska and Wałkowski (2000), *Limothrips denticornis* is a very common and abundant species in Poland. Kąkol and Kucharczyk (2004) have reported that *L. denticornis* and *Haplothrips aculeatus* are most common among the five thrips species in winter and spring wheat. Larsson (1988; 2005) have reported that in Sweden common species in rye are *L. denticornis*, *L. cerealium*, *H. aculeatus*, *Thrips angusticeps* and *Frankliniella tenuicornis*. In Finland, in winter rye and other cereals *L. denticornis*, *H. aculeatus*, *F. tenuicornis* and *Anaphothrips obscurus* were found (Köppä, 1970). A survey of thrips (*Thysanoptera*) in cereals was carried out in south eastern Norway in 1996. No high densities of thrips were recorded. *L. denticornis* and *F. tenuicornis* were the dominating species. *Stenothrips graminum*, which is new to the Norwegian fauna, was also found in abundance. *L. denticornis* reproduced in cereals only to a small extent. *F. tenuicornis* completed two generations, one in winter cereals in June, and a second generation in spring cereals in July (Kobro et al., 2000). Thrips species, *H. tritici*, *H. aculeatus*, *L. denticornis*, *L. cerealium*, *F. tenuicornis* and *T. angusticeps* were recorded on different wheat varieties (Andjus, 1998). Some authors noted that the number of thrips on cereals is increasing (Kąkol, Kucharczyk, 2004). Different thrips species can attack crops in different parts of the world. In Europe, this is very characteristic of cereal thrips (Kobro et al., 2000). In Lithuania thrips are one of the main insect pests in cereal crops (Šmatas, 2007). Thrips occurrence in winter wheat is more than eight-fold lower compared with winter rye (Šmatas, Šurkus, 2005).

Very important in the knowledge of the biotic potential is the sex ratio index of the population. Most species are bisexual, but females are often dominant in field populations (Vasiliu-Oromulu, 2001). In some species, reproduction is partly or wholly parthenogenetic and males are rare or unknown. Sex ratio can be influenced by year, host plant, the latitude (Köppä, 1970; Vasiliu-Oromulu, 2001).

The aim of our investigation was to determine *Thysanoptera* species biodiversity in winter wheat.

Materials and methods

Investigations were carried out at the Lithuanian Institute of Agriculture (currently – Lithuanian Research Centre for Agriculture and Forestry), Department of Plant Pathology and Protection. Investigations on the variation of species diversity and abundance of thrips were carried out in winter wheat according to the same methods as in rye (Šmatas, 2009).

Results and discussion

A total of 1382 adult thrips and 1009 of their larvae were collected and 13 thrips species were indentified in the observation sites. The observed thrips species belonged to three families: Aeolothripidae family – *Aeolothrips intermedius* (Bagnall, 1934), Thripidae family – *Anaphothrips obscurus* (Müler, 1776), *Aptinothrips rufus* (Haliday, 1836), *Aptinothrips stylifer* (Trybom, 1894), *Chirothrips manicatus* (Haliday, 1836), *Frankliniella intonsa* (Trybom, 1895), *Frankliniella pallida* (Uzel, 1895), *Frankliniella tenuicornis* (Uzel, 1895), *Limothrips denticornis* (Haliday, 1836), *Thrips angusticeps* (Uzel, 1895), *Thrips tabaci* (Lindeman, 1888), Phlaeothripidae family – *Haplothrips aculeatus* (Fabricius, 1803), *Haplothrips leucanthemi* (Schrank, 1781) (Tables 1–2). All species found belonged to phytophagous trophic status and only one species (*A. intermedius*) belonged to zoophagous trophic status.

Table 1. Species diversity of adult thrips in winter wheat

Thrips species	Total number of thrips found					
	Females			Males		
	number	spread period	GS	number	spread period	GS
			2002			
Anaphothrips obscurus	27	May III–July I	43–83	0	–	–
Chirothrips manicatus	6	May I, June I–II	32, 69–73	0	–	–
Frankliniella intonsa	17	April III, May II–July I	29–30, 33–77	7	May III–June III	43–75
F. pallida	2	May III, June II	59, 71	0	–	–
F. tenuicornis	77	April III–July II	29–92	29	May III–July I	47–77
Haplothrips aculeatus	192	April III–July II	29–92	61	April III–July II	29–92
H. leucanthemi	1	June II	71	0	–	–
Limothrips denticornis	256	May I–July II	30–92	39	June I–July I	69–83
Thrips tabaci	5	June I,June III	65–69, 75	0	–	–
Total	583			136		
			2003			
Aeolothrips intermedius	1	July II	75	1	July III	83
Anaphothrips obscurus	14	June I, June III–July III	51, 69–87	0	–	–
Aptinothrips rufus	2	July I	73–75	0	–	–
A. stylifer	2	July I	73–75	0	–	–
Chirothrips manicatus	4	July I–III	73–83	0	–	–
Frankliniella intonsa	29	May II, June I–July III	29, 45–85	28	June II–III, July II–III	55–73, 75–85
F. pallida	15	June I–July III	43–83	0	–	–
F. tenuicornis	123	May II, June I–July III	29, 45–83	54	June II–July III	55–83
Haplothrips aculeatus	65	May II–August I	30–89	39	May III–June II, July I, July III–August I	32–69, 73, 77–89
Limothrips denticornis	228	May I–August I	29–89	48	June II–July II	69–77
Thrips angusticeps	2	June III	73	0	–	–
T. tabaci	8	June I–II, July II	47–65, 75–77	0	–	–
Total	493			170		

I, II, III – ten-day periods, GS – growth stage

The most numerous species each year was *L. denticornis* reaching as many as 41.0% of all specimens collected in 2002, and 41.6% in 2003. This species also was the most numerous (79.3%) in winter rye in Lithuania (Šmatas, 2009). *L. denticornis* is the second numerous species in winter cereals in Poland and according to various authors constitute 19.3% (Szeflińska, 2005) – 27.6% (Zawirska, Wałkowski, 2000) of all individuals found in rye. In Yugoslavia *L. denticornis* is the main species on barley (Andjus, 1998). In North Europe and North America *L. denticornis* is one of main thrips species in rye (Mound, 1997), but other authors (Buntin, Beshear, 1995) did not find *L. denticornis* in rye in North America at all. According Polish sources in spring, the females of *L. denticornis* appear in the field very early (Zawirska, Walkowski, 2000). According our experiments it also seems true. They were the earliest species of thrips found on winter wheat in spring 2003 and in spring 2002 they appeared also early. First *L. denticornis* females in spring were found from the first decade of May in both experimental years.

H. aculeatus and *F. tenuicornis* appeared in winter wheat field ten days earlier in 2002 and at the same time as *L. denticornis* in 2003 and were the second dominating species (35.2–14.7% in 2002 and 15.7–26.7% in 2003). Šmatas (2009) has reported that *H. aculeatus* is the second and *F. tenuicornis* the third dominating species in winter rye. In Poland, *H. aculeatus* is the main species on rye and constitutes 65.2% (Zawirska, Wałkowski, 2000). This disagrees with the data of Szeflińska (2005) who has indicated that this species takes the third place and constitutes 12.2% of all thrips found on rye. In Finland, *H. aculeatus* takes the fourth place and it is often found on rye and winter wheat Köpä (1970). In North Europe, *H. aculeatus* is one of the six most important thrips on rye (Mound, 1997). It seems that particularly in Lithuania *F. tenuicornis* can be as numerous as *H. aculeatus* in winter wheat. Other authors (Kąkol, Kucharczyk, 2004; Szeflińska, 2005) also found *F. tenuicornis* and *H. aculeatus* on rye or other cereals. Zawirska and Wałkowski (2000) call *F. tenuicornis* "cereal" thrips. The abundance of this species in their

investigations in rye was 0.8%. *A. obscurus* constituted 2.1–3.8%, *F. intonsa* – 3.3–8.6% and other species – less than 2.5%. Simpson's index is heavily weighted towards the most abundant species in the sample while being less sensitive to species richness (Magurran, 1988). The Simpson diversity index was sufficiently high 0.68 and 0.72 in 2002 and 2003, respectively. That means the diversity of thrips species in winter wheat was high.

Table 2. Species diversity of adult thrips and their total number in winter wheat

Thrips species	Total number of thrips found					
	2002		2003		2002–2003	
	number	%	number	%	number	%
Aeolothrips intermedius	0	0	2	0.3	2	0.1
Anaphothrips obscurus	27	3.8	14	2.1	41	3.0
Aptinothrips. rufus	0	0	2	0.3	2	0.1
A. stylifer	0	0	2	0.3	2	0.1
Chirothrips manicatus	6	0.8	4	0.6	10	0.7
Frankliniella intonsa	24	3.3	57	8.6	81	5.9
F. pallida	2	0.3	15	2.3	17	1.2
F. tenuicornis	106	14.7	177	26.7	283	20.5
Haplothrips aculeatus	253	35.2	104	15.7	357	25.8
H. leucanthemi	1	0.1	0	0	1	0.1
Limothrips denticornis	295	41.0	276	41.6	571	41.3
Thrips angusticeps	0	0	2	0.3	2	0.1
T. tabaci	5	0.7	8	1.2	13	0.9
Total	719		663		1382	
Simpson index	0.68		0.72		0.72	

The larvae of the thrips found also were identified (Table 3). In the winter wheat, the prevalent genus was *Haplothrips* spp. (accounted for 64.4% and 37.4% in 2002 and 2003, respectively of the total content of thrips larvae). *Limothrips* spp. larvae constituted on average 34.9 and 9.0 in 2002 and 2003, respectively. More than half (53.4%) specimens in 2003 consisted of all other species. The *Limothrips* spp. larvae were found from flowering to fruit development stages each year. The *Haplothrips* spp. larvae spread for a longer period compared with *Limothrips* spp. larvae – to full ripening stages.

Table 3. Genus diversity of thrips larvae and their total number in winter wheat

Thrips genus	Total number of thrips larvae found			
	number	spread period	GS	%
	2002			
Haplothrips spp.	356	June I–July II	65–92	64.3
Limothrips spp.	39	June I–II	65–73	7.0
Other thrips larvae	159	May I–July I	32–77	28.7
Total	554			
	2003			
Haplothrips spp.	170	June II–August I	69–89	37.4
Limothrips spp.	42	June II–July I	61–75	9.2
Other thrips larvae	243	May III, June II–July III	37, 55–85	53.4
Total	455			

I, II, III – ten-day periods, GS – growth stage

Sex ratio of free-living phytopagous thrips such as those found on crops, herbacious plants, and flowers is low, despite the fact that these species are among more obvious and well studied representatives of the order (Wrensch, Ebbert, 1993). According to investigations carried out by Sęczkowska (1970), the percent of males hatched is a little higher than that of females, but the number of adult females is higher than males. The researcher indicates that high natural mortality rate of males after copulation is responsible for this. Vasiliu-Oromulu (2001) explains this by the influence of the latitude. Köpä (1970) claims that sex ratio of *L. denticornis* can markedly differ between years. In our study, sex ratio of all collected thrips was 81.1% in 2002 and 74.4% in 2003. Šmatas (2009) determined that sex ratio of *L. denticornis* on rye in Lithuania was 59.9–64.5%. Köpä (1970) found that sex ratio of *L. denticornis* on rye is higher – on average 72% and 83–93% on other crops. This agrees with our data for winter wheat where sex ratio of *L. denticornis* was 86.8% in 2002 and 82.6% in 2003. Sex ratio for *H. aculeatus* was 73.8% in 2002 and 62.5% in 2003. The same sex ratio level (65.1–73.4%) was found in winter rye (Šmatas, 2009). In our study, sex ratio of *F. intonsa* was 70.8% in 2002 and 50.9% in 2003. Sex ratio of *F. tenuicornis* was 72.6% in 2002, and 69.5% in 2003. Sex ratio of *F. tenuicornis* was much higher (78.3–97.8%) in winter rye (matas, 2009). In our trials males of *A. obscurus*, *C. manicatus*, *F. palida* and *T. tabaci* were not found at all, while females were found in both years. Sex ratio of other species found cannot be determined with certainty because of the sparsity of this species.

Conclusions

1. Among the 13 thrips species belonging to three thrips families in winter wheat there were 10 thrips species of *Thripidae* family, 2 species of *Phlaeothripidae* family and 1 species of *Aeolothripidae* family. Twelve species were phytophagous and one species (*Aeolothrips intermedius*) was zoophagous.

2. The predominant species in winter wheat were *Limothrips denticornis* (41.3%), *Haplothrips aculeatus* (25.8%) and *Frankliniella tenuicornis* (20.5%).

3. *Limothrips denticornis* was the earliest thrips species found on winter wheat in spring in 2003 and the second earliest in spring 2002.

4. An average sex ratio was: 84.7% of *L. denticornis*, 68.2% of *H. aculeatus*, 71.1% of *F. Tenuicornis*, and 60.9% of *F. intonsa*.

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Tripsų (*Thysanoptera*) rūšių įvairovė ir lyčių santykis Lietuvoje auginamuose žieminiuose kviečiuose

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Santrauka

Tripsų rūšinės sudėties ir lyčių santykio žieminio kviečio (*Triticum aestivum* L.) pasėlyje tyrimai atlikti 2002–2003 m. Lietuvos žemdirbystės institute. Tripsų gausumo žieminiuose kviečiuose stebėjimai pradėti javų krūmijimosi pradžioje (GS 21), baigti visiškos brandos tarpsniu (GS 89). Žieminiuose kviečiuose rasta 13 tripsų rūšių, kurios priklausė trims šeimoms: dešimties rūšių tripsai priklausė *Thripidae*, dviejų – *Phlaeothripidae* ir vienos – *Aeolothripidae* šeimoms. Pagal mitybinę grupę iš rastų 13-os rūšių tripsų *Aeolothrips intermedius* priklausė zoofagams, likusios – fitofagams. Žieminių kviečių pasėlyje anksčiausiai pradėjo plisti *Frankliniella intonsa*, *F. tenuicornis*, *Haplothrips aculeatus* ir *Limothrips denticornis* rūšių tripsai. Sezono metu vyravo *L. denticornis* (41,3 %), *H. aculeatus* (25,8 %) ir *F. tenuicornis* (20,5 %) rūšių tripsai. *L. denticornis* rūšies tripsų lyčių santykis buvo 84,7 %, *H. aculeatus* – 68,2 %, *F. tenuicornis* – 71,1 %, *F. intonsa* – 60,9 %.

Reikšminiai žodžiai: *Frankliniella tenuicornis*, *Haplothrips aculeatus*, javiniai tripsai, *Limothrips denticornis*, *Triticum aestivum*.