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Thrips species associated with cereals of the Lakes Region of Turkey with new records

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ABSTRACT

This study was carried out to determine the Thysanoptera species in the cereal production areas in the Lakes Region of Turkey, in 2016 and 2017. Thrips samples were collected at two different periods of cereal crops, before and after the spike stage. Destructive sampling and strike methods were used to obtain thrips species. The individuals were mounted on slides with Canada balsam for morphological characterisation. As a result of this study, a total of 51 species were identified including 9 species belonging to Tubulifera and 42 species belonging to Terebrantia. The most abundant species were *Haplothrips tritici* (Kurdjumov 1912) (58.25%), *Collembolothrips mediterraneus* Priesner 1935 (8.29%), *Thrips angusticeps* Uzel 1895 (6.61%), and *Limothrips cerealium* Haliday 1836 (4.31%). The most common species were *H. tritici*, *T. angusticeps*, *L. cerealium*, *Aeolothrips intermedius* Bagnall, 1934 and *Aptinothrips stylifer* Trybom, 1894. Three species were first recorded for Turkish fauna: *Tylothrips osborni* (Hinds), *Mycterothrips sanubari* Alavi Modarres Awal Fekrat & Minaei and *Tenothrips hispanicus* (Bagnall).

1. Introduction

The Lakes Region includes Afyonkarahisar, Antalya, Burdur, Konya, and Isparta in the west of the Mediterranean Region. Due to the coexistence of water and terrestrial ecosystems, it has a wide variety of fauna and flora. Cereals provide an important contribution to the Turkish economy in agricultural production, nutrition, domestic and foreign trade (Kızılaslan 2004). While Turkish cereal production in 2019 was 64588157 tonne, the Lakes Region cereal production was 1723972 tons, of which 441275 and 435768 tons are wheat and barley respectively (TUIK 2020). There are many important pests belonging to different insect groups, which cause economic loss in cereal crops are the main food source for humanity. Among these groups, thrips (Thysanoptera) are with about 6000 species (classified into two suborders, Terebrantia and Tubulifera), which are not well known by the farmers (Smith-Pardo and O'Donnell 2015). Thrips usually feed under the sheath of the flag leaves, on the stem, on the leaves and spikes. In the case of intensive contamination, adults and nymphs cause damage in the form of silvery staining as they feed on tissues and suck cell contents (Larsson 2005; Gaafar and Volkmar 2010). It has been reported that thrips feeding in fresh wheat grains may cause deformation, shedding and shrinkage in the grains (Lewis 1973). The economic damage threshold for thrips (*Limothrips* spp. and *Haplothrips* spp.) in cereals in Europe has been reported to be 5-10 thrips/spike (Seidel et al. 1983) and more than 30 nymphs and adults/spikes (Freier et al. 1982; Cuthbertson 1989; Parrella and Lewis 1997). Numerous faunistic studies have been conducted to reveal the insect biodiversity in the Lakes Region. However, there are just a few studies on determining Thysanoptera species found on cereals (Tunç et al. 2012a, 2012b; Demirözer and Bilginturan 2014). The aim of this study is to determine the Thysanoptera species in the areas where cereal production is extensive, in the Lakes Region, and to ascertain the distribution and incidence rates of these species in detail.

2. Materials and methods

Strike (Bacci et al. 2008) and destructive sampling methods (Demirözer and Bilginturan 2014) were used to collect thrips individuals from provinces and districts dependent on the cereal production capacity in the Lakes Region. Samplings were carried out in 2 periods; before spike (period starting from 15-20 cm plant height until spike formation) and after spike stage, in commercial cereal production fields of the Lakes Region, in March-June 2016-2017.

The number of fields to be sampled was determined depending on the cereal cultivated area capacity of each province of the Lakes Region including Afyonkarahisar (Dinar, Dazkırı), Antalya (Korkuteli), Burdur, Konya (Beyşehir), and Isparta. For this purpose, the scale included cultivated area (decare)/number of sampling locations was used (under 5 decares <5 sampling locations; 100-250 decares range, 10-15 sampling locations; on 250 decares, 15-25 sampling locations) (Uzun 2020) (Table 1).

Table 1. The locations where sampling was carried out in 2016 and 2017 in the grain production areas of the Lakes Region, the number of fields sampled and survey date

Province	District	Number of sampled fields in 2016	Survey date (BS/AS)	Number of sampled fields in 2017	Survey date (BS/AS)
Isparta	Yalvaç	13	27.04.2016/12.06.2016	6	26.04.2017/8.06.2017
	Şarkikaraağaç	7	11.05.2016/12.06.2016	4	26.04.2017/8.06.2017
	Gelendost	9	6.04.2016/18.06.2016	5	26.04.2017/8.06.2017
	Keçiborlu	5	7.05.2016/15.06.2016	3	20.04.2017/18.05.2017
	Gönen	3	7.05.2016/15.06.2016	3	20.04.2017/18.05.2017
	Merkez	3	27.05.2016/22.06.2016	3	4.05.2017/11.06.2017
	Senirkent	5	23.04.2016/19.06.2016	4	20.04.2017/18.05.2017
	Atabey	3	27.05.2016/22.06.2016	3	27.04.2017/7.06.2017
	Eğirdir	3	6.04.2016/18.06.2016	3	27.04.2017/7.06.2017
	Aksu	3	12.05.2016/25.06.2016	3	4.05.2017/11.06.2017
	Sütçüler	3	12.05.2016/25.06.2016	3	4.05.2017/11.06.2017
	Uluborlu	5	23.04.2016/19.06.2016	4	20.04.2017/18.05.2017
	Yenişarbademli	3	12.05.2016/25.06.2016	-	-
Burdur	Bucak	5	26.05.2016/21.06.2016	4	23.04.2017/17.05.2017
	Gölhisar	4	25.05.2016/16.06.2016	4	11.05.2017/15.06.2017
	Merkez	4	18.05.2016/17.06.2016	3	10.05.2017/14.06.2017
	Tefenni	3	18.05.2016/17.06.2016	3	10.05.2017/14.06.2017
	Yeşilova	4	18.05.2016/17.06.2016	3	10.05.2017/14.06.2017
	Kemer	3	26.05.2016/21.06.2016	3	11.05.2017/15.06.2017
	Çavdır	4	25.05.2016/16.06.2016	3	11.05.2017/15.06.2017
	Karamanlı	3	18.05.2016/17.06.2016	3	10.05.2017/14.06.2017
	Çeltikçi	3	26.05.2016/21.06.2016	3	13.05.2017/25.05.2017
	Altınyayla	3	25.05.2016/16.06.2016	3	11.05.2017/15.06.2017
	Ağlasun	3	26.05.2016/21.06.2016	3	13.05.2017/25.05.2017
Antalya	Korkuteli	16	20.04.2016/5.06.2016	9	23.04.2017/17.05.2017
Konya	Beyşehir	9	14.05.2016/18.06.2016	7	27.04.2017/7.06.2017
Afyon	Dazkırı	6	15.05.2016/15.06.2016	3	14.05.2017/3.06.2017
	Dinar	4	15.05.2016/15.06.2016	3	14.05.2017/3.06.2017
Total	**28**	**139**		**101**	

-: Absent

2. 1. Destructive sampling method

In both periods (BS and AS), the part of the plant remaining above of the soil was cut from randomly selected plants that were taken as 100-150 number depending on the size of the production area and then the label information was placed on the polyethylene bags (5 L) in which a paper towel was placed. The plant materials were brought to the laboratory and kept in a refrigerator at 4°C for 1 hour to slow down the movement of the thrips individuals. Adult individuals were collected with the help of a mouth aspirator and fine brush.

2.2. Strike method

Sampling was also made in the two periods mentioned above. For a sampling area, a total of 50-100 strokes were made into a white tub in both plant growth periods (Bacci et al. 2008). Individuals falling into the white container were taken to the Falcon tubes (50 ml) with the help of a mouth aspirator and brought to the laboratory with their label information.

Thrips individuals obtained by both sampling methods were separated under stereo-microscope (Leica S8 APO, 80X) and transferred to eppendorf tubes containing 70% ethyl alcohol for morphological diagnosis.

2.3. Morphological identification

Thrips specimens were separated under a binocular microscope (Nicon Eclipse E100, 40X) and slides of specimens were prepared according to Gibb and Oseto (2006). Morphological identification of prepared thrips slides was made by various keys, such as Mound et al. (1976) and zur Strassen (2003). All identifications were confirmed by the third author.

3. Results

Thrips species were collected from 240 points in total and the majority of these points (76%) came from Burdur (30.8%) and from Isparta (45.4%). In addition, 41% of thrips individuals in the Lakes Region were detected in Isparta and 29% in Burdur. Other sampling areas remained below 14%.

As a result of this study, a total of 51 thrips species, 42 species belonging to Terebrantia, and 9 species belonging to Tubulifera were identified (Table 2). It was determined that the most abundant species were *H. tritici* (58.25%), *C. mediterraneus* (8.29%), *T. angusticeps* (6.61%), and *L. cerealium* (4.31%). In addition, the most common species were also *H. tritici* (94%), *T. angusticeps* (59%), *L. cerealium* (44%), *A. intermedius* (38%) and *A. stylifer* (37%). According to the 2016 data, 58.6% of thrips individuals collected from cereal production areas were Tubulifera and 41.3% were species related to Terebrantia. In 2017, the second year of the study, it was determined that 62.4% of the thrips species collected consisted of Tubulifera and 37.5% were species belonging to Terebrantia. The incidence rates of Thysanoptera species in the cereal production areas of Lakes Region are listed as Isparta (41.19%), Burdur (29.98%), Antalya (13.35%), Konya (10.05%), and Afyonkarahisar (5.44%).

Table 2. Thysanoptera species identified in the cereal production areas of the Lakes Region

Sub-order	Family	Genus	Species	Host	
				2016	2017
Terebrantia	Aeolothripidae	*Aeolothrips*	*Aeolothrips collaris* Priesner 1919•	Barley, wheat, oat	-
			Aeolothrips intermedius Bagnall 1934•	Barley, wheat, oat	Barley, wheat, oat
			Aeolothrips priesneri Knechtel 1923•	Wheat, oat	-
		Rhipidothrips	*Rhipidothrips brunneus* Williams 1913•	Barley, wheat, oat	Barley, wheat, oat
			Rhipidothrips gratiosus Uzel 1895•	Barley, wheat, oat	Barley, wheat, oat
	Melanthripidae	*Melanthrips*	*Melanthrips pallidior* Priesner 1919▲	Barley, wheat, oat	Barley, wheat
			Melanthrips trifasciatus Priesner 1961▲	-	Wheat
	Thripidae	*Anaphothrips*	*Anaphothrips obscurus* (Muller 1776)▲	Barley, wheat, oat	Barley, wheat, oat
		Aptinothrips	*Aptinothrips stylifer* Trybom 1894▲	Barley, wheat, oat	Barley, wheat, oat
			Aptinothrips elegans mediterranea▲	Barley, wheat, oat	Barley, wheat, oat
		Chirothrips	*Chirothrips aculeatus* Bagnall 1927▲	Oat	Barley
			Chirothrips africanus Priesner 1932▲	Barley, wheat, oat	-
			Chirothrips manicatus Haliday 1836▲	Wheat	-
		Collembolothrips	*Collembolothrips mediterraneus* Priesner 1935▲	Barley, wheat, oat	Barley, wheat, oat
		Frankliniella	*Frankliniella intonsa* (Trybom 1895)▲	Barley, wheat, oat	Barley, wheat
			Frankliniella occidentalis (Pergande 1895)▲	Barley, wheat, oat	Barley, wheat, oat
			Frankliniella pallida (Uzel 1895)▲	Barley, wheat, oat	-
			Frankliniella tenuicornis (Uzel 1895)▲	Barley, wheat, oat	-
		Isoneurothrips	*Isoneurothrips australis* Bagnall 1915▲	Wheat	-
		Limothrips	*Limothrips angulicornis* Jablonowski 1894▲	Barley, wheat, oat	Barley, wheat
			Limothrips cerealium Haliday 1836▲	Barley, wheat, oat	Barley, wheat, oat
			Limothrips denticornis Haliday 1836▲	Wheat	-
			Limothrips transcaucasicus Sawenko 1944▲	Barley, wheat, oat	Barley, wheat
		Mycterothrips	*Mycterothrips sanubari* Alavi Modarres Awal Fekrat & Minaei*,▲	Wheat	-
		Neohydatothrips	*Neohydatothrips gracilicornis* (Williams 1916) ▲	Barley, wheat, oat	Barley, wheat
		Odontothrips	*Odontothrips aemulans* Priesner 1924▲	Wheat	
		Oxythrips	*Oxythrips ajugae* Uzel 1895▲	Wheat, oat	-
			Oxythrips priesneri Pelikan 1957▲	Barley, wheat	-
			Oxythrips uncinatus Priesner 1940▲	Barley	-
		Pezothrips	*Pezothrips bactrianus* (Pelikan 1968)▲	Barley	-
		Sitothrips	*Sitothrips arabicus* Priesner 1931▲	Barley, wheat, oat	Barley, wheat
		Tenothrips	*Tenothrips anatolicus* (Priesner 1961)▲	Barley	-
			Tenothrips hispanicus (Bagnall) *,▲	Wheat	-
		Thermothrips	*Thermothrips mohelensis* Pelikan 1949▲	Wheat	-
		Thrips	*Thrips angusticeps* Uzel 1895▲	Barley, wheat, oat	Barley, wheat, oat
			Thrips dubius Priesner 1927▲	Barley, wheat	-
			Thrips flavus Schrank 1776▲	Barley, wheat, oat	-
			Thrips hawaiiensis (Morgan 1913) ▲	Barley	-
			Thrips linarius Uzel 1895▲	Oat	-
			Thrips major Uzel 1895▲	Barley, oat	-
			Thrips meridionalis (Priesner 1926) ▲	Barley, wheat, oat	Barley, wheat, oat
			Thrips pillichi Priesner 1924▲	Barley, wheat	-
			Thrips hawaiiensis (Morgan 1913)▲	Barley	-
Tubulifera	Phlaeothripidae	*Haplothrips*	*Haplothrips acanthoscelis* (Karny 1910)▲	Barley, wheat	-
			Haplothrips bolacophilus Priesner 1938▲	Barley, wheat, oat	-
			Haplothrips distinguendus (Uzel 1895)▲	Barley, wheat, oat	Barley, wheat
			Haplothrips flavicinctus (Karny 1910)▲	Barley	Wheat
			Haplothrips knechteli Priesner 1923▲	Barley, wheat	Barley, wheat
			Haplothrips reuteri (Karny 1907)▲	Barley	-
			Haplothrips tritici (Kurdjumov 1912)▲	Barley, wheat, oat	Barley, wheat, oat
		Neoheegeria	*Neoheegeria dalmatica* Schmutz 1909▲	Barley	-
		Tylothrips	*Tylothrips osborni* (Hinds)*,▪	Wheat	-

-: Absent/ *new record for Turkey ▪Mycophagus ▲Phytophagous • Predator.

4. Discussion

The first systematic study for Thysanoptera fauna species in Turkey was carried out by Bagnall (1934). Thysanoptera's first inventory in Turkey was completed by Lodos (1993) and reported 154 thrips species in a catalogue. Tunç et al. (2012b) identified a total of 74 thrips species, 45 of which were determined for the first time in this region, within the scope of their study between 1990-1992, in order to determine the Thysanoptera fauna in the Lake Region. The most common and abundant species in this study were *Thrips meridionalis* Priesner 1926 (92-437 individuals), *Thrips tabaci* Lindeman 1889 (137-412 individuals), *Haplothrips reuteri* Karny 1907 (130-489 individuals) on different host groups. *Frankliniella tenuicornis* Uzel 1895, *Limothrips denticornis* Haliday 1836, *Limothrips transcaucasis* Sawenko, 1944 also were determined on barley, *Chirothrips manicatus* Haliday 1836 on barley and oats, *H. tritici* on wheat, barley and oats. Demirözer and Bilginturan (2014) determined the insect species found in the cereal production areas of the Lakes Region and identified 8 species including *H. tritici*, *F. tenuicornis*, *Aeolothrips collaris* Priesner, *A. intermedius*, *T. angusticeps*, *L. denticornis* and *Sitothrips arabicus* Priesner. The above-mentioned species were also found in our study. In studies conducted on cereal production areas in different countries in Europe, the most common or abundant species were reported to be *L. cerealium*, *L. denticornis*, *F. tenuicornis*, *Anaphothrips obscurus* (Muller), *T. angusticeps*, *Haplothrips aculeatus* (Fabricius) and *H. tritici* (Johansen 1938; Franssen and Huisman 1958; Franssen and Mantel 1963, 1965; Holtmann 1963; Lattauschke and Wetzel 1985; Larsson 2005; Šmatas 2009; Šmatas et al. 2013; Virteiu et al. 2015; Parnea et al. 2018). *Haplothrips tritici* (94%), *T. angusticeps* (59%), *L. cerealium* (44%) were the most common species in our study. However, *H. tritici* was the most abundant species (58.25%). In the current study three species, *Tylothrips osborni* (Hinds), *Mycterothrips sanubari* Alavi Modarres Awal Fekrat & Minaei and *T. hispanicus* (Bagnall) were the first time recorded for Turkish Thysanoptera fauna. *Tylothrips osborni* was reported from Massachusetts, New York State, Illinois, Florida, Cuba, Panama, Trinidad, Spain, Italy, and Germany (Mound 1977; Goldarazena and Mound 1998; de Marzo and Ravazi 2007; Ulitzka 2013, 2021). *Tenothrips hispanicus* has also been identified in Iran, Spain, Italy, Corsica, Greece, Albania, Rumania, Hungary, Georgia, Transcaucasia, Morocco (Bhatti 2003; Afsharizadeh Bami and Minaei 2020). *Mycterothrips sanubari* was recorded in Iran (Alavi et al. 2013). In addition, of the 51 species obtained, *T. osborni* is mycophagus, *A. collaris*, *A. intermedius*, *A. priesneri*, *R. brunneus*, and *R. gratiosus* are predator species. The remaining species are phytophagous which constitute 88.2% of all species.

In comparison to the PhD dissertation of the first author (Uzun 2020), the report of *Oxythrips retamae* (Priesner) and *Thrips herricki* could not be verified at present, due to insufficient materials. Furthermore, reports of *Neoheegeria sinaitica* Priesner, *Hoplothrips caespitis* (Uzel) and *Pezothrips frontalis* (Uzel) (Uzun 2020) are misidentifications of *Neoheegeria dalmatica* Schmutz, *Tylothrips osborni* (Hinds) and *Tenothrips hispanicus* (Bagnall) respectively. Also, although *Mycterothrips sanubari* Alavi Modarres Awal Fekrat & Minaei was not identified in the previous study (Uzun 2020), it is included in the current study. Additionally, *Aptinothrips stylifer* Trybom was considered to be the first record for Turkish insect fauna by Uzun (2020), however, it has been reported the first time in Turkey without specifying the coordinates by Tunç and Hastenpflug-Vesmanis (2016).

5. Conclusion

The results of this study have contributed to the Thysanoptera database of Turkey. Among 51 species that were identified in this research, there are some that have economic importance and need careful consideration.

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