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Research Article

POPULATION FLUCTUATIONS OF *Haplothrips tritici* (Kurdjumov, 1912) (THYSANOPTERA: PHLAEOTHRIPIDAE) IN WHEAT AND BARLEY FIELDS IN ISPARTA, TURKEY

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Abstract: Population fluctuation monitoring of wheat thrips *Haplothrips tritici* (Kurdjumov, 1912) (Thysanoptera: Phlaeothripidae) was evaluated on the Tosunbey (wheat) and Tarım92 (barley) cultivars by weekly samplings from plant emergence to the harvest season in 2016 and 2017 in Isparta (Center). Adult and nymphal stages of individuals were collected using direct sampling and shake-out methods. In the direct sampling method, the plant was cut from the above-ground part and brought to the laboratory in polyethylene bags. In the shake-out method, thrips individuals were forced to fall into a white container by making 50 strikes (totally) to the plants, were taken into the eppendorf tubes containing 70% alcohol with the help of a mouth aspirator. The thrips nymphal and adults were separated under a stereomicroscope and their presence numbers were recorded. The population of *H. tritici* (adult, nymph and egg stages) on Tosunbey wheat variety reached to high numbers with 28.77 and 8.85 specimens/ear on June 13 in 2016 and 2017, respectively. The highest numbers on Tarım92 barley variety was recorded as 3.22 and 3.2 specimens/ear on June 13 in 2016 and on May 25 in 2017, respectively. It is thought that the decrease in thrips population density in 2017 may be due to the number of rainy days in 2017 compared to 2016.

Özet: Ekin tripsi *Haplothrips tritici* (Kurdjumov, 1912) (Thysanoptera: Phlaeothripidae)'nin popülasyon dalgalanmasının takibi, Tosunbey (arpa) ve Tarım92 (buğday) çeşitleri üzerinde bitki çıkışından üretim sezonunun sonuna kadar haftada bir kere örnekleme yapılarak 2016 ve 2017 yıllarında Isparta (Merkez)'da gerçekleştirilmiştir. Ergin ve ergin öncesindeki bireyler doğrudan örnekleme ve silkme yöntemleri kullanılarak toplanmıştır. Doğrudan örnekleme yönteminde bitki toprak üstü aksamından kesilerek alınmış ve polietilen torbalara aktarılarak laboratuvara getirilmiştir. Silkme yönteminde ise bitkilere 50 kez vuruş (toplam) yapılarak beyaz küvete düşen trips bireyleri ağız aspiratörü yardımıyla %70 alkol içeren eppendorf tüplere alınmıştır. Trips nimf ve erginleri, laboratuvarda stereo mikroskop altında ayrılmış ve bireyler kaydedilmiştir. Tosunbey buğday çeşidinde *H. tritici* popülasyonu (ergin, nimf ve yumurta dönemleri) üretim sezonu boyunca hem 2016 hem de 2017 yılında 13 Haziran'da sırasıyla 28,77 ve 8,85 birey/başak olarak en yüksek sayılara ulaşmıştır. Tarım92 arpa çeşidinde ise, 2016 yılında 13 Haziran'da en yüksek sayılara ulaştığı (3,22 birey/başak), 2017 yılında 25 Mayıs'ta en yüksek sayıya ulaştığı (3,2 birey/başak) belirlenmiştir. 2017 yılında trips popülasyon yoğunluğunun azalmasının 2017 yılında 2016 yılına göre daha fazla yağışlı gün yaşanması nedeniyle olabileceği düşünülmektedir.

Introduction

Haplothrips Amyot & Serville is known as the largest genus of Phlaeothripidae (Thysanoptera) with about 230 described species. These species are widespread in the northern hemisphere and nearly 70% of them have been recorded in the Holoarctic Region (Kucharczyk *et al*. 2012). The wheat thrips *Haplothrips tritici* (Kurdjumov, 1912) is a major pest of wheat and barley in cereal cultivated areas in Western Europe and Asia combined, Eastern Europe and North Africa (Özsisli 2011, Minaei & Mound 2014) and it causes major damage in the east and southeast of the Palearctic region during hot summer conditions (Czencz 1994). *Haplothips tritici* has also been identified as a common or dominant species in wheat and barley production areas in different parts of the world (Kamangar & Radjabi 2000, Alavi *et al*. 2007, Benmessaoud-Boukhalfa *et al*. 2010, Minaei & Mound

2010, Karadjova & Krumov 2015, Vîrteiu *et al*. 2018). In cereals, thrips are generally feed under the sheaths of flag leaves, on the stem, on leaves and ears. In case of intensely increased number of adults and nymphs, they cause damage in the form of silvery as they suck up the cell contents of the plant parts they feed on (Larsson 2005, Gaafar & Volkmar 2010). When feeding on fresh wheat grains, they cause deformation, shedding and shrinkage of the grains (Lewis 1973). In Europe, the threshold for economic damage level for *Haplothrips* spp. has been reported as 5-10 thrips/ear and more than 30 nymphs and adults/ear (Freier *et al*. 1982, Seidel *et al*. 1983, Cuthbertson 1989, Parrella & Lewis 1997). *Haplothrips tritici* is among the most common and abundant species recorded in studies carried out in the Mediterranean region and Lakes Region cereal cultivation areas in Turkey (Özsisli 2011, Tunç *et al*. 2012a, Tunç *et al*. 2012b, Demirözer & Bilginturan 2014, Uzun 2020). The small sized bodies of thrips (usually around 1-2 mm), their hiding behavior and feeding habits on grains of cereals make it more difficult to succesfully manage these pests (Vierbergen & Mantel 1991, Gao *et al*. 2012, Nachappa *et al*. 2020). For the reasons listed above, there are very few detailed studies on this harmful species. This study aims to contribute to its control by determining the population density of this species in field conditions. Barley and wheat production is widespread in Isparta and the population fluctiation of wheat thrips in the conditions of Isparta was evaluated in the present study.

Materials and Methods

The population change of *H. tritici* was monitored by weekly samples taken between March and June of 2016-2017. The samplings were performed in the fields of Isparta University of Applied Sciences, Education, Research and Application Farm in Turkey where Tosunbey (wheat) and Tarım92 (barley) varieties were grown. Plant protection application has not been made in both of study areas (1.5 decares) and sampling was done as weekly. Two sampling methods, direct sampling and shake-out method, were used together to obtain the adult and nymphal stages of the thrips species.

Direct sampling method

The direct plant sampling was carried out from the period when the plant height was 15-20 cm in the pre-ear period (March in 2016, April in 2017) until the pre-harvest period (June in 2016 and 2017). In the pre-ear period, 50 randomly selected plants were cut from above-ground parts and placed into polyethylene bags (5 L) by adding label information (Demirözer & Bilginturan 2014). During the ear period, 50 randomly selected ears were sampled and placed into polyethylene bags. Paper towels were put in bags for both samplings in order to absorb humidity All samples were brought to the laboratory and kept in a refrigerator at +4 °C for 1 hour to slow down the movements of the thrips. Samples were placed into a white container and the nymphal and adult stages under the leaf sheaths and in the ear were transferred to eppendorf tubes containing 70% alcohol. The separation of nymphal and adult stages were performed under a stereo microscope (Leica S8APO, 8X) and the numbers of each stage were recorded. The eggs of the thrips were also taken from the plants with the help of a fine brush and put into eppendorf tubes containing 70% alcohol.

Shake-out method

The sampling in the pre-ear and post-ear periods was carried out by the shake-out method. Sampling was done every week during the production season. A total of 50 strikes (one strike/per plant) with the help of a 30 cm plastic stick were made into a white container on randomly selected plants for each variety (barley and wheat). Thrips specimens were ensured to fall by shaking the plant towards the white container. The specimens that fell into the container were collected with the help of a mouth aspirator and transferred to eppendorf tubes containing 70% alcohol (Bacci *et al*. 2008). Nymphal and adult stages were counted under a stereo microscope (Leica S8APO, 8X) and respective numbers were recorded. Eggs were not obtained with this sampling method.

Morphological identification

The specimens distinguished under a stereomicroscope were kept in 10% NaOH for 45 minutes and then were stored in 70% ethanol for 20 hours. The samples were transfered into 80%, 90%, and 100% alcohol for certain periods, respectively, and then placed into clove oil for 30 minutes. The samples extracted from clove oil were placed onto a slide on which a drop of Canada balsam was droped and the final shaping was done and a 12 mm coverslip was placed on it (Gibb & Oseto 2006). The prepared thrips slides were kept in an oven at 42°C for six weeks and dried. Identification of *H. tritici* specimens was done according to Benmessaoud-Boukhalfa *et al*. (2010), and Minaei & Mound (2010).

Results

The adult female population in Tosunbey cultivar reached the highest number (3.66 specimens/ear) on May 30, which coincides with the beginning of the ears by direct sampling in 2016. The adult female population reached its highest number (5.76 specimens/ear) on June 5 in 2017. The adult male population varied between 0.02 and 0.7/ear in 2016, it reached high value on May 15. In 2017, the male population were 0.57/ear on June 2. The first stage nymphs were first seen on May 30, while their populations reached the highest level (3.47 specimens/ear) on June 9 in 2016. Second nymphal stage first started to be seen on June 9, while the population of second nymphal stage reached a high number with an average of 21.88 specimens per ear on June 13 in 2016. This stage was not observed on June 20. First nymphal stage and second nymphal stage populations reached high numbers on June 21 (0.48 specimens/ear) and June 23 (6.92 specimens/ear) in 2017, respectively. In the direct samplings, eggs were found on June 9 and it was found that the number of eggs per ear (6.2 eggs/ear) reached the high number on June 20 in 2016. In 2017, the eggs were observed byJune 2 (0.97 eggs/ear) and the egg population reached the high number on June 9 (4.63 eggs/ear) (Fig. 1).

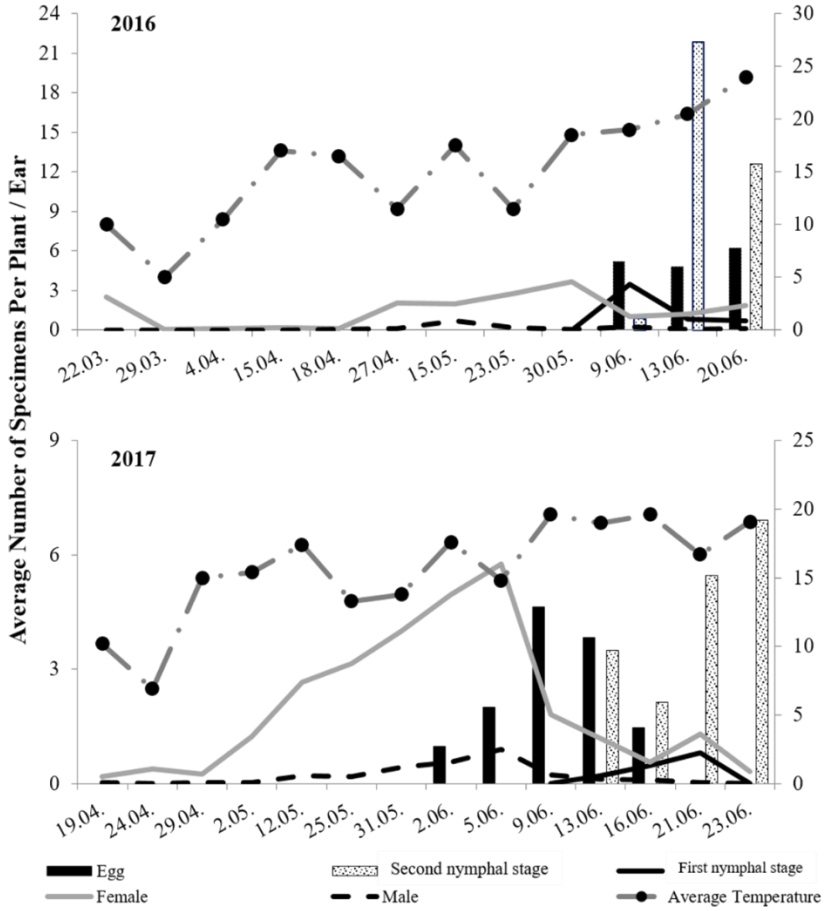

Fig. 1. Population fluctuation of *Haplothrips tritici* in wheat (Tosunbey) production area in 2016 and 2017.

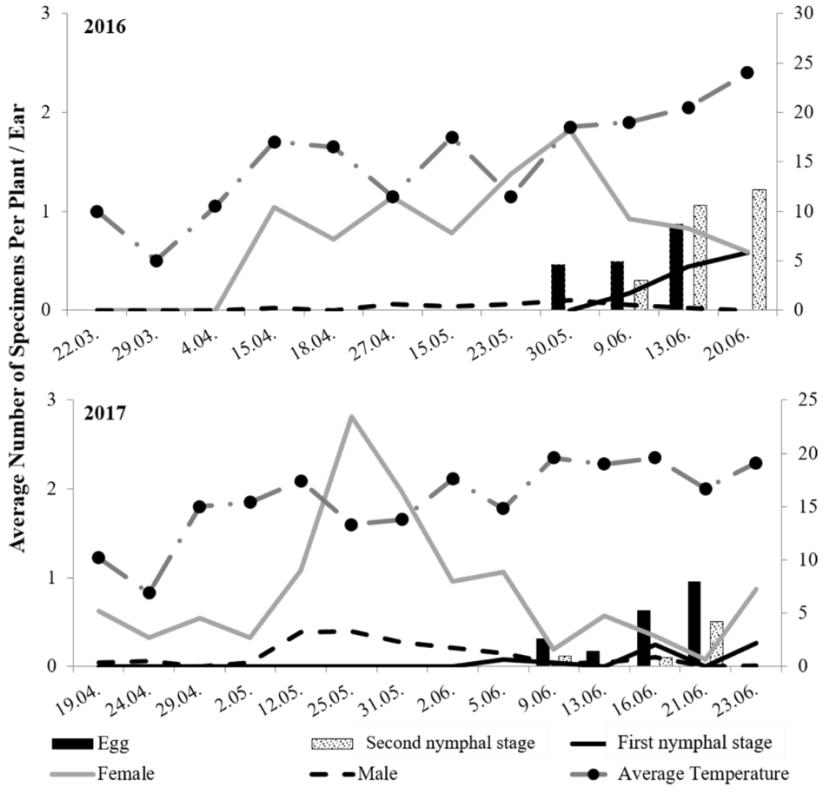

Fig. 2. Population fluctuation of *Haplothrips tritici* in barley (Tarım92) production area in 2016 and 2017.

The adult female and male populations reached their high numbers (1.82 and 0.1 specimens/ear, respectively) on May 30 in 2016. In 2017, the adult female and male populations reached their high numbers (2.81 and 0.39 specimens/ear, respectively) on May 25 and May 12, respectively. First and second nymphal stages started to appear on May 30 and June 9, respectively first (0.58 specimens/ear) and second nymphal stages of population (1.22 specimens/ear) reached high numbers on June 20 in 2016. First and second nymphal stage populations reached high numbers on June 23 (0.26 specimens/ear) and June 21 (0.5 specimens/ear) in 2017, respectively. The eggs were found on May 30 and the number of eggs per ear (0.87) reached to its highest value on June 13 in 2016. The eggs were observed on June 9 and the number of eggs per ear (0.95 egg/ear) reached its highest value on June 21 in 2017. The population density of *H. tritici* in Tarım92 cultivar reached high numbers (3.22 specimens/ear) on June 13 in 2016 (Fig. 2).

Discussion

Several studies have carried out to evaluate Thysanoptera species in cereal production areas in Bulgaria, Germany and Turkey up to now (Veselinov 1976, Gaafar & Volkmar 2010, Özsisli 2011). In study investigating the population density of *H. tritici* in different wheat cultivars in Bulgaria, the population reached the high numbers as with 52.9-57.5 nymphal stages/ear in Bezostaya 1 cultivar. The low population densities were observed in Aurora (10.25-13 nymphal stages/ear) and Roussalka (16.08-19.10 nymphal stages/ear) (Veselinov 1976). In the present study, the population density was reached 22.67-6.92 nymphal stages/ear in 2016 and 2017, respectively. In Germany, the adult density of *Limothrips cerealium* (Hal.) (Thysanoptera: Thripidae) and *H. tritici* in wheat ears in 2007-2009 was determined as 0.3-0.7/ear in the flowering period and 1.1-1.5/ear in the milk stage of the grain. The number was recorded as 1.3-3.4/ear for nymphal stages, and the total thrips density in which both periods found as 3.5-4.5/ear (Gaafar & Volkmar 2010). In our study, the high adult population density of only *H. tritici* was 2.98-3.34/plant in the pre-ear period in 2016-2017, while it was determined as 3.7-6.66/ear in the post-ear period in Tosunbey. The density for the nymphal stages reached the high numbers as with 6.92-22.67/ear. In Turkey, the population densities of *H. tritici* on different wheat and barley cultivars was reported for the first time in 2002 and 2003 in Kahramanmaraş (Özsisli, 2011). In the study *H. tritici*, in barley cultivars (Esterel and Pacific) from mid-May to mid-June and also in wheat cultivars (Bocro 4, Pehlivan, Yüreğir 89, Balcali 85, Ceylan 95 and Harran 95) from the end of April to the beginning of June was determined. In addition, the population densities of *H. tritici* were determined as 0.1-1.2 specimens/ear in barley cultivars. In the present study, the population density of *H. tritici* was 3.22 and 3.20 specimens/ear in 2016 and 2017, respectively in Tarım92. Whereas the population density of *H. tritici* reached its highest value on the Pehlivan (wheat) cultivar (21.1/ear on June 13) according to Özsisli (2011), the population density of *H. tritici* had the highest value (28.21/ear on June 13) in Tosunbey wheat cultivar, in our study. In addition, the population density of *H. tritici* was observed from mid-April to the end of June in Tarım92 and Tosunbey in this study. In the current study, the adult individuals of *H. tritici* were seen with the emergence of wheat and barley, and pre-adult stages were observed with the ear period. Moreover, it is known that the population density of this pest reaches the highest values in Turkey in mid-June in the wheat cultivars and in mid-May in the barley cultivars. In the current study, population density reached the highest level in mid-June in wheat variety, while it reached the highest values in the end-May in 2017. It can be said that the difference in the data obtained in the follow-up of the population change of *H. tritici* in this study when compared with previous studies in Turkey and other countries may be due to the use of different barley and wheat cultivars.

While the female population reached high numbers with 3.66/ear in Tosunbey cultivar, male population was 0.7/ear on May 15 in 2016. The female and male population reached high numbers with 5.76/ear (June 5) and 0.57/ear (June 2) in 2017. In Tarım92 cultivar, the number of male per ear (0.1/ear) reached the high number on May 30 in 2016, this was 0.39/ear on May 25 in 2017. Although females were predominant in field populations of most species, males are rare or unknown (Vasiliu-Oromulu 2002). Similarly, in both sampling years, the population density of male specimens remained lower than the female population in both wheat and barley cultivars during all periods of production in the present study.

The emergence times and densities of different biological stages of *H. tritici* on wheat and barley plants were revealed with this study. Adult individuals started to be seen from mid-April in both sampling years and other biological stages were observed until the last week of June. The fluctuation of thrips population density may be attributed to agroecological conditions as microclimate, cultivation area characteristic, plants around the cultivation area. The emergence time of the target biological stages and the time periods when the density increases are also of great importance in determining the control time with pests. Moreover, emergence of adults may provide an estimate of the next generation's population size, which may reveal the severity of the infestation.

Ethics Committee Approval: Since the article does not contain any studies with human or animal subject, its approval to the ethics committee was not required.

Author Contributions: Concept: O.D., Desing: O.D., Execution: A.U.Y., Material supplying: O.D., Data acquisition: A.U.Y., Data analysis/interpretation: O.D., Writing: A.U.Y.

Conflict of Interest: The authors have no conflicts of interest to declare.

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