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Research Article

Diversity of thrips species (Thysanoptera) in fruit orchards in Qazvin province, northwestern Iran

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Abstract: This study was done during 2012 to 2014 to determine the species composition of thrips on fruit trees and weeds of orchards in three counties of Qazvin Province (i.e. Buin-Zahra, Takestan and Qazvin). For each county 14 orchards were sampled. In each orchard, 10 trees and from each tree four shoots along with their leaves, flowers and fruits were selected as a sample unit. Diversity was calculated by Shannon-Wiener Index and evenness by Pielou evenness index. Species richness was estimated using the first-order jackknife richness estimator. One-way ANOVA was used to test whether there exists significant variation in species diversity, evenness and richness along the three counties. Of the 4,489 adult collected specimens from three locations, 27 species belonging to 13 genera were identified. The highest number of thrips was collected on plants of family Rosaceae, followed by Vitaceae and Moraceae, respectively. The number of collected species in Qazvin (18) and Buin-Zahra (17) counties were more than Takestan (13) county. Similar trend was observed for the total number of adult specimens collected in the three counties as more specimens were found in Qazvin and Buin-Zahra than Takestan. Results of this study showed that *Thrips tabaci* L. was found on all species of fruit trees and weeds. There were no significant differences among the three counties in terms of both diversity (P = 0.41) and evenness (P = 0.45). Across the counties, thrips estimated richness was higher in Qazvin county compared to Buin-Zahra and Takestan counties. Among the trees in Buin-Zahra and Takestan counties, grape had the highest thrips diversity. The highest value of diversity for Qazvin county was recorded for apricot. The polyphagous species *T. tabaci* was dominant in all three counties, followed by *Frankliniella occidentalis* (Pergande) (in Qazvin county), *Frankliniella intonsa* (Trybom) (in Buin-Zahra county) and *Frankliniella tenuicornis* (Uzel) (in Takestan county).

Keywords: Thysanoptera, biodiversity, fruit orchards, Iran

Introduction

Thysanoptera comprises an order of minute insects of considerable scientific and economic importance. Habitats can be found in forests, grasslands, gardens, and crops. Members of many species are fungivorous, phytophagous or carnivorous, or are gall makers or inquilines, and some are vectors of viral and bacterial diseases of plants, or are pollinators of flowers (Mound and Marullo, 1996). There are over 200 species of thrips in Iran (Mirab-balou, 2013), but

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only a few are among the serious pests list. Some thrips like *T. tabaci* cause serious damage to crops, greenhouse plants, and fruit trees (Pobożniak *et al*., 2007). This polyphagous species visits the flowers of many fruit trees, ornamental plants and herbs (Kucharczyk *et al*., 2006; Mirab-balou *et al*., 2012).

Region of northwestern Iran has various ecological conditions and provides fresh fruits for about 6 months in a year. Apple, peach, walnut, grape, cherry and apricots are the predominant crops. Fruit growers have some problems with insect pests. Thrips has also been causing serious problems on some fruit crops such as nectarines (Allsopp, 2010). There is a little knowledge about thrips species infesting the fruit orchards in Iran, and this is the first investigation on thrips species associated with fruit trees in Qazvin Province. Similar studies have been done on thrips fauna by Childers and Nakahara (2006) in Florida, Pobożniak and Anna (2011) in Cracow, Poland and Hurej *et al*. (2014) in Lower Silesia, Poland. Childers and Nakahara (2006) studied on thrips fauna of citrus orchards and their ground cover plants. They identified 36 species of thrips from 2979 specimens within citrus tree canopies and 18,266 specimens from ground cover plants within the citrus orchards. The thrips species included seven predators, 21 plant feeding species and eight fungivorous species. In the three years study by Hurej *et al*. (2014) a total of 2247 thrips individuals were collected on lupin plants belonging to 17 species. Pobożniak and Anna (2011) collected 16,058 adult thrips belonging to 22 Thysanoptera taxa from the flowers and inflorescences of 37 species of herbs.

Measuring species diversity is critically important because it gives the information on rates of species extinction and the extent to which humans alter the natural habitats (Sisk *et al*., 1994; Humphries *et al*., 1995). In addition, species diversity may be used to evaluate the evolution of species (Whittaker, 1972) and occurrence of new species in a habitat. Perhaps the simplest and most frequent use of biological diversity mesurment is„ species richness" (Brown *et al*., 2007). Species richness is simply a count of species, and it does not take into account the abundances of the species or their relative abundance distributions. Species diversity takes into account both species richness and species evenness.

Knowing the important thrips species for each region and their population densities on cultivated plants and weeds is of great importance for their management. Weeds as alternative host plants may serve as reservoirs for thrips that could migrate on cultivated plants and fruit trees. However, only limited information was available as to which thrips species occurred in Qazvin Province orchards. Therefore, this study was done to determine the species composition of thrips on fruit trees and weeds inside orchards in three counties of Qazvin Province (Buin-Zahra, Takestan and Qazvin), as well as to check which thrips species are the most dominant on fruit trees.

Materials and Methods

Study area

The Qazvin province is situated in northwestern Iran. The climate of the province in the northern parts is cold and snowy in winters and temperate in summers. In the southern parts the climate is mild with comparatively cold winters and warm summers. In this study, thrips specimens were collected during spring and summer seasons of 2012 to 2014 from three different counties of Qazvin Province including Buin-Zahra (N = 50° 04', E = 35° 46', 1225 a.s.l.), Takestan (N = 49° 42', E = 36° 03', 1283 a.s.l.) and Qazvin (N = 50° 03', E = 36° 15', 1279 a.s.l.) (Fig. 1).

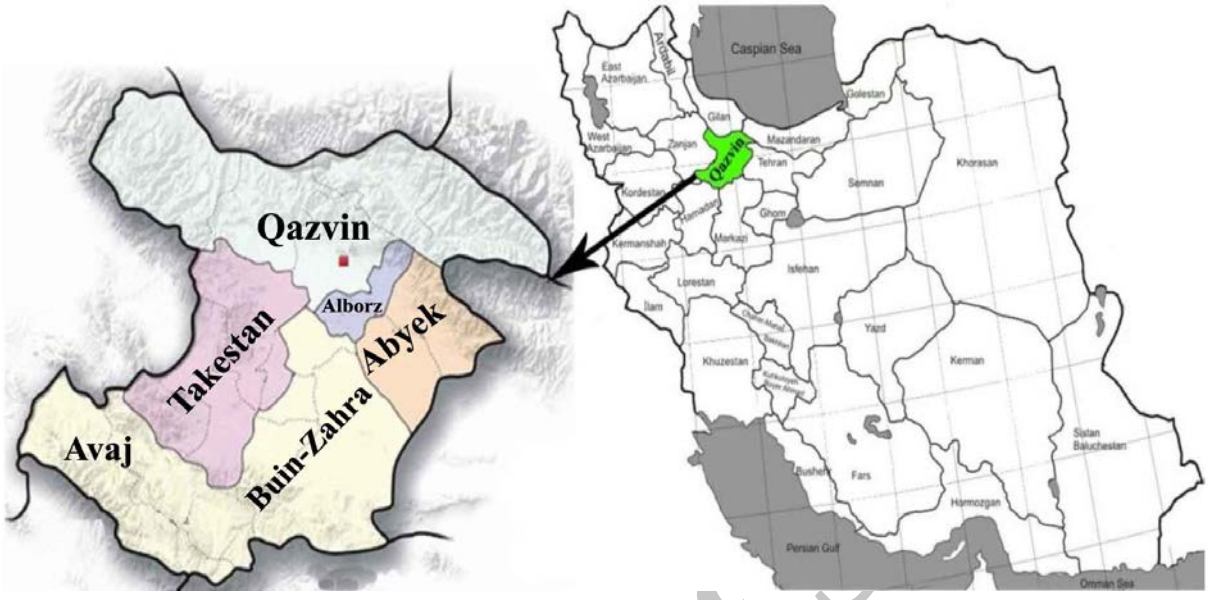

Figure 1. The map of Iran, showing Qazvin Province.

Collection of specimens

In order to establish the occurrence of Thysanoptera species associated with fruit trees of Qazvin Province, the following 12 fruit tree species belonging to six plant families were randomly sampled: Anacardiaceae: pistachio (*Pistacia vera* L.); Juglandaceae: walnut (*Juglans regia* L.); Moraceae: commercial fig (*Ficus carica* L.), white mulberry (*Morus alba* L.); Oleaceae: olive (*Olea europaea* L.); Rosaceae: almond (*Prunus amygdalus* (Mill.), apple (*Malus domestica* Borkh.), apricot (*Prunus armeniaca* L.), cherry (*Prunus avium* L.), peach (*Prunus persica* (L.), plum (*Prunus domestica* L.); and Vitaceae: grape (*Vitis vinifera* L.). For each county 14 orchards which were not subjected to pesticides were sampled and each orchard was surveyed for 60 min. In each orchard, 10 trees and 40 weeds were selected randomly. From each tree, four shoots (20 cm long) along with their leaves, flowers and fruits were selected as a sample unit and the number of thrips per shoot was determined for each sampling unit. The fruit trees and weeds were sampledonce evrey two weeks during the flowering period from spring to the end of summer. Specimens were collected using aspirator, shaking plants onto white dish and sweep net and then were preserved in 70% ethanol.

Preparation of material for identification

The adult thrips specimens and their larvae were extracted and placed in a conservation fluid. Adult thrips were macerated in 5% KOH and subjected to dehydration in an ethanol series before being mounted onto glass slides in Hoyer's medium [see Mirab-balou and Chen (2010), for details on slide mounting of thrips].

Identification of thrips species

Adult thrips species were identified and identifications were confirmed by comparison with slide-mounted material held at the collection of Department of Plant Protection, College of Agriculture, Ilam University, Iran (ILAMU); the Institute of Insect Sciences, Zhejiang University, Hangzhou, China (ZJUH); and the Insect Collection of Department of Entomology, South China Agricultural University (SCAU).

Alpha diversity analysis

Diversity was calculated by Shannon-Wiener's Index. This is the most commonly used index in ecology of communities (Ludwig and Reynolds, 1988) and allows comparisons between communities:

$$H' = -\sum_{i=1}^{s} \frac{n_i}{N} \ln \frac{n_i}{N}$$

in which, H'-Shannon-Wiener Index, n_i-number of specimens of i-species per sample, N-total number of individuals of all the species, and s-number of species in community.

Evenness was calculated by Pielou evenness index which have two contributing components including the number of species and the distribution of individuals among those species (equitability):

$$J = \frac{H'}{\ln S}$$

in which, J-Pielou evenness index, H' - Shannon-Wiener Index and S-total number of species collected in the sample.

Species richness was estimated using the first-order jackknife richness estimator. This estimator implies that the number of undetected species is approximately the same as the number of singletons.

$$S_{JK1} = S_{obs} + \frac{n-1}{n} f_1$$

in which, S_{JK1}-first-order jackknife richness estimator, S_{obs} the total number of observed species in the sample plots, f_1 the number of species observed in only one sample plot and n the number of sample plots.

Domination coefficient informs what percentage out of the total amount of the collected specimens for a given area is constituted by specimens of a particular species. It was calculated by Kasprzak and Niedbala (1981) formula:

$$D_i = \frac{n_i}{N} 100\%$$

in which, D_i Domination coefficient, n_i-number of specimens of a given species in a given area and N-number of all the specimens collected from a given area. Six classes of domination were as follows: eudominant (32.0-100%); dominant (10.0-31.9%); subdominant (3.2-9.9%); recedent (1.0–3.1%), subrecedent (0.32-0.99%) and sporadic (< 0.32%) (Engelmann, 1978).

The data was subjected to one-way ANOVA to test whether there exists significant variation in diversity and evenness along the three counties based on 14 samples in each county. The means were compared using the Tukey test at a 5% level of probability. The analyses were done using SPSS version 11.

Results

From the flowers and leaves of 12 fruit trees in the three studied localities of Qazvin Province, 4,489 adult thrips individuals of 27 specieswere collected (Tables 1-4). They belonged to four families: two predatory species from the Aeolothripidae, two species from the Melanthripidae, 20 species from the Thripidae (one of them, *Scolothrips longicornis* Priesner as the only predator) and 3 species from the Phlaeothripidae family.

The number of collected species in Qazvin (18) and Buin-Zahra (17) counties were more than Takestan county (13). Similar trend was observed for the number of adult specimens as more specimens were found in Qazvin (1567) and Buin-Zahra (1623) than Takestan (1299).

The species diversity, evenness and richness of adult thrips in the three counties are summarized in Table 1. The results of this study showed that there were no significant differences among the three counties in terms of both diversity ($F = 0.92$; $df = 2, 39$; $P = 0.41$) and evenness ($F = 0.81$; $df = 2, 39$; $P = 0.45$). Across localities, thrips richness was higher in Qazvin county compared to Buin-Zahra and Takestan.

Table 1 Total number of adult thrips species collected on fruit trees, their domination coefficient (in parentheses), Shannon diversity Index (*H'*), Pielou's evenness index (*J*) and first-order jackknife richness estimator based on each county in Qazvin Province, Iran (2012-2014).

Thrips species	Buin-Zahra	Takestan	Qazvin	Total
Family Aeolothripidae Uzel				
Aeolothrips fasciatus (L.)	0	74 (5.70)	47 (3)	121
Aeolothrips intermedius Bagnall	37 (2.28)	0	30 (1.91)	67
Family Melanthripidae Bagnall				
Melanthrips fuscus (Sulzer)	0	11 (0.85)	0	11
Melanthrips knechteli Priesner	0	9 (0.69)	0	9
Family Thripidae Stephens				
Chirothrips kurdistanus zur Strassen	13 (0.80)	0	0	13
Chirothrips manicatus (Haliday)	8 (0.49)	0	0	8
Drepanothrips reuteri Uzel	0	16 (1.23)	11 (0.70)	27
Frankliniella intonsa (Trybom)	103 (6.35)	0	15 (0.96)	118
Frankliniella occidentalis (Pergande)	65 (4)	11 (0.85)	167 (10.66)	243
Frankliniella pallida (Uzel)	17 (1.05)	11 (0.85)	0	28
Frankliniella tenuicornis (Uzel)	12 (0.74)	80 (6.16)	31 (1.98)	123
Mycterothrips tschirkunae (Yakhontov)	4 (0.25)	0	9 (0.57)	13
Mycterothrips weii Mirab-balou *et* Chen	0	6 (0.46)	0	6
Odontothrips confusus Priesner	13 (0.80)	0	1 (0.06)	14
Pseudodendrothrips mori (Niwa)	0	31 (2.39)	46 (2.94)	77
Rubiothrips vitis (Priesner)	8 (0.49)	21 (1.62)	8 (0.51)	37
Scolothrips longicornis Priesner	20 (1.23)	52 (4)	20 (1.28)	92
Tenothrips discolor (Karny)	28 (1.73)	0	12 (0.77)	40
Tenothrips frici (Uzel)	7 (0.43)	0	7 (0.45)	14
Thrips atratus Haliday	3 (0.18)	0	0	3
Thrips meridionalis (Priesner)	0	8 (0.62)	0	8
Thrips tabaci L.	1213 (74.74)	969 (74.60)	1139 (72.69)	3321
Thrips trehernei Priesner	0	0	3 (0.19)	3
Thrips vulgatissimus Haliday	0	0	14 (0.89)	14
Family Phlaeothripidae Uzel				
Haplothrips aculeatus (Fabricius)	0	0	6 (0.38)	6
Haplothrips reuteri (Karny)	29 (1.79)	0	0	29
Haplothrips tritici (Kurdjumov)	43 (2.65)	0	1 (0.06)	44
Total	1623	1299	1567	4489
Total number of observed species	17	13	18	
Shannon diversity index	1.04 ± 0.09a	1.07 ± 0.11a	0.90 ± 0.08a	-
Pielou's evenness index	0.48 ± 0.03a	0.54 ± 0.05a	0.49 ± 0.03a	
first-order jackknife richness estimator	17	13	20	

Means in a row followed by a common letter are not significantly different (Tukey's HSD test, P > 0.05).

Table 2 Total number of adult thrips species collected on fruit trees (S observed), their domination coefficient (in parentheses), Shannon diversity Index (*H'*), Pielou's evenness index (*J*) and first-order jackknife richness estimator (S_{JK1}) for each tree species in Buin-Zahra county, Qazvin Province (2012-2014).

Thrips species	Apricot	Fig	Grape	Peach	Pistachio	Plum	Walnut
Aeolothrips intermedius	4 (3.20)	8 (3.81)	8 (1.95)	0	17 (5.50)	0	0
Chirothrips kurdistanus	0	0	13 (3.17)	0	0	0	0
Chirothrips manicatus	0	0	0	0	8 (2.59)	0	0
Frankliniella intonsa	0	0	103 (25.12)	0	0	0	0
Frankliniella occidentalis	0	0	47 (11.46)	0	18 (5.83)	0	0
Frankliniella pallida	0	0	17 (4.15)	0	0	0	0
Frankliniella tenuicornis	0	0	0	0	12 (3.88)	0	0
Haplothrips reuteri	0	0	29 (7.07)	0	0	0	0
Haplothrips tritici	0	0	0	0	43 (13.92)	0	0
Mycterothrips tchirkunae	0	0	0	0	0	2 (1.75)	2 (3.08)
Odontothrips confusus	0	0	0	13(3.33)	0	0	0
Rubiothrips vitis	0	0	8 (1.95)	0	0	0	0
Scolothrips longicornis	0	0	0	7(1.79)	12 (3.88)	1 (0.88)	0
Tenothrips discolor	0	0	11 (2.68)	11(2.82)	6 (1.94)	0	0
Tenothrips frici	0	0	0	0	7 (2.27)	0	0
Thrips atratus	0	0	0	0	3 (0.97)	0	0
Thrips tabaci	121(96.80)	202(96.19)	174 (42.44)	359(92.05)	183 (59.22)	111 (97.37)	63 (96.92)
S observed	2	2	9	4	10	3	2
H'	0.05 ± 0.04b	0.11 ± 0.05b	0.90 ± 0.14a	0.23 ± 0.06b	0.79 ± 0.12a	0.05 ± 0.04b	0 ± 0b
J	0.08 ± 0.05bc	0.16 ± 0.08bc	0.71 ± 0.09a	0.33 ± 0.09b	0.66 ± 0.08a	0.07 ± 0.05bc	0 ± 0c
S_{JK1}	2	2	9	4	10	4	2

Means in a row followed by a common letter are not significantly different (Tukey's HSD test, P > 0.05).

Table 3 Total number of adult thrips species collected on fruit trees (S observed), their domination coefficient (in parentheses), Shannon diversity Index (*H'*), Pielou's evenness index (*J*) and first-order jackknife richness estimator (S_{JK1}) for each tree species in Takestan county, Qazvin Province (2012-2014).

Thrips species	Apple	Grape	Mulberry	Walnut
Aeolothrips fasciatus	42 (5.10)	21 (7.78)	11 (9.73)	0
Drepanothrips reuteri	0	16 (5.93)	0	0
Frankliniella occidentalis	0	11 (4.07)	0	0
Frankliniella pallida	5 (0.61)	6 (2.22)	0	0
Frankliniella tenuicornis	7 (0.85)	73 (27.04)	0	0
Melanthrips fuscus	8 (0.97)	3 (1.11)	0	0
Melanthrips knechteli	8 (0.97)	1 (0.37)	0	0
Mycterothrips weii	0	0	0	6 (6.52)
Pseudodendrothrips mori	0	0	31 (27.43)	0
Rubiothrips vitis	0	21 (7.78)	0	0
Scolothrips longicornis	31 (3.76)	0	0	21 (22.83)
Thrips meridionalis	7 (0.85)	1 (0.37)	0	0
Thrips tabaci	716 (86.89)	117 (43.33)	71 (62.83)	65 (70.65)
S observed	8	10	3	3
H'	0.46 ± 0.07a	0.61 ± 0.12a	0.10 ± 0.07b	0.07 ± 0.04b
J	0.49 ± 0.06a	0.61 ± 0.11a	0.14 ± 0.09b	0.10 ± 0.06b
S_{JK1}	8	12	3	3

Means in a row followed by a common letter are not significantly different (Tukey's HSD test, P > 0.05).

Table 4 Total number of adult thrips species collected on fruit trees, their domination coefficient (in parentheses), Shannon diversity Index (*H'*), Pielou's evenness index (*J*) and first-order jackknife richness estimator (S_{JK1}) for each tree species in Qazvin county, Qazvin Province (2012-2014).

Thrips species	Almound	Apricot	Cherry	Fig	Grape	Mulberry	Olive
Aeolothrips fasciatus	11 (3.36)	0	3 (6.12)	0	23 (8.78)	7 (9.33)	3 (1.83)
Aeolothrips intermedius	0	14 (3.89)	5 (10.20)	0	0	0	11 (6.71)
Drepanothrips reuteri	0	0	0	0	11 (4.20)	0	0
Frankliniella intonsa	0	15 (4.17)		0	0	0	0
Frankliniella occidentalis	0	21 (5.83)	0	111 (33.64)	0	12 (16.0)	23 (14.02)
Frankliniella tenuicornis	0	0	31 (63.27)	0	0	0	0
Haplothrips aculeatus	0	3 (0.83)	0	0	3 (1.15)	0	0
Haplothrips tritici	0	0	0	0	1 (0.38)	0	0
Mycterothrips tchirkunae	0	0	3 (6.12)	6 (1.82)	0	0	0
Odontothrips confusus	0	1 (0.28)	0	0	0	0	0
Pseudodendrothrips mori	0	0	0	0	0	46 (61.33)	0
Rubiothrips vitis	0	0	0	0	8 (3.05)	0	0
Scolothrips longicornis	0	13 (3.61)	7 (14.29)	0	0	0	0
Tenothrips discolor	0	0	0	0	12 (4.58)	0	0
Tenothrips frici	0	0	0	0	0	7 (9.33)	0
Thrips tabaci	316 (96.64)	279 (77.50)		213 (64.55)	204 (77.86)	0	127 (77.44)
Thrips trehernei	0	0	0	0	0	3 (4.0)	0
Thrips vulgatissimus	0	14 (3.89)	0	0	0	0	0
S observed	2	8	5	3	7	5	4
H'	0.09 ± 0.06a	0.42 ± 0.08a	0.15 ± 0.08a	0.20 ± 0.08a	0.31 ± 0.09a	0.23 ± 0.11a	0.26 ± 0.10a
J	0.13 ± 0.09a	0.52 ± 0.10a	0.21 ± 0.11a	0.26 ± 0.10a	0.36 ± 0.10a	0.24 ± 0.11a	0.33 ± 0.12a
S_{JK1}	2	9	5	3	8	5	4

Means in a row followed by a common letter are not significantly different (Tukey's HSD test, P > 0.05).

Thrips on fruit trees in Buin-Zahra county

Among 1,623 adult thrips individuals that were collected from Buin-Zahra county, 17 species were identified, most of them from Thripidae family (Table 2). The harmful polyphagous species, *Thrips tabaci* L. was found on different parts of fruit trees including flowers, buds and young leaves, and the highest number was also collected on flowers of some weeds under fruit trees including *Euphorbia* spp., *Melilotus officinalis* (L.) and *Convolvulus arvensis* L. (Table 5). Two predatory species were collected: *Aeolothrips intermedius* Bagnall during spring and summer, and *Scolothrips longicornis* Priesner which was found only in late summer. In this county, the high number of both predatory thrips were collected on pistachio (Table 2); and during spring, more specimens of *A. intermedius* were collected on *Euphorbia* species near fruit trees. Flower thrips, *F. intonsa* was also the most numerous on the grape and weeds (Tables 2, 5).

Table 5 Total numbers of adult thrips species on weeds occurring nearby or inside the fruit orchards in Qazvin Province, Iran (2012-2014).

Weed species	*F. int*			*F. occ*			*H. reu*			*O. conf*			*T. mer*			*T. tab*		
	B	T	Q	B	T	Q	B	T	Q	B	T	Q	B	T	Q	B	T	Q
Anthemis arvensis	6	2	3	0	2	0	0	1	0	0	0	0	1	0	1	11	6	8
Anagallis arvensis	3	0	0	0	1	4	0	0	0	0	0	0	2	0	2	14	9	13
Capsella bursa-pastoris	6	3	2	0	1	0	0	0	0	0	0	0	1	3	2	13	11	14
Cardaria draba	11	3	2	0	0	1	0	0	0	0	0	0	0	4	1	10	0	12
Chenopodium album	21	11	0	1	0	1	0	0	0	0	1	0	0	3	0	6	0	11
Convulvus arvensis	8	0	4	3	0	2	0	0	0	0	0	0	3	5	0	8	31	7
Ephorbia spp.	2	0	0	2	0	3	0	1	0	0	0	0	4	4	0	22	33	11
Fumaria officinalis	0	0	4	0	3	4	0	0	0	0	0	0	3	0	0	11	12	10
Galium aparina	4	0	0	0	2	0	0	0	0	0	1	0	2	0	1	3	13	6
Malva sylvestris	21	0	0	11	7	0	0	0	4	4	3	2	2	0	1	5	11	8
Melilotus officinalis	14	0	0	0	7	0	3	0	0	0	0	0	1	0	0	33	14	5
Medicago sp.	11	3	0	13	0	1	12	0	0	2	0	0	1	0	2	7	8	6
Raphanus raphanistrum	3	3	0	6	0	0	3	0	0	0	0	0	1	0	2	14	9	3
Sinapis arvensis	5	2	0	0	0	3	0	0	0	0	0	0	0	1	1	10	3	7
Solanum nigrum	0	4	1	0	0	2	0	3	0	0	1	0	0	1	14	11	7	11
Vicia sativa	0	1	2	1	0	1	0	3	0	1	0	0	1	1	0	5	11	9

Abbreviations: *F. int.*: *Frankliniella intonsa*; *F. occ.*: *Frankliniella occidentalis*; *H. reu.*: *Haplothrips reuteri*; *O. conf.*: *Odontothrips confusus*; *T. mer.*: *Thrips meridionalis*; *T. tab.*: *Thrips tabaci*, B.: Buin-Zahra; T.: Takestan; Q.: Qazvin.

On one hand the highest species diversity, evenness and richness were found on grape and pistachio, ($F = 23.26$; $df = 6, 91$; $P < 0.05$; $F = 17.88$; $df = 6, 91$; $P < 0.05$; $F = 17.40$; $df = 6, 91$; $P < 0.05$, respectively), remaining tree species showed low values for all indices (Table 2). On the other hand, dominant coefficient for *T. tabaci* was less than 60% on these two tree species (grape and pistachio) compared to the other orchard trees which showed higher than 90%.

Thrips on fruit trees in Takestan county

Among 1,299 adult thrips individuals that were collected from Takestan county, 13 species were identified (Table 3); one of them belongs to Aeolothripidae and the rest to Thripidae family (Table 3).

In Takestan county, thrips species diversity, evenness and richness were significantly different among tree species ($F = 11.17$; $df = 3, 52$; $P < 0.05$; $F = 9.14$; $df = 3, 52$; $P < 0.05$; $F = 12.55$; $df = 3, 52$; $P < 0.05$, respectively). Thrips species diversity on grape was nearly two times more than other trees (Table 3). On the flowers and leaves of grapevines, the following five species were respectively dominant: *T. tabaci* (43.3%), *F. tenuicornis* (27.0%), *Aeolothrips fasciatus* (L.) (7.8%), *R. vitis* (Priesner) (7.8%) and *Drepanothrips reuteri* Uzel (5.9%) (Table 3). High numbers of *T. tabaci* L. were also collected on flowers of weeds such as *Euphorbia* species and *Convolvulus arvensis* L. (Table 5).

Thrips on fruit trees in Qazvin county

Among 1,567 adult thrips specimens collected from Qazvin, 18 species were identified, most of them from Thripidae family (Table 4). The harmful thrips, *T. tabaci* was found in high numbers on different parts of almound and apricot (Table 4) and high numbers were also

collected on flowers of some weeds under fruit trees including *Capsella bursa-pastoris* (L.), *Anagallis arvensis* L. and *Cardaria draba* L. (Table 5). On fig, in addition to *T. tabaci*, the species *F. occidentalis* had also a considerable dominant coefficient (33.6%).

In Qazvin county, thrips species diversity and evenness were not significantly different among different tree species ($F = 1.54$; $df = 6, 91$; $P = 0.17$; $F = 1.45$; $df = 6, 91$; $P = 0.20$, respectively), however there was significant difference among tree species in terms of species richness ($F = 4.12$; $df = 6, 91$; $P < 0.05$), as the highest was observed for apricot (Table 4). The remarkable finding was the non-registration of *T. tabaci* on cherry and mulberry. On cherry, *F. tenuicornis* and on mulberry, *Pseudodendrothrips mori* (Niwa) had the highest dominant coefficient (63.26 and 61.33%, respectively).

Discussion

Knowing what species of thrips are present in a given area or agroecosystem is a key step in determining what control measure a grower should implement. For example, *F. occidentalis* is known to be quickly resistant as well as to be less susceptible to many pesticides (Eger *et al.*, 1998; Espinosa *et al.*, 2002; Bielza, 2008). In another example, the predatory thrips *A. intermedius* in case of existence could act as a biological control agent against *T. tabaci* (Conti, 2009; Mautino *et al.*, 2014).

A combination of the number of species (species richness) and their relative abundance defines species diversity. In spite of the fact that the number of thrips species in Takestan county (13) was considerably less than the two other counties (17 and 18), its higher evenness lead to the estimated diversity index being more than or statistically equal to the other two counties. Similar inference has been reported for diversity of Carabidae in fields of rape seed and broad bean (Rezaei Nodeh *et al.*, 2011)

Among the three counties, in Qazvin county the estimated species richness (20) was higher than the observed species (18). Based on jackknife richness estimator the number of undetected species is approximately the same as the number of singletons. In Qazvin county presence of two species each with only one individual resulted in higher richness value, while in Buin-Zahra and Takestan counties all species had at least 3 individuals (Table 1).

Among the fruit trees in Buin-Zahra and Takestan counties, grapevines had the highest thrips diversity, evenness and richness. In these two counties in addition to *T. tabaci* which was eudominant, there were several other species classified as dominant. Trees like apple, pistachio and apricot had also high diversity, evenness and richness of thrips. In general, thrips species composition on different plants and counties was different. This result is inconsistent with the study carried out by Pobożniak and Anna (2011), which indicated that thrips species composition infesting the flowers and inflorescences were very similar and not dependent on the plant species and the area of research.

Type of the tree species was somewhat different in the three counties which could have an effect on thrips species diversity. Local arthropod diversity varies with vegetation traits, including richness and composition of plant species, plant architectural heterogeneity, total productivity, and abiotic conditions (Joern and Laws, 2013). In general, some trees have richer insect faunas than others. Differences in leaf persistence between plant species can influence herbivore numbers and, conceivably, diversity (Opler, 1978). Size and shape of leaves in different species of Umbelliferae is different, and this influenced the species richness of leafmining agromyzid flies (Fowler and Lawton, 1982; Lawton and Price, 1 979).

The polyphagous species *T. tabaci* was eudominant in all three counties, after that the species *F. occidentalis* (in Qazvin county), *F. intonsa* (in Buin-Zahra county) and *F. tenuicornis* (in Takestan county) classified as dominant species. In Iran, *T. tabaci* population is composed of females; because the male of this species is very rare (Nault *et al*., 2006). In this study, only one male specimen was found

among 3,321 adult specimens. The results showed that in different counties, the domination of thrips species on a given plant species can be different. More species diversity in thrips of a given plant was accompanied by less dominance of *T. tabaci*. In addition to *T. tabaci*, some other thrips species reported here are considered as a pest. In Buin-Zahra county, *F. intonsa* and *F. occidentalis* on grape had considerable dominant coefficient. The first two species are important plant pests worldwide and have a wide range of hosts (Elimem and Chermiti, 2014; Gao *et al*., 2014; Do Bae *et al*., 2015). Western flower thrips, *Frankliniella occidentalis* was recently recorded in Iran (in 2004 and 2006) (Mirab-balou and Chen, 2011), infesting a wide range of wild and cultivated plants in Iran. In this study, high numbers of this species were collected on fig trees (Table 4) and a few specimens collected on weeds (Table 5) from Qazvin.The mulberry thrips, *P. mori* is a pest in some regions and sometimes becomes minor problem on trees grown for silkworms (Etebari and Bizhannia, 2006), but in Takestan, no damage was observed by this thrips.

In conclusion results of this study showed that *T. tabaci* was the most dominant species in the three studied counties (Tabels 2, 3 and 4). Although these three counties are located in a province and have almost similar climatic conditions, results showed prominent differences in their thrips species composition. Results showed that in estimating diversity index, evenness has a more important role than the number of species. There is a need for more investigations on the role of weeds as alternative hosts; distingushing the amount and type of damage each thrips species incites; population fluctuation and relationthips of different thrips species.

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References

Allsopp, E. 2010. Investigation into the apparent failure of chemical control for management of western flower thrips Frankliniella occidentalis, (Pergande) on plums inthe Western Cape Province of South Africa. Crop Protection, 29 (8): 824-831.

Bielza, P. 2008. Insecticide resistance management strategies against the western flower thrips, *Frankliniella occidentalis*. Pest Managment Science, 64: 1131-1138.

Brown, R. L., Reilly, L. A. J. and Peet, R. K. 2007. Species richness: small scale. Encyclopedia of Life Sciences, 1-8.

Childers, C. C. and Nakahara, S. 2006. Thysanoptera (thrips) within citrus orchards in Florida: Species distribution, relative and seasonal abundance within trees, and species on vines and ground cover plants. Journal of Insect Science, 6: 1-19.

Conti, B. 2009. Notes on the presence of *Aeolothrips intermedius* in northwestern Tuscany and on its development under laboratory conditions. Bulletin of Insectology, 62: 107-112.

Do Bae, S., Kim, H. J., Yoon, Y. N., Lee, Y. H., Hee, P. and Mainali, B. 2015. Yellow sticky card offers composite attractiveness to western flower thrips and greenhouse whitefly. Journal of Entomology and Zoology Studies, 3 (4): 110-113.

Eger, J. E., Stavisky, J. and Funderburk, J. E. 1998. Comparitive toxicity of spinosad to *Frankliniella* spp. (Thysanoptera: Thripidae), with notes on a bioassay technique. Florida Entomologist, 81 (4): 547-551.

Elimem, M. and Chermiti, B. 2014. Color preference of *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae) and *Orius* sp (Hemiptera: Anthocoridae) populations on two rose varieties. Plant Biotechnology, 7: 94-98.

Engelmann, H. D., 1978. Dominance classification of soil arthropods. Pedobiologia, 18: 378-380.

Espinosa, P. J., Bielza, P., Contreras, J. and Lacasa, A. 2002. Field and laboratory selection of *Frankliniella occidentalis* (pergande) for resistance to insecticides. Pest Management Science, 58: 920-927.

Etebari, K. and Bizhannia, A. R. 2006. Effects of Thrips (*Pseudodendrothrips mori* Niwa) Infested Mulberry Leaves on Silkworm Growth and Commercial Cocoon Parameters. Caspian Journal of Environmental Sciences, 4 (1): 31-37.

Fowler, S. V. and Lawton, J. H. 1982. The effects of host-plant distribution and local abundance on the species richness of agromyzid flies attacking British umbellifers. Ecological Entomol. 7: 257-65.

Gao, C. F., Ma, S. Z., Shan, C. H. & Wu, S. F. 2014. Thiamethoxam resistance selected in the western flower thrips *Frankliniella occidentalis* (Thysanoptera: Thripidae): Cross-resistance patterns possible biochemical mechanisms and fitness costs analysis. Pesticide biochemistry and physiology, 114: 90-96.

Humphries, C. J., Williams, P. H. and Vane-Wright, R. I. 1995. Measuring biodiversity value for conservation. Annual Reviews of Ecology and Systematics, 26: 93-111.

Hurej, M., Kucharczyk, H., Twardowski, J. and Kozak, M. 2014. Thrips (Thysanoptera) associated with narrow-leafed lupin (*Lupinus angustifolius* L., 1753) intercropped with spring triticale (*X Triticosecale* Wittm. ex A. Camus, 1927). Romanian Agricultural Research, 31: 337-345.

Joern, A. and Laws, A.N. 2013. Ecological mechanisms underlying arthropod species diversity in grasslands. Annual Review of Entomology, 58: 19-36.

Kasprzak, K. and Niedbała, W. 1981. Biocenotic indicators in quantitative research. In: Górny, M. and Grüm, L. (Eds.), Methods Applied in Soil Zoology. PWN, Warszawa, pp: 397-416.

Kucharczyk, H., Setniewska, M. and Legutowska, A. 2006. Zróżnicowanie fauny wciornastków na roślinach zielarskich w rejonie warszawskim. [Differentiation of thrips (Thysanoptera) fauna on herbal plants in Warsaw region]. Prog. Plant Protection/Post. Ochr. Roślin, 46 (2): 429-432.

Lawton J, H. and Price, P. W. 1979.Species richness of parasites on hosts: agromyzid flies on the British Umbelliferae. Journal of Animal Ecology, 48:619-37.

Ludwig, J. A. and Reynolds, J. F. 1988. Statistical ecology: A primer on methods and computing. New York, John Wiley.

Mautino, G. C., Bosco, L. and Tavella, L. 2014. Impact of control strategies on *Thrips tabaci* and its predator *Aeolothrips intermedius* on onion crops. Phytoparasitica, 42: 41-52.

Mirab-balou, M. 2013. A checklist of Iranian thrips (Insecta: Thysanoptera). Far Eastern Entomologist, 267: 1-27.

Mirab-balou, M. and Chen, X. X. 2010. A new method for preparing and mounting thrips for microscopic examination. Journal of Environmental Entomology, 32 (1): 115-121.

Mirab-balou, M. and Chen, X. X. 2011. Iranian Thripinae with ctenidia laterally on the abdominal tergites (Thysanoptera: Thripidae). Natura Montenegrina, 10 (4): 435-466.

Mirab-balou, M., Tong, X. L. and Chen, X. X. 2012. A new record and new species of the genus *Thrips* (Thysanoptera: Thripidae), with a key to species from Iran. Journal of Insect Science, 12 (90): 1-15.

Mound, L. A. and Marullo, R. 1996. The Thrips of central and south America: An introduction (Insecta: Thysanoptera). Memoirs on Entomology, International, 6: 487 pages.

Nault, B. A., Shelton, A. M., Gangloff–Kaufmann, J. L., Clark, M. E., Werren, J. L., Cabrera, L. A., Rosa, J. C. and Kennedy, G. G. 2006. Reproductive modes in onion thrips (Thysanoptera: Thripidae) populations from New York onion fields. Environmental Entomology, 35: 1264-1271.

Opler, P. A. 1978. Interaction of plant life history components as related to arboreal herbivory. G. G. (Ed.), The Ecology or Arboreal Folivores. Montgomery. Smithsonian, Washington, pp. 23-31.

Pobożniak, M. and Anna, S. 2011. Biodiversity of thrips species (Thysanoptera) on flowering herbs in cracow, Poland. Journal of Plant Protection Research, 51 (4): 393-398.

Pobożniak, M., Palacz, A. and Rataj, A. 2007. The occurrence and species composition of thrips (*Thysanoptera*) on onion. Communications in Agricultural and Applied Biological Sciences, 72 (3): 487-493.

Rezaei Nodeh, M., Afshari A., Yazdanian M. and Assadeh, Gh. A. 2011: Biodiversity of the ground beetles (Coleoptera: Carabidae) in agroecosystems of Azadshahr region, Golestan province, Iran. Journal of Agroecology. 3: 347-357.

Sisk, T. D., Launer, A. E., Switky, K. R. and Ehrlich, P. R. 1994. Identifying extinction threats: global analyses of the distribution of biodiversity and the expansion of the human enterprise. BioScience, 44: 592-604.

Whittaker, R. H. 1972. Evolution and measurement of species diversity. Taxon, 21: 213-251.

تنوع گونه‌های تریپس (Thysanoptera) باغ‌های میوه استان قزوین، شمال غربی ایران

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چکیده: این تحقیق با هدف تعیین ترکیب گونه‌ای تریپس‌های درختان میوه و علف‌های هرز موجود در باغ‌های سه شهرستان (بوئین‌زهرا، تاکستان و قزوین) استان قزوین طی سال‌های ۱۳۹۱ تا ۱۳۹۳ انجام شد. از هر شهرستان ۱۴ باغ نمونه‌برداری شد. در هر باغ ۱۰ درخت و از هر درخت چهار جوانه انتهایی همراه با برگ‌ها، گل‌ها و میوه‌های آن به‌عنوان واحد نمونه‌برداری انتخاب شد. تنوع گونه‌ای با شاخص شانون-وینر و یکنواختی با شاخص یکنواختی پیلو محاسبه شد. غنای گونه‌ای با تخمین غنای گونه‌ای شماره یک جک‌نایف برآورد شد. جهت تعیین اختلاف آماری غنا، یکنواختی و تنوع گونه‌ای بین سه منطقه مورد مطالعه از تجزیه واریانس یک‌طرفه استفاده شد. از این سه منطقه ۴۴۸۹ نمونه بالغ تریپس جمع‌آوری شد که حاوی ۲۷ گونه از ۱۳ جنس بود. بیش‌ترین تعداد تریپس از گیاهان خانواده Rosaceae و سپس به‌ترتیب از خانواده‌های Vitaceae و Moraceae جمع‌آوری شد. تعداد گونه‌های جمع‌آوری شده از قزوین (۱۸) و بوئین‌زهرا (۱۷) بیش‌تر از تاکستان (۱۳) بود. تعداد کل نمونه‌های بالغ تریپس جمع‌آوری شده نیز روند مشابه‌ای داشتند به‌طوری‌که تعداد نمونه‌ها در منطقه‌های قزوین و بوئین‌زهرا بیش‌تر از تاکستان بود. نتایج این مطالعه نشان داد .*Thrips tabaci* L روی همه گونه‌های درختان میوه و علف‌های هرز حضور داشت. نتایج این مطالعه نشان داد بین سه منطقه مورد مطالعه از لحاظ تنوع گونه‌ای (P = ۰/۴۱) و یکنواختی (P = ۰/۴۵) اختلاف معنی‌دار وجود ندارد. غنای برآورد شده گونه‌ای تریپس‌ها در منطقه قزوین بیش‌تر از بوئین‌زهرا و تاکستان بود. در بوئین‌زهرا و تاکستان درخت انگور بیش‌ترین تنوع گونه‌ای را دارا بود. درخت زردآلو بیش‌ترین تنوع گونه‌ای تریپس‌ها در منطقه قزوین را داشت. گونه چندخوار *T. tabaci* غالب‌ترین گونه در هر سه منطقه بود و بعد از آن گونه‌های *Frankliniella occidentalis* (در منطقه قزوین)، *Frankliniella intonsa* (در منطقه بوئین‌زهرا) و *Frankliniella tenuicornis* (در منطقه تاکستان) قرار داشتند.

واژگان کلیدی: راسته تریپس‌ها، تنوع زیستی، باغ‌های میوه، ایران