

# Species of thrips (Insecta, Thysanoptera) in two strawberry production systems in Rio Grande do Sul State, Brazil

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**ABSTRACT.** Species of thrips (Insecta, Thysanoptera) in two strawberry production systems in Rio Grande do Sul, Brazil. Thrips are tiny insects responsible for the reduction of strawberry fruit quality. The work aimed to record and quantify the thysanopterofauna present in two strawberry production systems, low tunnel and semi-hydroponic. Leaves, flowers and fruits were collected weekly, from July 2005 to December 2006 in Caxias do Sul and Bom Princípio municipalities, RS. A total of 664 individuals were collected, representing two families, four genus and 10 species: *Frankliniella occidentalis* (Pergande, 1895), *F. schultzei* (Trybom, 1910), *F. rodeos* Moulton, 1933, *F. simplex* (Priesner, 1924), *F. williamsi* (Hood, 1915), *F. gemina* (Bagnall, 1919), *Frankliniella* sp., *Thrips tabaci* (Lindeman, 1888), *Thrips tabaci* (Lindeman, 1888), *Caliothrips fasciatus* (Pergande 1895) from Thripidae and *Heterothrips* sp. from Heterothripidae. *Frankliniella occidentalis* represented 89.7% of the samples with 95.8% of the species collected in flowers, 3.9% in fruits and 0.8% in leaves. The results show that flowers are the most important food resource for these insects on strawberry plants. *Frankliniella rodeos*, *F. simplex*, *F. williamsi*, *C. fasciatus*, and *Heterothrips* sp. are new records on strawberry for Brazil.

**KEYWORDS.** *Fragaria x ananassa*; species survey; thysanopterans.

**RESUMO.** Espécies de tripses (Insecta, Thysanoptera) associadas à cultura do morangueiro em dois sistemas de produção no Rio Grande do Sul, Brasil. Tripses são insetos diminutos responsáveis pela redução da qualidade dos frutos do morangueiro. O trabalho objetivou registrar e quantificar a tisanopterofauna presente em dois sistemas de produção de morangueiro, túnel baixo e semi-hidropônico. Folhas, flores e frutos foram coletados semanalmente, de julho de 2005 a dezembro de 2006 em Caxias do Sul e Bom Princípio, RS. Foram coletados 664 indivíduos pertencentes a duas famílias, quatro gêneros e 10 espécies: *Frankliniella occidentalis* (Pergande, 1895), *F. schultzei* (Trybom, 1910), *F. rodeos* (Moulton, 1933), *F. simplex* (Priesner, 1924), *F. williamsi* (Hood, 1915), *F. gemina* (Bagnall, 1919), *Frankliniella* sp., *Thrips tabaci* (Lindeman, 1888) e *Caliothrips fasciatus* (Pergande, 1895) pertencentes a Thripidae, e *Heterothrips* sp. pertencente a Heterothripidae. Com 593 ocorrências, *F. occidentalis* representou 89,3% dos insetos coletados, com 87,9% dos indivíduos nas flores, 8,4% nas folhas e 3,7% nos frutos. Os resultados sugerem que as flores do morangueiro representam o recurso preferido pelos tripses. *Frankliniella rodeos*, *F. simplex*, *F. williamsi*, *C. fasciatus* e *Heterothrips* sp. são novos registros na cultura para o Brasil.

**PALAVRAS-CHAVE.** *Fragaria x ananassa*; levantamento de espécies; tisanópteros.

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Strawberries (*Fragaria x ananassa* Duchesne) (Rosaceae) are commercially produced in several countries such as France, Spain, United Kingdom, Germany, Poland, United States, Mexico, Guatemala, Ecuador, Chile, Argentina and Brazil, especially due to the attraction exerted by their red and aromatic fruits (Vieira 2001; Coll *et al.* 2006).

In Brazil, the area grown with strawberry is estimated in 3,500 ha, located mainly in the states of Minas Gerais (41.4%), Rio Grande do Sul (25.6%), São Paulo (15.4%), Paraná (4.7%), and Federal District (4%) (Calvete *et al.* 2005). In Rio Grande do Sul (RS), the area grown with strawberries is of 700 ha. The crop is grown mainly in low tunnel and more recently in a semi-hydroponic system (Emater 2004; Embrapa 2007). In the low tunnel system the seedlings are planted in the soil using beds covered with plastic and sustained by galvanized iron arches, forming a tunnel which main function is to protect the plants from rain, frost, UV rays, and to reduce the spread of

pests and diseases (Embrapa 2005). The semi-hydroponic system is derived from the hydroponics system and is conducted inside plastic or glass greenhouses, and the plants are kept in shelves located at different heights (Embrapa 2007).

Several species of Thysanoptera infest strawberry plants reducing fruit quality in several countries, being spread mainly by plant commerce (Coll *et al.* 2006; Ripa *et al.* 2009). Moreover, the control of thrips in infested areas is not easy due to their small size, rapid population growth and cryptic habits that include polyphagy and parthenogenesis (Coll *et al.* 2006; Mound 2007).

The order Thysanoptera comprehends approximately 5,800 species, but only 1% causes economic losses in commercial crops (Mound & Marullo 1996; Mound 2007). The damage caused by thrips is due to lesions on plant tissue produced by the bite-sucking mouth-parts and by the transmission of pathogens (Mound & Kibby 1998; Moritz *et al.* 2004).

Several species are associated with strawberry crops in Australia, according to Steiner & Goodwin (2005). These authors recorded *Frankliniella occidentalis* (Pergande, 1895), *Frankliniella intonsa* (Trybom, 1895), *Frankliniella tritici* (Fitch, 1855), *Thrips atratus* (Haliday, 1836), *Thrips major* (Uzel, 1895), *Thrips tabaci* (Lindeman, 1888), *Thrips fuscipennis* (Haliday, 1836), *Thrips imaginis* (Bagnal, 1926), and *Scirtothrips dorsalis* (Hood, 1919). In Florida, USA, according to Mass (1998), the more important species damaging strawberry plants are *Frankliniella tritici* (Fitch) and *Frankliniella bispinosa* (Morgan, 1913). In California, *F. occidentalis* is the prevalent species feeding on strawberry blossoms and causing the stigmas and anthers to turn brown and wither prematurely (UC IPM 2008). In Italy, Marullo & Tremblay (1993) mention *F. intonsa* and *F. occidentalis* as highly polyphagous species, having the strawberry as a host plant. The damage attributed to these species is the distortion and atrophy of the fruit, caused by insect's feeding on the flowers. In Brazil these injuries were studied by Nondillo *et al.* (2010). In Spain, Israel and Turkey, *F. occidentalis* is also reported to cause damage in strawberry flowers. In Turkey, among 14 identified species, *F. occidentalis* was the dominant species with 97% of insect collected (González-Zamora & García-Mari 2003; Coll *et al.* 2006; Atakan 2008).

In Brazil there is lack of information about the main species of thrips associated with strawberry plants especially in different production systems. In the state of Rio Grande do Sul few studies emphasize the thysanopterans on this crop. Thus, the main goal of this research was to identify and quantify thrips species associated with strawberry crops in low tunnel and semi-hydroponics systems in Rio Grande do Sul.

## MATERIAL AND METHODS

Between July 2005 and December 2006, weekly samplings were carried out in three commercial strawberry fields cultivar Aromas, being two developed in low tunnel systems (areas A1 and A2), located in Souza Farm, Caxias do Sul municipality (29°10'S, 51°10'W) and one in semi-hydroponic system (area A3), located in Bom Princípio municipality (29°29'S, 51°21'W), in Rio Grande do Sul.

The areas A1 and A2, measuring 114 m x 70 m each, had 71 beds of 70 m in length and 1 m in width, each with two rows of plants disposed at a distance of 35 cm between rows and 27 cm between plants, with a total of 518 seedlings. In each area, ten sampling stations were established with a ray of 1 m for sampling purposes. A3 had 520 m<sup>2</sup>, and 5,000 seedlings distributed in 22 benches of 40 m x 13 m each, with two rows of plants, with 114 seedlings/bench. In this area, ten sampling stations with a ray of 0.70 m were established.

From the planting date until the end of the second phenological cycle of the culture, samples were taken, collecting randomly one leaf, one flower and one fruit in each station from the same plant that were placed individually in plastic bags and taken to the laboratory. Flowers were collected when they were completely opened.

In the Entomology Laboratory of Embrapa Uva e Vinho in Bento Gonçalves, RS, adult and immature thrips were separated from the plants using a thin brush under stereomicroscope and placed in AGA (10 parts of ethylic alcohol 60%, one part of glacial acetic acid and one part of glycerin). In the Biology, Ecology and Biological Insect Control laboratory at the Federal University of Rio Grande do Sul (UFRGS), adults were mounted on microscopy slides according to Mound & Kibby (1998) and Moritz *et al.* (2004), and identified using specialized keys.

The number of individuals per area, plant part, sex, and species were recorded using a spread sheet of the statistical program SPSS. The data was subjected to descriptive analyses. The faunal index was based on the relative abundance (RA) according to the standard convention: rare if  $RA \leq 0.01$ , intermediate if  $0.1 \leq RA < 0.01$  and abundant if  $RA > 0.1$ .

Thrips specimens were deposited in the reference collection of Bioecolab/UFRGS and in the Entomology Laboratory of Embrapa Uva e Vinho, RS.

## RESULTS AND DISCUSSION

A total of 982 individuals were collected between July 2005 and December 2006 in the three sampling areas. From these, 318 (47.9%) were immature individuals and 664 (52.1%) were adults. Among the adults, 517 (77.9%) were females and 147 (22.1%) were males. Immature individuals were more abundant in flowers, 304 (95.6%), than in fruits, 14 (4.4%). Immature individuals were not identified due to the lack of identification keys for this stage, particularly for Neotropical species. Identification keys are available only for adult females according to Moritz *et al.* (2007). However, the presence of larval instars, pre-pupae, pupae and eggs, generally on the underside of the sepals, characterizes the strawberry as a suitable host plant, a criterion adopted by Pinent *et al.* (2005). However, factors determining reproductive host plant for the thrips are not yet understood or poorly defined (Ripa *et al.* 2009).

Ten species of thrips were identified belonging to four genera and two families. In the family Thripidae were identified: *F. occidentalis*, *Frankliniella schultzei* (Trybom, 1910), *T. tabaci*, *Frankliniella rodeos* (Moulton, 1933), *Frankliniella simplex* (Priesner, 1924), *Frankliniella williamsi* (Hood, 1915), *Frankliniella gemina* (Bagnall, 1919), *Frankliniella* sp., and *Caliothrips fasciatus* (Pergande, 1895). The family Heterothripidae was represented by *Heterothrips* sp.

The species *F. occidentalis*, with 593 records, represented 89.3% of all samples, with 95.8% collected in flowers, 8.4% in the leaves, and 3.7% in the fruits. Only *F. occidentalis* and *F. rodeos* occurred in the three areas, with the former being more abundant in the low tunnel systems A1 and A2, representing, respectively, 47.2% and 44.2%, and in the semi-hydroponic A3, 8.6% (Table I).

Considering abundance of thrips in the three areas, *F. occidentalis* was the dominant species (relative frequency above 10%). *F. schultzei*, *F. rodeos*, and *T. tabaci* were inter-

Table I. Number and relative frequency of thrips species sampled on leaves, flowers, and fruits of strawberry, cultivar Aromas, cropped in low tunnel system (A1 and A2), Caxias do Sul municipality, and semi-hydroponics system (A3), Bom Princípio municipality, in the state of Rio Grande do Sul, Brazil, from July/2005 to December/2006.

Family/Species	A1						A2						A3						
	Leaf		Flower		Fruit		Leaf		Flower		Fruit		Leaf		Flower		Fruit		
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Thripidae																			
<i>Frankliniella occidentalis</i>	0	0	268	95.7	12	4.3	1	0.4	253	96.6	8	3.0	49	96.1	0	0	2	3.9	
<i>Frankliniella schultzei</i>	0	0	2	100	0	0	0	0	0	0	0	0	0	0	0	31	100	0	0
<i>Thrips tabaci</i>	0	0	6	85.7	1	14.3	0	0	6	75	2	25	0	0	0	0	0	0	0
<i>Franklinella rodeos</i>	0	0	2	100	0	0	0	0	3	100	0	0	0	0	4	100	0	0	0
<i>Franklinella simplex</i>	0	0	2	100	0	0	0	0	2	100	0	0	0	0	4	0	0	0	0
<i>Franklinella williamsi</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	100	0	0	0
<i>Caliothrips fasciatus</i>	0	0	0	0	0	0	0	0	0	0	0	0	1	100	0	0	0	0	0
<i>Franklinella gemina</i>	0	0	0	0	0	0	0	0	1	100	0	0	0	0	0	0	0	0	0
<i>Franklinella</i> sp.	0	0	0	0	0	0	0	0	1	100	0	0	0	0	0	0	0	0	0
Heterothripidae																			
<i>Heterothrips</i> sp.	0	0	1	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0		281		13		1		266		10		50		41		2		

mediate (relative frequency between 10% and 1%) with the other species considered rare (relative frequency below 1%) (Pinent *et al.* 2006).

Analyzing the distribution pattern of these thrips species related to cropping systems, we observed that in the low tunnel A1, *F. occidentalis* was the dominant species and *T. tabaci* was the intermediate, while *F. schultzei*, *F. rodeos*, and *Heterothrips* sp. were rare. In the area A2, *F. occidentalis* was also the dominant species, with *F. rodeos* and *T. tabaci* intermediate, while *F. gemina*, *F. simplex* and *F. sp.* were rare. In the semi-hydroponic area A3, *F. occidentalis* and *F. schultzei* were dominant and *C. fasciatus*, *F. rodeos*, and *F. williamsi* intermediate, with no rare species. The knowledge of this distribution and frequency represents an important tool that indicates which species should be monitored and controlled in sampled areas.

Considering the micro-habitats, 588 specimens of thrips occurred in the flowers (88.5%), 51 in the leaves (7.7%) and 25 in the fruits (3.8%) (Table I). The most abundant species in flowers was *F. occidentalis* with 87.9% of individuals, 8.4% in leaves and 3.7% in fruits (Table I). The second most abundant species, *F. schultzei*, with 33 individuals recorded (5.0%), occurred only in the flowers in both production systems, in areas A1 and A3. *T. tabaci*, with 14 occurrences (2.1%), had 12 individuals in the flowers in areas A1 and A2 (85.7%), and two individuals in the fruits in A2 (14.3%). *F. rodeos*, *F. simplex*, *F. williamsi*, *F. gemina*, *Frankliniella* sp., and *Heterothrips* sp. were sampled in the flowers, with *C. fasciatus* being the only species collected in leaves of strawberry plant in addition to *F. occidentalis* (Table I).

The results suggest that the flowers of the strawberry plants constitute the major food resource for thrips. According to Kirk (1985), thrips on flowers are of particular interest

because they feed during the pollination stage reducing fruit and seed production. This is still a controversial aspect and should be studied with more details because during feeding in the flowers the body of the thrips gets covered with pollen that is transported to other flowers while the insects move around. Mound (2005) concludes that the major advance in the studies of Thysanoptera is the fact that these insects are recognized as effective pollinators alone or in association with other organisms. In Brazil, there is a lack of studies on this subject, as pointed out by Calvete *et al.* (2005), especially for strawberry plants in protected environments.

Among the ten thrips species recorded in the present study, seven belong to the genus *Frankliniella* which is represented in Brazil by 41 species described by Monteiro *et al.* (2001). Even though the genus is well characterized, the identification is complex because the species *F. gemina* (1.5 mm), *F. rodeos* (1.3 mm), and *F. williamsi* (1.1 mm) are very similar in relation to body length and coloration (light yellow). Among these species only *F. rodeos* have economic importance. *F. simplex*, despite the phytophagous habit and feeding on several cultures or spontaneous growth plants, are not associated with significant plant damage (Monteiro *et al.* 2001; Cavalleri *et al.* 2006; Pinent *et al.* 2005, 2006).

Among the three most common thrips species in this study, *F. occidentalis*, originally from California and México, was the most abundant and is currently broadly distributed around the world (Moritz *et al.* 2004). Ripa *et al.* (2009) have been recording this species in Chile since 1992, where it is considered as an important pest on fruit and vegetable crops. In Uruguay, the introduction of this species represents a serious phytosanitary threat to the vines due to lesions caused by oviposition on developing fruits (Mujica *et al.* 2007). In Florida, USA, according to Mass (1998), the species

*Frankliniella bispinosa* (Pergande) causes serious damage to strawberry crops, while *F. occidentalis*, although more abundant, rarely causes expressive damage. In Brazil, *F. occidentalis* is considered a pest of several cultures since 1993, especially on industrial cut flowers, such as chrysanthemum and roses (Monteiro *et al.* 1999). There are records of *F. occidentalis* in the states of Alagoas, Pernambuco, Rio de Janeiro, Rio Grande do Sul, and São Paulo (Monteiro *et al.* 2001). In São Paulo, this species was recorded tanning and deforming peach fruits (Pinent *et al.* 2008). In the present research, the damage caused to the strawberry plant results from feeding mainly on flowers causing tanned areas on stamens and flower receptacles. Damage on fruits has not been described in the literature, probably due to low frequency (3.7%) of thrips on them, indicating that this is not a preferential food source. Nondillo *et al.* (2010) characterized the damage caused by *F. occidentalis* in flowers and fruits of strawberry of the same cultivar, concluding that *F. occidentalis* tans flowers and fruits, but is not responsible for deformations. Another species that deserves consideration is *F. schultzei*, broadly distributed in African and Asian countries, Australia, New Zealand and in the North, Central and South Americas, where it has been observed feeding on flowers, especially Asteraceae plants, and also on weeds that represent a good resource for the development of their populations (Moritz *et al.* 2007). Wilson *et al.* (1996) observed that specimens of *F. schultzei* are important predators of eggs of mites in cotton crops in some regions of Australia. In Brazil, according to Monteiro *et al.* (1999), *F. schultzei* preys on mites of the species *Polyphagotarsonemus latus* (Banks, 1904) (Acari, Tarsonemidae) and *Tetranychus urticae* (Koch, 1836) (Acari, Tetranychidae). In Paranapanema municipality, in the state of São Paulo, Pinent *et al.* (2008) observed *F. schultzei* damaging peach fruits. Pinent *et al.* (2007) recorded *F. schultzei* as the most abundant species on leaves, flowers and fruits of strawberry in Rio Grande do Sul. In the present work, the highest abundance of *F. schultzei* occurred in flowers from the semi-hydroponic system.

It is important also to mention the onion thrips, *T. tabaci*, originated probably from the east Mediterranean where, according to Monteiro *et al.* (1999), the onion, *Allium cepa*, Linné (Liliaceae), is a native plant. *T. tabaci* is a common pest infesting several plants and feeding on larvae of other thrips and mites (Moritz *et al.* 2004). From a total of 280 species in this primitive genus of Thysanoptera, only four occur in Brazil (Monteiro *et al.* 2001). Mound (2005) considers that *T. tabaci* is losing its pest status because its population has decreased as well as its importance as vector of the tospovirus. In California, strawberry crops often have mixed colonies of thrips species including low percentage of *T. tabaci* (UC IPM 2008). This fact has also been observed in some strawberry production areas in Brazil. Pinent *et al.* (2007) recorded in Gaucho Highlands of Rio Grande do Sul small populations of *T. tabaci* in flowers of strawberry, representing only 2.5% of 356 specimens collected. In peach crops in Paranapanema, São Paulo, *T. tabaci* represented 7.0%

of a total of 115 individuals comprising seven species (Pinent *et al.* 2008). In the present study, only 1.9% of the individuals occurred in strawberry flowers.

The highest abundance of thrips was recorded in the low tunnel system, totalizing 294 (44.3%) adult specimens in A1 and 277 (41.7%) in A2. In the semi-hydroponic system (A3) 93 (14.0%) thrips specimens were recorded.

Different factors may interfere in the frequency of species in relation to different production systems, among them the presence of other crops or weeds, since thrips are easily carried by the wind rather than flying. The presence and absence of natural enemies is a relevant, but poorly studied aspect, deserving attention in future works. The semi-hydroponic system is a protected environment that makes it difficult the entrance of insects. However, it was found the same richness (six species) in this system than in the low tunnel production. Among the species recorded in our investigation, only *F. occidentalis* and *F. schultzei* have economical importance for the strawberry crop. *F. rodeos*, *F. simplex*, *F. williamsi*, *C. fasciatus*, and *Heterothrips* sp. are new records on strawberry plants in Rio Grande do Sul and Brazil.

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