Thrips Species (Thysanoptera: Thripidae) in Brazilian Papaya (Brassicales: Caricaceae) Orchards as Potential Virus Vectors

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Thrips species (Thysanoptera: Thripidae) in Brazilian papaya (Brassicales: Caricaceae) orchards as potential virus vectors

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Insect pests are the major threats to papaya production, due to feeding damage and the transmission of viral diseases. Worldwide, viruses are the main problem of papaya (*Carica papaya* L.; Brassicales: Caricaceae) and can limit the production (Presley & Ploetz 2003), and the *Tomato spotted wilt virus* (TSWV) has caused sporadic outbreaks in Hawaiian papaya orchards and in other parts of the world (Gonsalves & Trujillo 1986; Bautista et al. 1995; Silva et al. 1997). Several viruses may occur in all papaya-growing regions of the world, including *Papaya apical necrosis virus* (PANV), *Papaya meleira virus* (PMeV), *Papaya lethal yellowing virus* (PLYV), and particularly *Papaya ringspot virus* (PRSV-P), which are the most distributed papaya viruses worldwide (Ventura et al. 2004; Riley et al. 2011; Abreu et al. 2015). The rouging practices, which consist in eliminating plants with initial symptoms of viruses, are required to reduce infected plants and virus dispersion in the field, and yield loss due to viruses may reach up to 100% in Brazil (Ventura et al. 2004, 2015). Various insect pest species may vector viral diseases, for example, aphids that transmit PRSV-P (Ventura et al. 2004; Costa 2005; Martins & Ventura 2007) and chrysomelids and mirids that may be associated with the PLYV disease (genus *Sobemovirus*) (Martins & Ventura 2007; Daltro et al. 2012). The *Tospovirus* TSWV has been transmitted by at least 10 thrips species (Thysanoptera: Thripidae) (Gonsalves & Trujillo 1986; Bautista et al. 1995; Silva et al. 1997; Whitfield et al. 2005), mainly those of the genera *Ceratothripoides*, *Frankliniella*, *Scirtothrips*, and *Thrips* (Jones 2005; Whitfield et al. 2005). *Thrips parvispinus* Karny has been reported as papaya pest in Hawaii, scarring and deforming fruits, flower buds, and leaves, but not as virus vector (Sugano et al. 2015). Many thrips species that are *Tospovirus* vectors have many plant hosts in diverse climates (Whitfield et al. 2005), particularly in the Neotropics with a wide environmental range (Goldarazena et al. 2014). However, the diversity of Thripidae associated with papaya crops, particularly in the major production areas of southeastern Brazil, necessitates studies to investigate papaya virus transmission associated with thrips species. The aim of this study was to identify the most important thrips species in the main Brazilian papaya-producing and -exporting region, and those with potential as virus vector.

Thrips species were sampled during 2 yr in 20 papaya-producing orchards that had been cropped with the 'Golden', 'Sunrise Solo', and 'Tainung 01' cultivars. Fifteen orchards were sampled in the municipalities of Linhares (19.3821667°S, 40.0286667°W), 3 in Sooretama (19.0716667°S, 40.1477778°W), and 2 in Aracruz (19.7679722°S, 40.1763333°W) (Fig. 1), northern Espírito Santo State, the main Brazilian papaya-producing and -exporting region (Martins et al. 2014). Thrips specimens were collected with Moericke traps made of yellow plastic trays (30 cm diameter and 5 cm height) filled with a mix of water and a few detergent drops. Traps (n = 172) were installed according to Martins & Ventura (2007) in wood frames at 0.5 m above ground at a density of 1 trap per ha in the papaya orchards, and the insects were collected within 48 h. The thrips specimens collected were transferred to plastic pots containing alcohol (70%) in the Laboratory of Entomology of Incaper (Instituto Capixaba de Pesquisa, Assistência Técnica e Extensão Rural), and were identified by S. M. J. Pinent according to Moritz et al. (2001). The voucher specimens were deposited in the Bioecolab, Universidade Federal do Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil.

Seven thrips species were collected from the papaya orchards sampled (Table 1). Among these species, *Selenothrips rubrocinctus* (Giard) was the most frequent one (76.6%), followed by *Retithrips syriacus* (Mayet) (14.2%). Furthermore, this is the first record of *Frankliniella australis* Morgan and *F. schultzei* (Trybom) associated with papaya orchards. Worldwide, there are 9 species of Thripidae reported on papaya as potential vectors of papaya virus diseases, namely, *Frankliniella fusca* (Hinds), *F. occidentalis* (Pergande), *F. schultzei*, *F. tenuicornis* (Uzel), *Scirtothrips dorsalis* Hood, *Thrips moultoni* Ishida, *T. palmi* Karny, and *T. temporatus* Bailey (syn. *T. setosus* Moulton) (potential vectors of TSWV), and *T. tabaci* Lindeman (potential vector of *Papaya apical necrosis virus*, *Tobacco ringspot virus*, and TSWV) (Minaei & Azemayeshfard 2007).

Selenothrips rubrocinctus was the most frequent species found in Brazilian papaya orchards. This species probably originated from Africa or South America, where it has been found feeding on mature leaves of tree crops (Hoddle et al. 2012; Watson et al. 2014). It is widely distributed in the tropics, and it causes distortion and leaf abscission; however, it has not been reported as virus vector on papaya plants (Peng & Christian 2004; Denmark & Wolfenbarger 2010; Etienne et al. 2015).

Retithrips syriacus has been reported to suck sap from leaves, causing defoliation and leaf silvering, and may damage fruits of many plants (e.g., grapes) in Brazil, but not as a virus vector (Hamon & Edwards 1994; Moreira et al. 2012). This species has been reported on *Jatropha*

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Fig. 1. Location of the 20 papaya orchards sampled in the main Brazilian papaya-producing and -exporting region, Espírito Santo State, Brazil.

curcas L., *Manihot esculenta* Crantz, *Ricinus communis* L. (Malpighiales: Euphorbiaceae), *Mimosa caesalpiniifolia* Benth. (Fabales: Fabaceae), *Gossypium hirsutum* L. (Malvales: Malvaceae), *Vitis* sp. (Vitales: Vitaceae), and in species of Salicaceae (Malpighiales) and Polypodiaceae (Polypodiales) (Mound & Kibby 1998; Monteiro et al. 2001; Pinent et al. 2005; Silva et al. 2009). A complex of thrips species occurs on grapevine where *R. syriacus* was the most abundant and frequent species, and other work shows that *R. syriacus* may cause damage on papaya leaves and fruits if established (Haji et al. 2009; Moreira et al. 2012), but it may not act as a virus vector.

Frankliniella schultzei is first reported associated with papaya orchards. It is a widely distributed species in tropical and subtropical regions and a common tomato pest with a wide habitat range and ability to colonize economically important hosts, including *Cucumis melo* L., *Cucumis sativus* L., *Cucurbita pepo* L. (Cucurbitales: Cucurbitaceae), *Fragaria* × *ananassa* Duchesne (Rosales: Rosaceae), *Gossypium hirsutum* L. (Malvales: Malvaceae), *Lactuca sativa* L. (Asterales: Asteraceae), and *Nicotiana tabacum* L. (Solanales: Solanaceae) (Monteiro et al. 2001; Pinent et al. 2011; Kakkar et al. 2012). Although it has been reported as a vector of 5 *Tospovirus* species, namely, *Chrysanthemum stem necrosis virus*, *Groundnut bud necrosis virus*, *Groundnut ringspot virus*, *Tomato chlorotic spot virus*, and TSWV (Monteiro et al. 2001; Minaei & Azemayeshfard 2007; Swaminathan et al. 2007), it is not known to transmit major papaya viruses (Whitfield et al. 2005; Riley et al. 2011). However, the TSWV occurs worldwide and is found on *Emilia sonchifolia* (L.) DC. ex Wight (Asterales: Asteraceae), a common weed associated with papaya orchards in Brazil. Gonsalves & Trujillo (1986), by mechanically inoculating papaya seedlings with leaf extracts from TSWV infected plants, showed that TSWV can be transmitted to papaya. *Frankliniella schultzei* therefore is an important species, and its possible role as a virus vector of papaya in Brazil warrants further research.

This also is the first report of *F. australis* associated with papaya orchards, but low population densities of this species were found in our study. This species was reported on flowers of *Cestrum parqui* (Lam.) L. (Solanales: Solanaceae) in Chile (Funderburk et al. 2002), and *Vicia*

Table 1. Species, sampling location, occurrence per month, female specimens (Fem.), and frequency (Freq.) of thrips (Thysanoptera: Thripidae) collected in the main Brazilian papaya-producing and -exporting region, Espírito Santo State, Brazil.

Thrips species	Location[a]	Occurrence per month												Fem.	Freq. (%)
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Frankliniella australis	L, S	—	—	—	—	—	X	—	X	X	X			16	5.84
Frankliniella schultzei	L, S	—	—	—	—	—	—	X	X	—	—	—	—	6	2.19
Haplothrips sp.	S	—	—	—	—	—	—	—	X	—	—	—	—	1	0.36
Heliothrips haemorrhoidalis	S	—	—	—	—	—	—	—	X	—	—	—	—	1	0.36
Heterothrips sp.	L	—	—	—	—	—	—	—	—	—	X	—	—	1	0.36
Retithrips syriacus	L, S, A	—	X	X	X	—	X	X	X	X	X	X	X	39	14.23
Selenothrips rubrocinctus	L, S, A	X	X	X	X	X	X	X	X	X	X	X	X	210	76.64
Total														274	100.00

[a]A (Aracruz), L (Linhares), S (Sooretama).

faba L. (Fabales: Fabaceae) in Argentina (Zamar & Román 2012), identified as *F. cestrum* Moulton and *F. argentinae* Moulton, respectively. However, *F. cestrum* and *F. argentinae* are synonymous of *F. australis* (Nakahara 1997). We found no report of *F. australis* as virus vector.

Of the main thrips species identified in this study, especially *F. schultzei* could be a potential virus vector to papaya. Further research is needed to monitor thrips and determine their role as pests in papaya orchards in Brazil.

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Summary

Thrips (Thysanoptera: Thripidae) are pests of many fruit crops because they cause feeding damage or act as virus vectors. Seven thrips species were collected using Moericke yellow traps in papaya (Brassicales: Caricaceae) orchards, and *Selenothrips rubrocinctus* (Giard), the most frequent one (76.6%), occurred during all months evaluated. This is the first record of *Frankliniella schultzei* (Trybom) and *F. australis* Morgan in papaya orchards. Some of these species are minor pests of papaya, but some of them, such as *F. schultzei*, were reported as virus vectors to other commercial crops. The importance of these findings and needs for future research are discussed.

Key Words: *Carica papaya*; *Frankliniella australis*; *Frankliniella schultzei*; *Retithrips syriacus*; *Selenothrips rubrocinctus*

Sumário

Tripes (Thysanoptera: Thripidae) são pragas de plantas frutíferas devido à sua alimentação ou como vetores de vírus. Sete espécies de tripes foram coletadas em armadilhas amarelas Moericke em pomares de mamão (Brassicales: Caricaceae) e *Selenothrips rubrocinctus* (Giard), a espécie mais frequente (76,6%), que ocorreu em todos os meses de avaliação. *Frankliniella schultzei* (Trybom) e *F. australis* Morgan são registradas pela primeira vez em cultivo de mamão. Algumas destas espécies são consideradas pragas secundárias para mamão, mas outras foram relatadas como vetores de vírus para outras culturas comerciais, como *F. schultzei*. A importância dessas constatações e a necessidade de futuras pesquisas são discutidas.

Palavras Chave: *Carica papaya*; *Frankliniella australis*; *Frankliniella schultzei*; *Retithrips syriacus*; *Selenothrips rubrocinctus*

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