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Species and Abundance of Thrips Associated with Flowers of *Moringa oleifera* in Southeastern Mexico

Especies y Abundancia de Trips Asociados a Flores de *Moringa oleifera* en el Sureste de México

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Abstract. *Moringa oleifera* Lam. is a plant with nutraceutical and industrial value, and its seeds can be used to make biodiesel. In recent years, cultivation began in different regions of Mexico, from which reports on pests have increased. The objective of this work was to identify and determine abundance of thrips species associated with moringa flowers in a plantation in southeastern Mexico. Eight species of phytophagous thrips identified were *Frankliniella cephalica* (Crawford), *F. insularis* (Franklin), *F. invasor* Sakimura, *F. gardeniae* Moulton, *F. parvula* Hood, *F. bruneri* Watson, *F. williamsi*, and *Microcephalothrips abdominalis* (Crawford). A species of predatory thrips identified as *Karnyothrips texensis* (Hood) also was found. During the 1st year of sampling, the most abundant species of thrips was *F. cephalica*, while during the 2nd year it was *F. insularis*.

Resumen. *Moringa oleifera* Lam. es una planta con valor nutraceútico e industrial, cuyas semillas se pueden utilizar para elaborar biodiesel. En México, en años recientes se comenzó a cultivar en distintas regiones, con lo cual los reportes sobre plagas han aumentado. El objetivo de este trabajo fue identificar las especies de trips asociadas a flores de moringa y determinar su abundancia en una plantación del sureste de México. Se encontraron ocho especies de trips fitófagas, identificadas como *Frankliniella cephalica* (Crawford), *F. insularis* (Franklin), *F. invasor* Sakimura, *F. gardeniae* Moulton, *F. parvula* Hood, *F. bruneri* Watson, *F. williamsi*, y *Microcephalothrips abdominalis* (Crawford). Además, se encontró una especie de trips depredadora que se identificó como *Karnyothrips texensis* (Hood). Durante el 1st año de muestreos, la especie de trips más abundante fue *F. cephalica*, mientras que en el 2nd año fue *F. insularis*.

Introduction

Moringa oleifera Lam. belongs to the family Moringaceae that has only one genus with 13 species (Verdcourt 1985, Olson 2002). The shrub is native to

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southern India and northern Pakistan, but now is cultivated in tropical and subtropical regions of the world (Ramachandran et al. 1980, Morton 1991). Moringa is valuable for food, medicine, cosmetics, industry, and other uses (Bezerra et al. 2004, Cruz Da Silva et al. 2012). Because of the high oil content (30-50%) in the seeds, the species is a potential source of biodiesel (Nalivata et al. 2011).

Moringa tolerates warm temperatures, drought, pests, and diseases (Olson y Fahey 2011). Because of toxic properties, it also is used as pesticide, bactericide, and fungicide (Cáceres et al. 1991, Ileke and Oni 2011, Das et al. 1954). Several insects and mites feed on different parts of the plant (Parrota 1993). Among the most economically important insect and mite pests are: *Indarbela quadrinotata* Walker and *Indarbela tetraonis* (Moore) (Lepidoptera: Cossidae), *Noorda blitealis* Walker and *N. moringae* Walker (Lepidoptera: Crambidae), *Eupterote molifera* Walker (Lepidoptera: Eupterotidae), *Pericallia ricini* (Fabricius) (Lepidoptera: Arctiidae), *Pieris monuste* (Godart) (Lepidoptera: Pieridae) (Cáceres et al. 1991, Alfaro y Martínez 2008), *Gitonia distigmata* (Meigen) (Diptera: Drosophilidae), *Musca domestica* L. (Diptera: Muscidae) (Ojiako et al. 2012, Satti et al. 2013), *Batocera rubus* (L.) (Coleoptera: Cerambycidae) (Saha et al. 2014), *Zonocerus variegatus* (L.) (Orthoptera: Pyrgomorphidae), *Tetranychus neocaledonicus* (Andre) (Acarina: Tetranychidae), and *Tetranychus urticae* Koch (Acarina: Tetranychidae) (Kaimal and Ramani 2008, Dube et al. 2015).

In Mexico, area where moringa was planted increased more than 500% in the last 5 years (SIAP 2018), and reports of insect and mite pests associated with the crop are more common. *Estigmene acrea* (Drury) (Lepidoptera: Arctiidae), *Helicoverpa zea* (Boddie) (Lepidoptera: Noctuidae) (Pérez Ángel et al. 2011), *Trichoplusia ni* (Hübner) (Lepidoptera: Noctuidae), *Atta mexicana* (F. Smith) (Hymenoptera: Formicidae) (Valdés-Rodríguez et al. 2015), *Bagrada hilaris* (Burmeister) (Hemiptera: Pentatomidae) (Torres-Acosta et al. 2017), and *Oligonychus punicae* (Hirst) and *Tetranychus merganser* Boudreaux (Acari: Tetranychidae) (Monjarás-Barrera et al. 2015) have been reported as pests.

In contrast, reports of thrips associated with moringa are rare. Tillekaratne et al. (2011) reported *Thrips florum* Schmutz in Sri Lanka, and Murugesan and Kumar (1996) found *Thrips tabaci* (Lindeman) and *Megalurothrips distalis* Karny (Thysanoptera: Thripidae) in India. In México, no thrips were reported in *M. oleifera* plantations. The objective of this work was to identify species and abundance of thrips associated with flowers of moringa in a plantation in southeastern Mexico.

Materials and Methods

Thrips from flowers of *M. oleífera* were sampled in the germplasm bank and experimental plantation fields during flowering after the rainy season. The surface area of moringa was 2.5 ha at the Experimental Field Rosario Izapa (INIFAP), Tuxtla Chico, Chiapas, México (N14º 58.575'; W92º 09.296'; 455 m). The climate is tropical warm humid [Af(m)] according to classification by García (2004). Sampling was random between 0900 and 1200 hours from January 2013 through December 2014. One flower per each of 10 moringa shrubs was collected per sampling date. Each flower was kept individually with 70% ethanol in a 250-ml plastic bag that was labeled. The specimens were sorted with the aid of a stereoscopic microscope Nikon C-PS (Nikon Instruments, México). Insect pins and camel-hair brushes were used to detach thrips from flowers. The thrips were stored in 70% ethanol in suitably labeled 2-ml Eppendorf tubes for individual mounting on slides according to

Mound (2008). Species of thrips were identified by the senior author using keys by Mound and Marullo (1996) and Moritz et al. (2004). Voucher specimens were deposited in the Insect Collection of the Catholic University of Louvain.

Relative abundance of thrips was determined by A = n/N X 100, where A is abundance, n is the number of specimens of each species, and N is the size of the sample. Data on abundance of the most abundant species of thrips per date of sampling were analyzed using analysis of variance in a randomized block design with 10 replications. Means were separated by Tukey test ($\alpha = 0.05$). All statistical analyses used SAS (SAS Institute 2010). Abundance data were plotted with Excel (Microsoft Corp.).

Results and Discussion

During 2013, 1,145 adults of three genera and eight species were captured (Table 1, Fig. 1AB). *Frankliniella cephalica* (Crawford) was most abundant, followed by *F. insularis* (Franklin), *F. invasor* Sakimura, *F. gardeniae* Moulton, *Microcephalothrips abdominalis* (Crawford DL), *F. parvula* Hood, *F. bruneri* Watson (Thysanoptera: Thripidae), and *Karnyothrips texensis* (Hood) (Thysanoptera: Phlaeothripidae).

During 2013, flowering occurred between February and May (Fig. 1A). Abundance of *F. cephalica* and *F. insularis* was significantly different ($P < 0.01$) on each sampling date. *F. cephalica* was most abundant on 19 April (17.5 per flower), followed by 14 February (16.2 per flower), 8 March (13.1 per flower), 25 April (12.3 per flower), and 28 February (11 per flower). *F. cephalica* was scarce on 27 March and 10 May (2.1 per flower). Other populations of *F. cephalica* were intermediate in abundance. *F. insularis* was most abundant on 14 February (2.7 per flower), following by 8 March (2.6 per flower), 28 March (2.6 per flower), 25 and 19 April (1.2 and 1.1 per flower, respectively), 21 February (0.9 per flower), and 22 March (0.8 per flower). Populations were least abundant on 15 March (0.4 per flower), 10 May

Table 1. Relative Abundance of Thrips Species Associated with Moringa Flowers during 2013 and 2014

Tabla 1. Abundancia Relativa de Especies de Trips Asociadas con Flores de Moringa durante 2013 y 2014

	2013		2014	
Species	Thrips/ sample	Relative abundance (%)	Thrips/ sample	Relative abundance (%)
Frankliniella cephalica	984	85.94	126	45.29
Frankliniella insularis	134	11.70	94	28.57
Frankliniella invasor	15	1.31	83	25.23
Frankliniella gardeniae	6	0.52	NF	NF
Frankliniella williamsi	NF	NF	3	0.91
Microcephalothrips abdominalis	3	0.26	NF	NF
Frankliniella parvula	1	0.09	NF	NF
Frankliniella bruneri	1	0.09	NF	NF
Karnyothrips texensis	1	0.09	NF	NF
Total	1145		329	
Number of species	8		5	

NF = species not found

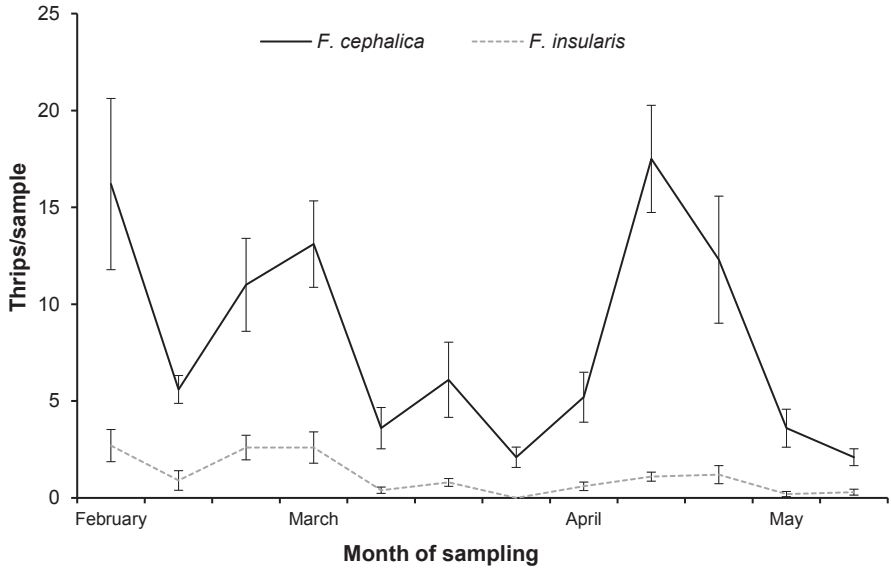

Fig. 1A. Thrips per sample associated with *M. oleifera* flowers from January to December 2013.
Fig. 1A. Trips por muestra asociados a flores de *M. oleifera* durante enero a diciembre de 2013.

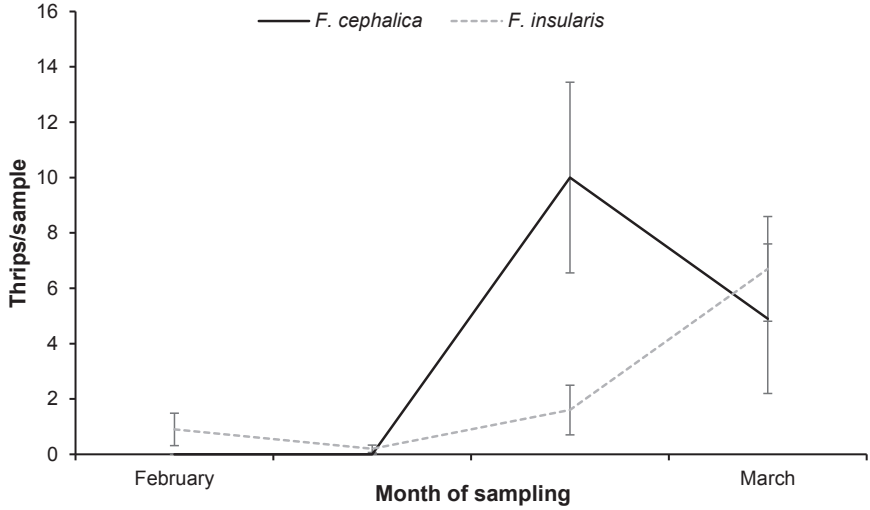

Fig. 1B. Thrips per sample associated with *M. oleifera* flowers from January through December 2014.
Fig. 1B. Trips por muestra asociados a flores de *M. oleifera* durante enero a diciembre de 2014.

(0.3 per flower), 3 May (0.2 per flower), and 27 March with no thrips. Abundance of *F. insularis* was intermediate on 5 April. The other species were scarce during sampling.

During 2014, 329 adults of four species of *Frankliniella* were captured (Table 1). The species (from most to least abundant) were: *Frankliniella cephalica*, *F. insularis*, *F. invasor*, and *F. williamsi* Hood. *F. williamsi* is opportunistic in moringa because it lives in maize (*Zea mays* L.) planted at the border of the experimental field. *K. texensis* is predatory on small arthropods and other species of thrips. Mound and Marullo (1996) reported *F. bruneri, F. cephalica*, *F. insularis*, *F. invasor*, *F. gardeniae, F. parvula*, and *F. williamsi* as phytophagous species. *F. bruneri, F. cephalica*, *F. gardeniae, F. insularis*, *F. invasor*, *F. parvula*, *F. williamsi,* and *K. texensis* were reported in flowers of moringa. Previously, in the same region of Soconusco, Chiapas State, *F. cephalica*, *F. gardeniae*, *F. invasor*, *F. párvula, F. williamsi,* and *K. texensis* were reported in flowers of 'Ataulfo' mango (De la Rosa et al. 2010, Rocha et al. 2012). The role of thrips in flowers of moringa is unknown; they might pollinate but abort flowers when abundant. *M. abdominalis* was reported in flowers of Asteraceae in Panama (Goldarazena et al. 2012) and in flowers of herbaceous species at Chiapas (Goldarazena et al. 2014).

During the 2nd year of sampling (2014), flowering occurred in February and March (Fig. 1B). Abundance of *F. cephalica* and *F. insularis* differed significantly ($P < 0.01$) at each date of sampling. *F. cephalica* was most abundant on 28 February (10.0 per flower) and 7 March (4.9 per flower). No *F. cephalica* were found on other sampling dates. Abundance of *F. insularis* was greatest on 7 March (6.7 per flower), followed by 28 February (1.7 per flower), 14 February (0.9 per flower), and 21 February (0.2 per flower). On 7 March, no *F. invasor* was found. Other species of thrips seldom were observed during sampling. Infante et al. (2017) found *F. cephalica* and *F. insularis* in flowers of *Coffea arabica* and *C. canephora* at Chiapas.

In conclusion, eight phytophagous species of thrips (*F. bruneri, F. cephalica*, *F. gardeniae, F. insularis*, *F. invasor*, *F. parvula*, and *F. williamsi*, and *M. abdominalis*) were found in the flowers although some did not reproduce on *M. oleifera* (*F. williamsi* breeds on maize and *M. abdominalis* breeds on Asteraceae). One predatory species, *K. texensis*, was found. During 2 years of sampling, the most abundant species were *F. cephalica* and *F. insularis*.

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