

## CHAPTER 3.12

# Reproductive Crop Hosts of *Bemisia tabaci* (Gennadius) in Latin America and the Caribbean

Pamela K. Anderson\*, Avas Hamon\*\*,  
Pilar Hernández\*\*\* and Jon Martin<sup>ψ</sup>

### Introduction

The sweetpotato whitefly *Bemisia tabaci* (Gennadius) is a vector of at least 30 begomoviruses (Geminiviridae: Begomovirus) in Latin America and the Caribbean (Morales and Anderson, 2001). As is often the case for insect vector-host relations, many of the crops that begomoviruses affect are not reproductive hosts for *B. tabaci*. A first critical step in vector entomology, then, is to answer the question. "Where is *B. tabaci* reproducing?"

Crop biomass can provide excellent breeding and feeding sources and thus give rise to large populations of *B. tabaci* (Byrne et al., 1991). We argue here that the first step to understanding regional population dynamics as the basis for area-wide management is to elucidate which crops *B. tabaci* utilizes as reproductive hosts and define their relative importance.

### Crop Hosts of *Bemisia tabaci*

The most reliable sources of host plant records for *B. tabaci* are published taxonomic reports and unpublished records from museum collections. The first author has reviewed the white and grey literature as well as the arthropod collections from the United States National Museum (USNM), the Florida State Collection of Arthropods (FSCA), the British Museum of Natural History (BMNH), and the Escuela Agrícola Panamericana (EAP) in Honduras. The EAP (1992) references are unpublished records from Latin America, collected and identified by R. Caballero as the basis for development of several taxonomic keys (Caballero, 1992). Table 1 also records *B. tabaci* host records generated by the national program (national agricultural research systems [NARS]) teams as part of the extensive diagnostic surveys for Phase 1 of the Tropical Whitefly Integrated Pest Management Project (TWF-IPM). P. Hernández identified these specimens and A. Hamon verified them. Verified specimens are deposited in the insect museum at the Centro Internacional de Agricultura Tropical (CIAT) in Cali, Colombia, and the FSCA in Gainesville, Florida, USA.

\* Former coordinator for Phase 1 of the Tropical Whitefly IPM Project; currently Research Director at the Centro Internacional de la Papa (CIP), Lima, Peru.

\*\* Florida State Collection of Arthropods (FSCA), Gainesville, Florida, USA.

\*\*\* Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia.

<sup>ψ</sup> British Museum of Natural History, London, UK.

Based upon the reliable published taxonomic reports, unpublished museum records and the verified specimen collected during Phase 1 of the TWF-IPM, we conclude that

*B. tabaci* is utilizing at least 50 cultivated species as reproductive hosts in Latin America and the Caribbean (Table 1).

Table 1. Known crop hosts of *Bemisia tabaci* in Latin America and the Caribbean.

Crop		Country	Reference <sup>a</sup>		
Latin name	Common name				
<i>Abelmoschus esculentus</i> (L.) Moench [= <i>Hibiscus esculentus</i> L.]	Okra	Cuba	Vázquez et al. (1996)		
		Dom. Rep.	TWF-IPM Project		
		El Salvador	USNM (1967), Lipés (1968), WF-IPM Project		
		Guatemala	TWF-IPM Project		
		Trinidad	BMNH (1989)		
		Venezuela	Arnal et al. (1993b)		
		Cuba	Vázquez et al. (1996)		
		Cuba	Vázquez et al. (1996)		
		Venezuela	Arnal et al. (1993b)		
		Cuba	Vázquez et al. (1996)		
<i>Annona muricata</i> L.	Soursop	Cuba	Vázquez et al. (1996)		
<i>Arachis hypogaea</i> L.	Peanut	Cuba	Vázquez et al. (1996)		
		Venezuela	Arnal et al. (1993b)		
<i>Beta vulgaris</i> L.	Beet	Cuba	Vázquez et al. (1996)		
<i>Beta vulgaris</i> subsp. <i>cicla</i> (L.) W. Koch	Swiss chard	Cuba	Vázquez et al. (1996)		
<i>Brasica rapas</i> L. subsp. <i>rapa</i>	Turnip	Cuba	Vázquez et al. (1996)		
<i>Brassica oleracea</i> L. var. <i>capitata</i> L.	Cabbage	Cuba	Vázquez et al. (1995)		
<i>Brassica oleracea</i> L. var. <i>gemminifera</i> DC	Brussel sprouts	Venezuela	Arnal et al. (1993b)		
<i>Brassica oleracea</i> L. var. <i>gongylodes</i> L.	Kohl-rabi	Cuba	Vázquez et al. (1995)		
<i>Cajanas cajan</i> (L.) Millsp.	Pigeon pea	Cuba	Vázquez et al. (1996)		
<i>Canavalia ensiformis</i> (L.) DC.	Jack bean, sword bean	Cuba	Vázquez et al. (1996)		
<i>Capsicum annuum</i> L. var. <i>annuum</i>	Bell pepper	Belize	EAP (1992)		
		Costa Rica	TWF-IPM Project		
		Cuba	Vázquez et al. (1996)		
		Honduras	EAP (1992)		
		Panama	TWF-IPM Project		
		Venezuela	Arnal et al. (1993b)		
		<i>Capsicum</i> spp.	Chilli peppers	Costa Rica	TWF-IPM Project
				Cuba	Vázquez et al. (1996)
				El Salvador	TWF-IPM Project
				Guatemala	TWF-IPM Project
Honduras	TWF-IPM Project				
Nicaragua	EAP (1992)				
Venezuela	Arnal et al. (1993b)				
<i>Carica papaya</i> L.	Papaya			Cuba	Vázquez et al. (1996)
				Guatemala	TWF-IPM Project
<i>Cicer arietinum</i> L.	Chick-pea			Cuba	Vázquez et al. (1996)
<i>Citrullus lanatus</i> (Thunb.) Matsum. & Nakai [= <i>Citrullus vulgaris</i> Schrad.]	Watermelon	Belize	EAP (1992)		
		Colombia	TWF-IPM Project		
		Costa Rica	TWF-IPM Project		
		Cuba	Vázquez et al. (1995)		
		Ecuador	TWF-IPM Project		
		El Salvador	TWF-IPM Project		
		Guatemala	TWF-IPM Project		
		Honduras	EAP (1992)		
		Panama	TWF-IPM Project		
		Venezuela	Arnal et al. (1993b)		
		<i>Cucumis melo</i> L.	Melon	Belize	EAP (1992)
				Colombia	TWF-IPM Project
				Costa Rica	TWF-IPM Project
Dom. Rep.	TWF-IPM Project				
Ecuador	TWF-IPM Project				
El Salvador	TWF-IPM Project				

(Continued)

Table 1. (Continued.)

Crop		Country	Reference <sup>a</sup>
Latin name	Common name		
<i>Cucumis sativus</i> L.	Cucumber	Guatemala	EAP (1992), TWF-IPM Project
		Honduras	EAP (1992)
		Venezuela	Arnal et al. (1993a; 1993b), TWF-IPM Project
		Colombia	TWF-IPM Project
		Costa Rica	TWF-IPM Project
		Cuba	Vázquez et al. (1996)
		Dom. Rep.	TWF-IPM Project
		El Salvador	TWF-IPM Project
		Guatemala	TWF-IPM Project
		Honduras	EAP (1992), TWF-IPM Project
<i>Cucurbita argyrosperma</i> C. Huber subsp. <i>argyrosperma</i>	Pipián	Venezuela	Arnal et al. (1993b), TWF-IPM Project
		El Salvador	TWF-IPM Project
<i>Cucurbita maxima</i> Duch. Ex Lam.	Squash	Cuba	Vázquez et al. (1996)
		Venezuela	Arnal et al. (1993b), TWF-IPM Project
<i>Cucurbita moschata</i> (Duch. ex Lam.) Duch. ex Poir.	Ayote	Colombia	TWF-IPM Project
		El Salvador	TWF-IPM Project
		Honduras	EAP (1992)
		Panama	TWF-IPM Project
<i>Cucurbita pepo</i> L.	Squash	Ecuador	TWF-IPM Project
		Nicaragua	USNM (1958)
		Venezuela	Arnal et al. (1993b)
		El Salvador	USNM (1967)
<i>Euphorbia pulcherrima</i> Willd. Ex Klotzch <i>Fernaldia pandurata</i> (A. DC.) Woodson <i>Glycine max</i> (L.) Merr.	Poinsettia Loroco Soybean	El Salvador	TWF-IPM Project
		El Salvador	TWF-IPM Project
		Argentina	TWF-IPM Project
<i>Gossypium hirsutum</i> L.	Cotton	Brazil	BMNH (1974)
		Colombia	EAP (1992), TWF-IPM Project
		Cuba	Vázquez et al. (1996)
		Ecuador	TWF-IPM Project
		Honduras	EAP (1992)
		Venezuela	Arnal et al. (1993a; 1993b)
		Argentina	Viscarret and Botto (1996)
		Barbados	BMNH (1982)
		Colombia	EAP (1992), TWF-IPM Project
		El Salvador	USNM (1964; 1965; 1967; 1969)
<i>Helianthus annuus</i> L.	Sunflower	Guatemala	EAP (1992)
		Honduras	USNM (1966)
		Nicaragua	USNM (1951; 1965; 1978)
		Venezuela	Arnal et al. (1993b)
<i>Ipomoea batatas</i> (L.) Lam.	Sweetpotato	Cuba	Vázquez et al. (1996)
		Venezuela	Arnal et al. (1993b)
<i>Lactuca sativa</i> L.	Lettuce	Cuba	Vázquez et al. (1996)
		Venezuela	Arnal et al. (1993b)
<i>Lycopersicon esculentum</i> Mill.	Tomato	Belize	EAP (1992)
		Colombia	EAP (1992), TWF-IPM Project

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Table 1. (Continued.)

Crop		Country	Reference <sup>a</sup>
Latin name	Common name		
		Costa Rica	TWF-IPM Project
		Cuba	Vázquez et al. (1996)
		Dom. Rep.	EAP (1992), TWF-IPM Project
		El Salvador	USNM (1967), TWF-IPM Project
		Guatemala	EAP (1992), TWF-IPM Project
		Honduras	EAP (1992), TWF-IPM Project
		Mexico	BMNH (1992)
		Nicaragua	USNM (1952), TWF-IPM Project
		Panama	TWF-IPM Project
		Puerto Rico	BMNH (1988)
		Trinidad	BMNH (1990)
		Venezuela	Arnal et al. (1993a; 1993b), TWF-IPM Project
<i>Mangifera indica</i> L.	Mango	Cuba	Vázquez et al. (1996)
<i>Manihot esculenta</i> Crantz	Cassava	Colombia	EAP (1992), TWF-IPM Project
		Cuba	Vázquez et al. (1996)
		Dom. Rep.	TWF-IPM Project
		Ecuador	TWF-IPM Project
		Venezuela	Arnal et al. (1993b)
<i>Musa × paradisiacal</i> L.	Banana/plantain	Cuba	Vázquez et al. (1996)
		Venezuela	Arnal et al. (1993b)
<i>Nicotiana tabacum</i> L.	Tobacco	Cuba	Vázquez et al. (1996)
		Guatemala	TWF-IPM Project
		Nicaragua	USNM (1951)
		Venezuela	Arnal et al. (1993b)
<i>Ocimum basilicum</i> L.	Basil	Cuba	Vázquez et al. (1996)
<i>Passiflora edulis</i> Sims	Passionfruit	Venezuela	Arnal et al. (1993b)
<i>Persea americana</i> Mill.	Avocado	Cuba	Vázquez et al. (1996)
		Guatemala	USNM (1954)
		Venezuela	Arnal et al. (1993b)
<i>Phaseolus acutifolius</i> A. Gray var. <i>acutifolius</i>	Tepary bean	El Salvador	TWF-IPM Project
<i>Phaseolus lunatus</i> L.	Lima bean	Brazil	BMNH (1975)
		Venezuela	Arnal et al. (1993b)
<i>Phaseolus vulgaris</i> L.	Common bean	Argentina	USNM (1982), TWF-IPM Project
		Colombia	USNM (1974), TWF-IPM Project
		Costa Rica	TWF-IPM Project
		Cuba	Vázquez et al. (1996)
		Dom. Rep.	BMNH (1979); TWF-IPM Project
		Ecuador	TWF-IPM Project
		El Salvador	USNM (1964); TWF-IPM Project
<i>Phaseolus vulgaris</i> L.	Common bean	Guatemala	USNM (1973); TWF-IPM Project
		Honduras	EAP (1992); TWF-IPM Project
		Nicaragua	USNM (1974); TWF-IPM Project
		Panama	TWF-IPM Project
		Venezuela	Arnal et al. (1993a; 1993b)

(Continued)

Table 1. (Continued.)

Crop		Country	Reference <sup>a</sup>
Latin name	Common name		
<i>Psidium guajava</i> L.	Guava	Cuba	Vázquez et al. (1996)
		Nicaragua	USNM (1978)
<i>Raphanus sativus</i> L.	Radish	Cuba	Vázquez et al. (1995)
<i>Sesamum indicum</i> L.	Sesame	Cuba	Vázquez et al. (1996)
		Venezuela	Arnal et al. (1993b)
<i>Solanum melongena</i> L.	Eggplant	Colombia	TWF-IPM Project
		Cuba	Vázquez et al. (1996)
		Dom. Rep.	EAP (1992), TWF-IPM Project
		Ecuador	TWF-IPM Project
		Guatemala	TWF-IPM Project
		Mexico	TWF-IPM Project
		Puerto Rico	BMNH (1987)
		Trinidad	BMNH (1988)
		Venezuela	Arnal et al. (1993b)
<i>Solanum tuberosum</i> L.	Potato	Argentina	USNM (1982)
		Cuba	Vázquez et al. (1996)
		Honduras	EAP (1992)
		Nicaragua	EAP (1992)
		Venezuela	Arnal et al. (1993a; 1993b)
<i>Spondias purpurea</i> L.	Spanish plum	Cuba	Vázquez et al. (1996)
<i>Vicia faba</i> L.	Broad bean	Cuba	Vázquez et al. (1996)
<i>Vigna unguiculata</i> (L.) Walp.	Cowpea	Cuba	Vázquez et al. (1996)
		Venezuela	Arnal et al. (1993b)
<i>Vigna unguiculata</i> subsp. <i>sesquipedalis</i> (L.) Verdc.	Yard-long bean	Cuba	Vázquez et al. (1996)
<i>Xanthosoma sagittifolium</i> (L.) Schott	Malanga	Cuba	Vázquez et al. (1996)

a. For references, see list at end of chapter.

BMNH, British Museum of Natural History, data from various dates;

EAP, Escuela Agrícola Panamericana, Honduras, unpublished data;

USNM, United States National Museum, data from various dates;

TWF-IPM Project, Tropical Whitefly-Integrated Pest Management Project.

## Relative Importance of *Bemisia tabaci* on Different Crop Hosts

*B. tabaci* is cosmopolitan in distribution, highly polyphagous and characterized by intercrop movement (Butler et al., 1986). Based on identified museum specimens, Mound and Halsey (1978) listed 317 plant species as host plants for *B. tabaci*, worldwide. However, sufficient empirical and experimental evidence exists to indicate *B. tabaci* populations do not reproduce equally among all potential crop hosts in any given geographical region. Rather, *B. tabaci* appears to develop strong host associations, resulting in host races. A

host race is a population of a species that is partially reproductively isolated from other non-specific, sympatric sister populations as a direct consequence of adaptation to a specific host or habitat (Diehl and Bush, 1984; Bush, 1994). Host races are one category of biotypes, that is, two or more morphologically similar or indistinguishable taxa that differ from one another in a biologically significant way such as host preference, emergence time or some other ecological or behavioral trait (Bush, 1994).

In any given geographical area, beyond more precisely defining the range of reproductive crop hosts, it is necessary to define the relative

importance, or reproductive potential, of the host plants, that is, to quantify the average number of *B. tabaci* produced per unit area. For example, intensive surveys carried out in Venezuela (Arnal et al., 1993a; 1993b) and Cuba (Vázquez et al., 1995; 1996) each identified 27 and 39 reproductive crop hosts for *B. tabaci* respectively (Table 1). The next step is to identify the relative importance of each crop as a reproductive host.

Caballero and Nolasco (1995) made 289 collections of *B. tabaci* from economically important crop hosts in Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama. They quantified *B. tabaci* abundance for each crop utilizing *B. tabaci* density/leaf as an indicator of abundance (Table 2).

However, comparisons of whitefly abundance on different crops is problematic because of variation in architecture, growth habits, foliage density and distribution of *B. tabaci* within the plant, among different crops and among different varieties within the same crop. Density

measures on a per ground unit basis are necessary for meaningful comparisons. Recently S. Naranjo and L. Cañas (United States Department of Agriculture [USDA]- Agricultural Research Service [ARS]) have developed a protocol to quantify *B. tabaci* abundance for a range of crop plants within the same area on a per ground unit basis. This protocol is currently being tested in Arizona (Cañas, Naranjo and Ellis, in preparation) and in El Salvador (Serrano and Anderson, in preparation). Such quantification will allow us to compare the relative importance of *B. tabaci* reproductive hosts within and among zones in a country, and among different countries; to monitor fluctuations in the *B. tabaci* populations on the same crop in the same zone from year to year; and to identify newly emerging reproductive hosts for *B. tabaci*.

We cannot effectively implement crop protection tactics aimed at source reduction within an area-wide management program if we cannot prioritize and target the principal reproductive sources for *B. tabaci*.

Table 2. Relative importance of *Bemisia tabaci* crop hosts in Central America, based on leaf samples.

Ranking <sup>a</sup>	Crop	Common name
5	<i>Gossypium hirsutum</i> L.	Cotton
	<i>Citrillus lanatus</i> (Thumb.) Matsum. & Nakai	Watermelon
	<i>Cucurbita pepo</i> L.	Squash
4	<i>Lycopersicon esculentum</i> Mill.	Tomato
	<i>Cucumis melo</i> L.	Melon
	<i>Capsicum annum</i> L.	Sweet pepper
3	<i>Nicotiana tabacum</i> L.	Tobacco
	<i>Solanum melongena</i> L.	Eggplant
	<i>Phaseolus vulgaris</i> L.	Common bean
2	<i>Glycine max</i> L. (Merr.)	Soybean

a. Rank 5, up to 100 nymphs per leaf, in all countries surveyed; rank 4, up to 100 nymphs per leaf, in certain countries; rank 3, up to 50 nymphs per leaf, in all countries; rank 2, up to 20 nymphs per leaf, in all countries; and rank 1, less than 10 nymphs per leaf, in all countries.

## Conclusions and Recommendations

After more than a decade of epidemic events in Mexico, Central America and the Caribbean, we still do not have a clear enough understanding of the range of reproductive crop hosts for *B. tabaci*. Nor do we understand the relative importance of the *B. tabaci* reproductive hosts within a zone, for purposes of area-wide management. The question, "where is *B. tabaci* reproducing?", continues to be a basic research priority for vector entomology in the region.

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