CHAPTER 3.5

Honduras

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Introduction

Geographical context

The territory of Honduras consists of highly mineralized soils and mountains, which favoured the development of mining and livestock exploitations in colonial times. Unlike in other Pacific Coast valleys of neighbouring countries, there are few volcanoes contributing their fertile ashes for the benefit of the soils. The first region to be devoted to agriculture was the humid Caribbean lowlands or "Costa", which possess fertile alluvial soils planted primarily to banana (*Musa* spp. L.). These geographic characteristics leave only the interior mid-altitude valleys (350-1000 m), for agricultural production (West and Augelli, 1977). One of the most important valleys in this mountainous region is the Comayagua, with an area of about 295 km^2. Much of the mountainous interior of Honduras supports one of the most extensive pine and oak forests in Middle America. Figure 1 shows the main agricultural regions affected by whitefly-transmitted begomoviruses.

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The emergence of Bemisia tabaci *as a pest and virus vector*

The isolated situation of the interior valleys and the absence of an extensive cotton (*Gossypium hirsutum* L.) industry in the Pacific coast of Honduras probably protected this country from early outbreaks of *Bemisia tabaci* (Gennadius) and begomoviruses recorded in neighbouring countries to the north, already in the 1970s. It was not until the mid-1980s that the intensification and diversification of cropping systems in the highland central valleys coincided with the emergence of begomovirus problems in Honduras. *Bean golden yellow mosaic virus* (BGYMV) emerged around 1985. In 1989, most common bean (*Phaseolus vulgaris* L.) producing regions in Honduras were already affected by BGYMV. The most affected areas were those in the central and southern agricultural regions of the country, where annual rainfall does not surpass the 1500 mm range, particularly from May through July (Rodríguez et al., 1994).

As in the rest of Middle America, in the last decade Honduras has experienced a boom in the production of non-traditional crops such as tomato (*Lycopersicon esculentum* Mill.), pepper (*Capsicum* spp. L.) and melon (*Cucumis melo* L.). The tomato industry in the Comayagua Valley (580 m) was developed as early as 1978, with a view

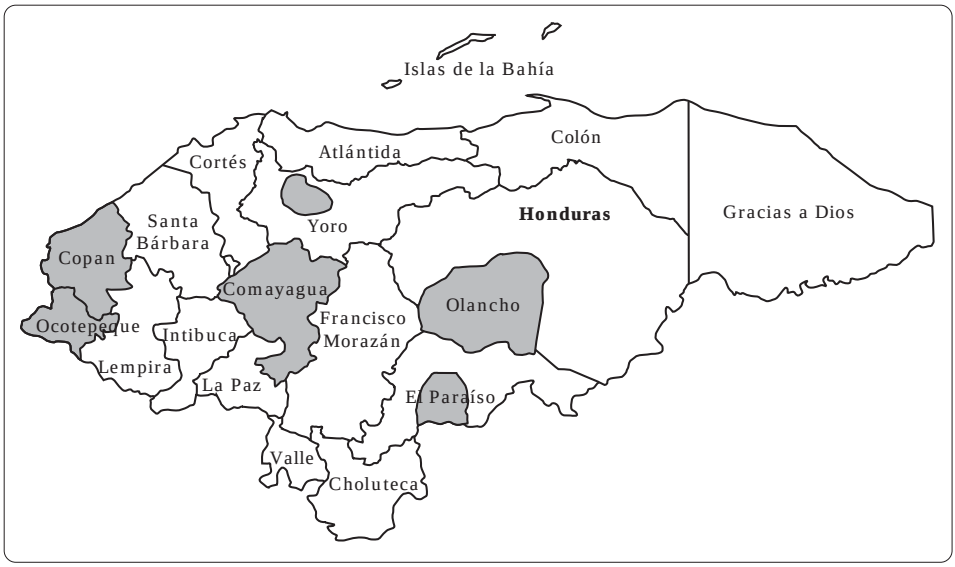

Figure 1. The main agricultural regions affected by whitefly-transmitted begomoviruses, Honduras.

to producing high-quality produce for export (Standard Fruit Company, 1978). This industry has come practically to an end now because of the persistent attacks of whitefly-borne viruses. A similar phenomenon has been recorded for the valleys of Jamastrán, El Paraíso and La Lima (El Paraíso Department), although the most affected crop in these areas is pepper. The melon industry of southern Honduras also has been brought to the point of extinction by whitefly-related problems (Caballero, 1995). These production problems have forced many growers to abandon the cultivation of susceptible food crops leaving as alternative crops such as tobacco (*Nicotiana tabacum* L.). However, tobacco is currently under attack by whiteflies and begomoviruses in neighbouring countries, particularly in Guatemala.

Advances in Biological Research

Research on whitefly-transmitted begomoviruses in Honduras has been scant. During this project, common bean plants exhibiting golden mosaic-like symptoms were tested with the monoclonal BGYMV antibodies. In these tests, the Honduran BGYMV isolate reacted with the broad spectrum monoclonal antibody (MAB-BS) but not with the Guatemalan (GA), as observed in this project for other BGYMV isolates from Guatemala and El Salvador. In a different survey, eight samples taken in the Comayagua Valley from diseased common bean, tomato, pepper, cucumber (*Cucumis sativus* L. var. *sativus*) and a new vegetable grown for export, *cundeamor* (*Momordica charantia* L.), were assayed serologically. Table 1 shows the results obtained with these samples.

Begomoviruses were detected in common bean and tomato but not in the two cucurbits tested, namely cucumber and *cundeamor*. The latter seemed to have a low incidence of a phytoplasma disease, and the cucumber sample was infected by a

Table 1. Results of various diagnostic assays performed on selected plant samples from the Comayagua Valley, Honduras.

Sample	Crop	Diagnostic assay[a]					
		EM	MAB-BS	MAB-GA	PTY1	CMV	PCR
1	Common bean	nt	+	-	nt	nt	+
2	Cucumber	+	-	nt	+	nt	nt
3	*Cundeamor*	nt	-	nt	nt	nt	nt
4	Common bean	nt	+	-	nt	nt	+
5	Common bean	-	-	-	-	-	nt
6	Tomato	nt	+	nt	nt	nt	nt
7	Tomato	nt	+	nt	nt	nt	nt
8	Tomato	nt	+	nt	nt	nt	nt

a. EM, electron microscopy; MAB-BS, a broad spectrum monoclonal antibody used to detect bi-partite begomoviruses; MAB-GA, a monoclonal antibody used to detect the original Middle American isolates of *Bean golden yellow mosaic virus*-Guatemala; PTY1, monoclonal antibody to detect potyviruses; CMV, monoclonal antibody against cucumoviruses; PCR, polymerase chain reaction; and nt, not tested.

potyvirus, most likely transmitted by aphids. The BGYMV isolates from Honduras did not react with the MAB-BS prepared in 1993 to the Guatemalan isolate. The original Guatemalan isolate reacted to this monoclonal when used as a control in this test. This result suggests that the present Honduran BGYMV isolates also have altered their capsid protein composition, probably in response to the arrival of a more ubiquitous vector, the B biotype of *B. tabaci*.

The deoxyribonucleic acid (DNA) of the BGYMV isolates found infecting common bean was amplified by polymerase chain reaction (PCR) for cloning and partial sequencing. These results (Table 2) show that the Honduran BGYMV isolate is a strain of the BGYMV species found in Middle America. In order to test the hypothesis that the differences in nucleotide sequence homology at the coat protein level (*AV1*) may have occurred in response to the presence of the new *B. tabaci* biotype.

Eight whitefly samples from common bean, four samples from cucumber, three samples from tomato and one sample from chilli were biotyped by random amplified polymorphic DNA (RAPD) analysis. The results from these tests (Table 3) do not support the hypothesis of coat protein changes in the Honduran BGYMV isolate due to the emergence of a new whitefly biotype, because only the A biotype of *B. tabaci* biotype was detected in these samples.

Table 2. Partial sequence homology (%) between a *Bean golden yellow mosaic virus* (BGYMV) isolate from Honduras (HD) and related BGYMV/*Bean golden mosaic virus* (BGMV) isolates characterized in the early 1990s.

ORF[a]	Isolates[b]				
	BGYMV-DR	BGYMV-PR	BGYMV-GA	BGMV-BR	BGYMV-HD
AC1	91.1	89.5	92.0	66.8	100
AV1	93.8	91.8	94.2	78.0	100

a. ORF, open reading frame; *AC1*, viral replicase gene; and *AV1*, coat protein gene.
b. DR, Dominican Republic; PR, Puerto Rico; GA, Guatemala; and BR, Brazil.

Table 3. Biotyping of whitefly (*Bemisia tabaci*) samples collected from different commercial crops grown in different municipalities of two departments in Honduras.

Department	Municipality	Crop	Biotype
Comayagua	V. San Antonio	Common bean	A
Comayagua	V. San Antonio	Common bean	A
Comayagua	V. San Antonio	Common bean	A
Comayagua	V. San Antonio	Common bean	A
Comayagua	V. San Antonio	Common bean	A
Comayagua	Comayagua	Common bean	A
Comayagua	Comayagua	Cucumber	A
Comayagua	Comayagua	Cucumber	A
Comayagua	San Nicolás	Tomato	A
Comayagua	San Nicolás	Tomato	A
Comayagua	Flores	Tomato	A
Comayagua	V. San Antonio	Common bean	A
Comayagua	Flores	Common bean	A
Comayagua	Comayagua	Cucumber	A
Comayagua	Comayagua	Cucumber	A
Francisco Morazán	Cedros	Chilli	A

Socio-economic Analysis

A case study was conducted in the Comayagua Valley with the collaboration of the Escuela Agrícola Panamericana (EAP), Zamorano. The results of this study are published in a thesis (Jara, 1998). In the Comayagua Valley, more than 70% of the 100 producers surveyed had been cultivating the land longer than 5 years. The number of literate farmers in the population surveyed was 75%, of which 66% had received only primary education. Only half or less (in some areas) of the farmers surveyed had received technical assistance to control whitefly problems.

Regarding whitefly incidence, 87% of the farmers believed that whiteflies and whitefly-borne viruses increased in the warmer months of the year. About 80% of the farmers noted that whitefly populations increase in periods of low rainfall. The worst whitefly/virus epidemics in the Comayagua Valley occurred in 1989, when drought and high temperatures struck the region. These results demonstrate that most farmers are aware of the key climatic factors that determine whitefly epidemics.

Over 40% of the farmers interviewed apply insecticides on a calendar basis for whitefly control. This practice can be interpreted as a risk reduction measure, particularly in the case of tomato growers, who invest between US$2100 and $3500 per *manzana* (0.764 ha). In tomato plantings, 63% of the growers apply insecticides against whiteflies as soon as the tomato plants are transplanted, 31% apply 1 week after transplanting and only 6% wait until they see whiteflies in their fields. In the case of common bean, 12% of the farmers apply pesticides at planting time, 42% start controlling whiteflies 1 week after germination of the plants and 46% apply insecticides later on during the vegetative phase of the crop. These results demonstrate farmers' perception regarding the investment required to plant tomato (usually 10 times higher than in the case of common bean).

Regarding the likelihood of introducing non-chemical control measures based on cultural practices such as changing planting dates to avoid whitefly population peaks, about 65% of the growers were reluctant to change. This finding suggests that climatic and market factors determine planting times in Honduras.

In economic terms, 53% of the production costs for tomato and 47% for common bean are related to the chemical control of whitefly/begomoviruses. In cucumber production, only 16% of the total costs are related to chemical whitefly control. Total production costs for tomato are up to 20 times more than for common bean or cucumber. It is evident from this study that the implementation of an integrated whitefly management package in the Comayagua Valley would significantly contribute to lessening the environmental impact of insecticides and to a significant reduction in production costs of high-value crops such as tomato and peppers.

Strengthened Research Capacity

The Tropical Whitefly Integrated Pest Management Project made possible the development of a thesis entitled "Characterization of the incidence and management of whiteflies (Homoptera:Aleyrodidae) in the valley of Comayagua, Honduras" at the Plant Protection Department, EAP-Zamorano. The case study helped acquire a better view of how small-scale farmers perceive the whitefly problem. Experts in various fields such as agronomy, entomology, virology, socio-economics and biometry developed the questionnaire, which consequently constitutes a guide for future surveys on similar field production problems.

The Plant Protection Department of the EAP sent Elsa Barrientos to the Centro Internacional de Agricultura Tropical (CIAT), Colombia, for training in molecular biotyping of *B. tabaci* and characterization of plant viruses during a 2-week period.

Current Status of Whitefly/Begomovirus Problems

Although the whitefly/begomovirus problems arrived relatively late in Honduras, most of the territory offers suitable environmental conditions for *B. tabaci* to reproduce and attack susceptible crops, either as a pest or as a virus vector. The exceptions are the northern Caribbean coast, which usually receives more than 2000 mm of rainfall, a deleterious climatic factor for *B. tabaci*. This region is the prime banana-producing zone of Honduras. The rest of the country has an average rainfall of less than 1500 mm and average temperature of 26 ºC, and most horticultural regions are located between 200 and 1000 m above sea level—all favourable conditions for *B. tabaci*.

A good indicator of the presence of whitefly-transmitted viruses in a region is the occurrence of BGYMV. This virus is distributed in the departments of El Paraíso, Francisco Morazán, Choluteca, Valle, Olancho, Comayagua and Copán, marking a vast region where whitefly/begomovirus problems can emerge on susceptible crops. Undoubtedly, one of the most affected areas is the Comayagua Valley, north of the capital, Tegucigalpa. This valley is located in a drier zone (500-1000 mm) and has been planted intensively to non-traditional export crops under considerable pesticide abuse.

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