CHAPTER 3.7

Costa Rica

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Introduction

Geographical context

The Central Plateau, around the capital city of San José, is one of the most intensively cultivated areas in Costa Rica. North and south of this region, the broken and volcanic topography of mountain ranges expands all the way to the northern border with Nicaragua and the southern border with Panama. East and west of the northern mountain ranges lie the Caribbean and Pacific lowlands, the least developed and inhabited regions of Costa Rica. South-eastern Costa Rica receives over 1500 mm of rain annually, which prompted the development of a thriving banana (*Musa* spp. L.) production industry towards 1880. Coffee (*Coffea arabica* L.) was introduced into Costa Rica in the 1830s and soon became a source of wealth for many farmers in the Central Plateau. Among the basic food staples, maize (*Zea mays* L.) and common bean (*Phaseolus vulgaris* L.) are important components of the Costa Rican diet, together with crops such as potato (*Solanum tuberosum* L.) and plantain (*Musa* × *paradisiacal* L.). Cotton (*Gossypium hirsutum* L.) is produced only to a limited extent in the Pacific lowlands of the Province of Guanacaste (West and Augelli, 1977; Pastor, 1988). The Central Plateau is undoubtedly one of the most affected areas in terms of whitefly-related damage. Figure 1 shows the main agricultural regions affected by whitefly-transmitted begomoviruses.

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

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

The lack of suitable reproductive hosts for the whitefly *Bemisia tabaci* (Gennadius) such as cotton or soybean (*Glycine max* [L.] Merr.), together with the high rainfall over much of the Costa Rican territory, protected the

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Central Plateau's agricultural region against the early arrival of this pest. The first records of the presence of *B. tabaci* in the country originated in the 1970s, precisely in the drier lowlands of the Pacific province of Guanacaste, where an incipient cotton industry was developed in the 1960s. The first record of *B. tabaci* as a pest and vector of a plant virus *Bean golden yellow mosaic virus* (BGYMV) in common bean fields in the Central Valley, occurred in 1987. BGYMV already had been observed in the country in the 1960s (Gámez, 1970), albeit at a very low incidence. In 1988, *B. tabaci* moved on to tomato (*Lycopersicon esculentum* Mill.) in the Central Valley (Hilje, 1997). Coincidentally, the attack to common bean and tomato took place in the western areas of the Central Valley, which is the closest region to the cotton-growing areas of Costa Rica. *B. tabaci* is currently a pest and vector of viruses in common bean and tomato fields in most of the horticultural provinces of the country.

Advances in Biological Research

A BGYMV isolate from Alajuela (Central Valley) had been characterized serologically at the Centro Internacional de Agricultura Tropical (CIAT) in 1993 as a member of the Central American/ Caribbean group of BGYMV isolates. However, different begomoviruses isolated during the course of this project from BGYMV-affected bean plants in different regions of Costa Rica (Puriscal, Alajuela and Los Chiles) were shown to be serologically distinct from the original Middle American BGYMV isolates characterized in the early 1990s (Cancino et al., 1995).

A begomovirus of tomato had been isolated previously in the locality of Turrialba (Castillo, 1997) and identified as *Tomato yellow mosaic virus* (ToYMV). This virus is currently considered a tentative new species referred to as *Tomato yellow mottle virus* (ToYMoV). Another begomovirus, isolated from diseased tomato plants in Turrialba, was shown in 1998 to be related to a tomato begomovirus tentatively designated as *Tomato leaf curl Sinaloa virus*, originally isolated in north-western Mexico (Idris et al., 1999).

The Tropical Whitefly Project financed a survey of *B. tabaci* biotypes in Costa Rica, conducted under the guidance of Dr. Luko Hilje of the Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), Turrialba. Table 1 shows the results of the molecular characterization analyses conducted at CIAT for some of the samples collected. These results confirmed the presence of *B. tabaci* in various crops of socio-economic importance and showed the penetration of biotype B of *B. tabaci* in different regions of Costa Rica. However, at the time of the survey, the original A biotype still predominated in the country. Some of the most heavily colonized crops were cucurbits but, unlike the case of other Central American countries, *B. tabaci* was found to colonize pepper (*Capsicum* spp. L.) in Costa Rica (Hilje, 1997; Vallejos, 1997).

Socio-economic Analysis

At the beginning of this project, a previous investigation on the economic impact of the *B. tabaci*-begomovirus pest complex in Costa Rica, and particularly on common bean, tomato and pepper, was used as ex ante data for the survey conducted during the current project (Vallejos, 1997). According to the results obtained in that investigation, the trend to replace

Table 1. Characterization of *Bemisia tabaci* biotypes in Costa Rica.

Province	Locality	Crop	Biotype
Alajuela	Orotina	Watermelon	B
Alajuela	Orotina	Cucumber	B
Puntarenas	Puntarenas	Melon	B
Puntarenas	Ticaral	Watermelon	B
Puntarenas	Ticaral	Pumpkin	A
Puntarenas	Lepanto	Common bean	A/B
Guanacaste	Carrillo	Melon	A
Guanacaste	Carrillo	Watermelon	A
Guanacaste	Bagaces	Melon	A
Guanacaste	Bagaces	Spider flower	A
Guanacaste	Bagaces	Cucurbit	A
Guanacaste	Tilarón	Tomato	A
Guanacaste	Tilarón	Chilli	A
San José	Pérez Zeledón	Snap bean	A
San José	Pérez Zeledón	Pepper	A
San José	Pérez Zeledón	Chilli	A
San José	Pérez Zeledón	Tomato	A
San José	Pérez Zeledón	Tomato	A
Heredia	not cited	Chilli	A
Heredia	not cited	Tomato	A
Heredia	not cited	Chilli	A
Heredia	not cited	Chilli	A
Limón	Guácimo	Chilli	A
Limón	Guápiles	Pumpkin	A
Alajuela	Gracia	Tomato	A
Alajuela	Gracia	Chilli	A
Alajuela	Naranjo	Chilli	A
Alajuela	Naranjo	Cucumber	A
Alajuela	S. Ramón	Tomato	A
Alajuela	Atenas	Tomato	A
Alajuela	Alajuela	Sweetpotato	A
Alajuela	Alajuela	Tomato	A
Alajuela	Alajuela	Chilli	A
Alajuela	Alajuela	Common bean	A
Alajuela	Alajuela	Cucumber	A
Cartago	Turrialba	Chilli	A
Cartago	Cervante	Tomato	A
Cartago	Turrialba	Tomato	B
Cartago	Turrialba	Chilli	A
Cartago	Cartago	Tomato	A
Cartago	Cartago	Chilli	A
Cartago	Paraíso	Tomato	B
Cartago	Paraíso	Chilli	B

basic food crops such as common bean for high-value crops such as tomato and pepper was quite apparent and still continues in Costa Rica. As a result, common bean and other traditional crops are increasingly planted in marginal soils, with an expected fall in the productivity of these crops.

Yield losses due to whitefly-transmitted viruses were 37% for common bean, 22% for tomato and 9% for pepper. The whitefly *B. tabaci* could

reproduce on pepper without causing apparent damage to this host plant. Regarding the economic feasibility of these crops, tomato and chilli (*Capsicum* sp.) were the most profitable crops, producing over US$6300/ha. The net return for common bean was US$145/ha.

Strengthened Research Capacity

Costa Rica, and specifically CATIE, has been a leader in the collection and dissemination of information on integrated pest management (IPM) strategies to control whitefly pests. Dr. Luko Hilje of CATIE has co-ordinated these information exchanges through an international network created in 1992. Annual workshops have been organized in different Latin American countries to update and discuss whitefly-related problems and the most suitable IPM measures implemented to date. The Systemwide Tropical Whitefly (TWF)-IPM Project has given its support to this effort by promoting complementary activities, particularly in the area of molecular characterization of whiteflies and begomoviruses. With the funds provided by this project, Dr. Hilje was able to attend the International Workshop on *Bemisia* and Geminiviruses held in San Juan, Puerto Rico, in June 1998. His presence in this meeting was important for maintaining the Latin American whitefly network active and for planning future activities. Additionally, the funds provided to CATIE allowed Dr. Hilje to conduct a countrywide survey of the whitefly/begomovirus-affected regions in Costa Rica.

A short study fellowship was awarded to Ing. Agr. Guillermo Sibaja Chinchilla of the Costa Rican Ministry of Agriculture and Livestock, Plant Health Division. Mr. Sibaja came to CIAT, Colombia, for intensive training on the characterization of *B. tabaci* biotypes.

Current Status of Whitefly/Begomovirus Problems

Whiteflies and begomoviruses in Costa Rica mainly affect common bean and tomato crops, particularly in the Central Valley, where most of the horticultural crops are grown. Another area where the whitefly problem is gaining momentum is the "Pacífico Seco" (Dry Pacific Region) in Guanacaste Province. Rainfall in this region ranges from 1220 to 2000 mm annually, with an average temperature of 20 to 25 ºC. These are not optimal conditions for *B. tabaci* but the occurrence of a prolonged dry period from December through April favours the build up of whitefly populations and transmission of viruses to susceptible horticultural crops. Fortunately, most of the Costa Rican territory receives over 1500 mm of annual rainfall, which maintains whitefly populations depressed most of the year. These climatic factors and various IPM measures implemented in Costa Rica, including the use of resistant varieties in the case of common bean, have contributed significantly to the attenuation of the whitefly/begomovirus problems in this country.

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