CHAPTER 3.11

Dominican Republic

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Introduction

Geographical context

The Dominican Republic comprises the eastern two-thirds of the island of Hispaniola. The country is generally mountainous, with the most prominent range being the Central Highlands (elevation up to 3175 m), the highest point in the West Indies. The Constanza Valley is a highly developed agricultural area located in the Central Highlands and is currently planted to high-value crops such as garlic (*Allium sativum* L.), onion (*Allium cepa* L.) and other horticultural crops. The Cibao Valley, in the north-west, is one of the most fertile agricultural areas in the country, where rice (*Oryza sativa* L.), maize (*Zea mays* L.), common bean (*Phaseolus vulgaris* L.), tobacco (*Nicotiana tabacum* L.) and coffee (*Coffea arabica* L.) are produced. The western part of the country is dry but rivers provide irrigation. San Juan de la Maguana is the main bean area and the Azua Valley is the main horticultural area in south-western Dominican Republic. The annual mean temperature is 25 °C and precipitation is 1346 mm. Tropical storms and hurricanes are a major threat every year (West and Augelli, 1977). Figure 1 shows the main agricultural regions affected by whitefly-transmitted begomoviruses.

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

Bemisia tabaci (Gennadius) was first observed attacking common bean in 1975. However, the presence of *Bean golden yellow mosaic virus* (BGYMV) in the Dominican Republic had been noticed as early as the late 1960s (Schieber, 1970). By 1988, other crops such as tomato (*Lycopersicon esculentum* Mill.), melon (*Cucumis melo* L.), eggplant (*Solanum melongena* L.), cucumber (*Cucumis sativus* L. var. *sativus*) and watermelon (*Citrullus lanatus* [Thunb.] Matsum. & Nakai) were under attack from *B. tabaci*. In 1991, biotype B of *B. tabaci* made its appearance in the main horticultural regions of the Dominican Republic. At the same time, the first begomovirus from the Old World, *Tomato yellow leaf curl virus* (TYLCV) was irresponsibly introduced into the Dominican Republic and the Americas. Following the introduction of a new and more aggressive biotype of the whitefly vector and an exotic begomovirus, crops such as tomato and melon practically disappeared, and the tomato processing plants had to close down in certain areas.

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

Advances in Biological Research

The first begomovirus of economic importance to be characterized at the molecular level in the Dominican Republic was BGYMV. This virus was isolated in the early 1990s by the senior author and later shown to be molecularly and serologically related to the Guatemalan isolate of BGYMV (Faria et al., 1994; Cancino et al., 1995). The BGYMV isolate from the Dominican Republic (San Juan de la Maguana) proved to be similar to BGYMV isolates from the Caribbean (Puerto Rica) and Central America (Guatemala). The BGYMV isolate from the Dominican Republic was shown to be a different species when compared with *Bean golden mosaic virus* (BGMV) from Brazil. BGYMV affects over 20,000 ha of common bean in the Dominican Republic each year, particularly in the south-western valley of San Juan de la Maguana. The presence of a begomovirus infecting tomatoes in the Dominican Republic was first noticed in 1992 and subsequently identified as TYLCV from Israel (Polston et al., 1994; Polston and Anderson, 1997). The introduction of an exotic begomovirus from the Old World created a major pandemic throughout the Caribbean at a cost to tomato growers and tomato processing plants worth millions of US dollars in yield/export losses (Dupuy, 1998).

At the beginning of this project, in April 1997, common bean samples were collected in San Juan de la Maguana and tomato samples in Azua, in south-western Dominican Republic. The common bean samples reacted with the broad-spectrum monoclonal antibody 3F7 as well as with the monoclonal antibody prepared to the Guatemalan isolate of BGYMV. However, the tomato samples did not react against the broad-spectrum

monoclonal antibody (MAB) in these tests. These tomato samples were then assayed by polymerase chain reaction (PCR) using two sets of primers (PTYIRV21/PTYIRC287 and PTYIRV21/RTYC2C1814) to TYLCV provided by Dr. M. Nakhla, Plant Pathology Department of the University of Wisconsin, Madison, WI. These primers amplified two fragments of M_r 287 and 1793 pb, respectively, demonstrating the presence of TYLCV in the tomato plants sampled in Azua.

In February 1998, six more tomato samples from Azua and one from the northern locality of Santiago were assayed with similar results (Table 1), demonstrating the endemic nature of TYLCV in the Dominican Republic. The three tomato samples (9-11) from the Centro de Investigaciones Aplicadas a Zonas Áridas (CIAZA), Azua, corresponded to TYLCV-tolerant tomato varieties (Gem-Pear, Gem-Star and UC82), which produce acceptably in this locality.

The common bean samples from the valley of San Juan de la Maguana behaved as expected for the BGYMV isolates previously detected in this locality. The presence of BGYMV in the Constanza Valley is interesting, because it is located at altitudes between 1000 and 1100 m, above the altitudinal range (0-950 m) at which *B. tabaci* is usually a problem. However, the incidence of the virus was moderate in the Constanza Valley.

Socio-economic Analysis

The agriculture of the Dominican Republic was described in the 1970s as a mixture of traditional and modern cropping systems. Traditional agriculture was equivalent to "subsistence" agriculture and included crops such as common bean, cassava (*Manihot esculenta* Crantz), rice, sweetpotato (*Ipomoea batatas* [L.] Lam.), pigeon pea (*Cajanus cajan* [L.] Millsp.) and taro (*Colocasia esculenta*

Table 1. Analyses of selected plant samples from the Dominican Republic.

Sample	Plant	Locality[a]	MAB-BS[b]	MAB-GA[c]	PTY1[d]	TYLCV[e]
1	Common bean	San Juan	+	+	-	nt
2	Common bean	San Juan	-	-	-	-
3	Common bean	Constanza	+	+	-	nt
4	Common bean	Constanza	+	+	-	nt
5	Garlic	Constanza	nt	nt	+	nt
6	Tomato	Azua	-	nt	nt	+
7	Tomato	Azua	-	nt	nt	+
8	Tomato	Azua	-	nt	nt	+
9	Tomato	CIAZA-Azua	-	nt	nt	+
10	Tomato	CIAZA-Azua	-	nt	nt	+
11	Tomato	CIAZA-Azua	-	nt	nt	+
12	Tomato	Santiago	-	nt	nt	+
13	Tomato	Santiago	-	nt	nt	+

a. CIAZA, Centro de Investigaciones Aplicadas a Zonas Áridas.
b. MAB-BS, a broad spectrum monoclonal antibody used to detect bi-partite begomoviruses.
c. MAB-GA, a monoclonal antibody used to detect the original Middle American isolates of *Bean golden yellow mosaic virus*-Guatemala; and nt, no tests for these samples.
d. PTYI, monoclonal antibodies to detect potyviruses; and nt, no tests for these samples.
e. TYLCV, polymerase chain reaction detection of *Tomato yellow leaf curl virus*; and nt, no test for these samples.

[L.] Schott). Modern agriculture was equivalent to the "plantation" agriculture going back to colonial times, represented mostly by the extensive cultivation of sugarcane (*Saccharum officinarum* L.). In 1970, sugarcane was the main agro-industry of the country, occupying over 150,000 ha.

In 1966, a Land Reform Programme began to be implemented in the Dominican Republic. Large-scale farming in the form of co-operatives began to take place with the support of the government, the financial contribution of international agencies —for example the Agency for International Development (AID)—and the technical support of third countries. The Sisal Project, for instance, was created at that time with the help of the Government of Israel. The objective of the project was to produce tomato under irrigation in the valley of Azua. The irrigation system was initiated in 1970 with the construction of the Sabana Yegua Dam to irrigate some 18,000 ha. Thus, the Dominican Republic was one of the first countries in Latin America to look into the possibility of producing non-traditional, high-value crops for export such as tomato, chilli (*Capsicum annuum* L. var. *annuum*), melon, watermelon and eggplant. In 1970, 1600 ha of tomato were planted in the Dominican Republic. In the late 1990s, the tomato industry covered 8000 ha, employed over 6500 small-scale farmers (farms averaging less than 2.5 ha) and created jobs for 90,000 people per crop cycle (Dupuy, 1998).

The arrival of TYLCV from Israel and biotype B of *B. tabaci* brought the thriving tomato industry to a halt, causing economic losses in excess of 30 million US dollars. Table 2 shows the yield losses in the production of industrial tomato for the two main production areas, Azua and Cibao, between 1988 and 1995 (Alvarez and Abud-Antún, 1995). This crisis was managed through the adoption of legal measures that included a 3-month crop-free period to break the cycle of the whitefly vector. Additionally, virus-resistant tomato cultivars were introduced.

Table 2. Yield losses (%) caused by whitefly/begomovirus damage to industrial tomatoes in the main tomato producing regions of the Dominican Republic.

Cropping season	Region	
	Azua	Cibao
1988-89	25	5
1989-90	45	10
1990-91	40	15
1991-92	30	15
1992-93	80	80
1993-94	95	50
1994-95	20	15

Following the implementation of legal measures against *B. tabaci*, the melon industry made a comeback. The case of common bean was not promising, because this crop was being displaced from the traditional bean-growing areas such as the valley of San Juan de la Maguana by other crops without whitefly problems and in higher demand, including cassava and sweetpotato. In 1984, there were 63,000 ha of red-seeded bean in the country and in 1994 the area planted to common bean is only 36,000 ha, almost half of the area planted 15 years ago. As a result, the country has had to import common bean, usually grain types of little demand in the country, considering that red-seeded bean is the main food staple in the diet of the Dominicans (Fundación de Desarrollo Agropecuario, 1995).

Strengthened Research Capacity

Considering that the two main horticultural regions affected by whiteflies and whitefly-transmitted geminiviruses in the Dominican Republic are Azua and Cibao, two Agricultural Engineers were contacted to collaborate in this project. They were Augusto Villar of the Secretaría del Estado de Agricultura (SEA)-CIAZA, Azua, and Emigdio Gómez of SEA-Programa Nacional de Manejo Integrado de Plagas (MIP), N-N.W. Cibao. These national programme scientists were brought to the Centro Internacional de Agricultura Tropical (CIAT) for training in the identification of *B. tabaci* biotypes and diagnosis of viruses affecting crops of socio-economic importance in their respective agricultural regions. Table 3 shows the results obtained by these two researchers at CIAT with the whitefly samples they collected in the Dominican Republic.

The two researchers were trained also in the identification of geminiviruses and other plant viruses using the enzyme-linked immunosorbent assay (ELISA) technique in conjunction with the utilization of monoclonal and polyclonal antibodies and financed by the project to attend the International Workshop on *Bemisia* and Geminiviruses, held in San Juan, Puerto Rico, June 1998. Here they presented the novel approach adopted in the Dominican Republic to control whitefly/begomovirus damage by regulatory measures designed to break the continuous populational cycle of *B. tabaci* in tropical environments.

The project also supported the activities of several researchers on horticultural crops in the Constanza Valley, in the central region of the country, in collaboration with the horticultural research network, La Red Colaborativa de Investigación y Desarrollo de Hortalizas para América Central, Panamá y República Dominicana (REDCAHOR). Two conferences were delivered on the Tropical Whitefly Integrated Pest Management (TWF-IPM) Project and on the breeding and selection of horticultural crops for their resistance to whitefly-transmitted begomoviruses. The CIAT Bean Project is collaborating with the Dominican Republic to breed Dominican bean cultivars, mainly the Pompadour types, for resistance to BGYMV.

Table 3. Results of the analyses of *Bemisia* spp. biotypes found in the Dominican Republic on different economically important crops.

Locality	Crop	No. samples	Whitefly
Azua-CIAZA[a]	Eggplant	3	*Bemisia tuberculata*
Azua-Estebanía	Tomato	9	*Bemisia tabaci*-B
Barahona	Eggplant	3	*Bemisia tuberculata*
Azua-Arroyo Salado	Eggplant	3	*Bemisia tuberculata*
San José de Ocoa	Tomato	6	*Bemisia tabaci*-B
Santiago	Okra	3	*Bemisia tabaci*-B
Santiago	Cucumber	3	*Bemisia tabaci*-B
Santiago	Eggplant	3	*Bemisia tabaci*-B
Montecristi	Melon	6	*Bemisia tabaci*-B
Santiago	Tomato	3	*Bemisia tabaci*-B
Santiago	Okra	3	*Bemisia tabaci*-B

a. CIAZA, Centro de Investigaciones Aplicadas a Zonas Áridas.

Current Situation of Whitefly/Geminivirus Problems

The Dominican Republic constitutes a unique example of a country that implemented legal measures to minimize yield losses due to the activity of *B. tabaci* both as a pest and virus vector. Nevertheless, pesticide use remains high in most agricultural regions of the country, and the existing cropping systems favour the reproduction of *B. tabaci*. Currently, the situation in the lowlands and highlands remains under partial control, and some crops that had been taken out of production such as melon are being planted again. Another crop and good host to the whitefly *B. tabaci*, tobacco, also has been increasing its area in the country. A recent viral epidemic in tobacco in the Cibao region was diagnosed at CIAT as being caused by *Tobacco mosaic virus*.

In the case of tomato, the cultivation of varieties resistant to TYLCV should contribute to the recovery of the production of industrial tomato plantings. In the case of common bean, however, we have noticed a marked reduction in the area planted, because of the susceptibility of most local varieties to BGYMV. Moreover, TYLCV has been reported to attack common bean in other parts of the world (Navas-Castillo et al., 1999).

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