CHAPTER 3.6

Nicaragua

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Introduction

Geographical context

Nicaragua is the largest country in Central America and one of its richest nations in terms of agricultural resources. Its agricultural economy follows the natural divisions of the country: the Pacific region, the northern part of the Central Highlands and the lowlands of the Caribbean. The Pacific region has been Nicaragua's centre of commercial agriculture since colonial times, when livestock and the production of indigo (blue dye) were two of the main commodities. Livestock production still remains an important activity in this region. Cotton (*Gossypium hirsutum* L.) became a highly important crop in the Pacific lowlands, between Lake Managua and the Gulf of Fonseca (Chinandega to León) and along the eastern side of Lake Managua (Tipitapa) in the early 1950s. By 1977, Nicaragua was the largest (217,000 ha) producer of cotton in Central America (Gill, 1994).

As in the rest of Central America, there are a number of fertile mid-altitude valleys in Nicaragua such as Boaco and Sébaco where a more intensive agriculture eventually developed, consisting of non-traditional crops such as tomato (*Lycopersicon esculentum* Mill.), pepper (*Capsicum* spp. L.) and other horticultural crops. Common bean (*Phaseolus vulgaris* L.) remains a major staple and consequently is grown throughout the country. However, the main regions producing common bean are the Pacific region (30% of total production), the Central Highlands (50%) and the Caribbean Plains (10%). In the highlands, the main departments producing common bean are Matagalpa, Jinotega, Estelí, Madriz and Nueva Segovia. 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) first became a pest of cotton in the 1970s, which together with adverse marketing circumstances reduced the area planted to cotton to a mere 2520 ha in 1993. Interestingly, *B. tabaci* was not an insect of economic significance in the early years of cotton production in Nicaragua. The emergence of this whitefly species as a major pest of cotton followed the introduction and intensive use of pesticides on this crop in the 1960s (Gill, 1994).

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

Bean golden yellow mosaic virus (BGYMV) was first observed affecting common bean in the Pacific Coast of Nicaragua, around 1971. BGYMV is particularly severe in Estelí, Nueva Segovia, León, Chinandega and the lowlands of Matagalpa (Llano et al., 1997). Large populations of *B. tabaci* have been reported on cotton in the Pacific Coast of Nicaragua since 1952, and from tomato in the Atlantic Coast as early as 1953 (Hidalgo et al., 1975). This whitefly species was the third most important pest problem in cotton in Nicaragua in the late 1970s (Kramer, 1966). The whitefly problem became so serious that, in 1975, Nicaragua created a special commission to study *B. tabaci* and make recommendations on research and whitefly management (Hildago et al., 1975).

Mid-altitude valleys such as Sébaco (Matagalpa Department) witnessed the emergence of whitefly-transmitted viruses in 1986. By 1992, yield losses reached 100% in several tomato fields affected by what growers referred to as "*crespo*" (leaf curl). In 1991, large populations of whiteflies attacked common bean and melon (*Cucumis melo* L.) but only bean was affected by begomoviruses. Whitefly-transmitted begomoviruses also attacked pepper and tomato plantings in the Central Highlands. Tomato plantings were affected in the region of Boaco in 1991. The same year, *B. tabaci* attacked tobacco (*Nicotiana tabacum* L.) plantings in the departments of Nueva Segovia, Jinotega, Estelí, Chinandega, Masaya and Rivas. The melon industry in the departments of León, Rivas, Managua and Matagalpa was first affected by whiteflies in 1991 but the incidence of viruses was low (Sediles, 1998).

Advances in Biological Research

No records exist of serological identification of BGYMV in Nicaragua prior to 1995. In 1993, a few common bean and tomato samples were collected near the town of Santa Lucía in the Boaco Valley. The common bean samples were taken from plants showing dwarfing symptoms, rather than mosaic. These samples reacted positively with the broad spectrum monoclonal antibody that detects whitefly-transmitted begomoviruses in general (MAB-BS). The virus was later identified as *Bean dwarf mosaic virus* (BDMV) by nucleic acid hybridization methods (Zamora 1996). At that time, and from the same locality, samples collected from tomato plants affected by *crespo* disease also gave positive results in serological assays with the same monoclonal antibody. The *crespo* disease of tomato was first observed in Nicaragua in 1986. An in-depth investigation conducted in 2000 showed that tomato in Nicaragua is infected by at least four distinct begomoviruses (Rojas et al., 2000).

In 1995, three BGYMV-affected common bean samples from the north-western department of Estelí were tested

with the monoclonal antibody used to detect the original Middle American isolates of BGYMV-Guatemala (MAB-GA), available at the Centro Internacional de Agricultura Tropical (CIAT). The three common bean samples reacted with the MAB-BS but only one common bean sample was recognized by the specific MAB-GA.

A survey in the departments of Estelí (Condega), Matagalpa (Apompua and Sébaco) and Managua (Managua and Pochocoape) was undertaken to collect plant samples for virus assay. Table 1 gives the results of this survey, which show a rather low incidence of whitefly-transmitted geminiviruses (GV) in the samples tested. However, the sampling was done at the peak of the rainy season, which, for the second time since Hurricane Mitch in the previous year, brought considerable amounts of rain. Rainfall in 1999 almost doubled the amount of rain recorded in 1998 in the Pacific

Table 1. Results of survey of virus-affected plants in three departments of Nicaragua.

Sample	Crop	Locality	Department	Reaction[a]	
				MAB-BS	PTY1
1-N5	Tomato	Condega	Estelí	-	-
2-N5	Tomato	Condega		+ / -	-
3-N5	Tomato	Condega		-	-
4-N5	Tomato	Condega		+	-
5-N5	Tomato	Condega		-	-
6-N5	Tomato	Condega		-	-
7-N6	Tomato	Apompua	Matagalpa	-	-
8-N6	Tomato	Apompua		-	-
9-N6	Tomato	Apompua		-	-
10-N6	Tomato	Apompua		-	-
11-N6	Tomato	Apompua		-	-
12-N6	Tomato	Apompua		-	-
13-N7	Tomato	Managua	Managua	-	-
14-N7	Tomato	Managua		-	-
15-N7	Tomato	Managua		-	-
16-N7	Tomato	Managua		-	-
17-N8	Tomato	Sébaco	Matagalpa	-	-
18-N8	Tomato	Sébaco		-	-
19-N9	Tomato	Pochocoape	Managua	-	-
20-N9	Tomato	Pochocoape		-	-
21-N9	Tomato	Pochocoape		-	-
22-N9	Tomato	Pochocoape		-	-
23-N9	Tomato	Pochocoape		-	-
24-N9	Tomato	Pochocoape		-	-
25-N10	*Pipián*	Apompua	Matagalpa	+	+
26-N10	*Pipián*	Apompua		+	+
27-N10	*Pipián*	Apompua		+	+
28-N11	Tomato	Sébaco	Matagalpa	-	-
29-N11	Tomato	Sébaco		-	-
30-N11	Tomato	Sébaco		-	-
31-N11	Tomato	Sébaco		-	-
32-N11	Tomato	Sébaco		-	-
33-N11	Tomato	Sébaco		-	-
34-N11	Tomato	Sébaco		-	-
35-N12	Tomato	Apompua	Matagalpa	-	-
36-N12	Tomato	Apompua		-	-

a. Positive or negative reactions to a broad spectrum monoclonal antibody used to detect bi-partite begomoviruses (MAB-BS); reactions to a potyvirus-specific monoclonal antibody (PTY1).

Lowlands of Nicaragua. The presence of begomoviruses in *pipián* (*Cucurbita argyrosperma* C. Huber subsp. *argyrosperma*) is interesting, considering that this crop had not been recorded previously as an important host/reservoir of begomoviruses. However, the same observation was made in El Salvador and, furthermore, this cucurbit was also doubly infected with aphid-transmitted potyviruses in both countries.

Because of the rainy conditions that affected Nicaragua in 1998 and 1999, very few whitefly samples could be taken for analyses. Table 2 summarizes some of the preliminary results obtained. Although representing only a limited sample, results are taken from one of the main horticultural valleys of Nicaragua and, consequently, are interesting in that they show a predominance of the original biotype A.

Table 2. Results of *Bemisia tabaci* biotyping analyses performed on 15 samples of whiteflies from Apompua and Sébaco, department of Matagalpa, Nicaragua.

Sample code	Biotype A	Other
N2	4	1
N3	5	-
N4	5	-

Socio-economic Analysis

Common bean is one of the two main food staples, together with maize (*Zea mays* L.), being grown on about 140,000 ha. However, productivity is low (about 450 kg/ha) because 80% of the national production takes place on farms of less than 3 ha. The new economic policies that followed the economic crisis of the 1970s have gradually led to the displacement of traditional food crops from most of the fertile valleys in Central America in order to make room for high-value, non-traditional export crops such as tomato, pepper and melon. As a result, there is a higher demand for traditional crops such as common bean in the region. Nicaragua could take advantage of its relatively larger agricultural area to capture the increased regional demand for food staples.

Horticultural crops such as tomato and pepper have been cultivated in Nicaragua mainly to meet local demand. The area planted to tomato has doubled in the past 30 years from 350 to 750 ha, whereas in Guatemala, tomato production grew from 5000 ha in 1960 to 12,000 ha in 1970. In 1986, tomato plantings in the Sébaco Valley, Matagalpa Department, suffered unusual infestations of the whitefly *B. tabaci* and, soon after, the emergence of viral diseases associated with the whitefly outbreak. By 1991, tomato production in the Sébaco Valley had been reduced 20%-50% because of yield losses ranging between 30%-100% (Sediles, 1998). A similar situation was observed for pepper plantings, which in 1991-92, reported yield losses between 30%-50%. Melon, another non-traditional crop grown mostly for export, was beginning to experience whitefly-related problems. However, there was no significant incidence of begomoviruses in this crop.

The whitefly problem on tomato became so severe that it prompted the creation of an inter-institutional tomato group composed of CATIE/MAG-MIP–NORAD-ASDI (for full names, see Acronyms list on page 345), which organized the first national meeting of tomato producers in April 1994. Tomato growers met to discuss whitefly management strategies with the technical organizing group (Grupo

Interinstitucional e Interdisciplinario de Tomate-GIIT). In June 1995, a second meeting took place in Santa Emilia, Matagalpa, with 24 producers representing 16 tomato-growing regions of Nicaragua, where the whitefly is a limiting factor to tomato production. In these meetings, tomato farmers became aware of the consequences of abusing pesticides as well as of the existence of integrated pest management practices (live barriers, yellow traps and organic insecticides). An outcome of the meeting was the creation of the Nicaraguan Tomato Growers Association, which is responsible for the sustainability of tomato production in Nicaragua.

Strengthened Research Capacity

The Universidad Nacional Agraria (UNA) located in Managua, the capital of Nicaragua, was selected as the main collaborating institution. The national program and the Ministry of Agriculture of Nicaragua, already have the substantial financial support of international organizations. The financial support to UNA permitted a general evaluation of the whitefly situation in the six administrative regions of Nicaragua described below.

Region I includes the north-western departments of Nueva Segovia, Madriz and Estelí. In this region, there are valleys and plateaus with altitudes ranging between 500 and 1000 m and a variety of food crops such as bean, tomato, cucurbits, tobacco and pepper, which attract whiteflies. The whitefly population peak occurs in the period November-May.

Region II includes the south-western departments of León and Chinandega and agricultural lowlands below 500 m. The region is formed by the hot Pacific Plains, where cotton production took place in past decades. The whitefly *B. tabaci* became a limiting biotic problem for cotton production and the region has moved on to new crops: tomato, watermelon (*Citrullus lanatus* [Thunb.] Matsum. & Nakai), squash (*Cucurbita* spp. L.), pepper, melon and traditional ones as well such as common bean and tobacco. Soybean (*Glycine max* [L.] Merr.), peanut (*Arachis hypogaea* L.) and cassava (*Manihot esculenta* Crantz) are other crops infested by whiteflies in this region. Whitefly population peaks occur in January and February.

Region III consists of Managua Department and two vegetable production zones, the coastal area of Lake Managua located north of the city of Managua and the zone of Pochocuape, south of Managua. Here, whiteflies attack tomato, squash, watermelon, common bean and tobacco and most of these crops are attacked also by begomoviruses.

Region IV includes the departments of Carazo, Granada, Masaya and Rivas, which form the southernmost portion of the Pacific Lowlands. At these low altitudes, the whitefly *B. tabaci* thrives, severely attacking tomato and tobacco and, to a lesser extent, watermelon, squash, common bean, pepper and melon. The main whitefly peak occurs in January and February.

Region V is formed by the departments of Boaco and Chontales. Although this area has been devoted primarily to livestock, there are some parts such as Santa Lucía, Boaco, where bean and tomato traditionally have been planted. These crops have been affected by whitefly-transmitted begomoviruses since the mid 1980s, particularly by BGYMV (common bean) and by the *crespo* disease in the case of tomato.

Region VI is a main horticultural area of Nicaragua, particularly the Sébaco Valley, in the department of Matagalpa. The second department that forms this region, Jinotega, lies further north, bordering Honduras. The tomato crop in this region has been affected severely by whitefly-borne begomoviruses, to the point that some farmers have abandoned this crop, particularly in the southern part of the Sébaco Valley. Large whitefly populations and viral symptoms also affected cucurbits such as squash, pumpkin (*Cucurbita* spp. L.) and cucumber (*Cucumis sativus* L. var. *sativus*).

It is evident that whiteflies and *B. tabaci*-transmitted viruses affect all of the agricultural regions of Nicaragua. Nicaraguan agricultural research institutions have come together to reach affected farmers and manage the whitefly problem in a highly exemplary manner. The integrated pest management projects developed in Nicaragua with the collaboration of international and national institutions have recovered some of the most affected agricultural areas for the production of traditional (e.g., common bean) and non-traditional (e.g., tomato) crops. It is expected that the scientific knowledge generated in these projects will contribute to the implementation of more effective measures to control whiteflies and the viruses they transmit in Nicaragua and Middle America.

Current Status of Whitefly/Begomovirus Problems

Most of the whitefly/begomovirus problems in Nicaragua occur in the western half of the country, mainly because this region concentrates most of the country's population. The eastern half of Nicaragua (the Caribbean Plains) is only cultivated to a minor extent with, for example, banana (*Musa* spp. L.), rice (*Oryza sativa* L.) and oil palm (*Elaeis guineensis* Jacq.), because it is one of the rainiest regions in Central America. This climatic factor is a major deterrent for the whitefly *B. tabaci* and for the establishment of its main plant hosts. The Pacific Lowlands, on the other hand, experience several dry months without significant rainfall and thus possess all the necessary conditions for the whitefly *B. tabaci* to thrive, including the presence of good breeding hosts such as cotton. Moreover, as in the rest of Central America, most horticultural crops are located in mid-altitude (200-1000 m) valleys created by the mountain ranges that make up the central and northern regions of Nicaragua. Valleys such as the Sébaco, Matagalpa Department (450 m) constitute an example of a locality with a high incidence of *B. tabaci* and begomoviruses, because of the favourable environmental conditions for the pest and the presence of susceptible horticultural crops, some of which also act as suitable reproductive hosts for *B. tabaci*.

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